On Deadly Ground

STORM SURGE

In late August 2005, Hurricane Katrina slammed into Florida and the coastal regions of Alabama, Mississippi, and Louisiana. The most severe damage was to New Orleans—a city of some 500,000 people that lies six feet below sea level.

Storm-driven waters rushed inland and overflowed the system of **levees** that had, until then, protected the city from the Mississippi River and Lake Pontchartrain to the north. These levees, walls constructed to hold back water, were no match for the massive amount of water. The effects of the deluge were numbing. More than 650 people were dead and millions were homeless. Some 90,000 square miles—equivalent almost to the size of the United Kingdom (England, Wales, Scotland, and Northern Ireland)—were declared a federal disaster area. According to scientists at the National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center in Asheville, NC, Hurricane Katrina will be recorded as the most destructive storm ever in terms of economic loss, but not when measured in loss of life: The hurricane that hit Galveston, TX, in 1900 claimed between 6,000 and 12,000 victims. Still, the death toll now makes Katrina the 10th worst natural disaster to affect our nation.

Flood of Horror

Water (in this case a storm surge), more than wind, can turn a hurricane—an act of nature—into a human catastrophe.

"The greatest potential for loss of life related to a hurricane," says Brian Jarvinen, a forecaster and storm research specialist for the NOAA's National Hurricane Center, "is from the storm surge."

A storm surge is a hideous bulge of water—often 15 feet high and 50 miles wide—that forms directly beneath a hurricane's center, or eye (an area of extremely low air pressure). You can see how this works by holding a straw about 1/10 of an inch above a bowl of water, and then sucking hard. Water will be drawn up toward the base of the straw, which represents the eye of the hurricane.

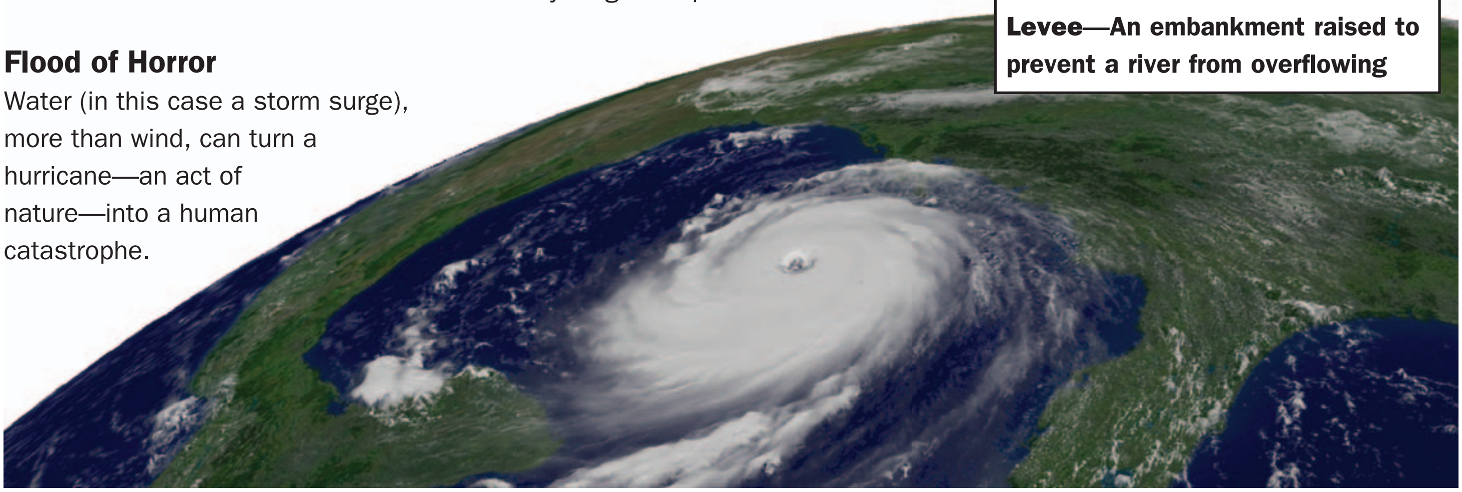
The surge is propelled forward by the advancing storm and its intense winds. In the northern hemisphere, a hurricane rotates counterclockwise, so the greatest impacts from the storm surge tend to occur to the right of the eye at landfall. Intensified by the hammering effect of 15- to 20-foot breaking waves, the surge acts like a giant bulldozer and sweeps away everything in its path. Nine out of ten deaths related to hurricanes are caused by the storm surge.

A Recipe for Disaster

When Katrina made landfall on August 29, the promise of a killer hurricane was delivered. At 7 A.M. a NOAA scientific buoy, located about 50 miles east of the mouth of the Mississippi River, recorded wave heights of at least 47 feet. Shortly thereafter, in a howling rage, Katrina smashed into the coast near New Orleans.

Using a Louisiana State University supercomputer, Joannes Westerink, an engineer at the University of Notre Dame, and his colleagues have recently created the first detailed computer model of the effects of Hurricane Katrina and its surge. In the 36 hours before Katrina hit New Orleans, the model shows a 15-foot dome of water forming in the Gulf of Mexico beneath the hurricane. The dome is being pushed forward by winds screaming at 140 miles per hour.

Levee—An embankment raised to prevent a river from overflowing



Dead fish in the floodwaters surround a worker as he repairs a levee in New Orleans.

On August 29, Destruction Day, the model shows the hurricane's northeasterly winds pushing a wall of water directly against the hurricane levees at the mouth of the Mississippi River, and then pouring over them. As the surge moves inland, it tops the hurricane levees that run toward the center of New Orleans. As Katrina moves toward Mississippi, the model shows a north wind pushing water in Lake Pontchartrain against south shore levees and into canals, where the rest of New Orleans floods as portions of the canal fail. Finally, the wave rises up 30 feet as it hits the Mississippi coast, where it causes massive destruction.

The Human Disaster

While the computer model has not solved any engineering problems, it is shedding some light on the cause of some of the resulting catastrophes. For instance, Westerink says that the surge may have raised the level of Lake Pontchartrain 12 feet or more, which could have been enough to top levees or floodwalls, which are built to withstand a maximum surge of only 11.5 feet.

The computer model is turning attention to the cause of the catastrophic collapse of several levees—ones that had been upgraded with a thick concrete wall!

The **irony** is that the Army Corps of Engineers strategically placed these levees and their concrete supports to prevent New Orleans from flooding. But according to the National Weather Service, over the almost three centuries (300 years) since the construction of the original levees along the river and lake, they have led to a *rise* in the water levels.

The result?

Each increase of water level puts more and more pressure on the levees. And while the levee system around New Orleans is quite extensive, it is old. The original structures, of which the Army Corps of engineers took possession, were built in *1718*! They had been built to withstand only what we now call a category 3 hurricane. Katrina was a category 4 hurricane.

The Power of Water

The power of water is extremely underestimated. Water weighs approximately 1,700 pounds per cubic yard. It's so dense that it cannot be compressed. So when water hits an object (as when a storm surge pushes against a levee), the water does not absorb the shock of the impact by compressing. Instead, the object being struck usually yields to the force of the water. The levee breaks!

And that's a far more dangerous situation than if water were to simply overtop a levee. When a levee breaks, the water behind it is released as a flash flood, which is catastrophic to life and property because of the tremendous energy of the sudden release of an immense amount of water.

Maybe Katrina's real lesson is, Don't Fool with Mother Nature!

Irony—When what might be expected to happen and what actually occurs are inconsistent

The Saffir-Simpson Hurricane Scale

The Saffir-Simpson Hurricane Scale is a 1 to 5 rating based on a hurricane's intensity at the time of measurement. Wind speed is the determining factor in the scale.

Category One: Winds 74–95 mph. Storm surge generally 4 to 5 feet above normal.

Category Two: Winds 96–110 mph. Storm surge generally 6 to 8 feet above normal.

Category Three: Winds 111–130 mph. Storm surge generally 9 to 12 feet above normal.

Category Four: Winds 131–155 mph. Storm surge generally 13 to 18 feet above normal.

Category Five: Winds greater than 155 mph. Storm surge generally greater than 18 feet above normal.

Adapted from an article by Stephen James O'Meara