

Storm That Drowned a City

PROGRAM OVERVIEW

NOVA reconstructs Hurricane Katrina's development and destruction and investigates causes of the flooding in New Orleans.

The program:

- reviews a computer model of a Category 3 hurricane that was shown to state and federal officials one year before Hurricane Katrina struck New Orleans.
- explains how hurricanes form and build in strength.
- presents how forecasters at NOAA's National Hurricane Center in Miami determine a storm's intensity and track.
- relates how U.S. Air Force personnel fly into a hurricane to gather information about a storm's wind direction, wind speed, pressure, humidity, and temperature.
- tracks Hurricane Katrina from its inception as a tropical storm to its Category 4 hurricane rating when it struck New Orleans.
- states how New Orleans—which is below sea level and sandwiched between the Mississippi River and Lake Pontchartrain—has traditionally relied on a system of pumps, canals, and levees to keep water out of the city.
- shows how Louisiana's wetlands, which can help reduce the impact of a storm surge, are being destroyed.
- interviews residents who did not evacuate and reports on what happened when the storm hit.
- notes that of the four major breaches in the city's flood defenses—two on the canal that flooded the Lower Ninth Ward and two in the northern part of the city—the northern breaches caused the most flooding.
- reviews how officials worked to repair the broken levees and to coordinate rescue efforts amid the turmoil that followed the storm.
- indicates that the northern breaches occurred because the flood walls failed to do the job for which they were designed.
- reveals that while hurricane frequency is cyclical, hurricane intensity seems to be increasing, possibly due to warmer sea surface temperatures brought on by global warming.
- explores whether or how New Orleans should be rebuilt, and whether residents will return to the city.

Taping Rights: Can be used up to one year after the program is taped off the air.

BEFORE WATCHING

- 1 Have students locate New Orleans and the Gulf of Mexico on a map. Then use a more detailed map of the city and point out Lake Pontchartrain, the Mississippi River, and the coastal wetlands.
- 2 Help students learn more about hurricanes by making a chart on the board (or a handout) that includes basic information about them (see Links & Books on page 5 for more information). Discuss the following with students:
 - What is a hurricane?
 - What causes it to form?
 - What are the main parts of a hurricane?
 - What stages does a hurricane go through?
 - What causes a hurricane to increase in intensity?
 - How are hurricanes rated?

AFTER WATCHING

- 1 Often before the arrival of major storms, people are asked to evacuate. Tell students that they are residents in a city that is 4 meters below sea level and a hurricane is heading toward the area. What might be some reasons they would leave or stay?
- 2 Some population centers are susceptible to area-wide hazards that may require evacuation. Ask students if they know what to do in the case of a disaster. Have them research their local civil defense plan. What hazards have people prepared for? How will citizens get instructions? What are citizens supposed to do? Have students find out what their school's emergency plan is. You might also have them create personal weather emergency plans.

CLASSROOM ACTIVITY

Activity Summary

Students will watch a teacher demonstration modeling how wetlands can help reduce a hurricane's impact and describe what the model represents.

Materials for Teacher

- steam kettle with spout
- hot plate or equivalent heat source
- protective gloves, such as oven mitts or rubber gloves
- materials with different mesh size, such as coarse window screening, fine window screening, cheesecloth, facial tissue, paper towel, cotton cloth (e.g., T-shirt), flannel, and diaper
- solid barrier, such as a block of wood, sheet of cardboard, or spatula

Materials for Each Student

- copy of the “Wetlands and Hurricanes” student handout

Background

Hurricanes need two basic ingredients to begin: a source of energy (warm tropical ocean waters) and a disturbance in the atmosphere (such as a thunderstorm). Most Atlantic hurricanes start as storm systems off the coast of West Africa. These storms move westward over warm, tropical ocean waters. A hurricane forms when warm, moist air rises from the ocean surface and begins to condense into storm clouds and rain. As the water condenses it releases heat, which warms the air around it. This warm air begins to rise; as it does so it is replaced by more warm, moist air from the ocean below. This cycle starts the hurricane's spinning motion. As a hurricane travels over the warm water it can gain more energy and increase in strength (a hurricane starts as a tropical depression before developing into a tropical storm and then a hurricane). A hurricane's strength diminishes as it moves over land and is robbed of its warm water energy source. Dense wetlands can help weaken a hurricane by breaking the connection between the hurricane and warm ocean water. Wetlands can also act as a physical barrier, slowing and reducing the force of the waves that reach the shore.

LEARNING OBJECTIVES

Students will be able to:

- record data related to how different meshed materials affect a steam plume.
- compare results and rate meshed materials according to how much steam each material blocked.
- infer how wetlands can sometimes help protect land from hurricanes.

KEY TERMS

hurricane: Intense rotating oceanic weather system with winds of at least 119 kilometers an hour.

wetlands: Lands that saturate with water. Wetlands vary greatly, and are found on every continent except Antarctica.

CLASSROOM ACTIVITY (CONT.)

Before Hurricane Katrina hit in 2005, the rate of loss of wetlands along Louisiana’s coast had been about 75 square kilometers per year, a loss that had been occurring for several decades. Some of this was due to natural processes such as tides and storm surges. Other losses resulted from dredging canals for sources of oil and for the use of commercial and recreational boat traffic through the wetlands. The dredged canals allowed salt water to mix with brackish and freshwater wetlands. In addition, the construction of levees and concrete channels to control the Mississippi River starved the coastal marshes of the fresh water and sediment necessary to restore and preserve them.

As a general rule, about a kilometer and a half of marsh can reduce a coastal storm surge by about 30 centimeters. The surge that hit the Gulf Coast when Katrina hit was close to nine meters—the highest ever recorded. The surge in Lake Pontchartrain was about three meters. Some scientists believe that a few kilometers of marsh could have lessened Katrina’s impact on Louisiana’s coast.

In this activity, students examine how wetlands can deprive a hurricane of some of the warm, moist air that supplies its energy. The steam represents the hurricane and different types of meshed materials represent dense and sparse wetlands. Students will record what happens to the plume of steam (hurricane) when different materials are placed in its path.

Procedure

- 1 Have students locate the tropical zone south of the equator on a map (the regions between 5° and 20° north and south of the equator are the belts where hurricanes can form). Review with students how hurricanes develop.
- 2 Choose the materials you would like to use. Make sure you use at least three materials of different mesh densities (see Activity Answer on page 5 for sample results). Organize students into teams. Distribute copies of the “Wetlands and Hurricanes” handout to each student.
- 3 Boil the water in the kettle. (You can make the steam more apparent by placing the kettle against a dark background.) **Safety note:** Steam scalds! Wear protective gloves. When placing materials over the spout tip of the kettle, as instructed below, hold the materials so your hands are below the spout tip. Stretch the materials taut over the spout’s opening so steam goes through the materials instead of being channeled out to the sides where it can scald your hands.
- 4 As the water heats, tell students that the water in the kettle represents the ocean, the hot plate represents the heat from Earth’s tropical zone that warms ocean water, and the steam plume represents a hurricane.

STANDARDS CONNECTIONS

The “Wetlands and Hurricanes” activity aligns with the following National Science Education Standards (see books.nap.edu/html/nses).

GRADES 5–8
Science Standard D
Earth and Space Science
Structure of the Earth system

Science Standard F
Science in Personal and Social Perspectives
Natural hazards

*Video is not required
for this activity.*

Classroom Activity Author
Developed by WGBH Educational
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CLASSROOM ACTIVITY (CONT.)

- 5 Ask students to record their observations about the plume of steam.
- 6 Ask students to predict how the different materials will affect the plume when you place them in its path. Have them record their predictions and reasoning.
- 7 Put on the protective gloves and place one of the materials across the tip of the spout. Have the class observe and record the effects on the plume of steam. Repeat the demonstration using the remaining materials. Explore how students' predictions compare to what actually happened.
- 8 Have each student answer the questions on his or her handout. Work with students to find answers to any additional questions they may have about wetlands.
- 9 As an extension, have students research where the nearest wetland area is to their school. Have them estimate the size of the wetlands and find during which months the wetlands are most likely saturated with water. Ask students to research the dominant soil type(s) and the names of some of the plants and animals that inhabit the wetland.

ACTIVITY ANSWER

Just as wetlands interfere with a hurricane's supply of warm, moist air, the materials placed over the kettle spout disrupt the connection between the warm, moist air produced inside the kettle and the plume of steam at the spout. The class should see that the plume's strength diminishes as the mesh gets finer.

Effect of Different Materials on a Steam Plume

Material	Effect on the Steam Plume
Coarse window screen	no change in plume's shape or speed at which steam comes out of spout
Fine window screen	no change in plume's shape or speed at which steam comes out of spout
Cheesecloth	speed of steam coming out of spout slows slightly
Facial tissue/Paper towel Cotton cloth (T-shirt)	speed of steam coming out of spout slows a little; steam rises straight up rather than leaving the spout forcefully at an angle
Flannel	speed of steam coming out of spout slows considerably; steam cloud becomes just a series of wisps
Diaper	steam cloud significantly disrupted

Student Handout Questions

- 1 What kind of wetlands do the coarse-meshed materials represent?
The coarse-meshed materials represent sparse wetlands.
- 2 What kind of wetlands do the fine-meshed materials represent?
The fine-meshed materials represent dense wetlands.
- 3 Why did the fine-meshed materials weaken the steam plume? *The fine material reduced the supply of warm, moist air from inside the kettle.*
- 4 How do healthy wetlands help protect a coastal area from hurricanes?
Dense wetlands reduce the amount of warm, moist air going into a hurricane.
- 5 Hurricanes die out when they travel inland because, when over land, they are no longer supplied with the warm, energy-rich, moist ocean air. In this kettle hurricane model, what could you do to the model to represent what happens when a hurricane travels inland? *Students' suggestions may include interrupting the flow of steam with a solid barrier, such as cardboard, or turning off the hot plate to eliminate the supply of warm, moist air.*
- 6 What are this model's strengths in representing hurricanes and the effect of wetlands? *The model accurately shows one way in which wetlands can reduce the impact of a hurricane.*
- 7 What are this model's limitations? *The model shows neither the complexity of a hurricane system nor the true nature of a wetland area.*

LINKS AND BOOKS

Links

NOVA—Stormed That Drowned a City

www.pbs.org/nova/orleans

Read an interview with one scientist who predicted the effects of a Katrina-like hurricane, learn about New Orleans' 300-year battle with water, track the hurricane's progression, zoom in on key sites that played a role in the Big Easy's flooding, and map the effect Katrina would have had on your city.

Estuaries.Gov

estuaries.gov/newjersey2.html

Provides a set of classroom activities related to estuaries.

Hurricane Features

www.comet.ucar.edu/nsflab/web/hurricane/311.htm

Describes where and how hurricanes form, the damage they can cause, and how they are rated in intensity.

National Wetlands Inventory

www.nwi.fws.gov

Provides information on the characteristics, extent, and status of the nation's wetlands.

What Is a Hurricane?

www.fema.gov/hazards/hurricanes/whatis.shtml

Provides general facts about hurricanes and links to tracking maps, forecasting information, and dates for Category 4 and Category 5 hurricanes that have occurred this century.

Book

Wetlands

by William Niering.

Alfred A. Knopf, 1985.

Includes descriptions of different kinds of wetlands and the plants and animals inhabiting them.

Wetlands and Hurricanes

In this activity, you will examine how wetlands can deprive a hurricane of some of the warm, moist air that supplies its energy. The steam represents the hurricane and different types of meshed materials represent dense and sparse wetlands. You will record what happens to the plume of steam (hurricane) when different materials are placed in its path.

Procedure

- 1 On a separate sheet of paper, describe what the steam plume coming out of the kettle's spout looks like. Predict how you think each material your teacher will be using will affect the steam plume when placed over the kettle's spout. Write down why you think each prediction will happen.
- 2 Record how each material affected the steam plume after it was placed over the kettle's spout.

Questions

Write your answers on a separate sheet of paper.

- 1 What kind of wetlands do the coarse-meshed materials represent?
- 2 What kind of wetlands do the fine-meshed materials represent?
- 3 Why did the fine-meshed materials weaken the steam plume?
- 4 How do healthy wetlands help protect a coastal area from hurricanes?
- 5 Hurricanes die out when they travel inland because, when over land, they are no longer supplied with the warm, energy-rich, moist ocean air. In this kettle hurricane model, what could you do to the model to represent what happens when a hurricane travels inland?
- 6 What are this model's strengths in representing hurricanes and the effect of wetlands?
- 7 What are this model's limitations?