

Corps of Engineers Responses to the Changing National Approach to Floodplain Management Since the 1993 Midwest Flood

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The Great Midwest Flood of 1993 brought the attention of the nation to the challenges it faced in dealing with floods. Over a six-month period, the ravages of the flood were shown nightly on television and filled columns in the print media. East–West transportation networks throughout the Midwest were severely disrupted and more than 100,000 people were displaced from their homes, many never to return. By the time the accounting was terminated, estimates of flood damage ranged as high as \$20 billion and the government’s costs for recovery exceeded \$6 billion. Parts of eight states had been hard hit by the floodwaters, and the overall impact on the national economy was significant.

Since 1993, major floods have continued to cause damages in riverine and coastal areas of the United States. Many of the significant floods of the Twentieth and early Twenty-First Centuries (i.e., in terms of number of lives lost and/or property damage) have occurred since the 1993 flood. The upper Mississippi basin itself experienced significant floods in 1997 and 2001, and other major floods occurred in the Southeast (1995), northern California (1995), the Ohio Valley (1997), the Red River Basin of the North (1997), and North Carolina (1999) (USGS 2000).

Before discussing floodplain management since the Great Midwest Flood of 1993, it is important to review briefly the history of floodplain management in the United States.

In 1928, Congress assumed federal responsibility for flood control in the lower Mississippi Valley as a result of a disastrous flood that occurred there in

1927. In 1936, following major flooding in the Northeast and Midwest, Congress passed a Flood Control Act that declared, “destructive floods upon the rivers . . . constitute a menace to national welfare; it is the sense of Congress that flood control is a proper activity of the Federal Government.” However, in spite of over 70 years of work by the U.S. Army Corps of Engineers (USACE) to reduce flood damages—primarily by constructing levees, floodwalls, dams and other structural measures—flood losses have continued to grow each decade and are now approaching \$6 billion a year (ASFPM 2001), mostly in unprotected areas. At the same time, the Corps has spent \$122 billion (in 2002 dollars) on flood control and has prevented an estimated \$709 billion (2002 dollars) in damages (USACE 2002a). (The paper by Lauren Cartwright in this issue provides considerable detail about trends in flood damages.)

Following the 1993 flood, considerable attention was focused on the nation’s flood damage reduction programs and what should be done to reduce flood losses. This paper reviews the changes that have occurred in national flood policies and programs since 1993 with special attention to the programs of the Corps of Engineers, the agency with primary responsibility for national flood damage reduction project development.

Post-Flood Reviews and New Directions

In December 1993, following the Great Flood, the Administration Floodplain Task Force, headed

by the Director of the White House Office of Environmental Policy, the Associate Director of the Office of Management and Budget, and the Assistant Secretary of Agriculture for Natural Resources, directed the formation of an Interagency Floodplain Management Review Committee (FMRC). The Committee, a multi-disciplinary and interagency group of experts in fields relevant to floodplain management, was assigned to the White House and charged with:

- Determining the major causes and consequences of the Great Flood of 1993;
- Evaluating the performance of existing floodplain management and related watershed management programs; and
- Making recommendations as to what changes in current policies, programs, and activities would most effectively achieve risk reduction, economic efficiency, and environmental enhancement in the floodplain and related watersheds.

In June 1993, the FMRC submitted its report, *Sharing the Challenge*, to the Task Force and the President (FMRC 1994). The report indicated that:

- The Midwest Flood of 1993 was a significant hydrometeorological event. In some areas, it represented an unusual event; in most others, however, it was just one of the many that have been seen before and will be seen again. Flood flows similar to those experienced by most of the Midwest can occur at any time.
- Human activities in the floodplains of the Midwest over the last three centuries have placed people and property at risk. Local and federal flood damage reduction projects were constructed to minimize the annual risk, and they prevented nearly \$20 billion in damages during the 1993 flood. Some of these programs, however, attracted people to high-risk areas and created greater exposure to future damages. In addition, flood control, navigation, and agricultural activities severely reduced available floodplain habitat and compromised natural functions upon which fish and wildlife rely.
- The United States simply has lacked the focus and incentive to engage itself seriously in floodplain management...all levels of government, all businesses, and all citizens have a stake in properly

managing the floodplain. All of those who support risky behavior, either directly or indirectly, must share in floodplain management and in the costs of reducing that risk. The federal government can lead by example, but state and local governments must manage their own floodplains. Individual citizens must adjust their actions to the risk they face and bear a greater share of the economic costs.

- The Review Committee supported a floodplain management strategy of, sequentially, avoiding inappropriate use of the floodplain, minimizing vulnerability to damage through both structural and nonstructural means, and mitigating flood damages when they do occur.
- Responsibility should be assigned to the Mississippi River Commission (MRC) for integrated management of flood damage reduction, ecosystem management, and navigation on the upper Mississippi River and tributaries.

The Committee recommended that the nation

[e]stablish, as goals for the future, the reduction of the vulnerability of the nation to the dangers and damages that result from floods and the concurrent and integrated preservation and enhancement of the natural resources and functions of floodplains.

Noting that “there are no silver bullets in the floodplain management,” the committee emphasized the need for those involved in floodplain management to make use of all the tools available to them and to balance structural and non-structural approaches to flood damage reduction. It urged special focus on including permanent evacuation of flood-prone areas, flood warning, floodproofing of structures remaining in the floodplain, creation of additional natural and artificial storage, and use of adequately sized and maintained levees and other structures.

The release of the FMRC report opened a continuing national dialogue on how best to deal with floods. Many saw the report as a repudiation of the emphasis since 1928 on structural solutions and either opposed its recommendations or called for an end to construction of structural works. Others saw it as a call for a balanced approach to flood damage reduction. In reality, the report represented a combination of the views of Jim Goddard of the

Tennessee Valley Authority and Gilbert White of the University of Colorado, who, since the 1950's, had been advocating for more attention to non-structural works and a recognition that, in some cases, structural solutions were necessary to preserve the integrity of existing communities, and had to be part of the calculus of flood damage reduction decisions (see Task Force 1966).

National Response to the Flood of 1993

The national response to the Flood of 1993 has been evolutionary not revolutionary. While the FMRC report called for several legislative actions, including a national Floodplain Management Act that would have rapidly caused changes in the way federal and state agencies did business in the floodplain, neither that act nor several other legislative and regulatory changes were implemented. President Clinton's administration endorsed the overall concept of a restructuring of floodplain management and even attempted in the 1996 budget to operationalize several changes; however, opposition in Congress and from grass-roots organizations prevented any giant steps forward. At the same time, some of the flood-related agencies began to make programmatic changes that, in the aggregate, represented significant progress in shifting the focus from largely structural to a more balanced approach to floodplain management.

Since 1993, there has been a greater national awareness of flooding. Because the 1993 flood kept some homes and property under water for months, the media coverage was extensive and cemented flood images in the minds of the American public. The growth of news stations that provide 24/7 attention to current events, including natural disasters, has maintained that awareness. The picture of a burning building in downtown Grand Forks, ND, surrounded by 1997 floodwaters that kept the fire department away, became a poster picture for the ravages of floods. The Federal Emergency Management Agency's (FEMA's) efforts to improve participation in flood insurance programs put its public service announcements on the air on a frequent basis and, at a minimum, pointed out to Americans the irreplaceable losses that can occur during flood events.

In October 1994, Congress passed and the President signed a flood insurance reform act that

lengthened the time required for flood insurance to take effect from 5 to 30 days, and placed pressure on lenders to ensure that homebuyers purchased and maintained required insurance coverage. Changes were also made in the federal crop insurance programs to increase the number of purchasers. Additionally, in response to a National Wildlife Federation report on repetitive losses (NWF 1998) and pressure from floodplain management professionals, the House of Representatives recently passed the Flood Insurance Reform Act of 2003 (H.R. 253), also known as the "Two Floods and You Are Out of the Taxpayers' Pocket Act of 2003," which would eliminate federal support of repetitive claims payments. Both this bill and a less stringent but similar bill—S. 228, Flood Insurance Reform Act of 2004—are under consideration in the Senate. Many state and local governments also reacted to the lessons of the 1993 flood by placing additional emphasis on strengthening their floodplain management programs. Nowhere was this increased attention seen better than in the expanded acquisition of floodplain properties at high risk. With strong support from FEMA and the states, over 27,000 families have been voluntarily relocated from floodplains, including more than 13,000 families from the 1993 flood area alone. Added to this is the acquisition for natural use purposes, under a variety of federal programs, of tile or easements for over a million acres of marginal farmlands (ASFPM 2000).

In December 1997, the Western Governors' Association (WGA), representing 18 western states, adopted a plan for reducing flood risk that generally supported the recommendations of the FMRC and called on state and local jurisdictions to:

Refrain from putting people and property at risk by avoiding development in the floodplain; move those at risk from the floodplain, when appropriate; share the risk among all levels of government and among flood-affected individuals; and treat the floodplain as part of a physical and biological system within the larger context of its watershed (WGA 1997).

Following the 1997 flood on the Red River of the North, the President of the United States and the Prime Minister of Canada directed the International Joint Commission (IJC) to report on the flood. The

IJC's 2000 report also paralleled that of the FMRC and indicated:

There is no single solution to the flood damage mitigation challenge. To reduce vulnerability to flooding, all possible approaches, including both structural and nonstructural damage reduction measures, must be considered as part of a comprehensive plan (IJC 2000).

In 2001, the Association of State Floodplain Managers proposed a new principle for floodplain management that would be easy to communicate and that would clearly spell out the direction that must be taken to reduce flood losses:

No Adverse Impact floodplain management is where the action of one property owner does not adversely impact the rights of other property owners, as measured by increased flood peaks, flood stage, flood velocity, and erosion and sedimentation. (ASFPM 2001).

Over the decade since the 1993 Flood, much of the nation has recognized the need for more attention to floodplain management and for a balance between structural and nonstructural approaches. Any long-term success in making this shift will depend on the approach taken by the Corps of Engineers.

The Corps of Engineers and Twenty-First Century Floodplain Management

The Corps of Engineers has been associated with national water resources development since the 1820's when Congress assigned it responsibility for improving navigation on inland waters. Over time, responsibilities for flood damage reduction, natural resources stewardship, waterways regulation, and recreation have been added to its mission.

The Corps has been involved with floods since the middle of the Nineteenth Century. While the current flood damage reduction efforts of the Corps have been influenced by the activities reviewed in previous paragraphs, the Corps appears to have set its own complementary path to moving forward with a new approach to floodplain management. In the ten years since the 1993 flood, the Corps has transformed its overall focus from structural-centric

to a program that embodies efforts to restore and protect the environment, reduce flood damages through structural and non-structural means, and incorporate flood damage reduction efforts into watershed or basin-level planning.

In 1995, the Corps completed its assessment of approaches that might be taken to solve the flood problems of the upper Mississippi River and lower Missouri River. The assessment validated the view that structural flood control measures have limitations, and, while important, they are only part of a more encompassing floodplain management program. The report noted that floodplains are managed best through a combination of structural and non-structural measures and that floodplain occupants must recognize the inherent risks of living in flood-hazard areas (USACE 1995).

As far back as 1970, the Corps had formed an ad-hoc group of Corps water resources professionals to meet periodically to discuss non-structural approaches to flood damage reduction. In 1985, this group was formally chartered as the National Floodproofing Committee. Following the 1993 flood, it served as a catalyst for efforts to consider more non-structural approaches and was rechartered in 2003 as the National Nonstructural Floodproofing Committee. (The activities of the Committee and some of the current projects with a non-structural component are described by Larry Buss in a subsequent paper in this issue of the *Journal of Contemporary Water Research & Education*.) The Committee has been most active in preparation of floodproofing guides for local governments and private citizens and in carrying the non-structural message throughout the Corps organization.

As FEMA moved forward with relocations following the 1993 flood, the Corps expanded the use of relocations in planning flood projects (USACE 1999). Typical of the many projects involving restoration was the relocation of over 300 families from homes and apartments along the Red River in Grand Forks and East Grand Forks, MN (Buss 2004). These relocations not only moved the residents out of harm's way but also enabled the development of a wider path for floodwaters that must move down the Red River. Relocation is clearly considered a first-line tool in the battle against floods. Other non-structural measures are in planning or construction at more than 50 locations (USACE 1999; USACE 2001).

The last decade has seen the Corps rapidly expanding its use of technology to capture the power of computer assisted decision support systems and geographic information systems (GIS) to support floodplain management and project development. With the assistance of its Topographic Engineering Center at Ft. Belvoir, VA and its research laboratories in Vicksburg, MS, USACE developed centers of GIS and modeling expertise within its districts and has put this expertise to work in support of project development (Blyler u.d.).

Following a recommendation of the FMRC, Congress authorized the development of an Upper Mississippi River Comprehensive Plan in 1999 (see article by Richard Astrack in this issue). Three Corps districts are currently carrying out development of the plan. Under this authorization, the Corps will plan for:

- Systemic flood management and flood damage reduction
- Continued maintenance and improvement of the navigation project
- Improving management of nutrients and sediment, including bank erosion
- Enhancing environmental stewardship
- Meeting river-related recreation needs and expectations (USACE 2003)

As part of an effort to enhance communications with the public and ensure that Corps project planning involves all levels of government and the public, the Corps Institute of Water Resources has carried out a significant effort to improve the conduct of public meetings, developed and improved techniques for alternative means of dispute resolution, and developed the concept of shared vision modeling. Under the latter program, the public is directly involved in shaping alternative futures scenarios and in establishing the objectives of projects.

Since the Corps operates under authorities given to it by Congress, legislative initiatives are important measures of the Congressional-Corps relationships on planning issues. Sections of the Water Resources Development Acts (WRDA) of 1996 and 1999 reflected the Corps movement toward the balance of non-structural and structural approaches to flood damage reduction:

- WRDA 1996 – §402
Before construction of any project for local flood protection, or any project for hurricane or storm damage reduction, that involves Federal assistance from the Secretary, the non-Federal interest shall agree to participate in and comply with applicable Federal floodplain management and flood insurance programs.
- WRDA 1999 §212 - Challenge 21
[S]tudies and projects shall be conducted, to the maximum extent practicable, in cooperation with State and local agencies and tribes to ensure the coordination of local flood damage reduction or riverine and wetland restoration studies with projects that conserve, restore, and manage hydrologic and hydraulic regimes and restore the natural functions and values of floodplains.
- WRDA 1999 §219
In calculating the benefits of a proposed project for nonstructural flood damage reduction, the Secretary shall calculate the benefits of the nonstructural project using methods similar to those used for calculating the benefits of structural projects, including similar treatment in calculating the benefits from losses avoided.

Perhaps most significant among the post-1993 changes are those related to the vision, goals, and guidance issued over the past three years by Corps leadership to Corps employees. These stress the need to give equal consideration to environmental factors and non-structural measures in planning Corps projects. Engineer regulation 1105-2-100 Planning Guidance indicates:

Non-structural measures shall receive equal consideration in the planning process to structural measures.

In 2002, Lt. General Robert Flowers, the Chief of Engineers, promulgated Corps *Environmental Operating Principles* (USACE 2002b):

- Strive to achieve environmental sustainability
- Recognize the interdependence of life and the physical environment
- Seek balance and synergy among human development activities and natural systems
- Accept corporate responsibility and accountability for activities and decisions that impact human health and welfare and the continued viability of natural systems
- Seeks ways and means to assess and mitigate cumulative impacts to the environment
- Build and share an integrated scientific, economic, and social knowledge base
- Respect the views of individuals and groups interested in Corps activities

The Corps draft *Strategic Plan for 2003-2008* (USACE 2000c) includes a vision for the Corps:

To contribute to the sustainability of our Nation's water and related land resources in ways that achieve important results:

- Preserve, protect, and restore ecosystem health
- Promote economic vitality
- Protect and promote quality of life

This vision points toward collaborative planning and decision-making processes among federal, state, and local agencies through watershed-scale planning and integrated management of core water functions to restore environmental degradation, reduce human and physical losses from disasters, and develop our water resources for future generations.

Since 1993, in dealing with the nation's flood problems, the Corps of Engineers has joined, if not led, federal and state agencies in moving its planning objectives towards a concurrent consideration of flood damage reduction and preservation and enhancement of the natural environment. In addition, it has, through internal and external actions, increased its focus on non-structural damage reduction methods. It would be incorrect, however, to indicate that this shift started in 1993. In the late 1960's, the Corps recognized the need for more extensive consideration of the environment in

planning of projects and the need for use of non-structural measures in planning flood damage reduction (USACE 1983). Although, prior to the early 1980's the executive branch was not supportive of non-structural approaches (Galloway 1980), the Corps had already initiated or completed work on non-structural projects, including major relocations, in Colorado, Wisconsin, Massachusetts, and Arizona. By 1993, the Corps had already completed 15 non-structural projects (USACE 1999). An Environmental Advisory Board was formed to assist the Chief of Engineers in carrying out his missions, and floodplain management services became a key section in the Civil Works Directorate. The Institute for Water Resources was active throughout the period in evaluating and proposing new planning approaches, improving public involvement, and in educating leaders on these new approaches. The period since 1993 has seen an acceleration of Corps efforts to ensure the needed balance of structural and non-structural approaches in planning, but it was certainly not the start.

Challenges of the Future

It seems clear that the challenges of flood damage reduction will remain, if not grow, in the years ahead. There is continuing pressure for development in areas that should not be developed, especially coastal areas. Development upstream of major urban areas threatens to increase the flood potential in those communities unless proper planning takes place. Climate change or climate variability is already bringing changes in hydrologic regimes. While total rainfall amounts may be reduced under climate change, rainfall that does occur in many parts of the country will occur with more intensity and increased probability of flooding. A review of the nation's infrastructure by the American Society of Civil Engineers indicates there is a considerable backlog in maintenance and repair of water-related structures and that many dams are at risk (ASCE 2001).

The Corps of Engineers also faces challenges beyond its control in gravitating towards a more balanced approach to flood damage reduction. The Corps operates under conflicting laws and congressional guidance that makes it difficult, if not impossible, to meet the goals it has set for itself. One Act directs the Corps to carry out navigation on a given river. Another defines Corps flood damage

reduction responsibilities. And the two may be in conflict. Other laws requiring compliance with environmental or historic preservation or water quality regulations create conflicts. Congress has been reluctant to deal with such conflicts.

New initiatives require funding support. Congress may authorize a “Challenge 21” program to offer the opportunity for innovative nonstructural projects, but if the same Congress refuses to appropriate funds for the program, the program is impotent. Federal guidance governing water projects as found in *Principles and Guidelines* (WRC 1983) has not been modified in over 20 years, in spite of continuous criticism (NRC 1999). Neither Congress nor the administration seems willing to address an apparent bias against non-structural projects in the economic accounting of costs and benefits. A 2004 report by a National Research Council Committee examining analytical methods and approaches for water resources planning stated: “*The Principles and Guidelines* should be revised to better reflect contemporary management paradigms, analytical methods, legislative directives, and social, economic and political realities” (NRC 2004). The requirement created by the 1986 WRDA for cost sharing of water resources projects, in some cases, has added another obstacle in the path of non-structural approaches to flood damage reduction. Local communities that are funding 25 percent of a project want to have a major voice in selection of alternatives and frequently do not favor alternatives that diminish flood damage reduction benefits to accommodate environmental benefits that may accrue to the public at large as opposed to the ‘paying’ community. In other cases, communities with tight budgets find it difficult to participate in the cost sharing for relocations and to support the long-term maintenance of evacuated lands. (Many have also suggested that the federal government should use its powers of eminent domain to acquire floodplain properties in cases where the owners do not wish to relocate and where their failure to relocate would create a checkerboard evacuation. While use of eminent domain might make planning sense, the political costs would far outweigh any planning benefits.)

Conclusion

Since 1993, the nation has modified its approach to floodplain management, moving slowly towards a balanced use of both structural and nonstructural solutions to flooding problems. The extent of this modification has yet to be determined. As part of this modification, the Corps has clearly adopted approaches to and taken actions in the management of floodplains that are moving, if not leading, the nation toward this balance.

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References

- American Society of Civil Engineers (ASCE). 2001. *2001 Report Card for America's Infrastructure*. <http://www2.asce.org/reportcard/pdf/2001reportcardreleasefinalwebl.pdf>.
- Association of State Floodplain Managers (ASFPM). 2000. *National Flood Programs in Review 2000*. Madison, WI: ASFPM.
- Association of State Floodplain Managers (ASFPM). 2001. *What is NAI?* <http://www.floods.org/NoAdverseImpact/whitepaper.asp>.
- Blyler, Nancy. u.d. ‘Civil Works Geospatial Data & Systems Strategic Focus.’ PowerPoint briefing. CECW-EP-S.
- Galloway, Gerald E. 1980. “Nonstructural Measures in Flood Damage Reduction Activities.” Consultant Report. Washington, DC: US Water Resources Council.
- International Joint Commission. 2000. *Living with Red*. Washington, DC: IJC.
- Interagency Floodplain Management Review Committee (FMRC). 1994. *Sharing the Challenge: Floodplain Management into the 21st Century*. Washington, DC: U.S. Government Printing Office.
- National Research Council (NRC), Committee to Assess the U.S. Army Corps of Engineers Water Resources Project Planning Procedures. 1999. *New Directions in Water Resources Planning for the US Army Corps of Engineers*. Washington, DC: Water Science and Technology Board, NRC.

- National Research Council (NRC), Panel on Methods and Techniques of Project Analysis, Committee to Assess the U.S. Army Corps of Engineers Methods of Analysis and Peer Review for Water Resources Project Planning. 2004. *Analytical Methods and Approaches for Water Resources Project Planning*. Washington, DC: Water Science and Technology Board, NRC.
- National Wildlife Federation (NWF). 1998. *Higher Ground: A Report on Voluntary Property Buyouts in the Nation's Floodplains*. Washington, DC: National Wildlife Federation.
- Task Force on Federal Flood Control Policy. 1966. *House Document No. 465: A Unified National Program for Managing Flood Losses*. 89th Congress, 2nd Session, on Public Works. Washington, DC: U.S. Government Printing Office.
- US Army Corps of Engineers (USACE). 1983. *Shaping Environmental Awareness - The United States Army Corps of Engineers Environmental Advisory Board, 1970-1980*. Washington, DC: USACE.
- USACE. 1995. *Floodplain Management Assessment of the Upper Mississippi River and Lower Missouri River and Tributaries*. Washington, DC: USACE.
- USACE. 1999. 'Nonstructural Flood Damage Reduction Projects.' http://www.usace.army.mil/inet/functions/cw/cecwp/branches/mp_and_dev/nonstr.pdf.
- USACE. 2000. *Planning Guidance*. Engineer Regulation 1105-2-100. Washington, DC: USACE.
- USACE. 2001. *Non-Structural Flood Damage Reduction Within the Corps of Engineers: What Districts Are Doing*. Washington, DC: USACE National Nonstructural/Floodproofing Committee.
- USACE. 2002a. Civil Works Program Statistics: Information Paper. CECW-ZD. 28 February 2002.
- USACE. 2002b. Environmental Operating Principles. <http://www.hq.usace.army.mil/cepa/envprinciples.htm>.
- USACE. 2002c. *Civil Works Program Strategic Plan FY 2003 - FY 2008. Draft*. September, 2002. Washington, DC: USACE
- USACE. 2003. 'Upper Mississippi River Comprehensive Plan.' <http://www.mvr.usace.army.mil/UMRCP/>.
- US Geological Survey (USGS). 2000. *Significant Floods in the United States During the 20th Century - USGS Measures a Century of Floods* USGS Fact Sheet 024-00 March 2000. Reston, VA: USGS.
- US Water Resources Council (WRC). 1983. *Economic and Environmental Principles for Water and Related Land Resources for Implementation Studies*. Washington, DC: U.S. Water Resources Council.
- Western Governors' Association (WGA). 1997. *An Action Plan for Reducing Flood Risk in the West*. Denver, CO: Western Governors' Association.

Gerald E. Galloway, Jr., Corps of Engineers Responses to the Changing National Approach to Floodplain Management Since the 1993 Midwest Flood, J. OF CONTEMP. WATER RES. & EDUC., Mar. Frequent floods on the Mississippi River have continued into modern times. In spite of humankind's best engineering efforts, the river occasionally flexes its muscles and escapes its banks, gobbling up everything in its path: sometimes it takes a hurricane to provoke this behavior; some-times it just takes rain. Much of the lower Mississippi Valley was inundated in 1849.³⁰ Major floods recurred every decade or so thereafter Flood risk management seeks to reduce the risk from flood events to the people who are located in floodprone areas. As indicated in earlier chapters, there is some level of risk to all locations within the floodplain. The magnitude of that risk is a function of the flood's characteristics without consideration of mitigation and risk transfer measures and the vulnerability of the population. Each mitigation and risk transfer measure reduces the overall risk to some degree, but it is impossible to completely eliminate risk. A flood risk management strategy identifies and implements measures that reduce the overall risk and what remains is the residual risk (Figure 6-1).

Corps of Engineers Responses to the Changing National Approach to Floodplain Management Since the 1993 Midwest Flood: Corps of Engineers more. by Gerald Galloway. Publication Date: 2009. Damages associated with the Mississippi River Flood of 1993 exceeded \$12 billion and these costs do not include the non-quantifiable, human impacts of this disaster. In a report submitted to the White House in June 1994, a federal interagency floodplain management review committee proposed better ways to manage the nation's floodplains.