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Flood Risk Management: Federal Role in Infrastructure

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Summary

Hurricane Katrina enlivened a national debate on managing flood hazards and raised concerns about flood vulnerability among communities across the nation. In the United States, local governments are responsible for land use and zoning decisions that direct floodplain and coastal development; however, state and federal governments influences community and individual decisions on managing flood risk. The federal government constructs some of the nation's flood control infrastructure, offers flood insurance, and provides disaster aid.

The 110th Congress, like many earlier Congresses, is faced with numerous flood control issues, including interest in changing federal policies. Current federal programs and flood control projects generally target reducing property damage and vulnerability to a 100-year flood. Discussions include whether current flood protection is sufficient, whether loss of life and economic and social disruption should be more prominent considerations in federal policy, and what are the advantages and disadvantages of a more risk-based approach to federal policy, spending, and infrastructure design.

This report discusses federal flood-related infrastructure investments, such as levees, floodwalls, and dams. The report also analyzes flood risk as a composite of flood threat, consequence, and vulnerability. The report illustrates that federal policy focuses attention on only some aspects of flood risk and summarizes the options being discussed for addressing other aspects of flood risk in the aftermath of Hurricane Katrina.

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Flood Risk Management: Federal Role in Infrastructure

Introduction

In the United States, local governments are responsible for land use and zoning decisions that direct floodplain and coastal development; however, numerous federal and state flood policies and programs influence local, and individual decision-making. The federal government funds construction of some flood control structures, manages a flood insurance program, and provides disaster assistance;[1] and it generates essential data through mapping and other efforts. This report discusses investment decisions for flood control infrastructure (such as levees, floodwalls, and dams), and how federal policies, programs, and practices that focus on reducing property damage and vulnerability to a *100-year flood* influence these decisions.[2] The report also describes how Hurricane Katrina enlivened a national debate on whether the current flood protection is sufficient and whether a more comprehensive approach to managing flood risk and federal investments is desirable.

Hurricane Katrina demonstrated that not only property damage, but also other flooding impacts (e.g., loss of life and economic disruption), may be national concerns. This report analyzes flood risk as a composite of three factors:

- *threat* of an event (e.g., probability of a Category 5 hurricane storm surge or a 200-year flood affecting a particular location);
- *consequence* of an event (e.g., loss of life, economic loss, environmental damage, reduced health and safety); and
- *vulnerability* that allows a threat to cause consequences (e.g., level of protection provided by levees and dams, and their reliability).[3]

The remainder of this report is divided into five sections. The first is a primer on federal flood control policy and infrastructure. The next two sections describe

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[1] For information on the evolution of federal disaster aid, see U.S. Senate Task Force on Funding Disaster Relief, *Federal Disaster Assistance*, S.Doc. 104-4 (1995).

[2] The term *100-year flood* is the flood elevation that has a 1% chance of being equaled or exceeded *annually*. It is *not* the flood that will occur once every 100 years; 100-year floods can occur more than once in a relatively short period of time.

[3] For more information on this three-part hazard risk framework, see CRS Report RL32561, *Risk Management and Critical Infrastructure Protection: Assessing, Integrating, and Managing Threats, Vulnerabilities, and Consequence*, by John Moteff.

two aspects of federal policies and practices — the 100-year flood standard, and benefit-cost analyses — that guide infrastructure investment decisions and how these federal policies and practices focus attention on only some aspects of flood risk. The fourth section summarizes how addressing other elements of flood risk are being discussed in the aftermath of Hurricane Katrina. The fifth section concludes the report by presenting a primer on the range of flood control issues before the 110th Congress. This report is not a comprehensive treatment of the topics of flood risk and flood control; rather, it is an introduction to the current debate on flood policy and focuses primarily on the U.S. Army Corps of Engineers as the principal federal agency for flood control infrastructure.

Federal Flood Control Policy and Infrastructure

Federal Interest. The federal role in flood control began in the late 19th century. Prompted by devastating floods in the Mississippi River basin, Congress created a commission to oversee the development of a levee system to control the river's flow. The Mississippi River Flood of 1927[4] and floods in the mid-1930s, ushered in a modern era of federal flood control investment. The Flood Control Act of 1936 (19 Stat. 1570) declared flood control a "proper" federal activity in the national interest.[5] Section 1 of the act established the following policy:

> It is hereby recognized that destructive floods upon the rivers of the United States, upsetting orderly processes and causing loss of life and property, including the erosion of lands and impairing and obstructing navigation, highways, railroads, and other channels of commerce between the States, constitute a menace to national welfare; that it is the sense of Congress that flood control on navigational waters or their tributaries is a proper activity of the Federal Government in cooperation with States, their political sub-divisions and localities thereof; that investigations and improvements of rivers and other waterways, including watersheds thereof, for flood-control purposes are in the interest of the general welfare; that the Federal Government should improve or participate in the improvement of navigable waters or their tributaries including watersheds thereof, for flood-control purposes if the benefits to whomsoever they may accrue are in excess of the estimated costs, and if the lives and social security of people are otherwise adversely affected.

Since the mid 1980s, local project sponsors (often local governments or special levee and drainage districts) share construction cost of federal flood control projects and are fully responsible for operation and maintenance. Local entities (and sometimes state entities) may construct flood control infrastructure independently

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[4] For more information on the response to the Mississippi River Flood of 1927, see CRS Report RL33126, *Disaster Recovery and Appointment of Recovery Czar: The Executive Branch's Response to the Flood of 1927*, by Kevin R. Kosar.

[5] The Beach Nourishment Act of 1956 (P.L. 84-826) expanded the federal role in constructing projects for hurricane, storm and shoreline protection, such as seawalls and the periodic placement of sand on beaches to control erosion. The Flood Control Act of 1950 (64 Stat. 170) began the Corps' emergency operations by authorizing flood preparedness and emergency operations.

from the federal government, and are responsible for land use and zoning decisions guiding development in floodplains and coastal areas.

Flood Insurance. By the 1950s, it had become clear to Congress that the federal response to flood risk through structural flood controls and post-disaster assistance for flood victims left much to be desired. Public works could not protect all areas, control all floods, and be completely reliable; meanwhile, private construction continued in flood-prone areas. Furthermore, relief payments were problematic because they were unpredictable and necessitated bargaining after each major flood. Pre-disaster funding via insurance began to look like an attractive alternative to flood control structures or disaster assistance. Flood insurance coverage was virtually unavailable from the private insurance markets because insurers could not profitably sell coverage at an affordable price; attempts at private flood insurance had been hampered by the catastrophic nature of flooding and insurers' inability to develop actuarial rates that reflected the flood hazard risk.

Attempts to create a federal flood insurance program eventually came to fruition with the National Flood Insurance Act of 1968 (NFIP, P.L. 90-448; 42 U.S.C. §4012), which authorized the creation of the National Flood Insurance Program (NFIP). Coverage is available to all owners and occupants of insurable property in a participating community. Managing flood risk through insurance was expected to greatly reduce the reliance on federal disaster relief assistance because participating communities were expected to adopt and enforce building and other standards that could greatly reduce losses from a 100-year flood.

An on-going issue with flood insurance are the accuracy of the maps used defining "special flood hazard areas" which are the triggers for NFIP's flood insurance requirements; for information on this topics, see CRS Report RL33264, *FEMA's Flood Hazard Map Modernization Initiative*, by Wayne A. Morrissey. Over 75% of the Federal Emergency Management Agency's (FEMA) flood maps are over 10 years old, raising concerns that the hydrologic data behind the maps is obsolete. Hydrology can change due to land use changes, channel modifications, erosion, and climate variability. For example, a 2004 analysis by the Corps found that the 100-year flood elevation at some locations along the Lower Missouri River is 4 feet higher than shown on previous flood map. As FEMA's maps are updated to reflect current conditions, many communities previously thought protected from the 100-year flood will not find themselves subject to flood insurance requirements.

A related concern is the certification of levees to FEMA for its administration of the NFIP. FEMA's policy requires that levees be structurally sound, properly maintained, and provide 100-year flood protection (including a 3-foot factor of safety) before FEMA will recognize that the levees provide protection. The Corps generally performs the inspections for certifying the levees; the Corps' inspection program is neither designed or funded to assess the geotechnical conditions of the levees nor the hydrological conditions they would be subject to; therefore, levee certification generally does not represent an evaluation of the structural integrity of existing levees. Performing such analysis requires could represent a significant cost for most communities and levee districts. The Corps estimate the cost of performing geotechnical and hydrologic analyses for 1,600 miles of levees in the Central Valley of California at $100 million, that is, around $60,000 per mile.

Flood Damage Reduction Infrastructure. The Corps is responsible for much of the federal investment in flood control and storm protection infrastructure.[6] It has constructed nearly 9,000 miles of the nation's estimated 15,000 miles of levees. Corps involvement in flood control construction is predicated on the project being in the *national interest*, which is determined by the likelihood of widespread and general benefits, a shortfall in the local ability to solve the water resources problem, the national savings achieved, and precedent and law.[7]

Over the last century, many of the communities most prone to flooding have been protected by significant investments in structural measures to reduce flood damages. Many of the current questions and concerns revolve around the following topics:

- whether the level of protection is sufficient if all consequences are considered (e.g., intensity and spread of urbanization, concentration of oil processing and distribution infrastructure);
- whether flood threat and vulnerability have changed (e.g., as the result of increases in ocean temperature, coastal wetlands losses; and the reliability of aging levees and dams); and
- how sufficient is the hurricane and storm protection for the nation's coastal communities.

Reducing Vulnerability to the 100-Year Flood: Minimum Standard Approach

In the United States, the 1% annual chance flood, more commonly known as the 100-year flood, is a standard often used as a basis for identifying, mapping, and managing flood hazards. For example, the NFIP and most state and local governments use location in the 100-year floodplain or similar coastal zone inundation areas as triggers for various requirements. The 100-year flood standard was established at the recommendation of a group of experts in the late 1960s. "It was selected because it was already being used by some agencies, and it was thought that a flood of that magnitude and frequency represented a reasonable probability of occurrence and loss worth protecting against and an intermediate level that would alert planners and property owners to the effects of even greater floods."[8] The adoption of the 100-year flood standard in many respects guides perceptions of what is an *acceptable level of vulnerability*. The 100-year flood standard is a vulnerability standard, and not a risk standard. Thus, the question of whether the 100-year flood

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[6] Other federal agencies are involved with flood control projects, including the U.S. Department of Agriculture's Natural Resources Conservation Service, the Department of the Interior's Bureau of Reclamation, and the Tennessee Valley Authority.

[7] This is described in the Corps' *Digest of Water Resources Policies and Authorities* Engineering Pamphlet EP 1165-21-1 (1999).

[8] Association of State Flood Plain Managers, *Reducing Flood Losses: Is the 1% Chance (100-year) Flood Standard Sufficient?*(Washington, DC: 2004).

standard combined with current threat and consequence information results in an *acceptable level of risk* remains largely unaddressed; this question is especially relevant for low probability, high consequence events such as a Category 4 hurricane hitting a major urban center.

The attempt to provide at least 100-year flood protection often drives local floodplain management and infrastructure investments, resulting in a measure of equity within and across communities. That equity in vulnerability, however, results in uneven levels of risk because flooding of different communities has different consequences, such as differences in the potential loss of life, social disruption, structures damaged, and economic impact because of variations in land use and development patterns.

The National Flood Insurance Program does not differentiate between 100-year flood protection provided by a flood control structure and flood protection resulting from natural topography and hydrology. As a result, development behind levees and downstream of dams providing 100-year flood protection is not designated as located in a "special flood hazard area," thus freeing occupants from flood insurance requirements. While the NFIP largely presumes that levees, dams, and other flood control structures will not fail, their presence does not entirely eliminate an area's vulnerability to flooding.

The *residual flood risk* behind levees or downstream of dams remains largely unaccounted for in the NFIP and often is not incorporated into individual, local, and state decision-making. Residual risk is the portion of risk that remains after flood control structures have been built and other damage-reducing measures have been taken. Risk remains because of the likelihood of the measures' design being surpassed by floods' intensity and of structural failure of the measures. Often when the designs of flood control structures are surpassed or when structures fail for other reasons, the resulting flood is catastrophic, as shown by the floodwall breaches in New Orleans (LA) with Hurricane Katrina in 2005. The consequences of floods increase as development occurs behind levees and below dams; ironically, this development may occur because of the flood protection provided. The nation's risk of low-probability events (e.g., 400-year flood, or Category 4 hurricane) having high-consequences in terms of lives lost, economic disruption, and property damage is increased by overconfidence in the level and reliability of structural flood protection for events that are less probable than the 100-year flood.

Reducing Property Damage Vulnerability: Benefit-Cost Analyses

The risk posed by low-probability events may be underestimated by current methods for analyzing flood control investments. The benefit-cost analyses compiled to support federal decision-making for water resources projects focus on the "national economic development benefits" of investments; regional, social, and environmental benefits may be analyzed but often are largely excluded from federal

decision-making.[9] Moreover, the Corps generally limits its benefit-cost analyses of the consequences of flooding to property damages.[10] That is, estimated benefits from flood control infrastructure investments are primarily the avoided losses to existing structures and land uses.

The evaluation and recommendation of a flood control project by the Corps involves multiple steps. After an initial reconnaissance study that is funded by the federal government, current policy is for the cost of the follow-on feasibility study to be split 50% federal - 50% nonfederal; flood control and storm protection construction generally is split 65% federal - 35% nonfederal.[11] When Congress authorizes the Corps to construct a project, the authorization generally is based on a Chief's Report. In that report the Corps' Chief of Engineers typically recommends the building of one of the alternative plans studied in the agency's feasibility report, consisting of an evaluation of alternative plans, benefit-cost analysis, engineering analyses, and environmental impact assessments.

The Corps' benefit-cost analysis of a project may result in a recommended plan for flood control infrastructure providing for protection greater than or less than the 100-year flood. Local project sponsors can request that a "locally preferred alternative" be built, instead of the plan identified by the benefit-cost analysis. The NFIP creates incentives for communities to support flood control alternatives providing at least the 100-year level of protection, but the program provides few incentives for local flood control entities and cities to provide more than the 100-year level of protection. For some local leaders and communities, the capital required to cost-share a Corps flood control project may be a financial barrier to pursuing greater protection.

The Corps' benefit-cost analysis does not constitute a comprehensive risk analysis, because the consequences considered are largely limited to property damage, leaving out other potential consequences, such as loss of life, public health problems, and economic and social disruption. The Water Resources Development Act of 1986 (WRDA; P.L. 99-662) required the Corps to address the prevention of loss of life in the formulation and evaluation of flood control projects. Section 904 (emphasis added) of the act stated:

> Enhancing national economic development (including benefits to particular regions of the Nation not involving the transfer of economic activity to such regions from other regions), the quality of the total environment, the well-being of the people of the United States, the *prevention of loss of life*, and the

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[9] This approach to benefit-cost analysis was developed following the *Principles and Guidelines for Water and Related Resources Implementation Studies* (P&G), prepared by the Water Resources Council in 1983 to guide federal water resources development projects.

[10] Some consideration is given to business income losses and emergency response costs. More information on the agency's benefit-cost analysis is addressed in the its *Planning Guidance Notebook*, Engineering Regulation ER1105-2-100 (2000), at [http://www.usace.army.mil/inet/usace-docs/eng-regs/er1105-2-100/entire.pdf].

[11] The construction cost share for periodic beach replenishment as part of a storm protection project is 50% federal - 50 % nonfederal.

> preservation of cultural and historical values shall be addressed in the formulation and evaluation of water resources projects to be carried out by the Secretary, and associated benefits and costs, both quantifiable and unquantifiable, shall be displayed in the benefits and costs of such projects.

Although potential loss of life is noted in Corps feasibility reports, there are no Corps regulations or guidelines for how to incorporate loss of life into the agency's benefit-cost analyses. Part of the reason for that reluctance to quantifying the value of human life is that its use in Corps project evaluation is unclear. Many projects have benefits that exceed costs without including the benefit from lives saved. Therefore, although preventing loss of life is a goal of federal flood control policy, current practice results in property damage being the primary consequence metric used for making Corps flood control investment decisions. A related benefit-cost analysis issue commonly debated is whether there is a bias toward lower levels of flood protection for low-income communities due to their lower property values. Another commonly debated issue is whether there is a bias toward structural flood control measures over nonstructural options (e.g., buyouts of structures in flood-prone areas).

Reducing Flood Risk

A fundamental question being raised is: do current federal policy, programs, practices result in an acceptable level of aggregate risk for the nation? Risk management is being increasingly viewed as a method for setting priorities for managing some hazards in the United States. Because floodplain and coastal development are largely managed by local governments, some aspects of national flood risk management likely would be unwelcome and infeasible, and could be perceived as resulting in an inequitable distribution of flood protection. For example, if floods in large urban concentrations are perceived as representing a greater risk for the nation, federal resources may be directed away from protecting smaller communities and less-populated states. Two of the concerns raised in discussions of greater emphasis on risk analysis in the development and design of specific projects are that risk analysis may result in lower levels of protection being implemented in some areas, and that information and knowledge are insufficient to perform an adequate analysis. However, an argument can be made that the federal government has an interest in reducing risks resulting in national consequences, and in prioritizing federal involvement and appropriations accordingly.

Factors complicating the determination of the nation's flood risk include changing conditions and incomplete information. For example, many flood control projects were built decades ago using the available data, technologies, and scientific knowledge of the period that may have underestimated flood hazards for particular areas. Similarly, there are issues with changes in risk over time due to processes such as land loss, subsidence, sea-level rise, reduced natural buffers, urban development, and infrastructure aging. For existing dams, there is some information on consequences of failure as measured by loss of life, economic loss, environmental loss, and disruption of lifeline infrastructure (such as bridges and power grids);

however, the database with this information only tracks the amount and type of losses, not the likelihood of failure.[12]

A risk-reduction approach for organizing federal flood-related investments likely would incorporate many structural and nonstructural flood management measures already being considered and implemented, but change their priority and mix. Options considered in a risk-centered approach may include shifting federal policy toward wise use of flood-prone areas (e.g., rules or incentives to limit some types of development in floodplains), incorporating residual risk and differences in riverine and coastal flood risk into federal programs (e.g., residual risk premiums as part of the National Flood Insurance Program), creating a national inventory and inspection program for levees, promoting greater flood mitigation and damage mitigation investments, re-evaluating operations of flood control reservoirs for climate variability and uncertainty, and investing in technology and science for improved understanding of flooding threats.

Flood Management Issues in the 110th Congress

The 2005 hurricane season focused the nation's attention once again on issues that flood experts have debated for decades. The devastation in the Gulf states renewed public concerns about reliability of the nation's aging flood control levees and dams. The debate over what is an acceptable level of risk — especially for low-probability, high-consequence events — and who should bear that risk is taking place not only in Gulf states, but nationally. The concerns being raised range widely, including interest in providing more protection for concentrated urban populations, risk to the nation's public and private economic infrastructure, support for reducing vulnerability by investing in natural buffers, equity in protection for low-income and minority populations, and consistency in and the form of flood insurance and disaster aid.

Response to the 2005 hurricane season included discussions of expanding mitigation activities (such as floodproofing structures and buyouts of structures on the most flood-prone lands), investing in efforts to restore natural flood and storm surge attenuation, and assuring vigilant maintenance of existing flood control structures, as well as interest in new and augmented structural flood protection measures. Although major flood events, such as the Midwest Flood of 1993, generally spur these discussions, the policy changes implemented often are incremental.[13] The 110th Congress, like previous Congresses, faces a challenge in reaching consensus on how to proceed on anything other than incremental change because of the wealth of constituencies and communities affected by federal flood

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[12] For information on dam safety, see CRS Report RL33108, *Aging Infrastructure: Dam Safety*, by Nic Lane.

[13] After the Midwest Flood of 1993, the Interagency Floodplain Management Review Committee was directed to evaluate the performance of floodplain management and make recommendations in current policies and programs of the federal government. The resulting 1994 report, titled *Sharing the Challenge: Floodplain Management in the 21st Century*, often called the "Galloway Report" for the Committee's chair, includes the Committee's recommendations; the report is available at [http://eros.usgs.gov/sast/2P-00526.PDF].

policy. Another practical challenge is the division of congressional committee jurisdictions over the federal agencies and programs involved in flood mitigation, protection, and response.[14]

There are many questions that remain about how events unfolded in the aftermath of Hurricane Katrina, and much information that is still needed to understand how to apply and communicate nationally the lessons in the Gulf states learned about flood risk and disaster preparedness and response. Although there is no way to protect against all flood risk, it is clear that more information is needed to evaluate flood risk, to understand the reliability and residual risk of structural flood protection, and to incorporate the full range of flood consequences into local, state, and federal decision-making and programs.

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[14] For example, Senate Committees that would likely have jurisdiction over elements of any comprehensive change in federal flood policy would include Banking, Housing, and Urban Affairs; Environment and Public Works; and Homeland Security and Government Affairs. For a discussion of the jurisdictional issues, see CRS Report RS21643, *House Committee System: Jurisdiction and Referral Reform Options*, by Judy Schneider and Paul Rundquist and CRS Report RL32112, *Reorganization of the Senate: Modern Reform Efforts*, by Judy Schneider et al.