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Did NEPA Drown New Orleans? The Levees, The Blame Game, and the Hazards of Hindsight

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I. Introduction

"There are only two kinds of levees, those that have failed and those that will fail."[1]

The failure of the New Orleans levees to prevent waters from Lake Pontchartrain, Lake Borgne and the Gulf of Mexico from flooding the city during Hurricane Katrina led to one of the worst disasters in this country's history. Although many other causes for the human suffering and economic loss that followed in the wake of Katrina have been identified and debated, no one disputes the causal connection between the flooding and the failure of the levees. Had the levees been differently designed, constructed, and/or maintained, the flooding would not have occurred. The critical question of *why* the levees failed, however, has generated considerable disagreement. Although the casual observer might assume that this is a primarily a question for engineering experts, a complete answer may also require a careful reconstruction of the planning history of the levee system and of the role that federal budgetary policy, environmental litigation, and other public policy developments played in the system's complex evolution.

In the heated political aftermath of Katrina, the analysis has been further complicated by the perhaps unavoidable tendency of participants in public policy debates to conflate causation with fault and to play the "blame game." Prominently featured in Katrina's immediate political aftermath was the claim that the levee system would have protected New Orleans had local fishermen and an environmental group not filed a lawsuit in the late 1970s under the National Environmental Policy Act (NEPA).[2] In particular, critics argue that because a federal district court responded to this suit by enjoining the levee project pending the preparation of an adequate environmental impact statement (EIS), the United States Army Corps of Engineers ultimately abandoned its original design for the New Orleans levees and adopted instead an alternative design that is said to have been less capable of protecting the city from the storm surge created by Katrina. In other words, some commentators contend that, as a result of the lawsuit, the Corps redesigned the project in a way that failed to protect the city.

This Article will evaluate the claim that the 1970s environmental lawsuit caused—in any meaningful sense—the destruction of New Orleans in 2005. Although correct answers to many engineering questions are critical to this analysis, the Article will not attempt to resolve those technical questions. It will rely instead on preliminary reports produced by various groups of engineers that have analyzed the failures of particular levees. The Article will also avoid to the extent possible other socio-political

[1] Ass'n State Floodplain Managers, *Hurricane Katrina & Rita: Using Mitigation to Rebuild a Safer Gulf Coast*, Sept. 9, 2005 (reporting common saying among U.S. Army Corps of Engineers staff).

[2] 42 U.S.C. §§ 4331, et seq.

explanations for the levee failures that were featured in the post-Katrina blame game, such as the failure of the current and past Administrations to request sufficient appropriations to build and maintain levees and the role played by alleged mismanagement within the special New Orleans levee districts.[3] Focusing exclusively on the environmental lawsuit claim, this Article will attempt to probe at a deeper level the difficulty of retrospective analysis in the hope that the discussion might prove helpful to those who are examining not only the levee failures, but those other potentially contributing causes as well. Just as the "lawsuit that drowned New Orleans" turns out to be oversimplified and misleading, other attempts to pin responsibility for the Katrina levee failure on any single act or omission are likely to obscure the broader lessons of the tragedy.

In that respect, scrutinizing the role of the NEPA lawsuit in Katrina levee failures also sheds some important light on the challenges facing government disaster policy from the forward-looking perspective. The same problems of uncertainty and complexity that confound the attempt through hindsight to attribute causal responsibility for a disaster also confound the attempt to predict through foresight the variety of outcomes, including potentially disastrous ones, which may flow from policy choices. Thus, in order to guard against catastrophic potentialities in the future—whether of economic, environmental, or human loss—one must keep firmly in mind not only the hazards of hindsight, but also the foibles of foresight.

The next Part of this Article provides both a detailed historical reconstruction of the decision process that eventuated in the New Orleans storm surge protection system—including the relevant litigation brought against the Corps of Engineers by various local interests including the environmental action group Save Our Wetlands[4]—and an analysis of how and why Katrina overcame that system. Part III then uses tort law's "but for" causation doctrine to introduce the blame game that has been played post-Katrina by policy-makers, politicians, and various others. Part IV considers in depth the counterfactual scenario of the New Orleans levee planning absent the NEPA lawsuit in order to construct a hindsight analysis if the likely causal role played by *Save Our Wetlands* in the flooding of New Orleans. Lessons about forecasting risk and appropriately preparing for future calamities are drawn from the foregoing analysis in Part V. Concluding thoughts are offered in Part VI.

II. History of the Levee System

Because New Orleans is situated in the delta formed at the mouth of the Mississippi River, it has long maintained a flood control system to protect it from the risks of flooding from the Mississippi River to the south, Lake Pontchartrain to the north,

[3] See, e.g., Ben Depoorter, this issue (observing numerous pre-Katrina warnings of the inadequacy of the existing storm surge protection system and noting that "[n]otwithstanding these warnings, federal funding of the New Orleans' levees dropped by 50% over the past four years"); Andrew Martin & Andrew Zajac, Flood-Control Funds Short of Requests, Chicago Tribune, September 1, 2005, at 7.

[4] Save Our Wetlands v. Rush, Civ. No. 75-3710, Slip Opinion (E.D. La. 1977).

and Lake Borgne and the Gulf of Mexico to the east.[5] The levee system that surrounded New Orleans prior to Hurricane Katrina provided by far the most sophisticated and powerful protection in the city's long history. Katrina demonstrated, however, that an even more sophisticated and powerful flooding and storm surge protection system will be needed to protect the city in the future. In particular, because of its unique topographical setting, the City of New Orleans will always be at risk from a catastrophic failure of the levee systems that have grown up around it, if levees are to remain the city's primary form of defense. Indeed, the risk will only increase as the city continues to subside and the protective wetlands between it and the Gulf of Mexico continue to diminish.[6]

In addition to its Gulf storm surge protection projects, the Corps of Engineers also designed and constructed the levee system that protects New Orleans from periodic Mississippi River flooding that typically occurs during springtime. The risk of flooding from the Mississippi River stems largely from flood waters moving down the river as a result of rainfall events that may take place hundreds of miles to the north of the city. The primary line of defense against river flooding is an extensive system of levees and dikes that extends along the length of the river as it flows through Louisiana. That system, which contains the city's highest levees, averaging 25 feet above sea level in height, was not involved in the Hurricane Katrina disaster.[7] Although one misinformed participant in the blame game following the Katrina disaster erroneously attributed the New Orleans flooding to an environmental lawsuit involving the Mississippi River levees (200 miles upstream, no less),[8] most of the critical attention to environmental litigation in the wake of Katrina has focused instead on the levee system that protects New Orleans from sea storm surge. Unlike the Mississippi River flood protection system, those levees did not perform during Katrina as they were designed to do. Accordingly, the discussion hereafter will focus exclusively on the levees, rather than the Mississippi River flood protection system.

Lake Pontchartrain and Lake Borgne are located side-by-side to the north and northeast of the city and are separated by a narrow strip of land that allows water to flow between the lakes through two narrow passes northeast of the city at the Rigolets and Chef Menteur (see figure 1).[9] While Lake Borgne is separated from developed areas of the city by a large area of open swampland, Lake Pontchartrain immediately borders the downtown and western parts of the city.[10] The primary flood risk from the lakes occurs in the late summer and fall during tropical storms and hurricanes. Surges in Lake Pontchartrain pose the greatest risk to the downtown area, and surges in Lake Borgne primarily threaten New Orleans East and St. Bernard Parish to the east of the downtown area. An interconnected series of levees protects the city from storm surges in the lakes.

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[5] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-2; Mark Fischetti, Drowning New Orleans, Scientific American, October 1, 2001.

[6] Fischetti, supra note ___, at [page].

[7] Bob Marshall, Levee System Along River Held Its Ground in Storm, Times-Picayune, Jan. 23, 2006.

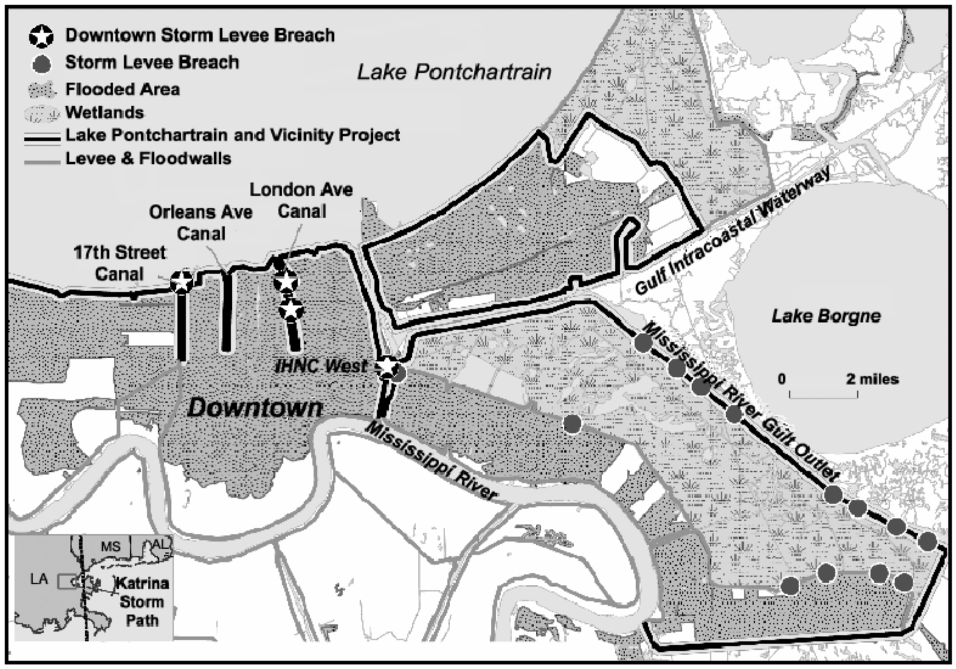
[8] R. Emmett Tyrell, Jr., Eco-Catastrophe Echoes, Washington Times, September 16, 2005

[9] A map of the lakes and levees prepared by the *New Orleans Times-Picayune* staff can be found at http://www.nola.com/hurricane/popup/nolalevees_jpg.html.

[10] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-2.

These levees are considerably smaller than the ones that line the Mississippi River, ranging from 13.5 to 18 feet above sea level in height.

Figure 1. New Orleans Hurricane Protection with Hurricane Katrina Breaches and Flooding



Source: National Oceanic and Atmospheric Administration; Federal Emergency Management Agency; U.S. Army Corps of Engineers

Prepared by the Congressional Cartography Program, Geography and Map Division, Library of Congress, 2005

Because much of the land mass of New Orleans is below sea level and continues to sink, rainwater that flows into the city must be removed not by natural drainage, but by huge pumps that force the water to move northward along three man-made canals, called "outfall" or "drainage" canals, into Lake Pontchartrain. Named for the streets that they parallel (17th Street, London Avenue, and Orleans Avenue), the canals are lined with levees and concrete floodwalls that prevent the water from spilling into the city.[11] In some places, water flowing through the canals is nearly as high as the rooftops of houses in the surrounding neighborhoods.[12] All of the levees were built by contractors working for the U.S. Army Corps of Engineers and, like all of the levees protecting the city, are maintained by various local levee districts.[13]

In addition to the drainage canals, the Corps of Engineers during the twentieth century constructed three large and interconnected "navigation" canals to permit ocean-

[11] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 2-1.

[12] First Line of Defense: Hoping the Levees Hold, available at http://www.nola.com/hurricane/popup/nolalevees_jpg.html.

[13] Id.

going vessels to move from the Mississippi River through the city north to Lake Pontchartrain, northeast to the Intercoastal Waterway that connects ports along the entire Gulf Coast, and south to the Gulf of Mexico. The Inner Harbor Navigation Canal (often referred to by the local population as the "Industrial Canal") slices north/south across the city between the river and Lake Pontchartrain at the point where they are closest to each other. The Mississippi River-Gulf Outlet (MRGO) canal bisects the Industrial Canal at right angles and travels east/west to a point in St. Bernard Parish where it forms a "Y" with the Intercoastal Waterway. From the Y, the Intercoastal Waterway moves to the northeast and the MRGO Canal continues in a southeasterly direction to the Gulf of Mexico.[14] Like the outfall canals, the shipping canals are all confined by earthen levees and concrete floodwalls.

The levee systems effectively divide the city and surrounding developed areas into four large protected basins called "polders," each of which is protected by its own perimeter levee system.[15] Thus, the land within one polder can flood while the land remaining within other polders remains protected. In the devastating Katrina flood, however, levees in all of the polders failed, and some or all of the land within each was flooded. Land located in the crescent bordering the Mississippi River at the south end of the downtown area is above sea level and therefore was not flooded.

A. Levee Planning and Construction History

The system just described grew out of a reevaluation of the protections that had failed when Hurricane Betsy struck New Orleans in September 1965. Reacting to the devastating flooding which resulted from that storm, Congress authorized a massive hurricane protection improvement effort called the Lake Pontchartrain and Vicinity Hurricane Protection Project (LPVHPP) to provide hurricane protection to all of the Greater New Orleans metropolitan area.[16] To implement this statute, the Corps of Engineers carefully studied two major options—the "high level" option and the "barrier" option.

1. The "High Level" and "Barrier" Options.

The "high level" option consisted simply of raising all of the existing levees and, where necessary, constructing new levees to a height that would prevent flooding that could result from the standard project hurricane (SPH), a hypothetical hurricane that was used to guide Corps levee design and that loosely represented the most extreme hurricane

[14] John Schwartz, Competing Plans to Repair New Orleans Flood Protection, New York Times, January 22, 2006, at A18.

[15] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-3. The word "polder" is a Dutch word that means "a contiguous land unit protected by a perimeter levee system." Id.

[16] Hearings on Hurricane Protection Plan for Lake Pontchartrain and Vicinity before the Subcommittee on Water Resources of the House Committee on Public Works and Transportation, 95th Cong., 2d Sess. (1978) [hereinafter cited as 1978 House Hearings], at 20 (testimony of Colonel Early J. Rush III). See also GAO, Hurricane Protection: Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project, Dec. 15, 2005, at 4.

that would be expected to hit New Orleans every 200 to 300 years.[17] Although experts later determined that the model hurricane could not possibly occur in the real world,[18] it was roughly equivalent to a fast-moving Category Three storm on the Saffir-Simpson hurricane scale.[19] In practice, the high level plan for protection against the SPH would have resulted in raising the levees from between 9.3 and 13.5 feet above sea level to between 16 and 18.5 feet above sea level.[20] The assumption was, of course, that the levees would be properly designed and constructed to withstand all storm surges that did not exceed those levels.

Under the "barrier" option, the Corps would have constructed levees along the far eastern edge of Lake Pontchartrain where it flows into Lake Borgne and ultimately the Gulf of Mexico through two relatively narrow channels at the Rigolets pass and Chef Menteur pass (see figure 2). The Corps would also have constructed structures at the two passes containing massive gates that would have allowed water to flow back and forth between the lakes but that would have been closed when hurricanes approached.[21] Finally, the Corps would have built a navigation lock, rock dike, and gated flood control structure at the point at which the Industrial Canal enters Lake Pontchartrain. The gates would have been closed during hurricanes to prevent water from entering the Industrial Canal from Lake Pontchartrain.[22] The Corps believed that the levees and the barrier structure would prevent storm surge preceding hurricanes from crossing from Lake Bourne into Lake Pontchartrain.[23] Consequently, the levees bordering the city along Lake Pontchartrain would be fortified, but not significantly raised as under the alternative plan. Still, like the high level option, the barrier option was designed to protect against the SPH.[24]

2. First Choice: The Barrier Option

The high level option had several drawbacks from the perspective of Corps officials, including the need to obtain rights of way for additional land near the levees to allow them to be widened and raised. In addition, the high level plan would not have prevented the flooding of some industrial areas and potentially developable wetlands

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[17] 1978 House Hearings, supra, at 21 (testimony of Colonel Early J. Rush III). For an extended discussion of the SPH, see infra text accompanying notes __-__.

[18] John McQuaid & Mark Schleifstein, Evolving Danger: Experts Know We Face a Greater Threat from Hurricanes than Previously Suspected, Times-Picayune, June 23, 2002 ("Meteorologists today say the Standard Project Hurricane could not exist in nature.") (quoting Louisiana State University engineering professor Joseph Suhayda).

[19] Jerry Mitchell, E-Mail Suggests Government Seeking to Blame Groups, Mississippi Clarion-Ledger, September 16, 2005, at A1 (quoting Corps of Engineers spokesperson John Hall); John McQuaid & Mark Schleifstein, Evolving Danger, New Orleans Times-Picayune, June 23, 2002, at J12; See Government Accountability Office, Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project, Dec. 15, 2005, GAO-06-322T, at page 1.

[20] United States General Accounting Office, Cost, Schedule, and Performance Problems of the Lake Pontchartrain and Vicinity, Louisiana, Hurricane Protection Project (PSAD-76-161 (August 31, 1976) [hereinafter cited as 1976 GAO Report], at 3.

[21] 1978 House Hearings, supra, at 22-24, 33-36 (testimony of Colonel early J. Rush III).

[22] 1978 House Hearings, supra, at 22-24, 33-36 (testimony of Colonel early J. Rush III).

[23] 1978 House Hearings, supra, at 22 (testimony of Colonel early J. Rush III).

[24] 1978 House Hearings, supra, at 22 (testimony of Colonel early J. Rush III).

located outside the existing downtown polder between the levees and the lake to the northeast of the city.[25] The Corps therefore decided to implement the barrier option.[26] To speed the project along, the Orleans Levee Board financed and constructed portions of the Industrial Canal floodwalls, and this relatively inexpensive aspect of the project was virtually completed by 1973.[27] Work on the barrier structures and levees running from New Orleans to the those structures, however, was greatly delayed because landowners opposed to the project demanded high prices for parcels of property that the Corps needed in order to construct the levees, forcing the Corps to exercise its power of eminent domain.[28]

In 1976, a coalition of local fishermen and an environmental group called Save Our Wetlands sued the Corps of Engineers alleging that the final environmental impact statement (FEIS) prepared for the project was inadequate.[29] On December 30, 1977, a federal district court agreed, issuing an injunction that prevented the Corps from conducting any further work on the barrier project until it had prepared an adequate FEIS. The injunction was subsequently modified to permit continued construction of the levees between the lake and the City of New Orleans.[30]

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[25] Id. at 21 (testimony of Colonel early J. Rush III).

[26] The Orleans Levee District -- A History, available at http://www/orleanslevee.com/history.htm [hereinafter cited as Levee District History]

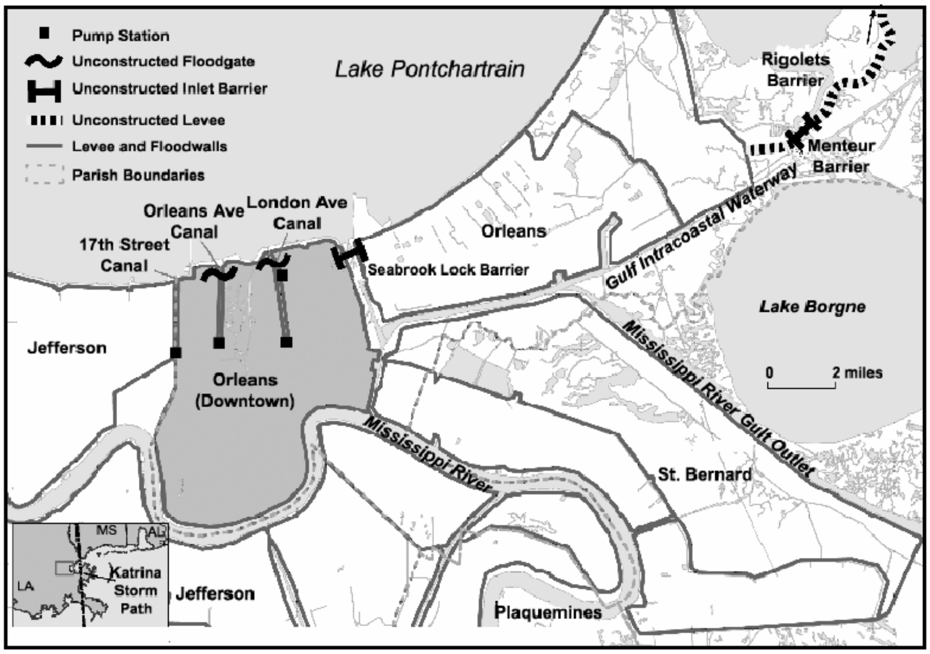
[27] Id.

[28] 1976 GAO Report, supra, at 16.

[29] Levee District History.

[30] Id.

Figure 2. Rejected Inlet Barriers and Canal Floodgates



Source: National Oceanic and Atmospheric Administration; Federal Emergency Management Agency; U.S. Army Corps of Engineers

Prepared by the Congressional Cartography Program, Geography and Map Division, Library of Congress, 2005

3. Second Choice: The High Level Plan

After the injunction issued, the Corps reconsidered the costs and benefits of the barrier and high level options. It was at that time encountering additional opposition to the barrier plan from local citizens who did not want to pay a very high price for a project that might endanger the vitality of Lake Pontchartrain,[31] from citizens who saw the project as "a land grab that would personally enrich some of the civic leaders pushing hardest for it,"[32] and from representatives of areas on the Lake Borgne side of the barrier who likely would have been placed at greater risk of flooding during hurricanes and who therefore felt the plan would foreclose economic development of their region.[33]

The intense public opposition was in evidence during congressional hearings conducted in New Orleans the week after the injunction issued. A spokesperson for the League of Women Voters argued that the Corps had never undertaken a study of the cost to taxpayers of maintaining the urbanization of wetlands that the project envisioned, and she noted that the voters of New Orleans had defeated proposals to participate in financing the barrier project on three separate occasions, but had voted to approve a

[31] United States General Accounting Office, Cost, Schedule, and Performance Problems of the Lake Pontchartrain and Vicinity, Louisiana, Hurricane Protection Project (PSAD-76-161 (August 31, 1976) [hereinafter cited as 1976 GAO Report], at 3.

[32] Carl M. Cannon, The Next Big One, National Journal, September 24, 2005, at 2902, 2907.

[33] Carl M. Cannon, The Next Big One, National Journal, September 24, 2005, at 2902, 2907.

similar project without the barriers the previous year.[34] An informal poll conducted by Representative Robert Livingston indicated that a substantial majority of the New Orleans citizens either opposed the project (38.5 percent) or favored discontinuation until the studies could be completed (23.6 percent).[35] Although not known for his antipathy to federally financed public works projects in his district, even Representative Livingston expressed considerable reservations about the wisdom of this particular project. The state representative from St. Tammany Parish, part of which was on the Lake Borgne side of the barrier project, warned that the project would put his parish at risk when the gates were closed because it would deflect the surge from Lake Borgne into St. Tammany Parish.[36]

By 1982, the New Orleans District of the Corps of Engineers had changed its mind. It now favored the high level plan "because it would cost less than the barrier plan" and would "have fewer detrimental effects on Lake Pontchartrain's environment."[37] One of the factors underlying the changed cost assessment was no doubt the escalating cost of acquiring rights of way from property owners who opposed the barrier project.[38] The Corps made a final decision to proceed ahead with the high level plan in 1985. Although nearly seven years had passed between the issuance of the injunction and the Corps' ultimate decision to abandon the barrier plan, the project was substantially completed prior to Hurricane Katrina.[39]

B. The Levee Failures

Although the explanation for *why* the New Orleans levees failed involves a complex interaction of engineering and policy considerations, the inquiry into what physically happened to the levees on August 29, 2005 is largely a technical question. This is not, however, to say that there is an easy explanation for what exactly happened to the levees that night, and the engineers studying that question will no doubt debate the finer points of the analysis for years. The description below draws primarily upon the Preliminary Report of a group of experts from the University of California at Berkeley and the American Society of Civil Engineers (the "Berkeley/ASCE group") based upon its analysis of the situation shortly after the hurricane.[40] The Corps of Engineers, a group from the Louisiana State University Hurricane Canter, and a panel assembled by the

[34] 1978 House Hearings, supra, at 11 (testimony of Charlotte H. Nelson).

[35] 1978 House Hearings, supra, at 12.

[36] 1978 House Hearings, supra, at 47-48 (testimony of Edward G. Scogin).

[37] United States General Accounting Office, Improved Planning Needed by the Corps of Engineers to Resolve Environmental, Technical and Financial Issues on the Lake Pontchartain Hurricane Protection Project (GAO/MASAD-82-39 (August 17, 1982), at 2.

[38] 1976 GAO Report, supra, at 16.

[39] Levee District History, supra.

[40] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005). The description also relies on newspaper accounts of conclusions of the experts involved in this and other investigations.

National Academy of Sciences are also conducting in depth inquiries that could well come to different conclusions.[41]

1. Lake Pontchartrain and the Outfall Canals.

The water that flooded the polder containing downtown New Orleans and the French Quarter did not flow over the high level levees situated between Lake Pontchartrain and the city. As previously discussed, these levees were designed to withstand a hurricane that was roughly equivalent to a fast-moving Category Three Hurricane, and they did their job. Most of the experts have agreed that by the time it encountered Lake Pontchartrain, Katrina's status had decreased from Category Four to the upper range of Category Three.[42] As the surge flowed from Lake Pontchartrain up the 17th Street, Orleans Avenue and London Avenue outfall canals, it did not overtop the levees confining those canals either.[43] The surge did, however, cause three major breaches in the 17th Street and London Avenue levees.[44] These breaches allowed water from Lake Pontchartrain to flood wide areas of the downtown polder. In the aftermath of the storm, the Corps of Engineers stressed that the two specific outfall levees that had breached were "fully completed" and not on the list of unfunded projects.[45]

The Berkeley/ASCE group concluded that the levee failure on the east side of the 17th Street canal "appears to have been a stability failure of the foundation soils beneath the earthen embankment" to which the floodwall was attached.[46] The group concluded as a preliminary matter that the breach on the west bank of the London Avenue canal "occurred as a result of the sheetpile/floodwall being pushed backwards by the elevated water pressures on the outboard side, and that support on the inboard side of the sheetpile/floodwall was reduced as a result of soil failure at or beneath the base of the earthen levee embankment."[47] According to the group's report "[e]vidence at both sites suggests that massive underseepage passed beneath the relatively short sheetpiles, and this may have weakened the foundation soils beneath the inboard sides of the earthen

[41] For more current information, Boalt Hall School of Law maintains a website of regularly updated information on the Katrina disaster and disasters and the law more generally. *See* http://128.32.29.133/disasters.php.

[42] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1

[43] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-5. See also John M. Barry, After the Deluge, Some Questions, New York Times, October 13, 2005 (citing the preliminary conclusions of three post-Katrina engineering studies); Celeste Biever, Flood Walls in New Orleans were "Structurally Flawed," New Scientist, September 22, 2005 (quoting Paul Kemp, and oceonologist at the Louisiana State University Hurricane Center).

[44] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-5.

[45] Andrew Martin & Andrew Zajac, Flood-Control Funds Short of Requests, Chicago Tribune, September 1, 2005, at 7.

[46] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 2-3.

[47] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 2-6.

levee embankments."[48] In other words, the pressure that the storm surge generated from within the canal caused the weak soil in which the floodwalls were anchored to give way in some places and pushed the walls backwards into the protected polders.

Consistently with this conclusion, most engineers who have examined the question have concluded that the underseepage occurred because the floodwalls were not anchored sufficiently deeply in the foundation soils at the time that they were designed and built in connection with the implementation of the high level option in the late 1980s.[49] The leader of the Berkeley/ASCE group noted that the safety margins employed in the designs for the levees were far lower than the safety margins employed in most other critical engineering projects.[50] The Corps of Engineers has traditionally employed a safety factor of 1.3 for levee construction projects, meaning that levees are designed to withstand pressure approximately one-third again as powerful as expected forces.[51]

According to documents from the mid-1980s when the high level option was being implemented along the outfall canals (accounts of which vary somewhat), tests of the soil below the existing levees encountered a layer of peat some 15-20 feet below the surface.[52] The design for the project called for sinking the pilings 17-20 feet below the surface.[53] Since peat expands and softens when it becomes wet, the pilings should have been extended sufficiently far beneath the peat to provide adequate stability.[54] A team of experts from Louisiana State University concluded from an examination of historical documents that the floodwalls built in the 1980s to implement the high level option were not anchored sufficiently deeply because the soils immediately below the existing levees consisted of spoil from digging the canals in the late nineteenth century and dredging them in the early twentieth century.[55] This explanation is consistent with documents filed in litigation during the mid-1990s between the Corps of Engineers and a construction

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[48] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 2-6.

[49] Eli Kintisch, Levees Came Up Short, Researchers Tell Congress, 310 Science 953 (2005); Joby Warrick & Spencer S. Hsu, Levees' Construction Faulted in New Orleans Flood Inquiry, Washington Post, November 3, 2005 (reviewing testimony of three groups of engineers); Celeste Biever, Flood Walls in New Orleans were "Structurally Flawed," New Scientist, September 22, 2005.(quoting Elizageth English of the Louisiana State University Hurricane Center).

[50] Ralph Vartabedian & Stephen Braun, System Failures Seen in Levees, Los Angeles Times, October 22, 2005 (quoting Raymond Seed, leader of the Berkeley/ASCE group).

[51] John McQuaid, Bob Marshall & Mark Schliefstein, Evidence Points to Man-made Disaster, New Orleans Times-Picayune, December 8, 2005.

[52] Christopher Drew & John Schwartz, Engineers Point to Flaws in Flood walls' Design as Probable Cause of Collapse, New York Times, October 24, 2005 (peat located 15 feet below the surface); Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1 (peat located 20 feet below the surface)

[53] Christopher Drew & John Schwartz, Engineers Point to Flaws in Flood walls' Design as Probable Cause of Collapse, New York Times, October 24, 2005 (pilings sunk 17 feet below the surface)Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1 (pilings sunk 20 feet below the surface).

[54] Christopher Drew & John Schwartz, Engineers Point to Flaws in Flood walls' Design as Probable Cause of Collapse, New York Times, October 24, 2005 (citing "[s]everal outside engineers); Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1 (quoting University of California at Berkeley engineer, Robert Bea).

[55] Joby Warrick & Spencer S. Hsu, Levees' Construction Faulted in New Orleans Flood Inquiry, Washington Post, November 3, 2005; Bob Marshall & Mark Schleifstein, Poor Design of Levee "Obvious," LSU Says, Atlanta Journal-Constitution, October 30, 2005.

company that had been working on the levees. The company claimed that sections of the floodwalls were failing to line up properly because of unstable underlying soils.[56] Although Corps of Engineers officials are not yet persuaded by this explanation, the design for rebuilding the floodwalls post-Katrina does call for sinking the pilings to a depth of 40 feet.[57]

Other evidence suggests that the contractors who were responsible for testing the soil and building the levees along the outfall canals may have been responsible for poor construction in places where the levees breached.[58] A team of engineers from LSU who investigated the levee failures at the behest of the State of Louisiana discovered that the piling extended only 10 feet below sea level in some areas, rather than the 17 foot depth called for in the design documents.[59] Although a Corps of Engineers analysis of the same pilings rejected this conclusion,[60] the LSU scientists are convinced that their assessment is correct because the measuring equipment that they used is more accurate than the Corps' equipment.[61] The Berkeley/ASCE group also heard allegations of malfeasance on the part of contractors in connection with the construction of the levees and "some field evidence" appeared to "correlate with those stories."[62] Berkeley Engineer Robert Bea worried that the outside engineering firms and contractors may have been more concerned with the bottom line than with identifying and correcting problems in the design and construction of the levees.[63] Louisiana's Attorney General has opened an investigation into these allegations.[64]

Finally, the Berkeley/ASCE group concluded that lax maintenance practices may have contributed to the breach of some of the levees lining the outfall canals.[65] For example, large trees were allowed to grow at the base of some of the levees. According to one of the engineers conducting the Berkeley/ASCE investigation, the root systems of

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[56] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1. According to a spokesperson for the Corps of Engineers, many of the documents contained in the 325 boxes of documents that the Corps has identified as being related to the construction of New Orleans levees may be withheld from the public because of "homeland security concerns." Mark Schleifstein, Levee Team Runs into Wall, New Orleans Times-Picayune, October 26, 2005.

[57] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1.

[58] John Schwartz, Panelist on Levees Faults Army Corps Budget Cuts, New York Times, October 19, 2005.

[59] John Schwartz & Christopher Drew, Louisiana's Levee Inquiry Faults Army Corps, New York Times, December 1, 2005.

[60] Tests on Key Levee in New Orleans Show Compliance, USA Today, December 14, 2005, at A4.

[61] Mark Schliefstein, LSU Expert Defends Piling Tests, New Orleans Times-Picayune, December 15, 2005.

[62] Joby Warrick & Spencer S. Hsu, Levees' Construction Faulted in New Orleans Flood Inquiry, Washington Post, November 3, 2005 (reporting testimony of Raymond B. Seed, leader of the Berkeley/ASCE group); John Schwartz, Malfeasance Might have Hurt Levees, Engineers Say, New York Times, November 3, 2005 (same).

[63] Mark Schleifstein, Levee Team Runs into Wall, New Orleans Times-Picayune, October 26, 2005.

[64] Christopher Drew, Inquiry to Seek Cause of Levee Failure, New York Times, November 9, 2005.

[65] Ralph Vartabedian & Stephen Braun, System Failures Seen in Levees, Los Angeles Times, October 22, 2005 (quoting Raymond Seed, leader of the Berkeley/ASCE group).

the trees could have opened up a pathway for water to seep through a soft layer of peat beneath the levees and reach the other side, thereby undermining the integrity of the levee wall.[66] In addition, state and local officials have admitted that they typically skipped the canal floodwalls when they were performing annual levee inspections, and that the levees they did inspect were given only cursory attention.[67] The Corps of Engineers has not yet agreed with these assessments, and it has instead undertaken an extensive investigation of the causes of the outlet canal levee failures.[68] Nevertheless, the information and analysis revealed thus far suggests that the outlet canal walls were not overtopped and that the downtown polder would not have flooded if the walls had withstood the lateral pressure of the storm surge inside the canals, as they were designed to do.[69]

2. Lake Borgne

The largest storm surge to hit the New Orleans area came not from Lake Pontchartrain to the north but from Lake Borgne to the east.[70] Although the Corps enhanced the levees for the polders protecting New Orleans East from Lake Borgne as part of the high level plan, the estimated 18–25 foot storm surge exceeded the height of some of the levees protecting that polder by as much as 5–10 feet.[71] These levees were simply not high enough to repel the storm surge, and they were "overwhelmed" and "massively eroded."[72] Colonel Richard Wagenaar, the Corps' head engineer for the New Orleans district, reported that the eastern levees were "literally leveled in places."[73] Large areas in this polder, which was inhabited mainly by low income residents and businesses that served local communities, were flooded. Since this surge came from Lake Borgne and not Lake Pontchartrain, it is clear that the barrier project—had it been constructed during the 1980s—would not have prevented this damage and might even have exacerbated it by deflecting some portion of the surge from the two passes to the southern half of Lake Borgne. A protection system more massive in scope that could have slowed or prevented a storm surge into Lake Borgne—such as the huge seagate

[66] John McQuaid, Bob Marshall & Mark Schliefstein, Evidence Points to Man-made Disaster, New Orleans Times-Picayune, December 8, 2005

[67] John McQuaid, Bob Marshall & Mark Schliefstein, Evidence Points to Man-made Disaster, New Orleans Times-Picayune, December 8, 2005

[68] Ralph, Vartabedian, Levee Report Jives With Early Speculation, Los Angeles Times, December 10, 2005.

[69] See also Ralph Vartabedian, Study Sees Design Issue in Failures of Levees, Los Angeles Times, May 3, 2006 (noting that investigators for the Army Corps had issued a report concluding that London Avenue levees failed due to erosion of the soil beneath the levee walls, much as earlier reports had concluded with respect to the 17th Street breaches).

[70] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-4.

[71] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-4 through 1-5.

[72] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-5.

[73] Ralph Vartabedian, Much Wider Damage to Levees Is Disclosed, L.A.Times, Sept. 13, 2005, available at http://www.latimes.com/news/nationworld/nation/la-na-corps13sep13,0,5962987.story?coll=la-home-headlines.

structures that are utilized to protect the Netherlands from North Atlantic storms[74]—might in theory have provided better protection to New Orleans. No such structures, however, were contemplated as part of the original barrier plan.

3. The Navigation Canals

Hurricane Katrina's storm surge also proceeded from the Gulf of Mexico and Lake Borgne up the MRGO Canal to the Industrial Canal in the heart of New Orleans. The MRGO Canal, which was completed in 1968, is a deep draft seaway channel that extends for approximately 76 miles east and southeast of New Orleans into Breton Sound and the Gulf of Mexico. It was designed to shorten the distance for ships traveling from the eastern shipping lanes of the Gulf to New Orleans, but it has never lived up to its economic expectations.[75] The storm surge overtopped the levees running along these canals at "a number of locations," and several breaches occurred.[76]

A post-Katrina modeling exercise undertaken by the LSU Hurricane Center concluded that the "funneling" effect of the MRGO Canal, which narrows from 2000 feet wide where it intersects the Intercoastal Waterway to 200 feet wide where it bisects the Industrial Canal, intensified the initial storm surge by about 20 percent and increased the velocity of the surge from three to 6–8 feet per second.[77] G. Paul Kemp, an oceanographer at the LSU Hurricane Center, concluded that the MRGO "funnel" was "a back door into New Orleans," and he had little doubt that it "was the initial cause of the disaster."[78] As a result of these levee failures, large areas of flooding occurred within the polder containing St. Bernard Parish and the Ninth Ward to the south of the MRGO Canal and within the polder containing New Orleans East to the north of the MRGO Canal.[79] As with the storm surge from Lake Borgne, the barrier project would not have protected the two flooded polders from the surge that overtopped and breached the levees along the MRGO Canal, because no protection systems were contemplated to prevent the "funneling" effect of the canal.

The levees lining the Industrial Canal experienced a number of much smaller failures along both of its banks. Several breaches occurred along the eastern bank

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[74] Molly Moore, Rethinking Defenses Against Sea's Power, Washington Post, Sept. 8, 2005, at A22, available at http://www.washingtonpost.com/wp-dyn/content/article/2005/09/07/AR2005090702400.html?referrer=emailarticle

[75] Michael Grunwald, Canal May Have Worsened City's Flooding, Washington Post, September 14, 2004, at A21. Less than three percent of the New Orleans port's cargo traffic uses the MRGO; this amounts to less than one ship per day. Id. According to one estimate, the government spends $7 million to $8 million per year (about $10,000 for every large vessel that uses the canal) just to maintain the canal. See Lake Ponctchartrain Basin Association, Martello Castle Background Information, available at http://wetmaap.org/Martello_Castle/Supplement/mc_background.html [hereinafter cited as Martello Castle Background Information].

[76] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-5.

[77] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1.

[78] Id.

[79] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-5.

between the MRGO Canal to the south and Lake Pontchartrain to the north.[80] These breaches allowed water to flow to the east into the New Orleans East polder. The levees along the western edge of the Industrial Canal were breached in three places located almost directly across from the point at which the MRGO Canal adjoins the Industrial Canal.[81] The Berkeley/ASCE group concluded that "storm surges overtopped numerous stretches of levees along this Canal frontage."[82] The LSU Hurricane Center's post-Katrina modeling exercise concluded that the enhanced velocity of the storm surge as it traveled up the MRGO Canal also contributed to the scouring that undermined the levees along the Industrial Canal.[83] These after-the-fact analyses are consistent with the contemporaneous observations of the lockmaster on the Industrial Canal, who reported to the Corps of Engineers that the surge reached that canal before dawn and overflowed on both sides.[84] The lockmaster's observations also cast doubt on the claim that the surge from Lake Pontchartrain caused the levee failures on the Industrial Canal because, according to the Corps of Engineers New Orleans Project Manager, the Lake Pontchartrain surge occurred much later in the morning after the hurricane's eye had passed east of the city and winds from the north began to force water to the south toward the city.[85]

It is theoretically possible that the overtopping and resultant erosion of the Industrial Canal levees would have occurred even in the absence of the MRGO Canal because of the subsequent storm surge from Lake Pontchartrain. However, the conclusion that the storm surge from the MRGO Canal caused the levee failures along the Industrial Canal to fail is amply supported by hindsight observations of the Industrial Canal levees, hindsight recreation of the storm surge using sophisticated mathematical models, and contemporaneous observations by at least one eye witness. It bears noting, nevertheless, that as of late October the Corps was reserving judgment on whether the MRGO contributed to the failure of the Industrial Canal levees in this manner.[86]

III. The Blame Game

The above description of the complex system of levees that was supposed to protect New Orleans at the time of Hurricane Katrina suggests that the question posed in the introduction to this article, "Why did the levees fail?", is framed too broadly or, perhaps, too simplistically. In fact, many levees failed in many places for many different

[80] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 1-10 (Figure 1.4).
[81] Id.
[82] R. B. Seed, et. al, Preliminary Report on the Performance of the New Orleans Levee Systems in Hurricane Katrina on August 29, 2005 (November 2, 2005), at 2-9.
[83] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1.
[84] John McQuaid, Katrina Trapped City in Double Disasters, New Orleans Times-Picayune, September 7, 2005.
[85] John McQuaid, Katrina Trapped City in Double Disasters, New Orleans Times-Picayune, September 7, 2005.
[86] Joby Warrick & Michael Grunwald, Investigators Link Levee Failures to Design Flaws, Washington Post, October 24, 2005, at A1.

reasons. Some were overtopped by floodwaters that then scoured out the levee support from inside the protected area. Others could not withstand the direct pressure of the storm surge from outside the protected area because they were not imbedded sufficiently deeply in the underlying soils. Some floodwalls may have come apart during the storm surge because connections between individual wall sections failed. Future investigations will no doubt uncover still other suggested reasons for the various levee failures that occurred during the Katrina storm surge.

Because the levee systems divided the city and surrounding areas into polders, the failure of the levee system protecting one polder did not necessarily contribute to the damage caused by the failure of the levee system protecting a different polder. Some areas of the city would not have flooded had one levee system held, even if the others had failed. Other areas of the city would not have flooded had two levee systems both held, but would have flooded if either of the two failed. All of these inquiries are essentially engineering questions and are best answered through detailed field investigations and complex mathematical modeling exercises. Still, although correct answers to these questions are relevant to the post-Katrina blame game, they will not by themselves be sufficient to resolve the broader issues raised by Katrina, including the prominent contention that NEPA played a causal role in the New Orleans flooding.[87]

Not long after the damage to New Orleans became apparent, a retired Corps of Engineers official, conservative pundits, and politicians began a concerted campaign to blame the damage on a lawsuit brought against the Corps of Engineers in 1976 by local fishermen and a local environmental group called Save Our Wetlands.[88] Citing that litigation and other clearly irrelevant litigation involving the Mississippi River levee system far upstream of New Orleans, conservative commentator R. Emmett Tyrell, Jr. claimed that "[f]or too long, environmentalist fanatics with no sense of a broad-based commonweal have had a veto over government and private-sector projects essential to the health and well-being of millions of Americans."[89] A columnist for FrontPage online magazine referred to the *Save our Wetlands* litigation as "green genocide."[90] The chairman of the Senate Environment and Public Works Committee asked the Justice Department to investigate whether any environmental litigation might have played a role

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[87] See, e.g., R. Emmett Tyrell, Jr., Eco-Catastrophe Echoes, Washington Times, September 16, 2005; John Berlau, Greens vs. Levees, National Review, Online, September 8, 2005, available at http://www.nationalreview.com; You Can Pay Me Now, or You Can Pay Me Later, The Quando Blog, available at http://www.quando.net/details.aspx?Entry=2595; Alan Levin & Pete Eisler, Many Decision Led to Failed Levees, USA Today, Nov. 11, 2005.

[88] Ralph Vartabedian & Peter Pae, A Barrier that Could Have Been, Los Angeles Times, September 9, 2005, at A1 (quoting former Corps of Engineers chief counsel Joseph Towers). See also Statement of Senator James M. Jeffords, in Hearings before the Senate Committee on Environment and Public Works, Pctpber 6, 2005 ("We all know that in 1977, lawsuits by environmental groups not only delayed the flood control solution for New Orleans, but forced the Corps to abandon its preferred solution"); Adriel Bettelheim, Corps Controversy Builds on Gulf Coast, Congressional Quarterly Weekly Edition, September 12, 2005, at 2381, 2382 (reporting comments of Former Representative Robert L. Livingston); Oliver A. Houck, The U.S. House of Representatives' Task Force on NEPA: The Professors Speak, 35 ELR 10895, 10897 (2005) (describing post-Katrina efforts to "claim[] that it was the environmentalists who drowned New Orleans").

[89] R. Emmett Tyrell, Jr., Eco-Catastrophe Echoes, Washington Times, September 16, 2005.

[90] Michael Tremoglie, New Orleans: A Green Genocide, FrontPageMagazine.com, September 8, 2005, available at http://www.frontpagemag.com/Articles/rintable.asp?ID=19418.

in the New Orleans flooding, and high level officials in that Department circulated an email to line attorneys asking for information about cases in which they had defended the Corps of Engineers from environmental claims involving the levees protecting New Orleans.[91] The House Task Force on Improving the National Environmental Policy Act ("NEPA Task Force")—already controversial due to its perceived heavy-handedness and overtly politicized agenda[92]—decided to add the *Save Our Wetlands* litigation to its agenda as it considered possible amendments to NEPA.[93]

The plaintiffs filed *Save Our Wetlands v. Rush*[94] in 1976, some time after work had begun on the levees between New Orleans and the passes at the Rigolets and Chef Menteur, but before work had been initiated on the barrier structures. The plaintiffs claimed that the Final Environmental Impact Statement (FEIS) that the Corps of Engineers had prepared for the barrier project did not meet the requirements of Section 102 of NEPA in several regards. In particular, they claimed that the FEIS had not adequately addressed the potential adverse impact of the structures on the normal tidal flows of water between Lake Borgne and Lake Pontchartrain. In their view, the flows were critical to maintaining the vitality of the Lake Pontchartrain fishery and the overall integrity of the marine ecosystem.

The district court held that the FEIS was in fact inadequate. It concluded that "the picture of the project painted in the FEIS was not in fact a tested conclusion but a hope by the persons planning the project that it could in fact be constructed so as to meet the environmental objectives set out in the FEIS."[95] The court noted that the chief engineer for the Corps' New Orleans Division had requested further model studies because the studies upon which the draft EIS relied were undertaken more than a decade earlier and had addressed an obsolete version of the project. The chief engineer feared that the flow of water between the lakes would be far less in the new version of the project than in the earlier version. The Corps' environmental staff initiated the requested model studies, but they had not completed them when the FEIS came out. Even though more appropriate studies were on the way, the FEIS continued to rely upon the obsolete studies, and this unexplained impatience on the part of the Corps clearly troubled the court.[96]

The court was also troubled by the content of the analysis that the FEIS did provide and the role of upper level officials in determining that content. The biological analysis presented in the FEIS relied entirely on a single telephone conversation with a marine biologist who was asked to speculate about the impact of the project on marine organisms using the inter-lake flow rates predicted by the obsolete model. The Corps of Engineers official responsible for preparing the EIS expressed reservations about key

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[91] Dan Eggen, Senate Panel Investigating Challenges to Levees, Washington Post, September 17, 2005, at A10; Jerry Mitchell, E-Mail Suggests Government Seeking to Blame Groups, Mississippi Clarion-Ledger, September 16, 2005, at A1; Mark Sherman, Justice Dept. Looks at Lawsuits, Levees, Seattle Post-Intelligencer, September 16, 2005.

[92] See Oliver A. Houck, The U.S. House of Representatives' Task Force on NEPA: The Professors Speak, 35 Env. L. Rev. 10895 (2005).

[93] Ralph Vartabedian & Richard B. Schmitt, Mid-60s Project Fuels Environmental Fight, Los Angeles Times, September 17, 2005, at A17; Task Force on Improving the National Environmental Policy Act, U.S. Reps to Revew Environmental Reg's Role In Affordable Energy, Post-Katrina Development, Press Release dated September 8, 2005.

[94] Save Our Wetlands v. Rush, Civ. No. 75-3710, Slip Opinion (E.D. La. 1977).

[95] Save Our Wetlands v. Rush, Civ. No. 75-3710, Slip Opinion (E.D. La. 1977).

[96] Id. at 5.

statements on the effects of the structures on marine life in the lake, and he suggested that the document's conclusion that the project "would not" have a significant impact on lake biology should at least be changed to "should not." That official, however, was overruled by his superiors. In addition, the assessment of the barrier project's benefits included the benefits of further urban development on wetlands that would be reclaimed from the lake after the project was completed, but it failed to take into consideration the fact that the area had also been designated as a protected wetland. A Corps economist had pointed this out and asked that the analysis be modified accordingly. He, too, was overruled by upper level officials.[97]

The court concluded that in light of "the problems of which the Corps was aware with respect to the possibility of significantly decreased tidal flow through the structures," the analysis of alternatives in the FEIS was inadequate. The court concluded that the FEIS "precludes both the public and the governmental parties from the opportunity to fairly and adequately analyze the benefits and detriments of the proposed plan and any alternatives to it."[98] It therefore enjoined further work on the barrier structures until the Corps had completed an adequate FEIS. The court made clear, however, that its opinion and order should "in no way be construed as precluding the Lake Pontchartrain project as proposed or reflecting on its advisability in any manner," and it stressed that "[u]pon proper compliance with the law with regard to the impact statement, this injunction will be dissolved and any hurricane plan thus properly presented will be allowed to proceed."[99]

IV. Hindsight Analysis of the New Orleans Flooding.

The starting point in a hindsight causation analysis is careful historical reconstruction of the event in question. The analyst must then compare that reconstruction to a hypothetical scenario in which the act or omission alleged to be the cause of the consequence at issue did not occur. If, in this alternative state of the world, the harmful event *still* occurs, then the suspected act or omission is not a "but-for" cause of the event.[100] Proper hindsight analysis therefore requires both an accurate reconstruction of the actual history of the event and a persuasive analysis of the appropriate counterfactual scenario. Of course, such but-for causation analysis by itself is insufficient for purposes of assigning legal or moral responsibility, given the variety of other considerations that ultimately must be brought to bear on the situation in order to move from "but-for" to blameworthiness analysis.[101] Nevertheless, the but-for method of identifying contributing causes does provide a conventional starting point for the ultimate attribution of responsibility. For post-Katrina NEPA debate, therefore, the first important question to ask is whether, but for *Save Our Wetlands*, would the catastrophic flooding of New Orleans still have occurred? This Part answers that question.

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[97] Id. at 6.
[98] Id.
[99] Id. at 7.
[100] *See* H.L.A. Hart & Tony Honore, Causation in the Law 110-114 (2nd ed. 1985); W. Page Keeton et al., Prosser & Keeton On The Law Of Torts § 41 (5th Ed. 1984).
[101] See text accompanying notes ___ - ___, supra.

A. The Lake Borgne and MRGO levee failures

From the engineering analysis related above,[102] it seems clear beyond cavil that the waters that flooded the New Orleans East polder, which lies north of the MRGO Canal and west of the intersection of the MRGO Canal and the Intercoastal Waterway, came directly from Lake Borgne and indirectly from the Gulf of Mexico via the MRGO Canal. The flooding of the polder to the south of the MRGO Canal and to the east of the Industrial Canal resulted when waters flowing up the MRGO Canal overtopped the levees along that canal and brought waters into interior of the polder. This flooding took place before the eye of Hurricane Katrina passed to the east of the city and began to drive waters from Lake Pontchartrain up the Industrial Canal and the outfall canals in the downtown polder. It clearly did not result from waters entering Lake Pontchartrain from Lake Borgne at the Rigolets and Chef Menteur passes. Had the barrier project been constructed, the flooding of this area would still have occurred due to waters entering the polder directly from Lake Borne and traveling up the MRGO Canal from Lake Borgne and the Gulf of Mexico. It is even possible that the flooding of the New Orleans East area would have been worse if the barrier plan had been implemented, given that more of the surge would have been directed along these channels. Thus, hindsight causation analysis strongly suggests that the lawsuit was not to blame for any of this flooding, and few uncertainties cloud this analysis.

B. The Industrial Canal Levee Failures

Hindsight analysis offers a somewhat less certain answer to the question of whether the overtopping of the levees on the west bank of the Industrial Canal would have occurred had the Corps of Engineers not abandoned the barrier project. That project was designed to reduce the chance that a storm surge from Lake Pontchartrain would breach the levees along the lake and along the canals that open to that lake. It also provided for a navigation lock, rock dike, and gated flood control structure where the Industrial Canal enters Lake Pontchartrain. Had the barrier project been completed and had it functioned properly (a topic addressed below), it would have added to the protection of areas placed at risk from overtopping of the Industrial Canal levees to the extent that the risk was attributable to waters from Lake Pontchartrain.

The engineers have agreed that the levees on the Industrial Canal were overtopped and that the breaches probably occurred because waters that flowed over the levees scoured out the soils behind those levees.[103] Engineering analysis of the levees after the flood, hindsight modeling, and the contemporaneous observations of the lockmaster all converge on the conclusion that the waters that overtopped the levees in the Industrial Canal came from Lake Borgne and points east, rather than from Lake Pontchartrain. The fact that the Lake Pontchartrain storm surge did not overtop the levees bordering the outlet canals during Hurricane Katrina further supports the conclusion that the levees bordering the Industrial Canal, which parallels those canals, would not have been overtopped in the absence of the larger storm surge that flowed up the MRGO Canal.

[102] See text accompanying notes ___ - ___, supra.
[103] Id.

The fact that the storm surge that flowed up the MRGO Canal did overtop the levees bordering that canal suggests that the MRGO surge had the capacity to overtop the levees on the Industrial Canal as the surge proceeded westward. Finally, the fact that the damaged portions of the levees along the west side of the Industrial Canal were directly across from the point at which the MRGO Canal enters the Industrial Canal at right angles is also consistent with the conclusion that the waters that overtopped the Industrial Canal levees came from Lake Borgne and the east, and not from Lake Pontchartrain.

As discussed above, the barrier project would not have prevented the storm surge that moved westward along the MRGO Canal. Indeed, had the gated flood control structure at the entrance of the Industrial Canal to Lake Pontchartrain been closed as envisioned in the barrier project, it could have exacerbated the effects of the storm surge moving along the MRGO Canal when it arrived at the Industrial Canal by preventing water from exiting the Industrial Canal into Lake Pontchartrain. It appears, therefore, that the failure to build the barrier project did not cause the flooding that resulted from the failure of the levees along the Industrial Canal. That conclusion cannot be stated as confidently as the prior conclusion about the flooding that resulted from the failures of the levees along the MRGO Canal, because the Industrial Canal was directly connected to Lake Pontchartrain and the barrier project (had it functioned properly) would have offered protection against waters from that lake. Moreover, it is still possible—though not likely—that all of the preliminary analyses are wrong and that the contemporaneous observations were mistaken.

C. The 17th Street and London Avenue Levee Failures

There is no dispute that the storm surge that caused the 17th Street and London Avenue levee failures originated in Lake Pontchartrain. To the extent that the force of the Lake Pontchartrain storm surge would have been reduced by the barrier project, some or all of the downtown polder may not have flooded had it been completed prior to Katrina. This is not a minor matter, because the greatest economic damage occurred in the downtown polder, and it appears that the largest number of deaths also occurred in that polder.[104] Even if *Save Our Wetlands* did not cause all of the flooding in the New Orleans area, the claim that it caused the flooding of the downtown polder alone is an extremely serious one that bears careful analysis.

Several large uncertainties, however, complicate but-for causal analysis of the connection between *Save Our Wetlands* and the flooding of the downtown polder. First, the storm surge from Lake Pontchartrain did not overtop the levees protecting the city from the lake itself, and they were not breached. Moreover, all of the engineering reports that have come to light thus far have concluded that the surge flowing from Lake Pontchartrain up the outfall canals did not overtop the levees lining those canals. Like the levees along the lake, those levees were designed to be of sufficient height to resist overtopping from the SPH, and Katrina apparently did not generate a storm surge exceeding that height. Most engineers have concluded that the levees along the 17th Street and London Avenue outfall canals failed because the storm surge forced parts of the floodwalls away from the canals and into the surrounding neighborhoods. The Lake

[104] John Simerman, Dwight Ou & Ted Mellnik, Canal Breaches Led to Most New Orleans Deaths, Austin American-Statesman, December 30, 2005, at A1.

Pontchartrain storm surge did not overwhelm those levees; it simply defeated them at critical weak points. Although the engineering analysis is still clouded with considerable uncertainty, it appears that those levees were either designed or constructed in a fashion that prevented them from doing what they were supposed to do.[105]

This conclusion, however, does not necessarily lead directly to the ultimate conclusion that the failure to construct the barrier project was not a but-for cause of the flooding of the downtown polder. Even if it is true that a cause of the outfall canal levees was improper design or improper construction, it is equally clear that neither of those factors caused the levees to fail in the absence of the storm surge from Lake Pontchartrain. More to the point, it is certainly possible that the storm surge in Lake Pontchartrain would have been much less powerful had barrier gates at the Rigolets and Chef Menteur passes been in place and closed before Katrina hit, such that the resulting storm surge would have lacked sufficient force to breach the outfall canal levees even at their weakest points. Viewed somewhat differently, the barrier project may have provided a critical margin of safety for the overall system that would have prevented the flooding of the downtown polder, allowing for the possibility that the outfall canals would have been negligently constructed or maintained.

A proper hindsight analysis to test this hypothesis would have to estimate the force of the storm surge in Lake Pontchartrain in a scenario during which the seagates at the Rigolets and Chef Menteur passes had been properly designed and constructed and had been properly closed prior to the time that the surge from Hurricane Katrina moved from the Gulf of Mexico and Lake Borgne into Lake Pontchartrain. The outcome of this analysis is by no means certain. For example, a spokesperson for the New Orleans division of the Corps acknowledged after Hurricane Katrina that he was not sure "how much [the barrier project] would have prevented anything."[106] Other reports suggest that "Corps staff believe that flooding would have been *worse* if the original proposed design had been built because the storm surge would likely have gone over the top of the barrier and floodgates, flooded Lake Pontchartrain, and gone over the original lower levees planned for the lakefront area as part of the barrier plan."[107]

It is necessary to go beyond these statements, however, given that Army Corps representatives have obvious reasons for discounting the likelihood that the barrier plan would have performed better than the high level plan. A proper analysis of how the barrier plan would have fared during Katrina would require a complex modeling exercise that would in turn require the analyst to determine the height of the storm surge at the passes and compare it to the design height of the levees and seagates. As noted previously, the project was designed to withstand the SPH, which in New Orleans was roughly equivalent to a fast-moving Category Three Hurricane.[108] Although the media

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[105] See John M. Barry, After the Deluge, Some Questions, New York Times, October 13, 2005 (citing three preliminary post-Katrina engineering studies for the proposition that "if the levees had performed as they were supposed to, the deaths in New Orleans proper, the scenes in the Superdome and the city's destruction would never have taken place").

[106] Jerry Mitchell, E-Mail Suggests Government Seeking to Blame Groups, Mississippi Clarion-Ledger, September 16, 2005, at A1.

[107] GAO, Testimony of Anu Mittal, Army Corps of Engineers, Lake Pontchartrain and Vicinity Hurricane Protection Project, Sept. 28, 2005 (emphasis added).

[108] John McQuaid, New Orleans Levee System Left Poor Neighborhoods Vulnerable, Newhouse News Service, September 21, 2005 [this was probably in the Times-Picayune]; Jerry Mitchell, E-Mail

initially reported expert conclusions that Katrina was a Category Four Hurricane on the Saffir-Simpson scale when the eye passed to the east of New Orleans,[109] subsequent analyses of the water levels along the levees have suggested that the storm may have receded to Category Three status by the time the storm surge from Lake Pontchartrain hit the city.[110] The Saffir-Simpson scale, in any event, is based on wind speed and not predicted storm surge levels, and in some circumstances it may be possible for a Category Two storm to produce a storm surge that exceeds that of a Category Three storm.[111] Hence, even estimating the height of the storm surge at the Rigolets and Chef Menteur passes is fraught with uncertainty.

If the storm surge would have exceeded the height of the levees and seagates between Lake Pontchartrain and Lake Borgne, then the surge would have entered the lake at an attenuated level and probably at a lower velocity. This alone, however, would not have prevented a surge in Lake Pontchartrain because the strong northeasterly winds produced by the hurricane still would have caused water that was already in the lake to surge against the levees protecting New Orleans. Some of that water would have surged up the ungated outfall canals and that surge would have tested the levees. Whether the seagates would have reduced the surge from Lake Pontchartrain sufficiently to prevent the breach of poorly designed or constructed levees is therefore an exceedingly complex question, the answer to which would require expertise in meteorology, hydrology, engineering, mathematical modeling, and probably other disciplines. Certainly one cannot conclude without a great deal of additional analysis that the barrier project as conceived in the early 1970s—even if perfectly implemented and executed—would have prevented the downtown polder from flooding during Hurricane Katrina.

Moreover, even if the analysts could confidently reach that conclusion, a proper hindsight analysis also would need to take into account an alternative scenario in which the barrier project was not properly implemented. If it is true, for example, that the high level project was poorly implemented, there may be good reason to question whether the barrier project would have been implemented as designed. A proper hindsight analysis would therefore factor in the possibility that the levees running from the city to the Rigolets and Chef Menteur passes or the seagates at the passes would have been breached, just as the levees along the outfall canals were breached. It might also examine the scenario in which the seagates were not properly closed in anticipation of the hurricane: Given the numerous instances of official breakdown that occurred as Katrina and its aftermath actually unfolded, such a possibility is not at all farfetched. In either case, the storm surge flowing into Lake Pontchartrain from the Gulf of Mexico and Lake Borgne would have been much larger, and the surge that moved up the outfall canals might not have differed greatly from the surge that did in fact move up those canals during Hurricane Katrina.

Suggests Government Seeking to Blame Groups, Mississippi Clarion-Ledger, September 16, 2005, at A1 (quoting Corps of Engineers spokesperson John Hall); John McQuaid & Mark Schleifstein, Evolving Danger, New Orleans Times-Picayune, June 23, 2002, at J12.

[109] Andrew Martin & Andrew Zajac, Corps: Lack of Funds Did Not Contribute to Flooding, Chicago Tribune, September 2, 2005, at A1.

[110] See note ___, supra.

[111] John McQuaid, New Orleans Levee System Left Poor Neighborhoods Vulnerable, Newhouse News Service, September 21, 2005 [this was probably in the Times-Picayune] (quoting former Corps engineer Lee Butler).

The hindsight analysis would next have to examine the effect of *Save Our Wetlands* on the Corps of Engineers' decision not to build the barrier project. Some legal analysts, including the United States Government Accountability Office, have concluded that the *Save Our Wetlands* injunction should have delayed the barrier option only until the Corps remedied the problems that the court had identified in the EIS.[112] There is little reason to believe that the court would not have lifted the injunction as soon as the Corps of Engineers updated the EIS with adequate hydrological modeling (as requested by its own chief engineer), conducted a more thorough biological assessment, and considered a few reasonable alternatives. This may have delayed the completion of the project during the time that it took for the Corps to finish this task and defend its product in court. Although further hypothetical analysis would be required to determine whether this would have delayed completion of the barriers past August 2005, there is little reason to believe that completion would not have proceeded at least as quickly as the high level project, which did not get started until 1985 but which was substantially completed by the time that Hurricane Katrina hit.

Of course, the Corps of Engineers did not respond to the injunction by preparing an adequate EIS for the barrier plan. Instead, it re-examined the mounting cost of the barrier project in light of cost of the alternative high level project and decided to implement the latter project. Thus, one could argue that the litigation caused the Corps to rethink the alternatives in a manner that might not have occurred absent the litigation-induced pause to rethink.[113] If the Corps would have forged ahead with the original barrier project despite its increasing cost and despite strong local opposition, then the lawsuit was indeed a but-for cause of the failure to implement the barrier project—albeit only in an attenuated, happenstance way. The likelihood of even that scenario, moreover, must be discounted by the probability that the Corps would have changed course at some point anyway prior to completing the project, given the variety of other considerations that began to weigh against the barrier plan.

D. From "But-For" to Blameworthiness

In a world of complexity and interconnection, any single event will be traceable to innumerable but-for causes that led to the event's occurrence.[114] With respect to the levee failures in New Orleans, for instance, potential causal contributors include not only *Save Our Wetlands*, which is said to have led the Corps to adopt an inferior levee plan, but also the local residents and officials who long opposed more robust protection plans out of cost concerns.[115] Additional contributors include the Corps officials who, after a lengthy and unexplained delay, ultimately made the decision to switch from the barrier to the high level plan; the contractors who allegedly implemented the high level plan with

[112] Oliver A. Houck, The U.S. House of Representatives' Task Force on NEPA: The Professors Speak, 35 Env. L. Rptr. 10895, 10897 (2005)

[113] See David Schoenbrod, The Lawsuit That Sank New Orleans, Wall Street Journal, September 26, 26, 2005, at A18.

[114] See Kenneth J. Rothman, Causation and Causal Inference in Epidemiology, 95 Am. J. Pub. Health S144, (2005).

[115] GAO 1982 Report, at 9. Final Environmental Impact Statement A-I-2 (1982) (noting that "local interests" requested study of a "100-year design hurricane" rather than the more severe standard project hurricane).

inadequate care; the land use planning officials whose decisions to permit massive conversion of wetlands for development rendered New Orleans much more vulnerable to storm surges regardless of which plan was adopted; the government officials who were responsible for the Mississippi River flood protection system which also perversely made New Orleans much more vulnerable to Gulf Coast storms; and perhaps even the incalculable number of causal contributors to human-induced climate change which might in theory have played a role in exacerbating Katrina's intensity.[116]

Apportioning responsibility and fault among these many but-for causes requires much more than simply empirical analysis and reconstruction. It requires an assignation of blameworthiness according to moral, political, and legal criteria. For seemingly opportunistic reasons, a number of officials and analysts have attempted to single out *Save Our Wetlands* for particularly severe blameworthiness in the aftermath of Katrina. If the preliminary engineering reports turn out to be correct, however, then the most damaging flooding in the New Orleans area is attributable most obviously and directly to the MRGO and to inadequate construction and maintenance of the 17th Street and London Avenue levees, *not* to the design of the LPVHPP.[117] Analysts who wish to pin responsibility for the Katrina disaster on NEPA must therefore offer an account not only of how *Save Our Wetlands* led to the adoption of the high level plan, but also how the litigation led to malfeasance in the implementation of that plan. No serious effort has been made to offer such an account, nor is it obvious how one could be constructed with any degree of plausibility.

In the end, the only clear but-for consequence of *Save Our Wetlands* was a court-imposed moment of taking stock, a moment in which the Army Corps was asked to reevaluate a long-troubled project in light of better information, changed circumstances, and competing values—precisely the point of the NEPA procedure. The Corps ultimately retained discretion to proceed with the barrier plan after conducting a proper environmental impact assessment, and it certainly need not have waited nearly seven years before deciding to abandon the barrier plan as it did.[118] In short, one simply cannot account for the Corps' behavior by focusing on NEPA and *Save Our Wetlands* alone. Instead, to appreciate why the Corps planning and implementation process for the LPVHPP took the shape that it did, one must broaden the critical focus to include the Congress, Army Corps leaders and staff, local residents and officials, scientific and engineering experts, government contractors, local and national political interests, and a variety of other key decisionmakers and influences. As the next Section describes, these numerous forces combined in New Orleans to create a policymaking process that, at least in hindsight, seems to have been especially handicapped in its ability to grapple with long-term catastrophic potentialities—the very point of natural disaster policy.

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[116] See Kerry Emanuel, Increasing Destructiveness of Tropical Cyclones Over the Past 30 Years, 436 Nature 686 (2005).

[117] See Houck, supra note __, at 10897 n. 28 ("Bottom line: the levee plan was fine, but its faulty construction flooded the city.").

[118] Complying with NEPA following the 1977 injunction is not the only time that the Corps seems to have dragged its feet on New Orleans hurricane protection matters. For example, Congress in 1999 appropriated money for a $12 million study to determine how much it would cost to protect New Orleans from a Category 5 hurricane, but the study had not even been launched as of September 2005. Andrew Martin & Andrew Zajac, Corps: Lack of Funds Did Not Contribute to Flooding, Chicago Tribune, September 2, 2005, at 1.

V. Lessons for Analysts from the Katrina Levee Debate

One obvious message of the forgoing discussion is that retrospective analysis of cause and effect can be an exceedingly complex and uncertainty-laden exercise. The fact that all of the relevant facts are in the past and can, at least in theory, be accurately ascertained does not mean that retrospective analysis can avoid the speculation that is inherent in prospective analysis: The counterfactual nature of the causation exercise demands a similar task of projecting unknown states of the world in order to determine what would have eventuated in the absence of the targeted causal factor. Hindsight analysis of the Katrina disaster suggests that in a changing world, the farther removed the analysis is in time from the event under inspection, the more difficult it will be to draw confident conclusions about cause and effect. Failing memories and lost documentation can, of course, hinder attempts to reconstruct past histories. In addition, intervening events can greatly complicate the construction and analysis of counterfactual scenarios. The more relevant intervening events that are possible, the more the counterfactual narrative will become clouded by uncertainties.

In short, as one moves farther away from the available data—whether in terms simply of time, or of the number of additional variables or intervening events—the risk increases that one's conclusions will be based on undefended modeling assumptions rather than on actual empirical evidence.[119] The NEPA Task Force, many of whose members have expressed a strong desire to reduce NEPA's procedural requirements, seems to have fallen prey to just such an undefended assumption in its haste to attribute the Katrina levee failures to NEPA litigation. Hindsight analysis of the Katrina disaster offers no support at all for legislative action aimed at repealing or amending NEPA to reduce the incidence of judicial intervention into Executive Branch activities under that statute. As discussed above, the causal analysis that leads from a 1976 injunction pending the preparation of an adequate EIS to the flooding of the downtown polder in 2005 is so laden with uncertainty, and so dependant on unsupported speculation, that it simply cannot provide a rational justification for an action as momentous as overhauling one of modern federal environmental law's keystone statutes.

Nevertheless, as this Section describes, the history of the LPVHPP planning process does offer some reliable lessons regarding the challenge of natural disaster policymaking, lessons that should guide analysts as they consider post-Katrina hurricane protection for New Orleans and other projects that guard against long-term, low-probability, high-consequence events. The rather pessimistic conclusion reached above regarding our powers of accurate, comprehensive hindsight analysis is likewise applicable to our predictive analysis of future consequences of government interventions. The systems that drive the incidence and severity of disaster consequences—whether in the form of natural systems that give rise to extreme weather and geological events, or of socioeconomic systems that determine in part how deadly and costly the consequences of such events will be—are characterized by enormous complexity and uncertainty. What

[119] Gary King & Langche Zeng, When Can History Be Our Guide? The Pitfalls of Counterfactual Inference.

often will be required in disaster planning, therefore, is collective judgment regarding the degree of moral and political commitment that citizens desire to express, both to their fellow citizens within the present generation and to the generations to come, through public prevention and mitigation projects that may have highly uncertain long-term payoffs. As this Section describes, through familiar tools of risk assessment and policy analysis, the LPVHPP planning process seems to have inadvertently obscured the need for precisely that brand of judgment.

A. The Standard Project Hurricane

In the immediate aftermath of Hurricane Katrina, many commentators assumed that New Orleans had finally outrun its luck. As noted above, initial reports suggested that Katrina made landfall as a storm with a severity and a path that numerous experts repeatedly had warned would someday strike the city with catastrophic results, a storm that simply overwhelmed the design standard of the LPVHPP and other New Orleans area levee systems.[120] At least at this stage, however, engineering reports point instead to a failure of implementation, such that it is quite possible that Katrina would *not* have overwhelmed the New Orleans levees had they been constructed and maintained properly. Still, this more mundane and lamentable explanation of the Katrina levee failure does not obviate the need to look closely at the levee design process for evidence of significant failures in our thinking about long-term catastrophic risks. Unfortunately, the many pre-Katrina warnings that seemed so prophetic in the storm's immediate aftermath remain urgently relevant today, both to the post-Katrina reconstruction process and to the challenge of natural disaster policy more generally.

At the heart of the LPVHPP and most other Army Corps hurricane protection projects since the 1960s has been a technical model known as the standard project hurricane (SPH).[121] Because development of this model preceded the Saffir-Simpson hurricane scale, attempts to describe the design standard of the LPVHPP in the wake of Katrina have been somewhat confused. Depending on whether one is referring to barometric pressure, radius, wind speed, or other critical storm characteristics, the SPH can vary from a Category Two to Four storm on the now more familiar Saffir-Simpson scale[122] (although most commentators have been describing the SPH as "roughly equivalent" to a fast moving Category Three storm). Nor does the SPH translate smoothly into the conventional return period approach of describing storms in relation to their expected interval of occurrence. Again, analysts have been describing the SPH as "roughly equivalent" to the worst storm that could be expected every 200 to 300 years,[123] although in actuality the SPH bears no direct relationship to such return-period or

[120] See supra note __.

[121] See Harry S. Perdikis, Hurricane Flood Protection in the United States, Journal of the Waterways and Harbors Division, Proceedings of the American Society of Civil Engineers 1, February 1967.

[122] See Government Accountability Office, Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project, Dec. 15, 2005, GAO-06-322T, at pp. 4-5.

[123] Populate

frequency intervals. As the National Weather Service stated in a 1972 technical memorandum, "the standard project hurricane has no frequency assigned to it."[124]

The SPH was developed by the Corps of Engineers at the request of Congress in the 1950s "to provide generalized hurricane specifications that are consistent geographically and meteorologically for use in planning, evaluating, and establishing hurricane design criteria for hurricane protection works."[125] In conjunction with the U.S. Weather Bureau, the Corps compiled data on all tropical storms of hurricane intensity within specific geographic zones over the period from 1900 to 1956.[126] Using this data, the agencies created an index representing "the most severe combination of hurricane parameters that is reasonably characteristic of a specified geographical region, excluding extremely rare combinations."[127] Specifically, central barometric pressure was used as the main estimation characteristic to generate a hypothetical or model storm for project planning with respect to any given geographic area. Although the original SPH model used a 100-year return period to identify the key central pressure measure for a given area,[128] the resulting model hurricane did not, strictly speaking, represent a 100-year storm. Instead, the 100-year pressure low was interpolated with other storm characteristics such as storm radius, wind speed, forward speed, and storm direction to generate "the most severe conditions . . . that are within the parameters of the SPH indices . . . for [a particular] location,"[129] a procedure that results in SPH storms of varying frequency depending on location-specific criteria.

Initially, an overriding goal of the SPH appears to have been simply a desire to compare hurricane protection standards from region to region: "The standard project hurricane wind field and parameters represent a 'standard' against which the degree of protection finally selected for a hurricane protection project may be judged and compared with protection provided at projects in other localities."[130] This standardized approach, however, led to disparities *within* particular localities. Different parts of the New Orleans area, for instance, are at higher risk from hurricanes than others. Because suburban areas

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[124] National Weather Service, Preliminary Revised Standard Project Hurricane Criteria for the Atlantic and Gulf Coasts of the United States, Memorandum HUR 7-120, June 1972.

[125] National Hurricane Research Project, Howard E. Graham & Dwight E. Nunn, Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States, Report No. 33 (1959). For a non-technical overview of the standard project hurricane and related engineering issues, see JJ. Westerink & R.A. Leuttich, The Creeping Storm, Civil Engineering Magazine (June 2003).

[126] National Hurricane Research Project, Howard E. Graham & Dwight E. Nunn, Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States, Report No. 33 (1959).

[127] Perdikis, supra note __, at 9.

[128] National Hurricane Research Project, Howard E. Graham & Dwight E. Nunn, Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States, Report No. 33 (1959).

[129] National Hurricane Research Project, Howard E. Graham & Dwight E. Nunn, Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States, Report No. 33 (1959).

[130] National Hurricane Research Project, Howard E. Graham & Dwight E. Nunn, Meteorological Considerations Pertinent to Standard Project Hurricane, Atlantic and Gulf Coasts of the United States, Report No. 33 at 2 (1959). See also (describing the SPH as being developed "to provide generalized hurricane specifications that are consistent geographically and meteorologically for use in planning, evaluating, and establishing hurricane design criteria for hurricane protection works").

across the Mississippi river from New Orleans are not at risk from Lake Pontchartrain, they face a 1 in 500 risk of flooding from a storm surge in a given year, whereas the downtown polder fronting the lake faced a 1 in 300 risk just prior to Hurricane Katrina. Likewise, the areas in the two polders to the east of the Industrial Canal, which were at risk from a storm surge flowing up the MRGO Canal, faced an annual risk of between 1 in 200 (according to the Corps analysis) and 1 in 100 (according to an analysis undertaken by a former Corps engineer who is now a private consultant).

The Corp's chief engineer for the New Orleans district, Al Naomi, questions the Corp's authority to take these varying risk levels into account in planning for future storm protections. In his view, Congress has mandated that all areas in the entire region be protected from the same model storm. Thus, the levees in place throughout the city prior to Hurricane Katrina were designed to withstand a storm surge of 11.5 feet, ignoring the fact that some areas in the region are likely to encounter storm surges of that magnitude much more frequently than others. As discussed above, the Berkeley/ASCE study concluded that the storm surge along the MRGO Canal exceeded the levees by as much as 10–15 feet, even though the storm surge from Lake Pontchartrain did not overtop any of the levees in the downtown polder.[131] Building higher levees in the areas that are, for geographical reasons, subject to more frequent storm surges would, according to Naomi, violate the Corp's legal mandate. In his view, Congress would have to authorize such variation specifically in legislation before the Corps could take it into account in designing future levees.[132]

Deciding how to define and implement equity concerns within the natural disaster context is a daunting task.[133] Should regulators seek to equalize the probabilistic risk that individuals face, or the amount of public money spent on protection per individual? To what extent should the seemingly voluntary choices of individuals to live in particularly vulnerable areas factor into the public policy assessment? How should disaster planning take account of the socioeconomic differences between, say, Trent Lott, whose historic oceanfront home in Mississippi was destroyed by Katrina, and the thousands of poverty-stricken New Orleans residents whose homes also were known to be located in areas of great vulnerability?[134] These are vital moral and political questions that currently receive little attention from the Corps or from Congress, perhaps in part because the SPH provides an unwarranted sense that relevant geographical variations already have been "accounted for."[135]

Over time, moreover, the SPH seems to have acquired an even stronger presumption of normativity, being described frequently in Corps documents and other proceedings as the most severe storm that the government "reasonably" or "practicably"

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[131] See text accompanying notes ___, supra.

[132] John McQuaid, New Orleans Levee System Left Poor Neighborhoods Vulnerable, Newhouse News Service, September 21, 2005 [this was probably in the Times-Picayune].

[133] Adler

[134] See http://www.cnn.com/2005/POLITICS/08/30/katrina.lott/.

[135] A recurring problem in natural disaster policy is that private insurance markets are ill-equipped to provide ex ante risk-spreading services given the enormous degree of uncertainty and loss correlation that characterize major catastrophes, while public officials are incapable of resisting the demand for ex post disaster relief and compensation. See Moss, supra note __. Without a much stronger *ex ante* public role, therefore, the country is likely to continue to experience a cycle of imprudent (or practically involuntary) private decisionmaking followed by costly public bailout.

should guard against when designing hurricane protection projects. Thus, the SPH came to represent not only a method for comparative assessment of storm risks across geographic areas, but also a design standard that carries its own implicit assurance of optimality:

- "The SPH is intended as a practicable expression of the maximum degree of protection that should be sought as a general rule in planning and design of coastal structures for communities where protection of human life and destruction of property is involved."[136]

- "An SPH is one that may be expected from the most severe combination of meteorological conditions that are considered reasonably characteristic in the region."[137]

- "The project has been designed to afford complete protection from the occurrence of the largest probable storm (SPH) that can reasonably be expected in the region. … Probability of occurrence of hurricanes having a greater magnitude than the SPH are too remote to warrant practical consideration."[138]

- "The project is designed to protect against the 'standard project hurricane' moving on the most critical track. Only a combination of hydrologic and meteorologic circumstances anomalous to the region could produce higher stages. The probability of such a combination occurring is, for all practical purposes, nil."[139]

- "[The SPH] was expected to have a frequency of occurrence of once in about 200 years, and represented the most severe combination of meteorological conditions considered reasonably characteristic for the region."[140]

- "To identify a level of risk a given area faces, we do an engineering and an economic analysis and come to an *optimum* solution for a level of protection."[141]

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[136] Preliminary Revised Standard Project Hurricane Criteria for the Atlantic and Gulf Coasts of the United States, Memorandum HUR 7-120, June 1972.

[137] See U.S. Army Engineer District, New Orleans, Louisiana, Final Environmental Statement, Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project I-2 (August 1974).

[138] See U.S. Army Engineer District, New Orleans, Louisiana, Final Environmental Statement, Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project (August 1974).

[139] See U.S. Army Engineer District, New Orleans, Louisiana, Final Environmental Statement, Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project VIII-11 (August 1974).

[140] GAO, Hurricane Protection: Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project, Dec. 15, 2005, at 4.

[141] John McQuaid & Bill Walsh, Warnings to Beef Up New Orleans' 60s-Era Levees Unheeded (quoting Gen. Carl Strock, Army Corps chief of engineers) (emphasis added). Statements such as these recall the claim of the Corps' Chief of Engineers in 1926—one year before the devastating Mississippi River flood that remains one of the country's worst ever natural disasters—that the lower Mississippi River levee system would "prevent the destructive effects of floods." David A. Moss, Courting Disaster? The Transformation of Federal Disaster Policy Since 1803 307, 314, in The Financing of Catastrophic Risk (Kenneth A. Froot, ed, 1999).

By tracing the SPH back to its origins, however, one finds strong basis for doubting the wisdom of this gradual normative reification of the design standard. To begin with, the SPH is obviously only as reliable as the data it is built upon. The original SPH model, which appeared in National Hurricane Research Program Report No. 33 in 1959, was built using data on all Atlantic tropical storms from 1900 to 1956 that reached hurricane intensity at some point during their lifetimes. As the authors of the 1959 report acknowledged, much of the data used was unreliable given the great imprecision of the available measurement technology. In particular, for much of the data the researchers had to extrapolate from land-based measurements in order to determine an estimate for off-shore storm pressure, because it was not until later in the twentieth century that scientists began using aircraft to measure storm pressure offshore.

Even assuming valid measurements, however, the 57 year record was quite limited in scope—containing only 22 storms in total for Zone B, the geographic area that corresponded to New Orleans—and was obviously insufficient to generate a statistically significant rendering of the overall distribution of potential storms from a multi-century perspective.[142] The researchers attempted to extrapolate from the existing data by, first, calculating the cumulative number of storms that had appeared during the observation period at or below various levels of pressure (see figure 3). This measure was then converted to a 100 year index simply by linearly stretching the data out from 56 to 100 years. Finally, the data were plotted on normal distribution graph paper with the idea that, if the observed data appeared to fall into a straight line, then one could conclude that hurricane frequency follows a normal distribution and, therefore, that extrapolationg to longer return periods could be accomplished simply by following the observed trend line (see figure 4).

[142] Preliminary Revised Standard Project Hurricane Criteria for the Atlantic and Gulf Coasts of the United States, Memorandum HUR 7-120, June 1972. Even with respect to the data that were available, one of the more severe storms in the geographic zone containing New Orleans was listed in the table, but a footnote disclosed that the storm was not used in the construction of the SPH because the frequency index had already been calculated by the time the storm occurred.

Figure 3

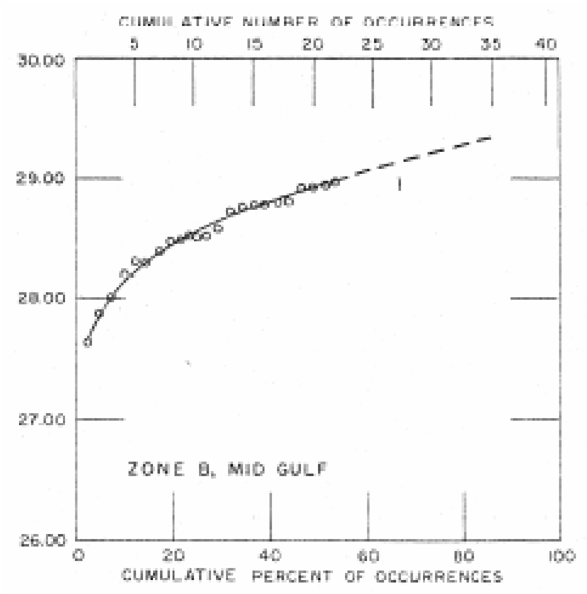
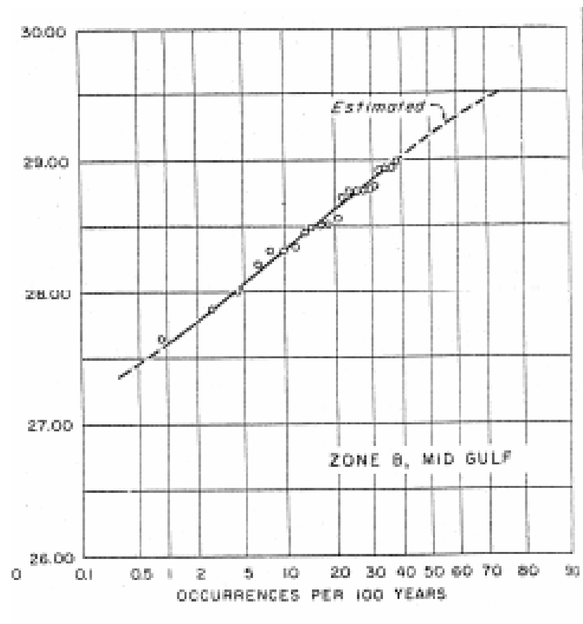


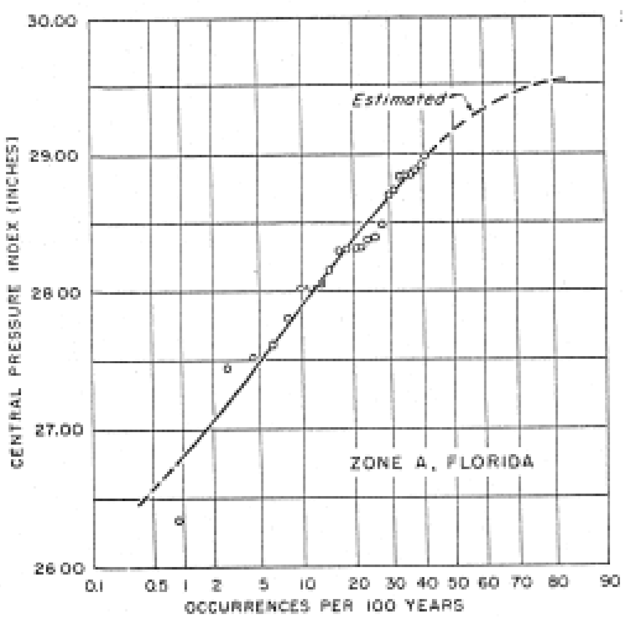
Figure 4



There may be reason to doubt these assumptions. Looking at Zone A—which included Florida and areas east of New Orleans (see figure 5)—one observes that, in addition to the much sharper slope of the pressure data, at least one recorded storm lies far outside the normal distribution trend. Of course, that is just one storm and it is very difficult to say whether it represents a 100, 500, or 10,000 year storm. But that is precisely the point: With such a small sample, there is really not much empirically supporting the assumption that storm intensity will follow a normal distribution. Instead, the decision to extrapolate linearly is one that depended on a relatively unexamined conviction that Gulf storm behavior follows the tidy world of classical mathematics. It may well, of course, but it may also represent what Dan Farber has called the world of “probabilities behaving badly,” a world in which complex, adaptive systems are characterized not by normal probability distributions, but by power law distributions in which extreme events appear with a surprising regularity.[143]

Figure 5

[143] See Daniel A. Farber, Probabilities Behaving Badly: Complexity Theory and Environmental Uncertainty, 37 U.C. Davis L. Rev. 145, 152-55 (2003).



Along those lines, consider a few facts from the 2005 Atlantic hurricane season:

- Twenty-seven Atlantic storms were named during 2005, the most on record, shattering the previous record of 21 from 1933. For the first time, meteorologists had to reach into the Greek alphabet for additional storm names.

- Fifteen hurricanes were observed, breaking the old record of 12 set in 1969.

- The most category 5 storms ever recorded in one season (Katrina, Rita, and Wilma).

- Wilma became the strongest hurricane on record in the Atlantic basin, as measured by barometric pressure. Three of the six strongest hurricanes on record occurred in 2005.

- Hurricane Katrina made landfall with wind speeds of 125 mph and a minimum central pressure of 27.13 inches, the third lowest on record at landfall behind Hurricane Camille from 1969 and the Labor Day Hurricane that struck the Florida Keys in 1935.[144]

- Katrina was the costliest U.S. hurricane on record. In addition, the overall season tally for damage was the costliest in U.S. history.

[144] See also Government Accountability Office, Statutory and Regulatory Framework for Levee Maintenance and Emergency Response for the Lake Pontchartrain Project, Dec. 15, 2005, GAO-06-322T, at p. 5 (reporting that at landfall Katrina had a central barometric pressure of 27.17 inches and a windspeed of 140 mph).

- Hurricane Vince became the first known instance of a tropical cyclone making landfall in Spain.

- Hurricane Delta became only the sixth hurricane on record in December since 1851.

- Tropical cyclone Zeta became the longest-lived tropical cyclone ever recorded in January.

A critical question facing disaster planners going forward is whether the classical scientific assumption of normal distributions and predictable, linear biophysical behavior is appropriate in a world of complexity and climate change. Even putting aside these problems of model uncertainty,[145] however, one still faces the basic decision of how conservative to be in setting the benchmark for the SPH. The 1959 researchers focused on central barometric pressure and constructed a table reflecting the lowest central pressure index that one would expect at various geographic locations with an annual probability of 1%. In other words, they chose the 100 year return period for central pressure, as estimated using their admittedly limited data sample and their contestable extrapolation technique. Figure 6 shows the resulting values at various geographic locations throughout the Gulf. For New Orleans, the 100 year estimate was 27.60 inches. Again, the SPH was not equivalent to a 100 year storm, because central pressure was then interpolated with other variables in a way that tended to make the SPH more severe at any given point than a 100 year storm. How much more, however, is hard to say because the SPH depends on location specific combinations of these variables. That is why the New Orleans levee system was frequently described as having been designed to guard against something like a 200 to 300 year storm.

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[145] One engineer who examined the New Orleans levee system in 2002 concluded that “risks may be significantly higher than the Corps maintains—perhaps double—on the east side along levees protecting eastern New Orleans, the Lower 9th Ward, Arabi and Chalmette.” John McQuaid & Mark Schleifstein, Evolving Danger: Experts Know We Face a Greater Threat from Hurricanes than Previously Suspected, Times-Picayune, June 23, 2002 (quoting Louisiana State University engineering professor Joseph Suhayda).

Figure 6

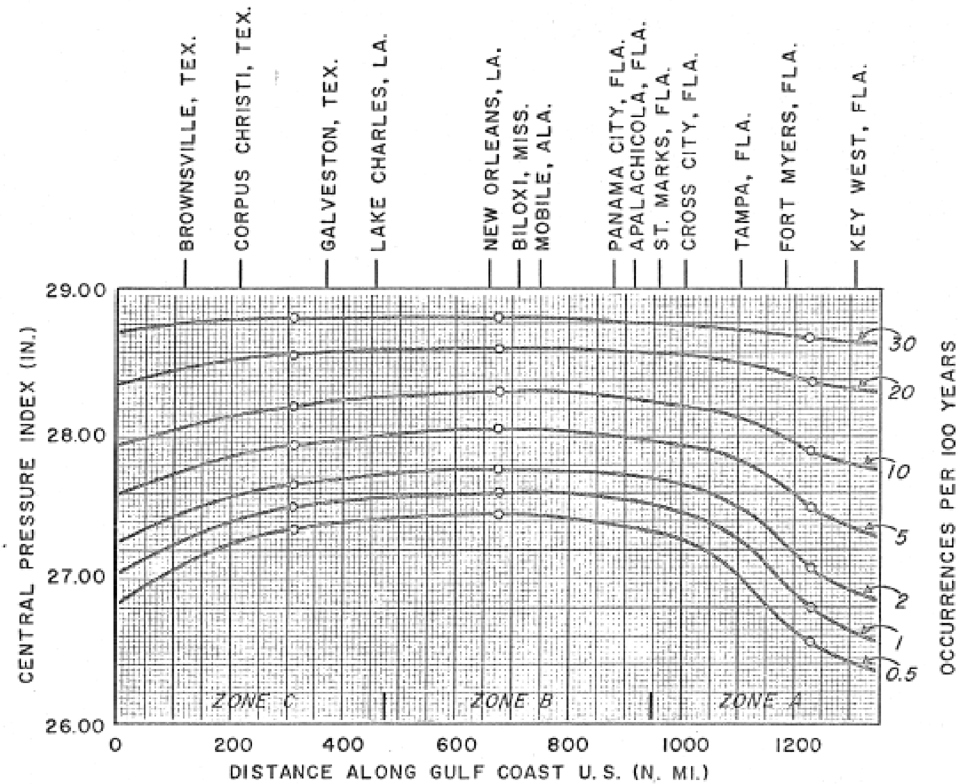


Figure 15. - Geographic variation of average frequency per 100 years of hurricane central pressure index, Gulf Coast United States (1900-1956) over zones approximately 80,000 square miles.

Still, why anchor on a 100 year central pressure index, rather than 500 or 10,000 years? As the Corps noted in its 1972 revision of the SPH, this decision to hinge determination of the SPH on a 100-year central pressure index return period was essentially an "arbitrary" one when considered from the scientific perspective.[146] This is *not* to say that the original analysts were unjustified in choosing a 100-year return period for central pressure or that some other period was obviously more appropriate. It is simply to say that the question was not a purely technical one.[147] One can find clues as to those non-technical considerations in contemporaneous descriptions of the SPH model, where commentators describe the model as being used to project the worst storm that is "economically reasonable" to guard against.[148] In fact, some Corps economists at the time believed that the SPH was too cautious, and that a less severe storm should be used as the benchmark for disaster planning and prevention.

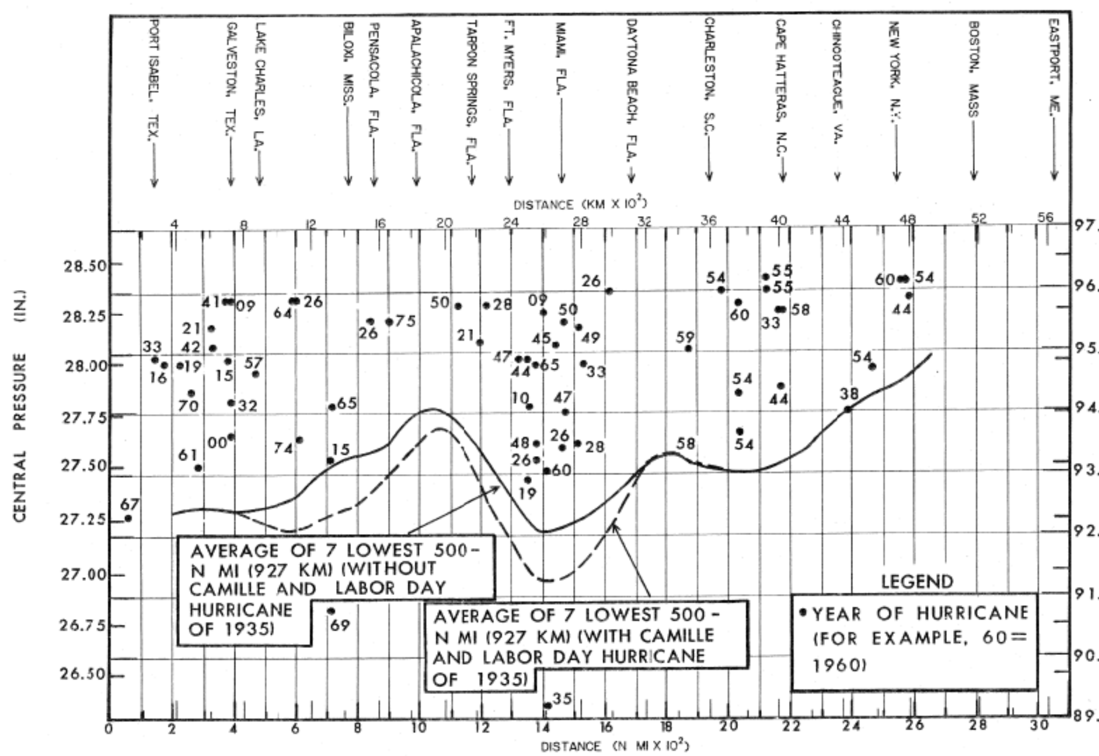
[146] Preliminary Revised Standard Project Hurricane Criteria for the Atlantic and Gulf Coasts of the United States, Memorandum HUR 7-120, June 1972.

[147] Even on narrow economic grounds, the choice of a 100-year return period for natural disaster planning might be questioned: Studies suggest, for instance, that a large majority (66%-85%) of flood losses come from events with recurrence intervals less frequent than the 100-year flood. See Burby, *supra* note __. Again, though, it bears noting that the SPH does not strictly speaking represent a 100-year storm. See supra text accompanying notes __-__.

[148]

This murky blending of science and policy continued in the much more elaborate and technical 1979 overhaul of the SPH . In this report, the SPH was changed so that the critical pressure parameter was derived not from the 100 year lowest expected pressure, but from the average of the seven lowest actually observed storms (see figure 7).

Figure 7



This procedure may seem to be an improvement over the arbitrary selection of a 100 year low, but it still begs the question, why not take the lowest 5 storms, or the single lowest storm, or even the single lowest storm with an additional safety margin included? In fact, the researchers did something quite the oppositein that they excluded the two worst observed storms from their seven lowest storm index: Hurricane Camille from 1969, and the Labor Day storm of 1933. The reasons provided for this exclusion are somewhat obscure in the report: "Our decision was based on the idea that these two hurricanes contained extremely low p_o's resulting in sustained wind speeds that were not reasonably characteristic of the northern gulf coast and the Florida Keys."[149]

To be sure, excluding outlier data is standard practice for much statistical analysis, yet the move seems inappropriate in the context of natural disaster planning. The extreme tails of a distribution in this context may be precisely the areas of most

[149] Richard W. Schwert et al., Meteorological Criteria for Standard Project Hurricane and Problem Maximum Hurricane Windfields, Gulf and East Coasts of the United States 143 (1979). See also id. ("These two hurricanes are much more severe than any other in the gulf and are therefore not 'reasonably characteristic.'"); id. at 2 ("By reasonably characteristic is meant that only a few hurricanes of record over a large region have had more extreme values of the meteorological parameters.")..

interest and concern.[150] After all, the two storms excluded—Camille and the Labor Day storm—were the only two on record with a lower central pressure than Katrina. The subjective nature of the data-trimming judgment is implicitly acknowledged elsewhere in the technical report, when the analysts recommend use of an alternative, much more conservative measure—the *probable maximum hurricane*—for disaster planning "in locations where high winds, waves and storm surge could pose a threat to the public health and safety from a hurricane-induced accident at a nuclear power plant."[151] Why not use this higher standard of protection for projects that do not involve nuclear power plants? As one observer noted, "[t]he design of structures to provide protection against the probable maximum hurricane would, in most locations, be economically unjustified."[152] Thus, loaded into the SPH model again is an implicit cost-benefit calculation, one that prevents policymakers from asking directly whether an extreme event is worth guarding against simply by excluding the possibility that such an event will occur.

Marshalling support for current public investment in long-term disaster prevention and mitigation projects is a political challenge of the highest magnitude. As Kenneth Boulding once wryly noted, "it seems very hard to organize a long-run crisis."[153] Given this difficulty, one advantage of the conventional return period approach to describing flood and storm protection projects is its ready accessibility to non-expert audiences.[154] For instance, when the Dutch suffered a devastating storm in 1953 that killed 2,000 people, the nation embarked on a 30-year plan to protect the country against the worst storm that could be expected in 10,000 years.[155] Similarly, when a massive Mississippi River flood in 1927 killed several hundred individuals, displaced over five hundred thousand, and destroyed property worth some $3 billion (1993 dollars),[156] Congress and the Corps developed an especially robust Mississippi River flood protection system that was designed to withstand an 800-year flood, some five hundred

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[150] Farber, Probabilities Behaving Badly.

[151] Richard W. Schwert et al., Meteorological Criteria for Standard Project Hurricane and Problem Maximum Hurricane Windfields, Gulf and East Coasts of the United States 5 (1979).

[152] Perdikis, supra note __, at 9. The new conservative approach of taking seven of the lowest storms on record did result in a further revision downward of the New Orleans SPH central pressure measure, from 27.36 to 27.30. Nevertheless, Katrina made landfall with a pressure of 27.13 inches—an intensity that was clearly foreseeable to the designers of the SPH model, as a comparison of the SPH and the MPH estimates for New Orleans demonstrates.

[153] Kenneth E. Boulding, Spaceship Earth Revisited, in Valuing The Earth: Economics, Ecology, Ethics 311, 311 (Herman E. Daly & Kenneth N. Townsend eds., 1993).

[154] As cognitive psychologist Gerd Gigerenzer has shown, individuals appear to process risk information much more reliably when it is presented in frequency rather than probability terms. See, e.g., Gerd Gigerenzer & Ulrich Hoffrage, How to Improve Bayesian Reasoning Without Instruction: Frequency Formats, 102 Psychol. Rev. 684, 697-98 (1995); G. Gigerenzer, The Bounded Rationality of Probabilistic Mental Models, in Rationality: Psychological and Philosophical Perspectives 284 (K.I. Manktelow & D.E. Over eds., 1993); Gerd Gigerenzer, Ecological Intelligence: An Adaptation for Frequencies, in The Evolution of Mind 11-15 (Denise Dellarosa Cummins & Colin Allen eds., 1998); Gerd Gigerenzer, How to Make Cognitive Illusions Disappear: Beyond Heuristics and Biases, 2 Eur. Rev. Soc. Psychol. 83 (Wolfgang Strobe & Miles Hewstone eds., 1991).

[155] See supra note __.

[156] Id. at 308.

years more forward-looking than the LPVHPP.[157] By most reports, the Mississippi River system performed extremely well during Hurricane Katrina despite storm surges that reached 15 to 20 feet along river stretches below New Orleans.[158]

Did the relative opacity of the SPH prevent the development of political support for a more robust hurricane protection system along the lines of the Mississippi River system? Almost certainly not. As the GAO reported in 1982, state and local sponsors in New Orleans repeatedly "recommended that the Corps *lower* its design standards to provide more realistic hurricane protection to withstand a hurricane whose intensity might occur once every 100 years rather than building a project to withstand a once in 200- to 300-year occurrence."[159] Still, over time, more widely comprehensible protection standards might help to overcome the apparent reluctance of political constituencies to support long-term, intergenerational disaster planning. Currently, the Association of State Floodplain Managers advocates a 500 year storm level of protection for urban areas and critical facilities.[160] The wisdom of such a standard depends in part on technical engineering and economic factors, but it also depends critically on the public's attitude toward risk, uncertainty, and intergenerational obligation. Rather than highlight such concerns for public scrutiny and deliberation, the SPH seems to have buried them within a confidently-expressed, but ultimately illusory assurance of "reasonableness" and "optimality."

B. Cost-Benefit Analysis

Since the Flood Control Act of 1936, Army Corps of Engineers project funding has been limited by Congress to those projects that have demonstrated benefits in excess of costs.[161] This early form of regulatory cost-benefit analysis was not originally associated with a perceived need for agency discipline, as it is today, but rather with a conviction that science, empiricism, and expert judgment could lead to wise policymaking.[162] Over time, such New Deal optimism became replaced by a more skeptical view of government, and the Army Corps in particular seemed to attract scrutiny from interests all along the political spectrum who began to view the statutory cost-benefit requirement as a valuable check on the otherwise overreaching impulses of the Corps. In part for reasons such as this, a number of prominent scholars and officials

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[157] As one expert put it: "The city is exposed to as much as four times the risk of hurricane flooding as it is to river flooding. That's always been an odd issue to me. Why would the government think that water from the lake is less dangerous than water from the river?" John McQuaid & Mark Schleifstein, Evolving Danger: Experts Know We Face a Greater Threat from Hurricanes than Previously Suspected, Times-Picayune, June 23, 2002 (quoting Louisiana State University engineering professor Joseph Suhayda).

[158] Bob Marshall, Levee System Along River Held Its Ground in Storm, Times-Picayune, Jan. 23, 2006.

[159] (emphasis added).

[160] Association of State Floodplain Managers, Inc., Hurricanes Katrina and Rita: Using Mitigation to Rebuild a Safer Gulf Coast 4, available at http://www.floods.org/PDF/ASFPM_HurricaneKatrina_WhitePaper_090905.pdf.

[161] See Flood Control Act of 1936, ch. 688, § 1, 49 Stat. 1570, 1570 (codified as amended at 33 U.S.C. § 701a).

[162] See Theodore M. Porter, Trust In Numbers: The Pursuit of Objectivity in Science and Public Life 148-89 (1995).

today regard the use of formal cost-benefit analysis to be of critical importance to the future of environmental, health, and safety regulation.[163]

The history of the LPVHPP planning process, however, suggests that the cost-benefit requirement may have had undesirable distortionary effects on Corps decisionmaking. A report in the Washington Post, for instance, claimed that the critical normative judgments described above regarding the construction of the SPH were driven in part by concern that the cost-benefit constraint facing Corps' projects would not justify higher levels of storm protection.[164] In fact, an Army Corps official in 1978 reported that economic cost-benefit analyses at the time were prescribing an even *lower* level of protection than the SPH.[165] No doubt these economic conclusions were driven in part by the standard use of a 3.25 percent discount rate in evaluating monetized projects costs and benefits,[166] a procedure that scholars have shown to reflect a clumsy and inadequate way of addressing questions of intergenerational equity, particularly in the face of very long-range planning of the sort implicated by disaster policy.[167]

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[163] See, e.g., Matthew D. Adler & Eric A. Posner, Rethinking Cost-Benefit Analysis, 109 Yale L. J. 165 (1999); Kenneth J. Arrow Et Al., Is There A Role For Cost-Benefit Analysis In Environmental, Health, And Safety Regulation?, 272 Science 221 (1996); Kenneth J. Arrow & Robert C. Lind, Uncertainty And The Evaluation Of Public Investment Decisions, 60 Am. Econ. Rev. 364, 366-67 (1970); Stephen Breyer, Breaking The Vicious Circle: Toward Effective Risk Regulation (1993); Richard A. Posner, Catastrophe: Risk And Response (2004); Richard Posner, Cost-Benefit Analysis: Definition, Justification And Comment On Conference Papers, 29 J. Legal Stud. 1153 (2000); Cass R. Sunstein, Laws Of Fear: Beyond The Precautionary Principle (2005); Cass R. Sunstein, Risk & Reason: Safety, Law, And The Environment (2002); Cass R. Sunstein, The Cost-Benefit State Ix (2002); Cass R. Sunstein, Cognition And Cost-Benefit Analysis, 29 J. Legal Stud. 1059 (2000).

[164] "The Corps was required to recommend the project with the most economic benefits—no matter who received them—compared to the cost to the taxpayers. It could not consider whether the benefits would be fairly distributed, or the value of wetlands the project might destroy, or even the value of protecting people from death. So the Corps settled on 200-year protection from storms, a sharp contrast to the 800-year protection from the river." Michael Grunwald & Susan B. Glasser, The Slow Drowning of New Orleans, Wash. Post, Oct. 9, 2005, at A01.

[165] Hurricane Protection Plan for Lake Pontchartrain and Vicinity, Jan. 5, 1978 Hearings ("Even though economists may, and in this case did, favor protection to a lower scale to produce a higher ratio of project benefits to project costs, the threat of loss of human life mandated using the standard project hurricane.") (testimony of J. Rush, District Engineer, U.S. Army Engineer District, New Orleans). See also U.S. House of Representatives, A Failure of Initiative: The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina 89-90 (2006).

[166] See U.S. Army Engineer District, New Orleans, Louisiana, Final Environmental Statement, Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project (August 1974).

[167] See, e.g., Frank Ackerman & Lisa Heinzerling, Priceless: On Knowing The Price Of Everything And The Value Of Nothing (2004); Douglas A. Kysar, Climate Change, Cultural Transformation, and Comprehensive Rationality, 31 Boston College Envtl. Affairs L. Rev. 555 (2004); Frank Ackerman & Lisa Heinzerling, Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection, 150 U. Pa. L. Rev. 1553, 1563 (2002); Douglas A. Kysar, Law, Environment, and Vision, 97 Northwestern Univ. L. Rev. 675 (2003); Douglas A. Kysar, Sustainability, Distribution, and the Macroeconomic Analysis of Law, 43 Boston College L. Rev. 1, 28-36 (2001); Lisa Heinzerling, Discounting Our Future, 34 Land & Water L. Rev. 39 (1999); Lisa Heinzerling, Environmental Law and the Present Future, 87 Geo. L.J. 2025 (1999); Lisa Heinzerling, Discounting Life, 108 Yale L.J. 1911 (1999); Lisa Heinzerling, Regulatory Costs of Mythic Proportions, 107 Yale L. J. 1981 (1998); Tyler Cowen & Derek Parfit, Against the Social Discount Rate, in Justice Between Age Groups And Generations 144 (Peter Laslett & James S. Fishkin eds., 1992); Richard B. Norgaard & Richard B. Howarth, Sustainability and Discounting the Future, in Ecological Economics: The Science And Management Of Sustainability 88, 97–98 (Robert Costanza ed., 1991).

It also bears noting that the Corps typically does not take potential loss of life into account when conducting cost-benefit analyses of its projects. According to the GAO, the Corps' guidance (Engineer Regulation 1105-2-100) directs analysts to address the issue of prevention of loss of life when evaluating alternative plans, but they are not required to formally estimate the number of lives saved or lost as a potential effect of a project.[168] In situations where historical data exist, the analysts have the option to estimate the number of persons potentially affected by a project and include this number as an additional factor for the consideration of decision makers. Hence, a high cost project that has few economic benefits, but which would save many lives, may not pass the cost-benefit test since the Corps does not include the lives saved as an explicitly monetized benefit.

In practice, this exclusion of saved human lives from cost-benefit calculation may have contributed to the Corps' apparent practice of liberally including prospects for private development as part of its flood control and hurricane protection projects. Because the Corps did not include saved human lives or ecological values in its cost-benefit analyses, the bulk of the identified benefit from hurricane protection tended to come from the safeguarding of real and personal property.[169] Thus, in order to generate a higher regulatory "budget" for project planning purposes, the Corps seems naturally to have been tempted to design projects in ways that generated easily identifiable and monetizable property protection benefits, even if that meant the earmarking of wetlands for future development that might otherwise have remained in their natural, storm surge dampening state.[170] Indeed, a key aspect of the local opposition to the LPVHPP centered on the question of whether the Corps had gone beyond protecting existing and anticipated land developments to actively promoting new development that would not have occurred but for the Corps' activities.[171] As one analyst noted, "[a]n extraordinary 79% [of the net benefits from the LPVHPP] were to come from new development that would now be feasible with the added protection provided by the improved levee system."[172]

The use of cost-benefit analysis for purposes of environmental, health, and safety regulation is, of course, highly controversial and a full treatment of the subject is well beyond the scope of this Article. Even if the Corps had included human health and

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[168] Government Accountability Office, Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project 20 n.13 (2003) (GAO-04-3).

[169] See U.S. Army Engineer District, New Orleans, Louisiana, Final Environmental Statement, Lake Pontchartrain, Louisiana, and Vicinity Hurricane Protection Project (August 1974) (reporting only property damage prevention, land intensification, and redevelopment as itemized annual benefits); id. ("Environmental losses were not evaluated in dollar terms.").

[170] See id. at ii ("Indirectly, the plan will hasten urbanization and industrialization of valuable marshes and swamps by providing for further flood protection and land reclamation."); ("Several areas would be rendered more suitable for urban use as a result of the project works. This effect will be reflected in increases in value of these lands, which increases are called 'enhancement benefits,' since they do represent additions to the Gross National Product.").

[171] See text accompanying notes 31-36, supra.

[172] Raymond J. Burby, Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing about Wise Governmental Decisions for Hazardous Areas, Annals Am. Academy Pol. & Soc. Sci., March 2006 (citing GAO 1976 Report). This conflation of protection and promotion purposes appears to be common within flood control and hurricane protection planning. See Raymond J. Burby & Steven P. French, Flood Plain Land Use Managed: A National Assessment (1985) (finding positive correlation between community flood controls works and the amount of new development taking place in flood hazard areas after flood control works completed).

environmental values within its cost-benefit calculations, theoretically and normatively difficult questions would have remained regarding how to monetize those values and how to account for their inter-temporal distribution.[173] What the Katrina planning process more narrowly seems to show, however, is yet another way in which cost-benefit analysis in practice leads to the very kinds of political and analytical distortions that the procedure is designed to guard against. For example, some observers of the regulatory process (including one of the authors of this article) have advocated greater use of retrospective cost analysis as a check on what appear to be systematic overestimates of industry regulatory compliance costs in prospective cost-benefit analysis—a distortion that leads to unduly modest levels of investment in environmental, health, and safety regulation.[174] Similarly, in the Katrina context, the failure to account adequately for the lifesaving purposes of hurricane protection seems to have led the Corps not only to understate the monetary justification for hurricane protection, but also to promote private land development schemes that may well have been counterproductive from the perspective of guarding against storm surges.

C. Priority Setting

The Corps is very reluctant to participate in the process of setting priorities for its projects. Once the Corps has determined that the benefits of a proposed project exceed its costs, the Corps leaves it to Congress to decide through the appropriations process those projects that receive funding and those that do not.[175] The Corps' reluctance in this regard is somewhat understandable, given the agency's desire to appear to be a politically-neutral, expert-driven body, rather than the self-aggrandizing pork processor it often is depicted to be in more cynical political discussion.[176] Yet the Corps' relative agnosticism on priorities deprives congressional decisionmakers of crucial contextual information regarding the relative seriousness of proposed projects. As one observer noted, "[s]aving New Orleans gets no more emphasis than draining wetlands to grow corn and soybeans."[177]

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[173] See sources cited supra note __.

[174] Thomas O. McGarity & Ruth Ruttenberg, Counting the Cost of Health, Safety and Environmental Regulation, 80 Tex. L. Rev. 1997 (2002). See also Office of Management and Budget, Validating Regulatory Analysis: 2005 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local and Tribal Entities ch. 3 (2005). Of course, to the extent that hindsight analysis of regulatory costs involves speculation about how regulated entities would have addressed the hazards of the regulated activity in the absence of the regulatory intervention (e.g., to avoid potential tort liability), the value of retrospective cost assessments may prove illusory. It should be noted, however, that many regulatory interventions address environmental hazards, the costs of which are relatively easily externalized, and health hazards, the costs of which are unevenly internalized by tort law. In these situations, the assumption that the regulated entities would have taken little or no action to address such hazards may yield a fairly accurate regulatory cost assessment.

[175] populate.

[176] See, e.g., Michael Grunwald, Money Flowed to Questionable Projects, Washington Post, Sept. 8, 2005, at A01, available at http://www.washingtonpost.com/wp-dyn/content/article/2005/09/07/AR2005090702462.html ("Despite a series of independent investigations criticizing Army Corps construction projects as wasteful pork-barrel spending, Louisiana's representatives have kept bringing home the bacon.).

[177] Cf. Michael Grunwald, Money Flowed to Questionable Projects, Washington Post, September 8, 2005, at A1 (quoting Tim Searchinger, senior attorney, Environmental Defense).

The Corps' agnosticism in this regard also encourages piecemeal, project-by-project congressional decisionmaking, when instead a more comprehensive approach is required that integrates flood control, hurricane protection, coastal restoration, ecosystem preservation, and mitigation projects within a single framework. The much-criticized MRGO Canal, for instance, might have appeared to be a far less attractive project had it been analyzed as part of a more direct and inclusive effort to balance economic development with human safety and the environment. As Professor Oliver Houck has noted, the MRGO costs taxpayers thousands of dollars per ship passing while it has destroyed 26,000 acres of cypress hardwood and marsh. As a result, "environmentalists have been trying to get [it] closed for 25 years."[178] Thus, for a variety of reasons beyond just its potentially risk-enhancing qualities with respect to hurricanes, the MRGO seems to represent indefensible public policy. The full egregiousness of the project, however, is difficult to perceive when its implications are analyzed only in a piecemeal fashion.

Moreover, the polder containing the Ninth Ward and parts of St. Bernard Parish that flooded during Hurricane Katrina also was inundated in 1965 during Hurricane Betsy, a fast moving CategoryThree hurricane. Officials at the time suggested that the MRGO Canal had acted like a funnel, channeling the storm surge from the Gulf of Mexico into New Orleans.[179] A Times-Picayune article in 2002 later noted that "proponents of closing and filling in MRGO say it has evolved into a shotgun pointed straight at New Orleans, should a major hurricane approach from that angle."[180] Levee analysis and sophisticated modeling exercises have led some experts to conclude that this very shotgun fired during Hurricane Katrina, with devastating results.[181] While it is certainly possible that the polder would have flooded even if the MRGO Canal had not existed in 1965 and again in 2005, policymakers could reasonably conclude that filling in the MRGO Canal now would eliminate a potential cause of future flooding.[182]

In order to appreciate these multidimensional implications of the MRGO Canal, one must move beyond narrowly framed modes of policy analysis and embrace something more like the emerging sustainable development paradigm, in which the many determinants of human well-being and environmental sustainability are treated as aspects

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[178] See, e.g., Recovering from Katrina and Rita: Environmental Governance Lessons Learned and Applied, 36 ELR 10139, 10150 (2006) (statement of Oliver Houck).

[179] Karen Turni, Upgrade of Levees Proposed by Corps, New Orleans Times-Picayune, November 12, 1998, at A1

[180] John McQuaid & Mark Schleifstein, Evolving Danger: Experts Know We Face a Greater Threat from Hurricanes than Previously Suspected, Times-Picayune, June 23, 2002 (quoting Louisiana State University engineering professor Joseph Suhayda).

[181] See text accompanying notes ___ - ___, supra.

[182] See Levees Washed Away Along MRGO and St. Bernard Parish, Army Corps Say, New Orleans Times-Picayune, September 13, 2005 (quoting State Senator Walter Boasso) ("If we didn't have MR-GO, we would have had some problems, but we wouldn't have had 30,000 homes flooded."); John Schwartz & Andrew C. Revkin, Levee Reconstruction Will Restore, but Not Improve, Defenses in New Orleans, New York Times, September 30, 2005, at A1 (quoting Dr. Crag E. Cohen of Louisiana State University) (advocating shutting down the MRGO Canal). In 1998, the St. Bernard parish Council unanimously passed a resolution demanding that the MRGO be closed. Michael Grunwald, Canal May Have Worsened City's Flooding, Washington Post, September 14, 2004, at A21. The Corps of Engineers has stopped dredging the MRGO Canal, and it may recommend that it be shut down. John McQuaid, Bob Marshall & Mark Schleifstein, Protecting the Area from Another major Storm is Crucial to Getting New Orleans back on Its Feet . . . But How? New Orleans Times-Picayune, October 25, 2005.

of a single complex, but integrated public policy framework.[183] It makes little sense, for instance, to talk about the optimal post-Katrina hurricane protection plan for New Orleans without also discussing wetlands, housing and transportation, climate change and energy, and a host of other policy areas that undoubtedly and significantly will impact the very parameters that also guide hurricane protection planning. Such decisionmaking will not lend itself to formulaic resolution. It is necessarily pluralistic and messy, yet it is apparently the only way that disasters such as Katrina can be anticipated and avoided in an increasingly intertwined and fragile world.

VI. Conclusion

Familiar aphorisms aside, hindsight is not necessarily 20/20: The counterfactual nature of the hindsight causation analysis inevitably requires the analyst to create a hypothetical world in which alternatives are chosen that were not in fact adopted in the real world. As with the related "cause-in-fact" inquiry in tort law, this inquiry invites a great deal of speculation. When the suggested cause of a catastrophic failure is remote in time and when many other actions that are also relevant to the causal analysis intervene or could have intervened between the suggested cause and the failure, the opportunity for analysts to speculate—or manipulate—becomes very real. Accordingly, how we sort among many uncertain counterfactual worlds to identify responsible causal agents says as much about our politics and our culture as it does about our science.[184]

In that respect, recent attempts by politicians and pundits to pin the levee failure in New Orleans on NEPA litigation do not speak well of our politics and our culture. Hindsight analysis provides little reason to believe that a barrier project of the sort envisioned in 1976 would have prevented the Hurricane Katrina storm surge from breaching the levees along the 17th Street and London Avenue canals, as recent critics of NEPA have argued. Looking forward, policymakers are well advised to examine what exactly caused the levees along the outfall canals to fail, taking action to rebuild or fortify those levees prior to investing in an expensive barrier project. Once that remedial work is accomplished, a more expansive barrier project may still be warranted, and it may even need to be substantially more protective than the project envisioned in 1976, including a seagate at the point at which the MRGO Canal intersects with the Intercoastal Waterway to provide equitable levels of protection to New Orleans East and St. Bernard Parish.[185] Any such project, however, should only be contemplated with the same commitment to integrated, environmentally-informed decisionmaking that has characterized NEPA since its adoption in 1969.

[183] See Douglas A. Kysar, Sustainable Development and Private Global Governance, 83 Tex. L. Rev. 2109 (2005).

[184] Cf. Douglas A. Kysar, The Expectations of Consumers, 103 Columbia L. Rev. 1803 (2003) (describing manner in which the perception of risk and the attribution of blame are freighted with cultural meaning).

[185] John McQuaid, Bob Marshall & Mark Schleifstein, Protecting the Area from Another major Storm is Crucial to Getting New Orleans back on Its Feet . . . But How? New Orleans Times-Picayune, October 25, 2005.

According to some estimates, a coastal protection system capable of guarding against a Category Four to Five storm for New Orleans would cost $2.5 billion and require 10 to 20 years of construction.[186] As hindsight analysis of the LPVHPP planning process shows, deciding whether to undertake such a project can never be reduced entirely to a technocratic exercise. Just as judgment and discretion inhere in the attribution of fault for a causally overdetermined disaster, so too does the prediction of harm from inherently complex and uncertain systems always require the exercise of collective agency and responsibility. To be sure, the tools of risk assessment and cost-benefit analysis do provide vital information for public policymaking. They must, however, be deployed with a degree of sensitivity regarding their limitations and a vigilant awareness of the need for moral and political judgments that go beyond the parameters of the formalized analytical frameworks.

The LPVHPP planning process suggests that such sensitivity and awareness may have been placed in jeopardy by overzealous confidence in the powers of technical decisionmaking apparatuses.[187] In the case of the SPH, a sophisticated meteorological model tended to obscure important decisions regarding the treatment of highly uncertain but potentially catastrophic risks to present and future New Orleans residents, suggesting a degree of normative agreement lurking behind the concept of "reasonably characteristic" hurricanes that was almost certainly absent in actuality. In the case of cost-benefit analysis, the Corps' approach to economic project evaluation seemed both to stack the deck against long-range investment in disaster prevention and mitigation, and to promote a form of "mission creep" in the Corps planning activities toward easily monetizable benefits.

In sum, neither the blame game nor the numbers game is up to the task of formulating sound and ethical natural disaster policy. Instead, analysts should set out the uncertainties of both hindsight and prospective analyses in a way that is easily accessible to decisionmakers and the public, so that the full challenge of long-term intergenerational risk regulation will be highlighted for consideration, rather than obscured from view. Focusing narrowly on any single parameter of complex natural and human systems is likely to dramatically distort environmental, health, and safety decisionmaking—whether the parameter is a "standard project hurricane" when we are planning a hurricane protection plan, or the equally mythical "lawsuit that sunk New Orleans" when we are attempting to allocate responsibility for a disaster some forty years later.

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[186] CRS Report, New Orleans Levees and Floodwalls: Hurricane Damage Protection, Sept. 6, 2005. These estimates are likely vastly optimistic. See Peter Whoriskey & Spencer S. Shu, Levee Repair Costs Triple, Washington Post, March 31, 2006, at A01, available at http://www.washingtonpost.com/wp-dyn/content/article/2006/03/30/AR2006033001912.html?nav=rss_email/components (noting that the Bush Administration had raised cost estimates for rebuilding the New Orleans levee system to "federal standards" to $10 billion in light of better understanding of wetlands loss, subsidence, and hurricane frequency and intensity).

[187] Porter, supra note __, at 7-8 ("Quantitative estimates sometimes are given considerable weight when nobody defends their validity with real conviction . . . Quantification is a way of making decisions without seeming to decide. Objectivity lends authority to officials who have little of their own.").