USA - EVOLUTION OF POLICY ON FLOODPLAIN MANAGEMENT CASE #86

This case describes integrated floodplain strategies in the US, involving the participation of three levels of government and the private sector.

Abstract

Flood damages are caused by excessive precipitation and actions that place people and property in watercourses, and account for more losses than any other natural hazard threatening the United States. Providing protection against flood damages involves land use controls, and must be integrated with other water management objectives. Moreover, floods cross jurisdictions and require a great deal of coordination. Analyzing floods requires hydrology, engineering, and social science. Responses to them include measures to regulate land use in the floodplain, use flood control reservoirs, use mitigation techniques, and preserve natural and cultural resources of floodplains. Nature favors the nonstructural approach, and there are beneficial effects of floods. However, reliable flood control structures sometimes prevent devastating damages and loss of life.

In the US, structural approaches dominated the early water development era. About 1940, thinking began to shift, influenced by work of Gilbert White at the University of Chicago. In 1966, a unified national program for flood losses was recommended. In 1976 a federal report cited coordination as the weakest component of management efforts. By 1986, the Federal Emergency Management Agency (FEMA) had assumed responsibility for a federal interagency task force, and presented a mitigation strategy. In 1993 a report of an interagency review committee after the Great Mississippi River Floods of that year, stated that structural measures should be used only when they can be integrated into a systems approach to basin–wide flood damage reduction. In 2001, an integrated strategy is favored, with participation by three levels of government and the private sector. Most flood plain management is by local government, with continuing integration of small and large problems, considering land use and water quality objectives, as well as flood damage reduction. FEMA operates a comprehensive program with a number of elements and is developing software (HAZUS) for national flood loss estimation.

Lessons Learned

- Flood damage reduction requires a complex mixture of policies that include both structural and non–structural measures to promote multiple objectives.
- Flood policy requires a comprehensive support program consisting of flood plain mapping, hydrologic and engineering studies, insurance, warning systems, and measures for mitigation, response, and recovery.
- Flood insurance programs require careful study to promote positive effects and to avoid unintended incentives and subsidies. The US system requires further evaluation.
- Floods require effective technological approaches that include use of information technology tools such as GIS, flood models, warning systems, and mapping. Small government units may not be able to afford sophisticated systems.
- Structural measures should normally be used only when they can be integrated into a systems approach to basin–wide flood damage reduction.
- Flood policy is closely connected to land use policy and is administered best at the local level.
- In addition to economic effects, flood policy has significant social and environmental implications, and both negative effects and beneficial effects of floods should be evaluated.
- River mechanics, sedimentation, and changing channels and flood regimes must be considered in evaluation of flood policy on specific rivers.

Importance of Case to IWRM

This case shows how floodplain management requires integration of hydrology, engineering, and social science issues. Flood insurance issues are largely unresolved in flood management schemes throughout the world, and the case underscores the value of early warning systems in saving lives, if not always property.

Main Tools Used

A1.2 Policies with Relation to Water Resources
A2.3 Reform of Existing Legislation
B1.5 Regulatory Bodies and Enforcement Agencies
C1.1 Water Resource Knowledge Base
C2.5 Risk Assessment and Management
C6.4 Land Use Planning Controls and Nature Protection

Main text

Background of Issues and Problems

Flood damages are caused by excessive storm precipitation and actions that place people and property near watercourses in jeopardy. Floods can also be caused by dam breaks. They occur in riverine and coastal settings, but this case deals primarily primarily with riverine situations.

The basic tools to assess flood risk are hydrologic and hydraulic analysis and historical experience. Flood risk depends on runoff, which in turn depends on hydrologic factors. A heavy rain can fall on a dry watershed and cause little flooding; or a moderate rain can fall on a saturated watershed and cause heavy flooding. Flow in channels causes flooding when it exceeds the capacity of the channel, overtops the banks, and covers the floodplain with water. There are many types of floods, ranging from high–intensity and short–duration flash floods to long–lasting floods covering vast areas.

Protecting against floods involves both structural measures, such as flood control reservoirs, and nonstructural mitigation techniques, such as floodplain zoning and regulation of land use. Nature favors the nonstructural approach, of course, and beneficial effects of floods can result from letting floods take their course to nourish wetlands, clear sediment, and flush out contaminants. However, reliable flood control structures sometimes prevent devastating damages and loss of life in built–up areas.

Floods threaten people in most countries and cause more financial losses than any other natural hazard threatening the United States. About 85% of the disasters declared by the President annually are caused by floods, and about 160 million acres, or 7% of all US land, are in floodplains (Schilling, et. al., 1987).

Actions Taken

Structural Approaches to Flood Control

As the US developed, early settlements were in the way of floods. For example, in 1870 a flood on the Poudre River inundated Camp Collins, and caused relocation of settlements to what is now Fort Collins, Colorado, the home of Colorado State University. One of the most famous US flood incidents occurred in 1889, when dam failure caused a devastating flood in Johnstown, Pennsylvania that killed 2000 people. In 1900, Galveston, Texas experienced the nation's worst natural disaster when hurricane–induced flooding covered the island, killing around 6000 people. As a result of these and other floods, Congress authorized the Flood Control Acts of 1917, 1928, 1936, and 1938. The emphasis in these acts was on works such as dams, levees, and channel modifications. Meanwhile other famous floods, such as the great

Mississippi River flood of 1927 occurred. Dealing with flooding brought new thinking about analysis methods, such as the unit hydrology and the use of benefit–cost analysis, required by the 1936 Flood Control Act (Grigg, 1996).

In this period of US history, structural approaches and federal government dominated thinking about flood control. This "structural, federal era" began with local efforts based on levee districts, conservancy districts, and individual landowners (Natural Hazards Research and Applications Research Center, 1992). The era led to a number of federal and other dams where flood control storage was a principal purpose. By the 1960's the federal government had completed many projects with an authorization for the Corps of Engineers alone for 220 reservoirs, over 9,000 miles of levees and floodwalls, and 7,400 miles of channelization at a cost of $9 billion.

Shift Toward Nonstructural Approaches

In the 1940s, influenced by work of Gilbert White (1945) at the University of Chicago, thinking began to shift toward nonstructural approaches. White's dissertation was entitled "Human Adjustment to Floods," and had influence on later thinking about flood response. In 1966, House Document 465, A Unified National Program for Managing Flood Losses, was prepared by the Johnson Administration to recommend a unified approach and federal agency actions. Then, in 1968 the Flood Insurance Act was passed. In 1976 a federal report cited coordination as the weakest component of management efforts and a federal interagency committee began to work of flooding problems. After additional actions during the Carter Administration, the Federal Inter-Agency Floodplain Management Task Force revised the Unified National Program in 1979 to include restoration and preservation of natural values and consideration of alternative approaches.
In 1986 the Federal Emergency Management Agency assumed responsibility for the Task Force, and revised the 1979 program to include a federal disaster mitigation strategy, research, and attention to coastal zone flooding.

Within its many flood policies, the US is noteworthy for its program of flood insurance, which leads to regulation of the 100–year flood plain in most communities. Unless communities map, zone, and regulate land uses in the flood plain, residents do not qualify for federally–subsidized flood insurance.

While these new policies were being implemented, the nation continued to gain experience with flooding. For example, widespread 1965 flooding in Colorado increased recognition of the need for regional solutions to flood problems and led to organization in 1969 of the Urban Drainage and Flood Control District. Early business of the district included developing an Urban Storm Drainage Criteria Manual and implementation of programs for drainageway master planning. Now, the district has active programs for master planning, floodplain management, capital improvement, maintenance, and a special South Platte River program. It entered the water quality field and prepared stormwater quality permit applications for several local governments. The history of the UDFCD shows what can be accomplished when local governments with the cooperation of the state legislature organize a regional approach to flood control. Also Colorado experienced a terrible flash flood in 1976 when the Big Thompson River killed 139 people in the space of a few hours (McCain, 1979). The Big Thompson is a mountain stream with headwaters in Rocky Mountain National Park near Estes Park, Colorado. The watershed is rocky and steep and has a drainage area of 305 square miles at the mouth of the Big Thompson Canyon above Loveland. The storm of July 31-August 1, 1976 was extraordinary and poured 6 to 10 inches of storm rainfall over a wide area of the basin. The peak discharge was several times the 100-year flood level, but prior floods on other streams in the foothills have approximately equaled the Big Thompson experience.

During the Summer of 1993, the nation experienced a landmark Mississippi River flood. The Upper Mississippi River Basin suffered the worst flooding in memory (Water, 1993). July rainfall in 10 basin cities ranged from 131 percent to 643 percent of the 30-year average, and new records were set at 42 gaging stations on 33 streams in seven states. A number of levees failed, and the misery and damage caused by the flood was shown each night on television. As a result of the flood, the efforts to combat it, and the damage it caused, the Interagency

Committee that reviewed the flooding and the response reported that nonstructural measures were clearly the best policy for events such as this.

Addressing Major Problems in Floodplain Management

The Report of the Interagency Floodplain Management Review Committee (1994), prepared after the floods, identified three major problems in floodplain management:

- People and property throughout the nation remain at risk from flooding, many don't understand the risk, and fiscal burdens of the risk are unevenly shared.
- Over the last two centuries, there has been tremendous loss of habitat in the upper Mississippi River Basin.
- The division of responsibilities (role definition) between federal, state, tribal and local governments needs better definition.

The report stated "By controlling runoff, managing ecosystems for all their benefits, planning the use of the land and identifying those areas at risk, many hazards can be avoided. Where the risk cannot be avoided, damage minimization approaches, such as elevation and relocation of buildings or construction of reservoirs or flood protection structures, are used only when they can be integrated into a systems approach to flood damage reduction in the basin." The Interagency Committee's report also underscored the importance of a coordinated approach: "The ... Committee proposes a better way to manage the floodplains. It begins by establishing that all levels of government, all businesses and all citizens have a stake in properly managing the floodplain."

Flood Authority

Historically, four federal agencies had lead roles in flood control projects: the Corps of Engineers, the Soil Conservation Service (now Natural Resources Conservation Service), the Bureau of Reclamation and the Tennessee Valley Authority. Other federal agencies, such as the Federal Highway Administration or the Federal Housing Administration, are involved with flood threats to their facilities. In addition, the Federal Emergency Management Agency has a key role in flood plain regulation and in flood response. FEMA operates a comprehensive program with a number of elements and is developing software (HAZUS) for national flood loss estimation.

Schilling et al (1987) described fragmentation of flood authority in the federal government and illustrate how programs are diffused through 26 agencies and 9 program purposes. The program purposes include: flood insurance studies, floodplain management services, floodplain information reports, technical and planning services, flood modifying construction, flood preparedness, emergency and recovery, warning and forecasting, research, and open space activities.

An Integrated Approach to Floodplain Management

After passing through the structural era to a new emphasis on nonstructural solutions, an integrated strategy is now favored, with participation by three levels of government and the private sector. Most flood plain management is by local government, with integration of land use and water quality objectives as well as flood damage reduction.

Potential responses to flood threats have been summarized as (Natural Hazards Research Center, 1992):

- Structural strategies to modify flooding such as: dams and reservoirs; dikes, levees, and floodwalls; channel alterations; diversions; land treatment; on-site detention.
- Nonstructural strategies to modify susceptibility such as floodplain regulations (zoning, subdivision regulations, building codes, and other regulatory tools); development policies (design and location of services and utilities, land rights, acquisition, and open space, evacuation); disaster preparedness and response; floodproofing, and flood forecasting, warning systems and emergency plans.

- Nonstructural strategies to modify impact of flooding such as: information and education; flood insurance; tax adjustments; emergency measures; post–flood recovery.
- Nonstructural strategies to restore and preserve natural and cultural floodplain resources such as: floodplain, wetland, coastal barrier resources regulations; information and education; tax adjustments; and administrative measures

Use of information technology

Throughout the implementation of new flood policy, information technology has had a major effect. It started with better databases and flood models, and now has progressed to flood warning systems, use of geographic information systems, and improved predictive models across the board. Information technology is useful in both structural and non–structural systems.

3 Outcome

Mixed Results

On the one hand, the results of US policy are mixed because losses mounted in spite of efforts to reduce them (ASFPM, 2000). Evidence shows that US flood policy has encouraged development in flood–prone areas and that a large share of losses are from properties that experience repetitive flooding. However, the US has not experienced devastating loss of life such as occurred in Johnstown in 1889 or Galveston in 1900. The greatest loss of life in recent years was in the 1976 Big Thomson River flood in Colorado, where a flash flood killed 139 people. Although all losses could not have been prevented, an effective warning system would have saved many of these lives, and regulation of the flood plain would have removed some of the property from risk.

While flood problems are similar from place–to–place, the responses have been different. The US system differs from UK, Canada, and other developed countries due to its unique national flood insurance program. According to Crichton (2002), the US system needs adjustment because, according to his studies, it is subject to adverse selection (only the people at risk buy insurance), it encourages people to live in flood hazard areas, and it undermines the private insurance market.

These issues, along with questions about flood losses, linkages with land use, transportation, and water quality, require further study to determine performance and results. Data is being collected under FEMA's HAZUS research program, and national and local loss estimates will be improved. Meanwhile, studies of the effect of flood policy will continue. FEMA is currently reevaluating the flood insurance program, for example. The story of US flood policy continues to be written.

Recommended Policy Changes

One important element in flood policy is experiences reflected in the membership of the Association of State Flood Plain Managers (ASFPM). ASFPM (2000) issued a report in 2000 to recommend fundamental policy changes. They think that flood losses have increased for two principal reasons. First, land use in flood–prone areas has intensified, and second, vague and overly–generous criteria for disaster declarations have fostered a culture of dependence. They recommend a new policy for sustainable actions that protect the integrity of flood plains as enduring ecological systems. Policy changes sought include:

- Foster responsibility and capability at individual, local, and state levels.
- Refine policies, programs, and coordination.
- Assemble and improve necessary data and tools.
- Enhance education, training, and public awareness.
- Assess and evaluate programs.

4 Lessons Learned

While results are mixed, the US has learned many lessons about flood policy. Some of these lessons are:

- Flood damage reduction requires a complex mixture of policies that include both structural and non–structural measures to promote multiple objectives.
- Flood policy requires a comprehensive support program consisting of flood plain mapping, hydrologic and engineering studies, insurance, warning systems, and measures for mitigation, response, and recovery.
- Flood insurance programs require careful study to promote positive effects and to avoid unintended incentives and subsidies. The US system requires further evaluation.
- Floods require effective technological approaches that include use of information technology tools such as GIS, flood models, warning systems, and mapping. Small government units may not be able to afford sophisticated systems.
- Structural measures should normally be used only when they can be integrated into a systems approach to basin–wide flood damage reduction.
- Flood policy is closely connected to land use policy and is administered best at the local level.
- In addition to economic effects, flood policy has significant social and environmental implications, and both negative effects and beneficial effects of floods should be evaluated.
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Replicability

To some extent, flood problems are generic from hydrologic, hydraulic, and economic standpoints. However, some places suffer more severe flooding than others, and some places suffer different types of floods. For example, flash floods in Arizona will differ greatly from great river flooding along China's Yangtze River or areawide flooding in Bangladesh. As floods relate to land use and to government involvement, they differ from place–to–place because countries have different economic and political systems.

The technological aspects of US experience should be most useful and replication of its regulatory policies should be least useful to other countries. However, in some cases different technology may be appropriate due to budgetary and data constraints.

The U.S. experience with regulatory policies may be of interest to some nations seeking to develop new approaches that are carefully linked to land use and environmental policy. The principles behind the policy are the most useful to regulate, such as using an integrated approach, considering various structural and non-structural measures, and re-evaluating land use practices.

Considering these, elements of US policy that might be replicated would include the knowledge base, organization of the national hydrological service, methods for flood modeling and mapping, use of information technology, and experience with engineering methods and means. Of significant but lesser interest would be zoning methods, ordinances, nonstructural programs, and government agency organization.

Importance of the Case to IWRM

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5 References and Web Sites

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