Lab Handout

Lab 9. 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. Figure L9.1 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.

FIGURE L9.1

The drainage basin of the Mississippi River

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.

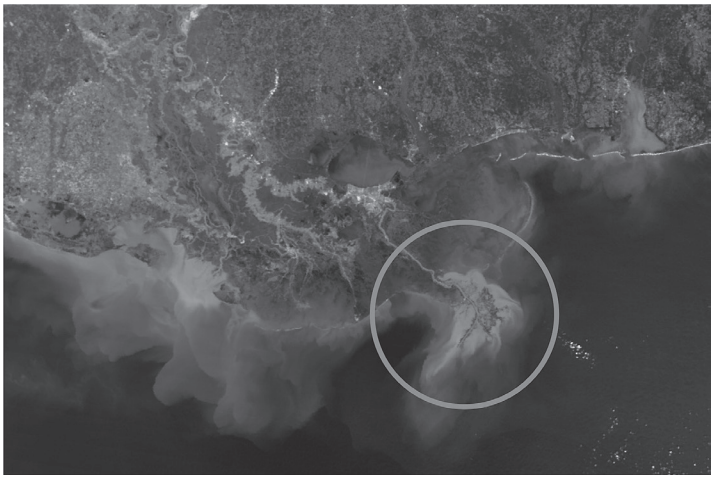
The *gradient* of a river channel is the vertical drop of a river over a specified distance. The velocity of a river increases as the gradient of a channel increases. The shape, size, and roughness of the channel, however, also affect the velocity of river because water encounters friction as it moves 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 ability 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 Figure L9.2.

FIGURE L9.2

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:

Consumables

- Water for the stream table
- Sand (for the stream table)
- Paper towels

Equipment

- Safety glasses or goggles (required)
- Chemical-resistant apron (required)
- Gloves (required)
- Stream table with water volume adjustment
- Plastic sheet (12" × 18")
- 1–2 Beakers (each 1,000 ml)
- Graduated cylinder (250 ml)
- Electronic or triple beam balance
- Stopwatch
- Funnel
- Ruler
- Protractor

Safety Precautions

Follow all normal lab safety rules. Be sure to use the stream table as instructed by your teacher. In addition, take the following safety precautions:

- Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant, nonlatex aprons and gloves throughout the entire investigation (which includes setup and cleanup).
- Keep away from electrical outlets when working with water to prevent or reduce risk of shock.
- Report and clean up spills immediately, and avoid walking in areas where water has been spilled.
- Handle all glassware with care.
- Wash hands with soap and water when done collecting the data and after completing the lab.

Investigation Proposal Required? ☐ Yes ☐ No

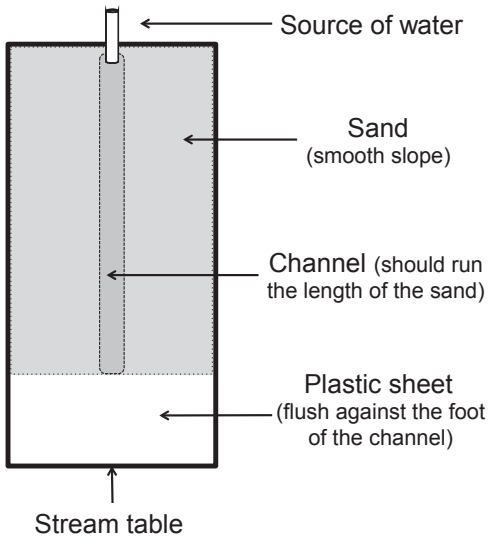
Getting Started

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 Figure L9.3. 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.

FIGURE L9.3

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



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 measurement scale or scales 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 difference between conditions or 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?

Connections to the Nature of Scientific Knowledge and Scientific Inquiry

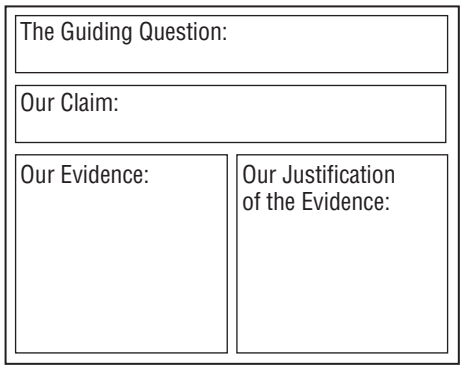
As you work through your investigation, be sure to think about

- the use of models as tools for reasoning about natural phenomena, and
- the nature and role of experiments in science.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The claim is your group's answer to the guiding question. The evidence is an analysis and interpretation of your data. Finally, the justification of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L9.4.

FIGURE L9.4
Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One or two members of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to what scientists do when they propose, support, evaluate, and refine new ideas during a poster session at a conference. If you are presenting your group's argument, your goal is to share your ideas and answer questions. You should also keep a record of the critiques and suggestions made by your classmates so you can use this feedback to make your initial argument stronger. You

can keep track of specific critiques and suggestions for improvement that your classmates mention in the space below.

Critiques of our initial argument and suggestions for improvement:

If you are critiquing your classmates' arguments, your goal is to look for mistakes in their arguments and offer suggestions for improvement so these mistakes can be fixed. You should look for ways to make your initial argument stronger by looking for things that the other groups did well. You can keep track of interesting ideas that you see and hear during the argumentation in the space below. You can also use this space to keep track of any questions that you will need to discuss with your team.

Interesting ideas from other groups or questions to take back to my group:

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

Report

Once you have completed your research, you will need to prepare an investigation report that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. You should write your report using a word processing application (such as Word, Pages, or Google Docs), if possible, to make it easier for you to edit and revise it later. You should embed any diagrams, figures, or tables into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid.