CHAPTER VI

LOCAL PROGRAMS

Status of Programs

As noted in Chapter I, the 1970s witnessed much growth in local floodplain management and increasing sophistication in the application of regulations in combination with other hazard reduction techniques. More than 17,000 cities, towns, villages, and counties have adopted or shown an intent to adopt regulations to qualify for the NFIP or to satisfy state floodplain management requirements.

Local regulation of floodplain areas is largely a phenomenon of the 1970s, although some cities, such as Milwaukee, adopted regulations in the 1940s and 1950s. A 1957 national assessment of floodplain regulations by Francis C. Murphy at the University of Chicago identified only 35 local governments with regulations.[1] He considered most of these programs ineffective.

By 1970, several hundred communities had adopted regulations. A University of Wisconsin survey of local regulations in 1968-1969 identified 183 municipalities and 71 counties with floodplain zoning, and 167 municipalities and 27 counties with flood-related subdivision regulations.[2] These communities were centered in two areas of the nation: the Tennessee Valley, where TVA had provided flood hazard maps and technical assistance since 1953; and the midwestern states of Iowa, Wisconsin, and Minnesota. In the late 1960s, the latter two states had adopted state floodplain statutes mandating local regulations.

Rapid local adoption of floodplain regulations since 1970 is attributable primarily to the incentives of the NFIP, although other various forces have also been important: serious and widely publicized floods such as those resulting from Hurricane Agnes, widespread availability of

flood maps, the development of model ordinances and floodplain regulation guidebooks, technical assistance from state and federal agencies, state statutes authorizing and often requiring floodplain regulations, concern with floodplain environmental values, and increased community land use planning and control capability. In general, local governments have adopted the minimum standards of the NFIP except where state standards are more restrictive.

Differences in Rural, Urban, and Metropolitan Areas

Rural Areas

Many rural communities and counties have adopted a resolution requiring floodplain development permits from a planning commission or board of adjustment. Others have adopted a single district floodplain zoning ordinance of the sort proposed in Volumes 1 and 2, Regulation of Flood Hazard Areas. Approximate flood maps developed by the USGS, historic flood maps, and soils maps provide the basis for regulation.

Rural communities are often handicapped in regulation by lack of detailed maps, personnel, funds, and expertise. State technical assistance has been particularly important for rural areas since state programs often provide model ordinances and manuals, training, and case-by-case review of permits. Regional planning agencies have also provided important technical assistance.

Highly restrictive rural regulations are most common in riverine areas of the Northeast, Midwest, and the mid-Atlantic states. In these areas, permanent dwellings are sometimes prohibited in the entire floodplain. Single-district zoning regulations are often combined with subdivision controls and sanitary regulations. Some subdivision regulations are combined with sanitary code provisions that prohibit septic tanks in hazard areas in order to control some development without zoning.

Often "resource protection" regulations are adopted for all or portions of rural floodplains. As discussed in Chapter V, inland wetland protection regulations have been widely adopted in Connecticut, Massachusetts, New York, and Rhode Island. State or local coastal wetland protection regulations have been applied in all coastal states. Shoreland regulations have been adopted in Maine, Michigan, Minnesota, New Hampshire, Wisconsin, and Washington State. Agricultural zoning has been adopted for some floodplain areas in California, Oregon, and Massachusetts. Wild and scenic river zoning with floodplain components has been applied to selected rivers in Maryland, Michigan, Minnesota, New York, Oregon, and Wisconsin. Some Colorado communities have adopted zoning to protect sand and gravel resources in floodplain areas.

Urban Areas

Many small and medium-sized cities have two-district floodplain zoning (floodway or coastal high hazard area and a flood fringe), subdivision control, and building code regulations. Two-district zoning is often applied to developed urban areas. Single-district zoning is common for smaller streams or those without detailed flood studies. Two-district regulations usually resemble the models set forth in Volume 1, Regulation of Flood Hazard Areas.[3] Subdivision regulations often contain drainage requirements. Building codes establishing minimum protection elevations without zoning are common in coastal areas. Urban areas usually adopt floodplain regulations as part of broader zoning and land use controls.

Expertise and staffing are problems for smaller cities, but less so than for rural areas. Detailed flood maps are available for some but not all urban areas. State assistance in mapping and project review has been somewhat less important for urban areas than for rural ones.

Metropolitan Areas

Large cities and metropolitan areas have adopted the most sophisticated floodplain management programs and regulations. Two-district floodplain zoning is common; however, some large cities such as Baltimore and Milwaukee exclude new development from the floodplain. Subdivision regulations with flood hazard and storm drainage provisions are found in many cities. Building codes may incorporate flood hazard provisions.

These areas have often developed more detailed flood maps with scales of 1"=100' to 1"=400' with 2-foot to 4-foot contour intervals. Mapping on a watershed basis is common: future watershed conditions are often considered. Sewer maps, topographic maps, and other large-scale maps may be used as bases.

Large cities and metropolitan areas often have engineering and planning staffs with some expertise in floodplain management. Regulations are typically combined with acquisition, flood control works, and urban renewal policies. Integrated floodplain and stormwater management regulations may be provided for smaller streams.

Program Characteristics

The most extensive survey of local floodplain regulation during the 1970s was conducted by the Center for Urban and Regional Studies at the University of North Carolina. In April of 1979, with funding from the National Science Foundation,[4] the Center sent questionnaires to 1,515 local governments and 648 regional agencies. The results of the survey are summarized below.

Local Government Responses

The 1,515 surveyed communities included 926 communities in the regular program of the NFIP and 489 in the emergency program. Community response to the questionnaire was an excellent 85%.

Regulatory objectives. As one might expect, most communities in both the regular phase and emergency phase adopted regulations to reduce property loss from flooding (73% and 53%, respectively) and to prevent threats to safety (69% and 50%). Reduction in erosion and sedimentation was also a major objective (43% and 36%), as was preservation of natural areas (41% and 35%).

Techniques. The regulatory techniques used for both phases were similar, but with different emphases. Both groups relied heavily on elevation requirements (84% and 63%) as part of permit systems, zoning, or other regulations. However, as one might expect, regular program communities, because they have more detailed flood maps, made greater use of elevation requirements. Subdivision regulations, which shift much of the data-gathering burden to developers and thus can be used with approximate flood data, were used with about the same frequency (76% and 75%). Both groups used zoning regulations (77% and 71%), which is somewhat surprising since other information suggests that zoning is more common in regular program communities. Floodproofing requirements were used more frequently in regular program communities (68% to 40%) because more detailed flood data and the personnel needed to evaluate development proposals are available there. As expected, floodway regulations were more common for regular program communities (60% to 35%), since floodway maps are usually available only for them.

Most communities devoted limited resources to program implementation. Fifty percent spent less than $1,000 a year on implementation (44% and 58%), and an additional one-quarter spent less than $5,000 (27% and 22%). Fifty percent spent less than one hour of staff time each week on regulations (44% and 62%) and another one-third spent less than seven hours per week (41% and 29%).

Several circumstances contributed to the development of comprehensive programs: severe flood hazard, higher perception of flood hazard, and community concern for the problems. Community land use control experience and financial resources were also important.

Program effectiveness. After analysis of the number of permits issued in regular and emergency phase flood insurance program communities, the researchers concluded that local floodplain management programs were not halting continued development of floodplains. This was to be expected since most communities followed minimum NFIP and state standards which permit flood-protected structures in outer fringe areas. However, flood protection through elevation on pilings or fill was routinely required.

Local officials rated their floodplain management programs very effective in dealing with new development (62% and 49%). However, only 15% and 14%, respectively, rated their programs as effective in dealing with existing development.

Floodplain regulations were considered very effective in protecting natural areas for about one-fourth of the communities (30% and 23%) and moderately effective in an additional one-half (51% and 53%). This low response rate could be expected since most regulations permit development within outer fringe areas and, in some instances, in floodways, providing flood flows are not substantially increased.

Negative effects of regulations were reported in some communities. Increased construction costs were cited in fewer than one-half of the communities (50% and 36%). Reduced land values were cited in fewer than one-quarter (22% and 15%). Slowed economic growth affected fewer than one-sixth (16% and 13%) and reduced tax base about one-tenth (13% and 9%). On the other hand, some communities (10% and 5%) cited increased value of existing structures outside of the floodplain.

Problems. Communities cited several major obstacles to effective management: the general populace did not perceive floods as a problem (35% and 46%), land development interests opposed regulations (36% and 31%), sufficient state or federal financial support was lacking (32% and 35%), floodplain occupants opposed efforts (27% and 20%), qualified personnel were lacking (19% and 24%), and public officials were insufficiently interested (17% and 23%).

Regional Council Responses

The North Carolina group also sent a questionnaire to all 648 members of the National Association of Regional Councils. Ninety percent responded.

The floodplain management objectives reported by the regional councils were similar to those reported by local communities; however, 47% also reported maintenance of good water quality as a goal--reflecting the influence of the Environmental Protection Agency Section 208 Areawide Water Quality Management Program. Many councils were concerned with inadequate storm drainage (58%) and increased runoff from impervious surfaces (48%). This also could be expected, since regional planning agencies often deal with regional hydrology and drainage problems.

The majority of the regional councils used five floodplain management methods: (1) providing technical assistance to local governments (82%), (2) incorporating flood hazard reduction measures in regional planning (75%), (3) using the A-95 review process to discourage public investment in floodplains (61%), (4) making the public aware of flood hazards (16%), and (5) coordinating local programs (44%). A principal technical assistance and educational role could be expected since regional planning agencies usually lack regulatory and implementation powers.

Although the agencies were interested in floodplain management, most (84%) spent less than one-half person-day per week on the subject. When asked to evaluate the overall effectiveness of programs within their jurisdiction, only 7% rated programs as very effective.

Regional councils identified five major obstacles to expanded regional action in floodplain management: lack of financial support (81%), lack of public support (72%), member agency resistance to area-wide policies (61%), lack of interest by policy board (59%), and failure of the public to perceive flooding as a regional problem (57%).

Both local governments and regional councils gave high marks to state floodplain management. Seventy-eight percent of local respondents said that their states were active in floodplain management. Of this 78%, 80% rated the state programs as moderately or very effective. State agencies had provided technical assistance to 40% of the surveyed communities.

Sixty-one percent of the regional agencies reported that the NFIP was having the most significant impact of any federal program on protecting lives and property from flood losses. An overwhelming majority of local governments also reported that they had received technical assistance from the NFIP. However, 37% reported that they needed better maps, and 23% said they needed more help in calculating elevations for new development.[5]

Problems

The North Carolina study and the present study identified major problems in implementing local programs. Many have already been discussed.

- Lack of personnel and funds (particularly in small communities).
- Lack of expertise in floodplain management techniques and the use of flood data.
- Lack of familiarity with or understanding of NFIP requirements for basements, floodproofing, and base flood elevations.
- Inadequate maps (no copies, not completed, inadequate scale, no floodways, inaccuracies, lack of adequate topographic base).
- Existing nonconforming uses.
- Exemptions in regulations.
- Problems with mobile homes.
- Inadequate procedures for monitoring development.
- Special flood problems such as erosion, alluvial fan flooding, and lake flooding, that are not addressed by NFIP standards.
- Federal, state, and local public projects (e.g., low-income housing) in the floodplain.
- Conflicts between federal and state standards.
- Development pressures and lack of flood-free construction sites.
- Court cases or threats of litigation.
- Inadequate enabling authority.
- Communities' boundaries too small to deal with the source of flood problems (e.g., uncontrolled development in headwater areas in other political jurisdictions).
- Federal subsidies for flood control works.
- Federal flood insurance subsidies encouraging development in barrier islands, beach areas, wetlands, and other floodplain areas.
- Lack of landowner and community awareness of the severity of flood problems.

Innovative Programs

Types of Innovation

Some communities have adopted innovative regulations to cope with the above problems, or to deal with other needs such as allocating lands

throughout communities to their most cost-effective uses.[6] California, Connecticut, Massachusetts, New Jersey, New York, and Wisconsin have many innovative local programs. These programs often serve as examples for new programs in other communities. Innovations are of several major types, many of which have been described in preceding chapters:

- Building moratoria adopted after a disaster.
- Coastal regulations incorporating wave heights or freeboard, particularly strict dune and beach and vegetative protection standards, and wetlands protection provisions.
- Inland regulations exceeding NFIP and state standards, including zero-rise floodways, regulations to a lower frequency of flooding (e.g., the 500-year level), freeboard requirements, and storm drainage requirements.
- Regulations that reduce flood losses but also serve broader objectives such as protection of prime agricultural lands, mineral deposits, forestry areas, and wetlands.
- Regulations combined with flood warning systems, acquisition, relocation, flood control works, and flood warning signs to reduce losses to future and existing uses and, in some instances, to serve broader objectives.

Factors Encouraging Innovation

Innovations were most common when one or more of the following factors were present.

Most innovative programs were located in inland communities with recurrent and serious flood problems (e.g., Warwick, Rhode Island; Klamath, California). Innovation was less common in coastal communities with severe flooding, perhaps because of offsetting development pressures. Although severe flooding was the principal motivation for innovation, environmental problems also fostered some programs.

Because of a serious flood threat and a high level of community awareness, innovative communities often adopted regulations before the NFIP came into existence or a state floodplain program was initiated. Regulations were often adopted within two weeks to six months of a particularly serious flood. In several instances, such as Lilydale,

Minnesota, regulations were quickly adopted in anticipation of a severe flood so that the community could qualify for the NFIP.

Recent innovative programs were often encouraged by federal and state maps, technical assistance, grants in aid, flood control works, flood insurance, and other assistance. However, many innovations were initiated before federal or state assistance was available.

Strong local leadership was evident in the most innovative programs. A local planner, architect, engineer, the mayor, or a city council member often provided key leadership, although interested citizens and elected officials were important in some programs. The extreme nature of the flood problems created a political climate conducive to such leadership.

Multipurpose planning and creative thinking were evident in most programs. "Larger thinking" that goes beyond dealing with the flood threat characterized most innovative programs. Urban renewal, recreation, wildlife protection, and open space protection were common additional concerns.

Examples of Community Approaches

Broad thinking and community acceptance of responsibility for the future economic, social, and environmental well-being of its residents underpin many of the innovations profiled below.*

Resource-based Regulations for a Rural Floodplain (Glastonbury, Connecticut)

Glastonbury, a rural New England town of 25,000, has been repeatedly and severely flooded by the Connecticut River, which flows through the

*The examples have been selected from profiles contained in Appendix B to this report, Innovation in Local Floodplain Management.

town for 7.5 miles. About 1,900 acres, much of them in agriculture and open space, lie within the 500-year floodplain.

Prompted by a general awareness of flood problems and environmental concerns, in 1963 the town adopted restrictive, resource-based regulations to reduce future flood losses and protect valued resources. A floodplain zoning ordinance controlled land use and prohibited almost all permanent structures and fill in the 500-year floodplain. The town adopted a density transfer scheme, which permits the shifting of development rights from one part of a parcel to another with a shift of one unit per acre. The state also regulated some of the floodplain pursuant to a state floodway encroachment statute.

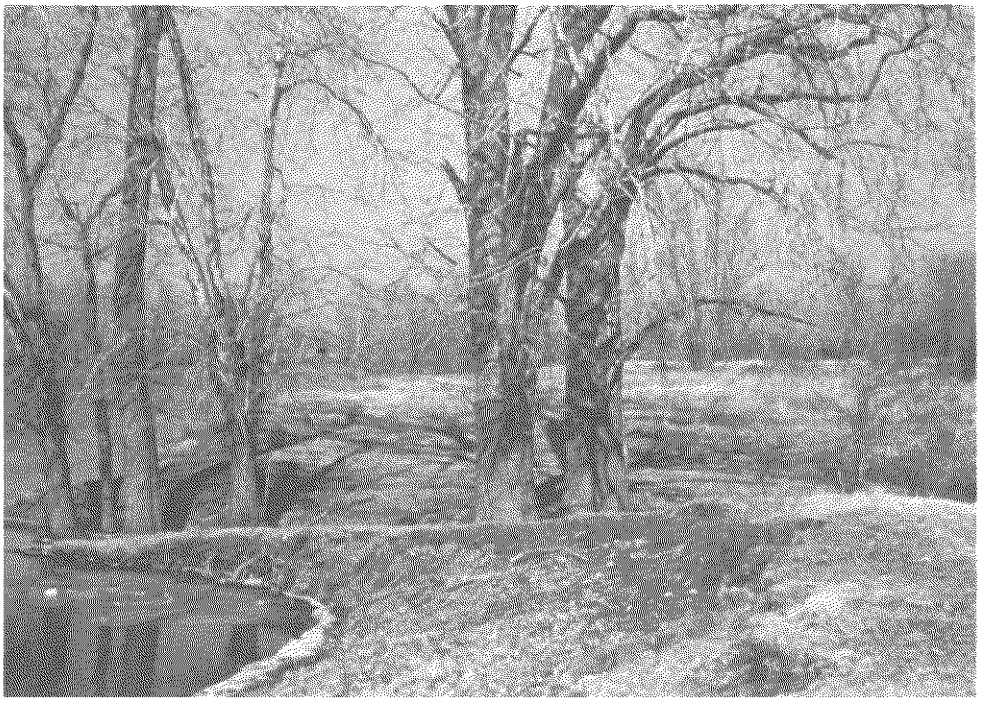
In 1974, local floodplain regulations were supplemented by wetland regulations which apply to most floodplain areas. Wetlands were mapped at a scale of 1"=100'. Fill and structures were prohibited in wetland areas. Restrictive agricultural zoning was also adopted for some areas.

The city supplemented floodplain regulations by acquiring some areas and providing tax incentives for open space uses. A group of private citizens formed the Glastonbury Trust to acquire floodplains and wetlands.

Keys to the success of this program include motivated and aware citizens, sound flood and wetland data, responsive government officials and staff, and a creative combination of regulations and nonregulatory techniques.

Regulations Combined with Acquisition (Sacramento County, California)

Sacramento County is an urbanizing area that includes the City of Sacramento and its 800,000 residents. Floods along the American River, the Sacramento River, and a number of smaller creeks have damaged the city and the county repeatedly. These damages and a concern for recrea-



Glastonbury, Connecticut, excludes structures from the 500-year floodplain along the Connecticut River which is zoned for wetland, agriculture and open-space use.

Photo by Jon Kusler

tion and other values led to planning, floodplain acquisition and the adoption of regulations.

The county first adopted floodplain regulations in the mid-1960s requiring that residences be three feet above the 10-year flood elevation. This standard was later amended to one foot above the 100-year flood. The county also adopted subdivision and storm drainage regulations: a natural stream plan incorporates highly restrictive standards for one area of the county.

Extensive lands along the American River have been acquired. A greenbelt plan for the river dates from 1915, but it was essentially unimplemented until the 1960s. In 1961, after the County Planning Commission approved subdivision plans for a portion of the American River floodplain, citizens reacted strongly and formed the Save the River Association. Public pressure forced the county board to adopt a parkway plan. Funding from a variety of sources, including a county bond issue, has been used to acquire more than 3,000 acres along 23 miles of the river. The remaining 1,900 acres in mixed public-private ownership are controlled through leases and special arrangements. A County Park Corridor Overlay Zone prevents incompatible adjacent development.

The regulations and acquisitions have been successful because of timely regulations and acquisition before development could occur, high public awareness, an active citizen lobby, effective staff leadership, and available funding.

Regulations Combined with Postdisaster Relocation (Soldiers Grove, Wisconsin)

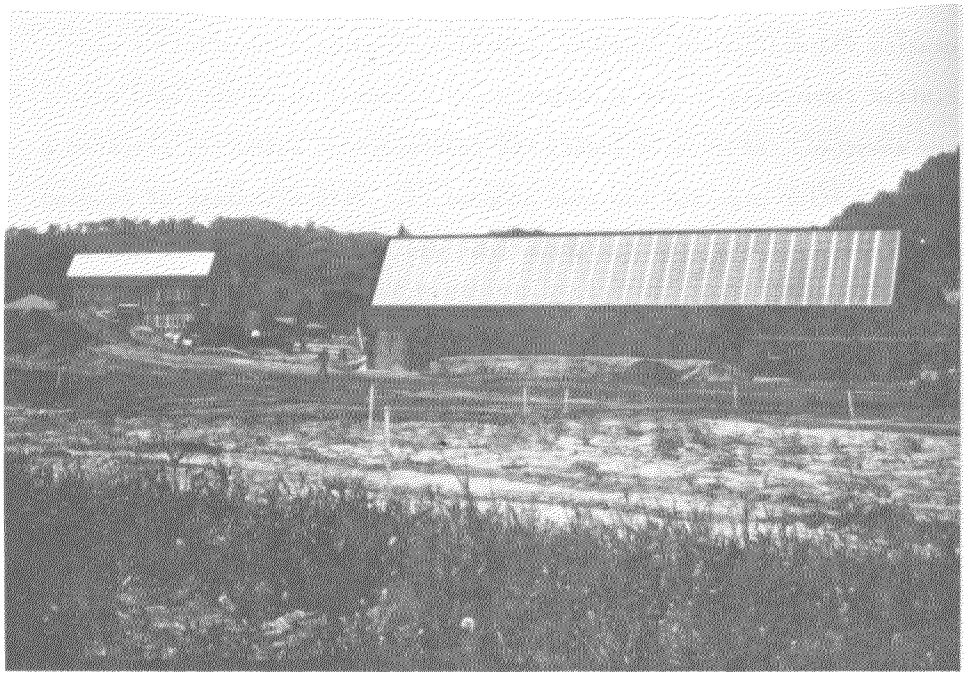
Soldiers Grove is a small southwestern Wisconsin town (population 680) which has been subject to repeated flooding by the Kickapoo River. Prior to 1978, the Corps of Engineers had constructed levees adjacent to the river, but these provided only partial protection from flooding.

The Corps also began construction of a 9,500 acre upstream dam and reservoir, but public opposition throughout the state halted the project.

In 1978, the town adopted floodplain regulations requiring that new structures be elevated one foot above the 100-year flood level. The town redevelopment authority also prepared a relocation plan. Later that year a severe flood overtopped the levees and flooded the entire town, causing $52 million in damages. Upgraded floodplain regulations prohibited rebuilding in the Kickapoo River floodway which includes most of the downtown. After this event, the redevelopment authority prepared a new relocation plan and the town adopted it. With a variety of funding sources, a 190-acre site for a new town was acquired and sewer and water supply facilities were installed.

The relocation plan is presently being implemented at an estimated total cost of $5.75 million with 60% federal and 40% nonfederal cost-sharing. Thirteen structures have been constructed at the new town site. Passive solar heating is required by ordinance as part of wider resource planning measures and to increase available grant sources. In addition, several residential structures in outer flood fringe areas have been elevated on fill or floodproofed with technical assistance and financial help from the town.

The success of this program has been due to the severity of the flood threat, strong leadership by the local redevelopment authority, education regarding the cost effectiveness of floodplain management, and the packaging of federal funds. This is among the most innovative of all local programs. It combines the objective of flood loss reduction with provisions for urban renewal, open space, and energy conservation. It demonstrates the importance of preflood planning that makes mitigation programs available for quick implementation when a flood occurs.



In relocating its flood-prone business district after the severe flood in 1978, Soldiers Grove, Wisconsin, also required passive solar construction for its new buildings in the new town.

Photo by Jon Kusler

Floodplain Regulations Combined with Stormwater Management Regulations (Dallas, Texas)

Dallas is a rapidly growing city of nearly one million residents. There has been repeated severe flooding, with a particularly serious flood in 1964. Because of flood problems and the need for recreation and open space, the city adopted a comprehensive floodplain regulation, stormwater management, acquisition, and relocation program.

Floodplain zoning was first adopted in 1965. In 1968, the city adopted regulations for the 100-year floodplain. In 1977, regulations were upgraded so that the city now allows only minor floodplain changes that will cause no increase in flood heights. Restrictions were imposed on nonconforming uses. A permit from the board of adjustment is required for any alteration or improvement valued over $300. The city also adopted subdivision and stormwater management regulations.

To implement regulations and facilitate watershed planning, detailed flood maps for 35 to 40 creeks at scales of 1"=50' to 1"=200' were developed on an orthophoto base with one- or two-foot contour intervals. These maps were based on flood flow projections assuming fully urbanized conditions consistent with land use planning and regulatory densities.

When a residential subdivision is developed, the subdivider ordinarily must dedicate the floodplain to the city as a condition to plat approval. Flood boundaries must be indicated on plats and marked on the ground.

The floodplain may not be used as a building site for apartments. However, floodplain portions of broader parcels intended for apartment use may be used as common open space if a floodway easement is dedicated to the city. Density bonuses are given for floodplain protection. Certain residential subdivisions have also been permitted to retain title to floodplain areas where a homeowners' association agrees to hold and maintain the land as open space.

Regulations have been supplemented by acquisition of more than 2,500 acres of undeveloped floodplain. Funding has been received from a variety of sources, including local bond issues; one landowner donated 400 acres. In addition to acquisition of undeveloped areas, the city acquired approximately 180 structures in two seriously flooded subdivisions through a voluntary relocation program. HUD Community Development Block Grant monies and other funds were used.

The city has undertaken some channelization to reduce flooding threats to existing uses, and it is acquiring and constructing stormwater retention basins.

The success of this program has been due to severe flooding problems, motivated and informed citizens, effective city council leadership and staff, high quality flood maps, and multiple funding sources.

Multijurisdictional Floodplain Management (Denver Metropolitan Area)[7]

The Denver metropolitan region consists of 34 units of local government with 1,100 miles of floodplain, a population of more than 1,200,000, and a total area of about 1,200 square miles. The area has been subject to repeated and severe floods along the Platte River and Cherry Creek.

In 1969, the Colorado Legislature created the Denver Urban Drainage and Flood Control District to address drainage and flood control problems on a metropolitan basis. Individual local entities were unable to deal with multijurisdictional flood and drainage problems. The District includes Denver and the urban portions of Adams, Arapahoe, Douglas, and Jefferson Counties. The District is governed by a 15-member board of directors. Funds are obtained by a tax levy.

The District is authorized to regulate floodplain areas but has chosen, instead, to establish standards for local regulation by the 28 local governments with flood problems. All 28 communities adopted

regulations by a deadline the District established; they are also enrolled in the NFIP.

The District has prepared detailed flood maps and master drainage plans for most areas. The drainage plans identify present and anticipated basin problems, flood flows based on projected urbanized watershed conditions, and measures needed to reduce flood problems. Thirty-one master plans had been prepared as of December 13, 1979. Planning is under way for six other areas.

Other District activities are the design and construction of drainage and flood control facilities, provision of technical assistance to local government, collection of flood and water quality data, preparation of flood disaster plans, and education of landowners.

Floodplain management activities have received strong support from citizen groups such as the Platte River Development Committee, which has lobbied for the protection and restoration of the Platte River. In 1974, the District prepared a "greenway" plan for that part of the river flowing through downtown Denver. The plan is now being implemented to improve water quality, enhance recreational opportunities, provide open space, and reduce flood losses. Over 350 acres of greenway along 10 miles of the river have been acquired with public and private funds. The Greenway Foundation, a nonprofit corporation, has played a major role in public relations and fund-raising for the program.

Success with the greenway plan has been due to a high level of awareness of flood problems, special enabling legislation, citizen support, effective staff, a thorough public education effort, and careful coordination of activities.

Two-zone Management of Coastal Flood Problems (East Providence, Rhode Island)

East Providence is a city of 52,000 with estuarine flooding on the Seekonk River. The waterfront suffered severe flood damage from hurricanes in 1938 and 1954. Following recommendations of a governor's task force on hurricane flood problems in 1955, the city adopted regulations prohibiting structures on lands less than 10 feet above mean sea level. If protected from flooding, structures for human occupancy were permitted in backlying areas between 10 and 15 feet above sea level. These regulations are still in effect.

The city acquired some floodplain areas for public use after the 1954 flooding. In 1974, it prepared a waterfront plan for the 14.4 miles of city waterfront. Additional park acquisition is recommended by the plan.

The success of this program has been due to the severity of flood problems, an active city planning office and conservation commission, and state coastal zone and wetland regulations that reinforce local controls. East Providence illustrates one of the oldest approaches to "high hazard area" and "low hazard area" coastal flooding in the nation.

Coastal Flood Hazard Reduction and Resource Protection (Virginia Beach, Virginia)

Virginia Beach is a coastal community of 285,000 with a large coastal floodplain and some riverine flooding. There was severe flooding in 1933 and 1962.

The city first adopted floodplain regulations in 1973, requiring permits for all activities involving fill, grading, or structures. First floors must be elevated one foot above the 100-year flood elevation. Development is prohibited in areas less than six feet above mean sea level. In one beachfront area subject to wave action, first floors

must be elevated 18.5 feet. The community has adopted its own flood maps at a scale of 1"=100'.

The city has also adopted coastal wetland regulations and sand dune protection regulations that require building setbacks. Four coastal inspectors have been hired by the city to monitor and enforce regulations. In addition, private citizens have helped by reporting violations.

Success in this program has been due to community awareness of flood and environmental problems, support by the city administration, and detailed flood maps. Virginia Beach illustrates a successful combination of floodplain and wetland regulations to achieve multipurpose floodplain management goals.

Mud Flows (San Bernardino, California)

San Bernardino is a southern California community of 170,000 residents. A 1979 forest fire north of the city denuded 750 acres in and adjacent to a canyon with unstable slopes. This, combined with heavy rainfall, caused increased runoff and mud flows. One area of the city was subject to four mud flows in January and February of 1979; 25 structures were seriously damaged.

Because of safety concerns, the city passed an emergency ordinance declaring the area unsafe and prohibiting new building or repair of damaged structures. Acquisition of damaged structures was made possible by funding from FEMA's Section 1362 program and loans from the Small Business Administration. The vacated land will be used as a city park. To contain future flows, retaining walls were constructed adjacent to the properties. In addition, the city has undertaken erosion control work in the headwaters of the canyon.

Success of this program has been due to the severity of the problem, public awareness, support of the city council and mayor, public education, and federal financial assistance. San Bernardino illustrates one

community's approach to a "special" flood problem using a combination of management techniques.

Similar floodplain management programs tailored to mud flows, alluvial fan flooding, long-term ground water fluctuations, high velocity flows, combined erosion and flooding and other special flood problems ar needed in thousands of communities. These could be encouraged by state and federal technical assistance and "special" mapping.

CHAPTER VI

Footnotes

1. Murphy (1958).

2. U.S. Water Resources Council *et al.*, (1970).

3. *Id.*

4. French and Burby (1981).

5. *Id.*

6. Sanibel, Florida; Lake County, Illinois; and Lincoln, Massachusetts, are examples of such broader resource management efforts that include floodplain management as one component.

7. For other examples see Platt *et al.* (1980).