Modeling River Delta Formation

A Carolina Essentials™ Activity

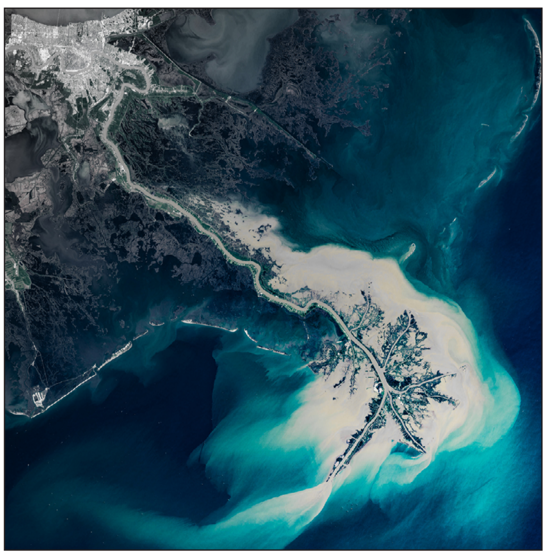
Overview

River delta formation is a great example of how the destructive processes of mechanical weathering and erosion (removal of river sediment) and constructive processes of sediment deposition (delta formation) can be seen over time. This activity prompts students to model the process of delta formation by simulating sediment erosion in non-flood periods and during flood periods where there is a high sediment load. A piece of gutter serves as a stream table, sand is the river channel, and a pan of water represents open water (sea, sound, bay, or gulf). Students manipulate flow rate and sediment load in order to construct a model for delta formation over time.

Earth and Space Science
Grades: 8–12

Phenomenon

Look at the pictures of the Mississippi River delta and the Nile River delta. How can this natural phenomenon be explained?



Mississippi River

Nile River

Essential Question

What effects does moving water have on land surfaces?

Activity Objectives

1. Determine how the sediment load and velocity of water affects the amount of sediment deposited by water.
2. Construct a model to explain what happens when moving water, carrying sediment, meets a large body of water.

TIME REQUIREMENTS

PREP	ACTIVITY
20–30 min	45–60 min

Teacher Prep: 20–30 minutes
Student Activity: 45–60 minutes

SAFETY REQUIREMENTS

MATERIALS

Section of U-shaped or half-round gutter, 3 or 4 ft

Square aluminum pan, 8 or 9 in

Polypropylene beaker with handle, 1,000 mL

Timer or smartphone

White sand (enough to cover the bottom and sides of the gutter)

Spoon

Tap water

Container for sand disposal

HELPFUL LINKS

Urban Stream Syndrome

Assessing Water Quality with Aquatic Macroinvertebrates

Move Your Classroom Outside

REFERENCE KITS

Transformative Properties of Water

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Next Generation Science Standards* (NGSS)

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence.	**ESS2.C: The Roles of Water in Earth's Surface Processes** • The abundance of liquid water on Earth's surface and its physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit light, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.	**Structure and Function** • The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Teacher Preparation and Disposal

Copy or upload the student activity sheets. Purchase the gutter and have it cut into sections. The gutter material doesn't matter—metal or vinyl will work.

Provide a bucket or other container for sand disposal. The sand may be dried and reused. All sand should be returned to the designated container, wet or dry. The gutter, beaker, and aluminum pan should be wiped out with a paper towel. Do not flush sand down the sink drain.

Student Procedure

Flow Rate

1. Line the gutter with sand. Cover the bottom and at least halfway up the sides. You may want to moisten the sand with a little water so it packs.
2. The gutter needs to drain into the aluminum pan. Place books or notebooks under the lower end of the gutter until it clears the side of the aluminum pan. With books or notebooks, raise the other end 3 to 4 inches so the gutter is sloped toward the pan.
3. Cover the bottom of the pan with about $^1/_4$ inch of water.
4. Fill the beaker with 1,000 mL of water.
5. Pour the 1,000 mL of water into the gutter over a 20 second interval.
6. Let the water and sand settle and sketch the results.
7. Pour the water out of the pan, leaving as much sand as possible. Do not pour sand down the sink drain.
8. Repeat the procedure from steps 3 to 7 with 1,000 mL of water but change the time to 10 seconds.
9. Repeat again but change the time to 5 seconds.

Teacher Preparation and Tips

Remind students to completely cover the bottom and sides of the gutter. Pat the sand in tightly.

To save time, place students in groups. Assign one group the plain water and the other group the sand/water mix. Students should share their results.

Students can use smartphones to keep the pour time.

Have a container available to collect the sand.

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Student Procedure continued

Sediment Load

1. Reline the gutter with sand by covering the bottom and at least halfway up the sides.
2. The gutter needs to drain into the square aluminum pan. Place books or notebooks under the lower end of the gutter until it clears the side of the aluminum pan. With books or notebooks, raise the other end 3 to 4 inches so the gutter is sloped toward the pan.
3. Cover the bottom of the pan with about $^1/_4$ inch of water.
4. Fill the beaker with 1,000 mL of water and stir in 100 mL of sand.
5. Pour the 1,000 mL of water and sand into the gutter over a 20 second interval.
6. Let the water and sand settle and sketch the results.
7. Pour the water out of the pan, leaving as much sand as possible. Do not pour sand down the sink drain.
8. Repeat the procedure from steps 3 to 7 with 1,000 mL of water but change the time to 10 seconds.
9. Repeat again but change the time to 5 seconds.

Teacher Preparation and Tips

Data and Observations

Sketch the result of each trial.

The sand that the running water picks up will be left near the end of the gutter. As the flow rate increases, it should wash down more sediment. The mix of water and sand should produce more deposition than the water alone.

Analysis

1. Calculate the volume of water per unit of time for the 6 trials. This is flow rate (mL/s).

   Flow rate = volume/time = 1,000 mL/20 s = 50 mL/s, 1,000 mL/10 s = 100 mL/s, 1,000 mL/5 s = 200 mL/s

2. Explain the destructive and constructive processes simulated in each trial.

   The destructive processes include the weathering of the stream bank and bottom. Sediment from the stream channel is removed and is transported downstream. When the stream flow reaches the open water in the pan, the velocity of the flow quickly decreases, causing the sediment to fall out. The sediment piles up and a delta forms in a constructive process.

3. Explain under what conditions the streambed remained unchanged and under what conditions it was most eroded.

   The streambed should remain unchanged with a low flow rate and no sediment load. There is less of a scouring effect on the stream bed.

4. Explain how the deposition of sediment in your investigation compared to the deltas of the Mississippi and Nile Rivers.

   There should be a noticeable piling up of sand, but the size of the deposition will be small. The Mississippi and Nile deltas have been forming for a long period of time.

5. Create a model or flowchart for the development of a river delta over a long period of time.

   Moving water weathers the sides and bottom of a stream channel → Moving water transports the sediment downstream → When the stream velocity slows, sediment is deposited → Deposited sediment builds up over time to form a delta

6. Outline an investigation in which you could compare the materials stream channels are typically made from.

   The steps of the investigation can remain the same. The independent variable is stream channel composition (gravel, sand, clay, silt, or combinations), and the dependent variable is the amount of deposition. Students may design a step to measure the amount of sediment deposited. Flow volume and flow rate should remain constant.

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TEACHER NOTES