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Federal Flood Policy Challenges: Lessons from the 2008 Midwest Flood

Updated January 27, 2010

Congressional Research Service
https://crsreports.congress.gov
R40201

CRS REPORT
Prepared for Members and
Committees of Congress

Summary

Floods remain a significant hazard in the United States. Developing and investing in flood-prone areas represents a tradeoff between the location's economic and other benefits and the exposure to a flood hazard. In the United States, flood mitigation, protection, emergency response, and recovery roles and responsibilities are shared. Local governments are responsible for land use and zoning decisions that shape floodplain and coastal development. State and federal programs, policies, and investments influence community and individual decisions on managing flood risk. The federal government constructs some of the nation's dams and levees, offers flood insurance, supports nonstructural risk reduction actions (known as hazard mitigation), and provides emergency response and disaster aid.

In June 2008, a series of storms in several midwestern states caused $15 billion in damages. The 2008 flooding drew comparisons to the devastating 1993 Midwest flood and raised questions about whether the lessons from the 1993 flood were heeded. In 1993, hundreds of levees throughout much of the basin were breached in the Midwest causing $30 billion in damages; much of the damage was agricultural and occurred in soaked upland areas. In contrast, the majority of the 2008 damages were concentrated along a few Mississippi River tributaries and in population centers with breached levees. The magnitude of the two floods simply overwhelmed the region's levees and dams, illustrating that some residual risk remains to people and investment behind these protective structures. Since 1993, emergency response and hazard mitigation programs have reduced risks in some Midwest communities; however, the region's flood risk continues to increase as more investments and people are located in flood-prone areas.

Since 1993, Congress, federal agencies, state, and local governments have taken steps aimed at reducing the nation's flood risk; at the same time, climate, population, and investment trends have increased the threat, vulnerability, and consequences of flooding. For example, Congress authorized using federal disaster assistance to cover more of the costs to acquire, relocate or elevate flood-prone homes and businesses. However, broader efforts to adopt a comprehensive flood policy and management strategy have not been pursued. The fundamental direction and approach of the national policies and programs remain largely unchanged since 1993. A comprehensive strategy would require regulation of floodplain use, significant changes to federal programs, and increased investment in flood risk reduction by all levels of government. Although they would reduce flood risk, these changes face significant opposition.

The 2008 Midwest flooding, Hurricane Ike in 2008, and Hurricane Katrina in 2005 have renewed interest in the suite of tools available to improve flood resiliency. The issue for Congress is deciding on whether and how to enact and implement feasible and affordable flood policies and programs to reduce flood risk. The challenge is how to structure federal actions and programs so they provide incentives to reduce flood risk without unduly infringing on private property rights or usurping local decision making. Tackling this challenge would require adjustments in the flood insurance program, disaster aid policies and practices, and programs for structural and nonstructural flood risk reduction measures and actions.

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U.S. Flood Challenge: A Federal Primer

In late May and early June 2008, several midwestern states were hit with a series of storms that produced flooding along many Mississippi River tributaries and nearby segments of the Mississippi River. This flooding raised concerns about both the risk of another disaster like the devastating 1993 Midwest flood and the state of the nation's flood policies, programs, and infrastructure. Although emergency response has improved since 1993 and hazard mitigation programs have reduced some risks, the region's flood risk continues to increase as more investments and people are concentrated in flood-prone areas affected by extreme precipitation.

Riverine and coastal flooding remain serious risks to the nation's population and economy. The principal causes of floods in eastern states and the Gulf Coast are hurricanes and storms. Coastal counties are 17% of the land area, and home to roughly 50% of the country's population and jobs. Flooding in the Midwest and western states is primarily from snowmelt and rainstorms. At least 9 million homes and $390 billion in property are at risk from a flood with a 1% annual probability of occurring.[1]

Increasing flood hazards are putting existing developments at risk.[2] New development is occurring in flood-prone areas, often behind aging levees constructed to reduce agricultural damages rather than protect urban populations. National flood damages, which averaged $3.9 billion annually in the 1980s, nearly doubled in the decade 1995 through 2004. Total disaster assistance for emergency flood response operations, and subsequent long-term recovery efforts, increased from an average of $444 million during the 1980s to $3.75 billion from 1995 to 2004.

Congress and federal agencies have taken steps to address selected flood challenges; at the same time, climate, population, and investment trends have increased the threat, vulnerability, and consequences of flooding. In response to the 1993 flood, Congress shifted federal programs to increase support for a wider range of activities that reduce damage and prevent loss of life, such as moving flood-prone structures and developing evacuation plans; this broader set of activities is known as hazard mitigation. This shift has prompted wider use of nonstructural mitigation, particularly for new development and repairing damaged property. Traditional structural approaches, such as levees, floodwalls, and dams, continue to dominate much of the national investment in flood damage reduction. Often structural measures are the most readily available and locally acceptable tools to reduce flood risk for existing population, economic, and infrastructure hubs.

Since 2005, Congress has considered legislation and enacted other measures to address some flood issues; broader efforts to adopt a comprehensive flood policy and management strategy, however, have not been pursued. Hurricane Katrina's devastation in 2005 and the 2008 Midwest flood have again prompted attention to the suite of tools available to create a more flood-resilient nation. Many of these tools would require action by local governments, regulation of floodplain use, significant changes to federal programs, and substantially increased investment in flood damage reduction. Achieving these actions and implementing improved floodplain management is likely to confront opposition from those benefitting from the status quo and those opposed to

[1] These estimates are a lower bound from the January 1997 FEMA report, *FEMA's Multi-Hazard Identification and Risk Assessment (MHIRA)*, available at http://www.fema.gov/library/viewRecord.do?id=2214. The magnitude of flood events traditionally has been measured by recurrence intervals, or the likelihood that a flood of a particular size occurring during any 10-, 50-, 100-, or 500-year period. Respectively, these events have a 10%, 2%, 1%, and 0.2% chance of being equaled or exceeded during any year.

[2] Information in this paragraph is from U.S. Army, *Fiscal Year 2008 United States Army Annual U.S. Army Corps of Engineers—Civil Works Financial Statement*.

land use regulation. And it likely would require broader congressional action than the incremental policy alterations that have been typical following recent floods.

This report first provides a primer on recent developments, the federal role in flood policy, and the limitations of levees and dams. The report then discusses lessons from the 2008 Midwest flood and contrasts the 2008 flood with the 1993 flood. It then discusses the evolution of U.S. flood policy, with particular attention to the role of Congress and federal agencies and programs, and the available tools for addressing the nation's flood challenge.

Recent Interest and Developments

The 2008 Midwest flood and the extensive damage and loss of life caused by Hurricane Katrina have raised awareness of flood risk, and levee construction and maintenance in particular. These disasters raised many flood policy questions, including whether to change the division of the roles and responsibilities between the federal, state, and local government; whether to have more federal leadership on floodplain management; and whether to increase coordination of federal flood-related actions.

Since Hurricane Katrina, Congress has conducted hearings and considered legislation on numerous aspects of federal flood programs and policies (see **Appendix A** for a list of flood-focused hearings since 1993). In the Water Resources Development Act (WRDA) of 2007 (P.L. 110-114), Congress enacted flood policy provisions aimed largely at improving the planning and safety of levees. Few other changes have been enacted, and the legislation considered has largely addressed individual programs or agencies, rather than attempting a comprehensive realignment of federal flood actions.

Two recent developments may garner congressional attention. In January 2009, the National Committee on Levee Safety (created by WRDA 2007) released its draft recommendations for a national levee safety program. On January 15, 2009, Congress received a report on the Upper Mississippi River Comprehensive Plan (UMRCP) study; the report identifies the costs and benefits of significantly increasing the level of flood damage reduction along the mainstems of the Mississippi and Illinois Rivers. Both developments are discussed later in this CRS report.

Flood Policy in a Federalist System: Shared Responsibilities

In the United States, flood-related roles and responsibilities are shared; local governments are responsible for land use and zoning decisions that shape floodplain and coastal development, but state and federal governments also influence community and individual decisions on managing flood risk. State and local governments largely are responsible for making decisions (e.g., zoning decisions) that allow or prohibit development in flood prone areas. Local and some state entities construct, operate, and maintain most levees and have initial flood-fighting responsibilities. Levees are embankments built alongside a river to prevent high water from flooding bordering land.[3] The federal government constructs some of the nation's levees and dams in partnership with local project sponsors, but turns over operation and maintenance responsibility for most of these levees to local entities. The federal government also supports hazard mitigation, offers flood insurance, and provides emergency response and disaster aid for significant floods.

Federal flood programs and investments consist primarily of:

[3] In this report, the term levees is used broadly to encompass both levees and floodwalls. Levees are broad, earthen structures, while floodwalls are concrete and steel walls, built atop a levee or in lieu of a levee. Floodwalls are often used in urban areas because they require less land than levees.

- Construction investments in select dams, levees, seawalls, and beach improvements;
- Nonstructural hazard mitigation assistance;
- Flood and crop insurance; and
- Disaster preparedness, response, and recovery assistance.

The principal federal agency involved in levee construction and repair is the U.S. Army Corps of Engineers (Corps). (See **Appendix A** for a table of selected congressional direction to guide the Corps' efforts in flood damage reduction.) Other federal agencies also are involved with flood-related activities, such as 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. The Federal Emergency Management Agency (FEMA) has primary responsibilities for federal hazard mitigation, flood insurance, and disaster assistance. FEMA and the Corps require levee inspection and certification for participation in the Corps' Rehabilitation and Inspection Program (RIP, also known as the P.L. 84-99 program, which is discussed on page 11) and FEMA's National Flood Insurance Program (NFIP). Crop insurance is administered by the U.S. Department of Agriculture.

CRS Flood-Related Reports

This report largely leaves the discussion of insurance and disaster assistance to other CRS reports, including:

- CRS Report RL33053, *Federal Stafford Act Disaster Assistance: Presidential Declarations, Eligible Activities, and Funding*, by Keith Bea;
- CRS Report RS22945, *Flood Insurance Requirements for Stafford Act Assistance*, by Edward C. Liu;
- CRS Report R40073, *FEMA Funding for Flood Map Modernization*, by Wayne A. Morrissey.
- CRS Report RL32825, *Hurricanes and Disaster Risk Financing Through Insurance: Challenges and Policy Options*, by Rawle O. King;
- CRS Report RL34207, *Crop Insurance and Disaster Assistance in the 2008 Farm Bill*, by Ralph M. Chite and Dennis A. Shields; and
- CRS Report RS21212, *Agricultural Disaster Assistance*, by Dennis A. Shields and Ralph M. Chite.

Although hazard mitigation is mentioned in this report, discussions of flood risk through hazard management are one focus of the following reports :

- CRS Report RL33129, *Flood Risk Management and Levees: A Federal Primer*, by Betsy A. Cody and Nicole T. Carter; and
- CRS Report RL34537, *FEMA's Pre-Disaster Mitigation Program: Overview and Issues*, by Francis X. McCarthy and Natalie Keegan.

Two other CRS reports discuss additional aspects of issues raised by the 2008 Midwest flood. According to CRS Report RL34610, *Midwest Flooding Disaster: Rethinking Federal Flood Insurance?*, by Rawle O. King, a key lesson learned from the 2008 Midwest flood is that many people believe that the government will provide them with economic assistance despite their lack of insurance. CRS Report RL34583, *Midwest Floods of 2008: Potential Impact on Agriculture*, by Randy Schnepf, addressed the concerns about disruption in agricultural markets.

Limits to Levees and Dams

Hurricanes, other severe weather systems, and rapid snowmelt can cause flooding. Floods are a vital element of variability in the hydraulic regime of healthy riverine, estuarine, and coastal ecosystems; however, they can result in immediate human suffering and economic loss. Failure of levees and dams and inadequate urban drainage also may result in flooding.

Hurricane Katrina focused attention on the performance of levees and floodwalls and the risk remaining behind these structures. There are over 100,000 miles of levees in the nation, only 14,000 miles of these receive regular inspections by the Corps. These levees do not work in isolation from the rest of the watershed. Levees restrict the size of the floodplain which constricts floodwaters to a smaller area, thus raising river crests and often increasing the river's velocity. How land is used can have a dramatic impact on the response of streams to flooding (e.g., tile drains in agricultural areas, impervious areas in urban developments can increase runoff and flood crests). Land use choices can cause 500-year flood levels to be produced by events of lesser magnitude. Some land uses can, therefore, result in levees having to hold back higher flows more frequently.

Generally the Corps no longer refers to levees and dams as "flood control" measures, rather it calls levee projects "flood damage reduction" measures and discusses them in the context of a suite of "flood risk management" actions. This language shift reflects an appreciation of the limitations of these structures. Levees, if constructed properly, should perform up to their design level of protection (i.e., 100-year level of protection is the design to reduce damages from a flood with a 1% probability of occurring in a given year); however, when a flood is greater than that design, the levees are overtopped. Sufficient overtopping often results in levee failure, known as breaching. Similarly, dam are designed to spill floodwaters when their capacity is exceeded.

Although floodwaters overtopped and breached many Midwest levees and a few dams in 1993 and 2008 causing significant economic damage, the dams and levees worked largely as designed.[4] The dams reduced the river crests, and many levees held, thereby preventing floodwaters from damaging many population centers and agricultural and industrial investments. Nonetheless, the potential role of the basin's levees in increasing damages because of their encouragement of risky development and reduction natural flood storage remains debated and part of the active discussion about the future of the basin's floodplains.[5]

The performance of the Midwest levees contrasts to the performance of floodwalls in New Orleans during Hurricane Katrina. Some of the floodwalls protecting urban New Orleans failed before their design level was reached, and the damage was catastrophic. These floodwalls lost their integrity, allowing the water level in the city to rise to the level of surrounding water bodies.

Residual risk is the portion of risk that remains after flood damage reduction structures have been built and other damage-reducing measures have been taken. Risk remains because of the likelihood that levees and dams will be overwhelmed by severe floods and the risk of structural failure. The damaging consequences of floods increase as development occurs behind levees and below dams; ironically, this development may occur because of the flood protection provided.

[4] The Corps performed an after-action report on its emergency response to the 2008 floods, but it did not conduct an engineering analysis to confirm whether the levees performed as designed.

[5] The then-General Accounting Office (renamed the Government Accountability Office, GAO) found that, according to three modeling simulations, the levees in the basin increased the height of water in the 1993 flood. For more information see GAO, *Midwest Flood: Information on the Performance, Effects, and Control of Levees* (GAO/RCED 95-125, Aug. 1995). Hereafter referred to as 1995 GAO Midwest Flood report.

The nation's risk in terms of lives lost, economic disruption, and property damage is increased by overconfidence in the level and reliability of structural flood protection.

The inability of infrastructure to protect against all flooding is fundamental to understanding why some flood risk always remains and to making decisions of how to prioritize flood risk reduction investments. Decision-makers are faced with choosing the level of protection to provide for urban areas, critical infrastructure, rural areas, etc., and making tradeoffs when distributing limited funds across different projects throughout the nation and across the range of flood damage reduction measures (e.g., levees, buyouts, insurance).

2008 Midwest Flood: What Happened and How Does It Compare to 1993?

Intense Precipitation in Tributary Watersheds in June 2008

Intense precipitation in May and early June 2008 led to numerous record and near-record river crests in the Midwest, particularly on Mississippi River tributaries in eastern Iowa and southern Wisconsin. The resultant flooding was localized, but extremely severe.[6] A few streams, particularly in eastern Iowa, had discharges that exceeded record levels for ten or more consecutive days. The 100-year and 500-year flood levels were exceeded in much of eastern Iowa. These exceptional flood levels overtopped levees and flooded areas that many people assumed to be safe.

The most affected tributaries were the Cedar, Des Moines, and Iowa Rivers. Record river stages were set at 47 river gage stations on more than 12 tributary rivers and creeks. In some locations, the new record crests were considerably higher than the previous record crests, including 1993 records. Levees in Des Moines and Cedar Rapids were breached. Two significant examples were the Cedar River at Cedar Rapids (see **Box 1**) and the Iowa River at Columbus Junction and Iowa City.[7] As the floodwaters from these tributaries entered the mainstem of the Mississippi River, they set records at Keithsburg and Gladstone, Illinois and Burlington, Iowa, and approached record stages at other locations.

Box 1. Cedar River Overwhelms Cedar Rapids Levees Causing Extensive Damage

The damage to Cedar Rapids by the 2008 flood was extensive. The river crest rose to more than 31 feet, well above the estimated 500-year flood level and 12 feet above the 1993 crest. The floodwaters easily overwhelmed the city's levees which stood at 22 feet. This crest exceeded the previous record set in the 1850s, when the river reached 20 feet. The flood inundated 9.2 square miles; 1,300 city blocks; 3,894 single family residences; and 818 commercial properties and government buildings. Because the floodwaters reached locations far outside the 100-year floodplain, many homes not covered by NFIP policies were inundated. Up to 400,000 cubic yards of trash and debris were expected to be generated during clean-up, more than the city produces in an entire year.

[6] Precipitation from January to June of 2008 exceeded levels for the same period in 1993. After June the severe precipitation largely subsided for the remaining summer months. In contrast, the major rains in 1993 occurred in June and July, resulting in the most significant flooding occurring in the later summer months.

[7] On the Iowa River, water flowed over the spillway at the Corps' Coralville Reservoir for only the third time since the reservoir began operation in 1958; the other two times were during the Midwest flood of 1993. Unprecedented flooding occurred in Columbus Junction, Iowa City and Coralville. The flood set the record at Columbus Junction at 32.49 feet. Flood stage is 19 feet. The flood's record crest at Iowa City was 31.53 feet. Flood stage is 22 feet. For more information, see the National Weather Service website at http://www.crh.noaa.gov/images/dvn/downloads/fall08.pdf and the U.S. Geological Survey website at http://ia.water.usgs.gov/flood08/.

Source: CRS adapted from Midwest Regional Climate Center, *Midwest Weekly Highlights - June 17-23, 2008*, available at http://mcc.sws.uiuc.edu/cliwatch/0806/080623.htm.

Storms in 2008 Were Quick, Which Caused Primarily Tributary Flooding; Extended Storms in 1993 Inundated the Region

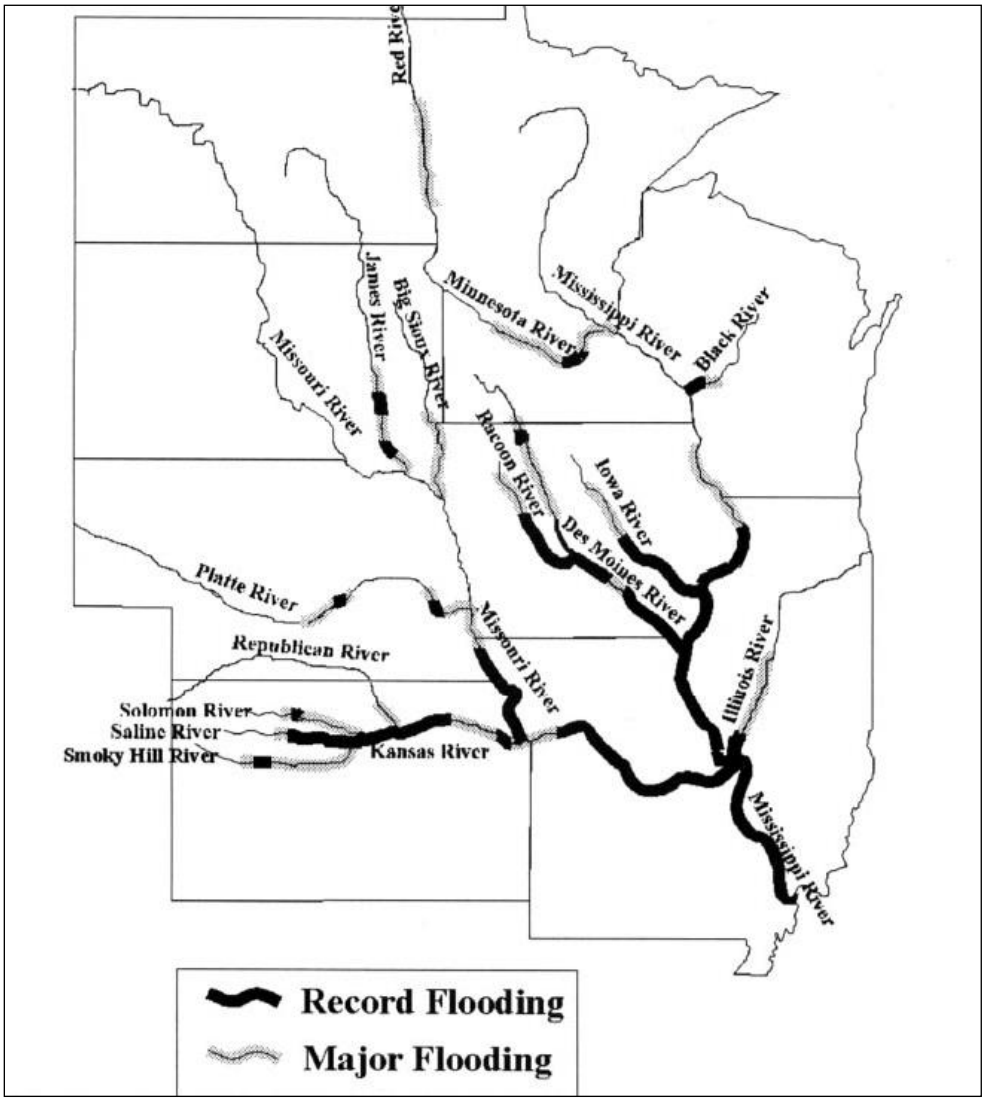
The 1993 flood is sometimes described as a "leisurely" disaster because it resulted not from a single storm but from a weather pattern that remained stationary for months.[8] From May through September of 1993, record or major flooding occurred across North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Wisconsin, and Illinois. The geographic scale of the flood was vast, much larger than the 2008 flood. The four-month duration of the 1993 flooding significantly increased the scale of its consequences.

In 1993, extensive reaches of the mainstems of the Missouri and Mississippi Rivers experienced flooding of extended duration (see **Figure 1**). Lower reaches of the Illinois River and extended reaches of the Kansas, Des Moines, and Iowa Rivers also recorded record flood crests. Approximately 600 river forecast points in the Midwest were above flood stage at the same time. In contrast, the 2008 flooding was shorter and concentrated along select Mississippi River tributaries and nearby segments of the Mississippi River.

The 1993 differs from the 2008 flood in its areal extent, magnitude, duration, volume of floodwater, extent of damage, and time of the year. The rainfall causing the 1993 flood was uncommonly persistent and covered a huge drainage area encompassing most of nine states. This scenario caused many tributaries to crest at about the same time and to synchronize with crests on the mainstem of the Mississippi and Missouri Rivers.

[8] The effects of the 1993 storms were exacerbated by preexisting saturated soils in the basin. The fall of 1992 was wet, saturating soils and raising stream levels. Winter rain and snow contributed to the nearly saturated soil conditions forcing spring precipitation and snowmelt, normally able to soak into the ground, to run off into streams and rivers. Heavy rainfall in late March fed directly into the headwaters of the Mississippi River. With the saturated soils, the precipitation in June, July, and August flowed directly to streams.

Figure 1. 1993 Midwest Flood: Major and Record Flooding on the Mississippi River and Its Tributaries



Source: Interagency Floodplain Management Review Committee, *Sharing the Challenge: Floodplain Management into the 21st Century* (July 1994), available at http://www.floods.org/PDF/Sharing_the_Challenge.pdf.

2008 Flood Damages Were Concentrated in Duration and Extent; 1993 Damages Created a Regional Economic Disaster

Forty-eight deaths and economic damages of $30.2 billion were attributed to the 1993 flood;[9] more than 70,000 homes were damaged.[10] Roughly150 major rivers and tributaries had flooded,

[9] Damage amounts are in normalized 2007 dollars. National Climate Data Center, National Oceanic and Atmospheric Administration, *1980-2009 Billion Dollar U.S. Weather Disasters*, available at http://www.ncdc.noaa.gov/img/reports/billion/disasters2009.pdf. Hereafter referred to as NOAA 1980-2009 Billion Dollar U.S. Weather Disasters.

[10] Corps, *Upper Mississippi River Comprehensive Plan: Final Report June 2008*, available at http://www.mvr.usace.army.mil/PublicAffairsOffice/MidwestFlooding2008/UMRCPFinalReport-17Jun08.pdf.

at least 15 million acres of farmland had been inundated. More than half of the economic losses were agricultural.[11] It is important to note that most agricultural damage resulted from wet fields in upland areas and a short growing season, rather than inundation by floodwaters.

According to a 1995 analysis of Corps records by the then-General Accounting Office (renamed the Government Accountability Office, GAO), many mainstem levees withstood the 1993 floodwaters, preventing both flooding of an additional 1 million acres and an additional $19 billion in damages.[12] Other levees in the basin were overtopped when floodwaters exceeded their design. Four levees that were regularly inspected by the Corps were breached or otherwise allowed water into protected areas before their design capacity was exceeded.

In 1993, transportation impacts were severe and lengthy. Barge traffic on the Missouri and Mississippi Rivers was stopped for nearly 2 months. Bridges were out or not accessible on the Mississippi River from Davenport, Iowa, downstream to St. Louis, Missouri. On the Missouri River, bridges were out from Kansas City, Missouri, downstream to St. Charles, Missouri. Major east-west rail and road transportation routers were severed, causing significant delays and rerouting. Numerous interstate highways and other roads were closed. Ten commercial airports flooded. Much of the railroad traffic in the Midwest was halted. Other public infrastructure, such as sewage treatment and water treatment plants, was damaged or destroyed.

The 2008 floodwaters caused local disaster conditions and significant damages. Property, agricultural, and other damages are estimated at $15.0 billion, and the weather was attributed to 24 deaths.[13] Unlike in 1993, damage in 2008 was from inundation by floodwaters along the rivers, not in saturated upland areas.

The magnitude and severity of the 1993 flood event was overwhelming. Hundreds of levees were breached along the Mississippi and Missouri Rivers; in contrast, dozens of levees were breached in 2008. The levees breached on the Mississippi mainstem in 2008 were primarily lower agricultural levees. In 2008, although some levees overtopped, they worked largely as intended; that is, they held back floodwaters until the floodwaters exceeded the level of protection the levees were expected to provide. Many of these overtopped levees were protecting primarily agricultural areas and provided the anticipated 5- to 25-year protection. Floodwaters overtopping levees protecting larger communities, like Cedar Rapids, resulted in considerable and concentrated damage; these damages contributed to the 2008 damage estimates being half of the 1993 flood damages even though the duration and extent of flooding was less than in 1993.

The lower regional damage estimates in 2008 ($15 billion compared to $30 billion in 1993) fail to capture the challenge of recovery in severely affected communities. The social and economic consequences for families and communities can be extreme, and recovery in severely damaged communities often takes years.

Some roads in eastern Iowa and northwest Illinois sustained severe flood damage in 2008, resulting in closings, delays, and lengthy detours.[14] Major rail lines in Iowa, Wisconsin,

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Hereafter referred to as UMRCP final report.

[11] The flood carried away more than 600 billion tons of top soil and deposited great amounts of sand and silt on valuable farm land. In large areas inundated by the flood, the harvest of 1993 was a total loss. Although most farmers recovered and had good harvests in 1994, some farmers were affected through the 1994 harvest.

[12] Information in this paragraph is from GAO Midwest Flood Aug. 1995 report and UMRCP final report.

[13] Damage amounts are in normalized 2007 dollars. NOAA 1980-2009 Billion Dollar U.S. Weather Disasters.

[14] Flooding forced the closure of I-80, I-380, and US 34. On I-80, flood waters from the Cedar River flowed over the interstate resulting in its closure between mile markers 265 and 267 (between Davenport and Iowa City) from June 6 through the 12th. The official detour route added 115 miles to the normal east-west route across the state. Flooding from

Minnesota, Missouri and Illinois were washed out. Navigation locks 13-25 on the Mississippi River closed, leaving 281 miles of the river closed to barge traffic. In June, the flooding was predicted to have major impacts on agriculture. CRS Report RL34583, *Midwest Floods of 2008: Potential Impact on Agriculture*, found that anticipated crop losses contributed to agricultural prices for corn and soybeans hitting record highs in late June and early July. After that, however, most of the "Corn Belt" experienced nearly ideal growing conditions resulting in substantial crop recovery and lower market prices. Therefore, although the floodwaters caused transportation and agricultural disruptions, they largely were resolved and repairs were underway once the localized flooding diminished.

Lessons from the 2008 Midwest Flood

Post-1993 Investments Paid Off, but More Development at Risk

Is the Midwest more or less at risk of floods now than in 1993? Some communities in the Midwest are less at risk than in 1993 due to buyouts, relocation, and floodproofing (i.e., adjustments to structures that reduce or eliminate flood damage) of vulnerable properties. Relocation of key public infrastructure such as drinking water facilities reduced the consequences of flooding. The general sense is that flood risk reduction in the Mississippi River basin since 1993 paid off in 2008.[15] However, the basin's aggregate flood risk appears to be increasing.

After the 1993 flood, the GAO found that not only had man-made changes within the basin over many decades raised the levels of floodwaters in the basin's rivers, but also the precipitation trend in the basin appeared to be increasing over the long term.[16] Congress reacted to the 1993 flood by enacting a number of policy and program changes. It authorized using a portion of federal disaster assistance to cover 75% of the cost to acquire, relocate or elevate flood-prone homes and businesses; prior to the change, the federal cost share had been 50%. Buyouts of at-risk properties using FEMA disaster mitigation funds were more extensive for the 1993 flood than for previous disasters. In the nine states that flooded, FEMA ultimately moved more than 300 homes, and bought and demolished nearly 12,000 at a cost of over $150 million. The lands were turned to flood-friendlier uses such as parks and wildlife habitat. State and federal agencies have also acquired interest in over 250,000 acres of flood-prone land, principally frequently flooded farmland. Another 9,140 properties in 140 communities were elevated, acquired or relocated under hazard mitigation grants. Taken together, these actions signaled a dramatic departure from historic flood policies, which relied primarily on levees and dams.

Significant redevelopment and new development has occurred in Midwest floodplains since 1993, including areas flooded in 1993. The population in the 500-year floodplain has increased by 17%; the population in the area flooded in 1993 has increased by 18%.[17] There also has been significant new commercial and industrial development and highway and interchange development within the 500-year floodplain.[18] New development in the 100-year floodplain would be required to meet

Coralville Reservoir resulted in the closure of I-380 between Iowa City and Cedar Rapids; the detour route added 272 miles to the normal route.

[15] Upper Mississippi River Basin Association, *Position of the Upper Mississippi River Basin Association on Flood Response and Recovery in the Wake of the 2008 Flooding: An Update to UMRBA's 1993 Flood Statement*, (St. Paul: Sep. 2008), available at http://www.umrba.org/publications/fp/flood9-17-08.htm.

[16] 1995 GAO Midwest Flood report.

[17] J. D. Hipple et al., "Development in the Upper Mississippi Basin: 10 years after the Great Flood of 1993 " *Landscape and Urban Planning* (72, 2005, pp.313-323).

[18] Ibid.

floodplain development regulations if the community participates in the NFIP. Therefore, this development ought to be more flood resilient than before. Development or redevelopment, however, may not be more flood resilient if built behind levees that are certified to provide 100-year protection or if the community does not participate in the NFIP. Therefore, risk from the 100-year flood in the NFIP-participating communities in the Midwest may have decreased since 1993, but the risk in these communities to more intense floods may have increased. Moreover, risk in the 500-year floodplain has increased substantially due to development.

Better Forecasting Data Needed to Improve Emergency Response

Rainfall and streamflow data are fundamental to coordinating and managing emergency flood response activities. In 2008, several Mississippi River tributaries rose quickly. At the most severely affected locations, rivers rose at a rate of one foot per hour. River crests on some tributaries eventually exceeded their river gauges ability to record. Limited river gauging information constrained the National Weather Service and others in developing timely and accurate river stage forecasts.

In October 2008, the Corps convened a Rainfall-River Forecast Summit of representatives of the Corps, the National Weather Service, and the USGS; the summit also included a public meeting.[19] Federal summit participants concluded that significantly more rainfall fell than was predicted resulting in record river flood stages that were not forecast with sufficient lead time for appropriate emergency response preparations. Although the coordination and data exchange generally went well, according to summit participants, discrepancies of reported data created forecasting challenges and raised doubts of forecast reliability. River gauges swept away by the floodwaters resulted in data gaps during critical periods. As a result, some river forecasts were inaccurate. Better coordination, communication, and collaboration, as well as more and better data measurements, were recommended by the summit participants.

Gains in Managing Levee Repairs, but Levee Deficiencies and Improvements Remain Challenges

During the 2008 flood, a total of 41 levees overtopped. Of these, only six were constructed by the Corps; these had been turned over to a local entity for maintenance. Another 19 of the 41 were constructed by local entities but met participation requirements for the Corps' Rehabilitation and Inspection Program, which assists with repairs.[20] The other 16 overtopped levees were built and operated by local entities and had not met RIP participation requirements.[21] Their repair is not

[19] Information in this paragraph is from "U.S. Geological Survey—Rainfall-River Forecast Summit" in *Interagency Task Force, Raising the Standard*, Oct./Nov. 2008 newsletter, available at http://www.iwr.usace.army.mil/ILTF/docs/ILTF_Newsletter_OctNov_08.pdf.

[20] Testimony by Brigadier General Michael J. Walsh, Army Corps of Engineers Mississippi Valley Division Commander, Senate Environment and Public Works Committee hearing on the Midwest Flood of 2008, July 23, 2008.

[21] RIP is a Corps program that serves three main functions. It provides for inspections of flood-related works (including levees and flood control dams); and it provides assistance to repair these works if damaged by a flood or other damaging events (e.g., earthquake). The program also rehabilitates federally authorized and constructed hurricane or shore protection projects (including beach nourishment) damaged by an extraordinary storm (i.e., a storm that, due to length or severity, causes significant damage to a project). Rehabilitation generally is cost shared at 80% federal and 20% nonfederal. The Corps' Chief of Engineers, when requested by the nonfederal sponsor, is authorized to implement nonstructural alternatives to repair; the Corps may bear up to 100% of these costs, subject to limitations. RIP assistance is limited to restoration to pre-disaster conditions and level of protection. Only flood works and hurricane/storm projects that are active in the program at the time of the damaging event are eligible for assistance. RIP participation requirements include that the levee have a public sponsor and be deemed through regular inspections to be properly

eligible for federal assistance through RIP, but may be eligible for some other federal assistance through the Natural Resources Conservation Service for levees in small watersheds or FEMA, particularly if there is an immediate threat to life and property.

Repairing levees following the 2008 floods has illustrated some improvements since 1993, as well as continuing issues with repair and maintenance. Reducing flood risk to conditions prior to the damaging event can be complicated by choices about whether and how to repair damaged levees and the availability of assistance from various federal agencies. At the same time these choices represent opportunities to consider alternative methods of managing flood risk.

In 2008 coordination of near-term alternatives for levee repair showed improvement over 1993. The Corps is leading a regional Interagency Levee Task Force for the 2008 Midwest flood. This type of task force has not been used extensively before. The basis for its use is a February 1997 guidance memo issued by the Office of Management and Budget and the Council on Environmental Quality. The memo was published as part of the Clinton Administration's efforts to improve flood and floodplain management policy after the 1993 floods. The memo instructed federal agencies to "fully consider relevant options, including non-structural alternatives, during evaluation and review of levee repair and reconstruction projects…".[22]

The 2008 Midwest Interagency Levee Task Force was established to assist in the rapid and effective recovery of floodplain management systems in the affected communities and areas before the next flood season. The task force is charged with implementing a collaborative and integrated regional approach by the federal agencies to the long-term restoration of damaged floodplain management systems. Its use is viewed by floodplain management advocates as promising because it is not only looking at rebuilding levees but also considering long-term mitigation and recovery.

A common issue that arises following a flood is local interest in not only repairing levees but improving the level of protection provided. Rehabilitation and Inspection Program funds are expressly restricted to repairing and cannot be used to increase protection. The RIP program is not designed to evaluate the federal interest in investments to further reduce the local flood risk. If federal participation is sought in increasing protection, the traditional process is to initiate a Corps flood damage reduction study. This is separate from repair work.

Interest in increasing the resiliency of levees and their level of protection has become more salient since the 2005 hurricane season. Since 2005, the levee inspection and certification programs used by the Corps for the Rehabilitation and Inspection Program and FEMA for the NFIP have been strengthened to address weaknesses identified in the programs. Consequently, significant numbers of levees have been identified as deficient since 2005. If the deficiencies are not addressed, the levee may not be eligible for federal repair assistance if damaged by a flood, and NFIP floodplain requirements may go into effect (e.g., areas behind the levee may be required to purchase flood insurance). The local entities that own and maintain the levees are responsible for making the improvements necessary to pass inspection and obtain certification. Generally federal funds are not available for these rehabilitations which are considered part of the local responsibility for levee upkeep. Additionally NFIP hazard map modernization and policy

constructed and maintained. Another participation criterion for levees and floodwalls constructed is provision of at least a 10-year protection for urban areas or a year level of protection for agricultural areas.

[22] The memo is available at http://www.iwr.usace.army.mil/ILTF/docs/OMB%20CEQ%20Directive.pdf.

changes have improved the understanding of current risks, resulting in some areas receiving higher risk designations and having stricter NFIP requirements apply.[23]

No Comprehensive Midwest Flood Management Strategy in Place

The dams and levees of the Upper Mississippi River System were largely constructed as separate projects, not in accordance with a basin flood damage reduction plan. The existing facilities have varying structural integrity, and provide varying levels of flood risk reduction for similar land uses.[24] The levels of protection range from less than 5 years up to 500 years, with three-quarters of the urban systems designed to manage a 500-year flood. Land use and flood management changes (e.g., levee building that constricts the flow of floodwaters to within the levee banks, or channel straightening that increases the velocity of floodwaters) in upstream areas can alter flood risk in downstream areas. Whether and how to integrate Midwest flood management and related infrastructure was an issue after the 1993 flood. Nonetheless, responsibilities for flood programs in the basin remains largely unchanged (i.e., distributed among local, state, and federal entities).

Like many other basins, no broad planning authority has guided the Upper Mississippi basin's water resource management since the termination of the Upper Mississippi River Basin Commission (UMRBC) at the end of 1981, which had been established in 1972.[25] The UMRBC was a regional entity for comprehensive planning that integrated federal-state-local planning with public input. The UMRBC prepared a comprehensive master plan for management of the upper Mississippi River system's water and related-land resources. The Commission's termination complicated implementation of the master plan. The interstate Upper Mississippi River Basin Association (UMRBA), which was founded in 1981 remains in operation; its role largely has been limited to a policy research and coordination forum for the basin states. Because the UMRBA is a state initiative, unlike the UMRBC, the federal government has no voice.

The long-standing Mississippi River Commission has authority for river improvements from the Mississippi River's delta to the headwaters.[26] The Commission provides water resources engineering direction and policy advice to the Administration, Congress, and the Army by overseeing the planning and reporting on river improvements. Unlike in the lower basin, the Commission currently does not have the funded authority to implement improvement plans in the upper Mississippi River. In 1997, the Commission initiated a process of listening, inspecting, and partnering in the upper basin, but has not pursued significant steps to increase its upper basin role.

Upper Mississippi Flood Management

Post-1993 Flood Proposals and Recommendations

The 1993 flooding engendered some congressional interest in a systemic approach to flood damage reduction on the upper basin. Following the 1993 flood, numerous reports were produced

[23] For more information , see CRS Report R40073, *FEMA Funding for Flood Map Modernization*, by Wayne A. Morrissey.

[24] Some concerns also have been raised about the aging of these works. Many levees were privately built between 1880 and 1920, then later upgraded. On average, the last major upgrades occurred nearly 50 years ago.

[25] In the early 1980s, President Reagan dissolved most large-scale river basin commissions. The commissions had received mixed reviews. They raised state concerns about federal planning that could influence water supply allocation, which historically has been deferred to the states. Some water resource stakeholders have argued that the dissolution of the commissions has resulted in a planning gap for basin-scale integrated water and related-land resource management.

[26] The Commission's statutory authority is the 1879 Mississippi River Commission Act (Chap. 42, 21 Stat. 37 (1879)).

recommending changes to various aspects of how floods are managed in the United States and the Midwest in particular. The most prominent of these reports was the July 1994, *Sharing the Challenge: Floodplain Management into the 21st Century*, by the Interagency Floodplain Management Review Committee, often called the Galloway report after the Committee's chairman, Brigadier General Gerald Galloway.[27] **Box 2** briefly describes the report's recommendations for the Upper Mississippi River and a general floodplain management strategy.

In August 1994, S. 2418 (103rd Congress) was introduced. It would have acted on many of the report's recommendations. If enacted, it would have represented a significant shift in flood and floodplain management for the Midwest. The legislation would have required development of comprehensive river basin management plans for the long-term ecological, economic, and flood management needs of the Upper Mississippi and the Missouri Rivers and established federal-state coordinating committees to review and recommend the basin plans. The bill also included numerous other broad water resources policy provisions that would have emphasized nonstructural measures for risk reduction. This legislation was not enacted.

Box 2. Recommendations for a Comprehensive Upper Mississippi Strategy from a Report on the 1993 Flood

The 1994 Galloway report recommended a floodplain management strategy that sequentially supported:

- avoiding inappropriate use of the floodplain,
- minimizing vulnerability to damage through both structural and nonstructural means, and
- mitigating flood damages when they do occur.

It also included a recommendation to reduce the vulnerability of population centers to roughly the 500-year flood. For the Upper Mississippi basin specifically, the report's recommendations included:

- establishing upper Mississippi River and Missouri River basin commissions with a charge to coordinate development and maintenance of comprehensive water resources management plans to include, among other purposes, ecosystem management, flood damage reduction, and navigation; and
- expanding the mission of the Mississippi River Commission to include the Upper Mississippi and Missouri rivers (to recognize ecosystem management as a co-equal federal interest with flood damage reduction and navigation, commission membership should be expanded to include the Department of the Interior); and
- assigning responsibility for development of an Upper Mississippi River and Tributaries system plan and for a major maintenance and major rehabilitation program for federally related levees (including those participating in RIP) to an expanded Mississippi River Commission, operating under the Corps.

Upper Mississippi River Comprehensive Plan

It was not until the Water Resources Development Act of 1999 (P.L. 106-53) that a new flood management study for the upper Mississippi River basin was authorized. In Sec. 459 of WRDA 1999, Congress authorized the Upper Mississippi River Comprehensive Plan (UMRCP). It directed the Secretary of the Army to "develop a plan to address water resource and related land resource problems and opportunities in the upper Mississippi and Illinois River basins, from Cairo, Illinois, to the headwaters of the Mississippi River, in the interest of systemic flood damage reduction….". The Corps chose not to perform a comprehensive watershed analysis encompassing the entire upper Mississippi River basin and its tributaries, citing fiscal and time constraints. Instead, it limited the study to the mainstem Mississippi River and Illinois River

[27] Hereafter referred to as 1994 Galloway report, available at http://www.floods.org/PDF/Sharing_the_Challenge.pdf.

floodplain. The Missouri River and smaller tributaries, such as the Cedar River and Iowa River, were excluded. This scope left out the majority of the areas most severely affected in 2008.

The UMRCP final report, dated June 2008, was transmitted to Congress on January 15, 2009.[28] Congress must decide how to proceed given the analysis presented in the report. The UMRCP was conducted as a preliminary study, similar to the level of detail in a Corps reconnaissance study. The UMRCP final report and supporting documents are not at the level of detail of a feasibility study, which typically informs decision-making on construction authorization.

The report states "additional authority to implement the Comprehensive Plan is not being recommended nor requested at this time based upon the [national economic development] evaluation of alternative plans." Although the report does not recommend proceeding with additional authority to implement the comprehensive plan, the report identified the Corps' preferred alternative; it would provide 500-year protection at a total cost $4.42 billion.

The Assistant Secretary of the Army (Civil Works) in his January 2009 transmittal letter to Congress also did not recommend proceeding with implementation; the letter stated that "recommendations for implementation of a specific plan based on a reconnaissance level of detail is premature."[29] Instead the Assistant Secretary recommended some intermediate steps ─ expanding the UMRCP to include Mississippi River tributaries, conducting cost-shared studies of the reconstruction needs for the basin's existing flood damage infrastructure (where a federal interest is identified), and conducting a study of flood protection for critical transportation infrastructure such as bridge approaches and railroads.

Earlier in August 2008, the Mississippi River Commission in its planning oversight and policy advice role voted to support implementing the preferred alternative.[30] The Commission believed that the full benefits of implementing the preferred alternative were not adequately measured with the current Corps project planning guidelines.[31] Also in 2008, the then-Governor of Illinois and the then-Governor of Missouri wrote letters of support for a comprehensive plan; these letters, however, supported an alternative that was studied but not the preferred alternative.

Congress is faced with deciding how to proceed given the differing recommendations of the Corps report and the Assistant Secretary of the Army, Mississippi River Commission, two state governors, and the many stakeholder viewpoints in the basin. For example, some stakeholders prefer emphasizing nonstructural measures to manage flood hazards, and others are concerned about tributary flood risk. **Appendix B** provides an analysis of the UMRCP final report and its limitation, the preferred alternative identified in the report, various stakeholders recommendations on how to proceed, the debate over the future of the Midwest flood and floodplain management, and the potential state and federal roles.

[28] UMRCP final report available at http://www.mvr.usace.army.mil/PublicAffairsOffice/MidwestFlooding2008/UMRCPFinalReport-17Jun08.pdf.

[29] Ibid.

[30] The Mississippi River Commission press release is available at http://www.mvd.usace.army.mil/offices/pa/releases/2008/RelMRC0801.pdf. Half of the Commission's members are Corps officers.

[31] Letter to Hon. James M. Inhofe, Ranking Member Committee on Environment and Public Works, from Assistant Secretary of the Army (Civil Works) John Paul Woodley, Jr., transmitting the UMRPC final report, Jan. 15, 2009.

Federal Flood Policy Since 1993: Tough Challenges Remain

Unfinished Business on Many Post-1993 Recommendations

Although Congress did take numerous actions after the 1993 flood to improve flood policy and programs, numerous recommendations in the Galloway report have not been implemented, including:

- Enact a national Floodplain Management Act to define government responsibilities, strengthen federal-state coordination and improve accountability. It should establish a national model for floodplain management that recognizes the states as the principal floodplain managers.
- Reactivate the Water Resources Council to coordinate federal-state-tribal water resources activities.
- Reestablish a river basin commission, as needed, as forum for coordination of regional issues.
- Issue a new Executive Order to reaffirm the federal government's commitment to floodplain management with a broader scope and more defined federal agency responsibilities than in the existing floodplain E.O. 11988.
- Limit public grant assistance available to communities not participating in the NFIP.
- Provide loans for the upgrade of infrastructure and public facilities.
- Reduce the vulnerability of population centers to damages from roughly the standard project flood (which is roughly the 500-year flood).

Many of the actions that were taken were among the narrower recommendations of the Galloway report, such as increasing the waiting period for flood insurance policies to become active.

Flood and Floodplain Management Policy

Over the years, many commissions and reports, like the Galloway report, have called for a fundamental reorientation in national flood policy that addresses not only the economic but also the social and environmental welfare tradeoffs of floodplain development.[32] These commissions and reports have urged Congress, relevant agencies, and the public to commit to the broad goal of reducing the dangers and damages via flood and floodplain management, rather than allowing development that could be located elsewhere to occur in flood-prone areas. Despite these recommendations, a fundamental reorientation for floodplain management has not occurred.

Although federal efforts have not been guided by a clearly defined flood policy or floodplain vision, many incremental changes to improve flood programs and projects have been enacted or adopted at all levels of government. These actions include supporting nonstructural flood damage reduction, retiring flood-prone farmland, purchasing repetitive flood loss properties, augmenting

[32] National Water Commission, *Water Policies for the Future: Final Report to the President and to the Congress of the United States* (Washington: GPO, 1973); Interagency Task Force on Floodplain Management, *A Unified National Program for Floodplain Management* (FEMA, March 1996), available at http://www.fema.gov/hazard/flood/pubs/lib100.shtm.

hazard mitigation activities, fostering floodplain regulation, and guiding federal actions in floodplains.

Notwithstanding these changes, the nation's flood risk is increasing. Many of these changes have seen only marginal implementation, enforcement, and funding. The incremental improvements largely have been overwhelmed by incentives to develop floodplains and coastal areas and by a growing population, or have never fully implemented or enforced. Other federal actions produce some indirect flood risk reduction benefits; for example, Congress has supported conservation efforts on agricultural lands and wetlands protection that may reduce flood damages by slowing down or temporarily storing flood waters. Whether these benefits are overwhelmed by changes in flood-prone land use (e.g., conversion of agricultural land behind levees to residential development) remains largely unknown because regional-scale and multi-agency plans and evaluations have been rare.

Generally, congressional oversight, administrative implementation, and federal appropriations have reflected a reactive and fragmented approach to flooding. Earlier institutional arrangements that provided avenues for more coordinated federal flood efforts have diminished. For example, the national-level Water Resources Council which was established by the Water Resources Planning Act (P.L. 89-80), disbanded in 1983; the Federal Interagency Task Force on Floodplain Management, which had continued some of the Water Resources Council flood-related functions after 1983, stopped convening in the late 1990s. Federal support and opportunities for local capacity building decreased with the loss of these institutions.

Flood policy continues to be dominated by separate treatment of structural flood damage reduction investments (e.g., levee building), the NFIP, and federal disaster aid, rather than a comprehensive flood risk and floodplain management approach. Current arrangements of aid, insurance, and water resources projects at times unintentionally provide disincentives to reduce exposure to flood risks. This is in contrast to recommendations promoting a focused and coordinated effort to reduce the cost of flooding on the economy, improve public safety, and promote state and local capacity and responsibility for flood management.

Federal Flood Insurance and Mapping

In 1968, Congress created the National Flood Insurance Program as an alternative to disaster assistance and to manage the escalating cost of repairing flood damage to buildings and their contents. Under the NFIP, the federal government identifies and maps areas subject to flooding, provides insurance to property owners in flood-prone areas, and offers incentives for communities to reduce future flood-related losses through floodplain management measures. Since 1973, homeowners in 100-year flood-prone areas are required to buy flood insurance if using a federally backed mortgage. Today, the NFIP provides flood insurance to more than 5 million homeowners, renters, and business owners in over 20,000 participating communities.

A significant policy reaction to the 1993 flood was passage of the National Flood Insurance Reform Act of 1994.[33] The flooding revealed that most flooded homeowners did not have flood insurance. And mortgage lenders had been lax in checking if federally backed mortgages were being granted in flood-prone areas, as required by NFIP. The 1994 legislation aimed to improve compliance with NFIP's mandatory flood insurance requirement, and to pressure lenders to ensure that at-risk owners in a flood zone purchase insurance. The legislation also:

[33] Information in this paragraph is drawn from G. Bucco, *Lessons Learned* available at http://www.dnr.state.ne.us/floodplain/PDF_Files/Lessons.pdf.

- Created the Increased Cost of Compliance program within the NFIP. This program gives money to insured owners of substantially damaged properties to meet the more expensive costs of rebuilding according to a local floodplain management ordinance.
- Created the Flood Mitigation Assistance program. This program funding is derived from a surcharge added to all flood insurance policies nationwide. The funds are distributed as grants to states for flood mitigation.
- Increased emphasis on floodplain mapping.
- Codified the Community Rating System (CRS) into the NFIP. The CRS is an incentive program to reduce communities' flood insurance premiums by exceeding the minimum flood risk reduction requirements of the NFIP.

After the 1993 floods, Congress authorized FEMA to use a portion of federal disaster assistance to cover 75% of the cost to acquire, relocate or elevate homes and businesses; set aside flood insurance premiums to relocate flood-prone buildings; and tighten flood insurance purchase requirements.[34] These actions signaled a shift toward hazard reduction away from reliance on levees and dams. Nonetheless, the potential consequences of floods are increasing as more people and investments are located in flood-prone areas.

Some of the more significant changes in flood-related policy have consisted of efforts to improve the NFIP (e.g., improvements to increase participation in the program and better manage repetitive loss properties) and reorganization of federal emergency response and recovery following the 9/11 attacks and Hurricane Katrina's impact on New Orleans. Considerable concerns continue to be raised about the degree of subsidization under the NFIP and the financial foundation of the program. Numerous GAO studies have reviewed various aspects of the NFIP; some recommendations have been implemented. In 2006, an independent review working group released its evaluation of the NFIP; the recommendations are among other changes that have been considered, but not enacted. Reorganization of emergency response, in particular the placement of FEMA within the Department of Homeland Security, remains a topic of much debate.

Flood Map Accuracy

As part of the NFIP, FEMA has implemented a standardized flood mapping program covering a large fraction of the population at risk. Government agencies use these maps to establish zoning and building standards and to support transportation, infrastructure, and emergency planning. Insurance companies, lenders, realtors, and property owners use maps to determine flood insurance needs and to assess their flood risk.

In January 2009, the National Research Council released *Mapping the Zone: Improving Flood Map Accuracy*. The report calls for investments in improving the accuracy of NFIP maps. It cites maps as central to anticipating, preparing for, and insuring against flooding. It found that current maps have significant uncertainties and do not necessarily represent current floodplain conditions. The Council concluded that these investments are needed and economically justified despite recent investments. From 2003 to 2008 at a cost of more than $1 billion, FEMA and local and state partners collected new flood data in unmapped areas, updated existing data, and digitized flood maps that were previously on paper. The Council found that although 92% of the

[34] Information in this paragraph is from Environmental Defense Fund, *Flood Loss Reduction White Paper*, available at http://www.edf.org/documents/594_FloodPolicy.pdf.

continental U.S. population now has digital flood maps, only 21% has maps fully satisfying FEMA's data quality standards.

To remain accurate, flood maps must require updating to reflect changes in the flood threat (e.g., changes in sea level or precipitation patterns) and land use changes that affect flood risk. Future conditions (e.g., anticipated sea level rise, changes in hydrology due to land use changes) currently are not considered in developing NFIP maps.

Trends Affecting Flood Risk

Climate, Demographic, and Development Trends

Growth in total damage from floods in the United States since the early 1930s can be attributed to both climate factors and societal factors: that is, increased damage associated with increased precipitation and with growth in population and wealth.[35] Much of the flood-related damage in recent decades is the result of numerous human choices, meaning that society has considerable potential to reduce flood risk. Without major changes in societal responses to weather and climate extremes, it is reasonable to predict ever-increasing losses even without any detrimental climate changes.[36] As the former General Counsel of FEMA put it:

> The challenge is that more and more development is taking place in flood prone and hurricane prone areas. People like to live near the seashore. But unless the actual cost of living by the water is reflected in the cost of ownership ─ including the cost of building property to resist wind damage, elevating out of floodplains, and insuring at actuarial rates for the cost of rebuilding after inevitable floods and hurricanes ─ the result will only be more development in more risk prone areas …[37]

Climate and population trends are combining in coastal areas so that flood risks of coastal storms exceed river flooding risks. The top eleven amounts paid for NFIP claims were for coastal storms (including Hurricane Ike). The 1993 Midwest flood ranks twelfth, and the 2008 Midwest flood is not in the top 20 NFIP events.

Coastal Vulnerability

Damage caused by Hurricane Katrina and other coastal storms illustrates the vulnerability of the nation's coastal developments to storm surge, flooding, erosion, and other hazards. Hurricane-prone states have increasingly dominated NFIP outlays and disaster losses. The risk facing the nation's coastal development, particularly barrier islands and other particularly vulnerable locations, is great regardless of whether climate change may alter the intensity and frequency of hurricanes. Severe storms and their surges have plagued coastal communities for centuries, costing thousands of lives, and damaging communities, businesses, and infrastructure.

Since the mid-1960s, the federal role in coastal hurricane storm protection has become more prominent; the Corps, with nonfederal sponsors, builds structures and places sand periodically for beach renourishment to reduce flooding. Congress also has enacted laws aimed at protecting

[35] R.A. Pielke, Jr. and M.W. Downton, "Precipitation and Damaging Floods: Trends in the United States, 1932-1997" in *Journal of Climate* (Oct. 2000, Vol. 13, 20, pp. 3625-3637).

[36] For a discussion of this finding for weather hazards, see S.A. Changnon, "*Human Factors Explain the Increases Losses from Weather and Climate Extremes*" in Bulletin of the American Meteorological Society (Vol. 18, 3, Mar. 2000, pp. 437-442).

[37] E. B. Abbott, Floods, "Flood Insurance, Litigation, Politics—and Catastrophe: The National Flood Insurance Program," *Sea Grant Law and Policy Journal* (Vol. 1, 1, Jun. 2008, pp. 129-155).

coastal resources that have some flood risk reduction benefits. Through reauthorizations and amendments to the Coastal Zone Management Act of 1972 (P.L. 92-532) and the Coastal Barrier Resources Act of 1982 (P.L. 97-348), Congress has tried to improve federal actions that support coastal resource protection.[38] With the passage of the Coastal Zone Management Act in 1972, Congress was responding primarily to widespread public concern about estuarine and oceanfront degradation; the act provides for federal assistance to state and local coastal zone. The Coastal Barrier Resources Act prohibits federal spending that would support additional development in designated relatively-undeveloped coastal barriers and adjacent areas. Notwithstanding these efforts, both increasing coastal populations and the dominance of NFIP claims and federal disaster aid to coastal states indicate that significant coastal flood risk remains.

Recent Congressional Steps to Address the Flood Challenge

The 2008 Midwest flood, Hurricane Katrina, and other levee breaches have increased the congressional debate about how to manage flood and infrastructure risks, what is an acceptable level of risk—especially for low-probability, high-consequence events—and who should bear the costs to reduce flood risk (particularly in the case of levee construction and rehabilitation). Issues to be addressed include protecting concentrated urban populations, reducing risk to the nation's public and private economic infrastructure, reducing vulnerability by investing in natural buffers, and equity in protection for low-income and minority populations. A challenge for Congress is structuring federal actions and programs so they provide incentives to reduce flood risk without unduly infringing on private property rights or usurping local decision making. Tackling this challenge would require significant adjustments in the flood insurance program, disaster aid policies and practices, and programs for structural and nonstructural measures and actions.

Steps Toward a Flood Policy Reorientation

Since Hurricane Katrina, Congress has conducted hearings (see **Appendix A**)and considered legislation on numerous aspects of federal flood programs and policies. Actions by many federal agencies shape the nation's flood risk management.[39] Legislative efforts since 2005 have largely proceeded by addressing individual programs or agencies, rather than through a comprehensive attempt to reorient flood policy. For example, in the 110th Congress, both the House and Senate passed a Flood Insurance Reform and Modernization Act (H.R. 3121 and S. 2284) aimed at changing the NFIP and FEMA's programs; this legislation was not enacted. The Water Resources Development Act of 2007 enacted numerous provisions related to Corps flood projects and

[38] For more information on federal coastal zone management efforts, see CRS Report RL34339, *Coastal Zone Management: Background and Reauthorization Issues*, by Harold F. Upton. In the early 1970s, Congress also considered general national land use planning legislation to foster state (and local) planning capacity and coordination; bills were reported by Senate committees in 1970 and 1972 and passed the Senate in 1972 (S. 632 in the 92nd Congress), but were not enacted. Many in Congress concluded that the challenges that national land use planning legislation was intended to address were most concentrated in coastal areas and needed immediate attention. The result was the enactment of the Coastal Zone Management Act with a promise by some congressional leaders to continue to pursue national land use legislation. These leaders stated that they intended to fold coastal management into this more encompassing legislation at a later date. Comprehensive land use planning legislation was never enacted, and Congress has not ventured beyond the CZMA with this approach to resource planning and management.

[39] Some changes come about by agency action without congressional direction. For example, the Corps established the National Flood Risk Management Program in May 2006 for the purpose of integrating its flood risk management programs and activities, both internally and with counterpart activities of the Department of Homeland Security, FEMA, other Federal agencies, state organizations and regional and local agencies.

programs. While implementation of WRDA 2007 provisions may shift the Corps' flood-related actions, few other changes to federal programs have been enacted.

In WRDA 2007, Section 2032 calls for the Administration to prepare a report by the end of 2009 describing flood risk and comparing regional risks. The report also is to assess the effectiveness of flood efforts and programs, analyze whether programs encourage development in flood-prone areas, and provide recommendations. The report's preparation, however, is delayed; the Corps has not received appropriations to prepare it.

Another provision in §2031 requires Corps feasibility studies to calculate a proposed flood damage reduction project's residual risk of flooding, loss of human life, and human safety. The benefit-cost calculations of the study also must include upstream and downstream impacts and give equitable consideration to structural and nonstructural alternatives.

Section 2031 of WRDA 2007 also called for the Secretary of the Army to update water resources planning guidance; the update would affect how Corps flood damage reduction projects are planned, evaluated, and selected. Sec. 2031 also stated:

> NATIONAL WATER RESOURCES PLANNING POLICY.—It is the policy of the United States that all water resources projects should reflect national priorities, encourage economic development, and protect the environment by—
> (1) seeking to maximize sustainable economic development;
> (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and
> (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

How this planning update and implementation of this policy statement may alter flood damage reduction and other water resources planning by federal agencies remains unknown.

Levee Reliability

Hurricane Katrina also brought national attention to the issue of levee and floodwall reliability and different levels of protection provided by flood damage reduction structures. Floodwall failures contributed to roughly half of the flood damages in New Orleans. A large percentage of locally built levees are poorly designed and maintained.

Section 9004 of WRDA 2007 required the Corps by 2009 to establish and maintain a national levee database. The database structure was completed; the process of populating the database with information on levees is ongoing. Section 9004 also requires the Corps to establish an inventory and inspect all federally owned and federally constructed levees. The provision also requires the Corps to establish an inventory of levees participating in the Corps' Repair and Inspection Program; the Corps may inspect these levees if requested by the owner. The Corps has completed an initial survey identifying 14,000 miles of Corps-owned, Corps-constructed, and RIP participating levees.

No federal program specifically regulates the design, placement, construction, or maintenance of nonfederal levees built by private individuals or by public entities such as levee districts. Section 9003 of WRDA 2007 created a National Committee on Levee Safety to make recommendations to Congress for a national levee safety program. WRDA 2007 also requires Corps planning to consider the risk that remains behind levees and floodwalls, evaluate upstream and downstream impacts, and equitably analyze structural and nonstructural alternatives. This provision put in statute requirements similar to direction in agency planning guidance.

How WRDA 2007 provisions and previous congressional direction (see **Appendix A**) are implemented and enforced, and whether the recommendations by the National Committee on Levee Safety (see **Box 3**) are pursued, may influence the nature of federal and local levee investments. However, levees represent only a portion of the nation's efforts at flood risk management.

Reducing Flood Risk

Recommendations for how to improve flood policy abound. **Figure 2** illustrates how different tools can combine to lower risk, but that some risk will always remain. Often following a significant flood or hurricane, changes are made to implement some tools and improve existing programs, but other tools and changes are not pursued. A comprehensive strategy to realign floodplain management would confront many challenges and require dramatic changes in how local, state, and federal government agencies and programs operate. One proposal for a national strategy was the 1986 Unified National Program for Floodplain Management by the Interagency Task Force on Floodplain Management. It laid out a four-part strategy for a balanced approach to floodplain management (see **Box 4**). Implementing the risk reduction tools in this strategy would realign government programs to reward behaviors that decrease flood risk. Use of these tools also would represent a policy choice to shift more of the long-term costs of staying or locating in flood-prone areas from the federal government to local communities and individuals.

Box 3. Selected Recommendations in the 2009 Draft National Levee Safety Committee Report

On January 15, 2009, the National Levee Safety Committee, established by WRDA 2007, released a draft of its report, *Recommendation for a National Levee Safety Program*.[40] The report set out 20 principal recommendations, including:

Building and Sustaining Levee Safety Program in All States

- Design a levee safety program and delegate program responsibilities to states.
- Provide grants to assist in implementing the program.
- Establish a national levee rehabilitation, improvement, and flood mitigation fund to aid in improvement or removal of aging or deficient levees.

Aligning Existing Federal Programs

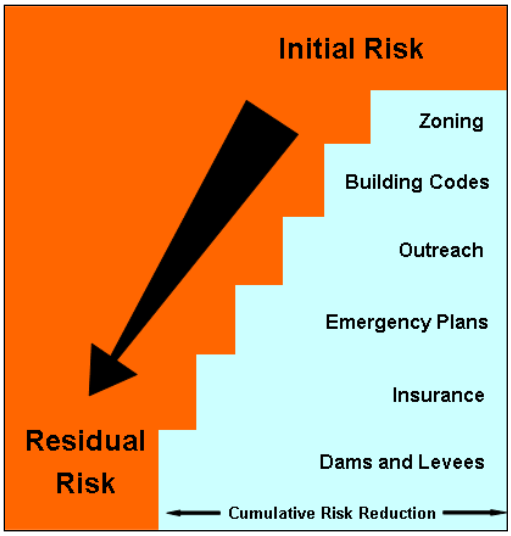
- Align federal programs to provide incentives for good levee behavior.
- Mandate purchase of risk-based flood insurance in areas behind levees.

Comprehensive and Consistent National Leadership

- Establish a National Levee Safety Commission.
- Expand and maintain the National Levee Database.
- Develop and adopt national levee safety standards.
- Address growing concerns regarding liability of engineering firms and government agencies for damages resulting from levee failures.
- Develop a national levee safety training program.
- Develop a national public involvement and awareness campaign to communicate risk behind levees.

[40] The report is available at http://www.iwr.usace.army.mil/ncls/docs/NCLS-Recommendation-Report_012009_DRAFT.pdf.

Figure 2. Multiple Tools Available To Reduce Flood Risk



Source: Adapted from materials by D. Bollman, U.S. Army Corps of Engineers, *Raising the Standard: Post Flood Restoration Opportunities*, available at http://www.iwr.usace.army.mil/iltf/docs/Dorie_Final_DU_Presentation.pdf.

Box 4. Floodplain Management Strategy and Tools Proposed in the Unified National Program for Floodplain Management

Modify Susceptibility to Flood Damage and Disruption

1. Floodplain regulations
2. Development and redevelopment policies
3. Disaster preparedness
4. Disaster assistance
5. Floodproofing
6. Flood forecasting and waning systems and emergency

Modify Flooding

1. Dams and reservoirs
2. Levees, floodwalls, and dikes
3. Channel alterations
4. High flow diversions
5. Land treatment measures

Modify the Impact of Flooding on Individuals and the Community

1. Information and Education
2. Flood Insurance
3. Tax adjustments
4. Flood emergency measures
5. Post-flood recovery

Restore and Preserve the Natural and Cultural Resources of Floodplains

1. Floodplain, wetland, coastal barrier resources regulations
2. Development and redevelopment policies
3. Information and education
4. Tax adjustments

Source: Interagency Task Force on Floodplain Management, *A Unified National Program for Floodplain Management* (FEMA, March 1986).

Resilient Recovery

The 2008 Midwest flood and Hurricane Ike will not be the last riverine flood or coastal storm to affect these areas and devastate communities. See **Box 5** for a discussion of Hurricane Ike's impact on coastal communities and the challenge of recovery. To assist communities to rebuild in a more resilient manner, the Disaster Mitigation Act of 2000 (P.L. 106-390) requires that each state and community must have a mitigation plan to be eligible for certain disaster assistance. This planning requirement represents an initial step in improving the identification of risks; however, these plans have not translated into mitigation actions and assessment being incorporated into community comprehensive plans. There is no requirement for catastrophic recovery planning in communities that face significant risk, such as Galveston.[41] Such planning could assist recovery by vetting, prior to the disaster, preliminary needs, priorities, and plans for rebuilding. New Orleans after 2005 and the Texas coast, Cedar Rapids, and other severely affected Midwest communities after 2008 illustrate the challenge of undertaking an extensive

[41] For another discussion of the challenges of recovering from a disaster, see CRS Report RL34087, *FEMA Disaster Housing and Hurricane Katrina: Overview, Analysis, and Congressional Issues*, by Francis X. McCarthy.

recovery effort. It can be difficult to balance minimizing the disaster's disruption to the community and its economy and reestablishing a more resilient community.

Box 5. The Challenge of Disaster Recovery: The Case of Texas Coastal Communities after Hurricane Ike

In September 2008, Hurricane Ike produced a damaging, destructive and deadly storm surge across the Gulf, affecting the eastern Texas and southwest Louisiana coasts most severely. At $27 billion and more than 100 deaths, Hurricane Ike is costlier and more deadly than the 2008 Midwest flood ($15.0 billion and 24 deaths). While more deadly, Hurricane Ike is closer to the 1993 Midwest flood ($30.2 billion and 48 deaths) in its economic impact. Hurricane Ike's disaster damages include not only coastal flood losses but also the effects of the storm's wind and other damage incurred as it tracked across Texas and the Midwest.

Many of the coastal communities damaged during Hurricane Ike face years of recovery. Much of the coastal residential damage was from storm surge, not wind. The storm generated storm surges between 10 and 13 feet in most of the area around Galveston, Texas; the surge in some areas reached 15 to 20 feet. Individuals, neighborhoods, and communities have many important surge-related rebuilding decisions. The threat of these communities being affected by another hurricane is significant; in less than 60 days during the summer of 2008, Hurricanes Dolly, Gustav, Ike and Tropical Storm Eduardo hit Texas.

Thousands of families remain challenged to find affordable accommodations near their jobs and children's schools. After the storm, only 14 of 3,400 homes in the Texas town of Bridge City remained inhabitable. In Gilchrist, TX, only one home was left standing. Only 39% of flood damages were insured. Residents face difficult financial challenges and decisions regarding whether and how to rebuild.

Business owners are faced with reinvestment decisions that depend on the collective decisions of property owners, their customer base, and municipalities. The City of Galveston's downtown historic strand was significantly damaged; up to 85% of the city's business base is gone. In the near-term, saltwater intrusion from the storm surge hurts agricultural production, and disruption to bay and coastal ecology hurts fishing and tourism. Nonetheless, the long-term regional economic development is likely to rebound. The petrochemical, fishing, and shipping industries remain tied to the Gulf of Mexico navigation infrastructure and fishery and oil resources.

Each municipality is confronted with questions regarding development regulations, zoning ordinances, building codes, city planning, and utility and public safety service delivery. Local officials are faced with both recovery costs and a smaller base. Much of the storm damage was to public infrastructure further taxing local municipalities; repairs to most public infrastructure is eligible for some FEMA reimbursement.

Source: CRS compiled primarily from FEMA's report, *Hurricane Ike Impact report,* December 2008, available at http://www.fema.gov/pdf/hazard/hurricane/2008/ike/impact_report.pdf.

Concluding Remarks

The 2008 Midwest flood, Hurricane Ike, and Hurricane Katrina have been recent reminders of the nation's flood risk. These events have raised both concerns about the state of the nation's flood policies, programs, and infrastructure, and awareness of the tradeoff between the benefits and risks of developing flood-prone areas.

After the 1993 Midwest flood, Congress took several actions that departed from historic flood policies which relied heavily on structural solutions by providing more incentives and assistance for hazard mitigation. Nonetheless, many fundamental issues identified in reports following the 1993 flood remain today. Many federal, state, and local policies and programs continue to encourage floodplain development and use. Local-state-federal tensions over proper and respective roles and responsibilities continue to cloud resolution of difficult water resource issues and can slow recovery in disaster-affected communities. Flood damage reduction and mitigation projects are still largely authorized and implemented in piecemeal fashion, and water and related land use decisions and programs are rarely coordinated. Federal legislation enacted since 1993 generally has addressed individual programs or agencies, rather comprehensively dealing with the

disparate federal policies, programs, and agencies influencing the nation's flood risk. In summary, although federal programs have improved through congressional and agency action since 1993, the fundamental direction and approach of national flood policies and programs remain largely unchanged.

Appendix A. Congressional Flood Direction and Oversight

Congress shapes how federal agencies implement their missions through authorization, appropriations, and oversight. To illustrate how Congress shapes federal agencies flood-related actions through legislative direction, **Table A-1** provides a list of the direction that Congress has given to the Corps on how the agency should implement its flood damage reduction mission and conduct its flood studies and projects. How to use this direction in guiding implementation can be challenging when one provision of law may conflict with another. **Table A-2** is a listing of flood-focused congressional hearings between the 1993 Midwest flood and 2008; the table illustrates the role and focus of congressional oversight. **Table A-3** is a list of flood-focused reports by the GAO from 1993 through 2008; GAO reports investigate how the federal government spends taxpayer dollars in order to assist Congress in meeting its constitutional responsibilities and to help improve the performance and ensure the accountability of the federal government.

Table A-1. Selected Congressional Direction on Corps Flood Damage Reduction Efforts

Topic	Section of Law	Summary of Effect	U.S. Code
Federal Involvement in Flood Damage Reduction Projects			
Flood	§1 of Flood Control Act of 1936 (49 Stat. 1570)	Declared flood control a proper federal activity and that the federal government should participate in the flood control improvements of navigable waters or their tributaries if the benefits are in excess of the costs and if the lives and social security of people are otherwise adversely affected.	33 USC 701a
Shore Protection	§2018 of WRDA 2007	Established that it is the policy of the United States to promote beach nourishment for flood and storm damage reduction and related research, including beach restoration and periodic nourishment for 20 years on a comprehensive and coordinated basis by federal, state, local, and private entities.	33 USC 426e-1
Nonstructural Measures in Corps Flood Damage Reduction Projects			
Flood Risk, Adjacent Impacts, and Nonstructural Alternatives	§2033 of WRDA 2007	Required that a feasibility study ensure equitable analysis of structural and nonstructural alternatives.	33 USC 2282a
Nonstructural Flood Alternatives	§219 of WRDA 1999	Directed that benefits of nonstructural alternatives be calculated using methods similar to those for structural projects, and that double counting of benefits should be avoided.	33 USC 2318
Nonstructural Alternatives	§905 of WRDA 1986	Required feasibility reports to describe a nonstructural alternative to the recommended plan when it does not include significant nonstructural features.	33 USC 2282

Topic	Section of Law	Summary of Effect	U.S. Code
Nonstructural Flood Alternatives	§73 of WRDA 1974 (P.L. 93-251)	Required consideration of nonstructural alternatives for flood damage prevention or reduction during planning.	33 USC 701b-11
Evacuation in Lieu of Levees	§3 of Flood Control Act of 1938 (52 Stat. 1216)	Allowed the Chief of Engineers to modify the plan of any authorized flood control project if construction costs can be substantially reduced by the evacuation of a portion or all of the area proposed to be protected and to use the amount saved toward the evacuation costs, including rehabilitation of the persons evacuated.	33 USC 701i
Analysis of Corps Flood Projects			
Flood Risk, Adjacent Impacts	§2033 of WRDA 2007	Required that a feasibility report include as part of the calculation of benefits and costs the residual risk of flooding, residual risk of loss of life and human safety, and upstream or downstream impacts.	33 USC 2282a
Flood Control Integration	§216 of WRDA 1999 (P.L. 106-53)	Required the Secretary of the Army to coordinate with FEMA and other federal agencies to ensure that flood control projects and plans are complementary and integrated.	33 USC 709a
Exclusion of Floodplain Development	§308 of WRDA 1990	Directed that the Secretary, in justifications for new federal projects, cannot consider benefits from protecting new or substantially improved structures built in the 100-year floodplain after July 1991.	33 USC 2318
Uneconomic Flood Increments	§903 of WRDA 1986	Authorized the Secretary to include flood control features that do not have national economic development benefits greater than costs if the nonfederal interest pays for the element until the remaining costs equal the national economic benefit.	Not codified. 100 Stat. 4184
Flood Measures	§914 of WRDA 1986	Allowed the Secretary to consider flood damage reduction measures without regard for flood frequency, drainage area, or runoff amount, so long as the federal share is less than $3 million.	33 USC 2289
Watershed Analysis for Flood Control	§3 of Flood Control Act of 1917 (39 Stat. 950)	Required surveys for flood control to include a comprehensive study of the watershed.	33 USC 701
General Water Policies Affecting Flood Damage Reduction Projects			
Water Projects	§2031 of WRDA 2007 (P.L. 110-114)	Established as U.S. policy that all water resources projects reflect national priorities, encourage economic development, and protect the environment by maximizing sustainable economic development, avoiding unwise use of flood-prone areas and minimizing adverse impacts of floods, protecting and restoring natural system functions, and mitigating unavoidable natural system damage.	42 USC 1962-3

Topic	Section of Law	Summary of Effect	U.S. Code
Water Policy	§2 of Water Resources Planning Act of 1965 (P.L. 89-80)	Declared that congressional policy is to encourage conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the federal government, states, localities, and private enterprise with the cooperation of all affected and others.	42 USC 1962
Water Policy (including state deference)	§1 of Flood Control Act of 1944 (58 Stat. 887)	Declared that congressional policy is to recognize rights and interests of the states in water resources development, to preserve and protect potential uses, to facilitate project consideration on a comprehensive and coordinated basis, and to limit navigation works to those with substantial benefit which can be operated consistently with appropriate and economic water uses.	33 USC 701-1

Source: CRS, compiled from public laws and assisted by Chapter 2 of Corps, *Digest of Water Policies and Authorities* (EP 1165-2-1, July 1999).

Table A-2. Flood-Focused Congressional Hearings from Summer 1993 through 2008

Hearing Date by Theme	Hearing Title	Committee and Subcommittee
Flood Policy		
Oct. 27, 2005	Reducing Hurricane and Flood Risk in the Nation	House Transportation and Infrastructure (T&I) Subcommittee on Water Resources and Environment
May 26, 1994; July 20, 1994	Floodplain Management and Flood Control	Senate Environment and Public Works (EPW)
Levees		
May 8, 2007	National Levee Safety and Dam Safety Programs	Joint hearing: House T&I Subcommittee on Economic Development, Public Buildings, and Emergency Management; and Subcommittee on Water Resources and Environment
April 6, 2006	H.R. 4650, the National Levee Safety Program Act	House T&I Subcommittee on Water Resources and Environment
April 10, 1997	Flood Control Projects and ESA	House Resources
Hazard Mitigation and Floodplain Management		
June 24, 2008	Comprehensive Watershed Management Planning	House T&I Subcommittee on Water Resources and Environment
Flood-Related Disaster Aid and Response		
Feb. 16, 2000	Flood Water Rescue	House T&I Subcommittee on Oversight, Investigations, and Emergency Management
March 26, 1998	Federal Cost of Disaster Assistance	House T&I Subcommittee on Water Resources and Environment
July 14, 1993	Agricultural Disaster Relief	House Agriculture
Flood Insurance and Mapping		
April 2, 2008	National Flood Plain Remapping	House T&I Subcommittee on Economic Development, Public Buildings, and Emergency Management
July 17, 2007	H.R. 920, the Multiple Peril Insurance Act of 2007	House Financial Services Subcommittee on Housing and Community Opportunity
June 12, 2007	Flood Insurance Reform and Modernization Act of 2007	House Financial Services Subcommittee on Housing and Community Opportunity
June 12, 2007	National Flood Insurance Program: Issues Exposed by the 2005 Hurricanes	Joint Hearing: House Financial Services Subcommittee on Oversight and Investigations and House Homeland Security Subcommittee on Management, Investigations, and Oversight

Hearing Date by Theme	Hearing Title	Committee and Subcommittee
Feb. 28, 2007	Insurance Claims Payment Process in the Gulf Coast After the 2005 Hurricanes	House Financial Services Subcommittee on Oversight and Investigations
Aug. 15, 2006	Look at the National Flood Insurance Program and Flood Mitigation Efforts: Is Bucks Country, Pennsylvania Ready for Another Flood?	House Financial Services
May 8, 2006	FEMA's Floodplain Map Modernization: A State and Local Perspective	House Government Reform Subcommittee on Regulatory Affairs
Oct. 20, 2005	Management and Oversight of the National Flood Insurance Program	House Financial Services Subcommittee on Housing and Community Opportunity
Oct. 2, 2005; Jan. 25, 2006; and Feb. 2, 2006	Future of the National Flood Insurance Program	Senate Banking, Housing, and Urban Affairs
Aug. 17, 2005	Look at the National Flood Insurance Program: Is Ohio Ready for a Flood?	House Financial Services Subcommittee on Housing and Community Opportunity
June 12, 2005	Flood Map Modernization and the Future of the National Flood Insurance Program	House Financial Services Subcommittee on Housing and Community Opportunity
April 14, 2005	Review and Oversight of the National Flood Insurance Program	House Financial Services Subcommittee on Housing and Community Opportunity
March 25, 2004	National Flood Insurance Repetitive Losses	Senate Banking, Housing, and Urban Affairs Subcommittee on Economic Policy
April 1, 2003	National Flood Insurance Program: Review and Reauthorization	House Financial Services Subcommittee on Housing and Community Opportunity
July 19, 2001	National Flood Insurance Program and Repetitive Loss Properties	House Financial Services Subcommittee on Housing and Community Opportunity
Oct. 27, 1999	National Flood Insurance Program	House Banking and Financial Services Subcommittee on Housing and Community Opportunity
June 24, 1993	Status of the National Flood Insurance Program	House Banking, Finance, and Urban Affairs Subcommittee on Consumer Credit and Insurance
May 27, 1993	Insurance Availability in Communities at Risk of Natural Disaster	House Banking, Finance, and Urban Affairs Subcommittee on Consumer Credit and Insurance
Hurricane Katrina & Coastal Louisiana		
April 18, 2006	Field Hearing: Oversee the Ongoing Rebuilding and Restoration Efforts of Hurricane and Flood Protection by the Army Corps of Engineers	Senate EPW

Hearing Date by Theme	Hearing Title	Committee and Subcommittee
Dec. 15, 2005	Hurricane Katrina: Who's in Charge of the New Orleans Levees?	Senate Homeland Security and Government Affairs Committee
Nov. 17, 2005	Evaluate the Degree to Which the Preliminary Findings on the Failure of the Levees Are Being Incorporated into the Restoration of Hurricane Protection	Senate EPW
Nov. 9, 2005	Comprehensive and Integrated Approach to meet the Water Resources Needs in the Wake of Hurricanes Katrina and Rita	Senate EPW
Nov. 9, 2005	Coastal Louisiana Hurricane Protection Project	Senate EPW
Nov. 2, 2005	Hurricane Katrina: Why Did the Levees Fail?	Senate Homeland Security and Government Affairs Committee
Nov. 2, 2005	Second in a Series of Two Hearings to Discuss the Response to Hurricane Katrina	Senate EPW
Oct. 20, 2005	Expert Views on Hurricane and Flood Protection and Water Resources Planning for a Rebuilt Gulf Coast	House T&I Subcommittee on Water Resources and Environment
Oct. 6, 2005	Roles of the Environmental Protection Agency, the Federal Highway Administration and the Army Corps of Engineers as they Relate to Katrina and the Ongoing Recovery (First in a Series of Two)	Senate EPW
Sept. 29, 2005	Hurricane Katrina: Assessing the Present Environmental Status	House Energy and Commerce Subcommittee On Environment and hazardous Materials
Midwest Floods		
July 23, 2008	The Midwest Floods: What Happened and What Might Be Improved for Managing Risk and Responses in the Future	Senate EPW
Feb. 22-24, 1994	Condition of Agricultural Land Damaged by the Midwest Flood	House Agriculture Subcommittee On General Farm Commodities and Subcommittee On Environment, Credit, and Rural Development
Nov. 19, 1993	SBA Disaster Assistance Programs	House Small Business
Nov. 9, 1993	Federal Response to the Midwest Floods of 1993	Senate EPW
Oct. 28, 1993	Federal Response to Midwest Flooding	House Public Works and Transportation Subcommittee. On Investigations and Oversight
Oct. 27, 1993	Midwest Floods of 1993: Flood Control and Floodplain Policy and Proposals	House Public Works and Transportation Subcommittee on Water Resources and Environment
Sept. 23, 1993	Effect of Midwest Flooding on Rail Transportation	House Energy and Commerce Subcommittee on Transportation and Hazardous Materials
Sept. 14-15, 1993	National Flood Insurance Reform Act of 1993: S. 1405	Senate Banking, Housing, and Urban Affairs Subcommittee on Housing and Urban Affairs
July 16, 1993	Flood and Disaster Relief in the Midwest	Senate Agriculture, Nutrition, and Forestry

Hearing Date by Theme	Hearing Title	Committee and Subcommittee
Other Geographically Specific Flood Issues		
Aug. 23, 2008	Hearing on the Small Business Administration's Response to the July 5 Floods in Beaver County, Pennsylvania	House Small Business Subcommittee on Investigations and Oversight
Nov. 1, 2007	Impact of the Flood Control Act of 1944 on Indian Tribes Along the Missouri River	Senate Indian Affairs
Nov.28, 2006	FEMA's Response to the Rockford Flood	House Small Business
Sept. 22, 1998	Coastal Barrier Resources System: Pumpkin Key, Florida	Senate EPW
May 27, 1998	Field Hearing on Proposed Modifications of Folsom Dam	House Resources/Subcommittee on Water and Power
Oct. 23, 1997	Flood Control at Devils Lake, North Dakota	Senate EPW
March 19, 1997	Recent Flooding in California	House T&I Subcommittee on Water Resources and Environment

Source: Information compiled by Lynn J. Cunningham, Information Research Specialist, CRS Knowledge Services Group.

Notes: CRS identified these hearings using flood-related keywords in the hearing title; flood issues may have been discussed during other congressional hearings during this period.

Table A-3.Flood-Focused GAO Reports from Summer 1993 through 2008

Report Date by Theme	GAO Report Title
Flood Policy	
Jan. 1, 2003	Major Management Challenges and Program Risks: Federal Emergency Management Agency, GAO-03-113
Levees	
	None identified.
Hazard Mitigation and Floodplain Management	
Aug. 22, 2007	Natural Hazard Mitigation: Various Mitigation Efforts Exist, but Federal Efforts Do Not Provide a Comprehensive Strategic Framework, GAO-07-403
March 19, 2007	Coastal Barrier Resources System: Status of Development That Has Occurred and Financial Assistance Provided by Federal Agencies, GAO-07-356
April 21, 2003	Agricultural Conservation: USDA Needs to Better Ensure Protection of Highly Erodible Cropland and Wetlands, GAO-03-418
Dec. 20, 2002	Results-Oriented Management: Agency Crosscutting Actions and Plans in Border Control, Flood Mitigation and Insurance, Wetlands, and Wildland Fire Management, GAO-03-321 (also listed under Flood Insurance and Mapping)
Aug. 4, 1999	Disaster Assistance: Opportunities to Improve Cost-Effectiveness Determinations for Mitigation Grants, RCED-99-236
Flood-Related Disaster Aid and Response	
Aug. 4, 1999	Disaster Assistance: Opportunities to Improve Cost-Effectiveness Determinations for Mitigation Grants, RCED-99-236 (also listed under Hazard Mitigation and Floodplain Management)
Flood Insurance and Mapping	
June 16, 2008	National Flood Insurance Program: Financial Challenges Underscore Need for Improved Oversight of Mitigation Programs and Key Contracts, GAO-08-437
April 25, 2008	Natural Catastrophe Insurance: Analysis of a Proposed Combined Federal Flood and Wind Insurance Program, GAO-08-504
Dec. 28, 2007	National Flood Insurance Program: Greater Transparency and Oversight of Wind and Flood Damage Determinations Are Needed, GAO-08-28
Nov. 26, 2007	Natural Disasters: Public Policy Options for Changing the Federal Role in Natural Catastrophe Insurance, GAO-08-7
Sept. 5, 2007	National Flood Insurance Program: FEMA's Management and Oversight of Payments for Insurance Company Services Should Be Improved, GAO-07-1078
March 16, 2007	Climate Change: Financial Risks to Federal and Private Insurers in Coming Decades Are Potentially Significant, GAO-07-285
Dec. 15, 2006	National Flood Insurance Program: New Processes Aided Hurricane Katrina Claims Handling, but FEMA's Oversight Should Be Improved, GAO-07-169
Oct. 18, 2005	Federal Emergency Management Agency: Improvements Needed to Enhance Oversight and Management of the National Flood Insurance Program, GAO-06-119
March 31, 2004	Flood Map Modernization: Program Strategy Shows Promise, but Challenges Remain, GAO-04-417
Dec. 20, 2002	Results-Oriented Management: Agency Crosscutting Actions and Plans in Border Control, Flood Mitigation and Insurance, Wetlands, and Wildland Fire Management, GAO-03-321 (also listed under Hazard Mitigation and Floodplain Management)

Report Date by Theme	GAO Report Title
June 21, 2002	Flood Insurance: Extent of Noncompliance with Purchase Requirements Is Unknown, GAO-02-396
Hurricane Katrina & Coastal Louisiana	
Dec. 31, 2007	Army Corps of Engineers: Known Performance Issues with New Orleans Drainage Canal Pumps Have Been Addressed, but Guidance on Future Contracts Is Needed, GAO-08-288
Dec. 14, 2007	Coastal Wetlands: Lessons Learned from Past Efforts in Louisiana Could Help Guide Future Restoration and Protection, GAO-08-130
June 29, 2007	Preliminary Information on Rebuilding Efforts in the Gulf Coast, GAO-07-809R,
June 25, 2007	Hurricane Katrina: EPA's Current and Future Environmental Protection Efforts Could Be Enhanced by Addressing Issues and Challenges Faced on the Gulf Coast, GAO-07-651
May 23, 2007	U.S. Army Corps of Engineers' Procurement of Pumping Systems for the New Orleans Drainage Canals, GAO-07-908R
Sept. 6, 2006	Hurricane Katrina: Strategic Planning Needed to Guide Future Enhancements Beyond Interim Levee Repairs, GAO-06-934
Midwest Floods	
Aug. 7, 1995	Midwest Flood: Information on the Performance, Effects, and Control of Levees, RCED-95-125
Other Geographically Specific Flood Issues	
April 16, 2007	IRS Emergency Planning: Headquarters Plans Supported Response to 2006 Flooding, but Additional Guidance Could Improve All Hazard Preparedness, GAO-07-579
Dec. 12, 2003	Alaska Native Villages: Most Are Affected by Flooding and Erosion, but Few Qualify for Federal Assistance, GAO-04-142
Oct. 27, 2003	Corps Of Engineers: Improved Analysis of Costs and Benefits Needed for Sacramento Flood Protection Project, GAO-04-30
Dec. 15, 1999	Food and Drug Administration Facility: Requirements for Building on a Floodplain Met, GGD-00-17
Oct. 2, 1996	Bureau of Reclamation: An Assessment of the Environmental Impact Statement on the Operations of the Glen Canyon Dam, RCED-97-12
Other	
June 8, 2007	Weather Forecasting: National Weather Service's Operations Prototype Needs More Rigorous Planning, GAO-07-650
May 15, 2002	U.S. Army Corps of Engineers: Scientific Panel's Assessment of Fish and Wildlife Mitigation Guidance, GAO-02-574
July 9, 2001	Federal Emergency Management Agency: Status of Achieving Key Outcomes and Addressing Major Management Challenges, GAO-01-832
April 2, 1996	Lands Managed by the Corps of Engineers, RCED-96-101R
Aug. 12, 1993	Water Resources: Factors That Lead to Successful Cost Sharing in Corps Projects, RCED-93-114

Source: Information compiled by the Wayne A. Morrissey, Information Research Specialist, CRS Knowledge Services Group.

Notes: CRS identified these reports using flood-related keywords; flood issues may have been discussed in other GAO reports not listed in the table.

Appendix B. Analysis of the Upper Mississippi River Comprehensive Plan

WRDA 1999 authorized the Upper Mississippi River Comprehensive Plan (UMRCP). The UMRCP final report, which is dated June 2008, was transmitted to Congress on January 15, 2009. The UMRCP was conducted as a preliminary study, similar to the level of detail in a Corps reconnaissance study. The UMRCP final report and supporting documents are not at the level of detail of a feasibility study, which typically informs decision-making on construction authorization.

The UMRCP Preferred (But Not Recommended) Plan

The UMRCP final report states "additional authority to implement the Comprehensive Plan is not being recommended nor requested at this time based upon the [national economic development] evaluation of alternative plans." Nonetheless, the UMRCP final report did identify a preferred alternative from among the fourteen analyzed; the alternatives were evaluated on multiple criteria, including environmental, social, and regional benefits. The report presented one "no action" alternative and thirteen other alternatives that would provide 500-year urban protection. These thirteen varied primarily on the level of protection and type of flood damage reduction actions taken in agricultural areas; the alternatives ranged from increase in existing protection to 500-year protection for agricultural areas.

The preferred alternative, known as Plan H, would provide a 500-year level of flood protection along the length of the mainstem of the Mississippi and Illinois Rivers (but not other tributaries) and ecosystem restoration benefits. The preferred plan would protect urban areas and towns with 500-year levees; for agricultural areas it would provide 500-year levees except where buyouts would be more cost effective.[42] The UMRCP final report indicates that up to 39 levee districts would be bought out while 144 would have levees raised to 500-year protection. If buyouts of districts are implemented, there would be opportunities to pursue ecosystem restoration actions. The total initial cost for Plan H would be $4.42 billion ─ $3.97 billion for flood damage reduction construction, and $460 million for ecosystem restoration; these costs do not include operation, maintenance, and rehabilitation.

Mixed Recommendations on How to Proceed

The UMRCP final report indicates that none of the alternatives studied would meet the current economic test for federal participation of the plan's national benefits exceeding costs. Current guidelines exclude regional benefits from these calculations because regional benefits are viewed as transfers from one region to another, and do not produce national gains.

The thirteen UMRCP alternatives analyzed (excluding the no action alternative) had costs from $3 billion to $9 billion and benefit-cost ratios ranging from 0.03 to 0.07 for the national economic development benefits. For Corps projects, other than ecosystem restoration projects, a national benefit-cost ratio greater than 1.0 generally is used in gauging the economic attractiveness of the federal investment, consistent with the direction in the Flood Control Act of 1936.

[42] UMRCP final report.

Congress is faced with deciding how to proceed given differing recommendations. Consistent with the UMRBC final report, the Assistant Secretary of the Army (Civil Works) in his January 2009 transmittal letter to Congress stated that "recommendations for implementation of a specific plan based on a reconnaissance level of detail is premature."[43] The Assistant Secretary instead recommended intermediate steps ─ expanding the UMRCP to include Mississippi River tributaries, conducting cost-shared studies of the reconstruction needs for the basin's existing flood damage infrastructure (where a federal interest is identified), and conducting a study of flood protection for critical transportation infrastructure such as bridge approaches and railroads.

Earlier in August 2008, the Mississippi River Commission voted to support implementing the preferred alternative.[44] The Commission believed that the full benefits of implementing the preferred alternative were not adequately measured with the current Corps project planning guidelines.[45]

In 2008, the then-Governor of Illinois and the then-Governor of Missouri wrote letters of support for Plan M. Plan M at a total cost of $6.88 billion would provide 500-year protection without the option for agricultural district buyouts and without trying to minimize the impacts in the lower basin (i.e., Plan M would increase the height of floodwaters below St. Louis). Plan M would provide less ecosystem restoration opportunities than Plan H.

A Plan with Limited Scope and Detail

Although the study authorization was labeled as comprehensive and inclusive of some navigation maintenance and habitat management considerations, the authorized flood study did not fully integrate navigation, flood, and ecosystem management as recommended in the 1994 Galloway report. Instead, the Corps studied and obtained construction authorization for navigation and ecosystem restoration actions (in Title VIII of WRDA 2007, P.L. 110-114) separately from the flood plan.

Due to the large study area for the flood plan, the Corps chose not to perform a comprehensive watershed analysis encompassing the entire 185,000 square miles, instead it limited the study to the Mississippi and Illinois River floodplain encompassing 4,000 square miles, and the only tributary that was included was the Illinois River. The Missouri River and smaller tributaries were excluded.

For the comprehensive flood plan, the Corps identified preliminary alternatives and scoped out the federal interest in the effort; the level of detail of the plan is compared to a Corps reconnaissance study. Therefore, the UMRCP final report and supporting documentation are not at the level of detail typically used to inform congressional decision-making regarding construction authorization.

The analyses used to support the UMRCP (e.g., counting as benefits the increased development opportunities behind levees[46]), the scoping of the study and the selection of alternatives studied,

[43] Ibid.

[44] The Mississippi River Commission press release is available at http://www.mvd.usace.army.mil/offices/pa/releases/2008/RelMRC0801.pdf.

[45] Letter to Hon. James M. Inhofe, Ranking Member Committee on Environment and Public Works, from Assistant Secretary of the Army (Civil Works) John Paul Woodley, Jr., transmitting the UMRPC final report, Jan. 15, 2009.

[46] The Tennessee Valley Authority prepared for the Corps, *An Economic Evaluation of Proposed Flood Protection Plans on the Upper Mississippi River and Illinois Waterway* (Oct. 2004), available at http://www2.mvr.usace.army.mil/UMRCP/Reports.cfm. The report states "As flood risks are reduced in floodplains, the likelihood of economic activity

and whether nonstructural alternatives and enhanced floodplains were given equal consideration are some of the items that may be scrutinized as the final report is discussed. For example, the hydrology and hydraulics analysis supporting the UMRCP final report did not account for the effects on precipitation, runoff, and river crests from future changes in land use, population, and climate.[47] Moreover, the scope of the UMRCP final report leaves out much of the areas most severely affected in 2008.

Visions of the Future Floodplain

Whether Plan H, particularly the raising of most agricultural levees to a significantly higher level of protection than currently available, contrasts with the vision of the future floodplain described in the Galloway report likely will be debated. The Galloway report stated:

> Urban centers whose existence depends on a river for commerce or whose locational advantage is tied historically to a floodplain would be protected from the ravages of devastating floods by means of levees, floodwalls, upstream reservoirs, or floodwater storage in managed upland and floodplain natural areas. Sections of communities with frequently flooded businesses or homes would become river-focused parks and recreation areas as former occupants relocated to safer areas on higher ground. In areas outside of these highly protected communities, where land elevation provided natural protection from floods, state and local officials would control new construction by requiring it to be at elevation well out of harm's way. Those who were at risk in low-lying areas would be relocated, over time, to other areas. … Outside of the urban areas, industry would protect its own facilities against major floods. Critical infrastructure, such as water and wastewater treatment plants, power plants, and major highways and bridges would be either, elevated out of the flood's reach or protected against its ravages. Much of the infrastructure, as well as the homes, businesses, and agricultural activities located behind lower levees, would be insured against flooding through participation in commercial or federally supported insurance programs.[48]

The potential role of higher mainstem levees in increasing risk because of their encouragement of floodplain development and reduction in flood storage is an active part of the debate over the future of the basin's floodplains. The experience of extreme floodwaters along Mississippi River tributaries in the 2008 flood and differing visions for the future of the upper Mississippi River basin floodplains may be central to the debate about how to proceed with reducing flood risk in the Midwest and the UMRCP.

Regional Development and the Federal Role

According to the economic analysis used for the development of the UMRCP final report, the regional economic benefit of an alternative similar to Plan H would be $27.1 billion. The majority of regional benefits (79%) cluster in Illinois, with Iowa and Missouri receiving most of the remaining benefits. Therefore, regional stakeholders, particularly in Illinois, Iowa, and Missouri, may view plans, like Plan H and Plan M, as attractive investments. The majority of those regional economic benefits ($20.5 billion) are due to the increase in economic development behind the higher levees. Plan H potentially would open to development up to 215,775 acres. This potential

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may increase … Portions of land previously zoned to prohibit development could become usable." (p. 2)

[47] Appendix B of the May 2006 draft of the Upper Mississippi River Comprehensive Plan May 2006, available at http://www2.mvr.usace.army.mil/UMRCP/Reports.cfm. (It is unclear whether updated appendices accompany the June 2008 UMRPC final report.) UMRCP final report stated "for the purposes of this study, it is assumed that whatever climate changes occur within the 50-year planning timeframe will have little effect on the types of vegetation, cropping patterns or flood frequencies as currently determined." (p. 51)

[48] 1994 Galloway report, pp. 67-68.

for expanded economic development behind levees raises concerns regarding the residual risk behind levees and the evaluation of that risk in selecting Plan H as the preferred alternative. That is, it remains unclear the extent to which the flood risk reduction benefits of Plan H may be offset by the residual risk of more development behind levees. The methodology used in developing the study appears to be more similar to the traditional Corps flood damage reduction study, than a flood risk reduction study.

As well as noting that Plan H has not been thoroughly vetted with the public and stakeholders, the UMRCP final report stated:

> There is likely to be limited Federal interest, based upon current guidance, in plan implementation by Federal agencies.… Regional or national oversight (e.g., the Mississippi River Commission) would be required to ensure the plan functions as a system over the implementation and operation phases of the project and project priorities are established to reflect the changing systemic needs.… The States of Illinois, Iowa, and Missouri need to agree on the plan and plan implementation to insure the plan is acceptable. The Corps could provide facilitation and technical support to this effort.[49]

In effect, the UMRBC final report is identifying that the states could choose to further develop then implement one of the alternatives studied without significant federal leadership or funding.

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[49] UMRCP final report, p. ES-13.