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"River Systems 2": A Lesson on Rivers; Channel Erosion and Stages

Prerequisite: This lesson follows the previous lesson on watersheds and streams. The focus is shifted from the creation of streams and rivers to the interrelationship of topography, waterflow, and deposition of soils to alter both the riverbed and banks as well as the land surrounding the channel.

Time: It is best to allow two short periods or one block period for this lesson.

Concepts:

- **Stages of rivers as a function of shape and erosion more than of time**
- **Water volume and sediment deposits as a function of time, erosion, and gradient**
- **Changing topography and the motion of river banks: meanders, flood plains, and oxbow lakes**
- **Flow vectors as a representation of current**

<u>Exploration</u> [the section of the lesson that informs you, the teacher, about what the students know and believe about river systems]:

Materials and Instruction: [Students work in pairs with crayons and large butcher block paper. Also have available for each pair one small toy boat no larger than a toy matchbox car that they can place on the paper.]

Instructions to students:

"On your sheet of paper, draw a picture of a river that allows a scale of about 10 miles from one end of the paper to the other. Indicate the direction of flow with a few arrows, and label the compass directions as well. When you have finished, imagine you are paddling the boat upstream starting from the most downstream location on your picture and finishing at the most upstream part of your picture. Discuss and demonstrate the route you would paddle the boat so that you could move upstream as quickly and easily as possible." [Note: Allow about 15 - 20 minutes for this activity. Circulate through the room to monitor and inquire about student strategies.]

Possible Questions to Pose to Students:

How long is your river?

How wide is your river?

Why did you place north, south, east, and west the way that you did? Could you have drawn these differently? Would it be correct if you had?

Why does the river flow in the direction that you indicated? Could it flow in the reverse direction? Why or why not?

Why does the river have the shape you gave it? Is there anything that would cause the river to be shaped that way?

Do you imagine that your river looked like this always? Could it? What, if anything, might change the shape of your river?

Is the current the same anywhere and everywhere on your river? Where is it faster or slower and why? Where would you direct your boat so that you can paddle it the fastest with the least amount of effort? Why this particular route?

Invention: [The section of the lesson where students learn the concepts and the scientific language for the concepts that define the science content]

Instruction: Having already identified those students whose illustrations make for excellent discussion, ask them beforehand to share their drawing and their reasons for their drawing with the class at the front of the class. They may do this together as a pair *and with at least five minutes advance warning*. At the end of each presentation ask the class if they have any questions for the presenters. Then have the students demonstrate how they intend to paddle their boats to move them the fastest with the least amount of effort.

After three or four pairs have shared their illustrations, ask if there are any other volunteers from the class who would also like to share. Again ask for questions from the class. *Without giving any indication about whose illustrations are best or better*, ask students to read in their text the sections about river systems [sample included here]. They should follow their reading with a paired discussion about the illustrations they drew, how they would change them, and how they would answer the questions on the overhead [placed on the overhead again].

There will also be discussion and questions regarding the reading itself.

Sample Reading:

Sager, R.J.; Ramsey, W.L.; Phillips, C.R.; Watenpaugh, F.M., (1998). *Modern Earth Science*. New York: Holt, Rinehart and Winston, 250-251.

13.2 River Systems

Stages of a River System

As a river erodes its banks and bed, it changes the landforms it passes through and alters its own course. The development of a river system is divided into three stages --- youthful, mature, and old. These stages are not based on the actual age of the river but on its shape and how it erodes the land. The time required for a river to pass through each of these stages depends on the composition and structure of the rock through which the river flows.

Youthful Rivers

In its youthful, or early stage, a stream usually erodes its bed more rapidly than it erodes its banks. This produces a V-shaped valley with steep sides, like the one shown in Figure 13-6. Waterfalls and rapids are common features of youthful streams. These features are especially common in stream channels cut into hard rock, because the rock resists erosion.

Youthful rivers usually have relatively few tributaries. For this reason, a youthful river usually carries a small volume of water. Much of the precipitation falling on the watershed of a youthful river system does not reach the main stream because so few tributaries have developed. Instead, much of the precipitation may form lakes at high elevations.

Mature Rivers

A mature river, by comparison, has well-established tributaries. It drains its watershed effectively. Because of good drainage and many tributaries, a mature river can carry a larger volume of water than a youthful river can carry. A mature river, however, tends not to deepen its channel as much as a youthful stream does. Instead, erosion occurs mostly along the valley walls when the river overflows its banks and covers the valley floor. A mature-river channel usually occupies only a small part of the wide and relatively flat valley floor that it produces. Most of the waterfalls and rapids that existed during the youthful state of a mature river have disappeared. The gradient also has become less steep.

A mature stream with a low gradient tends to curve back and forth across the flat valley floor. A slight bend in the stream channel usually becomes a wider curve, because the water flows fastest around the outside edge of the curve. The faster-flowing water erodes the outside bank of the curve more quickly than the

slower moving water erodes the inner bank. The slower-moving water often deposits sediments along the inner bank. This process enlarges the curve and shifts the stream channel toward the outside bank. Generally, a series of these wide curves, called **meanders**, form across the valley floor.

Frequently, a meander becomes so curved that it almost forms a loop, separated by only a narrow neck of land. When the river eventually cuts across this neck, it deposits sediments at both ends of the meander and eventually abandons it. The meander is thus isolated from the river, as shown in Figure 13-7. If the water remains in the abandoned meander, an **oxbow lake** is formed.

Old Rivers

As a river continues to age, its gradient and velocity decrease. The stream no longer erodes the land; instead, it begins to deposit its sediments in its own channel and on its banks. A broad, flat plain is formed. More meanders develop, and there are fewer tributaries, as smaller tributaries merge and become larger. How do you think the drainage of an old river compares with the drainage of a mature river?

Rejuvenated Rivers

Any movement of the earth's crust that increases the slope of the land will change the gradient of existing streams. A rejuvenated river is one whose gradient has become steeper in this way. The increased gradient of a rejuvenated river allows the river to cut more deeply into the valley floor. Rejuvenation often results in the formation of steplike terraces on both sides of a stream valley. These terraces provide evidence that the valley floor has been uplifted and a new floor has been cut through. There are many terraces along the Mississippi River.

<u>Discovery:</u> [the section of the lesson where the students' understanding is challenged with questions that apply the concepts or confront the concepts with compelling and credible arguments from misconceptions on the topic]

Activity: [Keeping students in pairs] Have students revisit their previous illustration and reassess which route they would select for their boat paddle. Also, describe what a flow vector is and have them draw many of them on their illustrations (note: *a flow vector is an arrow whose length represents the speed of the water at that location and the direction it is pointing represents the direction of water flow at that point*). Then ask students to demonstrate the path of the boat upstream and to relate the path taken to the flow vectors drawn. Finally, ask students to locate places on the river where they would choose to fish, where they would build a house and a dock for their boat, where they would consider buying land and where they would not, where they would choose to plant a garden, where they would look for a place to gather sand for a concrete company, etc.

The activity described above could be continued as homework.

Computer Research Project and Assessment:

Students may also demonstrate their knowledge of rivers by joining with their partners to identify at least five major world rivers, print images of them, and discuss their respective stages and aspects of human development and activity along the rivers. They should write a brief report about what they find and how it is related to what they learned about rivers. Guiding questions may be generated with the students in class prior to the activity.

The images students identify may later be used as an assessment of the concepts of instruction. Project the image and ask students to write descriptions of the type of river, its age, and to describe the observations that support their conjectures (note: students may be permitted to have an open-book assessment so that they may reference their texts and notes for this activity). This assessment may be written individually and handed forward. Students may follow up with pair work to discuss their answers, rewrite their solutions, and share these with one other pair before making their final revisions to be handed in a second time. Finally, there will be a class discussion on the images displayed and student explanations.