1. Executive Summary

This preliminary analysis has two purposes: to identify information and knowledge gaps in the management of flood hazards, and to propose some policy options for further consideration that could beneficially affect such management.

THE APPROACH

Five basic elements are involved in meeting the above purposes.

- Determining long-term trends in relation to floods and flood hazards management.
- Identifying issues—the points of enduring conflict.
- Proposing the lifecycle of a flood hazard as a diagnostic and prescriptive framework for policy study.
- Identifying knowledge and information gaps.
- Proposing several policy options.

SUMMARY

Floods as a Policy Concern

Every year, flood disasters, which include hurricanes, flash floods, mudslides, subsidence, river valley floods, and winter coastal storms cause hundreds of deaths and result in property losses of about $2 billion. Some recent examples are:

- the 1972 Agnes floods— 105 lives and over $4 billion in damage;
- the 1972 Rapid City, S. Dak., flash flood —237 lives and over $164 million in damage;
- the 1973 Mississippi Valley floods-33 lives and $1.15 billion in damage;
- a 1974 flash flood in Colorado's Big Thompson Canyon, which destroyed virtually everything in its path— 123 lives.

The Federal Disaster Assistance Administration reports flood-related assistance expenditures of $872 million between 1974 and October 1978.

Despite an estimated $14 billion spent by the U.S. Army Corps of Engineers and other Federal agencies for structural flood control projects since 1936, losses have continued to rise. Concomitantly, Federal disaster assistance payments have increased sharply from $52 million in 1952 to an all-time high of '$2.5 billion in 1973. These dollar figures, however, only represent a small fraction of the total social costs of dislocations due to floods.

In vulnerable areas, urban expansion into floodplains and coastal hazard areas has been estimated to increase flood losses an average of 1.5 to 2.5 percent per year. This represents roughly a doubling of investment risk in one generation.

Urbanization and other changes in land use contribute to the frequency and intensity of floods. As permeable natural surfaces give way to roofs, pavements, and sewer development, rainfall and snowmelt are channeled directly to streams instead of soaking into the ground. In one watershed north of Boston, the estimated 100-year flood (having a l-percent chance of occurring in a given year) became a 20-year flood (5-percent chance) within the course of 15 years of rapid development. This, of course, applies to development anywhere in the watershed, not simply in the floodplain.

Any strategy for coping with flood losses must contend with the fragmentation of political and legal authority over the Nation's river basins and floodplains. Rivers and streams typically flow from one jurisdiction to another, and frequently are used as convenient boundaries between local governments, counties, and States. Actions in one jurisdiction may affect other jurisdictions downstream, across the stream, or even (in the case of backwater flooding) upstream. Individual encroachments on floodplains cause cumulative impacts in the form of increased flooding in neighboring areas. Yet, land use and floodplain policy has been viewed as largely a local matter. Floodplain management, therefore, has proceeded on a parochial and fragmented basis, ill-suited to the achievement of national or local flood loss reduction.

The National Flood Insurance Program (NFIP), since its inception in 1968, and strengthened by substantial amendments in 1973, has become the major new instrument in national flood policy. It

reflects the recent emphasis on a mixed-strategy approach.

The actual effect of NFIP on flood losses is questionable. Specifically, the program involved both the sale of federally subsidized flood insurance, and the management of floodplains by non-Federal public authorities. The insurance without floodplain management could lead to the increased development of flood hazard areas. This would drive flood losses still higher. At present, the management component of NFIP lags far behind the sale of insurance. Consequently, a special effort will be required to attain the floodplain management goals of NFIP.

A Framework for Flood Hazards Management: The Lifecycle of a Hazard

Flood hazards, like other natural hazards, have their origin in nature. F1ood disasters, however, are a consequence of the intrusion of man and his works into an environment that puts them both at risk.

An effective management strategy for moderating a flood hazard, or any other natural hazard, must take into account the hazard's total lifecycle as it evolves from its natural condition in an environment into the risk conditions created by the people's activities in that environment. The lifecycle shown in figure 1 presents an overall picture from which the relative strengths and weaknesses in current public policy can be identified.

At present, the relatively strong capabilities of flood hazards management are its emergency organization and its planning for dealing with the immediate postdisaster situation (items 6 and 14 in figure 1). The readiness to exercise an emergency response (item 15) is a much weaker capability. Damage assessment (item 17) is relatively well-done after minor floods but much less so after major floods in most areas.

Planning for rehabilitation and recovery (item 18) is seriously deficient in all areas subject to floods. For maximum effectiveness, comprehensive plans to provide relief, as well as rehabilitation, must be readied before a disaster strikes. The only long-term strategy that will reduce future flood disasters is to rebuild properly designed structures on suitable sites, avoiding the repetition of past errors. At the present time, however, without proper planning for rehabilitation and recovery after a major flood, it is not likely that the unsound building patterns of the past will be changed.

Prevention has traditionally relied on controlling floods by means of civil engineering works. The increasing inadequacy of civil works that are not closely tied to land use planning is widely recognized. For this reason, how to make long-term land use planning an effective tool for controlling development in flood hazard areas and for guiding postdisaster recovery is a principal public policy question in flood hazards management. Without effective means for controlling floodplain development and guiding postdisaster recovery, the cost of floods nationwide will continue to rise.

Three Basic Approaches to Flood Hazards Management

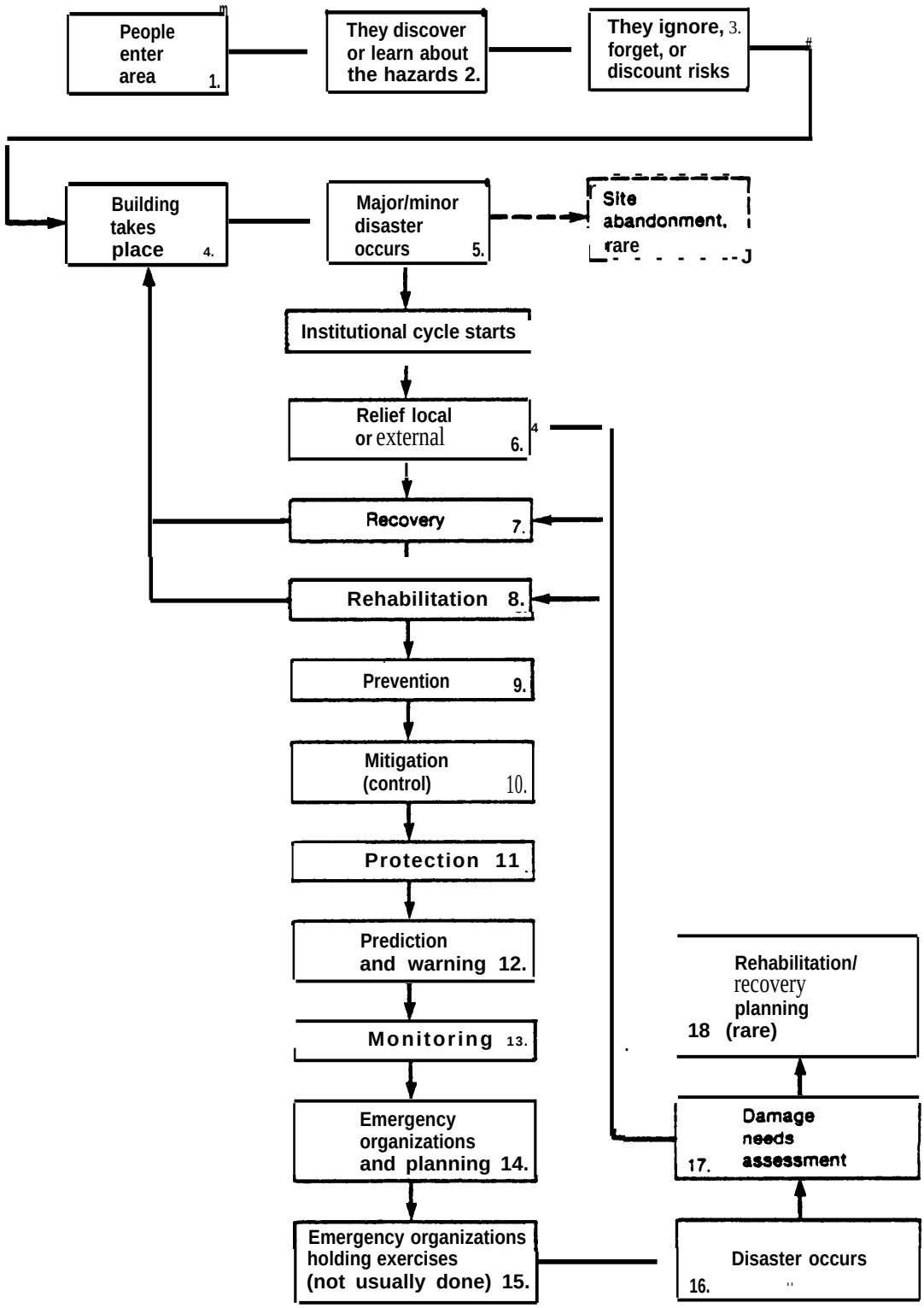
The U.S. Water Resources Council in its 1976 policy statement, "A Unified National Program for Floodplain Management" (revised in 1979), assigns all possible public responses to flood hazards to three basic approaches:

- Modify flooding itself by using structural controls to alter the course or flow of the water.
- Moderate the impacts of flooding on individuals and communities through insurance, disaster relief, and tax adjustments.
- Reduce the risks of flood damage.

The traditional approach to flood hazards at the Federal, State, and local levels has primarily been to modify the hazard. Flood control dams and reservoirs may influence the volume of runoff during peak stages of a flood and consequently affect when a flood occurs and its duration, as well as the extent of area flooded. Within the limitation of their design capacity, levees and dikes can protect certain downstream areas from floods. But both types of structures affect the natural flow of streams, thus increasing erosion and sedimentation, and impairing natural habitats and ecological processes. Furthermore, as noted above, flood losses continue to rise despite the major national investment in flood control. One reason is that it is unfeasible to build works that will protect against every conceivable flood. When the design limits are exceeded, catastrophic losses may be inflicted on settlements originally attracted to the floodplain in the belief that it was protected.

Two other traditional approaches to flood hazards are emergency measures including flood warnings and temporary removal of property, and

Figure 1-Lifecycle of a Flood Hazard



SOURCE. Office of Technology Assessment.

disaster assistance. Again, it is recognized that the consequences of floods cannot be effectively dealt with by these measures alone. The most that can be achieved through warning schemes is saving a few lives and slightly reducing property loss. Disaster relief encourages continued occupancy of unsafe locations.

The approach to the management of flood hazards is shifting toward measures that would reduce the susceptibility to flood damage by integrating land management techniques, such as restricted occupancy, with the traditional tools and strategies, such as civil works. Emphasis is being placed increasingly on zoning codes, regulations, the implementation of development and redevelopment plans, and policies to improve the design and the location of structures.

Trends Related to Flood Hazards

Trends analysis is useful in at least three ways. It defines the boundaries on alternative future developments; it forces one to search for underlying factors that may either stabilize or perturb the trend; and it suggests opportunities for policy intervention to modify what would be a stable but undesirable development.

Trends that will shape the future of exposure to flood hazards in the United States fall into four categories:

- the degree of risk posed by floods,
- Ž the effects of demographic trends on flood hazards,
- Ž evolving patterns of floodplain use, and
- trends in public policy responses.

Trends related to flood risk.–The most important risk-related trend is that public policies, by continuing to encourage floodplain development, are causing losses to continually rise and may cause catastrophes of unprecedented scale. The number of lives lost in these potential major events could easily be in the thousands and property loss could amount to billions; far exceeding any previous experience.

The loss of life from floods, while low compared with that of developing countries, has shown a slight upward trend over the past several decades. Property loss has grown. It is not clear how much the effect has been of true increases, inflation, better reporting schemes, insurance availability, or other factors.

Compounding the problem created by increased urbanization of floodplains, watershed flooding itself is increasing. As natural surfaces are covered by impermeable-roofs and pavement, runoff increases and floods are magnified in frequency and intensity. "Acts of God" are a decreasingly important aspect of flood hazards. As an understanding of the causes and prevention of flood losses increase, the responsibility for such losses inevitably must shift from unanticipated events to people's disregard of the known facts, along with their reluctance to plan.

There is a downtrend in the original historical reasons for the occupancy of floodplains. Proximity to bodies of water is normally no longer required for energy, water supply, waste disposal, and transportation. The growth of the highway system, pipelines, railroads, electric utility grids, and other similar infrastructures has virtually eliminated the economic need to locate next to rivers and streams. However, water resources and adjacent areas are increasingly the subject of conflict over alternative uses and allocations. Among the competing forces presently involved in the use of floodplains are commercial and industrial development, housing, the growth of outdoor natural and commercial recreation areas, the desire for the conservation of natural resources-especially in wetlands—and historical preservation. There is more legislation today than in the past that relates to floodplains and coastal zones.

Demographic trends.–Flood hazard potential is, in part, increased by the continuing migration of population to coastal areas on both a seasonal and permanent basis. Between 1960 and 1970, coastal counties of the United States gained 20 percent in population as compared with a 14-percent gain for the Nation as a whole. This trend is believed to be continuing. In most riverine floodplains, the number of people is less important than the expansion of investment in nonresidential property. However, there is evidence of continued development of mobile home communities and lower cost, vulnerable housing in marginal floodplain locations.

Space for building to meet a growing population is fast disappearing in areas with mountainous terrain such as West Virginia, and in sites of heavy industrial development. Where there is a need to be near the workplace, development of marginally hazardous areas tends to be promoted. Development pressure coupled with recreation demands

has increased the number of residences and people exposed to floods, especially in coastal recreation areas. Furthermore, the elderly and other retirees are moving to warm coastal climates, often unaware of the natural hazards risks they may be facing.

Trends in the management of flood hazards.–From 1936 to 1968, the prevailing national response to flood hazards was to undertake flood control projects, largely.at Federal expense. Since the 1966 Report of the Task Force on Federal Flood Control Policy (House Document 465), several trends have led to challenging the primacy of flood protection by physical methods as the chief public approach to dealing with flood hazards.

There is a shift in emphasis from "structural," or engineering, measures such as dams to moderate losses, to "nonstructural" economic sanctions and incentives. These latter are adopted instead, or in addition to, physical measures. Together they achieve what the Task Force on Federal Flood Control Policy termed a "unified program for managing flood losses. " Implementation of mitigation, prevention, and loss reduction measures at local levels is being emphasized as a precondition for the receipt of Federal disaster relief. Such nonstructural measures as floodplain zoning, building and design controls (e.g., minimum elevation requirements), and acquisition and relocation are being increasingly applied. The last, however, has not proven practical owing to the lack of consistent and timely Federal cost sharing. There is also a growing trend to view land use planning as an essential tool of flood hazards management.

Lastly, there is a trend toward the use of flood insurance as an alternative to outright disaster relief. Through insurance premiums calculated to reflect the extent of flood hazard at a particular location and elevation, it is intended that voluntary private decisions will act to minimize exposure to flood loss.

issues in Flood Hazards Management

The issues or conflicts in flood hazards management fall into seven major areas.

Equity issues.–There are two **key** equity issues. The first finds the right of property owners to the unrestricted use of their property in conflict with governmental responsibility to safeguard health, safety, and the welfare of citizens. The second involves the distribution pattern of costs and benefits from the mitigation of flood hazards and from disaster relief. The central question is whether the distribution should principally involve all local payers and beneficiaries or should cover a broader national base.

State and local government versus the -- Federal Government.–The conflict between Federal and non-Federal public authorities flows from two considerations. The first reflects the constitutional limitation on federalism and the distribution of sovereign power among Federal, State, and local governments. The second reflects the piecemeal, contradictory, and poorly integrated plans and programs of the Federal Government in dealings with State and local governments.

Integration of Federal programs.–There is . little integration within the Federal system in terms of agency plans and programs concerned with flood hazards management. This may be improved by the President's reorganization of Federal agencies responsible for hazards and emergency preparedness.

Goal conflicts. -Goal conflicts arise from two sources. First, there are no action-oriented national goals with regard to flood hazards management. Second, existing programs that are directed at dealing with flood hazards areas are disorganized and at cross-purposes.

Means conflicts.–The traditional means of flood control are increasingly seen not only as inadequate but also as methods that cause the situation to worsen. Yet, political, social, and institutional conflicts are inherent in any transition to an integrated approach using nonphysical or socioeconomic strategies along with physical or engineering design strategies.

Short-term versus long-term interests.–The short-term benefits of development in hazardous terrain conflict with the longer term risks. In addition, conflicts arise over the calculations of short- versus long-term costs and benefits.

Information.–Information about all aspects of flood hazards is inadequate. A policy information base is not available and there is a reluctance to generate it. Research programs are uncoordinated and information is not disseminated in a useful and timely form to all concerned. (Information needs particularly relevant to policy development are discussed in chapter XI.)

The National Flood Insurance Program

The National Flood Insurance Program (NFIP) seeks to promote two interrelated objectives in the Nation's coastal and riverine flood hazard areas:

- To stabilize and eventually reduce flood losses by stimulating the planning and management of flood hazard areas by States and local governments.
- To reallocate the costs of financial assistance to flood victims from Federal taxpayers to occupants of flood-prone areas through the mechanism of insurance.

These are related goals. Effective management of floodplains will keep future losses from continuing to rise; while the intent of establishing a federally sponsored flood insurance program is to reinforce the management of floodplains by setting insurance premium rates for new structures according to the risks at specific sites.

The Accomplishments of the Federal Insurance Administration (FIA)

A number of positive achievements can be cited for NFIP.

- The Flood Disaster Protection Act of 1973 amended NFIP to provide for compulsory participation and emergency eligibility.

  This succeeded in establishing the insurance as a standard feature of Federal flood policies, as evidenced by the approximately $67.3 billion in insurance coverage held by over 1.7 million policyholders.
- Progress is being made towards achieving the national objective of completely mapping about 20,000 flood-prone communities by 1983. The preliminary mapping has so far informed some 19,000 local governments about their flood hazards.
- Building codes and practices in many flood-prone communities have improved.
- The delineation of the Nation into flood-prone areas has stimulated public awareness of flood hazards.
- The program is stimulating the purchase of flood insurance.
- The state-of-the-art has improved in such pertinent subject areas as home construction, economics, environmental engineering, hydrology, and hydraulics.

Flood Insurance Issues

NFIP is confronted by a number of issues whose resolution would greatly accelerate the achievement of its objectives. These issues deal with the following problems:

- *Reorganization*— By executive order, FIA has been reassigned to the new Federal Emergency Management Agency (FEMA). The purpose of this reorganization is to place Federal emergency mitigation and response activities in one agency and to provide "one-stop" service to States and local governments.
- *Coordination within the Federal Government*—Collaboration between FIA (especially as part of FEMA) and other Federal agencies such as the Office of Coastal Zone Management and the Environmental Protection Agency needs to be improved in order to more effectively pursue mutual goals.
- *Intergovernmental relations—Coordination* must be improved between public units, both vertically (Federal, State, regional, and local) and horizontally (between adjoining units of government).
- *Premium rates and* equity—As more communities enter the regular program of NFIP, the actuarial rates must be set accurately and fairly.
- *Coastal* hazards-NFIP flood studies must reflect wave heights. Flood insurance should be withheld entirely in the velocity zone (V). Recognition of erosion hazards should be improved in NFIP mapping and regulations.
- *Postdisaster mitigation—Section* 1362 of the National Flood Insurance Act of 1968 should be implemented. Postdisaster recovery planning should be required to provide for mitigation of hazards through land acquisition and relocation.
- FIA has assumed direct responsibility for the marketing of flood insurance in addition to its commitment to provide technical assistance on floodplain management.

Knowledge Gaps and Research Needs

The purpose of this report is to identify what information is needed, which, if provided, will assist Congress in policy formulation, legislation, budget allocations, and oversight on flood hazards management. There are five main areas where additional knowledge is needed:

- the generation of information,
- the transmission of information,

Ž the utilization of information,
Ž the effectiveness of already established hazards-related programs, and
. information gaps in NFIP.

Generation of Information.–Federal disaster research needs to be coordinated. There is no procedure for identifying information needs for policy setting, program planning, land use management, and engineering design utilization.

- The means are inadequate for identifying and transmitting State and local information needs to the Federal agencies.
- There is no mechanism for determining what needs to be known to improve flood hazards management.
- There are not enough first-rate researchers in the field due to the lack of steady and adequate support, and because there is no sense of urgency on the part of the Federal Government.

Transmitting information.–There is no single source for data and information produced by the various Federal agencies that deal with flood hazards. Until recently, there has not been any focus on transmitting information about hazards. This could be accomplished by the newly established FEMA.

- At present, no criteria have been established for determining the relative value, success, or failure of research projects.
- The functions of the various components of a delivery system. Who should be transmitting information to whom; and in what form? These questions are all unanswered at the Federal agency level.
- Information about the potentials of flood hazards is not well disseminated, either to the public or to public officials and organizations, owing to the lack of coordination among Federal agencies.

Utilization of information.– " '

- The criteria for determining whether there has been a discernible impact on the decision processes of individuals and organizations, have not been established.
- In what way does the utilization of information differ from its dissemination and transmission?
- The absence of programing and policy goals and the lack of a client orientation undercuts attempts at utilization.

Information gaps in NFIP.–NFIP plays a significant role in flood hazards management, therefore particular note is made of inadequacies in its information base.

- Who purchases flood insurance and for what reasons? ...
- Which communities drop out of the program, and why?
- How can the Federal agencies relate better to local needs?
- Who at the local level is responsible for identifying the needs and making plans for their local communities?
- How much new construction is going on in floodplains during the emergency program?

Study and research projects to fill the above gaps in knowledge, and their relationships with the four congressional functions of policy formulation, legislation, budget allocation, and oversight are shown in table 1.

POLICY OPTIONS

This report sets forth some suggested policy options for improving the management *of flood* hazards. These options are not recommendations, but proposals for further consideration. They fall into seven categories.

Setting Goals

The absence of goals specific enough to guide change and *to evaluate* progress acts as a major impediment to achieving an integrated strategy for flood hazards management. Three alternative, but not exclusive, goals are suggested below that would allow standards of accomplishment to be defined and evaluated.

- Hypothetical goal I.–The national objective over the next 10 years is to put flood insurance on a fully actuarial basis.
- Hypothetical goal 2.—National policy is that over the next four decades population and physical investments in floodplains at the 100-year risk level shall be reduced by 80 and 70 percent, respectively.
- Hypothetical goal 3.–The annual losses from floods as part of a national program shall be reduced by 25 percent per decade (in 1975 dollars)

Table I.-Policy Research and Study Needs in Relation to Congressional Functions

Budget

- use of remote sensing and other advanced data collection techniques
- study of the 25- to 50-year cost implications of:
  - —insurance without regulation
  - —acquisition of flood lands
  - —alternative management strategies
- Ž general cost-effectiveness of alternative mitigation techniques
- . cost-effectiveness of warning systems
- funding of implemental ion programs for warning systems in small towns

Policy

- reassessment of the efficacy of the 100-year flood guideline, and study of the implications of alternative standards
- a handbook of maximum credible flood disasters in each flood-prone region of the United States
- development of options for local governments to accumulate disaster "war chests"
- preparation of manual for States to learn cost-effectiveness of different flood strategies
- a comprehensive guidebook to Federal grants, assistance in all aspects of disaster planning, response, and rehabilitation

Legislatlon

- . integration of flood hazards with management of other hazards
- further use of the "unified national program" approach to identify operational steps for converting concepts into programs and projects
- . integration of flood warning with other natural and man-made hazards warning and information systems
- study of the existing authorities of the agencies, police powers, the "taking issue," and tort liability of the design and structure professions

Oversight

- case histories of successful and unsuccessful flood management strategies
- alternative modes of information delivery
- effects of specific Federal predisaster, disaster, and postdisaster actions on floodplain management
- alternative decisionmaking arrangements for setting plans and for the regulation of the floodplain
- the perception, interpretation, and use of risk information by the public-at-large
- analysis of the long-term geophysical and environmental phenomena related to floods
- review of foreign experience pertinent to U.S. situation
- National Flood Insurance Program:
  - —actuarial future
  - —subsidy and development in floodplains
  - —as substitute for disaster assistance
  - —choice of participation by individuals
  - —retargeting of premiums to local communities
  - —gap between adoption and implementation
  - —lessons for other hazards
- effects of relocation on business
- acceptability y of flood losses by the public
- examination of the land acquisition question
- macroeconomic evaluation of impact of floodplain management
- models for State government programs
- evaluation of agency compliance with flood management objective
- opportunities in architectural design related to floods

SOURCE Office of Technology Assessment.

Land Use Management

Land use management is the most effective tool for mitigating flood hazards in the long term. Its costs, however, are incurred in the short term and its benefits are deferred and difficult to evaluate. Therefore, it is politically the most difficult measure to implement.

Land use control could largely be used to remove land from residential and commercial use via acquisition by Federal, State, or local governments. Particular attention should be given, in flood hazards areas, to long-term land acquisition programs over a period of 30 to 40 years, the usual turnover time for structures. Land management can in this way be closely tied to other social goals such as in urban and rural development, and cause a minimum of dislocation in long-term land tenure.

A Federal Opportunity: Leadership by Example

The large number of buildings and structures owned or subsidized by Federal, State, or local governments that are located in flood hazards areas offer an opportunity for leadership. The locations of federally subsidized structures, as well as Federal buildings, is an opportunity for Federal leadership and at the same time could help to develop a more detailed sense of the macroeconomics and the social impacts of land use hazards management.

A move in the direction of leadership assumption by the Federal Government was made by Executive Order 11988, May 24, 1977, which in section 1 states:

> Each agency shall provide leadership and shall take action to reduce the risk of flood loss, to

minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrving out its responsibilities for (1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing Federally undertaken, financed, or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing.

The National Flood Insurance Program as Hazards Manager

At present NFIP is a subsidized program that operates locally to monitor the regulatory process. Its function could be expanded to make it the chief instrument by which flood hazards would be managed. This could be carried out by utilizing insurance premiums as a financial base for local flood management programs.

An All-Hazards Approach to Insurance

An argument has been made for an all-hazards strategy for dealing with the multiple problems caused by natural events confronting man and his works. A comprehensive catastrophe insurance program has been proposed that would consist of 13 parts.

- standardized all-risk coverage for all catastrophe perils except war,
- broad territorial divisions,
- Federal subsidies,
- coverage for residential and small business properties,
- land use control and loss prevention requirements,
- incentives for participation,
- elimination of Federal disaster assistance benefits for private property,
- full availability of insurance,
- Federal reinsurance,
- establishment of catastrophe reserves,
- adequate limits,
- mandatory deductibles, and
- administration by a combination of the private and public sectors.

The Mission of the Corps of Engineers

The historical role of the Corps of Engineers has been to build and maintain civil works for flood control. Although these have been beneficial, the present problem is how to effectively integrate them with strategies such as floodplain management. An examination of the successes and shortcomings of the Corps' civil works programs could provide insights for recommendations to modify its operations, particularly with respect to flood hazards control.

Research for Policy Planning

The policy planning of Federal agencies currently dealing with flood hazards would benefit from information generated by policy research.

Mapping Delays and Alternate Entry Policies

Mapping is a legislatively mandated prerequisite for joining the regular NFIP. Accomplishing the mapping is excessively time-consuming as well as extremely costly. This raises the question of whether there might not be some alternative procedure for entering the program more readily.

A number of suggestions have been made for simplifying the mapping requirement.

- The Flood Hazard Boundary Maps produced by NFIP are already in the hands of local communities. If amended to eliminate gross errors, these could be used locally until better information arrives.
- A method long in use at the State level is the use of fixed setbacks from the stream center or bank in the case of small streams and creeks.
- Refer to the area inundated by the flood of record (largest flood to have occurred in an area), or other significant historical flood, as the regulatory floodplain.
- Use the generalized relations between regulatory flood depth and readily measurable stream and/or drainage basin characteristics. Such an approach, using drainage area, stream width, and stream slope (measured from topographic maps) as independent variables, was proposed in 1961 in Pennsylvania.
- Use normalized curves to estimate flood discharges and stages which have reasonable correlation with regulatory flood stages estimated by traditional methods.
- The mapping of soils has also been shown to be a useful tool in identifying flood-prone areas in some regions.