

The New Orleans Hurricane Protection System

Assessing pre-Katrina Vulnerability and Improving Mitigation and Preparedness

Hurricane Katrina, which struck New Orleans and surrounding areas in August 2005, ranks as one of the nation's most devastating natural disasters. Shortly after the storm, the U.S. Army Corps of Engineers established a task force to assess the performance of the levees, floodwalls, and other structures comprising the area's hurricane protection system during Hurricane Katrina. This report provides an independent review of the task force's final draft report and identifies key lessons from the Katrina experience and their implications for future hurricane preparedness and planning in the region.

New Orleans is well known for its important historical role near the mouth of the Mississippi River, for its status as a major U.S. port city, and for its jazz music and cuisine. New Orleans also is well known for its vulnerability to flooding. Large areas of the New Orleans metropolitan region are located at or below sea level and are surrounded by bodies of water—the Mississippi River, Lake Pontchartrain, and Lake Borgne—that rise and can overflow during hurricanes and floods. The region's proximity to the large, shallow continental shelf of the northern Gulf of Mexico makes it even more vulnerable to hurricane storm surge, which is a mass of water pushed shoreward by hurricane winds.

These vulnerabilities were made painfully clear during Hurricane Katrina. During and immediately after the hurricane's landfall, homes and buildings throughout New Orleans and surrounding areas were inundated with storm surge and floodwaters; more than one thousand lives were lost in the event. Although there were hundreds of miles of levees and floodwalls and an extensive pumping system in place when Katrina struck, the storm exposed many weaknesses in this infrastructure. Large sections of the network of levees and floodwalls were overtopped and eroded; levee breaches at four sites across the city further allowed waters to penetrate and overwhelm much of the city.



Image courtesy of NOAA.

Floodwaters inundated much of New Orleans during Hurricane Katrina, exposing vulnerabilities in the area's hurricane protection system.

Evacuation efforts in the days before Katrina successfully evacuated tens of thousands of residents, but these efforts were inadequate to move all of the city's residents to safety. Property damages were extensive and widespread; in many areas, the destruction from Katrina is still apparent today.

In the wake of Katrina, the U.S. Army Corps of Engineers established the Interagency Performance Evaluation Task Force (IPET) to address fundamental questions about the performance of the New Orleans hurricane protection system during Hurricane Katrina and to assess the risks posed to the New Orleans region by future tropical storms. The Army Corps of Engineers requested

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that the National Academy of Engineering and the National Research Council convene a committee of experts to examine a series of draft reports released by the IPET. This, the committee's fifth and final report, reviews the final IPET assessment and identifies key lessons from the Katrina experience that can inform future efforts to enhance hurricane mitigation and preparedness.

Key Lessons Learned

Better hurricane preparedness for New Orleans will require a combination of structural and nonstructural measures. Some key lessons from the Katrina experience that the report identifies are as follows:

The Limits of Protective Structures

The major guiding principle behind the construction and maintenance of the New Orleans hurricane protection system has been to "make the city safe." However, this report finds that approach to be—although noble—flawed. The greater New Orleans metropolitan region is naturally vulnerable to flooding, especially in areas below sea level. Although post-Katrina repairs to and strengthening of the physical hurricane protection structures have reduced some vulnerabilities, the risks of inundation and flooding never can be fully eliminated by protective structures, no matter how large or sturdy those structures may be.

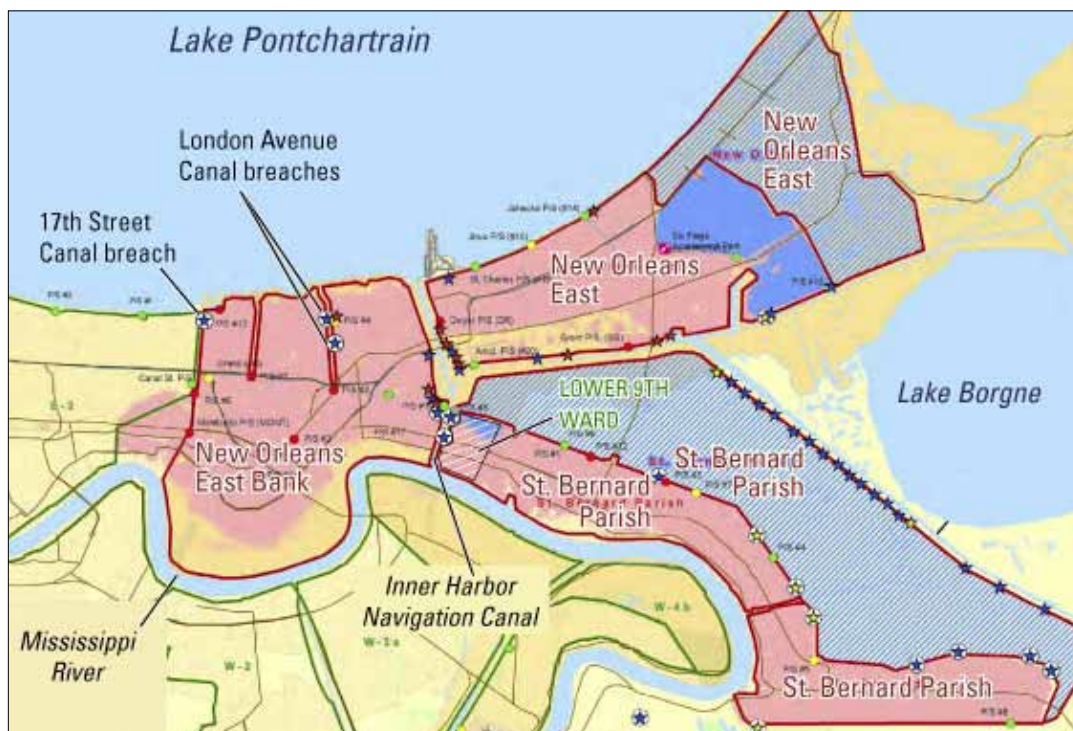


Image courtesy of NOAA.

The New Orleans hurricane protection system is composed of roughly 350 miles of levees, floodwalls, and other structures. Large sections of this system were overtopped during Hurricane Katrina; there were levee failures at four sites in New Orleans. The above image shows a breach at the Inner Harbor Navigation Canal.

Future Footprint of the Hurricane Protection System

Hurricane Katrina showed that there was undue optimism about the ability of the hurricane protection infrastructure in the greater New Orleans area to provide reliable flood protection. Despite the weaknesses in the system that were exposed during the Katrina experience, however, it appears that reconstruction activities are taking place largely according to the system's pre-Katrina footprint—without serious



Map showing features of storm surge damage in New Orleans during and following Hurricane Katrina. Pink and blue shading indicates areas that flooded; blue-striped areas are wetlands. Stars indicate levee breaches or distressed levee areas; circles indicate pumping stations. Map courtesy of USGS.

consideration of whether this design is advisable and sustainable. For example, the creation of a protection system with a smaller overall footprint might offer significant advantages in terms of cost, inspection, and maintenance requirements. This report recommends that, at the very least, there should be discussions that consider the pros and cons of different designs and different levels of protection across the region.

Relocation to Improve Public Safety

Regardless of future levee construction activities, it likely will not be possible to provide equal degrees of flood protection across the city. Higher-elevation parts of the region, such as areas on the natural Mississippi River levees, inherently are safer than lower-lying areas, such as extensive areas below sea level in St. Bernard's, Orleans, and New Orleans East parishes. Rebuilding the New Orleans area and its protective system to its pre-Katrina state would simply leave the city and its inhabitants vulnerable to additional Katrina-like disasters. This report recommends that planning and design for upgrading the system instead should discourage settlement in those areas that are most vulnerable to hurricane storm surge flooding. Because protective structures never can provide absolute protection against hurricane storm surge and flooding, the voluntary relocation of people and neighborhoods out of particularly vulnerable areas—with adequate resources to improve their living conditions in less vulnerable areas—should be considered as a viable public policy option.

Enhancing Floodproofing Measures

Where it is not feasible to relocate people and buildings out of vulnerable areas, significant improvements in floodproofing measures will be essential. To adequately protect the safety of homes and residents in these areas, the first floor of houses should be elevated to at least an elevation associated with the 100-year storm event. Raising them even higher, to meet a more conservative level of flood protection, is preferable (see the section below for further discussion of the 100-year flood protection standard).

In addition to elevating homes and other buildings, critical infrastructure, such as electric power, water, gas, telecommunications, and flood water collection and pumping facilities, should be strengthened to ensure that interdependent infrastructure systems can function reliably in an extreme flooding event.



Image courtesy of FEMA.

This elevated house, the only one in its neighborhood, sheltered 37 people through Hurricane Katrina. Elevation of homes is an essential floodproofing measure to protect people and buildings in vulnerable areas.

Re-examining the 100-year Level of Flood Protection

The 100-year level of flood protection—which defines areas with a one percent chance of flooding each year—is a crucial flood insurance standard. It has been applied widely across the nation and it is being used in some circumstances for reconstruction and planning activities in the New Orleans region. For areas where levee failure is not a safety concern, it may be appropriate to use this 100-year standard in developing regulations, setting insurance rates, and informing decisions in city planning and disaster preparedness. However, for heavily-populated urban areas where the failure of protective structures would be catastrophic—such as New Orleans—this standard is inadequate.

Rethinking Evacuation Plans and Protocols

The disaster response plan for New Orleans, although extensive and instrumental in successfully evacuating a very large portion of the New Orleans metropolitan area population, was inadequate for the Katrina event. The report identifies a need for more extensive and systematic evacuation studies, plans, and communication of evacuation plans. A comprehensive evacuation program should include not only well designed and tested evacuation plans, protocols, and criteria for evacuation warnings, but also alternatives such as improved local and regional shelters that could make evacuations less imposing. It also should consider longer-term strategies that can enhance the efficiency of evacuations, such as locating facilities for the ill and elderly away from more hazardous areas that may be subject to frequent evacuations.

Improving Risk Communication

Communicating the risks posed by hurricanes and storm surge is essential to preparing a vulnerable population for the potential occurrence of a hurricane or other disaster. Unfortunately, before Katrina, there was a limited understanding and appreciation of the risks of living behind levees. Risks facing residents in the New Orleans area need to be refined, simplified, and communicated consistently. Residents also need to clearly understand how those risks vary across the region. To achieve more effective communications, this report recommends that IPET hire a firm to create a professional summary and compilation of the entire IPET draft report in “layman’s” terminology so as to make its findings more accessible to citizens, business owners, and decision makers.

Communicating Results from Inundation Maps

The IPET report contains a series of inundation maps, which indicate the level to which floodwaters are likely to rise in specific areas during storms of varying intensity. Unfortunately, the IPET report contains only limited discussion of the implications of these maps in terms of the

levels of flood risk posed to specific areas in the New Orleans region. Citizens, businesses, and others looking to make resettlement plans would benefit greatly from an explicit, detailed discussion of these maps and their implications. An objective, candid discussion of the limitations of the models IPET used to evaluate risks and reliability of protective structures also would be useful.

Periodic Assessment and Independent Review of Projects

Changing environmental conditions affect the performance and operation of large hurricane and flood protection projects. In addition, advances in scientific and engineering theories and methods may render assumptions on which these projects were based partly or fully obsolete. For the New Orleans hurricane protection system, regular assessments are needed to review the underlying environmental, scientific and engineering factors that affect the expected system performance. An independent “second opinion” would provide an opportunity to ensure that calculations are reliable, methods employed are credible and appropriate, designs are adequate and safe, potential blind spots are minimized, and other issues are raised as appropriate.

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The National Academies appointed the above committee of experts to address the specific task requested by the U.S. Department of the Army. The members volunteered their time for this activity; their report is peer-reviewed and the final product signed off by both the committee members and the National Academies. This report brief was prepared by the National Research Council based on the committee’s report.



For more information, contact the Water Science and Technology Board at (202) 334-3422 or visit <http://nationalacademies.org/wstb>. Copies of *The New Orleans Hurricane Protection System: Assessing pre-Katrina Vulnerability and Improving Mitigation and Preparedness* are available from the National Academies Press, 500 Fifth Street, NW, Washington, D.C. 20001; (800) 624-6242; www.nap.edu.

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