Go with the Flow: Model Rivers

Science Film Festival Knowledge Through Entertainment

Science Film Festival Film

Earth: The Nature of Our Planet – Episode 03: Water

Introduction

Have you ever played in the terrain of your backyard, pouring water over dirt and rocks to create little rivers that eventually flow into a gully or gutter? You might know that water is a major element shaping the landscape around us. Think of the devastation after a flood or the destructive power of a tsunami. Water also shapes and reshapes the landscape in a much slower way, gradually over long periods of time. Water comes from rainfall and snowmelt. Some water soaks into the ground. The rest flows across the land as runoff into rivers, streams, and lakes. On its way, water erodes the land and drags sediment and debris with it. Not all sediments are equal. Scientists classify sediment based on its grain size, all the way from giant boulders to pebbles, gravel, sand, silt, clay, and colloid. In a colloid, the grain size is microscopically small.

Why is this classification of sediments important? One reason is that water with more speed, or fast-running water, has more energy and can carry bigger, heavier sediments with it. Some of the sediment sinks and settles out on the ground. This can leave self-organized structures behind like ripples or dunes on the beach or on riverbeds. When water from rainfall and snowmelt accumulates too quickly for the ground to absorb or the rivers to carry away, flooding happens. This type of flooding is called alluvial flooding, or river-based flooding. The flooded water retreats slowly or is absorbed by the ground, leaving sediments behind. Although water tends to accumulate at the lowest point, it does not always take a straight path there. Some water will meander. Braided rivers have several small channels separated by often temporary islands. Hydrologists use models in addition to outdoor observation to gather information. Models are simplified representations of an object in the real world. Some models exist on the computer, others are physical replicas. Both are handy tools to study rivers.

In this geology science project, you will build a model that represents a river in the real world. Your model will act the same as a river in nature in important ways. You will change the speed at which water runs in your river and observe how this affects other characteristics like the width of the riverbed, if and where deposits are formed or whether or not flooding occurs.

Key Objectives

- To understand what function rivers have in the water cycle.
- To understand how rivers shape the land and what major processes take place.
- To be able to identify other natural formations formed by water.
- To understand why models are handy tools for hydrologists.

Materials

- Empty milk/water jugs, 1-gallon size (4)
- Utility knife or box cutter
- Permanent marker
- Area with small slope that is OK to get messy (at least 16 by 20 inches).
  Some examples are:
  - Sloped area in a larger sandbox, suggested dimension 20 inches long, 16 inches wide, and a slope of about 4 inches high.
  - A brick or big block under one side of a movable sandbox to obtain a 4-inch slope.
  - A driveway with a slight slope equivalent to 5 inches over a length of about 2 feet.

Advanced

Resource Type
Project

Topics
Alluvial flooding | Erosion | Water cycle

Subjects
Geology | Earth Science

Keywords
Water | Rivers | Riverbed | Sediment | Hydrologist | Colloid | Debris

Time For Activity
45 – 60 minutes

Safety Instructions

Adult help is required to cut the water or milk jugs.

Go with the Flow: Model Rivers

- Plastic sheet or tarp (20 by 22 inches)
- Sand (25 pounds)
- Dowel, diameter approximately 1 inch, length between 10 and 20 inches. Any sturdy material is fine: PVC, wood, or the inner cardboard roll from a roll of paper towels work well.
- Ruler
- Pencil (3) or drinking straws (3)
- Cornmeal (16 pounds)
- Video and/or photo camera (optional)
- Water from household or garden tap
- Volunteer or helper (can be the same as the adult helper)
- Notebook
- Pen or pencil

Guiding Questions

1. **What function do rivers have in the water cycle?**
2. **How do rivers shape the land? What major processes take place?**
3. **Can you find other natural formations formed by water?**
4. **Why are models handy tools for hydrologists?**

Tasks/Steps

Prepare Your Work Area and Tools

1. **Prepare your jugs.**
   - a. Have an adult remove the tops of the four jugs. This enables you to pour water easily in and out of the jug.
   - b. Have an adult to cut a small triangular hole near the bottom of the first jug. The sides of this triangle should be between ¼ and ½ inch long and the horizontal line of the triangle should more or less align with where the bottom of the jug touches the ground when standing.
   - c. Have an adult to cut a medium triangular hole near the bottom of the second jug. This time, the sides of the triangle should be about ¾ inch long.
   - d. Have an adult to cut a large triangular hole near the bottom of the third jug. This time, the sides of the triangle should be about 1-¼ inches long.
   - e. The fourth jug will be used as a watering can. Using a permanent marker, draw a line where this jug is approximately ¾ full. (Note: You will want to be more exact here if you plan on making quantitative measurements of water flow speed. Fill the jug with ¾ of a gallon of water (12 cups) and mark this water level with permanent marker on the jug.) This way - you will know you used exactly ¾ gallon for each river. Measuring the time it takes for the ¾ gallon of water to flow will allow you to calculate the water speed in gallons per seconds.
2. **Prepare your work area.**
   - a. Cover your work area with the big plastic sheet or tarp. This will make cleanup easy.
   - b. Flatten the plastic as much as possible.

Go with the Flow: Model Rivers

c. Spread sand evenly over the plastic, covering an area about 16 inches wide by 20 inches long with a layer of sand roughly 1 inch thick. The 20 inch length should be on a downhill slope. In total there should be a change of 4 inches in height over the length of he area.

d. Use your dowel to spread and flatten the sand.

e. Push the dowel in the sand to make three riverbeds.

f. Create three riverbeds parallel to each other, leaving about 4 inches of space between them. Start about 2 inches from the side of your workspace.

g. Push the dowel in the sand so approximately half of the dowel is in the sand. This creates riverbeds of about ½ inch deep at the deepest point.

h. Put a pencil (or drinking straw) at the end of each riverbed so you remember where the riverbeds are once you cover the area with cornmeal.

3. Create a top layer of cornmeal.

a. Cut a small hole in the cornmeal bag.

b. Spread the cornmeal over the sand by shaking the bag. Try to pour an equal amount of cornmeal over the whole work area. This layer should be between ½ and 1 inch thick. Make sure you leave at least 4 pounds (or a fourth) of the cornmeal remaining for future testing.

c. Use your dowel to spread and flatten the layer of cornmeal.

d. Push your dowel at the same locations where you had the sand riverbeds to re-create those riverbeds. The pencils (or drinking straw) sticking up at one end will indicate where the riverbeds are.

e. Use step 2g as a guide. Riverbeds will be about ½ inch deep.

f. You can use a camera to take pictures of your riverbeds to go on your science fair project display board.

Let the Rivers Run

Time to let the water flow! You will pour an equal amount of water on each model riverbed, but the water will run at different speeds, depending on the size of the hole cut in the bottom of the jug. You will start with the slow-running river (the jug with the smallest hole) and move on to the medium- and fast-running rivers as you move from one riverbed model to the next.

If you would like to be more quantitative about how fast each river is flowing then try timing how long it takes for each jug to empty. You can report the flow rate as the number of gallons per second.

1. In your lab notebook, create a table like below. You will use it to record your observations.

	Slow-flowing River	Medium-flowing River	Fast-flowing River
Observations While Water Flows			
Evidence Seen in Riverbed after Water Flows			

Go with the Flow: Model Rivers

2. If you plan on taking a video of your project, get everything ready for videotaping.

3. Position the jug with the smallest hole and the jug you will use as a watering can near the first model riverbed. To model the slow flowing river.

4. Fill the watering can up to the ¾ line.

5. Let the river run:

   a. Hold the jug with the hole hovering over the end of the first model riverbed. The hole should be aligned with the riverbed.

      - If you have the space and extra sand to create a stable platform to put your jug down, you can do so. But if you do, make sure you create platforms of the same height for the three different river models.
      - If you need to hold your jug a little higher because the edge of your sandbox is in the way, do so. But be sure to keep the jugs at the same height as you let the water run in the three different river models.

   b. Let a helper pour the water from the watering can in the jug, being sure that he or she pours the water in without stopping and interrupting the water flow into the model riverbed.

   c. If you choose to videotape your project, begin filming now.

6. Note any observations about what happened while the river was flowing in Table 1. Here some things to look for:

   a. Did you observe any braiding, meandering, or flooding while the water flows?

   b. Were islands created by the water in your river model? Did they stay the entire time, or get washed away?

   c. Did the banks of your river hold firm or break down? If they broke down, did it happen gradually or suddenly?

   d. Do you see evidence of what happened in the riverbed after water flows?

7. Repeat steps 4 through 6 for the jug with the medium hole (medium-flowing river) and the second riverbed model.

8. Repeat steps 4 through 6 for the jug with the large hole (fast-flowing river) and the third riverbed model.

9. You can use a camera to take a new picture of your new riverbeds to go on your project display board.

10. Measure how wide the riverbeds are at 5-inch intervals. Create a table like below in your lab notebook. You will use it to record your measurements.

Distance from Source	Slow-Flowing River		Medium-Flowing River		Fast-Flowing River	
	Width (inches)	Observations	Width (inches)	Observations	Width (inches)	Observations
0 inch						
5 inch						
10 inch						
15 inch						
20 inch						

Go with the Flow: Model Rivers

a. Measure the width of the riverbeds at 5-inch intervals, starting from the source (or the place where you held the jug with the hole).

b. Note all your measurements in your table.

c. Add any further observations about erosion and sedimentation you observe. Some things to look for are:

- Visible sand on the riverbed shows the cornmeal bed has completely eroded away.
- Pockets of cornmeal in a riverbed that looks completely eroded are a sign of sediment deposit. This is possibly a leftover island of a braided river.
- Widened riverbanks are evidence of erosion.
- Wet areas outside the riverbanks can be signs of flooding.

11. Repeat the experiment on the riverbed models two more times.

a. If any plunge pools were created, fill them with sand. You do not have to fill the sand layer in any other way. (Plunge pools form where vertically falling water touches the ground or the riverbed and the force creates a depression, or pool, of deep water. Plunge pools would typically form if you held your jugs higher than the riverbed.)

b. Add cornmeal to create a new riverbed for each river model.

c. Repeat steps 1 through 10.

12. Clean up your work area.

a. Dispose of all the cornmeal and sand on the plastic sheet or tarp. This material can go to the compost bin or be mixed in with the dirt in your garden. It is not advised to leave the cornmeal in the sandbox as it might attract rodents and other animals.

b. Clean up all your spills, wash out and dispose of the jugs and plastic sheet or tarp in the appropriate recycling bin (if you have one).

Analyze Your Data

1. If you videotaped the experiments, rerun your video.

a. See if your can time how long it takes for the jug to empty in the slow, medium and fast-flowing river using your video. If so, you can use these measurements to calculate the speed of each river by dividing the amount of water used (¾ gallons) by the number of seconds it took for the jug to empty.

b. Look at the details in your video and see if you can complete your observation tables similar to Table 1 in your notebook.

2. Compare your observations and measurements; can you see any trends? Here are some things to look for:

a. Did any of the rivers (slow-, medium-, or fast-flowing) show more/less erosion and/or deposits at specific distances from the source than the other types?

b. Did any of the rivers show evidence of becoming a braided river, a meandering river, or island formation?

c. Did any of the rivers show evidence or flooding or drought (water not reaching the end of the river)?

3. Do your findings match your expectations?

Authors/Source

Science Buddies Staff. (2018, April 28). Go with the Flow: Model Rivers with Cornmeal, Sand, & Water. Retrieved from

→ **https://www.sciencebuddies.org/science-fair-projects/project-ideas/Geo_p045/geology/model-rivers-with-cornmeal-sand-water**