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Undergraduate

HURRICANE KATRINA

AN ENVIRONMENTAL PERSPECTIVE

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B S J

Hurricane Katrina, the massive storm that decimated the southern coast in 2005, still lingers in the minds of people across the nation as they prepare their own disaster plans and watch the evening news, where stories of extreme weather events seem to steadily become more frequent. The process of modeling climate systems is complex, and scientists are still puzzling over exactly why Hurricane Katrina became such a disastrous accident and how to best prepare for the future. However, the fact remains that a greater understanding of the environmental and social factors that merged to make New Orleans so vulnerable to destruction can help the entire country avoid disaster and better manage environmental risk. In order for this process to be effective, scientists, politicians, and residents all must understand the factors that allowed Katrina to be so destructive, what kind of effects the storm has caused, and what can be done in the future to prevent the scenes of 2005 from being repeated.

The city of New Orleans was built on shaky foundations. Constructed predominantly on reclaimed wetlands, the city has always been vulnerable to land subsidence—a gradual sinking that has resulted in the city lowering by up to five meters since its foundation (ScienceDaily, 2006). The unique bowl-like formation of New Orleans adds to this problem, preventing excess water from draining out, a phenomenon that was painfully evident in the wake of the hurricane (Handwerk, 2005). The Gulf region is also particularly sensitive to storm surges, the rise in sea level associated with a hurricane's low atmospheric pressure and high winds. Its long, gently sloping continental shelves and shallow waters made it easier for Katrina's powerful surge to overcome New Orleans's protective levees. Thus, the entire region, and New Orleans in particular, has long been in a precarious situation.

The Gulf region also has a long history of hurricane damage. In 1965, Hurricane Betsy struck New Orleans, causing \$6.5 billion dollars in damage and straining the city's environment and economy (Roberts, 2006). While the amount of damage caused by Betsy is significantly smaller than Katrina's \$81.2 billion dollar price tag, the fact that violent storms have long been a part of New Orleans's past should have served as a stronger warning to contemporary residents and policymakers. While it is difficult to anticipate every accident that might arise in the future, there is no question that a more cogent awareness of New Orleans's geological situation and relationship to

the surrounding environment could have gone a long way in preventing extensive hurricane damage.

Despite the fact that New Orleans began on unstable footing, the heavy flooding that buried the city "was really an unnatural disaster," says John Day, Louisiana State University School of the Coast and Environment professor. "We spent the last century doing almost everything we could to destroy our coast in all sorts of ways—putting levees on the Mississippi River, slicing thousands of kilometers of canals, massive oil and gas production." (Guillot, 2006). Day's words illuminate another facet of the New Orleans' troubled history—this one caused by human activities that took place with little regard to the natural environment.

The canals carved into the wetlands have posed a special series of environmental problems. They served as a powerful conduit for floodwaters, allowing the damaging water from storm surges to travel inland, but their detrimental effects began long before the storm. Salt water intrusion caused by the canals has long been a problem in the Gulf region, assumed to be the culprit for the death of thousands of acres of cypress swamp, which forms a natural buffer against storms and may have prevented some of the levee failures that occurred when Katrina made landfall (Guillot). Wetlands and reefs have traditionally worked to protect coastal regions from strong winds and large ocean waves. However, their stability has increasingly been threatened by storms and environmental engineering projects such as canal and levee building, which prevents fresh sediment deposits from rebuilding the islands (Guillot). It is possible that if the vital protective role of these ecosystems had been better understood and appreciated, they could have helped defend the city alongside manmade structures, as opposed to being destroyed by them.

Unfortunately, not even the complex configuration of dams and levees proved capable of withstanding Katrina's wrath. The levee systems in place to protect the cities along the Gulf Coast were in need of repair at the time of Katrina, but the exact nature of the necessary repairs and the precise factors that led to the levee failure are still contested among various environmental and governmental organizations. Scientists and engineers from Louisiana State University's Hurricane Center claimed that the size of the surges was not sufficient to overtop the levee walls, pointing instead to deficiencies in design

or inadequate construction as the most likely explanation for the levee failure (Glasser, 2005). They claim that the flood models their center created revealed that none of the storm surges should have surpassed 13 feet, whereas the Army Corps' flood-protection system was designed to withstand surges up to 14 feet above sea level, implying that the levees, not the storm, were responsible for the majority of the damage (Glasser).

Representatives from the Army Corp of Engineers, coming to a different set of conclusions, claimed that Katrina was simply more powerful than the levee system was designed to handle, and blame powerful storm surges for the floodwall failures as opposed to any specifically deficiency in the levees themselves (Glasser). However, a slightly different interpretation emphasizes the weakness of the soil on which the levees were constructed, pointing out widespread erosion, seepage, and soil failure in the areas where the levees stood and claims that "many of the levee problems involved significant soil-related issues." According to this theory, localized areas of weaker soils may be responsible for some of the breaches in the levee system (American Society of Civil Engineers, 2005). These different analyses likely reflect different political interests invested in the situation as well as different scientific focuses; it also may be that no one theory is completely true or exhaustive. However, the fact remains that—for whatever the reason—the city of New Orleans was not aware of its delicate position and was not adequately prepared, and the result was one of the costliest natural disasters in US history (Heming, McCallum, 2006).

However, this cost was not purely economic—the hurricane took a toll on the environment as well. The same barrier islands and wetlands that could have come to the region's defense were instead damaged by the storm, primarily by powerful waves, salt sprays, and chemical alterations of the soil (Kupfer, 2007). Storm surges also besieged most of the barrier islands along the Mississippi coast, scattering significant amounts of debris (Guillot, 2006). Saltwater intrusion and coastal erosion were also made worse by the storm, and were perhaps exacerbated by the nearby canal systems (Guillot). The damage to these wetlands appears more significant when considering the fact that, besides serving as storm buffers, they serve as valuable habitats for endangered and threatened species, three of which were affected by the environmental alterations caused by the hurricane (Sheikh, 2006). However, despite the damage caused by the storm, wetland and marsh habitats rebounded fairly quickly in the wake of the storm, showing a marked strength and resiliency that served as a stark contrast to the complex and often floundering attempts made to rebuild the population centers. In fact, according to some reports, the same storm surge that was so detrimental to human construction may have even been beneficial in

some natural habitats, protecting the marshes at Grand Bay from the heavier wave damage (Kupfer, 2007). While some long-term effects caused by the storm may still be possible, overall marsh and estuary environments have shown a tremendous amount of fortitude in the face of Katrina's destructive power (Kupfer).

Lake Pontchartrain was notably thrust into an environmentally questionable situation immediately following the hurricane. After the storm, 224 billion gallons of floodwaters containing toxic chemicals, carcinogens, pathogens, human waste, nitrate, and phosphate were pumped into the lake in order to clear the city (Kupfer). It was feared that the initially high concentrations of contaminants injected into the lake after the storm would strain the ecosystem—already polluted by human activities—harming the endangered manatee population (Sheikh, 2006). Seeming to confirm these initial fears, in the month following the hurricane, samples taken from bodies of water all around the area revealed higher pH, conductivity, and salinity compared to those waters that were unaffected by the hurricane. However, these numbers gradually decreased in the months following the hurricane, accompanied by increases in dissolved oxygen levels, indicating that the lake was on the road to recovery. By December 2006 only the conductivity of surge-affected bodies was significantly higher than those that had not been impacted (Kupfer, 2007). The lake's water seems to have since returned to pre-storm conditions, despite the contamination from saltwater and chemical components. This rapid revitalization reflects the ability of ecosystems to respond to and regain equilibrium following even radical environmental disturbances (ScienceDaily, 2006). The health and stability of many species that rely on these delicate aquatic environments was threatened immediately after the storm, but they too followed the



Figure 3. Toxic floodwaters were pumped into Lake Pontchartrain and subsequently released into the Gulf of Mexico.

overall trend of recovery. Katrina did cause initial declines in fisheries and wildlife populations—threatening both the ecology and economy of the region—but the picture is not as bleak as some scientists had originally feared, as populations have shown strong signs of recovery (Sheikh, 2006). Some of the environments most threatened by storm damage was the seagrass beds on barrier islands, which various aquatic species use for breeding grounds and feeding and nesting areas. One of these threatened aquatic species investigated was phytoplankton, whose numbers managed to return to pre-storm levels within 45 days after the passage of the hurricane, despite the permanent habit loss that occurred as large areas of seagrass beds were eroded or submerged by the storm (Kupfer, 2007). Overall, the Katrina's impact on livelihoods of aquatic organisms may not be as severe as initially predicted, though there is still concern about long-term contamination caused by bioaccumulation of lead and mercury up through the food chain, whose effects may take years to come to the surface (Sheikh, 2006).

The same winds and waters that afflicted the coast also touched wooded areas, having a powerful impact on forested areas in southern Louisiana and Mississippi, damaging 1.3 million acres of land in Mississippi alone (ScienceDaily, 2006). While wind damage may not appear to pose an immediate threat to ecosystem health, dead and damaged trees can become environmental hazards if they serve as fuels for wildfires or breeding grounds for pests and diseases, or conduits for invasive species to enter the ecosystem, all with the potential to completely reshape the dynamics of an ecosystem (Sheikh, 2006). Soils were also affected by the influx of chemicals and nutrients caused by Katrina's storm surges and flooding. Soil pH was significantly higher one month after Katrina, but like the marshes and other bodies of water, levels returned to normal within months of the storm. Samples showed that higher levels of sodium, phosphorous, magnesium, calcium, and potassium seemed to linger in the soils after the storm's passing, but repeated samplings revealed a general pattern of recovery, though it may take more time (Kupfer, 2007). Unfortunately, there the data on these potential long-term side effects is lacking. This wide trend of resilience and recovery observed in habitats as diverse as marshlands to forests helps illuminate the ability of biological systems to return to natural equilibrium levels, cleansing themselves of contaminants with an efficiency and effectiveness that the human residents of the New Orleans area could benefit greatly from adopting.

However, the long-term effects of the hurricane on various habitats are difficult to judge and still a subject of debate, much like the mechanisms that caused the levees to fail. Continued observations of the recovery of natural systems in the area could lead to great progress in understanding how the world's bodies of water and



Figure 2. An aerial view of the impact of the hurricane's rain and winds on forested regions in New Orleans.

wetland ecosystems adapt to such violent disruptions as Katrina-level hurricanes. For instance, one active line of inquiry is into the ability of oceans to mitigate an influx of pollution from the Gulf Coast. Some scientists state that the risk of damage by contaminated floodwaters entering the Gulf of Mexico is not high, claiming that tidal forces and the circulation of Gulf waters will dilute substances to non-harmful levels, and that organic matter and bacterial contaminants do not pose any long-term threat to the waters. Others claim that this is not the case—that chemicals and excess nutrients will continue to interact with the environment for some time, depleting fisheries and contaminating sediments (Sheikh, 2006). Another area of study is the effect that the storm will wreak on the annual dead zone that forms off the Gulf Coast. Scientists have placed their opinions on all levels of the spectrum, from believing that the increased levels of chemicals and nutrients released into the Gulf by the Storm will not have an effect on dead zone formation at all, to those who believe that the effects will be detrimental and profound (Sheikh). The long-term effects of the storm on land forms are also a subject of debate. Storm surges tend to shift sediments, moving them from wetlands, beaches, and barrier islands to land areas, which mean that some wetland areas may be permanently destroyed while others may recover with time (Sheikh). There is also concern that reduced habitat area for wildlife may lead to increased competition for scarce land and resources on already stressed populations, which may further threaten already endangered species (Sheikh).

As this multitude of unknowns demonstrates, if Hurricane Katrina reveals nothing else, it will show both the public and the scientific community how much there still is to understand about climate systems and the role that we play in them. Indeed, despite the economic

and humanitarian disaster that the storm caused, it will no doubt serve as a valuable educational opportunity, allowing scientists, engineers, and government officials to have a rare glimpse of how both natural and man-made systems respond to massive disruptions. There will likely always be questions regarding what the primary factor that allowed Katrina to blossom into such a destructive event occurred—whether it was the structural integrity of the floodwalls, depletion of wetlands, unusual climatic conditions, or some unpredictable combination of all three may be a question that is beyond the grasp of even the most dedicated investigators. The many swirling puzzles that Katrina has left in its wake reveal the complexity of the world around us, beckon us to peer deeper into the connections between people and their environment that often slip below recognition, and need a terrible accident like Katrina to erupt to the forefront of the public eye. While there may never be perfect climate models that can effectively spare population centers from all weather fluctuations, incidents like Katrina encourage people of all backgrounds to learn from the past and prepare for the future.

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PICTURES:

FIGURES 1 & 2:

[HTTP://RST.GSFC.NASA.GOV/SECT14/SECT14_10A.HTML](http://rst.gsfc.nasa.gov/SECT14/SECT14_10A.HTML), ACCESSED 2 OCTOBER 2011.

FIGURE 3:

OMAR TORRES/AFP/GETTY

[HTTP://WWW.TIME.COM/TIME/MAGAZINE/ARTICLE/0,9171,968014,00.HTML](http://www.time.com/time/magazine/article/0,9171,968014,00.html), TIME MAGAZINE, ACCESSED 2 OCTOBER 2011.

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