LAB 8

Lab Handout

Lab 8. Surface Erosion by Wind: Why Do Changes in Wind Speed, Wind Duration, and Soil Moisture Affect the Amount of Soil That Will Be Lost Due to Wind Erosion?

Introduction

Earth scientists use the term *erosion* to describe what happens when liquid water, ice, or wind moves rock, soil, or dissolved materials from one location to another. The process of erosion is responsible for the creation of many interesting landforms or natural phenomena that we observe in the world around us. The rock shown in Figure L8.1, for example, was sculpted by wind erosion. Wind erosion can also produce dust storms such as the one that moved through Casa Grande, Arizona, on July 5, 2011. This enormous storm was 101 miles wide and 7,000 feet high, with wind gusts reaching 60 miles per hour (mph). It obscured mountains and covered freeways and homes with massive amounts of soil (see Figure L8.2).

FIGURE L8.1

A rock sculpted by wind erosion in the Altiplano region of Bolivia

FIGURE L8.2

A dust storm in Casa Grande, Arizona

Wind is the movement of air. It is caused by differences in air pressure within the atmosphere. Wind erodes the surface of Earth through abrasion or deflation. *Abrasion* is the wearing down of rock or other objects. Wind abrasion over a long period of time can make significant changes to the shape of a rock. In fact, the rock in Figure L8.1 looks the way that it does because of wind abrasion. *Deflation* is the removal of soil particles, such as sand, silt, and clay, from an area by wind. Wind can remove soil particles from one location and move them to a different location because moving air exerts a pushing force

on objects. Wind can move soil particles by suspending them in the air or causing them to bounce or slide along the ground. Soil particles will continue to move until the pushing force of the wind acting on them weakens or stops. These soil particles often accumulate and form mounds or dunes around physical barriers. The dust storm in Figure L8.1 is an example of wind deflation. This dust storm moved a massive amount of soil into the city of Casa Grande.

Wind erosion is a big problem in some regions of the United States because wind can remove and transport a lot of soil in these regions. Some regions struggle with the effects of wind erosion and some regions do not because different regions of the United States have different wind patterns, types of soil, and climates. In some regions of the United States, for example, the average wind speed never exceeds 4.0 mph, but in other areas the average is consistently above 10.5 mph. Wind speed is important to consider because fast-moving air applies a greater pushing force than slow-moving air. The soil found in a region differs in terms of the proportion of sand, silt, and clay that is present in it.

Earth scientists use the soil classification triangle shown in Figure L8.3 to classify soils. Figure L8.4 shows the different types of soil particles and their relative sizes. The size of soil particles is important to consider because objects with more mass require more force to move. The climate of a region affects how much rain a region will typically have at different times of the year. The amount of rainfall affects the moisture of the soil.

Wind speed, wind duration, and soil moisture, as well as several other factors (such as amount and type of vegetation in a region), will affect the amount of soil that will be lost from a given area due to wind erosion. Soil loss due to wind erosion

FIGURE L8.3

Soil types by composition

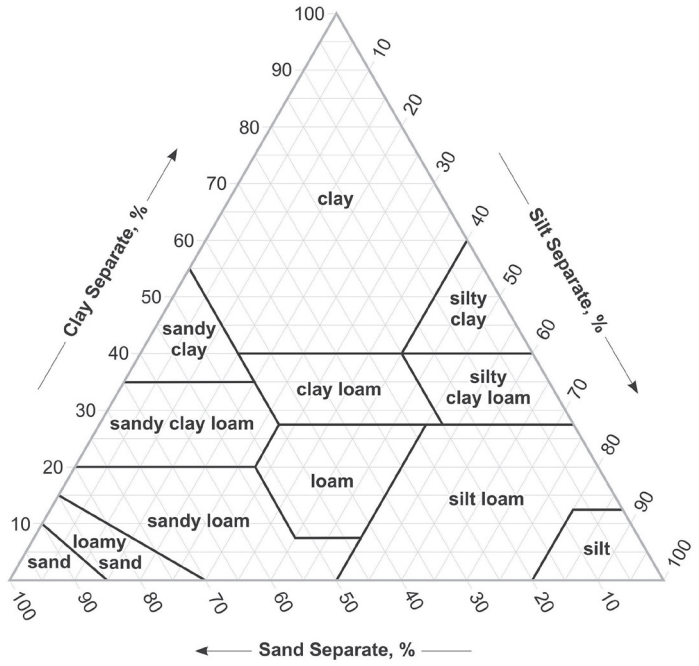
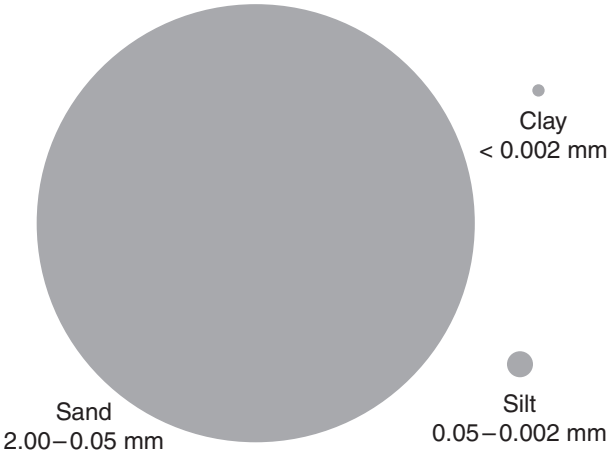


FIGURE L8.4

Soil particle types and sizes



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can destroy crops, put farmers out of business, lead to food shortages, and devastate the economy. During the 1930s, for example, winds removed so much soil on farms in the Midwest that entire crops failed. The winds that blew across the plains suspended so much topsoil in the air that it sometimes blackened the sky. These billows of dust, which were called black blizzards or black rollers at the time, transported soil across the country and even deposited some of it in East Coast cities such as Washington, D.C., and New York. Many farmers went out of business, and the United States, as a result, faced massive food shortages. To prevent a crisis like this from happening again, people must understand how and why soil erodes due to wind. You will therefore explore how wind speed, wind duration, and soil moisture affect the amount of soil that is lost to wind erosion and then develop a conceptual model that you can use to explain your observations and predict how much soil will be lost due to wind erosion under different conditions.

Your Task

Use what you know about wind erosion, soil types, factors that affect rates of change, and the importance of quantity, scale, and proportion in science to determine *how* wind speed, wind duration, and soil moisture affect the amount of soil lost from different types of soil. Then develop a conceptual model that can be used to explain *why* these factors affect the amount of soil lost due to wind erosion. Once you have developed your conceptual model, you will need to test it using a different type of soil to determine if it allows you to predict how much soil will be lost due to wind erosion under a different condition.

The guiding question of this investigation is, ***Why do changes in wind speed, wind duration, and soil moisture affect the amount of soil that will lost due to wind erosion?***

Materials

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

Consumables

- Soil sample A
- Soil sample B
- Soil sample C
- Soil sample D
- Water

Equipment

- Safety glasses or goggles (required)
- Chemical-resistant apron (required)
- Gloves (required)
- Cookie sheet
- Trash bag
- 2 ml Beakers (each 250 ml)
- Graduated cylinder (100 ml)
- Fan with multiple speeds
- Electronic or triple beam balance
- Flowchart for soil texture by feel

Safety Precautions

Follow all normal lab safety rules. 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).

- Handle all glassware with care.
- Plug the fan only into a GFCI-protected circuit. Keep the fan away from water to avoid risk of shock.
- Use caution when working with the fan. Blades can be sharp and cut skin. Do not place fingers into the fan, and never place any object into the turning fan blade.
- Report and clean up any spills immediately, and avoid walking in areas where water has been spilled.
- Wash hands with soap and water when done collecting the data and after completing the lab.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

The first step in developing your model is to plan and carry out three different experiments to determine how wind speed, wind duration, and soil moisture affect the amount of soil lost from different types of soil. You will use soil samples A, B, and C during your experiments. To design each experiment, you will need to determine what type of data you need to collect, how you will collect it, and how you will analyze it.

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

- How will you identify the type of soil?
- How will you determine wind speed?
- How will you determine soil moisture quantitatively?
- How will you determine the amount of soil lost due to wind erosion quantitatively?
- How can you describe the other components of the system?
- How could you keep track of changes over time quantitatively?

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

- What will be the independent variable and the dependent variable in each experiment?
- What will be the treatment and control conditions in each experiment?
- What other factors will you need to keep constant?
- What scale or scales should you use when you take your measurements?
- What equipment will you need to collect the data you need?
- 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 change over time?
- How could you use mathematics to determine if there is a difference between the experimental conditions or a relationship between variables?
- What types of proportional relationships 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 identify a trend in the data?

Once you have carried out your three experiments and understand how changes in wind speed, wind duration, and soil moisture affect the amount of soil lost from different types of soil, your group will need to develop a conceptual model. The model needs to be able to explain why these three factors affect the amount of soil lost to wind erosion in the way that they do. The model also needs to account for the physical properties of the particles that make up soil.

The last step in this investigation is to test your model. To accomplish this goal, you can use soil sample D to determine if your model leads to accurate predictions about the amount of soil that will be lost from a different type of soil under specific conditions (e.g., high wind speed, short duration, and low moisture). If you are able to use your model to make accurate predictions about the effects of wind erosion under different conditions, then you will be able to generate the evidence you need to convince others that the conceptual model you developed is valid or acceptable.

Connections to the Nature of Scientific Knowledge and Scientific Inquiry

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

- the difference between data and evidence in science, and
- the nature and role of experiments in science.

Initial Argument

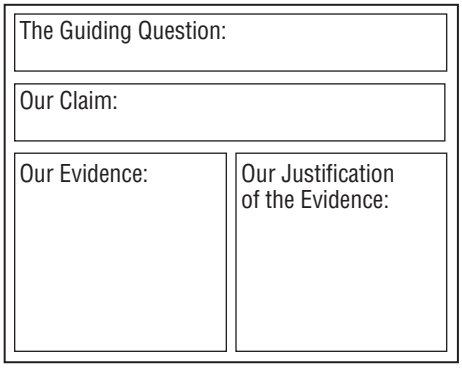
Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The *claim* is your group's answer to the guiding question. The *evidence* 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 L8.5.

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.

FIGURE L8.5

Argument presentation on a whiteboard



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.