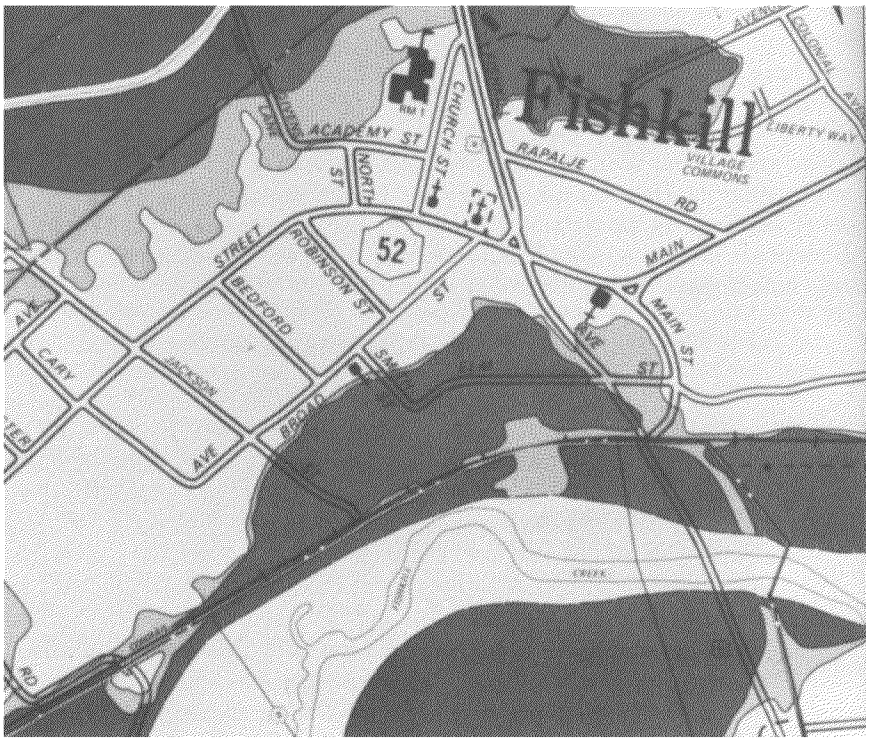
Mapping Flood Hazards

Nationwide mapping of floodprone areas may well be the single greatest achievement in floodplain management to date. Before enactment of the National Flood Insurance Act, floodplain mapping was done through the programs of the Corps, the Soil Conservation Service, the U.S. Geological Survey, and the Tennessee Valley Authority. Each agency mapped floodplains according to its individual authority and primary mission, and often on a project-by-project basis or only after major floods. The Corps compiled a national list of incorporated communities with flood problems and in 1962 began mapping and providing the information to individual communities in floodplain information reports. Mapping of floodplains for the National Flood Insurance Program began in 1968, when the Federal Insurance Administration began producing temporary maps to show approximate boundaries of floodprone areas in identified communities and entered into cooperative efforts with other federal agencies and contracts with private engineering firms to develop methods for preparing more detailed maps. By 1990 more than 12,000 new flood insurance map studies had been initiated and over 1,700 restudies undertaken at a cost of nearly $900 million. In addition to contracting with numerous private firms, the Federal Insurance Administration used the resources of the Corps, the U.S. Geological Survey, the Soil Conservation Service, the Tennessee Valley Authority, the Bureau of Reclamation, the National Oceanic and Atmospheric Administration, the Delaware River Basin Commission and the Susquehanna River Basin Commission, and some states to perform this work.

Twenty-three states fund and prepare their own floodplain maps to complement the National Flood Insurance Program—to provide greater detail or a better scale, to reflect changes in development or hydrology, to extend mapping beyond corporate limits, to meet special requirements, or to cover special natural values In the past few years, communities themselves have become more involved in mapping, either because of unique floodplain problems or because comprehensive local programs require more specialized mapping. In addition, private consultants frequently perform hydrological or drainage studies for subdivisions and other developments. These studies form the basis for many amendments and revisions to original flood insurance maps.



The foundation of the National Flood Insurance Program is accurate maps of hazard areas in floodprone communities The program has been producing such maps since its inception in 1968

Flood Boundary and Floodway Map of the Fishkill, New York, area.

THE COST OF FLOOD MAPS

The Federal Insurance Administration now spends about $36 million annually to keep published flood risk information updated and current and to provide detailed flood risk data where none existed before. Of this amount, about $4 million annually is spent to distribute about seven million maps to states, communities, lenders, agents, banks, consultants, and others

Understanding and Mapping Wetlands

Since the 1970s significant progress has been made in both scientific and public awareness of the value of wetlands. In 1986 the Environmental Protection Agency adopted a plan of research on ways to create, restore, and enhance wetlands and their functions. National wetlands mapping is being performed by the U.S. Fish and Wildlife Service. The detailed (scale 1:24,000) wetland maps are used by local, state, and federal agencies and private organizations for many purposes, including comprehensive resource management plans, environmental impact assessments, permit reviews, facility and corridor siting, oil and chemical spill contingency plans, natural resource inventories, and wildlife surveys. They show the location, shape, and characteristics of wetlands and deepwater habitats on a U.S. Geological Survey base. Wetlands are classified according to the Fish and Wildlife Service's wetland classification system. Maps have been done for 65% of the lower 48 states and 20% of Alaska. In addition, many states have developed their own wetlands mapping programs.

Understanding Natural and Cultural Resources

As discussed in Part II, the nation's floodplains contain some of its most important natural and cultural resources. A wide variety of data sources now provides information about these national assets. For example, the U.S. Environmental Protection Agency maintains several dozen water-quality-related data bases, and the U.S. Geological Survey compiles extensive natural resources data through its Water Data Storage and Retrieval System and the National Water Data Exchange. Additionally, the U.S. Fish and Wildlife Service, as part of its National Wetlands Inventory, is developing a computerized multidimensional wetlands mapping scheme for the entire country. The U.S. National Park Service has established the Nationwide Rivers Inventory of more than 1,500 river segments and maintains much other data on both natural and cultural resources. NOAA's National Ocean Service and National Marine and Fisheries Service maintain natural resources data in several data bases as part of NOAA's responsibilities as the nation's principal marine science agency. The Soil Conservation Service oversees the National Resources Inventory—a survey of land use and quality, based on 160-acre units across the United States—and the U.S. Forest Service similarly keeps extensive information on lands within the national forest system.

Beyond these federal resources, state agencies, private organizations, and universities also maintain comprehensive data describing many aspects of the nation's cultural and natural resources.

Remote Sensing Techniques

In the past 20 years the availability and analysis of high-altitude photography, satellite imagery, and other forms of remote sensing have increased tremendously. Systematic comparison of images from different times yields information on changes in land use, which can be used to help assess many natural resources and identify areas where future flood damages may occur. After the land uses and natural resources of an area are calibrated, most of the subsequent analysis can be automated. So far these techniques have had limited application in relatively small areas of the nation's floodplains, but technological advances in computer capabilities and data management systems should accelerate the use of remotely sensed data in the near future.

At least one Arizona community uses periodic aerial observations to look for floodplain violations. Aerial photography combined with floodplain maps has been used in some communities to count the number of structures within selected floodplains. Other communities have used or plan to use low-level aerial photography after floods to help determine the extent of flooding and damage. As digital mapping becomes more widespread, it will become easier and more inexpensive to monitor floodplain activities through remote sensing.

Geographic Information Systems

Many organizations now make routine use of geographic information systems (GIS)—computer systems that allow users to collect, manage, and analyze large volumes of spatially referenced and associated attribute data—

HENDERSON COUNTY'S GIS

The Henderson County, North Carolina Soil and Water Conservation District is one of the first in the nation to install a microcomputer-based geographic information system to provide better interpretative soils information. The county's published soil survey has been digitized and stored in the system, and the computer can capture, store, analyze, and retrieve soils maps and other geographic data. Funding for the demonstration project was provided by the Tennessee Valley Authority, supplemented by the Soil Conservation Service and the Henderson County Commissioners.

for a wide variety of purposes, including natural hazards and natural resource management. GIS-generated maps are easily manipulated and can be updated at a low cost. However, GISs have not yet become widely used, mostly because the initial cost of digitizing the needed information for input into a GIS system can be formidable. Another handicap is that the different systems now in use are not always compatible. Once these obstacles are overcome, GIS technology will allow planners and managers to more easily obtain and apply the information they need to make wise decisions about floodplains. The Federal Emergency Management Agency is developing a standard for digital flood insurance maps in public domain format and has committed to a program to digitize the maps for over 340 metropolitan counties with large amounts of property at risk from flooding.

Regulatory and Design Standards

Over the past 20 years numerous standards of terminology, procedure, performance, and quality have been developed in floodplain management. They include both prescriptive standards (clearly identified limits set by law, policy, or custom), and performance standards (requirements that a specified goal be reached by unspecified means). Some of these standards are freely adopted, others are met in response to an incentive, and still others are required by law. Many manuals and technical reference volumes have been developed to assist builders and regulators to meet the performance standards required by the National Flood Insurance Program. Having these standards has provided a uniform means of applying, reviewing, and evaluating the design, construction, and regulation carried out in support of floodplain management.

Not all aspects of floodplain management are amenable to nationwide standardization. There have been no national standards established for minimum setbacks from river channels, although there are some statewide standards for designated streams, lakes, and other water bodies. Lincoln Township, Michigan, for example, requires setbacks of 110 feet from dune and bluff areas on Lake Michigan, while Wisconsin requires a minimum setback of 75 feet from the ordinary high-water mark. There are no national standards for dam and reservoir construction; instead, each federal agency has its own set of criteria. Likewise, each of the three agencies (the Corps, the Soil Conservation Service, and the Bureau of Reclamation) that constructs federally funded levees has its own policies for construction and maintenance.

Judicial Support for Floodplain Management

Over the last few decades the types of lawsuits and the specific issues litigated in floodplain management have changed, reflecting the predominant techniques of the time and general status of the relevant law. Before 1968, most litigation challenged the power of governments to undertake flood control measures and to regulate floodprone lands. From 1968 to 1978 concepts of legal liability expanded and government defenses to it diminished. Constitutional challenges to regulations increased and shifted from broad constitutional attacks to specific challenges to the reasonableness of particular measures. Since then, courts have continued to hold governments liable for their actions that increase flood damages. The number of constitutional challenges to regulations has diminished, however, due to the widespread judicial support for regulations over the previous 20 years. Most recent cases have addressed relatively technical issues, such as the validity of nonconforming use provisions and setbacks

Constitutionality of Regulations

Floodplain management regulations have been challenged as unconstitutional on two fronts: as violations of due process guarantees and as takings of private property. The due process claims, which were based on a general legal argument that the federal, state, and local governments had no legal authority to regulate activities on floodplain lands and waters, have almost disappeared over the years as the statutory authority to regulate was clarified and strengthened With the exception of a few cases in which regulations prevented all

AVOIDING CONSTITUTIONAL CHALLENGES TO REGULATIONS

To reduce the chances of having their floodplain management regulations found unconstitutional, many jurisdictions have

- *adopted regulations with stringent performance standards rather than simply prohibiting all activities in hazard areas,*
- *mapped floodplains in more detail and more accurately than has the National Flood Insurance Program,*
- *provided real estate tax breaks for tightly controlled land to diminish the financial burden of owners whose use of their property is greatly restricted,*
- *improved their permitting and record-keeping procedures to include detailed statements of findings on denials in order to provide a better defense in court*

economic use of floodplain property, courts likewise have upheld the general validity of floodplain regulations against claims that they take private property for public use without payment of just compensation, in violation of the Fifth Amendment to the U.S. Constitution. These rulings are consistent with a much larger body of law in which courts have upheld other land use regulations against claims of taking, despite the impact of the regulation upon property values. Floodplain management regulations have been supported for a number of reasons.

- The rights of private landowners to their water-oriented lands are subject to public trust and navigable servitude rights and interests.
- Courts give great weight to protection of public health and safety and have, without exception, sustained regulations needed to prevent nuisances (such as blockage of flood flows) and to prevent private actions that may threaten public or private safety on other property (such as construction of dams).
- Over the past 20 years courts have upheld performance standards such as the requirements that private landowners protect the floodway's conveyance capacity and elevate or otherwise protect structures to the 100-year flood elevation.
- Courts have supported technically based regulations adopted consistent with a federal, state, or local overall plan and standards (pollution controls or the National Flood Insurance Program, for example).

Liability for Flood Damages

In contrast with the small number of successful constitutional challenges to governmental floodplain management actions over the last 20 years, landowners have won thousands of damage suits against governmental units for causing or increasing flood damages. Most of these have been based on such common law grounds as nuisance or trespass.

There have been more successful liability suits in recent years because

- Large damage awards from juries (and subsequent payments of them by governments with "deep pockets") have made plaintiffs and lawyers more willing to litigate;
- Courts have recognized broadened concepts of public and private landowner responsibility to other landowners and the public;
- The "act of God" defense has diminished as a result of improved flood prediction capability and maps;
- Improved data on stream flow and better hazard modeling have made proof of causation of the damages easier;
- Improved technology, wider use of that technology, and adoption of regulations and guidelines have all raised the standard of "reasonable" actions on the part of government; and
- The "sovereign immunity" defense of states and local governments, and to a lesser extent the federal government, has been modified by statutes and case law, making the governments responsible for more actions and their consequences.

Avoiding Legal Problems

There is little doubt that performance-oriented floodplain regulations (building codes, subdivision regulations, zoning, etc.) will continue to be upheld in the courts despite restrictions that may affect private property owners in some instances. Likewise, carefully crafted flood loss reduction measures will reduce community and state liability in the long run. It is important, however, that governments take care when formulating and implementing these measures to reduce potential legal problems and lessen the risk of constitutional challenge.

AVOIDING LIABILITY FOR FLOOD DAMAGES

There are many actions that state and local governments can take to reduce their potential liability for flood damages:

- *obtaining legal advice before taking anticipated actions;*
- *adopting comprehensive flood hazard plans, because they can avoid liability if they avoid flood hazards,*
- *enrolling in the National Flood Insurance Program, because landowners are less likely to sue for damages if they are insured and thus quickly receive compensation for their losses;*
- *adopting drainage as well as flood hazard reduction plans and regulations (most suits against cities for flood problems are really for damages due to interference with natural drainage);*
- *operating flood loss reduction measures (structures, warning systems) with greater care to avoid claims of negligence;*
- *avoiding hazardprone locations for public facilities;*
- *designing public works—roads, sewers, bridges, and water treatment facilities—to comply with federal, state, and local floodplain guidelines and regulations so they do not block flood flows or cause drainage problems;*
- *undertaking remedial flood loss reduction measures for existing floodprone development, particularly where the problem has been partly the result of government action;*
- *purchasing liability insurance and establishing self-insurance pools*

The Present and the Future

Overview

It is difficult to assess the effectiveness of floodplain management in the United States. The degree of accomlishment to date is impressive; at the same time, a considerable distance remains between the status quo and the ideal that can be envisioned. Two principal complications are that there are few clearly stated, measurable goals, and that there is not enough consistent, reliable data about program activities and their impacts to tell how much progress is being made in a given direction.

Between 1916 and 1985, there were an average of about 100 flood-related deaths annually; there is no indication that deaths are increasing or decreasing on a per capita basis.

Per capita flood damages were almost 2.5 times as great from 1951 to 1985 as they were from 1916 through 1950, after adjusting for inflation.

The natural and cultural resources of floodplains are being lost at unacceptable rates.

Overall Effectiveness

There is general agreement on three fronts:

- Floodplain management should reduce the number of flood-related deaths in the nation. This goal has been partially achieved. Average annual loss of life from flooding has been somewhat reduced from the level that prevailed early in this century and has remained relatively constant for many years.
- Floodplain management should result in an actual decline in the nation's flood losses, including public and private property damage, injuries, and disaster relief. This has not been achieved. In fact, there was a definite increase in flood damages from 1916 to 1985, although there is evidence that these losses have remained fairly constant over the last two decades when compared to broad economic indicators like the GNP.
- Floodplain management should reduce the loss of the natural and cultural resources of the nation's floodplains The programs designed to do this have not yet arrested that deterioration.

Achievements to Date

Several significant achievements in floodplain management can be noted, even though all the goals have not yet been reached.

- There is now more widespread public recognition of flood hazards, the value of the cultural and natural resources of floodplains, and the close interrelationship of the hazards and the resources.
- There is an extensive body of judicial decisions supporting floodplain management activities, indicating a perception throughout society that floodplain losses can and should be managed
- Numerous standards of terminology, procedures, performance, and quality have been developed, providing a uniform means of applying, reviewing, and evaluating the design, construction, and regulations needed for floodplain management, and also providing limited measures of effectiveness.
- In many locales, floodplain development has been prevented or reduced in high hazard areas as a result of mapping and the establishment and enforcement of regulations.
- New development that meets commonly accepted flood-loss reduction standards has experienced greatly reduced losses.
- The institutional framework for floodplain management has been improved through an expanded legislative base, new agencies, and supportive judicial interpretations. There has been a shift away from federal dominance toward a more equal partnership among federal, state, and local governments, and the private sector.
- A considerable amount of floodplain acreage, particularly wetlands, has been preserved by both the public and private sectors.

The Need for Specified Goals

No single piece of legislation or other authority outlines a comprehensive set of measurable goals and objectives for floodplain management in the United States. Floodplain management would benefit from a set of specified goals meant to be achieved by a certain date and whose success can be measured. Numerous national goals have been proposed by various government agencies and observers of floodplain management. Some examples of these suggestions are managing the natural resources of floodplains in conjunction with loss reduction efforts by the year 2000; moving people out of areas where they are continuously threatened by flooding, removing all residences and commercial establishments from the 20-year floodplain by the year 2020 and restoring these lands to their natural state; reducing losses to existing buildings and infrastructure by requiring all federal agencies to assess the vulnerability to flooding of existing federal facilities and those state and local facilities constructed with federal aid, and reducing losses to areas and structures outside regulated floodplains.

The Need for a Comprehensive Data Base

There is a considerable amount of information about floodplain management available, but most of it was not collected with evaluation in mind; thus it is not precise enough to support judgments about the effectiveness of various floodplain management activities. This not only inhibits evaluation, but also hinders legislators, regulators, and other professionals in their efforts to establish, overhaul, or fine-tune programs and strategies to make them more effective A more complete data base will also give local government leaders a better opportunity to identify the public risks and costs associated with floodplain development.

The obstacles to developing and maintaining an adequate data base are substantial. Important determinations must be made about the type of data to be collected, how often it should be collected, by whom, and using what criteria Adequate funding must be found.

Additional information should be developed on several important topics, including an examination of the full benefits and costs, both public and private, of floodplain occupancy; an evaluation of the monetary benefits of maintaining the natural uses of the floodplain; and a determination of the steps needed to reduce the potential losses in the areas of the nation with the highest risk of catastrophic impacts from flooding.

The Effectiveness of Management

Although a truly unified national program to manage floodplains is not yet in place, great strides have been made in that direction The management framework has matured and expanded significantly since the 1960s. The growing recognition of the need for alternatives to federal investments in structural projects for flood loss reduction has been of particular importance. A major improvement was made in 1979, when protection of natural floodplain resources was formally embraced. But the conceptual approach presented in the current *Unified National Program for Floodplain Management* is still evolving. Further improvements could be made in the framework by developing a clear definition of floodplain management and a set of measurable goals Management efforts in general would be more effective if there were more flexibility for different approaches, smoother coordination among government agencies, and ways to account for local conditions.

Allowing for Different Approaches

Many floodplain losses are of a sort that simply cannot be addressed through a by-the-book approach. For example, management techniques for such high risk flood problems as ice jams, flash floods, coastal flooding and erosion, mudslides, ground failure, alluvial fans, fluctuating lake levels, moveable stream beds, and areas behind unsafe levees or below unsafe dams, are not included in most local programs, which are designed to meet standardized National Flood Insurance Program minimum criteria. New methods for identifying, mapping, and regulating areas with these flood hazards have been developed in some states—particularly in the arid West—through special

GISs AND THE FLOODPLAIN MANAGEMENT DATA BASE

Recent advances in the development and application of geographic information systems can improve the floodplain management data base. With these systems, layers of information, such as that from flood insurance maps, cultural resource maps, and the TIGER data system of the U S. Census Bureau, can be combined for display, analysis, and management applications.

cooperative efforts with the Federal Emergency Management Agency This sort of flexible and innovative approach yields more effective management in the long run. Incentives for communities to map and regulate high risk hazard areas are now being provided through the Community Rating System of the National Flood Insurance Program.

Another reason that management flexibility is needed is that the conditions that cause floods do not recognize the political boundaries by which most floodplain management techniques are applied. Many professionals believe that comprehensive management based on hydrologic units must be made a higher priority, especially if natural resources are to be protected. The river basin commissions, the Environmental Protection Agency's National Estuarine Sanctuary Program, and the National Park Service's State and Local River Conservation Program are examples of this technique To facilitate broader management, the states could enact legislation providing for regional or watershed management, for river corridor management, and for other regional efforts based on hydrologic and other natural boundaries rather than political jurisdictions.

Coordination among Government Agencies

There is more coordination and better cooperation among all levels of government now than there was 25 years ago, but improvements could still be made. Each government agency involved with floodplain management has its own legislative mandate and in general, each has been diligent in carrying out that mandate within the imposed statutory limits From the standpoint of an overall federal program for floodplain management, however, there are many inconsistencies of purpose and procedure, overlaps, gaps, and conflicts Some of the inconsistencies can be reduced or eliminated by administrative action, but some conflicts result simply from differing attitudes and expectations about the ultimate responsibility and commitment of resources to respond to flood problems, and these are not likely to be readily resolved. Nevertheless, a spirit of cooperation and common purpose can smooth many conflicts and enhance existing efforts

Providing for Local Conditions

Prescribing uniform national standards for the preservation, use, and development of floodplains and other hazard areas for application at the local level can be inefficient and result in social inequities. Many of the existing floodplain management tools are more easily applied in communities with fairly high standards of living, where the local government has adequate staff, resources, and expertise. This excludes many small rural communities and economically disadvantaged areas. Natural resource preservation is a bottom priority in low-income communities where a resident cannot even count on the availability of potable water or sanitary facilities during and after a flood. An awareness of local conditions could be incorporated into the national program through wider use of performance standards, provisions of the Community Rating System of the National Flood Insurance Program, and more flexibility in the application of requirements for a positive benefit/cost ratio for federal funding of flood control projects

AGENCY AND ORGANIZATION COORDINATION

Positive interagency coordination is exemplified by professional groups like the Association of State Floodplain Managers and the Association of State Dam Safety Officials, and bodies like the Interagency Committee on Dam Safety. Federal, state, and local officials, and representatives of the private sector form the memberships of these groups, and they have brought an important spirit of cooperation and coordination that has been of tremendous benefit to floodplain management over the past decade. They meet formally once a year and coordinate throughout the year through subcommittee work and special projects.

The Effectiveness of Floodplain Management Strategies and Tools

Additional accomplishments could be achieved through better or more extensive use of the strategies and tools of floodplain management. Of the four strategies, modifying flooding has traditionally been the most popular because most of the planning, funding, construction, and implementation for structural measures is carried out by the state or federal government, and because local and individual adjustments or sacrifices are minimal. In contrast, many measures to modify susceptibility to flood damages or to modify the impacts of flooding are implemented on a structure-by-structure or property-by-property basis and require constant vigilance, personal inconvenience, and financial sacrifice These drawbacks resulted in a lack of public support for such measures in the past, and consequently local governments were often reluctant to impose or enforce them. By the mid-1980s, however, this impediment had been largely overcome and local officials began to focus on how to comply with federal and state requirements and administer community programs to manage floodplains. Measures to modify susceptibility to flood damage and disruption and to modify the impacts of flooding are now widely accepted, even though some communities still have difficulty administering them. The strategy of restoring and preserving the natural and cultural resources of floodplains has had little exposure to date and needs to be better integrated with the other strategies, both conceptually and in practice.

Modifying Susceptibility to Flood Damage and Disruption

The tools used for this strategy have enjoyed widespread, fairly successful implementation. Susceptibility to flooding in the United States is constantly being effectively lessened at individual and local levels through the use of regulations, development policies, programs for disaster preparedness and assistance, and warning systems. Evidence indicates, however, that overall vulnerability has either increased or stayed the same, probably because of the large amount of vulnerable development already in place, numerous exceptions to the state and local policies that would reduce that development, and the fact that population growth, movement, and urbanization sometimes take place so quickly or in such unexpected ways that adequate planning and regulation simply cannot be established soon enough to prevent unwise use of floodplain areas. This strategy may have the most potential for widespread future use, however, because its tools can be coordinated well with other strategies and because it provides an ongoing, more enduring way of adjusting to the flood hazard—that is, altering human behavior usually before the losses occur

Improvements could be made in the implementation of this strategy by

- improving the enforcement of floodplain regulations by local governments,
- reducing the usually unfounded concern of local and state officials that strict floodplain regulations will be challenged as unconstitutional takings of private property,
- minimizing flood damage to existing infrastructure and properly designing and regulating future infrastructure that must be located in or near the floodplain, and
- ensuring that current disaster assistance policies do not undermine long-range floodplain management efforts.

Modifying Flooding

National efforts to modify flooding have probably been more successful than those directed toward any other strategy. The approach of controlling floods is older than the other strategies, and over the course of five or six decades countless floodprone situations have been alleviated with structural measures.

There is increasing recognition that the strategy of modifying flooding can be counterproductive in at least two ways. First, it has been suggested that the creation of structural protective works encourages development in the

REDUCING LOSSES THROUGH WARNING SYSTEMS

Annual flood damages in the Connecticut River Basin were reduced by $750,000 with a flood warning system that cost about $250,000 annually

FLOOD CONTROL INVESTMENT AND RETURN

The federal government spent over $13 billion for dams and other flood control structures between 1936 and 1975 About $360 million had been expended on shoreline protection studies and projects by 1985 In return for these investments, billions of dollars in property damage have been avoided and hundreds of thousands of people have been protected from anxiety, injury, and death

"protected" area, resulting in increased vulnerability, perhaps not to the design flood, but to larger ones or to unforeseen catastrophic events like structural failure. Second, structural measures can have adverse impacts on wildlife habitat, scenic resources, and water quality, thus undercutting other floodplain management strategies.

Partly as a result of these concerns, there has been a considerable shift away from reliance on structural solutions since the early 1960s. The planning and installation of measures to modify floods, however, have not been abandoned. Flood control projects are still needed to complement the application of other floodplain management strategies, particularly to protect existing development.

There is an opportunity now to reformulate this strategy to acknowledge its relationship to other techniques. Some of the tools to implement this strategy, such as land treatment measures, on-site detention, and shoreline protection, can be important components of comprehensive floodplain management and resource protection programs

Modifying the Impact of Flooding on Individuals and the Community

The impacts of flooding on individuals and communities have definitely been modified over the last 25 years, largely through increased awareness of flood hazards as a result of the provision of information and education, and because of the availability of flood insurance. After many years of counterproductive effects, two of the tools for this strategy have recently undergone basic revisions that may make them more effective at reducing future losses: tax adjustments for flood losses have been reduced, and postflood recovery measures designed to minimize future losses have been determined to be an appropriate use of disaster assistance funds.

The implementation of this strategy could be improved by

- expanding individual awareness of and knowledge about floodplains;
- improving training programs for code administrators, planners, inspectors, public works directors, and other local government personnel directly involved in floodplain management;
- enlarging the premium base by increasing the number of insured structures, and thereby moving the National Flood Insurance Program closer to a fully actuarial basis; and
- ensuring that postdisaster mitigation funds are used completely and creatively

Restoring and Preserving the Natural and Cultural Resources of Floodplains

As the latest addition to the array of floodplain management strategies and the one least well-integrated with the others, it is not surprising that this strategy has met with limited success. Floodplain land is being preserved in a limited way through acquisition, public understanding and support for preservation and restoration of natural resources is growing, and mapping of the nation's wetlands is more than half finished. These accomplishments, however, have been the result largely of programs, policies, and efforts outside the floodplain management arena. Regulations to protect and manage natural resources in general are not well coordinated with those to reduce flood losses, resulting in conflicts when implementation and enforcement are at stake. The strategy itself needs to be better integrated both with other floodplain management tools and strategies and with compatible efforts in other fields, such as river corridor management, endangered species protection, and nonpoint pollution control programs.

THE EXTENT OF THE NFIP

As of 1990, 82% of the nation's 20,000 floodprone communities had joined the National Flood Insurance Program. In 1990, 2 39 million flood insurance policies were in force, providing over $200 billion in coverage. From 1978 to 1989, over 384,000 flood damage claims had been paid, totalling about $3 1 billion.

PROTECTING RIVERS FROM ALTERATION

As of 1990, 9,351 miles on 123 of the nation's rivers had been designated as wild or scenic, and therefore protected under federal law. But these protected stretches are greatly outnumbered by the stream segments that would be altered by proposed dams, channel modifications, and other projects