



Stream Table Science: How Water Changes the Land

Curriculum Unit 17.02.07
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Introduction

This unit is designed to help 2nd grade level students develop an understanding of the effects of weathering and erosion caused by water. Students will explore and test the creation of a variety of landforms using a stream table to conduct a series of investigations related to water erosion. Students will learn about how water changes the land through hands-on play and investigation. In addition, students will use programs such as Google Earth and/or USGS Streamer to identify landforms and trace the path of the Connecticut River. A literature connection and several class activities round out the study of water's role in changing and shaping the earth. This unit focuses on three questions: If I floated on a boat down the Connecticut River, where would I go? Why is there sand at the beach? How does water change the land?

Rationale

The New Haven Public School district encourages science literacy for all students by building a solid foundation of science topics that are interesting and relevant to students. Science is learned in a context of real world issues through active and thoughtful exploration of questions and problems. Whenever possible, learning about science topics should involve hands-on exploration that enables students to make observations, conduct investigations, test ideas, and communicate their understanding.

Water is an extremely valuable resource. Not only do we need it to sustain life, but it also shapes our environment. This unit will help students understand the role the of water in erosion and river formation in a hands-on manner consistent with the vision of New Haven Public Schools. Although at the time of this writing in 2017, water is one of the 4th grade science standards and is currently taught using a district provided Science and Technology Concepts (STC) kit. However, with the rollout of the NGSS within the district, the content of this unit has been shifted to 2nd grade. This unit will provide an additional experience for students to learn about some of the roles of water on our planet.

Concepts/Content: Watershed

This unit will help students understand the scientific principles that affect water erosion and the subsequent creation of identifiable landforms. Using a stream table, students will investigate how the rate of water flow as well as differences in sediment and vegetation impacts the rate of erosion and subsequent deposition of material. The students will be immersed in scientific inquiry, observations, and experimentation to explore answers to the question “How does water change the land?”

The USGS (United States Geological Survey) defines a watershed as “an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel. The watershed consists of surface water--lakes, streams, reservoirs, and wetlands--and all the underlying groundwater. Larger watersheds contain many smaller watersheds.”⁵ Any point of land is a watershed, since as soon as a drop of water hits the ground, that water has to go somewhere. When you think of the basic model of a water cycle where water comes down as precipitation, a watershed is any point on land on which that precipitation travels as it empties into the ocean or other large body of accumulated water. A divide separates watersheds such as a ridge, where water will flow to either side of that ridge. “Temperature and rain patterns, underlying rock types, and topography (mountainous, hilly, flat) influence the structure of these watersheds and help to define the specific types of habitats available along the river continuum in each watershed.” The USGS defines 78 major watersheds, or river basins, in the lower 48 states and 8 major watersheds in Connecticut.¹

The single greatest contributor to a watershed is precipitation in the form of rain or snow. The amount of precipitation is a major factor of a stream's rate of flow. Of course, not all precipitation reaches the ocean. When water lands on dry ground, some of that water infiltrates the soil. That water can be retained in the soil, or permeate the ground and collect in underground aquifers. That water can travel short or great distances and remain in underground storage for up to thousands of years before it ever reaches the surface. The type of soil influences how much water is absorbed. Clay and rocky soil will absorb water at a lower rate than sandy soil. Soil that absorbs more water will result in less runoff water, unless that soil is already saturated. Some of the water is released through the process of evapotranspiration. Evapotranspiration is water that is released into the atmosphere through plant and soil.

Once water begins to flow, it forms a stream. One way streams are classified is by stream order. Arthur Newell Strahler, a geoscience professor at Columbia University, developed a mathematical system for classifying streams in 1952. First order streams are small tributaries (a tributary is any stream that feeds into a river) that have no other tributaries. First through third order streams are also described as headwater streams. When two first order streams intersect, they form a second order stream. When two second order streams connect, they form a third order stream, and so on. Fourth through sixth order streams are classified as medium streams, while seventh order and beyond is classified as a river. The Amazon River is a twelfth order waterway.² The larger the number, the larger the river.



Source: <http://greenfieldgeography.wikispaces.com/Hydrographs>

Concepts/Content: Water Erosion

Water erosion is a natural process that occurs whenever water transports soil, rock, sediment, or any dissolved material from one place to another. Since erosion occurs whenever the flow of water is greater than the strength of the sediment's ability to resist it, loose and sandy sediments are more susceptible to erosion than clay or rock. Rainfall and any accompanying surface runoff results in four main types of soil erosion: splash erosion, sheet erosion, rill erosion, and gully erosion. Imagine a drop of water falling into a pan of sand, creating a small crater as it displaces the sand from the point of impact. This displaced sand is a result of splash erosion. As water continues to fall on the pan of sand, water infiltrates the sand until it becomes saturated. If you tilt the pan, creating a slope, some of the sand from the top layer will be carried by the water. This is sheet erosion. As the water continues to rain down on the pan of sand, small channels might form. These are known as rills. As the flow of water becomes stronger, some of these rills might become deeper and more defined channels. As water carves deeper channels into the sand, these deep channels are known as gullies.

Another type of erosion is wave erosion. As waves of water from a large body of water or ocean collide with the surrounding landscape, sediment is carried away by the continuous rushes of water. The degree of erosion depends on the type of material, the strength of the waves, and the amount of time that has passed. Over thousands of years, ocean waves can carve into the land and form cliffs.

Glaciers, basically large chunks of ice, also contribute to erosion. As water freezes, especially at higher and colder altitudes, rocks and soil can be carried away by the slow-moving ice (or fast moving ice in the case of an avalanche). This process is known as abrasion or scouring. As ice penetrates surrounding rock and bedrock, pieces may break off and be carried away in a process known as plucking. Glacial ice may also freeze and adhere to the underlying bedrock, breaking it off and carrying it with it. This is known as ice thrusting.

While erosion is the process of moving sediment, soil, and rocks; deposition is the process of adding those materials to a landform. As the kinetic energy of the eroding water lessens, earth materials are left behind. It is through this process that some landforms are created.

Concepts/Content: Landforms of Fluvial Erosion and Deposition

While there are many types of landforms caused by weathering and erosion, this second-grade level unit will focus on seven particular landforms caused by the flow of water and deposition of sediments. (images to be added)

Braided Channels: Braided channels form as the result of a river or stream carrying a heavy load of sediment. The channels through which the water flows divide and rejoin, forming a stream pattern that resembles the strands of a braid as opposed to the look of a meandering stream straight channel. Temporary islands are formed and eroded as the heavy load of sediment is deposited and carried away. Braided channels form when the soil is highly erodible with an abundant supply of sediment, there is a steep channel gradient, and there is a frequent variation of the rate of water flow. ⁴

Canyon: Canyons form when flowing water carves a steep channel through the surrounding land. Over a long period, the continuous flow of water erodes the underlying bedrock and the sides of the channel. The headwater is at a higher elevation than the estuary and the encompassing earth consists of hard and soft rock.

Cliff: A cliff is a steep, vertical rock exposure usually found along coastal waters or mountainous areas. Cliffs can be formed by tectonic activity or by the erosion caused by continuous lapping of water against rock as the sediment is eroded away.

Delta: A delta is formed when the river or stream empties out into a lake or ocean. As the kinetic energy of the water decreases, sediment is deposited in layers. Heavier sediment is dropped first, followed by finer sediment. When a river deposits more sediment than the lake or ocean can carry away, a delta is formed.

Meander: A meander is a bend in the stream or river. Meandering streams and rivers often take on a snake like appearance as the stream curves inward and outward over the course of the stream distance. A meander, or bend, occurs when the moving water erodes the outer banks and widens its valley, and the inner part of the river has less energy and deposits silt. The outer bank is deeper than the inner bank and the water flows faster. As silt builds up and is deposited on the opposite side, the course of the stream is diverted and the meandering pattern is formed.

Oxbow Lake: An oxbow lake is the result of a loop in a meandering stream becoming cut off from the rest of the stream. As deposited sediment fill in the cutoff in the loop, the u shaped point of the curve is left and an oxbow lake is formed.

Valley: A valley is a depression in the land often caused by the erosion of land by either rivers and streams or glaciers. There are three main types of valleys: V-shaped, U-shaped, and flat formed. Young, fast moving rivers or streams usually create v-shaped valleys. Over time, soil and rock is eroded and cuts into the land. A U-shaped valley has steep sides that curve at the bottom, characteristic of the letter "u". Slow moving glaciers usually create them. Sometimes, glacial ice travels down a previously carved V-shaped valley and flattens the bottom as the glacier is pulled downstream. A flat-floored valley is formed by a mature stream that is no longer fast moving. The valley floor widens as the slope of a stream's channel becomes smooth and it erodes the bank of its channel rather than the valley walls. The stream continues to meander and erode the valley's soil, widening it further. The material that is eroded and carried in the stream is deposited and builds

up the floodplain and the valley. During this process, the shape of the valley changes from a V or U shaped into one with a broad flat valley floor.

Teaching Strategies

Lesson 1: Read and discuss *Cracking Up: A Story About Erosion (Science Works)* by Jacqui Bailey (or a similar text). This book is about the cause and effect relationship of how water, ice, wind, and sun affect erosion. Although this text is recommended, there are many other on-grade-level texts that could fulfill this purpose. Having a literature connection helps to build a frame around the educational content to be studied. At this point, introducing a landforms anchor chart and/or watching a few video clips that are grade level appropriate and related to landforms would be helpful. The objective here is for students to learn vocabulary related to fluvial landforms and to set the stage for further investigation.

Lesson 2: Play dough landforms. Have students create physical depictions of braided channels, a canyon, a cliff, a delta, a meandering stream, an oxbow lake, and a valley using play dough. They can use texts or online pictures as a reference.

Lesson 3: Google Earth (landform identification). In the computer lab, or using a classroom set of computers, have students access Google Earth. Simply type "Google Earth" into your internet browser or navigate to <https://earth.google.com/web>. The program can also be downloaded for free. Some prep work is required here, as you may want to create a customized Google Earth tour with preselected locations. Have students locate each of the above-mentioned landforms (braided channels, canyon, cliff, delta, meandering stream, oxbow lake, valley). The objective here is for students to learn how to use a virtual map to locate examples of fluvial landforms. As an alternative, images of these landforms can be printed on paper and students

Lesson 4: Paper mountains. Using an 11x17 piece of construction paper (preferably white or a light color), have students make a fist and wrap the paper around it, making a "mountain" out of the paper. Tape the sides of the paper to a table and have the students trace along all the ridges with a washable color marker (preferably blue). Have students predict where they predict water will travel and accumulate. Using a spray bottle filled with water, mist the colored paper mountain until it is saturated and the colored ink begins to run. Have students compare their results with their predictions in preparation for a follow-up group share and discussion. The objective here is for students to understand that a watershed is anywhere water flows once it has reached the surface of the earth.

Lesson 5: Google Earth (If I floated in a boat down the Connecticut River, where would I end up?). Have students return to using Google Earth. This time, have them look up the Connecticut River and pose the above question. Have students take note of any landforms or water features they would encounter as the floated down the river. This can be done in a science notebook or a teacher created worksheet. As an extension, you can provide the names of other rivers and have students repeat the same task with a different location. The objective for this lesson is for students to understand the paths of natural rivers and that they eventually empty out into an ocean or large body of accumulated water. If Google Earth is too advanced for your students, you can also use a USGS stream tracker tool located at <https://txpub.usgs.gov/DSS/streamer/web/>. This tool will allow you to select a waterway and click on a button to trace up or down stream. If computer access is difficult, printed maps of New England that show the

Connecticut River can also be used. The source of the Connecticut River is just above the Canadian border on the 4th Connecticut Lake. The mouth of the Connecticut River is the Long Island Sound, which then connects to the Atlantic Ocean.

Lesson 6: Sediment part 1 (Why is there sand at the beach?). Take five sheets of construction paper placed lengthwise, side by side, and labeled 1 to 5. Draw a mountain with the beginning of a river on sheet 1 and continue the river on sheets 2, 3, and 4. On sheet 5, draw the end of the river as it empties out into an ocean. You will need one set for each group of up to four students. Using another sheet or two of construction paper, cut or tear out “paper rocks” that are roughly the size of a half dollar (can be a bit larger). These are the initial boulders. Have students place all the boulders on sheet one with the mountain. They will simulate what happens as boulders travel and crash into each other down the river. Set a timer for 15 seconds. On go, students will take one boulder at a time from sheet one, tear it in half, and place it on sheet two. It is okay if not all boulders are removed from sheet one. Once again, set timer for 15 seconds and students will tear each paper boulder that was on sheet two in half and place it on sheet three. Continue this process until you reach sheet 5. Students should observe how the boulder broke down over time as it traveled downstream, creating smaller and smaller pieces.

Lesson 7: Sediment part 2 (What settles first?). Take a clear plastic bottle that can be capped at the top, such as a clear two-liter soda bottle. Fill the bottle about one third of the way with different sizes of sediment - rocks of various sizes, sand, soil, etc. Fill the rest of the bottle with water and cap it tight. You can make one of these as a classroom example or have students make their own. Have students shake their bottle and then place it upright on the table and leave it alone. Have them observe which sediments sink first, second, third, etc.... Observations can be noted in their science notebook and the results discussed in a follow-up discussion. A good question to discuss is how could the size of the particle affect how far it can be carried by moving water?

Lesson 8: Stream table observations. In this lesson, students will explore and take note of models of fluvial landforms created in a classroom stream table. A large classroom stream table is exciting, engaging, and a great place to experiment with how the rate of water flow, steepness of slope, and size of sediment can affect fluvial landforms. Instructions for creating various levels of stream tables are attached to this unit. Students will attempt to create and identify various landforms from the above list in the concepts/content section of this unit. Use plastic flags labeled with each type of landform as markers for students to use when they have identified a landform. Students can raise or lower the flow of water, as well as adjust the incline of the stream table to observe cause and effect relationships between the water and the land. Students can also experiment with adding natural or manmade items to the stream table, such as plastic trees or a dam.

Lesson 9: Personal stream tables. Students can construct their own, smaller version of a stream table at their desks. See the attached instructions for personal stream tables. Display pictures of river deltas, land deposition, canyons, etc... Have students compare their models to others and the pictures. Discuss if they observe any similarities to the real-life landform pictures.

Lesson 10: Glacial erosion. If you have a large classroom stream table, you can setup a model of glacial erosion by placing a large block of ice on a sloped stream table bed. Take note of what the land looks like before any movement of the ice. Then, let the ice slowly melt and slide down the stream table over a couple of days. It might be best to set this up over a weekend and observe the changes that occurred in the land over the past few days. Another idea is to setup a time lapse video to record the movement over time.

Resources

How to Construct a Classroom Stream Table:

A classroom stream table should be able to accommodate a group of 5-6 students at a time. You will need a watertight container, such as an under-the-bed storage container, that is at least three feet long. The longer, the better. Sterilite makes one that is 44 inches long and costs under \$20.00. In my class, I used a sandbox that I found at Toys R Us.

Once you have located a container, the next step is to fill it with a substrate. The least expensive option is to use sand sourced locally. A mix of silica, clay, and gravel will work and you will need about 80 pounds of it. Another option is to use ground walnut shells. Ground walnut shells are often used in the metal polishing industry and can be easily be sourced online. A third, and more expensive, option is to use plastic granules sold by <http://www.emriver.com/>. Their plastic modeling compound is color coded based on grain size and is an ideal and clean material. Unfortunately, the cost for this material will range between \$4,000.00 to \$6,000.00, compared to about \$50 for purchased sand.

You will need to construct a drain plug on one of the short sides of the container, approximately one inch above the bottom. A small “L-shaped” pipe (about 1 inch diameter) will suffice. I recommend using a metal washer on each side where it connects to the container. Use an adhesive caulk or epoxy to insure a watertight connection. The bend in the pipe should be facing down. Use plastic or vinyl tubing to make a drain hose that attaches to the drain spout. You will want at least three feet of tubing. A 5 or 10-gallon bucket should be used to collect the water. I recommend gluing a screen to the inlet of the drain spout to help prevent clogging of the tubing.

Now that you have a stream table bed and drain created, the next decision is to determine if you want to use a small aquarium pump to recirculate the water, or if you want to simply swap buckets and recirculate the water manually. I recommend using an adjustable aquarium pump rated at a maximum of 120 gallons per hour. Anything higher is too fast of a water flow. Aquarium pumps are submersible, so simply attach about 5 feet of tubing to the outlet of the pump and place the pump in your drainage bucket. Attach the other end of the tubing to the opposite end of the stream table using a small clamp.

Once the water pump is connected, at the substrate you selected. Fill about 2/3 of the container with the substrate at the top of the stream table, where your water flow begins. Be sure that your drainage bucket has ample water to provide a continuous flow of water. You may need to add water to prevent the pump running dry. The pump needs to remain submerged or it can quickly overheat and become damaged.

Add plastic foliage, small rocks, and other materials to give your model a more realistic representation of natural conditions. Green Christmas tree garland is a good substitute for grass. Use blocks of wood to adjust the slope of the table.

How to Construct a Personal Stream Table:

In addition to a classroom stream table, students can also create a small-scale model on their own. Each student (or pair) will need a small tray such as the ones used in the cafeteria. Use a few scoops of cornmeal as a substrate, and place it in a mound on one end of the tray. The tray does not need to be sloped. Students will need a few blocks or books to make support towers that hold a ruler above and across the mound of

cornmeal. Use a pin to make a small hole in the bottom of a paper cup, place the cup on the ruler so that the hole is above the cornmeal, and fill the cup about 2/3 full of water. Water will slowly drip through the hole and carve landforms into the cornmeal. Be careful not to use too much water, or you will flood the tray. You can vary the size of the hole to adjust the water flow.

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Appendix

Implementing District Standards

NGSS has four performance expectations (PE) for Grade 2 Earth & Space Sciences. They are:

2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly. ³

Throughout this unit, students are using text, online mapping (Google Earth), and physical models to represent the cause and effect relationships of water and land.

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. ³

Students investigate the effects of various materials on fluvial landforms, such as trees and man made obstructions (dams), to change how water shapes the land at the community stream table.

2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. 3

In lessons one and two, students learn about the names for different types of landforms. In lesson two, students also make a physical model of each landform out of play dough.

2-ESS2-3 Obtain information to identify where water is found on Earth and that it can be solid or liquid. 3

Students use Google Earth as one resource to investigate major bodies of water and resulting physical landforms. The stream table also helps students identify that some water percolates through the soil until saturated, then runoff occurs as water is carried by gravity to an accumulation point.

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