Stream Channel Physics Curriculum

Objectives: The Student Will

- Recognize the three components of a river system.
- Comprehend the role erosion plays in a river system and wetland.
- Create variable erosion patterns with the placement of vegetation and change of shape of a river.
- Understand and calculate the flow velocity of a stream and its relative erosion potential.

Materials:

1. Stream Trailer
2. Piece of wood
3. Ruler
4. Pencils
5. Slope ruler (bubble level)
6. Small ball or marble
7. Stopwatch
8. String, open reel measuring tape, or map wheel
9. Copies of the "Stream Channel Worksheet"
10. Calculator (optional)
11. Vegetation Props (optional)

Activity Duration: 25 minutes

Introduction

Start with a meandering river & a straight-line river.

* Describe the trailer and hypothesize: which has the fastest velocity
* Why does slope and velocity matter to streams?
* How does that effect our land management or drinking water supplies?

What affects water in a river?

* Slope
* Size of particles
* Speed & amount of water

3 components of a river

* Water
* Sediment
* Vegetation

3 processes that change rivers

* Weathering
* Erosion
* Deposition

Urban effects.

* Concrete & Impervious surfaces
* Have you seen any of these things in real life?

Assign student roles (timer, measure, etc.)

* Faster flow in Straight river or meandering river?
* Importance of slow-moving rivers.

Measurements:

* Rise
* Run
* Flow time

Calculations:

* Slope
* Velocity
* Sinuosity

Measure and Compare the erosion in both shapes.

Factors that determine velocity:

* Slope
* Volume of flow
* Shape of stream

Recap questions

Procedures:

A few rules to remember as we go:

- Please be keep your hands out of the crushed buttons unless I have said otherwise
- If you have crushed buttons on your hands please do not wipe them off on the ground. It is plastic and we want to make sure it stays in the trailer.
- Always respect your classmates and instructor, listen carefully and participate fully. We need your help to make this lesson a success!

INTRODUCTION

Introduce the Stream Trailer

Start by introducing yourself with your name and where you work. Then continue with what makes up the trailer. Explain that the trailer has 1 tank that holds 100 gallons of water, then 2 pumps pump the water from the tank up into the pan of the trailer. The water goes down the river and through the black screen and back into the tank.

SETTING UP THE DEMO STREAM

Straight Line River System

To set up the sand, push the sand into the middle flattening it so that it is parallel with the top of the trailer. Take the piece of wood and push it through the middle of the sand.

Meandering River System

Setting up the sand, push the sand into the middle flattening it so that it is parallel with the top of the trailer. Then using your hand, draw out an S shape making sure to put the excess sand on the sides. You should be able to see the bottom of the trailer.

CONCEPTS

Straight Line River

Start with a straight line down the middle. Inform them that they are going to pretend that there are 2 reservoirs in the trailer. The first one is up at the top where the pumps are and the second is at the other end by the black screen. Have the students hypothesize what they think will happen when the water is turned on. Now, turn the pumps on and wait between 1-2 minutes for the water and or ball to reach the end of the trailer. After it reaches the reservoir, ask the students to describe what they are seeing. ASK: was your hypothesis the same as what happened? ASK: what is one of your vocab words that describes what is happening? ANSWER: erosion

Once the students connect erosion to what is happening in the river, have them point to where it is occurring. This leads to ASKING: what is falling into the water due to erosion and where does it end up? ANSWER: sediment; ends up in the lakes

Why Everyone Should Care

Connect erosion to time, energy, and money. You can see that as the time goes on erosion is occurring and the soil is falling into the river and being swept into the reservoir. ASK: “why do you think this is a bad thing?” while having them look at the “bottom” reservoir. Go on to say that the reservoir is where they get their drinking water. ASK: “would you want to drink that water that has the sediment?” After you finish asking questions, summarize why it is important to slow down erosion.

What Affects a Meandering River?

ASK: what are those curves called? OR Can you tell me the name of the curves? ANSWER: meanders. After you have defined what a meander is, explain how the more defined the meander is the older the river. **Slope:** The slope of the land affects the meandering river by increasing or decreasing the amount of energy the water has. The more slope a river has the more energy the water will have. SHOW: bend your arm at a 90 degree angle and raise it so that it is horizontal. ASK: "Will the water be flowing very fast if there is no slope?" Tilt your arm so that your fingers are going towards the sky. ASK: "I increased the slope of the river, will the water be flowing faster or slower?" ANSWER: the flow of the water will increase.

Size of the particle: there are many different size particles of sediment that are flowing through the river. These include gravel, sand, silt, and clay. The larger the particle size, the more energy needed to move the particle through the river.

Speed of water: speed of the water depends on the slope of the land, the size and shape of the river bed, the amount of water, and the amount of material carried by the water. The more slope the river has the faster the water will flow. The more curves or meanders a river has to move through the decrease in the speed of the water.

Different Shapes of a River

Straight: the river has no wiggle or meander in the stream channel. The water moves faster because there are no meanders in the river for the flow of the water to slow down. The water goes straight through, which increases the flow.

Meandering: The more defined the curves are the older the river system is. The meanders are formed when sediment from the outer curve of each meander erodes and deposits it on the inner curve further downstream. SHOW: aerial picture of the Red River and Trinity River**.**

Sinuosity: a measure of the wiggle or meander of a stream channel. Increase in sinuosity increases length of the river and results in energy dissipation. Indicators of energy dissipation: rocks, woody material, vegetation, adequate floodplain size, and overflow channels.

3 Components of a River System

Three components of a river system: water, sediment, and vegetation. The **water** accumulates in the channel, which is the deep part of the stream where water flows downstream. **Sediment**: Proper name for dirt is soil and when it enters into a body of water, it is called sediment. Sediment is any bit of rock or soil such as mud, clay, silt, sand, or gravel- even boulders. Excess sediment blocks out light, killing aquatic plants or preventing their growth. Sediment covers up the nooks and crannies where aquatic organisms live. It smothers fish by clogging their gills and by reducing the amount of dissolved oxygen in the water. **Vegetation** is an important part of the river, it helps hold soil in place, trap sediment, filter and cool the water, dissipate energy, slow the velocity of floodwater, enlarge the riparian sponge, increase the groundwater recharge, and sustain the base flow over time.

Flooding

Flooding: A floodplain is the relatively flat land extending outward on both sides of a stream or a river. This is where water flows over the river channel during flood events. Sediment is deposited onto the floodplain every time there is a flood. A straight river will flood downstream more frequently.

Weathering, Erosion and Deposition

Weathering, Erosion, and Deposition: Erosion- the wearing away of land surface materials, especially rocks, sediments, and soils, by the action of water, wind, or ice; usually includes the movement of such materials from their original location. Soil particles are more likely to be dislodged and carried away by water. Erosion and deposition are in balance when eroded bank material is being deposited not far downstream, building a new or expanded point bar and helping create sinuosity. Erosion of topsoil build-up in streams and lakes can harm aquatic life. Degradation- a geologic process that lowers the stream channel due to erosion. Aggradation- the geologic process by which a stream bottom or floodplain is raised in elevation by the deposition of material.

Human Impacts

Human impacts: the USGS did a study on the effects of urban development on stream ecosystems in 9 metropolitan study areas. One of them was the Dallas and Fort Worth Metropolitan area. The study stated that there was an increase of contaminants in the water with urban development. Urban development increases the amount of water entering a stream after a storm, while decreasing the time it takes for the water to travel over altered land surfaces before entering the stream. In urban areas, water must quickly be drained from roads and parking lots in order to reduce flooding. This increases the amount of water that is entering into a river within a shorter period of time. This increase can lead to stream flashiness and altered stream channels. Stream flash flood is when streams rise and fall due to the response to storms. The quicker a stream rises and falls the flashier it is. Since the runoff water is flowing quickly, there is a decrease in the amount of water available to infiltrate the soil and recharge the aquifers. When the hydrology of the stream is altered, the physical habitat of a stream becomes degraded from channel erosion.

Importance of slow moving rivers

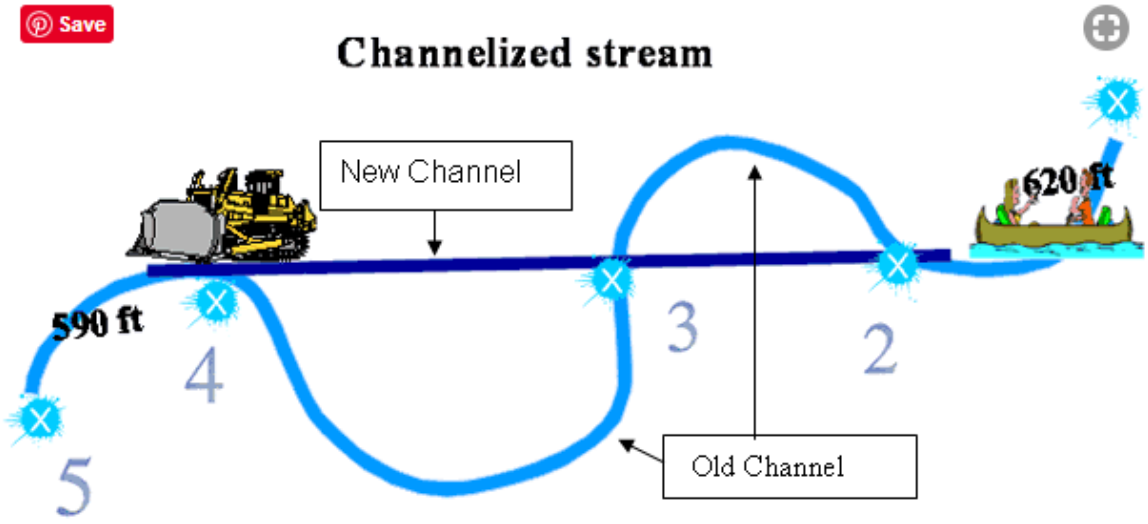
A slow river flow is important because of its impact on the habitats and the organisms existing in it. When sediment is introduced to slow flowing streams, it can easily settle to the bottom, while fast-flow streams impede the settling, keeping the sediment suspended for longer periods in the water column.

Measurements & Calculations[1]

Measurements

1. In the trailer, measure the vertical height (Rise) of the upper end of the level with the ruler.
2. Measure the length of each channel (Run) using flexible tape, string or a map wheel.
3. With a stopwatch, measure the amount of time it takes for the ball (or water) to go from top of each channel to the bottom.

Actual Length (stream miles) vs. straight-line length



http://mostreamteam.org/activity_guide/stream_channel/short_float.htm

Calculations

1. Calculate the slope: divide the rise over the run, and multiply the result by 100.
2. Calculate the velocity: divide the length of the channel over the time it took for the ball to reach the bottom of it.
3. Calculate the sinuosity: divide the channel length over the straight-line length from top to bottom of the channel.
4. Calculate the relative erosion potential: square the velocity.

Once done with the calculations, ASK:

Which slope is the steepest?

Which slope is the shallowest?

What 3 factors determine the velocity in each channel? A/ slope, volume of flow, and shape of streambed.

If you straighten the channel, what will happen downstream? Why?

[1] Texas A&M AgriLife Extension, "Current Events- Watching how streams and Rivers Flow".

STREAM CHANNEL WORKSHEET

Stream Channel Worksheet								
Channel	Height (in)	Actual Length (in)	Straight-line Length (in)	Slope (%)	Time (sec)	Velocity (in/sec)	Relative erosion potential (vel^2)	Sinuosity
Straight								
Sinuous								
Meandering								

- Slope:
$$\frac{\text{Height}}{\text{Length}} * 100$$
- Velocity:
$$\frac{\text{Length}}{\text{time}}$$
- Sinuosity (dimensionless):
$$\frac{\text{Actual Channel Length}}{\text{Straight} - \text{line Length}}$$