El Paso Water & SCIENCE

Science, Water and the Rio Grande:
THE MEANDERING RIO GRANDE

Grade 4th

Vocabulary

arroyo
chamizo saltbush
channel
dam
deposition
erosion
flow
river
stream
weathering

Social Studies Vocabulary

boundary
Chamizal National Memorial
Chamizal Treaty
Mexican-American War
Parque Publico Federal
El Chamizal
President Adolfo Mateos
President Lyndon Johnson
Treaty of Guadalupe Hidalgo

Activity Overview

In this activity, students will understand the behaviors of our meandering river due to flow, erosion and deposition.

There are three parts to this lesson for the student to investigate.
Part I: The Meandering River Model *(page 7)*
Part II: Building and Testing a Channel Model *(page 8)*
Part III: Investigate Your Own River Model *(page 10)*

TEKS Alignment

Science:

4.3 (B) The student is expected to: represent the natural world, using models such as the water cycle and stream tables and identify their limitations, including accuracy and size.

4.7 (B) The student is expected to: observe and identify slow changes to the Earth's surface caused by weathering, erosion and deposition from water.

Social Studies:

4.2 (D) The student will identify Texas' role in the Mexican War of Independence and the war's impact on the development of Texas.

4.8 (B) The student will describe and explain the location and distribution of various towns and cities in Texas, past and present.

THE SCIENCE BEHIND IT: Slow changes such as erosion and how rivers meander

Slow changes that happen on the Earth's surface may not necessarily be something that a student can see during a class period or while outside looking out at the land. A slow geological change that was a result of weathering and erosion can happen as quickly as over a day (such as a result of flooding) or can happen over days, months, years or even hundreds, thousands and millions of years. In this investigation students will be using a stream table model to explore how the Rio Grande has changed its shape despite the declaration that the river was to be used as the boundary of two countries: the United States and Mexico, along the Texas border.

River Terms

straight river
meandering river
ox-bow lake
braided river
tributaries
distributaries
deltas

These terms are defined on the Observation Guide.

During the process of this investigation, the teacher will need to explain what happens when water flows through a **river** at different speeds and how the force of the water may cause the rocks and soil along the walls of the channel to loosen, break away and deposit further down the river. A **channel** is a bed where a natrual stream of water runs. Deposits of silt and rock can create barriers to the water and cause a river to make turns or start new channels.

Flow

Flow describes the force and speed of the water as it flows through a river. Some rivers are fast moving and others are slow, depending on the water source (runoff of mountains or glaciers) and the incline of the land where the river is flowing. Some rivers are very steep (such as the Colorado River) while others run at a low grade (such as the Mississippi.)

The Rio Grande originates in the Southern Colorado and North ern New Mexico Rockies and is the result of melting snowpack in the spring. If these areas experience a heavy snowpack during winter, the Rio Grande may see a lot of water in spring. If the snowpack is low, the melting will only provide limited water. Other phenomena that may also contribute to the flow of the river are the tributaries and **streams** that add to the river as it makes its way through New Mexico and Texas. These tributaries and streams recharge the river as it travels along. Annual rainfall may also help to recharge the river as we have seen when El Paso experiences it's rainy season.

The river may also have less or more water depending on the people that use the river along its course. Towns and farms pull river water for everyday use including drinking, bathing and cooking or to water crops. Now that the river is used by so many people, we **dam** the river at various points to conserve the water. The Caballo and Elephant Butte Dams are used to store and manage the water flow for downstream users.

Water from the river is collected over a period of months and then released back into the river when it is time to irrigate crops. For this reason, stretches of the Rio Grande may seem dried up during certain parts of the year and students may have the misconception that the Rio Grande does not contain water anymore. Rivers may not always have water flowing. Many

times, rivers are seasonal and recharge in the spring. This is a typical characteristic of rivers that exist in desert environments and is explored more in the Rio Bosque Wetland Riparian Environment unit.

Weathering and Erosion in a River

Weathering is the breaking down of rock and soil as a result of wind, water, ice and biological influences. **Erosion** is the movement of soil or rock from one place to another. The erosion of rock or land has to have a force to help it move. In some cases wind or ice can help rock and soil travel; in the case of a river, it is water. Students may underestimate the force water has, but by looking around just at the base of our mountains, it is evident that water carves our land and creates channels and **arroyos**. The water carves out or erodes the area that it seems to prefer, but in actuality, it is just moving the easiest pieces out of the way first. As water flows over a surface it will pick up loose soil or rocks and will leave behind the channel. The same things happen when rivers change course.

Meandering

Rivers that at one time ran straight can change course for many reasons. The steep sides of a river channel can weaken due to changes in flow, with water hitting the banks at high speeds and then low speeds when rivers get recharged. Animals and plants can also affect the sides of a riverbank. For example, animals that build their homes along the banks of a river can help the riverbanks to erode. Plant roots that keep the riverbanks from eroding can die after a period of drought. This will also weaken the walls of the channel. When water flows over a weakened channel wall, it will start to erode the easiest pieces. Then soil and rocks become loose and fall and are deposited farther down in the river. These deposits can collect and form islands and deltas in the river. This is called **deposition**. These islands and deltas deflect the water into different directions, causing the river to hit the sides of the riverbank with greater force. Eventually the river that once ran in a straight line, will start to curve and form a shape like a snake. Meandering rivers happen all over the world and the Rio Grande is no exception. The Chamizal Treaty is an agreement to keep the Rio Grande cemented in between El Paso, Texas and Juárez Mexico because this river meanders and changes course.

THE HISTORY BEHIND IT: The Chamizal Treaty and the Cementing of the Rio Grande.

In 4th grade the student will be taking Texas History as part of their social studies lessons. This science lesson will also address historical events that happened between the US (Texas) and Mexico.

In 1848, after the Mexican-American War, the US signed a treaty with Mexico called the Treaty of Guadalupe Hidalgo. The treaty called for the United States to pay $15 million to Mexico and gave the US the Rio Grande as a boundary between Texas and Mexico. It also gave the US ownership of California and a large area comprising roughly half of New Mexico, most of Arizona, Nevada, Utah and Colorado. Mexicans in those annexed areas had the choice of relocating within Mexico's new boundaries or receiving American citizenship.

Issues with the border of Mexico and Texas arose as the river changed course due to meandering. This was especially problematic in the town of El Paso during the years of 1852 through 1907 when the river dramatically changed course four times, leaving homes, businesses and churches changing countries every few years.

In 1910 President Taft of the US and President Diaz of Mexico signed an agreement to allow the international boundary commission to settle the dispute of the boundary by regulating water flow into the river through dams in order to slow the erosion and meandering. However, because of flooding during heavy rains, the river still changed course due to erosion. Many US presidents tried to settle the dispute, but it wasn't until US president John F. Kennedy agreed to honor the 1911 boundary agreement, that a compromise was reached about the El Chamizo land and Cordova Island. President Lyndon Johnson and President Adolfo López Mateos met in 1963 to work out the details of the agreement. A cemented channel would replace the river between the two cities to prevent further erosion. The two countries would split the cost of building the channel. Mexico would pay for 382 structures that the US would lose to the treaty. About 5,600 residents were relocated in order to build the channel between the two cities. To commemorate the sacrifices of the two countries a national memorial and parks were

built on both sides of the channel and were named the Chamizal National Memorial and the Parque Público Federal El Chamizal.

Part I: Materials for Investigation

Per Group:

- Stream Table or large oblong storage tub (gift wrap paper size)
- Clean playground sand (available at most home improvement centers)
- Diatomaceous earth (available at pool supply or home improvement centers)
- A large dish tub to mix the sand
- 2-4 handfuls of small rocks (pebble size or a little larger)
- 1cm plastic blocks, small plastic toy homes (found in games) or Legos to represent buildings and neighborhoods
- Paintbrush (watercolor size)
- Popsicle sticks
- Toothpicks
- Plastic spray bottle
- Measuring cups
- Water
- A large bucket to catch water (available at home improvement stores)
- Plastic wrap
- Permanent marker (Sharpie)
- Plastic two-liter bottle
- River shape worksheet
- River Observation Data Worksheet
- Carmen and Ernie's River Observation Guide
- Measuring tape
- Drill or hammer and nail (1/4 inch)

Part II: Materials for Investigation

Miscellaneous building materials for non-eroding channel: ex: modeling clay, blocks, rocks, tubing, foil or other materials that can act as a liner for a straight channel.

- **Optional:** camera devices such as iPads, cell phones or computer cameras to take pictures and/or video

*A smaller model can be created for an individual student using a cookie pan or disposable lasagna pan and a 12. oz water bottle in lieu of a stream table.

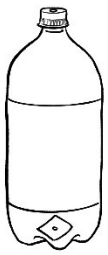
Setup: The Meandering River Model

Teacher will need either commercial stream tables or oblong shallow tubs (the kind for gift wrap) to be used for each group.

Option 1 Stream tables: Stream tables should be set up one per group and should be set up at a low grade of incline. Stream tables should be allowed to empty into a large bucket during the demonstration.

Option 2 Oblong Shallow Tubs: A hole should be drilled in the far end corner of the tub to allow the tub to drain after the demonstration. You can use cork or rubber stopper to plug the hole until ready to drain or use modeling clay to fill the hole as a stopper. Tub Stream tables should be set up one per group and should be set up at a low grade of incline. Tub stream tables should be allowed to empty into a large bucket during the demonstration.

Before class prep: Teacher will need to drill ¼ diameter hole into the lid of each empty 2-liter bottle, as well as create an additional hole at the base of the bottle. The base hole will be covered with duct tape. Fill bottles with water. The duct tape will act as a seal until ready to peel off of the base hole to create the water source.



Sand mixture: Teacher will prep a mixing tub with 2 parts sand to 1-part diatomaceous earth. It is recommended that each stream table will need 8-12 cups of sand and 4-6 cups of diatomaceous earth. Teacher should wear a mask while mixing this mixture, and soil must be dampened before giving to the student groups.

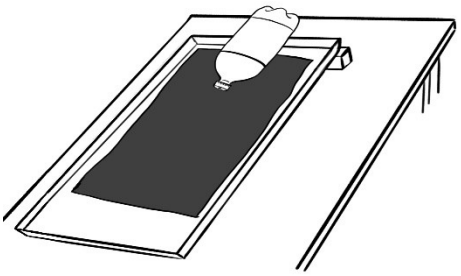
ENGAGE: The Meandering Rio Grande Folded Booklet and Carmen and Ernie's River Observation Guide

1. The students will read the Meandering Rio Grande Folded Booklet (or use the Meandering River Booklet Online). The teacher should use the History Behind It section of this lesson plan to answer any questions or provide more information regarding the Chamizal Treaty.
2. Teacher and students will read and discuss Carmen and Ernie's River Observation Guide to acquaint themselves with river terminology. This will help them to describe the changes that their river models will create when running water through the stream table. They should also review the different river shapes that the river took over the period from 1852-1907. Each group should choose one of the sample rivers to model with their stream table.

Part I Meandering River Model

After reading and discussing the **Meandering River Book and Carmen and Ernie's River Observation Guide** with the class:

1. Have the student groups choose a Traceable River Pattern (Rivers A-D) that the El Paso area Rio Grande had once taken. This will act as the river shape that the students will investigate.
2. Have students arrange the stream table and soil mixture as shown in this diagram.
3. The table should be propped up on one side at a low grade as opposed to a steep grade. Soil should be damp so that it is easily moldable but not soaking wet.
4. Using a sheet of plastic wrap as an overlay for the river pattern, students will trace the river pattern using the permanent marker.



5. Have the students place the overlay plastic wrap onto the soil mixture in the stream table. Using their fingers, they will create depressions onto the soil mixture in the shape of the river pattern. Once the pattern is visible on the surface of the sand, students will remove the plastic wrap to further carve out the river channel using their fingers, popsicle sticks and paint brushes to clear out the channel.
6. When the channel is clear, students may use the pebbles and small rocks to reinforce sections of the river channel while being careful that the rocks do not change the shape of the channel. Toothpicks may help with the placement of these pebbles.
7. Students may model neighborhoods using small blocks, toy houses or "Legos" on each side of the river.

8. Students will draw what their model looks like and measure the length of the river channel using the **River Model Observation Data Sheet Part I** found on the student pages. They may also take "before" pictures with their devices.
9. Once the data from the model has been collected, students may position the 2-liter bottle over the head of the river model and remove the duct tape seal from the end of the 2-liter bottle to create a water flow into their river. Students may create a movie of the effects of the flow if using devices to record the model.
10. Once the water has been drained from the bottle, students will collect data about what happened to their river model. First, they will remeasure the channel shape to see if the river's path became longer or shorter and record their measurements. Using **Carmen and Ernie's River Observation Guide**, they will describe the shapes that were made from the water flow on the model. They will then draw the path that was created by the flow in the "after" section of the data observation worksheet. They may also take "after" pictures with their devices.
11. Once the students complete their investigation, they will drain the water from their model into the bucket, remove the rocks, blocks and houses from the model and scoop the sand mixture into a tub to dry out for the next day's investigation.

Part II: Building and Testing a Channel Model

EXPLORE: Investigating the Rio Grande

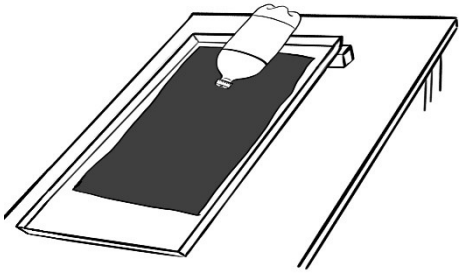
Teacher will use the same stream table set up used for Part I of this activity in order to create the model for Part 2.

Before class prep: Teacher will need to fill the 2-liter bottles with water, making sure to seal the bottom hole with duct tape. The duct tape will act as a seal until ready to peel off of the base hole to create the water source.

Sand mixture: If the soil from yesterday's investigation has not dried enough to create a new model, the teacher will need to prep a mixing tub with 2 parts sand to 1-part diatomaceous earth. It is recommended that each stream table will need 8-12 cups of sand and 4-6 cups of diatomaceous earth. Teacher should wear a mask while mixing this mixture, and soil must be dampened before giving to the student groups.

Building Materials: Teacher will set up an area with a variety of different building materials for students to choose from to build a channel. Sample materials may include: modeling clay, rocks/pebbles, plastic tubing, plastic wrap, aluminum foil, craft sticks, etc.

Procedure:



1. Have the student groups choose from different building materials to help them construct a channel that will not erode after heavy rains and flooding.
2. Students will arrange the stream table and soil mixture as shown in this diagram. The table should be propped up on one side at a low grade as opposed to a steep grade. Soil should be damp so that it is easily moldable but not soaking wet.
3. Using their fingers, students will create depressions onto the soil mixture in the shape of a straight river. Once the river has taken shape, students will further carve out the river channel using their fingers, popsicle sticks and paint brushes to clear out the channel.
4. Students will construct a river channel using the building materials they have. Their goal is to have their channel withstand heavy rains and flooding so that it would not meander or change shape.
5. Students may model neighborhoods on each side of the river using small blocks, toy houses or Legos.
6. Using the **River Model Observation Data Sheet Part 2** included on the student pages, students will draw what their model looks like and measure the length of the river channel. They may also take "before" pictures with their devices.

Student Pages

7. Students may position the 2-liter bottle over the head of the river model by removing the duct tape seal from the end of the 2-liter bottle to create a water flow into their river. Students may create a movie of the effects of the flow if using devices to record the model.
8. After the water has been drained from the bottle, students will collect data about what happened to their river model for each trial. In each trial section the students will draw their model and any evidence of erosion. Their model will be tested four times, each time carefully draining the water from their model into the bucket.
9. Once the students complete their trials, they will remove the channel materials, blocks and houses from the model and scoop the sand mixture into a tub to dry out for the next day's investigation.

EXPLAIN: Researching the Causes of River Erosion and How to Develop a Testable Question.

Students will write a proposal to investigate a new river model, write a procedure for the model, and test the model. Teacher will brainstorm with students to come up with different ideas to test by posing the question, "What questions would you like to further investigate using your Rio Grande Stream table model?"

Next the teacher should provide guidelines to an investigable question:

The question should lead to something observable and testable. Words like affect and effect can be used in the question as well as Do, Does, What and Which. Try to steer clear of questions that cannot be investigated with a stream table model.

Possible investigable questions include:

- Does the height of the stream table affect the shape of the river? (change the grade of the stream table)
- Does the rate of flow affect the shape of the river? (experiment with different sized holes in the cap of the bottle)
- Do plants and rocks help stop erosion in a river? (use more rocks and perhaps string or pipe cleaners to simulate roots from trees along the river.)

- Do animals that live along the river have an effect on the erosion of the river? (investigating the effects of burrows and dams along the river)
- Which soil experiences the least amount of erosion? (test the effects of erosion on sand, silt, topsoil, etc.)

Once the student groups come up with an investigatable question, have the students further research meandering rivers and the causes for why rivers meander. Students should find out that rivers can change shape due to heavy rains, release of water flow from dams, deposition of rocks and silt that block the flow, plants and trees that grow along and in the middle of rivers during dry seasons, animals that create dams such as beavers and animals that burrow along the edges of the river. There are many reasons why a river can meander. This will help them come up with an informed hypothesis for their investigation.

Part III: Investigate Your Own River Model

After students have decided on a testable question and have done their research, they will be ready to write a procedure for their model, test and record their findings. Have the students write their procedure for their model in their science notebooks. Teacher should approve both their testable question and procedure before allowing students to proceed in building their models. Using the **River Model Observation Data Sheet Part 3** students will:

1. Fill in their testable question
2. Fill in the vocabulary that applies to their model
3. List the materials needed to create their model
4. Draw, measure and describe their model after building their model

On page 2 of the **River Model Observation Data Sheet Part 3**, students will:

1. Design their data collection (will it be a before and after data collection or a series of trials?)
2. Do their test on the model
3. Record their findings by drawing, labeling and describing what happened
4. Describe the advantages of the model
5. Describe the limitations of the model
6. Suggest improvements to the model
7. Write a conclusion that involves the hypothesis
8. Relate their model to the real world

VOCABULARY

arroyo	An arroyo is a steep-sided gully formed by the action of fast-flowing water in an arid or semi-arid region.
chamizo	The name Chamizal, comes from the chamizo saltbush. This **saltbush** shrub grew abundantly on El Chamizal, l and in the floodplain contested between the United States and Mexico.
channel	A channel is a bed where a natural stream of water runs.
dam	A barrier preventing the flow of water or of loose solid materials
deposition	Soil and rock that is loose and collects further down in a river to form islands and deltas.
erosion	Is the movement of soil or rock from one place to another.
flow	Describes the force and speed of the water as it flows through the river.
river	A river is a large natural stream of water flowing in a channel to the sea, a lake, or another such stream.
stream	A stream is known as a small, narrow river.
weathering	Is the breaking down of rock and soil as a result of wind, water, ice and biological influences.