TABLE 9-1

BENEFITS AND COSTS OF FLOODPLAIN MANAGEMENT IN TEN CITIES

Category of Benefit/Cost	Indicator
ECONMIC EFFICIENCY BENEFITS AND COSTS	
Benefits	
1. Reduction in average annual flood damages	$10.994 million
2. Reduction in disruption of business activity	1,590 acres of commercial and industrial activity diverted from floodplain
3. Enhancement of living environments	$10,427 per acre increase in value of vacant lots zoned for residential use and adjacent to open space
Costs	
1. Program costs (per year)	
a. Local programs	$0.288 million
b. State programs	Not ascertained
c. Federal programs	$0.057 million
Total operating cost	$0.345 million
d. Mapping cost (one-time cost)	$0.948

TABLE 9-1 - continued

BENEFITS AND COSTS OF FLOODPLAIN MANAGEMENT IN TEN CITIES

Category of Benefit/Cost	Indicator
2. Added cost of building in the floodplain (per year)	
a. Residential construction	$0.643 million
b. Nonresidential construction	$0.947 million
Total increased construction costs	$1.590 million
3. Decreased land values due to lower development potential	Unknown
ENVIRONMENTAL QUALITY BENEFITS AND COSTS	
Benefits	
1. Conservation of natural	3,513 acres of open space preserved (land which would have been converted to urban use in absence of floodplain management)
2. Reduction in pollution of surface waters	1,590 acres of commercial and industrial activity diverted to

TABLE 9-1 - continued

BENEFITS AND COSTS OF FLOODPLAIN MANAGEMENT IN TEN CITIES

Category of Benefit/Cost	Indicator
	upland areas away from streams
	9,444 dwellings diverted to upland areas away from streams
	Floodways adjacent to stream channels protected in 6 of 10 communities
3. Provision of open space amenities	3,513 acres of open space preserved
Costs	
1. Environmental damage (e.g., deterioration in water quality due to filling in floodplain)	2,545 residential building sites filled 379 nonresidential building sites filled
2. Environmental damage at sites to which potential floodplain development was diverted	9,444 dwelling units diverted to upland areas 1,590 nonresidential acres diverted

TABLE 9-1 - continued

BENEFITS AND COSTS OF FLOODPLAIN MANAGEMENT IN TEN CITIES

Category of Benefit/Cost	Indicator
INDIVIDUAL SAFETY, PEACE OF MIND, AND SOCIAL WELL BEING	
1. Reduction in number of persons exposed to risk of injury and death from flooding	21,920 persons
2. Increase in peace of mind as a result of:	
a. Decreased exposure to injury from floods	21,920 persons
b. Protection of dwellings from flood damage through floodproofing	6,363 persons
c. Protection from financial loss through insurance	19,040 persons 7,616 households 1,324 firms
3. Provision of insurance coverage against flood losses	$556 million in coverage through NFIP
Costs	
1. Added constructino costs	$1.590 million per year
2. Cost of flood insurance to individuals/firms	$2.694 million per year

$0.345 million per year. Those costs include $0.288 million per year in costs to the city governments and $0.057 million per year in federal costs of the National Flood Insurance Program allocated to the cities on the basis of the proportion of their floodplain acreage to urban floodplain acreage in the nation as a whole. The National Flood Insurance Program also incurred initial floodplain mapping costs in the ten cities which we estimate at $948 thousand. Our program cost data do not include the cities' proportionate share of state government floodplain management program costs, for which data were not available. We believe, however, that those costs would be relatively minor (see Burby and French et al., 1985).

We estimate the second major category of costs--those to individuals and firms for undertaking mandatory floodproofing--at $1.590 million per year based on the actual amount of floodplain construction in the ten cities over the ten-year study period, and on estimates of added construction costs supplied by builders and developers.

Since floodplain land use management programs diverted some development from the floodplain, they could have generated some economic efficiency costs if households and firms were forced to locate new construction at less desirable locations. Those economic efficiency losses should have been reflected in decreased floodplain land values; however, our analysis of floodplain land markets indicated that variation in program stringency had no effect on land values in the ten cities. That could have resulted from landowners refusing to sell at prices below expectations they formed prior to the initiation of more stringent floodplain management programs. Other studies which have compared floodplain and nonfloodplain property values have also found no discernible adverse effects of programs on land values.

Comparing the benefits and costs for which we have reasonable monetary figures ($10.994 million per year in reduced property damages versus $1.293 million per year in program and private costs) indicates that the net economic efficiency benefits from floodplain management in the ten cities have been substantial.

Environmental Quality

The environmental effects of floodplain land use management appear to be positive, although we could not develop direct measures for the three types of effects--natural resource conservation, reduction in pollution, and community amenity--that need to be considered. Instead, we use the acreage of open space preserved by floodplain land use management as a proxy measure for conservation and amenity benefits, and the number and acreage of residential and business structures diverted from the floodplain as a proxy measure of

pollution benefits. We used the number of structures constructed in floodplains on fill as a proxy for potential environmental costs that have resulted from floodplain management. Environmental disruption outside the floodplain from diverted development is another environmental cost we noted.

Natural resource conservation includes the preservation of resources such as unique ecosystems, wetlands, groundwater recharge areas, prime agricultural land, and mineral deposits (alluvial gravels) that are often destroyed when land is converted from open space to urban use. Floodplain management programs in the ten cities preserved 3,513 acres of open space between 1976 and 1985 that otherwise would have been converted to urban use, which suggests that the programs produced substantial natural resource conservation benefits during that period. Since dwellings and businesses diverted from the floodplain located somewhere, with a resultant loss of open space and natural resource values, the programs incurred some environmental costs as well. However, since land along streams generally has greater natural attributes than upland areas, it seems safe to assume that there are net benefits from conserving floodplain property in exchange for upland areas.

Urban development often results in an increase in pollution from dispersed, nonpoint sources such as stormwater runoff and leakage from sanitary sewers. When development is displaced from the floodplain, those sources of pollutants locate farther from streams and lessen the threat of pollution. Additionally, preservation of portions of the floodplain closest to stream channels through limitations on building in the floodway provides a buffer for surface waters which can filter out pollution from upland areas as well. Elevation of sanitary sewers, as mandated by floodplain regulations, should lessen the possibility of contamination from that source during flood events. We estimate floodplain management resulted in substantial reduction in pollutants reaching surface waters in the study cities, since the programs diverted 1,590 acres of commercial and industrial activity and 9,444 dwelling units from floodplains to upland areas. We should subtract from those benefits additional pollution attributable to filling floodplain property to raise the elevation of building sites to or above the base flood elevation; we estimate fill was added to raise the elevation of 2,545 residential and 379 nonresidential building sites in the ten communities.

Open space provides a visual break to urban development and, although the preservation of natural beauty is an aesthetic judgment, it also should not be overlooked in assessing the benefits and costs of land use management. The fact that floodplain land use management programs preserved 3,513 acres of open space in floodplains that otherwise would have been converted to urban use suggests that the programs produced substantial amenity benefits for their communities.

Individual Safety, Peace of Mind, and Social Well Being

By diverting residential development from flood hazard areas, floodplain land use management programs can reduce the exposure of people to injury and death from flooding. In the ten cities, we estimate that 21,920 persons settled in upland areas away from flood hazards between 1976 and 1985 as a direct result of floodplain land use management programs. Thus, the programs produced substantial benefits in protecting public safety, not only to those people but to public safety personnel and others who endanger their lives in search and rescue operations during flood events.

Floodplain land use management programs also produce benefits by reducing the personal insecurity and stress that results from exposure to flood hazards and flood losses. Programs can do that in three ways. First, as we just noted, they divert some people from living in hazardous areas and exposing themselves to flood risks. Second, people who do locate in flood hazard areas occupy structures that have been protected through building elevation from some degree of flood risk. In the ten cities, 6,363 persons benefited from that protection by occupying elevated structures constructed between 1976 and 1985. Finally, the adoption of floodplain land use management programs makes it possible for people in a community to purchase flood insurance, which also should relieve anxiety and stress related to the threat of flooding. In the ten communities, 26% of the structures in flood hazard areas were covered by insurance, we estimate that this contributed to the peace of mind of over 7,000 households (more than 19,000 persons). Flood insurance coverage in force amounted to $556 million in the ten communities in 1985.

As with other types of benefits of floodplain management, safety, security and peace of mind were not cost-free. As we noted in the discussion of economic efficiency, elevation of structures added $1.59 million per year to the cost of construction in the floodplain. In addition, in 1985 floodplain occupants paid flood insurance premiums of $2.694 million, some proportion of which they would not have carried had not insurance been required for construction financed by federally regulated financial institutions through provisions of the Flood Disaster Protection Act of 1973.

Conclusions

Floodplain management as a comprehensive approach to mitigating flood hazards is coming of age. Over the period 1976 through 1985 covered by this research, the ten riverine communities we studied successfully adopted, administered, and enforced land use and building regulations in their floodplains. Concurrently, most of the communities also undertook flood

control projects to further lessen the threat of flooding. That is significant, since it indicates communities strongly support the original concept of floodplain management, promulgated over 50 years ago by Gilbert White (1936a; 1936b), who advocated floodplain management as a *combination* of structural or corrective flood control projects, and nonstructural or preventive regulatory and other supporting measures.

We found that the benefits of floodplain land use management programs far exceeded the costs of the programs to individuals and to government. Floodplain management in the U.S., at least as exemplified by the programs in the ten cities we studied, is very effective in protecting new development in flood hazard areas from losses due to flooding up to the 100-year flood event. Those benefits are achieved primarily through influence on the development decisions of builders and land developers. Strengthening floodplain land use management programs will result in the adoption of additional loss prevention measures by builders and developers, who, in strong markets, will pass added building and development costs on to consumers. In weak markets, developers and builders may avoid floodplain locations.

Because households and business firms hesitate to invest in additional loss prevention measures (beyond those mandated by local building regulations) unless they have had flood losses, immediately following a flood there is a window of opportunity in which government programs may induce households and firms to take additional steps to protect their property from flooding. Many households and firms would find technical assistance and low-cost loans useful aids in helping them put flood loss prevention measures in place.

Flood insurance is not playing the role Congress intended it to play in shifting the costs of floodplain development from the public to the private sector and in spreading the risk of loss widely among floodplain occupants. In part, that is so because the federal government is not enforcing provisions of the Flood Disaster Protection Act of 1973 that require persons holding mortgages on floodplain property from federal regulated financial institutions to purchase and maintain flood insurance coverage for the balance of the mortgage. There appear to be some roles local governments could play in promoting the purchase of flood insurance by floodplain occupants.

Although Congressional legislation and federal policy statements seek to discourage additional floodplain development, the NFIP's minimum land use and building criteria are less effective in doing that than they are in suggesting ways to protect development from flood damages after a decision has been made to locate in the floodplain. Local floodplain land use management programs, however, often exceed federal minimum criteria and can be successful in discouraging floodplain development.

Floodplain development pressures can be reduced if communities ensure--

through annexation, service extension, and zoning policies--that a large supply of flood-free land is available for urban development. That policy is not likely to be opposed by floodplain property owners, and thus it provides a subtle way in which communities can guide development to locate on flood-free sites.

Floodplain property owners do not oppose government acquisition of vacant flood-hazard areas for parks and other open space uses, since that increases the value of adjacent property. Land acquisition is thus also an important policy tool for limiting future floodplain development.