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CASE STUDY

USA: *FLOOD MANAGEMENT - MISSISSIPPI RIVER*

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1. Location

1.1 The Mississippi Basin occupies the center section of the contiguous 48 states of the United States (Figure 1). Flood prone areas in the basin are found adjacent to the Mississippi River and its tributaries, with the largest flood prone region found in the 90,650 km^2 Lower Mississippi River Valley (Center longitude: 90W**;** latitude: 40N). While outlining the features of the entire basin, this study will focus on only the Mississippi River itself and not its major tributaries

1.2 Basin Description

1.2.1 Physical Features

From its headwaters in upper Minnesota at Lake Itasca, the Mississippi runs 3700 km to its mouth in the Gulf of Mexico, some 145 km below New Orleans, Louisiana. The Mississippi River drainage basin is the fourth largest in the world, over 3,60,000 km^2, and includes 41% of the contiguous United States (portions of 31 states) and parts of two Canadian provinces (Table 1). The Mississippi basin stretches from the Rocky Mountains in the West to the Appalachian Mountains in the East. Tributaries of the Mississippi include the second and third largest rivers in the United States, the Ohio and Missouri, as well as numerous smaller, yet still imposing rivers. The Missouri River stretches from near St. Louis, Missouri, to the northwest into the Rocky Mountains. The Ohio flows from the northeast, joining with the Mississippi near Cairo at the southern tip of the state of Illinois. The Upper Mississippi River begins near the Canadian border and flows south to its confluence with the Ohio. The river can be divided into two segments: the upper Mississippi from its headwaters through Minneapolis and St. Louis to the Ohio, 2120 km, and the lower Mississippi, from the Ohio to the Gulf, 1580km. At a distance of 485 km above the Mississippi's mouth at the Gulf of Mexico, the Mississippi flows are shared with its principal distributary, the Atchafalaya River. This division results in the Atchafalaya receiving, on an average, approximately 30 percent of the flow at that latitude while the remaining 70 percent is carried by the Mississippi. From Lake Itasca (440 m above MSL) to Minneapolis, the upper Mississippi meanders through glacial outwash, plains and moraines. From Minneapolis south it flows through valleys with well-defined floodplains and valley walls. Just north of the junction of the Ohio and the Mississippi, the alluvial valley of the Mississippi River begins. This valley of 90,650 km^2 falls from an elevation of 91.5 m above MSL at Cairo to sea level at the Gulf of Mexico some 1580 river km distant. Between Cairo and Vicksburg, it is joined by the Arkansas River. The valley varies in width from 32 km to 129 km across with an average width of 73 km. At Vicksburg, Mississippi, 874 km to the south of Cairo, the mean annual flow is nominally 16,510 $m^3.s^{-1}$. (Galloway) The climate along the river is continental with annual rainfall maximums varying from 200 cm in the south to 110 cm in the north.

1.2.2 Land and Water Use Patterns

The Mississippi River was a major highway for early exploration and settlement of the Midwest United States. As a result hundreds of cities were built along its banks. Some prospered over the years; others have dwindled in size and importance. Most notable among the large cities are Minneapolis and St Paul in Minnesota, St. Louis, Missouri; Memphis, Tennessee; Vicksburg, Mississippi; and Baton Rouge and New Orleans, Louisiana. They range in population from 3 million in the Minneapolis-St Paul metropolitan area in New Orleans to under 50,000 in smaller cities like Vicksburg. All or parts of these communities are located in the floodplain and have been subject to floods or a flood threat since settlement. Industry is present in and adjacent to

1 U.S. Army Corps of Engineers; International Joint Commission - Canada/USA

the major cities along the river. Agriculture, grains, soybeans and cotton, is a major element in the economy of the10 states though which the river flows. The river and the land adjacent to it provide important habitat for fish and wildlife with the Mississippi providing the largest and longest continuous system of wetlands in North America (USGS). A Mississippi River navigation project provides a minimum channel depth of 2.7 m and a minimum channel width of 91.4 m between St. Paul and Baton Rouge, Louisiana. From Baton Rouge to the Gulf of Mexico, the navigable, channel is 13.8 m deep by 152.4 m wide allowing both Baton Rouge and New Orleans to serve as major termini for international waterborne commerce. Navigation on the upper Mississippi is made possible by 29 locks and dams that maintain the required channel depths. (Nav Study). Each year over 500 million short tons of cargo pass up and down the Mississippi. This cargo is predominately bulk and consists primarily of coal, grains, and other large items. The largest single cargoes travel from the coal and agricultural fields of the central United States to the ports of Baton Rouge and New Orleans for export overseas. Mississippi system traffic handles 42% of the agricultural products exported from the US.

2. Floods

2.1 Types of Floods

The most significant floods on the Mississippi River result from regional rainfall and snowmelt events that cause slow rise on the rivers and extend for days or weeks. Because of the influence of tributary flow (including the major tributaries, the Ohio, Missouri and Arkansas Rivers), the magnitude of flooding increases moving downstream from the headwaters to the mouth. Short, intense rainfall events can cause flash floods or quick rise and fall floods on the tributaries but do not normally affect the mainstem.

2.2 Historical Flood Events

Floods have were part of the earliest recorded history of the Mississippi. In 1543, explorer Hernando Desoto encountered a flood on the Mississippi near Memphis, Tennessee that extended over 40 days. The founders of New Orleans in began to erect local levees in the early 1700's to protect against floods. Over bank flow was and continues to be a natural occurrence in the bottomlands and alluvial valleys of the river but only became a problem as settlement occurred along the river and within the floodplains. Floods and flood damages significant enough to merit regional or national attention occurred on the Mississippi in 1849, 1850, 1882, 1912, 1913, 1927, 1936 1950, 1973, 1993 and 2001. The largest flood flow recorded on the lower Mississippi was 64,500 $m^3.s^{-1}$. The 1993 flood flow on the upper Mississippi exceeded 28,000 $m^3.s^{-1}$.

2.3 Today, when a natural or human induced event is of such severity and magnitude that effective response is beyond the capabilities of a state or local government, it is designated by the President of the United States as disaster. Prior to the use of Presidential designations, floods that displaced thousands of people or covered large land areas for extended periods generally were labeled disasters by the media and the government. The Flood of 1927 on the lower Mississippi was the flood that brought national attention to the need for federal involvement in flood damage reduction. This event devastated the levee protection system and resulted in flooding of over 67,340 km^2 of land, displaced more than 600,000 people from their homes, took over 200 lives and cost over $10 billion in 1998 dollars (Barry, McCormick). A significant flood occurred in 1936 in the Ohio and lower Mississippi basins and while causing enormous damage in the Ohio passed through the lower Mississippi without significant impact. The major flood events in 1973 and 1993 similarly were passed in the lower valley without major economic disruption. The 1993 flood reached disaster proportions in the upper Mississippi (and Missouri basins). Thirty-eight deaths were attributed directly to the flood, estimates of fiscal damages ranged from $12 billion to $20 billion and over 6.6 million acres were flooded. Agriculture accounted for over half of these damages. More than 100,000 homes were damaged. Flood response and recovery operations cost more than $6 billion.

3. Flood Management Measures

3.1 Flood Management Measures in the United States

For over two centuries, structural measures dominated the US response to flooding. From the settlements in Louisiana in the early 1700's until the early 20th century, the country, the principal and frequently only approach to flood damage reduction was the construction of levees. In the early 20th century, levees were augmented by channel work to speed floodwaters to their ultimate destinations. Prior to 1927, for the most part, the federal government limited its involvement in preventing and mitigating flood damages. While the impacts of flooding were recognized, the government restricted its efforts to development of hydrologic and hydraulic information, advice on flood damage reduction methods, (essentially levee and channel work) and enactment of laws that permitted sale of federally owned swamp (bottomlands) to produce revenue to permit the draining of these lands and their flood protection. Following the 1927 flood disaster on the Mississippi, the federal government assigned primary responsibility for flood protection in the lower Mississippi to the US Army Corps of Engineers (Corps) which embarked on a major program of levee strengthening, construction of major floodways (Table 2) and river bend cut offs (discontinued at the end of the 1930's) and channel stabilization, efforts which continues to this day. The 1936 flood in prompted the federal government to assume responsibility for flood control throughout the nation with a clear structural focus - construction of levees, floodwalls, channel work, floodways and flood storage in reservoirs. Concurrent with the expansion of interest in these structural measures, federal efforts were under way to preserve eroding lands and reduce runoff by holding water on upstream lands. At the same time, upland and floodplain wetlands were being converted to agricultural and urban use. In the mid 1950's, initial proposals were made for the use of non-structural measures to reduce flood damages and a slow movement in that direction began. In 1969, the federal government instituted the National Flood Insurance Program (NFIP), which combines subsidized flood insurance with requirement for participating communities to regulate land use in the floodplain. The evolution of attention to environmental factors in water resources development brought increased focus on the need to include preservation and protection of the environment in plans for flood damage reduction.

3.2 Efficacy of Flood Management Measures

Flood management measures in themselves have over the years prevented significant flood damages. In the 1993 Mississippi River flood, the presence of federal projects prevented over $18 billion in damages in the upper Mississippi and Missouri basins. The lower Mississippi River flood control project has cost over $10 billion but has prevented over $244 billion in damages. Relocation of flood prone structures in the upper Mississippi basin following the 1993 flood produced immediate benefits during flood events in 1995, 1997 and 2001. However, in spite of these statistics, annual flood losses in the United States continue to increase. Average annual flood losses in the United States are currently estimated at $6 billion representing a four-fold increase over the last century. Lack of comprehensive planning, encroachment on the floodplain and upstream development and land conversion, which eliminates storage and increases flood flows, continue to increase the risk of flood damages. While much has been written since the 1993 flood about what needs to be done to reduce flood damages, there has been no comprehensive legislation offered to address the flood challenge. As indicated in subsequent sections, the National Flood Insurance Program has been tightened to close loopholes in the program, and the government has undertaken a major effort to relocate those at most risk, but these efforts provide only partial solutions to the larger problem of increased floodplain occupant vulnerability.

3.3 Flood Mitigation on the Mississippi

3.3.1 Structural

On the upper Mississippi and its tributaries, levees and floodwalls provide the bulk of the flood protection. Flood storage reservoirs exist on the tributaries to provide protection, primarily to communities on the tributaries. Federal projects have been individually approved and constructed and are not part of any comprehensive plan for the upper basin or the upper Mississippi River. They are complemented by over 1600 km of local and private levees. In the lower Mississippi Valley the bulk of the protection is also structural but has been put in place under a comprehensive plan developed in 1928 by the Corps and implemented and modified over the succeeding years by the Mississippi River Commission and the Corps. The plan includes over 2500 km of levees and floodwalls, channel stabilization and four major floodways. Tributaries are controlled by upstream flood storage reservoirs, which protect the areas below them and have a relatively minor impact on the mainstem flows and flood stages

3.3.2 Nonstructural

Nonstructural activity has played a relatively small role in flood damage reduction activities on the Mississippi. National flood insurance has been available to floodplain residents since 1969 yet only 20%-30% of those eligible for insurance participate in the program (see appendix). Some floodplain zoning has taken place as a result of community participation in the flood insurance program. Relocation of flood prone homes and activities has concurred and its use is growing. Flood notification systems have been in use for decades to inform the public about the threat of flooding and provide residents the opportunity to clear the hazard area and move valuables to higher ground. In the Mississippi Valley, resident rely primarily on the media and access to flood information on the Internet to get information about the timing of flood stages.

3.4 Modifications following extreme Flood events

3.4.1 Flood Mitigation

Prior to the 1928 flood, flood mitigation was essentially a levees only approach. The 1928 plan for the lower Mississippi focused on development of a basin-wide approach and added use of floodways, cutoffs, and increased attention to channel improvement and stabilization. Tributary reservoirs were added in subsequent years. Because of the degradation of the river stability caused by the cutoffs built in the 1930's, further use of this approach was halted. Following each major flood, the Commission has evaluated the project flood flow line and has modified the levee heights required to pass a new project flood that takes into account the most recent flood event. Between 1928 and 1999, this has resulted in several increases in levee height. Analysis of the 1973 flood indicated that some sections of the levee system in lower Mississippi would have to be raised as much as 1.5 meters in order to safely pass the expected maximum flood. The 1993 flood disaster on the upper Mississippi focused attention on the lack of a comprehensive plan for the upper basin and such a plan is now under development. It also brought into question the essentially levees only approach being employed on the upper Mississippi. Since 1993, efforts have been made to give greater attention to non-structural measures on the upper Mississippi and one community, Davenport, Iowa, has rejected a federal levee project in favor of a non-structural approach.

3.4.2 New Approaches

On the upper Mississippi (as well as throughout the nation), following the 1993 flood the federal government increased its support of relocation activities. Since 1993, over 13, 000 homes have been relocated or removed from the floodplain in the upper Mississippi-Missouri region (over 25, 000 nation-wide). One community in Illinois was relocated in its entirerity. State and federal governments and private organizations have voluntarily acquired several hundred thousand acres of frequently flooded agricultural lands from willing sellers. These now serve as flood storage areas. Increased attention in planning is given to upland wetland restoration and improvement of farming practices. Federal funding support is now provided for farmers to voluntarily place land in conservation reserve to provide habitat and flood storage. The occurrence of the major floods as well as increased attention to the environment caused the Mississippi River Commission to seek means to ensure that flood control and related channel

improvement projects can be accomplished in a manner that not only supports attainment of project purposes but also preserves and enhances the natural environment. Examples include the following:

- To provide a freshwater supplies to vast wetland acreages near the Louisiana coast that had been isolated from these supplies by the construction of levees, the Corps has constructed two major structures in levees near New Orleans (and is planning a third) to permit, in non-flood periods, the diversion of Mississippi River waters into these areas and the overland flow of the waters into the Gulf of Mexico. The most recently completed project, Davis Pond Diversion (figure 2) that cost nearly $120 million, will divert, during non-flood periods, 301 $m^3.s^{-1}$ of fresh water, nutrients and sediments from the Mississippi to the salt-threatened Bataria estuary that connects with the Gulf of Mexico. The project is expected to provide over $15 million in benefits to fish and wildlife each year.

- As part of a program to stabilize the river banks in the Lower Mississippi, articulated concrete revetment is placed on the banks. In a new program, the surface of the 1.2 x 7.6 meter sections that make up the revetment is being roughened to increase the production of aquatic macro-invertebrates. In 2001, over 70,000 of these new sections were placed on the banks.

- As levee heights are increased to comply with new flood lines considerable soil must be obtained from nearby areas. Not only must the height be increased but also the entire cross section. In accomplishing this work, every effort is made to concurrently increase the wetland habitat on the riverside of the levees. The areas used to provide material for the levees, borrow pits, are designed to provide irregular bottoms and small uncleared islands that improve fish and wildlife habitat.

- Tree screens, buffer strips of trees, are being planted along the riverbanks to shield levees from the adverse effects of river overflows and to provide habitat.

- Long-term environmental programs have been instituted on both the upper and lower Mississippi to monitor the impact of both navigation and other river development activities, including flood control.

Because of the magnitude of the flood events experienced on the lower Mississippi River and the nature of the catastrophe that would occur if levees were overtopped or failed, the maintenance of a strong levee system and channel stabilization program remains of paramount importance. Nonstructural approaches, such as relocation of floodprone structures and floodproofing are being applied in the limited number of cases where homes are located on the river side of existing levees.

4. Flood and Water Management Instruments

4.1 Information and Data Collection

The federal government provides a vast array data collection, storage and dissemination in support of integrated flood management. The US Geological Survey is charged with providing baseline information on US water resources and operation of gauging stations on most US rivers (http://water.usgs.gov). There are 84 sites on the lower Mississippi and its tributaries and 406 on the upper Mississippi and its tributaries (not including the Ohio and Missouri). The Corps also remotely operates and monitors selected gauges in the Mississippi basin for use in water control activities (http://www.mvd.usace.army.mil/riverstages.html). The National Oceanic and Atmospheric Administration makes weather forecasts and flood stage data as well as historic data available on the web (http://www.noaa.gov)

4.2 Allocation of Resources

The largest allocation of federal resources to support integrated flood management is made annually to the Corps for conduct of its activities on the river and within this, the majority is directed to the lower river project activities (which include navigation, flood control, environmental enhancement and recreation) In the fiscal year 2002 over $350 million was provided to the Corps, the bulk of which was directed to the lower river (State of the River). Additional funds are provided on a national basis to the information and data agencies to the information and data agencies such as the US Geological Survey and the National Oceanic and Atmospheric Administration which collect and disseminate river, and weather and climate data and information, to the Federal Emergency Management Agency which supports flood mitigation activities such as relocations, advanced preparation for floods, and flood insurance, and to the resource agencies of the Department of Interior which provide advice to the Corps on flood management. States and communities also provide resources to support flood management and the development of both structural and non-structural projects. For the most part, state efforts are directed to coordination of local activity and development of legislation related to floodplain management. Communities and special organizations such as levee districts operate and maintain completed structures and normally provide the 25 percent non-federal cost share of federal projects, both structural and non-structural. Specific cost figures are not available from these organizations. Since, at present, under federal laws, it is easier to justify structural than non-structural projects, local governments gravitate toward the former.

4.3 Mechanisms for Effective Use of Floodwaters and Floodplains

Because of the magnitude of the floods on the Mississippi, nothing is done to 'capture' floodwaters. The attention is on passing these waters as rapidly as possible down the river into the Gulf of Mexico. Until the last two decades, the emphasis on floodplains was directed to providing protection for the floodplains against flood to enable the economic use of the rich, flat and fertile alluvial lands for agriculture and development. More recently there has been increased attention to moving unsuitable uses (homes and fields that frequently flood or whose protection is not economically justified) out of the floodplain and conversion of those lands to natural uses.

4.4 Law Enforcement Mechanisms, Incentives And Sanctions

In order for members of community to participate in the National Flood Insurance Program, the community must agree to require all new construction or substantial modifications of post flood-damaged structures in the floodplain to meet federal guidelines (essentially first floor elevation above the one percent floods elevation). Failure to comply with this restriction results in exclusion form the federal program. Communities that have developed exceptional programs and are actively moving to reduce flood risks are identified and insurance holders within those communities receive lower rates for their insurance. Where communities, in or out of the NFIP permit construction activities in the floodway, federal agencies can go to court to seek removal of the structures.

5. Policy

5.1 National and State Policies

The national Flood Control Act of 1936 states that "…flood control is a proper activity of the Federal Government" and that "…the Federal Government should improve or participate in improvements...for flood control purposes if the benefits to whomsoever they accrue are in excess of the estimated costs..." While this Act remains in force, over time, it has shifted from a program of almost full federal funding to one in which states and local sponsors share the costs of both structural and non-structural activities. The ability of federal agencies to operate under the Flood Control Act has been modified by the enactment of other laws governing the environment and flood mitigation.

5.2 Policy Changes Made In Response To Extreme Flood Events

5.2.1 Cost Sharing

While no single flood event triggered the enactment of cost-sharing for federal water projects, the growing national concern over a failure of local interests and beneficiaries to bear their fair share of project costs led the federal government to move in 1986 to cost-sharing between the federal government and the local sponsors of federal water projects.

5.2.2 Policy

Following the 1993 Mississippi Flood, the President directed a study of federal flood policy. In its report to the White House in 1994, the federal team chartered to examine the flood stated that the nation was not making full use of non-structural approaches to flood damage reduction. The team proposed that development in the floodplain should be avoided unless no alternative locations existed. When development was to take place, it argued that the first method of reducing potential damages should be the retention of rainwater in the location in which it falls through use of land treatment and natural and artificial reservoirs. It then suggested that structures in the floodplain should be floodproofed, that where possible those at most risk should be relocated from the floodplain and that only after the first approaches had been attempted should levees and floodwalls be constructed. Much attention has been given to the report and several federal programs are supporting its recommendations.

5.2.3 Watershed Management

Increased concern over water quality and the environment in general led the federal government to institute major initiatives to encourage development of comprehensive watershed plans that would not only address these issues but would also integrate other water resource development activities in the planning. Federal agencies are directed to coordinate with each other and the relevant state agencies. in the development of any actions within a watershed. Such watershed planning encourages the integration of flood management activities within the context of integrated watershed planning

6. Institutions Responsible For Flood Management

6.1 Institutions

The Corps of Engineers and the Federal Emergency Management Agency are the lead federal agencies in flood management. The Corps role is to lead in the development of comprehensive plans for flood damage reduction, and then as authorized by the Congress and the President, to carry out flood damage reduction projects, both structural and non structural. FEMA is charged with preparing for and responding to all natural disasters and operation of the NFIP. Parallel state agencies perform similar functions at their level. Other federal and state agencies dealing with housing, economic development, agriculture, transportation, energy, and the environment collect and provide data, support post-disaster reconstruction, advise the Corps and FEMA on the impacts of their activities and support actions by communities and sectors to reduce their vulnerability. The most challenging responsibilities fall to local governments that must ensure, through zoning or other land planning, the proper use of the floodplain and, in the event of a flood, must become first responders to the hazard situation. Typically, local governments have more responsibility than resources needed to deal with the challenges.

6.2 Institutional Cooperation

The nature of the US federal organizations (sector stovepipes) creates the potential for lack of coordination. Comprehensive and project planning activities of the agencies is less well coordinated than activities that take place during or immediately following a major flood. On the occasion of a major flood, the President will typically name a senior member of his cabinet to ensure coordination of the federal agencies. For smaller floods, the Director of FEMA assumes this role.

6.3 Interest Groups

Non-governmental Organizations are active in flood management. During the development of plans for flood damage reduction or mitigation by any federal or state agency there is ample opportunity for public comment and participation in the planning process. During a flood NGOs are among the first on the scene to assist with disaster response. Following the flood, these same organizations participate in the dialog over the correct approaches that should be taken in responding to this flood and preparing for the next.

7. Lessons Learned

In nearly three centuries of flood management activities on the Mississippi the US federal government policies and activities to deal with flooding have shifted from 'let the locals do it' to full federal responsibility for an essentially structural only approach, to a federally led, locally shared mix of structural and non-structural elements that are gradually being combined with other water resource activities in a an integrated and comprehensive approach to basin water resources management. The sheer size of the Mississippi and the Constitutional authorities of the states lessen the ability of the federal government to develop a uniform approach. The 75 years of comprehensive planning for flood management in the lower Mississippi was initially focused on flood control and navigation and has essentially succeeded in meeting these goals. Over time, navigation and flood control interests have integrated environmental and recreational needs to begin to develop a more integrated approach. In the upper Mississippi, the absence of a comprehensive flood management plan, a separate systems approach to navigation, and ad hoc environmental activities have not produced an integrated flood management strategy; however, efforts have now begun to do so. The technology of powerful data storage and manipulation devices, geographic information systems, remote sensing capabilities and global positioning are now making integrated planning of this complex river possible.

Appendix

The National Flood Insurance Program (NFIP)

Spurred by the increasing level of flood damages throughout the nation and the significant percentage of the costs of those damages that fell to taxpayers as well as a push from those favoring non-structural approaches to flood damage reduction, in 1969 the US Congress created the National Flood Insurance Program (NFIP). The Federal Emergency Management Agency's Flood Insurance and Mitigation Administration (formerly the Flood Insurance Administration) manages the NFIP and oversees its operations. The insurance is actually sold and administered by private insurance companies or through independent brokers.

Any resident – homeowner or business person - of a community participating in the NFIP may purchase flood insurance. Under the NFIP, in order for a community to join the program, it must agree to establish and enforce floodplain management ordinances designed to limit development in the floodway and at elevations below the 1 percent flood level (the 100-year flood). In 2002, nearly 20,000 communities were participating in the NFIP with over 4 million polices in effect. Those buying homes in a NFIP community and who require loans from a federally regulated or federally insured lender are required to purchase flood insurance if they live in a designated flood risk zone (the 1 percent flood zone). Those who do not live in NFIP communities are not eligible for participation in the federal program. The rates for flood insurance for structures built after the community joined the NFIP and after a flood map was developed for the community are actuarial. Rates for those whose homes were already built are slightly subsidized by the federal government. In both cases, the costs of NFIP administration are borne by the federal government. If, in the course of periodic program evaluations, FEMA determines that the community's program is especially effective, it will reduce the insurance rates for those in the community. More than 70 percent of homes in the NFIP are insured at the actuarial rates and the percentage grows each year as older homes leave the program.

Until the 1993 Mississippi River Flood, purchase of insurance by individuals in flood hazard areas was spotty, with participation among those eligible ranging from 10-30%. Reasons for low participation varied from lack of knowledge of the program, lack of enforcement of the mandatory purchase provision for borrowers, to a well substantiated belief among many that the federal and stare governments would provide relief funds in the event of a flood so insurance would not be necessary. In addition, flood insurance could be purchased and take effect within a 5 day period. As a result of the 1993 Flood, the Congress legislated that there be a 30-day waiting period and directed lender compliance with the mandatory purchase provisions. FEMA also began a major public affairs program to get the flood insurance message to every community.

A major challenge facing the NFIP is the cost of respectively damaged property. Under current law, a property owner of repetitively damaged property does not see an increase in insurance rates. Efforts to legislate a change in this policy have failed; however, FEMA, under its own authorities and other authorities available to it, has required those whose homes were damaged to more than 50% of their value to relocate or rebuild in compliance with the flood plain ordinances. FEMA, under its mitigation authorities, has also sought to voluntarily relocate the homes that are most at risk. The NFIP also permits communities to eliminate the mandatory insurance provisions when the affected properties are located behind a levee or a floodwall that provides protection at or above the 100-year flood elevation. The 1994 federal report on the Mississippi Flood recommended that insurance, albeit a t a reduced rate, should be mandatory for those locate d behind levee in order to alert the residents to the potential hazard as well as cover the costs of flood damages for those occasions when levees are overtopped.

On average, the NFIP is self-supporting. In a typical year, the costs of flood claims and operating expenses are paid for by the premiums collected from participants. In a year with excessive flooding, the program may borrow funds from the federal government to cover its costs but these funds must be paid back to the government with interest. In 2000, FEMA received over $1.7 billion in premium payments. FEMA indicates that, " Flood damage is reduced by nearly $1 billion a year through partnerships with communities, the insurance industry, and the lending industry. Further, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance. And, every $3 paid in flood insurance claims saves $1 in disaster assistance payments." FEMA is currently conducting a major review of the NFIP to determine its effectiveness and potential for improvement. A final report is expected in 2003.

Tables

Table 1. Major Mississippi Basin Catchment Areas

Catchment	**River Length (km)**	**Mean Flow ($M^3.S^{-1}$)**	**Catchment Area km^2**
Upper Mississippi	2,120	5,918 (Thebes)	390,000
Missouri		4,090	2,300	1,371,000
Ohio	2,100	7,870	419,000
Lower Mississippi	1,580	16,510 (Vicksburg)	269,000
Arkansas	2,350	2,067	608,000
Red	2,080	687 (Shreveport)	244,000

Table 2. Mississippi River Floodways

Floodway	**Capacity ($M^3.S^{-1}$)**
New Madrid, Missouri	15,580
Old River, Louisiana	17.650
Morganza, Louisiana	17,000
Bonnet Carre, Louisiana	7,080

Figure 1 Mississippi river basin

Figure 2.