



USA: FLOOD MANAGEMENT - MISSISSIPPI RIVER

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Abstract. Comprehensive information is provided on approaches and experience in flood management for the Mississippi basin. Of interest are the changes to mix of structural and non-structural elements gradually being combined with other water resources activities in an integrated and comprehensive approach to basin water resources management, and the establishment of the national flood insurance programme

1. Location

1.1 The Mississippi Basin occupies the center section of the contiguous 48 states of the United States. From its headwaters in upper Minnesota, the Mississippi runs 3,700 km to its mouth in the Gulf of Mexico, some 145 km below New Orleans, Louisiana. Its drainage basin is the fourth largest in the world, with over 360,000 km², and includes 41% of the contiguous US (portions of 31 states) and parts of two Canadian provinces. Its tributaries include the second and third largest rivers in the US, as well as numerous smaller, yet still imposing rivers. Flood-prone areas in the basin are found adjacent to the Mississippi and its tributaries, with the largest flood-prone region found in the 90,650 km² Lower Mississippi River Valley. This valley varies in width from 32 km to 129 km across, with an average width of 73 km.

Many cities were built along its banks; they range in population from 3 million in the Minneapolis-St Paul metropolitan area and in New Orleans, to under 50,000 in smaller cities like Vicksburg. All or parts of these are located in the floodplain, subject to floods or a flood threat since settlement. Industry is present in, and adjacent to the major cities. Agriculture is a major element in the economy of 10 states through 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 the US. Finally, the river constitutes an important navigation system for national and international waterborne commerce.

2. Nature of floods

Floods have been part of the earliest recorded history of the Mississippi. Significant floods result from regional rainfall and snowmelt events that cause slow raises on rivers and extend for days or weeks. Due to the influence of tributary flows the magnitude of flooding increases moving downstream 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 main stem.

About 11 significant flood events and flood damages occurred on the Mississippi between 1849 and 2001, with catastrophic flooding in 1927, 1936, 1973 and 1993. The 1927 event on the Lower Mississippi devastated the levee protection system and resulted in flooding of over 67,340 km² of land, displaced more than 600,000 people from their homes, took over 200 lives and cost over USD 10 billion (in 1998 dollars). The flood in 1993 reached disaster² proportions in the upper Mississippi and Missouri basins. Thirty-eight deaths were attributed directly to the flood; estimates of damages ranged from USD 12 to 20 billion and over 6.6 million acres were flooded. Agriculture accounted for over half of these damages, and more than 100,000 homes were damaged. Flood response and recovery operations cost more than USD 6 billion.

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² 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



3. Flood management and mitigation strategies

For over two centuries, *structural measures* dominated the US response to flooding. The founders of New Orleans began to erect local levees in the early 1700's to protect against floods. Over-bank flow was 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. Thus the principal, and frequently only, approach to flood damage reduction was the construction of levees.

The flood of 1927 on the Lower Mississippi brought national attention to the need for federal involvement in flood damage reduction. The 1928 plan for the Lower Mississippi focused on development of a basin-wide approach with levee strengthening and added use of floodways, cut-offs, and increased attention to channel improvement and stabilization work so as to speed floodwaters to their ultimate destination. Tributary reservoirs were added in subsequent years. The 1936 flood prompted Government to assume responsibility for flood control throughout the nation, again with a clear structural focus. Concurrent with the expansion of the above 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 converted to agricultural and urban use.

As a result, 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. They are complemented by over 1600 km of local and private levees. Federal projects were individually approved and constructed. However, since the 1993 flood a comprehensive plan for the upper Mississippi River is now under development. 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 and implemented and modified over the succeeding years. The plan includes over 2500 km of levees and floodwalls, channel stabilization and four major floodways, and tributaries are controlled by upstream flood storage reservoirs.

In the mid 1950's, initial proposals were made for the use of also *non-structural measures* to reduce flood damages and a slow movement in that direction began. In 1969, 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. Currently, 20%-30% of those floodplain residents eligible for insurance participate in the program. Some floodplain zoning has taken place as a result of community participation in the NFIP. Flood notification systems have been in use for decades to inform and warn the public about the threat of flooding. 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.

Following the 1993 flood Government increased its support of relocation activities. 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.

Flood management structural and non-structural measures have over the years prevented significant flood damages. However, annual flood losses in the US continue to increase (currently estimated at USD 6 billion), representing a four-fold increase over the last century. Encroachment on the floodplain and upstream development and land conversion continue to increase floodplain occupant vulnerability. There is still need for a comprehensive legislation offered to address the flood challenge.

4. Flood and water management instruments



The federal Government provides a vast array data collection, storage and dissemination in support of integrated flood management. Amongst these, the *US Geological Survey* (USGS) provides baseline information on national water resources and operation of gauging stations on most US rivers. 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 of Engineers* also remotely operates and monitors selected gauges in the Mississippi basin for use in water control activities. The *National Oceanic and Atmospheric Administration* (NOAA) makes weather and flood stage forecasts as well as historic data available.

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 for various purposes. Additional funds are provided to the information and data agencies such as the USGS and NOAA, to the *Federal Emergency Management Agency* (FEMA) 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 % non-federal cost share of federal projects, both structural and non-structural.

In order for members of community to participate in the NFIP, the community must agree to require all new construction or substantial modifications of post flood-damaged structures in the floodplain to meet federal guidelines. Failure to comply with this restriction results in exclusion from 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. Institutions responsible for flood management

The abovementioned *Corps of Engineers* and FEMA 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, once authorized, 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.

Due to the nature of the US federal agencies, their comprehensive and project planning activities are 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, FEMA assumes this role.

Non-governmental Organizations (NGO's) 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.

6. Policy

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.

Following the 1993 flood, a study undertaken of federal flood policy stated that the nation was not making full use of non-structural approaches to flood damage reduction. It was proposed that development in the floodplain should be avoided unless no alternative locations existed. When development was to take place, 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. Furthermore, that structures in the floodplain should be flood-proofed, 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 ensuing report and several federal programs are supporting its recommendations.

Increased concern over water quality and the environment in general led 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. This encourages the integration of flood management activities within the context of integrated watershed planning.

7. Main lessons learned

- In nearly three centuries of flood management on the Mississippi 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 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.