

## Storm Surge Synthesis

Lesson plan for grades 6-8

Length of lesson: 45 minutes

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### **SOURCES AND RESOURCES:**

- Storm Surge Overview  
<http://www.nhc.noaa.gov/surge/>
- Storm Surges Simulation by Carol McRight  
[http://www.create.cett.msstate.edu/cosee/cosee-lplan\\_view.asp?articleID=18](http://www.create.cett.msstate.edu/cosee/cosee-lplan_view.asp?articleID=18)
- Storm Surge: Information, Facts, and Resources  
<http://www.thefreeresource.com/storm-surge-information-facts-and-resources>
- Kerry Emanuel: Hurricanes in the Gulf of Mexico: The History and Future of the Texas Coast  
<http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/gulf-hurricanes-our-history-and-future>
- Highlights From the 2005 Atlantic Hurricane Season  
[http://cimss.ssec.wisc.edu/satmet/modules/8\\_wild\\_weather/ww-11.html#tag](http://cimss.ssec.wisc.edu/satmet/modules/8_wild_weather/ww-11.html#tag)

### **POTENTIAL CONCEPTS & TEKS ADDRESSED THROUGH THIS LESSON:**

§112.19. Force, Motion, & Energy                      Grade 7: a4C

§112.19. Earth & Space                                      Grade 7: b8A

### **PERFORMANCE OBJECTIVES (in order of increasing difficulty to permit tailoring to various age groups):**

Students will be able to:

- Draw out what approach of hurricanes will damage coasts the most
- Compare the damage different coastal areas will experience from the same hurricane/which cities near the coast stand a better chance of surviving against a hurricane
- Describe how hurricanes cause erosion and the effect of erosion on the coast

### **MATERIALS (per group of four):**

- soil, sand, rocks
- water jugs
- cooking trays
- plates/boards/paddles
- popsicle sticks
- small water bottles (pins)

- ruler
- permanent marker
- medium balls (softball, soccer ball, basketball)

### **CONCEPTS:**

Hurricanes, as everyone knows, cause much damage. However, most damage isn't done by the lightning storms, rainfall, wind, or even tornadoes; it's done by storm surge. The storm surge is the water piled up by the cyclonic winds of the hurricane as it makes its way inland. There are many factors that affect the strength and height of the storm surge, particularly how steep/shallow the shore is, the width of the opening into the ocean, and the angle of approach the hurricane makes with the coast. The storm surge (along with the wind and rain) will cause erosion that magnifies the long-term damage a hurricane has on the coastline.

### **BACKGROUND:**

During his Hot Science –Cool Talks lecture, Dr. Kerry Emanuel says a storm surge behaves the same as a tsunami, except the giant volume of water is piled up by hurricane winds, not underwater earthquakes (minute 18:59). What conditions allow for a hurricane's storm surge to do the most damage? What evidence for storm surge vulnerability lies behind disasters such as the 1900 Galveston, TX Hurricane? Levees are built as giant walls to stop flooding. If a shore is aligned with the path of the hurricane, major damage by storm surge can occur. However, a direct hit perpendicular to the coast line would do the most damage: even more so if a shallow shoreline area is exposed to the ocean in front of the levee like in areas of New Orleans. Even high areas can lose support if the lower areas wear out from constant barrages of the heavy storm water (erosion). While concrete and rocks take longer to wear down, the Galveston, TX beaches are full of sand which is easy for the ocean water to remove, and make it easier to move inland. Dr. Kerry Emanuel says this was why hurricanes like Ike still did a lot of damage to Texas despite drills and better city planning (minute 30:49).

### **PREPARATION:**

For the bowling ball activity, depending on the number of students, the pins should be distributed as equally as possible while still having enough for each group (try to do 8-10 pins per group). Each group gets 1 ball.

Have the sand, dirt, and rocks, already in bags. Water will be available from pitchers and can be refilled via the sink. Each group of students gets 1 tray, 1 paddle, 1 jug, and 1 bag for each sand, dirt, and rocks.

### **ENGAGE:**

Make a bowling set out of bottles and a basketball/softball/soccer ball. Have a ramp and stage whose heights can be adjusted. Have the students do bowling while changing a couple of factors: the angle of approach and speed of the bowling ball and the height and slope of the ramp and stage. The pins will be on the stage (the pins are elevated since the hurricane often attacks from low to high, and the bowling ball goes up the ramp). The slope of the ramp is the key to the lesson (higher shores are affected less by storm surge).

Narration: A storm surge pushes against the shore and causes havoc. We can try to show this using bowling balls. Imagine a bowling ball as the storm surge and the pins as your houses. Depending on the path and angle, the number of pins/houses that fall will vary. We will also add the addition of angle since storm surges push water up the shore. Now try your best to throw the ball with the same strength each time, while changing the angle and height of impact.

Ask: What is the best way to knock over all of the pins?  
How did speed and angle affect impact?  
How did the height/slope of the ramp affect impact?

Note to teachers: Help to set up the sets to go by faster, and make sure kids change the factors each time

**EXPLORE:** Notes for the teacher: Now that we've taken an initial look at slope, speed, and angle of storm surges on shorelines, now we're going to further examine the shoreline's features to examine other factors. These factors are:

- A. How wide the shoreline is
- B. How shallow/steep it is.
- C. What material was used to make the shoreline

Instructions for Students:

1. Every group of students (3-4 students) gets a tray, bag of soil, rocks, and sand, popsicle sticks, and a shovel/paddle.
2. When making the coast of your city, determine how high the coast should be, if it should have a steep or shallow slope into the water, and whether the coast will be aligned along the wider or shorter side of the tray. This makeshift coast should take about 1/3-1/2 of the tray. Also determine what material is going to line up with the shore (the dirt, rocks, or sand).
3. Put popsicles into the soil. These are your buildings.
4. With the marker, trace the coastline on the tray for a reference to compare the original coastline to the eroded one later.
5. Now, fill the other half of the tray with water. Try not to disturb the soil.
6. Using your shovel/paddle, or your hands, try to push water from your "ocean" onto the soil.
7. With each surge of water, try to use your ruler to measure how much of the shoreline is being eroded. State whether the shore is being eroded from the shallow or deep end.

**EXPLAIN:**

- What occurred to the shoreline the more the water hit against it?

- What angle was most effective in taking out as much shore material as possible?
- Where did you observe more damage: Wider or narrower shores? Shallower or steeper shores?
- Which of material eroded faster? Soil? Rocks? Sand?
- Keep track of how quickly the soil eroded based on the combination of the 3 characteristics of their coastline. Try to get quantitative or qualitative data by using the ruler to measure the new shoreline against the traced line of the original shoreline
  - Material: dirt, rocks, or sand
  - Slope of Coastline: steep or shallow
  - Width of Coastline: narrow or wide

	Dirt	Rocks	Sand
<b>Wide &amp; Shallow</b>			
<b>Wide &amp; Steep</b>			
<b>Narrow &amp; Shallow</b>			
<b>Narrow &amp; Steep</b>			

**ELABORATE:** Using the picture of Hurricane Rita and Katrina’s path, the students will try to describe the relative damage afflicted to all the hit areas based on the angle of approach. These include:

1. Different parts of Florida
2. Mississippi, Louisiana, and Texas
3. Cuba
4. Mexico

Pictures from: [http://cimss.ssec.wisc.edu/satmet/modules/8\\_wild\\_weather/ww-11.html#tag](http://cimss.ssec.wisc.edu/satmet/modules/8_wild_weather/ww-11.html#tag)

**EVALUATE:** Now, using Hurricanes Wilma and Emily, whose paths differ significantly from the previous 2 in the elaborate section, the students will have to write down (individually now) which areas for each hurricane were hit harder by the storm surge based on the angle of approach.

Pictures from: [http://cimss.ssec.wisc.edu/satmet/modules/8\\_wild\\_weather/ww-11.html#tag](http://cimss.ssec.wisc.edu/satmet/modules/8_wild_weather/ww-11.html#tag)