

# In the Eye of the Storm: A Case Study in Natural Disasters

by

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## Part I—A Storm is Born

To: mom@hotmail.com  
From: Kate@louisiana.edu  
Date: August 25, 2005 10:57 PM  
Subject: Heard about the hurricane?  
Attachment: eye.jpg

Dear Mom,

I couldn't wait to write you about my field trip with the Hurricane Hunters. Remember I told you about them? It's a group of people in the Air Force Reserve that work with the National Oceanic and Atmospheric Administration (NOAA) to collect data about how hurricanes form and develop.

We were in Florida to study the storm system that was forming near the Bahamas a couple days ago. We lucked out because it started heading right for Florida! It made landfall around 6:30 this evening, when we were up in the plane. The wind speed was around 90 mph and we flew right through it! The pilot was awesome; he let me take lots of pictures. Check out the attachment for one of the pictures I took as we were traveling through the eye of the storm. Did you know the eye of the storm is very calm? By now, the storm should be over the Gulf Coast. I can't wait for tomorrow!

Love, Kate

Attachment: eye.jpg



*Photo credit: US Air Force photo of storm eye, courtesy of Hurricane Hunters Association.*

To: Kate@louisiana.edu  
From: mom@hotmail.com  
Date: August 26, 2005 8:34 AM  
Subject: RE: Heard about the hurricane?

Dear Kate,

Be careful! I'm worried about you being down there in the storm. Your picture was amazing! I had heard the eye of the storm is calm, but I never imagined it would be like that. Why does the eye form? I've always wondered what makes hurricanes spin with such an amazing amount of force.

I know that most storms die down when they hit land, but I have a feeling this one may be different. I heard that it could intensify as it travels over the warm water in the Gulf Coast. Do you think it will hit land again? Where would it hit if it did?

Love, Mom

### *Questions*

1. How strong was the hurricane when Kate went through it in Florida? What category storm is this?
2. How much damage would a storm of this strength be expected to cause in Florida?
3. Would you be worried to go into the storm again if you were Kate?
4. What more do you need to know to answer the questions posed by Kate's mom?

### *Assignment*

- Write an e-mail back to Kate's mom answering her questions.

## Part II—Intensity Increases

To: Kate@louisiana.edu  
 From: mom@hotmail.com  
 Date: August 27, 2005 11:16 AM  
 Subject: RE: Heard about the hurricane?

Dear Kate,

Thanks for answering my questions. I heard on the radio that the hurricane is now up to Category 3. I guess that warm ocean water really did something to increase the intensity of the storm. Are you sure you are safe down there? I know that it's still over the ocean, but it can still be dangerous. Keep me posted.

Love, Mom

To: mom@hotmail.com  
 From: Kate@louisiana.edu  
 Date: August 28, 2005 6:08 PM  
 Subject: RE: Heard about the hurricane?  
 Attachments: eye2.jpg; satellitel.jpg

Dear Mom,

What a day! The hurricane has nearly doubled in size. At its peak at 1:00 this afternoon, the maximum wind speed was 175 mph and the pressure had dropped to 902 mbar. This is the fourth lowest pressure in a hurricane ever recorded. It looks like this will be the strongest hurricane ever seen in the Gulf! It's certainly heading for shore. Take a look at the satellite picture I've attached that I got from one of the other Hurricane Hunters. You can see the path that the storm is taking.

Don't worry about me, I'll be fine. It's the people on the ground that may have problems!

Love, Kate

Attachment: eye2.jpg



*Image credits:* Photo of storm eye by US Air Force, courtesy of Hurricane Hunters Association. Satellite image by NASA/Jeff Schmaltz, MODIS Land Rapid Response Team.

Attachment: satellitel.jpg



*Questions*

1. What happened in the time between the two e-mails to increase the size of the storm?
2. Hurricanes are classified (into categories) based on the intensities of their sustained winds and the potential damage and flooding they will cause upon landfall. What was the category of this storm at its peak? What damage is associated with this intensity storm?
3. Why is Kate so excited about the pressure measurement she made? What does low pressure tell us about the storm?
4. After looking at Kate's satellite photo, where do you think the hurricane will hit land?
5. How would the character of the hurricane change if it did hit land? What damage will the hurricane cause when it hits land?
6. What damage might the hurricane cause indirectly?

*Assignment*

- As a meteorologist with NOAA, what would you advise the people living along the coast to do? Keep in mind the associated costs (physical, mental, and financial) of an unwarranted evacuation. What would they have to do to protect their property?

## Part III—Predicting Disasters

To: Kate@louisiana.edu  
From: mom@hotmail.com  
Date: August 28, 2005 10:09 PM  
Subject: RE: Heard about the hurricane?

Dear Kate,

Thanks for the update. I'm getting increasingly nervous as the storm gets closer to shore. I was just reading an article in *National Geographic* from last year predicting what might happen if the storm hits New Orleans. It's not good. They predict that the storm surge could go over the top of the levees and the city will be covered in murky brown water. They talked about people being stranded on the roofs of their homes. After the water subsides it will leave behind a nasty mess of mud, industrial waste, and sewage. Can you believe that the engineers have known about these problems for years (even decades!) and the politicians have not taken their advice?

I'm here waiting for you if you decide to evacuate. Good luck, honey. I love you.

Mom

### Questions

1. Does the brewing storm have the potential to do the damage cited in the article? You may wish to consult the *National Geographic* article for more information (see "Gone with the Water" by Joel K. Bourne Jr., in the October 2004 issue of the *National Geographic*; also available online at <http://ngm.nationalgeographic.com/ngm/0410/feature5/>).
2. Based on the evidence you have thus far about the storm, what would you do if you were Kate? Would you stay or leave?
3. After learning about the engineer's predictions, how would you change your recommendations to the people who live on the coast?
4. Why do you think the politicians ignored the advice of the engineers?

### Assignment

- You are the governor of Louisiana, who has just been reminded about this *National Geographic* study. You are about to go on TV and radio to give a press conference. What do you say to the people of your state?

## Part IV— After the Storm

### **HURRICANE KATRINA: Scientists' Fears Come True as Hurricane Floods New Orleans**

By John Travis, with reporting by Carolyn Gramling, Jocelyn Kaiser, Eli Kintisch, and Erik Stokstad. [Excerpted from the September 9, 2005 issue of *Science*, 309:1656–1659. Reprinted with permission from AAAS.\*]

There are times when scientists would prefer to be wrong. Such was the case last week as Ivor van Heerden and other researchers reflected upon the devastation that Hurricane Katrina wrought on New Orleans and the Gulf Coast towns to the east. As director of Louisiana State University's Center for Public Health Impacts of Hurricanes, Van Heerden has since 2002 led a multidisciplinary team looking at what would happen if a major hurricane directly hit New Orleans. The center has studied everything from how the city would flood to how many people might ignore evacuation orders or be unable to flee—almost 1 in 4, they had estimated. “The sad part is that we called this 100%,” says Van Heerden.

Causing the largest natural disaster in U.S. history, Katrina slammed into the Gulf Coast on 29 August with its eye hitting about 55 km east of the city. Although the storm initially brought more destruction to other areas along the Mississippi and Louisiana coast, several levees protecting New Orleans failed the following day, and the city, about 80% of which is below sea level, filled with water. The floods may have killed thousands, stranded many more, and triggered a massive relief and evacuation effort.

Numerous studies had warned of this catastrophic scenario, and as it played out, many scientists watched with anger and frustration. “It’s easy to do studies. Sometimes it’s hard to act upon them,” says Rick Leuttich of the University of North Carolina, Chapel Hill, who has helped model how a hurricane could flood New Orleans. “We’ve had plenty of knowledge to know this was a disaster waiting to happen.”

In one sense, Katrina, which left many researchers without homes and laboratories, was a rarity: Few hurricanes that powerful have struck the Gulf Coast in recorded history. At the same time, say hurricane experts, the storm contained few surprises. After speeding across south Florida as a category 1 hurricane, it reached the Gulf of Mexico and began converting energy from the warm, moist air into increased intensity. By Saturday, 27 August, Katrina was a category 3 storm—and still growing.

Timothy Olander, a tropical cyclone researcher at the University of Wisconsin, Madison, recalls waking up the next morning to see that Katrina’s central air pressure had dropped from about 960 millibars to below 905 millibars. The storm was now a category 5 hurricane with winds topping 175 mph. “I thought, ‘Holy cow. That’s an amazing development.’ You don’t see that rapid intensification very often,” he says. Katrina “became one of the strongest storms ever recorded in the Gulf of Mexico-Caribbean region.” Two factors, says Olander’s colleague James Kossin, fueled Katrina’s growth: “phenomenally warm” waters in the gulf and a lack of strong, high-altitude winds that could have dispersed the storm’s energy.

On Sunday morning, 28 August, thousands in New Orleans failed to pay heed to an evacuation order or couldn’t leave. Although that shocked many, Van Heerden’s center had recently polled 1000 randomly chosen New Orleans residents, using social workers to reach poor people, and had found that 21.4% would stay despite an order to leave, many of them because they lacked the means to escape.

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Just before landfall, Katrina took a jog to the east, sparing New Orleans from the full force of the storm. Because of the way spinning storms interact with land, “hurricanes often wobble to the right as they come ashore,” says meteorologist Hugh Willoughby of Florida International University (FIU) in Miami.

By landfall, Katrina had also shrunk to a category 4 storm. Scientists have a poor understanding of what regulates hurricane intensity, but Kossin and Willoughby note that some data indicate Katrina weakened because it had just undergone a phenomenon called eyewall replacement. The eyewall is the band of intense wind and clouds that forms around the hurricane’s eye. Large storms sometimes develop an outer eyewall that starves the inner one of energy until it degrades.

Katrina’s wobble and weakening seemed at first to prevent what many have called the New Orleans “nightmare scenario.” The city’s main threat from hurricanes is a storm surge, the wall of water pushed onto land as the hurricane comes ashore. This surge can rise 8 meters or more as the water goes from deep water into shallow areas and then onto land. Because Atlantic hurricanes spin counter-clockwise, the surge tends to be highest on their east side as the winds help any water moving north.

Because much of the city is below sea level, New Orleans is particularly vulnerable to a storm surge moving through the gulf and into Lake Pontchartrain. Over the past few decades, several computer models have shown how strong hurricanes on the right track could cause massive “overtopping” of the levees that, averaging almost 5 meters high, keep the lake from the city. The National Oceanic and Atmospheric Administration’s (NOAA’s) official storm surge model SLOSH (Sea, Lake, and Overland Surges from Hurricanes) was developed in the late 1960s, and Leuttich and several collaborators have created a more sophisticated model called ADCIRC (Advanced Circulation) that has been adopted by the Army Corps of Engineers and other groups. Last year, in an exercise simulating a direct hit by a slow-moving category 3 hurricane, both models showed that the levees would not prevent the flooding of New Orleans.

According to these models, Katrina’s storm surge should not have submerged the city. Joannes Westerink of the University of Notre Dame in Indiana, who helped develop ADCIRC, says it estimated that the southern shores of Lake Pontchartrain only rose about 3 meters during Katrina. (The various models estimate that the Mississippi coast received a peak storm surge of about 7 to 9 meters, which would be the highest in U.S. history.)

Instead of overtopping, the catastrophic collapse of several levees—ones that had been upgraded with a thick concrete wall—apparently sealed the city’s fate. Stephen Leatherman, director of FIU’s hurricane research center, suggests that the lake’s raised levels may have increased water pressure to the point that water flowed through the earthen levees on which the concrete walls sat. “Then the whole thing collapses. This is how an earthen dam collapses during a flood,” he says.

The devastation from Katrina may reignite interest in bolstering the wetlands south of New Orleans to provide more of a hurricane barrier. As a storm passes over, wetlands and barrier islands along the coast sap its energy and reduce storm surge. By some estimates, however, up to 100 square kilometers of this buffer disappear each year, largely because the Mississippi River has been leveed and dammed so much that it deposits much less sediment onto the delta. (Katrina wiped out barrier islands herself.)

In 1998, a collection of state and federal agencies, including the Environmental Protection Agency and the Army Corps of Engineers, proposed Coast 2050, a \$14 billion strategy to restore Louisiana’s wetlands. But the project never won federal funding and hasn’t moved beyond the planning stage.

Any renewed debate over coastal restoration will likely have to await the long cleanup and recovery of New Orleans and the surrounding areas, a process that will take months, if not years. Among the research institutions bearing the brunt of Katrina were Tulane University, the University of New Orleans, and Xavier, all of which lost power to most of their campuses. The three universities have canceled their fall semesters and are still surveying damages. ...



### *Questions*

1. Why did everyone think New Orleans was safe when the hurricane first hit?
2. What was directly responsible for most of the damage in New Orleans?
3. Why did the levees break? You may wish to consult other sources including articles on the web to help you answer this question.
4. As an engineer, what could you do to strengthen the levees? What else could be done to protect the city from hurricane damage?

### *Assignment*

- As an independent counsel, what is your recommendation to the city? Would you rebuild the homes and levees that were destroyed or relocate the residents to other neighborhoods?

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