Shifting Sands: How Our Coastlines Change

Developed by Morgan Treon, S.C. Sea Grant Consortium

About This Activity

Topic: Coastal Erosion Processes.

Grades: 4th–6th.

Lesson Length: Approximately 90 mins (two class periods recommended).

Theme: Coastlines are dynamic systems.

Objectives

Students will be able to:

- Define erosion.
- Describe how currents, waves, and wind change barrier islands.
- Explain how humans have modified coastal processes.
- Evaluate man-made solutions to prevent coastal erosion.

South Carolina College- and Career-Ready Science Standards Alignment

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

6-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Ocean Literacy Principles. #2 The ocean and life in the ocean shape the features of Earth.

Materials

- Internet access/computer and a projector, smart board, or other display.
- Shifting Sands Demo:
  - Sand or soil (can be purchased at your local hardware store).
  - Paddle or other flat tool (to make waves).
  - Clear tub, such as a Tupperware tub.
  - Dry-erase markers (3 colors per group).
  - Rocks and/or cardboard (to build seawall).
  - Metronome (www.metronomeonline.com).

Engage

Observations of Coastal Change (15–20 mins)

To introduce students to the idea that shorelines are constantly changing, visit the Google Earth Engine site (https://earthengine.google.com/timelapse/), which allows users to select a location and observe photos taken by satellite over time. A suggested list of locations in South Carolina to enter into the search bar on the timelapse website is below.

***Tip**: To help students hone in on a particular area, use the navigation tools to zoom into the area you want students to observe changes.*

Place of Interest	Location	Coordinates
Murrells Inlet	Murrells Inlet, S.C.	33.530273, -79.034726
North Inlet-Winyah Bay	Georgetown, S.C.	33.201813, -79.187069
Lighthouse Inlet	Folly Beach, S.C.	32.687443, -79.883318
Bird Key	Between Kiawah Island and Folly Beach, S.C.	32.633335, -79.988788

Deveaux Bank	Between Seabrook and Edisto, S.C.	32.552921, -80.184452
Hunting Island	Beaufort County, S.C.	32.343743, -80.457023

After allowing students to observe the timelapse of your selected area, have students respond to the following questions either independently or with a partner(s):

- What changes did you notice?
- What was the timescale of these changes (i.e., years, months, days)?
- Did these changes appear to follow any patterns?
- What stayed the same?
- Any other things you noticed?

After students have had time to answer the reflection questions about the timelapse, come together as a class to share observations. As students share their observations, point out these observations on the timelapse, pausing the animation as necessary. Suggested areas to point out include:

- Areas where sand increased or decreased.
- Direction of movement.
- Timeframe of movement.

Explore

Moving Coastlines (20–30 mins)

Now that students have observed that coastlines and barrier islands are moving over time, we will introduce how the shore changes through a lab/demo on coastal changes. The following lab is a slightly modified version of the Eroding Beaches activity by Sea. Earth. Atmosphere., a product of the National Oceanic and Atmospheric Administration, the Hawai'i Sea Grant College Program, and the Hawai'i Institute of Marine Biology.

The original activity can be found at the following link: https://manoa.hawaii.edu/sealearning/grade-3/physical-science/forces-waves/activity-eroding-beaches?q=grade-3/physical-science/coastal-erosion/activity-disappearing-beaches

Part A: Make a Beach Simulation Tank

1. Gather materials to model beach erosion and pass out to student groups of around 4–5 students.
    a. Rectangular dish (e.g. Tupperware container), sand, rocks of varying sizes, water, flat spatula, markers (3 colors), ruler, metronome
2. Have students use the ruler to mark each centimeter along the sides of your rectangular dish. This will help you measure beach erosion throughout the experiment.
3. Add enough sand to your dish that it covers the bottom. Push it all to one side to form a sloping beach.
4. Add water to your ocean model so that it covers the bottom of your dish and some of the sand. Note: There should be a section of sand above the water line (about 5 cm).
5. Reform your beach to ensure that:
    a. It has a uniform shape from side to side.
    b. There is at least a 5 cm wide beach above the water.
6. Use a marker to trace the slope of your beach on the outside of your container. Note: You will use this line to reform your beach in the same shape for each trial.
7. Make a “before” sketch of the side view of the beach. This is the beach profile.

Part B: Making Waves in Your Ocean Model

1. Use a metronome or sound recording (search metronome online) set at 60 beats per minute (or similar).
2. To make a wave, place the large side of your paddle in the water at the edge of your container on the opposite side of the beach. Move the paddle gently towards the beach in time to the beat.
3. Follow the metronome sound and use the paddle to make a wave at each second for 30 seconds. Note: Remind students to try to give each wave the same force with your paddle.
4. After 30 seconds, pass the paddle to the member of your group on your right and repeat. Continue until each student has had a turn. Tip: Have the metronome up for the class and pause for each rotation. Repeat the 30-second intervals until each student has had a turn to make waves.
5. After everyone has had a turn to make waves, use a different color marker to trace the

new line of the beach and mark the shoreline on the side of your container. Make an "after sketch" of your beach profile following the wave action and describe the changes you observed.

Part C: Building a Seawall

1. Using the original line you drew on your container, recreate the shoreline you started with.
2. Create a seawall by placing and stacking rocks and/or cardboard at the shoreline.
3. Draw another "before" sketch of the beach profile.
4. Repeat part B to test the force of the waves against the seawall.
5. Describe how your beach and seawall have changed.
6. Make an "after sketch" of the beach profile and seawall following the wave action and describe it.

Explain

Erosion and Coastal Engineering (15–20 mins)

Have students read the following article from NASA about shoreline change on Assateague Island, Virginia, and answer the following guided reading questions. A student worksheet and teacher answer key are included in the resources section of this lesson.

Article: https://earthobservatory.nasa.gov/images/145695/assateague-on-the-move

Elaborate

How can we design solutions to prevent erosion? (10 mins)

As a class, watch the following video, *Why Sea Walls Alone Won't Save Our Cities from Rising Seas* (www.youtube.com/watch?v=OMMLaV38EZE), and have students complete the supplemental notes in the resources section of this lesson.

After watching the video as a class, pull up the following website from NOAA about living shorelines (www.habitatblueprint.noaa.gov/living-shorelines/leading/).

- Guide students through the images on the website, asking them to share observations on the before and after images. Suggested class discussion questions for the images are below.

- What types of structures do we notice in the “before” images? Tip: Most images describe the coastline protection method that was in place before the installation of the living shoreline structure.
- What changes do we notice from the “before” photo to the “after” photo?
- Most images show an increase in plants growing near the shorelines.
- After reviewing the before and after photos, pass out or display at least one of the following resources for students to review prior to the next activity. Have students talk in small groups about the similarities and differences in the different approaches of “green” and “gray” shoreline stabilization.

    1. Infographic: How Green or Gray Should Your Shoreline Be? https://media.fisheries.noaa.gov/dam-migration-miss/md_1sP5p4cExhgY.jpg?1505221773
    2. NOAA’s Natural and Structural Measures for Shoreline Stabilization Brochure: https://coast.noaa.gov/data/digitalcoast/pdf/living-shoreline.pdf (pages 3–6)

    Optional: If students are interested in learning more about living shorelines, have students read the following resource on living shorelines from NOAA Fisheries: www.fisheries.noaa.gov/insight/understanding-living-shorelines

Evaluate

Evaluate: Letters from a Concerned Community (15–20 mins)

Now that students have learned about shoreline erosion and the impacts of seawalls as a form of erosion control, have them respond to the following prompt by writing a persuasive letter to a fictional character who is building a seawall. A suggested grading rubric is included in the resources section of this lesson.

Optional: Allow students to refer to the above shoreline stabilization graphics to assist them with constructing their argument in the writing prompt below.

Writing/Drawing Prompt

Bo Diamond has lived in his home at Creekside Beach for several years. Recently, he has noticed that as the shoreline has eroded, the water level is getting ever closer to his home. To help protect his home, Bo Diamond wants to install a shoreline stabilization method but isn’t sure

where to start. He recently learned about sea walls and has asked for help from your company in determining if installing a seawall in front of his home would be a good idea. Write Bo a letter to explain to him the impacts installing a seawall would have on his home and Creekside Beach, and propose one shoreline stabilization solution he may want to consider.

Be sure to include:

- An explanation to the homeowner of why their beachfront is changing.
- Describe at least one benefit to the homeowner of building the seawall.
- Describe at least one negative impact of building the seawall.
- Suggest an alternative solution to the seawall that will reduce erosion.
- Describe at least two benefits of the alternative solution.

Part A: Make a Beach Simulation Tank

1. Gather your materials to model beach erosion: rectangular dish (e.g. Tupperware container), sand, rocks of varying sizes, water, flat spatula, markers (3 colors), ruler, metronome.
2. Use the ruler to mark at each centimeter along the sides of your rectangular dish. This will help you measure beach erosion throughout the experiment.
3. Add enough sand to your dish that it covers the bottom. Push it all to one side to form a sloping beach.
4. Add water to your ocean model so that it covers the bottom of your dish and some of the sand. Note: There should be a section of sand above the water line (about 5 cm).
5. Reform your beach to ensure that it has a uniform shape from side to side and there is at least a 5 cm wide beach above the water.
6. Use a marker to trace the slope of your beach on the outside of your container. Draw a small mark where the water and sand meet. This is the shoreline. Note: You will use this line to reform your beach in the same shape for each trial.
7. Make a “before” sketch of the side view of the beach below. This is the beach profile.

My beach model: No wave erosion.

Part B. Making Waves in Your Ocean Model

1. To make a wave, place the large side of your paddle in the water at the edge of your container on the opposite side of the beach. Move the paddle gently towards the beach in time to the beat.

2. Follow the metronome sound, played by your teacher, and use the paddle to make a wave at each second for 30 seconds. Note: Try to give each wave the same force with your paddle.
3. After 30 seconds, pass the paddle to the member of your group on your right and repeat. Repeat until everyone has had a turn to make waves.
4. After everyone has had a turn to make waves, **use a different color marker** to trace the new line of the beach and mark the shoreline on the side of your container. Make an "after sketch" of your beach profile below, and describe how your beach changed.

My beach erosion model: Wave erosion.
Describe how your beach has changed.

Part C. Building a Seawall

1. Using the original line you drew on your container, recreate the shoreline you started with.
2. Create a seawall by placing and stacking rocks and/or cardboard at the shoreline.
3. Draw another “before” sketch of the beach profile below.

My beach erosion model with a seawall (before).

4. Repeat part B to test the force of the waves against the seawall.
5. Make an “after sketch” of beach profile and seawall following the wave action and describe the changes you saw.

My beach erosion model: Wave erosion and a seawall.

Describe how your beach has changed.

Guided Reading Questions: Assateague on the Move!

Article Link: https://earthobservatory.nasa.gov/images/145695/assateague-on-the-move

1. Where is Assateague Island located?

2. What type of island is Assateague?

3. What two forces are mentioned that are changing Assateague's coastline?

4. Which direction(s) is Assateague Island moving?

5. Is this movement of sand a new occurrence? How many years has Assateague Island been growing?

6. Looking at the image at the top of the article and moving the slider tool to reveal the changes between 1985 and 2019, describe one change you've observed. Hint: The text also describes some observable changes!

7. What unique animal has lived on the island for several hundred years?

Guided Notes: Why Sea Walls Alone Won't Save Our CIties from Rising Seas

Video Link: https://www.youtube.com/watch?v=OMMLaV38EZE

1. Miami is one of the fastest growing cities but also the most vulnerable to _____ _____. That's because hurricanes are _____, sea levels are _____, and homes are built _____.

2. While seawalls can provide some _____, they are only part of the puzzle and in some cases, they can make problems _____.

3. The three main types of seawalls are: _____, _____, and _____.

4. How much is the eight-mile proposed wall in Charleston, S.C. estimated to cost?
   $_____

5. A seawall only protects the property that is _____ the sea wall.

6. Seawalls can amplify effects, including:
   a. Making a site more susceptible to _____.
   b. Scouring can lead to instability issues, and potential _____ of the seawall.
   c. More _____ conditions can deflect water around the sea wall to adjacent unprotected shores causing _____ erosion and flooding.

7. Miami Beach is a type of _____ _____.

8. _____ one of the most biodiverse ecosystems, can break down and _____ their energy.

9. In North Carolina (and South Carolina too!) researchers study how _____ _____ slow down wave energy.

10. Restoring is _____ _____ another method to mitigate shoreline erosion.

11. Seawalls, whether concrete or nature-based, are only _____ of the _____.

12. True or False (circle one): There is no such thing as a “bad” structure, and seawalls can be useful if used in the correct way.

Suggested Rubric for Letters from a Concerned Community Activity.

Name: _____

Objective	**2**	**1**	**0**
The student describes why the beachfront is changing.	The student mentions longshore currents, waves, wind, or another factor that is causing the shoreline to change.	The student somewhat mentions the factors that are causing shoreline change.	The student describes a reason that the shoreline is changing, but it is not accurate or factual.
Describe one benefit of building a seawall.	The student includes one factual benefit of building a seawall, such as protection from erosion.	The student includes a benefit to the seawall, but it may not be factual.	The student does not include a reason why a seawall may be beneficial.
Describe one negative impact of building a seawall.	The student includes at least one negative of building a seawall, and they are factual.	The student includes a negative to the seawall, but it may not be factual.	The student did not include a benefit to building a seawall.
Provide an alternative solution to the seawall that will reduce erosion.	The student provides an accurate alternative to a seawall for shoreline protection.	The student provides an accurate alternative to a seawall for shoreline protection.	The student does not include an alternative solution for shoreline protection.
Describe why the alternative solution may be preferred over the seawall.	The student describes at least two accurate benefits of the alternative suggestion for erosion control.	The student only includes one accurate benefit of the suggested alternative erosion control.	The student does not include a benefit of the suggested alternate erosion control.

Total: __/10