EROSION: ON THE MOVE...DEFENDING THE COAST AGAINST WAVE ATTACK

GRADES 5-8

JANIECE MISTICH

TIME ALLOTMENT:

Introductory Activity: 15 minutes
Learning Activity: 60-75 minutes
Culminating Activity: A) Research: 45-60 minutes
B) Group Discussion/Planning: 30 minutes
C) Trials with Model: 60-75 minutes

OVERVIEW:

Erosion is defined as the gradual wearing away of land by water, wind, ice, and general weather conditions; or the diminishing of property by the elements. The forces of erosion have changed landscapes the world over. Erosion has been responsible for the creation of waterfalls, streams and canyons, as well as the wearing away of sand dunes and beaches. Erosion can be both natural and man-made. Many of the things that man does to prevent erosion actually contribute to it.

In this lesson, students will learn about beaches and explore some of the ways people have tried to save them from wave erosion. Students will discuss the pros and cons of various methods to prevent beach erosion and learn to map the changes that have occurred to the barrier island at Cape Hatteras.

SUBJECT MATTER:

Environmental Science, Physical Science

LEARNING OBJECTIVES:

Students will be able to:

- Predict the effects of moving water on sand.
- Understand the processes of erosion and deposition occurring along coastlines and the causes of each
- Model an erosion simulation
- Compare the effects of parallel waves versus longshore waves on coastline shape
- Understand the different methods of shoreline erosion control and their benefits and disadvantages
- Understand the implications of building structures too close to the shoreline
- Make manual GIS overlays to compare changes in a shoreline as a result of parallel and longshore waves, and after implementing the use of an erosion control

STANDARDS:

National Geography Standards
http://www.ncge.org/publications/tutorial/standards/

Essential Element I: The World in Spatial Terms

Standard 1: How to use maps and other geographic representations, tools and technologies to acquire, process and report information from a spatial perspective.

Essential Element III: Physical Systems

Standard 7: The physical processes that shape the pattern of Earth's surface.

Essential Element V: Environment and Society

Standard 14: How human actions modify the physical environment.

Standard 15: How physical systems affect human systems.

National Science Education Standards
http://bob.nap.edu/html/nses/
Content Standard A: Science as Inquiry

Louisiana Science Frameworks:
State Standards for Curriculum Development
http:www.doe.state.la.us/doe/assessment/standards/SCIENCE.pdf

SI-M-A2: Designing and conducting a scientific investigation

SI-M-A6: Comparing alternative explanations and predictions

SI-M-A7: Communicating scientific procedures, information, and explanations

SI-M-B6: Communicating that scientific investigations can result in new ideas, new methods or procedures, and new technologies

(continued)

SI-M-B7: Understanding that scientific development/technology is driven by societal needs and funding
ESS-M-A7: Modeling how landforms result from the interaction of constructive and destructive forces
ESS-M-A8: Identifying the man-made and natural causes of coastal erosion and the steps taken to combat it
ESS-M-B3: Understanding that earth processes such as weathering and erosion affect the earth today and are similar to those which occurred in the past
SE-M-A4: Understanding that human actions can create risks and consequences in the environment
SE-M-A10: Identifying types of soil erosion and preventive measures

MEDIA COMPONENT:

Video:
Enviro-Tacklebox™—*Erosion: On the Move*
While reviewing the work of running water, waves, wind and ice, viewers explore the importance of soil as a resource necessary for our present and future generations.

Web sites:

Enviro-Tacklebox™ http://www.envirotacklebox.org This is Louisiana Public Broadcasting's Web site providing teaching information, films, articles and student activities involving environmental science.
WETMAAP: Wetland Education through Maps and Aerial Photography http://www.wetmaap.org This Web site provides students with information about Cape Hatteras and the effects of wave erosion on the historical lighthouse on its shores. Students are provided with background information, habitat slides, ghost fleet maps, shoreline change maps, habitat, topographic, land change maps and aerial photography for the Cape Hatteras site.
How to Prevent Erosion http://www.needham.mec.edu/High_School/cur/Envir98_99/p4/mbp4/prevention.html This Web site includes descriptions of various methods of wave erosion control.
Shoreline Engineering http://cse.cosm.sc.edu/hses/coastal/pages/shore.htm This Web site shows pictures and contains descriptions of different methods used to control shoreline erosion.
Living Along the Shoreline http://www.glc.org/living/pdf/living.pdf This Web site explains different types of structures that can be used to prevent shoreline erosion and shows pictures of each.
Human Intervention on Our Coast? http://www.cofc.edu/CGOInquiry/human.htm This Web site focuses on jetties, groins, beach nourishment, and seawalls.

MATERIALS:

Video: Enviro-Tacklebox™—*Erosion: On the Move*
Per Group (Introductory Activity):
- Rectangular Aluminum pan
- Plastic cup
- Dry sand (one cup)

Per Group (Learning Activity):
- Paint pan with sloped side
- 2-3 houses from a monopoly game
- water
- sand
- 2 sheets of clear acetate (transparencies) slightly larger than paint pan
- 3 fine point permanent markers of different colors

Per Group (Culminating Activity)
- Same paint pan used in learning activity
- 1 clear acetate sheet (transparency)
- sand for pan
- water
- 4-5 fine point permanent markers of different colors
- Materials for creating model groins, jetties, seawalls, breakwaters, etc. (ask students to bring in own materials for creating their structure)

PREP FOR TEACHERS:

1. Prior to teaching the lesson, view ***Erosion: On the Move*.**

2. **CUE** the video to the segment right after you see the words *Gulf of Mexico* and a map of the Gulf Coast.

3. Bookmark the Web sites used in the lesson for each computer in your classroom or in the computer lab.

4. Divide students into groups of four for the activities.

5. When using media, provide students with a **FOCUS FOR MEDIA INTERACTION**, a specific task to complete and/or information to identify during or after viewing of video segments, Web sites or other multimedia elements.

INTRODUCTORY ACTIVITY:

1. Provide each group with a rectangular aluminum pan. Pour a cup of dry sand at one end of the pan. Ask students to find at least two ways that the sand can be moved to the other end of the pan. Give students the following rules:
   - Don't pick up the pan.
   - Don't move the desk.
   - Don't let any part of your body touch the sand.
   - Continue the action until you have moved most of the sand from its original position (not necessarily to the other end of the pan).
   - Describe in written form the new appearance of the sand and its location after each attempt.
   - After each attempt, move the sand back to one end of the pan before trying another method.

2. Have students discuss possible ways to move some of the sand to the other end of the pan, using these rules. After making a plan, have each group try it out. (Encourage students to think about how sand moves in nature if they are unsure of how to start.) After students have finished, discuss results.

3. Ask students, "What forces in nature move sand?" **(*wind and water*)** How did different groups simulate wind? Water movement? **(*blowing on the dry sand, waving a piece of cardboard or stiff material to create air movement, pouring water on top of the sand, putting water in the other end of the pan and creating wave movement with a ruler, etc.*)** "Did you do anything that caused it to move faster or farther? **(*increased the speed of the action: i.e., stronger wind, stronger wave movement, heavier pouring*)**

4. What did they notice about the shape the sand took after blowing on it or causing air to move over it? **(*it spread out and covered the other side of the pan and/or built up in piles on the other side of the pan*)** What do we call these piles of sand? **(*dunes*)** What happened to the sand that was "rained on"? **(*First, water soaked into the sand, then the sand slid downward and spread out along the bottom of the pan*)** What happened to the sand that was hit with wave action? **(*It was pushed up onto the sand pile and then pulled out into the middle of the pan. The height of the sand pile decreased.*)**

5. Ask, "What do we call the movement of sand or soil from one location to another?" **(*erosion*)**

6. Tell students that today they will learn about one type of erosion, beach erosion, and how it occurs.

LEARNING ACTIVITIES:

1. **Provide students with a Focus for Media Interaction,** asking them to view the video segment about wave action on beaches to determine some of its effects. **Play** the video from the cued part until right after you see a red sign saying *Warning Hazardous Beach Erosion* and then see the land that has been eroded to look like a cliff (37 seconds). **Pause** the video.

2. Ask, "What effects of wave action did you see? **(*eroded beaches, land embankments falling into the water*).**

3. Ask, "What did you notice about the placement of the homes and buildings on the beaches?" **(*They were built very close to the edge where the beach meets the water.*)** Ask, "Why is the placement of these buildings creating a problem?" ***(The waves are washing out the foundations from under the buildings, as the beach disappears because of wave action, the buildings are getting closer and closer to the water).***

4. Tell students they will explore the effects of wave action on beaches. Have students get into small groups (3-4 students per group). Provide each group with the materials listed above.

5. Have students cover the sloped end of the paint pan with sand about two centimeters deep and gradually decreasing to one centimeter deep at the bottom of the slope. Stop the sand about one centimeter into the bottom of the pan from the slope, making sure it is parallel to the end of the pan. This will be the beach. Place a few monopoly-sized houses up and down the beach at different distances from the water.

6. Carefully add water to the bottom of the pan until the depth is one centimeter.

7. Take a piece of clear acetate a little wider and longer than the size of the pan and lay it on top of the model.

8. Use a permanent marker to make a tic mark on the acetate to show each corner of the pan. Then draw the outline of the beach edge on the acetate.

9. Have students hypothesize what will happen to the shape of the beach and the houses when they create wave action that hits the beach in parallel waves. Use a different color marker to make a dotted line on the acetate that shows where they think the beach will be after they make waves.

10. Remove the acetate and lay it to the side for use later.

11. Make waves by lifting the end of the pan opposite the beach about 3 cm off the table and quickly returning it to the starting position. Repeat this every five seconds for one minute. These waves should be parallel to the beach.

12. Observe changes to the beach. Place the acetate back on top of the pan and use a third color to mark the change made in the beach. Compare the hypothesized change to the actual change.

13. Rebuild the sloping beach and replace the houses in the same approximate locations along it. Take a new sheet of acetate and repeat step 8, marking where the corners of the pan are and the beach edge. Hypothesize what will happen to the beach and houses when angular waves **(*longshore waves*)** are created and mark their hypothesis with a dotted line of a new marker color on the acetate.

14. Make waves again. This time lift one of the corners of the pan opposite the beach about 3 cm off the table and quickly return it to its starting position. Repeat this action every five seconds for one minute. The waves should hit the beach at an angle.

15. Observe changes to the beach. Place the acetate back on top of the pan and use a third color to mark the change made In the beach. Compare the hypothesized change to the actual change.
16. Lay the acetate sheet created in Step 12 on top of the acetate sheet created in Step 15, making sure to match the corner tic marks. Ask, "Do both types of waves **(*parallel and longshore*)** change the beach in the same way? Why or why not? **(*the angle of the waves moves the sand in different directions*)** Which type of wave action changed the beach the most?

CULMINATING ACTIVITIES:

A1. **Provide students with a Focus for Media Interaction,** asking students to look for problems that occur when people build homes and businesses on beaches. **Resume** the video and play until right after you hear the words, "And this place by the sea almost became a place in the sea after the same waves worked on the ground below," and you see the edge of the dock with no sand below it (32 seconds). **Stop** the video and **Fast Forward** to the picture showing the west coast and the words *Wash-away Beach.* **Pause** the video. Ask, "What are some problems that occur when people build homes and businesses on beaches? **(*waves actually wash the sand from under the structures, causing them to collapse into the water, beaches disappear from in front of hotels, homes, etc.*)** What are some things that are being done by people to try to stop beach erosion? **(*rock jetties, hurricane walls, and underwater artificial reefs have been placed at the beach edge to slow wave action*).**

A2. **Provide each group with a Focus for Media Interaction,** asking them to watch the video to learn about some other methods used by people to stop beach erosion. **Resume** the video and play until you see sand being pumped onto a beach through a large pipe and after you hear the words, "Pumped in sand, or beach nourishment is also being used to combat beach erosion." **Stop** the video and **rewind** it to the beginning of the segment showing the Cape Hatteras light house. Ask students, "What are some techniques being used to stop wave erosion at Wash-Away Beach? ***(An underwater dyke and groin have been placed offshore and are slowing down beach erosion. New sand is being pumped back onto the beach to replace the lost sand.)***

A3. Tell students that in the culminating activity they will model one of the techniques used to slow down beach erosion to see what effects it has on the beach.

B1. **Provide students with a Focus for Media Interaction,** asking them to access the following Websites to obtain information about one of the techniques used to slow down beach erosion:
- **How to Prevent Erosion** http://www.needham.mec.edu/High_School/cur/Envir98_99/p4/mbp4/prevention.html This Website includes descriptions of various methods of wave erosion control.
- **Shoreline Engineering** http://cse.cosm.sc.edu/hses/coastal/pages/shore.htm This Web site shows pictures and contains descriptions of different methods used to control shoreline erosion.
- **Living Along the Shoreline** http://www.glc.org/living/pdf/living.pdf This Web site explains different types of structures that can be used to prevent shoreline erosion and shows pictures of each.
- **Human Intervention on Our Coast?** http://www.cofc.edu/CGOInquiry/human.htm This Web site focuses on jetties, groins, beach nourishment, and seawalls.

B2. Rebuild the sloping beach. Take a new sheet of acetate and mark where the corners of the pan are located and along the beach edge. Place the acetate sheet aside for later.

B3. With your group members, construct one of the model techniques you researched. Repeat steps 13-15 at least three times, using the model to see how it affects beach erosion. Vary the speed at which you create the waves to see if the results change.

B4. Record changes to the beach using a new acetate sheet and different markers for each trial.

B5. Share your results with the rest of the class in the form of a report, showing pictures of the type of method used, how it was supposed to work, and how it actually did work.

B6. **Provide students with a Focus for Media Interaction**, asking them to watch the last segment of the video to see how one very important historical landmark was nearly washed away and how it was rescued from the sea. **Resume** the video and play it until you see the lighthouse moved in away from the ocean's waves and you hear, "Here it is hanging out in the ocean, and here it is today." Ask students, "How was the lighthouse rescued from the disappearing beach?" **(*It was moved inland, away from the waves*)**

B7. **Provide students with a Focus for Media Interaction,** telling them to access the WETMAAP Cape Hatteras Site to see how the coastline of Cape Hatteras has changed over a period of 128 years and how close the lighthouse came to falling into the ocean.

- Access the Web site: http://www.wetmaap.org.
- Select *Wetmaap Sites* from the menu at the top of the webpage.
- Select *Cape Hatteras* from the map.
- Select *Shoreline Change Map* from the Focal Elements of Study List.
- Click on the words ***Click to see this map in motion*** under the page title to see the changing coastline.

Notice how close the coastline got to the lighthouse before it was moved. Ask, "Based on what you learned from the Culminating Activity, are there any other methods that might have worked to save the lighthouse from falling into the ocean?" **(Students should conclude that some of the methods might have worked temporarily, however, the lighthouse would have eventually ended up in the sea because none of the methods provide a permanent solution. Moving it away from the edge of the ocean was the best way to save it. In the end, nature always wins.)**

CROSS-CURRICULAR EXTENSIONS:

GEOGRAPHY:

- Have students research land forms created/affected by wave action (dunes, berms, beach, inlets, barrier islands, etc.) and create a poster diagram to explain each.
- Use the WETMAAP Web site: http://www.wetmaap.org to access the Cape Hatteras Wetmaap site and watch the changes that have occurred to the shoreline. Select *Shoreline Change Map* from the Focal Elements of Study List. Then click on the words ***Click to see this map in motion*** to watch the changes to the shoreline of Cape Hatteras over the last 128 years.
- Have students map the changes that have occurred along one of the barrier islands in Louisiana in the last 50-100 years.

HISTORY:

- Read about the history of Cape Hatteras, Cape Lookout, or another barrier island and how man coped with the changing landscape.
- Have students research the shipwrecks that occurred off the coast of the Outer Banks, the "Graveyard of the Atlantic."
- Have students learn about one of the historical lighthouses that are members of the National Seashore Lighthouses and create a model of it.

SCIENCE:

- Research the natural dynamics that create and destroy beaches, such as sea-level rise, wind patterns, currents, and seasonal storms and explain to classmates how each one affects beaches.
- Research the different barrier island environments (marshlands, grasslands, dunes & overwash, berm, and ocean front beach) and explain how each one is affected by the changing natural dynamics and man-made changes.

COMMUNITY CONNECTIONS:

- Invite someone from the Corps of Engineers to speak to the class about methods used to prevent beach or stream erosion.
- Visit a beach to observe coastal processes: winds, waves, currents and tides**.**

STUDENT MATERIALS:

- None