

Sediment Transport by Water: How Do Changes in Stream Flow Affect the Size and Shape of a River Delta?

Introduction

A *drainage basin* is all the land that contributes water to a river system. The land within a drainage basin is marked on a map by watershed boundaries. A *watershed boundary* is the location where water will either flow into a given drainage basin or flow into a different one. Watershed boundaries follow ridgelines because water always flows from a higher elevation to a lower elevation. Below is a map of the Mississippi River drainage basin, which is the largest drainage basin in North America. It extends between the Rocky Mountains in the west and the Appalachian Mountains in the east. The Mississippi River and its tributaries collect water from more than 3.2 million square kilometers (1.2 million square miles) of the continent. All this water empties into the Gulf of Mexico in Louisiana.

A *river* is water that flows in a channel. Water makes its way to the sea in a channel under the influence of gravity. The time required for the journey depends on the velocity of the river. *Velocity* is the

distance the water travels in a unit of time. The ability of a river to erode and transport materials depends on its velocity. Even slight changes in velocity can lead to significant changes in the load of sediment that water can transport. Several factors affect the velocity of a river. These factors include the gradient of the channel; the shape, size, and roughness of the channel; and the stream flow.

The *gradient* of a river channel is the vertical drop of a river over a specified distance. The velocity of a river increases as the gradient of a channel increases. The shape, size, and roughness of the channel, however, also affect the velocity of river because water encounters friction as it moves through a channel. Water moves faster through straight, large, and smooth channels than it does through irregular, small, and rough ones. The *stream flow* of a river is the volume of water flowing past a certain point in a given unit of time. The stream flow of most rivers is not constant because it is influenced by the amount of surface water runoff that is currently in the drainage basin. In general, the more surface water runoff that is in a drainage basin, the greater the stream flow of a river. Surface water runoff comes from rain or melting snow.

Rivers create different types of landforms because of the way they are able to produce, transfer, and deposit large amounts of sediment. River deltas are an example of a landform that is produced by a river. River deltas form where a river meets a larger body of water, such as a lake, gulf, or ocean. When the two bodies of water meet, the water from the river cannot flow at the same speed it did in the river channel. As the stream flow slows, the river is no longer able to carry sediment. The sediment therefore accumulates in large amounts where the two bodies of water meet. Over a long period of time, this sediment builds into a fanlike structure such as the delta of the Mississippi River, seen in the figure below.

The drainage basin of the Mississippi River



The Mississippi River delta; notice the amount of sediment deposited where the river enters the Gulf of Mexico (marked with a circle)



Native vegetation flourishes around river deltas because the soil is rich in minerals and organic nutrients. The land around a river delta is also excellent for growing crops. River deltas also create wetlands and marshes that protect the shorelines and *estuaries* (transition zones between river and marine environments) because they absorb excess runoff from both floods and storms. River deltas provide unique habitats for many different species that live along the coast and within the estuaries. Many species, as a result, need these habitats in order to grow and thrive. Humans often change the characteristics of rivers to

better suit their needs. For example, humans build dams to generate electricity, create levees to protect buildings or homes from flooding, and dig channels to divert water from rivers to farms in order to produce crops. These are just a few examples of the many ways humans alter the characteristics of rivers. The addition of a dam, levee, or channel anywhere in a drainage basin will change the stream flow of a river. It will also affect the amount and type of sediment in the water that is able to reach the mouth of a river. Human activity that changes the characteristics of a river, as a result, will affect how water moves through a drainage basin and could contribute to a number of environmental, economic, or social problems. In this investigation, you have an opportunity to learn how changing the stream flow of a river affects the size or shape of its delta.

Your Task

Use a stream table to create a physical model of a river that empties into a larger body of water. Then use this physical model and what you know about erosion, sediments, how matter flows within a system, and scales, proportion, and quantity to design and carry out an investigation in order to determine the relationship between the river stream flow and the size or shape of its river delta. The guiding question of this investigation is: **How do changes in stream flow affect the size and shape of a river delta?**

Materials

You may use any of the following materials during your investigation:

- Stream table
- Water for the stream table
- Sand for the stream table
- Paper towels
- Plastic sheet (12" × 18")
- 1–2 Beakers (each 1,000 ml)
- Graduated cylinder (250mL)
- Balance
- Stopwatch
- Funnel
- Ruler
- Protractor

Getting Started

To answer the guiding question, you will need to carry out an experiment using a stream table. The stream table simulates the behavior of a drainage basin. You can set up the stream table as shown in the figure below. When you add sand, carve a channel into the sand, and then add water to one end of the channel, a river will flow through the channel. The delta will then form on the plastic sheet.

Before you collect your data, spend some time familiarizing yourself with the stream table that you will use. Once you understand how the stream table works, you can plan your experiment. To accomplish this task, you must determine what type of data you need to collect, how you will collect it, and how will you analyze it.

To determine *what type of data you need to collect*, think about the following questions:

- What are the boundaries and components of the system you are studying?
- How can you describe the components of the system quantitatively?
- How can you track how matter flows into, out of, or within this system?
- How will you quantify the size and shape of the delta?

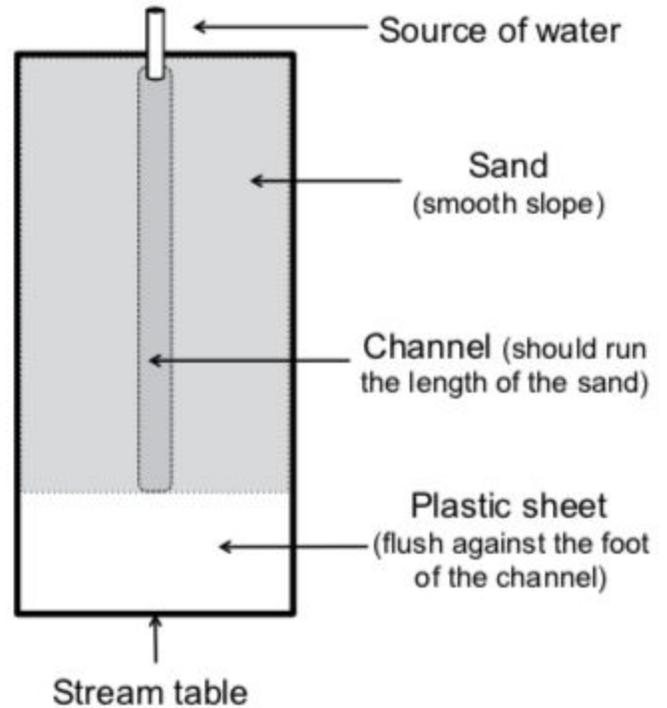
To determine *how you will collect the data*, think about the following questions:

- What will be your independent variable and dependent variables in the experiment?
- What will your treatment conditions be and how will you set them up?
- What will serve as a control condition?
- How many trials will be run for each condition?
- How long will each trial run before data are collected?
- When will you need to take measurements?
- What kind of measurements should you use to collect data?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of and organize the data you collect?

To determine *how you will analyze the data*, think about the following questions:

- How could you use mathematics to describe a relationship between variables?
- What types of patterns might you look for as you analyze your data?
- What type of calculations will you need to make?
- What type of table or graph could you create to help make sense of your data?

How to set up a stream table (image is as seen from above)



Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question were you trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning)

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.