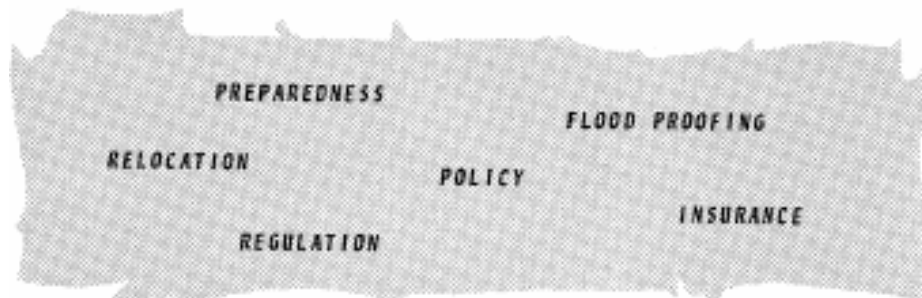




**US Army Corps  
of Engineers**  
Hydrologic Engineering Center

# Annotations of Selected Literature on Nonstructural Flood Plain Management Measures



**March 1977**

# REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

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<b>1. REPORT DATE</b> (DD-MM-YYYY) March 1977			<b>2. REPORT TYPE</b> Research Document		<b>3. DATES COVERED</b> (From - To)	
<b>4. TITLE AND SUBTITLE</b> Annotations of Selected Literature on Nonstructural Flood Plain Management Measures				<b>5a. CONTRACT NUMBER</b>		
				<b>5b. GRANT NUMBER</b>		
				<b>5c. PROGRAM ELEMENT NUMBER</b>		
<b>6. AUTHOR(S)</b> H. James Owen, Consultant Palo Alto, California				<b>5d. PROJECT NUMBER</b>		
				<b>5e. TASK NUMBER</b>		
				<b>5f. WORK UNIT NUMBER</b>		
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> US Army Corps of Engineers Institute for Water Resources Hydrologic Engineering Center (HEC) 609 Second Street Davis, CA 95616-4687				<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b> RD-9		
<b>9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b>				<b>10. SPONSOR/ MONITOR'S ACRONYM(S)</b>		
				<b>11. SPONSOR/ MONITOR'S REPORT NUMBER(S)</b>		
<b>12. DISTRIBUTION / AVAILABILITY STATEMENT</b> Approved for public release; distribution is unlimited.						
<b>13. SUPPLEMENTARY NOTES</b> .						
<b>14. ABSTRACT</b> This document is based on a comprehensive literature review of nonstructural flood plain management measures. Nonstructural measures include flood proofing of structures; land use regulation of potential flood hazard areas and, in some cases, regulation of runoff contributing areas; permanent evacuation from the flood plain of damageable activities; and temporary evacuation and emergency preventive actions based on pre-determined preparedness plans. The evaluation process that leads to selection of nonstructural measures requires assessments of more site-specific flood loss reduction components that do the more traditional structural measures. Such assessments must be made with less well known economic, social, institutional, and legal consequences. These annotations will be helpful in determining which publications dealing with nonstructural measures are potentially useful and which are redundant. The report contains an index of various types and aspects of nonstructural measures. This document will assist Corps of Engineers and other water resources planners by reducing the time required for literature search.						
<b>15. SUBJECT TERMS</b> non-structural alternatives, planning, bibliographies, flood plains, management, land use, flood proofing, publications, abstracts, water resources planning, flood plain management, Corps of Engineers						
<b>16. SECURITY CLASSIFICATION OF:</b>				<b>17. LIMITATION OF ABSTRACT</b> UU	<b>18. NUMBER OF PAGES</b> 108	<b>19a. NAME OF RESPONSIBLE PERSON</b>
<b>a. REPORT</b> U	<b>b. ABSTRACT</b> U	<b>c. THIS PAGE</b> U	<b>19b. TELEPHONE NUMBER</b>			

# **Annotations of Selected Literature on Nonstructural Flood Plain Management Measures**

**March 1977**

US Army Corps of Engineers  
Institute for Water Resources  
Hydrologic Engineering Center  
609 Second Street  
Davis, CA 95616

(530) 756-1104  
(530) 756-8250 FAX  
[www.hec.usace.army.mil](http://www.hec.usace.army.mil)

RD-9



## FOREWARD

Water resource planners are charged with evaluating a broad range of alternative flood loss management measures. Among the measures presently receiving more emphasis than in the past are those that do not involve major construction activity and hence have proportionately less environmental impact. These measures\*, often unfortunately referred to as nonstructural measures, include flood proofing of structures, land use regulation of potential flood hazard areas (and perhaps runoff contributing areas), permanent evacuation of potential damage activities from the flood plain, and temporary evacuation and emergency preventive actions based on predetermined preparedness plans.

The evaluation process for these adjustments requires assessments of more site-specific, flood-loss-reduction components than does the more traditional structural, or flood control measures. Unfortunately, they must be made with, at present, less well known or understood economic, social, institutional and legal consequences. A result of this has been a proliferation of publications dealing with various types and aspects of nonstructural measures. While many of these publications are beneficial to water resource planners, others are redundant or add little of value to the planning process. Often planners either waste valuable time searching and reviewing the voluminous literature for potential assistance or they simply ignore the literature entirely.

This document is designed to assist Corps of Engineers and other planners by providing annotations of selected literature about nonstructural measures. The purpose is to make a review of potentially useful publications thereby reducing the time required for literature search. The selection of material contained herein was based on a comprehensive literature review process. Those publications determined to be of value may be acquired for more detailed information. An index of various types and aspects of nonstructural measures is contained in the back of the report for easy reference.

This study prepared by H. James Owen, a private consultant, was supported by Contract No. DACW05-76-P-2718 from the Hydrologic Engineering Center, with funds provided under Flood Plain Management Services, by the Office of the Chief of Engineers, Washington, D. C.

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\* The use herein of the term "nonstructural" is expedient rather than informative. It ties to the legislative language of Section 73 of the 1974 Water Resources Act. "Nonstructural" is not a communicator of important ideas, and, in fact, causes confusion of the type which must be overcome if understanding in the field of hazards adjustments is to be fostered. See for instance the contradiction in "structural" flood proofing. It has no place in the Flood Plain Management context. The proper context of flood proofing and all other adjustments whether they modify floods, e.g., flood control works, or modify the way in which man occupies or uses the flood plain, e.g., flood proofing, flood plain regulations, et al, is the flood plain management context as described in the Corps of Engineers regulation of 1970, entitled "Alternatives in Flood Related Planning" and in the "Unified National Program for Flood Plain Management" issued by the Water Resources Council.



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## INTRODUCTION

This report contains brief summaries of 18 publications dealing with nonstructural measures for reduction of flood losses. Its overall purpose is to aid planners in consideration of these increasingly important techniques by presenting the principal contents of selected publications in a condensed form. Selection of reports for inclusion was based on review of a substantial number of candidate publications suggested by persons knowledgeable about the pertinent literature.

Within its overall purpose, the report serves three objectives of special usefulness, namely:

1. Careful review of the entire report provides an introduction to the concept and technology of nonstructural measures for those lacking familiarity with the topic. Along with identifying the major categories of nonstructural measures, several of the 18 summaries illustrate the large number of variations in approach which can be designed to suit specific cases. Additionally, a number of the summaries call attention to the diverse social, environmental, institutional and other aspects of planning and implementing nonstructural measures which require consideration. This information can be of particular assistance in avoiding inadvertent omissions during preparation of plans of study, formulation of alternative plans for investigation, and similar activities requiring a broad overview of the field;
2. Most of the included publications are recent and several focus on the technical aspects of the planning, design and evaluation of one or another nonstructural measure. The summaries of those publications provide a sampling of the present state-of-the-art of planning nonstructural measures and description of what analytical procedures have been developed to date. They also include a substantial amount of information on costs, benefits, conditions of applicability and other factors useful in evaluation;
3. Many of the original publications which are summarized contain extensive bibliographies. The report can thus serve as a guide for those wishing to find examples and further information concerning specific nonstructural measures or aspects of their use.

The summaries present, to the extent possible, the key contents, findings and recommendations of publications rather than just describe their presence.

however, some publications were too extensive or so organized that they did not lend themselves well in every case to this approach. Readers should not overlook review of the original reports on the assumption that the summary fully extracts and presents all that might be useful.

Readers should also bear in mind while reviewing the summaries that they constitute only a sampling of the literature. Some publications were not included in the interest of balancing attention given to various topics. Other excellent publications may have escaped notice altogether. In addition, a large number of useful publications dealing with narrow topics are available but were excluded in favor of more comprehensive reports.

The several summaries are grouped for presentation according to their dominant theme. The first group relates to national policy concerning non-structural measures and the second group provides a general overview of the state-of-the-art. Succeeding groups of summaries pertain to the individual measures of floodproofing, regulations, and warning and preparedness planning and to the related economic and institutional aspects. However, few of the publications fall neatly into only one category. Use should be made of the index to avoid overlooking available information.

The publications selected for inclusion reflect the evolution of nonstructural measures from a largely untried concept into a set of key tools for flood loss reduction. The oldest report included is A Unified National Program for Managing Flood Losses published in 1965 as House Document 465. This report, prepared by a distinguished committee of experts at the request of Congress, was a milestone in efforts to develop a coherent national approach to flood loss reduction. It recognized that the extensive reliance up to that time on structural measures had not been altogether successful and recommended the development of programs and commitment of funds to greatly expand the application of nonstructural measures and accelerate the data collection and research to support that expansion. While several of the recommendations have been implemented or are in the process of implementation, others still await action.

Regulation of land use received some of the earliest and most widespread attention of the nonstructural approaches, possibly because of the extensive past use of zoning, building codes and other regulations for general health and safety and other non-flood purposes. Regulations for Flood Plains introduces the concepts and justification of flood plain zoning and other regulatory approaches. Regulation of Flood Hazard Areas to Reduce Flood Losses discusses a large number of legal and institutional issues related to land use regulation. It also provides a number of alternative models for regulatory provisions and examples of language in use in numerous states. Establishing an Engineering Basis for Flood Plain Regulation describes the type of accuracy of engineering information needed for community decisions regarding regulations and to implement successful regulatory programs. The report also describes a community decision-making procedure for deciding among alternative plans. Together, these reports and others like them have laid the conceptual foundation for broad attention by engineers to the potential of regulatory measures.

Flood proofing also gained early attention. Introduction to Flood Proofing describes the essentials of floodproofing and outlines a number of simple and effective measures. It is one of the first and better general treatments of floodproofing available for providing information to both professionals and non-professionals.

Past efforts in flood preparedness planning were largely as an offshoot of planning for military crises and research into the sociological aspects of disasters. Two publications typical of the latter which give some general background for flood warning and flood preparedness planning are included. A Perspective on Disaster Planning is a generalized treatment of the sociological aspects of disaster behavior. It catalogs the types of demands placed on communities by disasters and dispels numerous myths about panic and other disaster effects. The Warning System in Disaster Situations: A Selective Analysis describes component parts of a warning system and the implications of various characteristics of disasters with respect to the system. It provides a broad framework for conceptual design of warning systems.

Even though the technical aspects of various nonstructured measures were not well developed at the time the foregoing publications were prepared, some attention was focused on the management aspects of their implementation and conjunctive use with one another and their relationship with other types of activities. Community Goals-Management Opportunities: An Approach to Flood Plain Management is of this type. It examines flood plain management alternatives in an urban environment and provides an operational methodology for decision-making and case study examples.

The foregoing nine reports span a period from 1965 through 1972. The nine remaining, with one exception, have all been published in 1975 and 1976. They reflect the growing emphasis on nonstructural measures and the progression from conceptual design to their technical application.

A Unified Program for Flood Plain Management describes present national policy and includes some description of nonstructural technology. Most importantly, it presents a lengthy list of recommendations for federal and state flood plain management efforts and a set of working principles to guide future actions. Statutory Land Use Control Authority in the Fifty States provides readers with an up-to-date summary and analysis of the authorities of local units of government and state agencies to adopt zoning regulations, subdivision controls, building codes and special flood hazard regulations. The report also answers some common questions concerning regulatory programs. Reducing Flood Damage Through Building Design: A Guide Manual, Elevated Residential Structure is an example of the type of detailed technical information which is becoming available in the literature concerning floodproofing. Flood Proofing Regulations also pertains exclusively to design and construction and is intended for direct application. Guide and Checklist for Preparedness Planning in Communities Subject to Floods and Flash Floods takes an engineering

approach to planning and design of flood warning systems and flood preparedness plans. Extensive lists are included of matters to be considered for inclusion in designs. The report Estimating Cost and Benefits for Nonstructural Flood Control Measures summarizes data from Corps reports including some not yet published. The report also identifies the categories of costs pertinent to each of several types of nonstructural measures. LIF Report Phase II: Evaluation of and Recommendations for Legal, Institutional and Financial Methods for Implementing Purposes and Plans for Flood Plain Management in the Connecticut River Basin identifies an extremely wide range of issues related to implementation of a nonstructural plan. While much of the report is specific to the study site, many of the topics are likely to be of concern in other areas.

Three of the more recent reports summarize experience to date and describe present practice and the state-of-the-art of planning. Proceedings of a Seminar on Nonstructural Flood Plain Management Measures describes recent experiences in various Corps offices in planning, evaluation and implementation. Several of the contained papers illustrate new planning methodologies and identify key areas for future research. Flood Hazard Research in the United States: A Research Assessment is notable for three reasons. First, it describes the benefits potentially available with one or another nonstructural measure and thereby suggests where emphasis might be placed most effectively. Second, it identifies many of the constraints on increased national use of each of the major categories of measures. Third, it provides explicit suggestions for research, including specification of lead agencies in some cases, and recommends approximate levels of effort. Formulation Criteria for Nonstructural Flood Plain Management Measures describes various measures with respect to purpose, applicability, cost, economic feasibility, and types of information which is needed in study reports.

ANNOTATIONS



Task Force on Federal Flood Control Policy. A Unified National Program for Managing Flood Losses. House Document No. 465. 89th Congress, 2nd Session, Washington, DC. 1965 (47 p.).

The report provides a broad historical overview of the Nation's approach to flood damage reduction and identifies major existing problems. Principals are enumerated for guiding future actions and specific recommendations are made for consideration by Congress and others. The report was transmitted to Congress by President Johnson coincident with issuance of Executive Order 11296 which directed federal agencies to consider flood hazard in locating new federal installations and in disposing of federal land.

Major points made in the description of the existing situation are the following:

1. Federal investments in flood protection and prevention through the Corps of Engineers and Soil Conservation Service in the period 1936-1966 have been immensely helpful but estimated annual average losses have none the less trended upward to in excess of \$1 billion;
2. National and regional studies point to increasing damage potential and present programs offer little hope of avoiding waste or of preventing occasional catastrophies due to:
  - A. failure of flood control works to prevent damage due to great and infrequent floods exceeding design floods;
  - B. uncontrolled development in unprotected areas; and
  - C. a shift in emphasis from protection of established property to underwriting of new development;
3. Floodplain encroachment is encouraged by ignorance of the hazard and alternative land uses, expectations of federal protection or relief, and ability to secure profits even though large social costs are caused; and
4. Federal support of activities of individuals and local governments in using both protected and unprotected parts of flood plains has increased without concurrent recognition of the expanded interests.

Recognition is given to the large percentage of the Nation's population and tangible property located on the approximately 5 percent of the Nation's territory made up of flood plains and coastal strips and the need for efficient management. Numerous principals for management are described

including those related to characteristics of geographical location and hydrologic events, conditions of economic efficiency, and the recognition of individual, as well as social, responsibility in management decisions. Public policies relevant to preventing further excessive losses are discussed and an integrated flood loss management program is suggested which includes:

1. Federal responsibility for collection and dissemination of needed data; provision of technical services to assist in intelligent application of data in local planning; construction of flood control projects; management or supervision of an actuarially sound indemnification program; and provision of credit, where needed, for local contributions to flood project construction;
2. State responsibility for establishing flood plain encroachment lines; granting of authority to assure conspicuous demarcation by State or local planners of flood hazard areas; and assisting local planning and project financing efforts;
3. Local responsibility for guiding desirable expansion and avoiding, to the fullest possible degree, use of high hazard areas for uneconomic activities and for organizing flood project beneficiaries to pay for services rendered; and
4. Individual responsibility for careful weighing of the costs and advantages of developing and occupying alternative sites and for financial aspects of new locational decisions.

The following specific federal actions are recommended to remedy obstacles to an integrated program of flood loss management:

1. A three stage program to delineate major flood hazards should be initiated by the Corps of Engineers, the Geological Survey, and other competent agencies including:
  - A. listing of towns and streams with flood problems;
  - B. outlining the flood plain on maps or aerial photographs; and
  - C. accelerating the present program of flood hazard information;
2. A uniform technique of determining flood frequency should be developed by a panel of the Water Resources Council;
3. A new national program for collecting more useful flood damage data should be launched by the interested agencies, including a continuing record and special appraisals in census years, organized to provide for:



- A. decennial nationwide appraisals of potential average flood hazard by the Corps of Engineers and Department of Agriculture with cooperation of other agencies;
  - B. development of a continuing record of flood damages in selected stream valleys and coastal areas constituting a statistically efficient sample of hydrologic and land use characteristics;
  - C. immediate surveys after major floods by the Corps of Engineers and the Department of Agriculture with assistance from other agencies to determine area inundated and resulting damages; and
  - D. development by the Water Resources Council of sound and uniform procedures and of forms for summary and dissemination of results for use by all agencies participating in flood damage appraisals;
4. Research of flood plain occupancy and urban hydrology should be sponsored by the Department of Housing and Urban Development, the Department of Agriculture, and the Geological Survey;
  5. The Federal Water Resources Council should specify criteria for using flood information and should encourage State agencies to deal with coordination of flood plain planning and with flood plain regulation including:
    - A. provision for State regulation of encroachment and, where appropriate, local land use regulation as conditions for construction of federal and federally assisted projects;
    - B. encouragement of preparation of model State enabling legislation and development of State capability for coordination of flood plain planning;
    - C. establishment of criteria and procedures for integrating and applying flood information; and
    - D. scheduling of an annual conference of pertinent entities to review uses of data, possible revisions of use and future plans for providing data;
  6. Steps should be taken to assure State and local planning takes proper and consistent account of flood hazard including:
    - A. full site planning and engineering analysis of potential drainage and flooding problems for all land development proposals in connection with federal mortgage insurance;

- B. encouragement by Federal Home Loan Bank Board of financial institutions with which it deals to consider flood hazards in making home loans;
  - C. actions by HUD to emphasize water resources planning as part of comprehensive planning, serve as a clearinghouse for information concerning flood plain use, and develop, in cooperation with the Corps of Engineers, an information service to provide technical information and planning examples to non-federal governments;
  - D. increased cognizance of flood hazard by the Bureau of Public Roads;
  - E. emphasizing use of flood plains in open space and recreation area planning;
  - F. emphasizing opportunities for flood plain acquisition in open space acquisition programs;
  - G. explicit consideration of flood hazards in urban renewal projects; and
  - H. requiring consideration of flood hazard in sewer and water facilities projects;
7. Actions should be taken to support consideration of relocation and flood proofing as alternatives to repetitive reconstruction including:
- A. development of consistent administrative policies for federal relief and rehabilitation programs;
  - B. requiring consideration of relocation and structural floodproofing as criteria for Small Business Administration loans; and
  - C. amendment of the tax code to provide incentives for floodproofing or relocation of hazardously located property;
8. Issuance of an executive order directing federal agencies to consider flood hazard in locating new federal installations and in disposing of federal land, including direction to:
- A. refrain from construction in hazardous sites unless gains will offset social costs; and
  - B. consider attaching future use restrictions on land disposed of to non-federal agencies or private owners;

9. Programs to collect, prepare and disseminate information and to provide limited assistance and advice on alternative methods of reducing flood losses, including land use regulation and floodproofing, should be undertaken by the Corps of Engineers, in close coordination with the Department of Housing and Urban Development and the Department of Agriculture including:
  - A. dissemination of flood data and flood loss management report information;
  - B. dissemination of guides and pamphlets providing technical assistance;
  - C. provision of limited technical assistance to State and local planners and officials and to individuals in preparing flood plain regulations and assessing flood plain location;
  - D. demonstration of the feasibility of floodproofing by floodproofing public buildings;
  - E. provision of limited architectural and engineering information on floodproofing to State and local governments; and
  - F. provision of training for personnel required to carry out activities related to items A through E;
10. An improved system for flood forecasting should be developed by the Environmental Sciences Services Administration as part of a disaster warning service including:
  - A. making and dissemination of flood forecasts;
  - B. provision of means to:
    - i. automate reporting networks,
    - ii. take advantage of technology to keep abreast of changes in channel regime,
    - iii. extend the system nationwide, including flash flood forecasts,
    - iv. provide prompt and reliable dissemination of forecasts, and
    - v. provide assistance to individuals, groups and communities in developing preparedness plans;
11. A five-stage study of the feasibility of insurance under various conditions should be carried forward by the Department of Housing and Urban Development including:

- A. hydrological and statistical studies to evaluate average annual damages and their variance, geographic distribution, required rates, and affect on feasibility of differences in land use, age of structures, types of hazard, local planning and other factors;
  - B. design of an experimental test program;
  - C. conduct of an experimental test program;
  - D. evaluation of the results of the experimental test program; and
  - E. recommendation of a course of action with respect to a national program of flood insurance;
12. Survey authorization procedure and instructions should be broadened in concept to:
- A. direct the presentation of alternative solutions; and
  - B. expand the objectives of flood control studies and carry out planning on a continuing basis with State and local authorities;
13. Modification of cost-sharing requirements for federally assisted projects should be considered including:
- A. sharing costs more widely among beneficiaries;
  - B. repayment of a larger proportion of costs;
  - C. improved identification and distribution of costs to beneficiaries;
  - D. use of a uniform basis for cost sharing between salt and fresh water protection projects and between regions; and
  - E. use of a consistent cost-sharing policy by all federal construction agencies;
14. Flood project benefits should be reported in the future so as to distinguish protection of existing improvements from development of new property including:
- A. classification of benefits as:
    - i. reduction of damages to existing development, or
    - ii. benefits anticipated from future land development; and

- B. action by the Water Resources Council to insure uniformity among federal agencies in allocations of cost for multiple purpose projects;
- 15. Authority should be given by the Congress to include land acquisition as a part of flood control plans; and
- 16. Loan authority for local contributions to flood control projects should be broadened by the Congress.

The report provides generalized estimates of cost for implementation of the recommendations which total approximately \$13 million annually for the succeeding 10 year period, exclusive of equipment requirements for improved flood forecasting.

Executive Order 11296 was issued concurrent with transmittal of the report to the Congress. It directed federal agencies to provide leadership in preventing uneconomic uses and development of flood plains and in reducing flood losses including:

1. Preclusion by Executive agencies responsible for construction of federal buildings, structures, roads or other facilities of uneconomic, hazardous or unnecessary uses of flood plains;
2. Conspicuous display of past and probable flood heights on existing federally owned properties;
3. Floodproofing of existing facilities whenever practical and economically feasible;
4. Evaluation of flood hazards by agencies responsible for administration of federal grant, loan or mortgage insurance programs for buildings, structures, roads or other facilities;
5. Attachment of appropriate restrictions on future uses of disposed property; and
6. Issuance of procedures and regulations for implementing a unified program to reduce flood losses.

The report sets forth a conceptual framework and recommends federal and state actions for a continuing unified program of planning and action at all levels of government to reduce flood losses through flood plain management. It also identifies available management strategies and tools for reducing flood losses and assesses implementation capability of existing federal and state agencies and programs. Preparation of the report was accompanied by development of a revised version of Executive Order 11296.

A review of background and setting is included which briefly describes events leading to publication of House Document 465 and issuance of the original Executive Order 11296. Major changes since that time are summarized including those related to flood insurance, preparedness planning, water quality management planning, extension of federal cost sharing to nonstructural measures, and others.

Three major problems are described which require solution if a unified national program for flood plain management is to be implemented. They include:

1. Fragmented and uncoordinated responsibility for flood plain management which leads to inconsistency among areas and between programs, inadequately conceived measures, and generation of costs;
2. Over reliance upon public investment to solve all problems; and
3. Inability to resolve conflicts of private property rights with state and national interests which tends to prevent implementation of land use regulations.

The conceptual framework presented consists of both general and working principles intended to provide decision-makers encouragement for comprehensive assessment of alternative flood plain uses and judicious selection of management tools. General principles presented deal with:

1. Declaration of the federal interest in how flood plains are managed and the responsibility of state and local government for regulation;
2. Need to consider flood plains in the total community, regional and national context;
3. Need to consider flood loss reduction within context of economic efficiency, environmental quality, and health and safety; and

4. Description of the several aspects of sound flood plain management including goals, objectives, identification of future needs, use of all alternative strategies, full accounting of costs and benefits and interrelated impacts, motivation of decision-makers, coordination of programs and agencies, and continuous evaluation of management efforts.

Two working principles are stated, the first providing definitions and the second a series of general statements. The general statements point out that:

1. Complete control of floods is practically never realized;
2. A variety of means is usually required to reduce damages and meet flood plain management needs;
3. Priorities for implementation must consider short-and long-term problems of developed and undeveloped flood plains in both rural and urban areas;
4. Management in already developed areas should focus on modifying the flood hazard while in undeveloped areas emphasis should be placed on regulating land uses to prevent those inconsistent with the hazard;
5. Flood characteristics are sensitive to development and land use change both in and outside an area;
6. Flooding causes economic losses in areas serving, served by, or reached through a developed area which is inundated;
7. The effect of flooding on life, health, property and peace of mind should be considered in planning flood plain use;
8. The acceptable degree of hazard differs with types of use;
9. Flood plain management costs ought to be equitably shared among the beneficiaries;
10. Intangible attributes of flood plains have social and economic values;
11. Opportunities to preserve wildlife habitats and open areas should be considered whenever practical;
12. Areas of high velocity flood flows and wave action have special problems and require regulation more restrictive than do other flood plains; and
13. All actions affecting flood plains should be evaluated for possible effects on water quality.

A major portion of the report is devoted to discussion of the three strategies for achieving flood loss reduction which are aimed respectively at modifying susceptibility to damage, modifying the flood, and modifying the impact of flooding. Tools applicable for use in each approach are identified and described, namely:

1. Tools to modify susceptibility including:
  - A. state flood plain regulations;
  - B. local zoning, subdivision, building code, housing code, sanitary and well code, and other regulations;
  - C. design and location of services and utilities;
  - D. land rights acquisition and open space use;
  - E. redevelopment and renewal;
  - F. permanent evacuation;
  - G. disaster preparedness and response planning;
  - H. floodproofing; and
  - I. flood forecasting and warning systems;
2. Tools to modify floods including:
  - A. dams and reservoirs;
  - B. dikes, levees and flood walls;
  - C. channel alterations;
  - D. high flow diversions and flooding;
  - E. land treatment measures; and
  - F. on-site detention measures;
3. Tools to modify the impact of flooding including
  - A. provision of information and education;
  - B. flood insurance;
  - C. tax adjustments;
  - D. emergency floodproofing and flood fighting; and
  - E. post-flood relief and recovery aid.



One chapter of the report reviews progress since the 1966 report of the Task Force on Federal Flood Control Policy (H.D. 465) and discusses two other landmark actions toward a coordinated approach including passage of the National Flood Insurance Act, as amended, and promulgation of the Principles and Standards for Planning Water and Related Land Resources. Recommendations from H.D. 465 are listed and categorized as to progress made since 1966 in implementation. Other related legislation discussed includes the National Environmental Policy Act (P.L. 91-190), the Coastal Zone Management Act (P.L. 92-583), the Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500) and the Disaster Relief Act of 1974 (P.L. 93-288).

Lack of coordination is identified as the most serious impediment to implementation of a unified national program within the conceptual framework provided by the report. Several recommendations are made to improve recognition and acceptance of the conceptual framework and to achieve the institutional coordination for carrying through a unified national program for flood plain management. They include:

1. Federal actions to:

- A. establish a flood plain management technical committee under the auspices of the Water Resources Council;
- B. accelerate flood plain and hazard studies and dissemination of information to state and local users;
- C. standardize techniques for collection and analyses of hydrologic data;
- D. improve the flood forecasting system;
- E. increase social research on flood plain occupancy, hazard perception and response;
- F. revise Executive Order 11296 to formalize its relationship to the National Flood Insurance Program;
- G. assure all land, water and related resources programs are in harmony with the precepts enunciated in the report;
- H. require appropriate flood plain management programs, or control measures as a prerequisite for federal expenditures to modify flooding or the impact of flooding;
- I. support cost sharing policies that facilitate achieving a desirable mix of structural and nonstructural measures; and
- J. provide support to states in their primary role in flood plain management.

2. State action to:
  - A. enact enabling legislation addressing flood plain management and regulation where presently inadequate or not existing;
  - B. establish or designate a single state agency or another mechanism to assure responsibility for flood plain management and to insure standards for flood plain management;
  - C. supplement federal efforts to provide information about flood hazards and flood plain management;
  - D. apply the concepts of Federal Executive Order 11296 to all state agencies and programs; and
  - E. support regional and substate entities in flood plain management activities;
3. Federal-interstate compact commission action to support state and federal programs for flood plain management.

A revised version of Executive Order 11296 was prepared concurrent with the report. It directs federal executive agencies to:

1. Evaluate flood hazard when planning the location of new facilities;
2. Assure evaluation and alleviation of flood hazards are considered in administration of any direct or indirect financial assistance for buildings, structures, roads or other facilities;
3. Evaluate and alleviate flood hazards in the disposal of federal lands or properties;
4. Take flood hazard into account when evaluating plans affecting land use and encourage appropriate land use;
5. Consider removal of flood-damaged properties from incompatible use as soon as practicable;
6. Comply strictly with requirements of the Flood Disaster Protection Act of 1973 (P.L. 93-234) regarding approval of federal financial assistance;
7. Accompany all authorization or appropriation requests to OMB with certification that related flood hazard evaluation and alleviation efforts are completed or that relevant regulations have been met;

8. Implement programs consistent with the Unified National Program for Flood Plain Management and issue rules and regulations [for carrying out 1-7 above];
9. Conspicuously display delineation of past and probable flood heights on existing federally owned buildings used by the public and which have either suffered flood damage or are in an identified flood hazard area; and
10. Apply floodproofing measures to existing structures in identified flood hazard areas whenever practical and economically desirable.

The evaluation and alleviation procedures to be applied in complying with the revised Executive Order are to be comparable to those consistent with the intent of the Flood Insurance Program's regulations in cases where federal structures are similar in type and setting to non-federal structures. For other structures, the evaluation and alleviation is to be in accord with each agency's individual procedures.

Proceedings of A Seminar on Nonstructural Flood Plain Management Measures  
4-6 May, 1976. Co-sponsored by the Hydrologic Engineering Center  
and the Institute for Water Resources, U.S. Army Corps of Engineers.  
The Hydrologic Engineering Center, Davis, California (193 p.).

The proceedings comprise a collection of prepared papers presented at a seminar on nonstructural flood plain management measures. The seminar brought together Corps staff and others including field level planners, policy and review personnel and researchers. The objectives of the seminar were to report on experience in planning, evaluation and implementation of nonstructural measures and to identify issues deserving attention in the future. Papers included are not official Corps documents.

Information contained in the proceedings generally fall into one or another of the following categories:

1. Description of policy issues related to nonstructural measures;
2. Discussion of techniques for analysis of nonstructural measures, available analytical tools, and means available for implementation;
3. Examples of nonstructural analyses and plan formulations;
4. Identification and discussion of needed research; and
5. Observations and diverse points of interest.

Description of Policy Issues Related to Nonstructural Measures

Development of policies and procedures for carrying out nonstructural flood control planning is cited as one of the Corps' most pressing problems. Full discussion and supportive data on nonstructural measures is expected in every planning report but cost sharing policy is lacking and no recommendations for cost sharing are to be included. Bias toward nonstructural alternatives and comprehensive flood plain management is encouraged.

Background of the report A Unified National Program for Flood Plain Management is reviewed and the "program package" including the report and its associated "Executive Order 11296, Revised" is described.

Major policy issues presented and discussed at the Seminar include:

1. The role in formulation and evaluation of nonstructural measures of:
  - A. recreation;
  - B. analysis of external economics and diseconomies; and
  - C. land use analysis.

2. The need for clear guidance on economic benefit evaluation;
3. Difficulties in identifying the Principles and Standards components of objectives;
4. Applicability of Section 73 of PL 93-251 to measures such as zoning and flood warning systems;
5. Differences in the need for collective as opposed to individual action for implementation of measures; and
6. Cost sharing arrangements including:
  - A. multiple policies resulting from Sec. 73 in conjunction with provisions for cost sharing on hurricane protection and acquiring lands for recreation; and
  - B. Sec. 73's limitation of non-federal share to 20 percent of nonstructural program costs compared to the unlimited non-federal share for "a,b,c's" of structural measures which often approximates 50 percent of total costs.

#### Techniques for Analysis, Available Tools and Implementation Means

Principle problems in analysis and evaluation of nonstructural measures are identified as the following:

1. Assessing the effectiveness of some nonstructural measures;
2. Definition of separable project increments;
3. Decisions regarding the individual or collective treatment of structures;
4. Evaluation of related environmental quality benefits;
5. Rapid screening of communities to identify potential for application of nonstructural measures; and
6. Problems attributable to:
  - A. lack of understanding of the nonstructural approach;
  - B. history of not funding nonstructural projects;
  - C. lack of adequate formulation and design methodologies; and
  - D. lack of acceptance of nonstructural measures by local officials and the public.

Several analytical techniques are presented in varying level of detail which are pertinent to one or another nonstructural measure or to overall aspects of plan formulation. Some presentations include quantitative information and/or example computations and results. The major techniques described include:

1. The "Jersey Shore" approach for screening communities with respect to the applicability of nonstructural measures. The approach successively eliminates communities from consideration for which damage due to less than the 15 year flood is not significant, and which have less than 25 appraisals. Depending on whether residential damage is greater or less than 67 percent of total damages, either residential appraisals are considered key indicators of applicability or more detailed studies are undertaken. Methodology is briefly discussed for subsequent evaluation of individual measures including floodproofing, permanent relocation, flood forecasting and warning, and flood plain management;
2. Procedure for computing the reduction of flood insurance program costs as a benefit of evacuation/relocation;
3. Procedure for analysis of the applicability of floodproofing to residences based on the stage-frequency relationship and the difference in elevations between the 100 and ten year recurrence interval floods. The procedure indicates applicability when elevation differences are small. Examples are included of computations of floodproofing costs and benefits; and
4. Procedure for determination of 100 year open-coast flood levels on the Great Lakes from recorded maximum annual flood levels.

An approximate method for nonstructural planning is presented, condensed from Formulation of Nonstructural Flood Control Programs by L.D. James. Procedures are described for development of target levels of compliance for individual actions to accomplish flood control as a step toward selecting appropriate implementation techniques. General government means for promoting individual flood control measures are summarized with respect to their intended effect and obstacles including:

1. Disseminate information on the flood hazards;
2. Disseminate information on adverse external or ecological effects of flood plain occupancy;
3. Use taxes or other charges to penalize "inappropriate" individual activity;
4. Provide expert advice on the design of individual measures;

5. Enact and enforce land use and building code regulations;
6. Subsidize financing of individual measures; and
7. Purchase hazard areas for recreation or natural uses.

A number of factors affecting response to implementation efforts are listed and categorized as attributes of the desired response, physical situation, community, and flood plain property owners.

Experience of one District in the applicability of various nonstructural measures based on economic, political, environmental and social conditions are summarized in tabular form. Measures considered include floodproofing, evacuation and regulations. Each are rated on a scale of 1 to 10 for application to various types of property in drainage areas of less than 100, 100 to 400 and greater than 400 square miles.

A summary of information needed for formulation of nonstructural measures is presented and includes:

1. Emergency measures:

- A. flood hazard and stream response characteristics;
- B. infrastructure data;
- C. institutional structure and capabilities for disseminating information and supervising crews;
- D. social information on perception of the flood hazard and propensity to undertake action; and
- E. effectiveness of individual measures in specific situations;

2. Flood proofing and Evacuation/Relocation Measures:

- A. site-specific quantitative definition of the flood hazard;
- B. cost and performance of individual measures; and
- C. spatial location of individual measures;
- D. community institutional and social data to design implementation strategy;

3. Policy and Regulatory Measures:

- A. existing flood hazard and conditions affecting future flood hazard;
- B. cost and effectiveness of individual measures in terms of potential to cause locational changes and facility adjustments;

C. local acceptability of individual incentives and sanctions; and

D. institutional data to design implementation strategy.

Analytical tools presently available within the Corps and presently under development by the Hydrologic Engineering Center and Institute for Water Resources are discussed with regard to application for flood hazard, economic and environmental assessments, plan formulation, data management and social/institutional analysis.

#### Examples of Nonstructural Analyses and Formulations

A variety of examples are provided which are described in varying detail. Descriptions providing significant background and presented in the nature of a case study include:

1. Southwestern Jefferson County, Kentucky (combined structural-nonstructural plan);
2. Charles River Watershed, Massachusetts (acquisition and preservation of valley storage);
3. Pawtuxet River Watershed, Rhode Island (structural plus flood insurance);
4. Connecticut River Basin (regulation, floodproofing, relocation);
5. Baytown, Texas (Evacuation of subsidence area);
6. Scottsdale, Arizona (evacuation and greenbelt development); and
7. Logan, Ohio (floodproofing).

Plan formulations or other aspects at numerous other locations are discussed in lesser detail including:

1. James River through Richmond, Virginia;
2. Prairie du Chien, Wisconsin;
3. Charles River Watershed, Massachusetts;
4. Susquehanna River Basin (Jersey Shore, Pennsylvania);
5. Namu River, Guam;
6. Iao stream, Maui, Hawaii;
7. Agana River, Guam;



8. Kawainui Swamp, Oahu, Hawaii;
9. Crabtree Creek, Raleigh, North Carolina;
10. Pittsburgh, Pennsylvania;
11. Oliver Springs, Tennessee;
12. St. Bernard Parish, Louisiana; and
13. Waterloo, Iowa.

#### Needed Research

Fruitful areas of research are pointed out in the presentations including:

1. Data management and damage analysis of individual structures and future land use;
2. Locational and land use analysis of future development;
3. Social/institutional analysis, particularly that related to financial structure of institutions and communities;
4. Data management to service analytical methods and overall study management; and
5. Methods of analysis to identify during planning the probable success of nonstructural measures.

Needed analytical tools identified included the following:

1. A model for selecting an optimal nonstructural program from economic, ecologic, and administrative considerations;
2. Systems for measuring the physical, community, and flood plain manager attributes noted earlier and relationships for predicting the probabilities of the various responses that the manager of flood plain property might make given his measured attributes, the measured physical and community context, the specified implementation means, and the initial situation;
3. A simulation model for predicting the response pattern to a specified set of implementation means; and
4. A simulation model for predicting the cost of carrying out a specified set of implementation means.

## Observations

Numerous observations on various points, some of which may conflict directly or indirectly with one another, are contained in the proceedings. Some are included here as examples of material to be found there which does not fall neatly into the four previous categories.

1. Nonstructural measures may have more local support than structural measures, leading to a higher percentage of purchases and less condemnation in real estate acquisition;
2. Performance of a nonstructural analysis for a community of 5,000 population will require approximately 5 man-weeks after methodology and procedure is finalized;
3. The terms "structural" and "nonstructural" should be abandoned in favor of the single term "flood damage prevention planning;"
4. Floodproofing is most effective for commercial and industrial facilities staffed on a 24 hour basis and is generally not desirable for residences;
5. A common weakness in land use regulations is their basis on existing hydraulic conditions;
6. An inherent danger exists in fixed design levels such as 100 year levels due to overloading of development immediately above the level and consequent susceptibility to disaster from larger floods;
7. Evacuation as a solution to flooding will never be a major program by the Corps since average annual damages are not generally sufficient for justification;
8. Nonstructural measures can and should be used both alone and in combination with structural measures; structural measures should never be used alone;
9. Implementation of nonstructural measures generally takes place at the community level and in a setting where solutions require tailoring a mix of measures to individual site characteristics;
10. Floodproofing and evacuation/relocation require site specific design for virtually each individual structure; and
11. Floodproofing applicability can be determined early based on the stage-frequency curve and interest rates to be used in cost and benefit analysis.

White, Gilbert F. Flood Hazard In the United States: A Research Assessment.  
Institute of Behavioral Science. The University of Colorado. Boulder,  
Colorado. 1975 (133 p. and references).

The report presents results of an investigation into research needs on natural hazards performed under the National Science Foundation's RANN Program. Investigation included review of the literature, workshops, a national conference and individual reviews by authorities in the field. The publication is one of a series dealing with various natural hazards.

The first chapter of the report describes the geographic distribution of floods and flood plains throughout the Nation and the distribution of population at risk among communities according to population. Tables show the number of communities of various sizes subject to flooding and flash flooding and the demographic and economic characteristics of selected flood sites.

Chapter II deals with the general categories of adjustments to flooding including control and protective works, floodproofing, warning and preparedness planning, land use management, insurance, and relief and rehabilitation. Each are briefly described with respect to concept and current status of implementation. Combinations of adjustments are discussed. Four main combinations suggested as occurring on urban flood plains are:

1. loss bearing by individuals combined with flood insurance and with relief and rehabilitation;
2. flood insurance and land management;
3. warning schemes and preparedness planning; and
4. control and protective works combined with relief and rehabilitation.

Three sets of factors are identified as affecting the perceived benefits and costs of land use on flood plains including physical characteristics, economic conditions and legislative constraints.

Effects of flooding are covered in Chapter III. The report notes that annual damages are increasing and that in 1966 losses totalled about \$5.10 per capita. Figures show the variation in damages from year to year and the distribution of types of losses between floods and flash floods. The rising trend in costs of adjustments to floods is pointed out but not quantified due to a lack of useful data. Gross estimates place total expenditures for flood control by the Corps and Soil Conservation Service at about \$2-3 per capita annually.

The report points out that the potential for catastrophic losses of property and life are increasing as increasing development takes place on flood plains protected by levees or dams. The case of Rapid City is cited as showing the danger of heavy losses of life so long as any city subject to flash floods does not have adequate forecasting, warning dissemination and preparedness plans.

A simulation of flood loss management on urban flood plains is provided in which various national adjustments to a random set of flood events are evaluated with respect to their effect on losses. The principal findings were that the losses which would occur if the historical trend of constructing control and protection works were maintained could be reduced by certain actions as follows:

<u>Adjustment</u>	<u>Change in Losses</u>
Maintain present level of adjustments	20 percent increase
Instantaneous adoption of warning systems	27 percent decrease
Gradual adoption of warning systems	13 percent decrease
Land use management	10 percent decrease
Floodproofing	6 percent decrease
Land use management and floodproofing	12 percent decrease

Simulation indicated that the upper limit of savings resulting from instantaneous adoption of all adjustments would be about 35%.

Costs for various adjustments are discussed and the following general estimates provided of their economic viability:

1. floodproofing costs about 5 percent of the cost for new structures;
2. floodproofing costs vary from 1-100 percent of the cost of old structures; and
3. warning systems are estimated to yield benefits of five times their cost.

Chapter IV deals with national forces which affect decisions regarding adjustments to floods including population shifts, trends toward protection of workers and consumers, citizen participation in environmental decisions, and federal aid. Current research on floods is discussed along with constraints on making more effective adjustments.

Population shifts from rural to urban areas have increased development of residences and commercial structures in areas subject to floods. Growth

and diversification of industries has simultaneously reduced sensitivity to the potential losses at any one location.

Consumer and worker oriented legislation has stimulated concern over flooding and possibly provided new management tools. Examples cited are Occupational Safety and Health Administration authorities and controls over design and location of housing. Citizen participation is noted mostly in regard to the severe limitation on authorization and construction of new flood control works.

Federal attention to and stress on various adjustments in response to national movements are shown in a series of charts for degree of adoption, public responsibility, cost, capacity to avert flood effects, and feedback on flood plain development. Of the measures shown, warning, floodproofing and land use are shown as having the highest capacity for reducing losses on a local and national basis and for reducing loss of life and social disruption. The same measures produce the smallest adverse feedback on flood plain development. Notwithstanding their potential, warning, floodproofing and land use are shown as having the lowest emphasis in degree of adoption although a marked increase in emphasis occurred in the 1952-1972 period covered in the charts. Insurance and relief are shown as having the highest federal emphasis for adoption, highest cost of adoption to the federal government and low capacity to reduce losses and save lives.

Constraints on increased use of major types of adjustments include:

1. Control and protection works:
  - A. budgetary limits;
  - B. shortcomings in hydraulic theory and economic data;
  - C. opposition due to environmental considerations; and
  - D. lack of knowledge of behavior of complex drainage systems and effects of urban development on drainage systems;
2. Warning systems:
  - A. technical problems of forecasting;
  - B. uncertain public response to warnings; and
  - C. interest of public officials in preparedness planning;
3. Floodproofing:
  - A. lack of technical information on floodproofing;
  - B. economic costs of floodproofing older structures;
  - C. lack of public encouragement for floodproofing;

- D. unawareness of property owners, engineers and architects of the potential benefits of floodproofing; and
  - E. reluctance of property owners to make visible changes in structures;
4. Land use management:
- A. lack of fully effective state enabling legislation, recent experience in flood events, and basic technical information on the flood hazard and the cost of data collection;
  - B. difficulty in quantifying locational advantages;
  - C. apathy and unconcern;
  - D. large investments in flood plain locations; and
  - E. reliance on other adjustments;
5. Insurance:
- A. lack of incentive due to availability of alternative federal programs of disaster relief;
  - B. property owner's views of the probability of floods; and
  - C. lack of knowledge that flood insurance is available;
6. Relief and Rehabilitation:
- A. lack of centralized coordination of relief organizations; and
  - B. ambiguity over which organization provides specific services.

Alternative scenarios for Rapid City, South Dakota are presented in Chapter V. Each explores what might have happened there in the case of the 1972 flood. Scenarios are based on assuming:

1. The city had undertaken an emergency preparedness warning plan;
2. Flood plain development had been regulated; and
3. Control works were installed providing 100 year protection.

The report's Chapter VI is devoted to recommendations for research concerning flood plain management. Present flexibility in management is cited as increasing the influence of present research. Principal topical categories and subjects for research identified are:

1. Control and Protection:
  - A. design and maintenance of urban highway, sewer and storm drainage systems to provide low cost handling of interior drainage; and
  - B. channel hydraulics to develop more scientific design procedures;
2. Short-Term Warning and Floodproofing:
  - A. forecasting methods;
  - B. improvement of warning systems;
  - C. social aspects of floodproofing; and
  - D. floodproofing technology;
3. Land Management :
  - A. adoption processes;
  - B. social effectiveness of land use management; and
  - C. coordination of land use measures;
4. Insurance, Relief and Rehabilitation :
  - A. determination of factors affecting decisions to purchase flood insurance;
  - B. linkages between both insurance and relief activities and other measures.
  - C. investigation of proposal for compulsory all-risk insurance;
  - D. determination of incentives and disincentives to insure rehabilitation expenditures result in a reduction of losses;
  - E. determination of full range of costs and benefits of relief and rehabilitation efforts; and
  - F. methods of providing relief;

5. Basic Data and Methods :

- A. flood frequency estimation methods;
- B. hazard mapping methods;
- C. flood damage variables;
- D. means of public participation in project choice; and
- F. methods of estimating the optimal mix of adjustments.

Cost estimates are provided for various areas of research in dollars and person-years. Needs for research are ranked according to urgency. Those identified as most urgent are ones related to methods of improving warning and evacuation programs, floodproofing technology, enhancing public choice of adjustments and accelerating adoption of land use planning and management.

The report concludes with a description of past development in Boulder, Colorado and a scenario of a future flood there. An appendix to the report describes the simulation model used to estimate the extent of damage reductions achievable through various adjustments.



Formulation Criteria for Nonstructural Flood Plain Management Measures. The Hydrologic Engineering Center, U.S. Army Corps of Engineers (draft). December, 1976 (239 p. and bibliography).

The report provides an explicit identification of the types of situations where various nonstructural measures for flood loss reduction are likely to be applicable. Quantitative descriptions are provided wherever enabled by available data. The objective of the report is to provide assistance in screening potential measures during plan formulation. The measures investigated include:

1. Installation of watertight and waterproofing sealants to existing structures;
2. Elevation of existing structures in-place;
3. Construction of small walls or levees around existing structures;
4. Relocation of damageable property within an existing structure;
5. Construction of new structures on fill or columns;
6. Use of water damage prevention materials and measures in new construction;
7. Relocation of structures and/or contents out of a flood hazard area;
8. Establishment of flood plain regulations to regulate land use in a flood hazard area;
9. Adoption of development and/or redevelopment policies such as land acquisition, location of major facilities, land easement and urban renewal for flood hazard land; and
10. Forecasting, warning and preparedness planning.

The analysis is presented in four principal parts including a summary, a series of chapters dealing with individual measures, a chapter dealing with economic analyses and an appendix pertaining to structural analysis of watertight structures.

The summary section includes a series of one page statements of criteria concerning each measure investigated. Each set of criteria briefly covers purpose, applicability, advantages, disadvantages and economic feasibility of each measure. Two tables summarize the conditions favoring economic feasibility of the several measures for existing and new structures. The major findings are that:

1. Economic feasibility increases with structure value and frequency of flood with most measures feasible for a \$30,000 structure only if located within the 25 year flood plain and, in many cases, within the ten year flood plain;
2. Nonstructural measures are not applicable to all structures on account of problems related to collapse, flotation and seepage;
3. Elevation of structures in place is generally limited to structures on raised foundations and to no more than 3 to 4 feet without special structural considerations;
4. Walls and levees are generally applicable to all types of structures but are sensitive to topography and character of the area;
5. Temporary relocation of damageable property is generally applicable and feasible but can only accomplish limited damage reduction;
6. Economic feasibility of permanent relocation is generally restricted to structures flooded to first floor elevations by the five year flood and built on a raised foundation;
7. Cost of damage reduction is considerably less for new structures than for old;
8. Economies of scale can be gained by applying some measures to large numbers of structures;
9. Preparedness planning is applicable to both existing and new development, particularly when other measures are not feasible or cannot be immediately implemented; and
10. Preparedness planning is likely to be economically feasible where more than a few structures are involved.

The second part of the report includes ten chapters with each devoted to a specific measure. Materials presented in each chapter expand upon the brief statements of purpose, applicability, cost and other aspects contained in the summary. Statements of purpose are generally one paragraph explanations of the measures' concept and how the measure reduces flood damages. Descriptions of measures vary in length. They discuss basic physical requirements for implementation, techniques which can be used and points to be considered such as structural integrity, need for advance warning and others. Discussions of applicability describe the key questions to be addressed in determining the suitability of a measure to a particular case. Each chapter contains a tabular summary of the advantages and disadvantages of the subject measure. Information on costs are presented along with discussion of relevant assumptions. Wherever appropriate, costs are tabulated as unit costs and separated

into "base" and "optional" categories. Each chapter also provides a listing of the main types of information which should be developed for consideration of the measure and presentation in reports.

The third portion of the report deals with analysis of the economic feasibility over the range of applicability of each measure to determine trends in feasibility and general conclusions. Analyses are based upon elevation-frequency curves, depth-damage curves and relationships between structure value and contents value. Only inundation reduction benefits are considered. Computations were made using HEC's Expected Annual Damage computer program. Numerous tables are provided listing:

1. Structural damage as a percentage of total value of a structure for various levels of flooding and types of structures;
2. Contents damage as a percentage of total value of contents for various levels of flooding and locations within the structure;
3. Expected annual percent damage for various types of structures and frequencies;
4. Average annual cost for nonstructural measures for various periods of analysis;
5. Average annual cost for nonstructural measures for various structural values;
6. Nature (level) of protection provided by each measure; and
7. Percent of damages prevented with 3 feet protection for various flooding frequencies and ratios of content value to structure value and for various types of structures.

In addition to the tables, much of the information is presented in charts showing trends in the various relationships. The conclusions of the economic analysis are that:

1. Expected annual percent damage is relatively insensitive to the percentage value of contents to value of structure;
2. The effect of skew is highly variable and annual percent damages to residences may vary widely depending on the flood hazard factor (FHF) and other conditions;
3. The magnitude of the expected annual percent damage for one and two story structures without basements increases between 71 percent and 164 percent as the FHF increases from 1.0 to 20.0; and

1480  
180

4. The frequency of event at the first floor has the greatest single effect on the magnitude of the expected annual percent damage.

Feasibility was calculated for those measures that prevent damage to a specified level including watertight closures, elevation in place, walls and levees, relocation and elevation of new structures. Assuming protection to 3 feet above the floor, watertight closures were found feasible over a narrow range of FHF for structures without basements worth \$20,000 or more and located in the 10 year flood plain. Higher valued structures yield feasibility for lower frequencies and greater FHF's.

Elevation of an existing structure on a new wall is only feasible for \$30,000 value structures if the 10 year or more frequent event is at the first floor and if the FHF is less than 4.0. Elevation by extending existing piers showed feasibility for \$30,000 value structures without basements which were located in the 10 year flood plain without regard for the FHF.

Five foot walls were only feasible for \$30,000 value structures if the 10 year or more frequent event is at the first floor and the FHF is approximately 1.0. For a structure located in the 5 year flood plain, the wall would be feasible with FHF less than 12.0. Levees, considerably less expensive than walls, were found feasible for a wide range of FHF with the 10 year or more frequent event at the first floor. Levees were found generally infeasible for use in the 25 year or greater flood plain.

Analysis showed feasibility for relocation of a \$30,000 structure existed generally only when located in the 25 year flood plain. Even for structures in the 10 year flood plain, feasibility depended upon the FHF. Demolition feasibility required that structures be located in the 5 year flood plain.

Elevation of new structures is much less expensive than that for existing structures and has a longer life. The consequently lower annual cost tends to make elevation of new structures feasible for one and two story structures without basements in the 50 year flood plain without regard for the FHF.

The appendix containing structural analyses pertinent to watertight structures describes the types of forces to be analyzed, construction practices and materials and types of failures. Example analyses are included for typical walls and floors and for investigation of flotation.

Sheaffer, John R., and Associates. Introduction to Flood Proofing. The Center for Urban Studies, University of Chicago. Chicago, Illinois. 1967 (60 p. and bibliography).

The report is intended to acquaint public officials, building owners and professionals with the essential principles of floodproofing and to outline a number of simple but effective measures. Numerous drawings and photographs illustrate floodproofing techniques and show completed installations. The body of the report is divided in five chapters dealing sequentially with the uses and limitations of floodproofing, the effect of the physical environment on floodproofing, floodproofing procedures, structural engineering aspects of floodproofing procedures and programs of floodproofing.

Limitations of floodproofing are mentioned including generation of a false sense of security, discouragement of needed flood control works, possible adverse effect on economical use of the floodplain, and danger of applying floodproofing to structurally inadequate buildings. Other practical difficulties cited are the unwillingness to invest for securing long-term benefits, difficulty of obtaining cooperation in areas of complex land ownership patterns and the requirement for accurate and timely flood forecasts for successful floodproofing operations.

The principle values of floodproofing cited are:

1. Enables continued occupancy of flood plain sites and new development of such sites where shortages of land preclude alternatives;
2. Provides an additional tool in comprehensive flood damage reduction program;
3. Increases protection afforded by partial protection flood control projects;
4. May improve the availability of flood insurance; and
5. Properly understood, increases interest in flood damage reduction programs by heightening the awareness of flood risk.

Floodproofing is briefly discussed as an interim measure for use while flood control works are constructed, as an element of flood plain regulations and with respect to the reduction of risk for insurance purposes. Stress is placed on the importance of professional and experienced assistance in decisions to floodproof and in design of floodproofing measures. Several factors affecting the appropriateness of floodproofing are mentioned including stages, velocity and duration of flooding and relation of floodproofing to other measures for damage reduction. Circumstances cited which would normally warrant serious consideration of flood proofing programs are:

1. Where studies have concluded that it is not economically feasible to provide flood control structures, flood proofing could provide a substitute means of reducing flood losses.
2. Where authorized flood control projects have not been constructed because of lack of local cooperation, flood proofing could provide property owners with an opportunity to reduce their flood risk.
3. Where utilities, manufacturing plants and navigation terminals require riverfront locations to function effectively, flood proofing could provide the owners of these facilities an opportunity to achieve a degree of flood damage reduction. The highest practicable level of protection should be afforded to assure continuation of utilities.
4. Where flood proofing and flood insurance are closely allied, a property owner could elect to flood proof to reduce his flood risk in order to obtain more favorable flood insurance rates.
5. Where flood control projects have provided only partial flood protection, flood proofing could enable property owners to achieve a higher degree of protection than would otherwise be provided.

The report points out that stability of flood plain slopes, interconnection of flooding with groundwater and other environmental factors influence the source and type of flooding and may promote, rule out, or affect the type of floodproofing useful for a specific structure.

Soil permeability is discussed with respect to movement of floodwaters around foundations and under floor slabs and consequent pressures on buildings. Permeability ranges (low, intermediate, high, etc.) are given for selected soils.

Reliable, accurate and timely forecasts of flooding and flood stages are stated as a prerequisite for a flood proofing program. The disparity in forecasting services between major river valleys and those of smaller streams is noted.

Types of flood proofing measures are categorized as permanent, contingent or standby, and emergency. Permanent measures described include elimination of openings or reorganization of space within buildings. Advantages of permanent flood proofing are the minimal reliance on advance warning and special personnel and reduction in the element of human error. Contingency measures are those which are prepared in advance but which require action at the time for installation. Emergency measures encompass sandbagging, evacuation of contents and others carried out extemporaneously at the time of flooding. The latter measures have the greatest reliance on advance warnings.

Four general procedures for achieving flood proofing are briefly described including:

1. Proper layout of building sites including location of structures at safe elevations and use of low lying areas for parking, scenic elements and wildlife habitats;
2. Elevating buildings on supports to keep main floors above flood levels;
3. Provisions for keeping water out of buildings including shields for doors, windows and other openings; and
4. Internal flood proofing measures including use of water resistant materials.

The report addresses the analysis of the structural aspects of flood proofing in non-technical terms, explaining the nature of dead and live loads encountered in typical buildings and restraint to lateral loads from floor and roof systems. Flood and non-flood loadings on foundations and basement walls are similarly explained and illustrated.

Several techniques for reducing or offsetting uplift forces are identified including drains, sumps and pumps, and intentional flooding. Solutions to seepage described include both waterproofing of walls and use of interior drains equipped with pumps. Several design features for stopping sewer backup are also suggested and illustrated including use of cut-off and check valves and elimination of gravity sewer drains. Advice is given pertinent to all floodproofing techniques that their complexity prevents design simply based on intuition and that failure of floodproofing measures can increase damages and endanger lives in some cases.

The final chapter of the report illustrates and describes a program of flood proofing. Aspects included are:

1. Need for development of a standard operating procedure including advance planning, a timetable or checklist keyed to flood stages and a manpower mobilization schedule;
2. Maintenance of a state of readiness through periodic testing, employee education, assigned duties and drills;
3. Protection of subsurface portions of building including adjusting ground level entrances to prevent entry of overland flow, construction of dry cells around equipment and "mothballing" of equipment;
4. Installation of valves in gas mains, sewers, conveyor systems, water pipes and drain tubes to prevent water entry;

5. Closure of wall vents and openings;
6. Protection of display windows;
7. Provisions for sealing public, personnel and freight doors; and
8. Evacuation of contents.

A checklist is provided which summarizes some of the major items which should be considered in any plan for flood proofing a building.

Floodproofing benefits and costs are covered briefly. While cases are cited in which b/c ratios of 5 to 1 were found, it is noted that the comparative costs of floodproofing can vary widely depending on:

1. Local flood characteristics;
2. The type and size of the structure to be flood proofed;
3. The extent of efforts to make the measures esthetically pleasing; and
4. The financial terms of capital invested in flood proofing.

Correspondingly, factors affecting the potential benefits that would accrue are identified including:

1. The amount of investment in the structure;
2. The intensity of use; and
3. The elevation to which the flood proofing measures are carried.

According to the report, expenses of floodproofing can be used to some extent to reduce tax liabilities. However, contact with the Internal Revenue Service is recommended to determine the specific effect of floodproofing a given building.



Federal Insurance Administration. Reducing Flood Damage Through Building Design: A Guide Manual, Elevated Residential Structures. September, 1976 (111 p. and bibliography).

The Guide provides basic information on elevated residential foundations. It is organized into an introduction and four major parts. The four parts deal with general considerations and techniques for elevation, design aspects, examples of elevated residences, and cost analysis.

The introduction describes the magnitude of the flood problem and identifies general flood plain management strategies. The National Flood Insurance Program is described in some detail.

Part 1 is divided into sections addressing general considerations concerning elevated residential structures and techniques which may be used for elevation. General considerations described include site selection, design, engineering factors, building materials and utilities. Guidance given for the considerations include:

1. Building sites should be:
  - A. located in the flood fringe area if the flood plain cannot be avoided altogether;
  - B. located only where soil investigations assure safety from mudslides and erosion; and
  - C. selected after appropriate consideration of drainage, height of water table, soil and rock formations, topography, water supply and sewage disposal as well as economic and planning criteria;
2. Design should consider:
  - A. types of interference or damage likely from floods and need for safe accommodations; and
  - B. improving the acceptability of elevated homes to the owner and community through good design and landscaping;
3. Foundations must resist static and dynamic forces caused by high velocity floods, debris and scour;
4. Building materials and furnishings (e.g. carpets) should be resistant to water damage and structures should be designed and engineered in a manner that will allow them to dry out quickly; and

5. Mechanical equipment should be elevated above the base flood and utilities designed to resist or minimize flood damage infiltration.

Techniques described for elevating residences include use of fill and the construction of elevated foundations. Several types of elevated foundations are briefly described including posts, piles, pedestals, piers and walls. A state-of-the-art section provides photographs illustrating several uses of each technique.

Part 2 of the Guide outlines construction guidelines and performance criteria developed for light-frame residential structures which, if appropriately used, would reduce flood losses. An introduction to Part 2 describes the context and content of the material presented. Five factors are identified which affect the appropriateness of using a raised building approach including applicable regulations, flood characteristics, types of existing protective works, encroachment, and community characteristics.

The design and construction guidelines provide short discussions and suggestions concerning site conditions, durability and maintenance, insulation, utilities and breakaway walls. Post and pile foundations are discussed with respect to embedment, anchorage, bracing, and framing and connections. Types of pier foundations are described and discussed with respect to their design and construction and methods of framing and connections. Numerous figures illustrate the various guidelines.

Performance criteria which are presented are accompanied by identification of the procedure for testing compliance and a commentary concerning the objective of the criteria. Criteria deal with the following:

1. Building strength;
2. Stability and flotation;
3. Debris and scour;
4. Disruption of service systems;
5. Execution of rescue operations;
6. Disruption of utility connections;
7. Drinking water contamination;
8. Contamination of potable water wells;
9. Prevention of permanent damage; and
10. Prevention of unnecessary damage.

The criteria frequently refer to or include applicable definitions and pertinent provisions from the Corps of Engineers' publication, Flood Proofing Regulations.

Part 3 of the Guide presents several residential design concepts which were developed to test the applicability and usefulness of materials presented in the early portions of the Guide. The concepts included reflect the flood hazard condition, material availability, construction capability, social acceptability and aesthetic characteristics associated with various regions of the county. The presentation includes a description of the type of floods for each region and presents design ideas for particular cities. Figures illustrating the design concepts accompany the text. Types of residential concepts described are single family, multi-family, low and high cost town houses, row housing, and multi-building developments.

Part 4 of the Guide addresses the effect of elevated construction on building costs. The following foundation cost estimates made in 1974 are a nationwide average based on a 1500 sq. ft. house in the \$25,000 range.

<u>Conventional Foundations</u>	<u>Cost per Square Foot</u>
slab on grade	\$1.27
crawl space	1.95
basement	3.49
<u>Elevated Foundations</u>	
wood pole	3.25
wood pile	3.05
concrete pier	3.59

Cost comparison considerations are identified and discussed including those associated with fill, options for using lower spaces, earthquake-related requirements, foundation depths, and stairs and utilities. Real costs of elevating a residence are described with recognition of damage reductions and savings in insurance costs. An example cost comparison is presented to illustrate the appropriate analytical technique. Various charts and tables are included which compare costs of different types of foundation for various heights of elevation in a particular area.

Estimating forms are provided for use in determining current costs for each major type of foundation.

An appendix to the Guide describes sources of data and information concerning local flood situations, provides a glossary of terms, and includes a bibliography.

U.S. Army Corps of Engineers. Flood Proofing Regulations. Office of the Chief of Engineers, U.S. Army. Washington, DC. June, 1972 (79 p.).

This report was prepared specifically to assist in meeting the need for special flood proofing requirements and minimum standards of design and construction for buildings and structures susceptible to flood damages. It assembles information into a workable set of standards intended to be suitable for national application which, if properly used, would assist in safeguarding users and property in flood hazard areas. Floodproofing measures and techniques that should be followed to regulate private and public building construction in riverine hazard areas. Problems associated with coastal and tidal flooding, such as wave impact and erosion, and problems of mud slides and other high density flows are not addressed.

The regulations presented are intended for direct use or for incorporation into existing building codes. The report recommends that compliance with the regulations be made a mandatory requirement for existing buildings, for approval of plans or issuance of permits for new construction, and for major alteration or reconstruction in flood hazard areas.

Report organization includes an introductory chapter followed by 12 chapters comprising example regulations dealing with one or another aspect of flood proofing. A final chapter describes procedures for flood proofing.

Chapter 1 provides a general introduction to the report and a general discussion of floodproofing and use of building codes. Several points important to understanding concepts for application of floodproofing are presented including:

1. Main purposes of floodproofing are to reduce loss potentials and provide for early return to normalcy;
2. Only very substantial and self-contained structures should be occupied during a flood despite floodproofing;
3. Incorrect use of floodproofing can tend to increase uneconomical use of the floodplain and increase damage; and
4. Many attempts to use a "common sense" [without explicit analysis and design] approach to floodproofing neither prevent nor reduce flood damages.

Chapter 2 regulations provide for the administrative aspects of implementing controls and requirements. It provides statements of purpose and scope, tests of compliance, organization and arrangements for enforcement, a permit program and other program components. Sections are included for inspections, public notice of flood hazard, provision of safe refuge and for the classification of various types of floodproofing. Examples are provided of permit forms and of various placards suitable for use on buildings to provide public notice of its floodproofing classification.

Chapter 3 provides the definition of terms required for use of other portions of the floodproofing regulations.

Chapter 4 pertains to the classification of spaces within buildings which are at an elevation subject to the regulation. Several classifications are defined based upon the type and effect of floodproofing to be used including: completely dry spaces, essentially dry spaces, spaces intentionally flooded with potable water, spaces flooded with flood water and non-floodproofed spaces. A chart is provided which identifies for each space classification the types of waterproofing and closures to be used, design requirements and suitable contents.

Chapter 5 addresses the design, use and methods of construction and materials to meet the requirements of each floodproofing classification. Waterproofing is defined on the basis of satisfying a degree of dryness including Type A which is completely impermeable, Type B which passes water vapor and slight seepage, and Type C which does not meet either of the previous requirements and is considered as non-waterproofed. Regulatory sections cover three approaches to meeting Type A requirements including exterior membrane waterproofing, integrally waterproofed concrete construction, and use of interior linings. Detailed requirements for each approach are included which cover structural prerequisites, materials and installation. Regulatory sections pertaining to Type B and Type C waterproofing deal with their definition, upgrading, and inspection.

Chapter 6 deals with flood loads and structural requirements. Classes of loads are established based on the type of floodproofing used. Various loads are defined for consideration including static (lateral, vertical and uplift) and hydrodynamic loads. A procedure is provided for conversion of dynamic loads into equivalent hydrostatic loads. Definitions and considerations to be given various degrees of impact loads are specified as well as provision for appropriate soil loads. The chapter also deals with loading conditions, combined loads, allowable stresses and allowable soil pressures. Stability against overturning and flotation is required and anchorage specified. Regulatory provisions provide for reduction of uplift pressures using impervious cutoffs, foundation drainage, pumps and sumps, and other suitable provisions. Requirements for other types of floodproofing are provided including techniques of elevation on natural terrain, fill and "stilts", and protection by dikes, levees and floodwalls.

Chapter 7 is devoted to the closure of openings in interior and exterior walls of structures and buildings. Five types of closures are specified according to their compatibility with requirements of the various floodproofing classifications. Regulatory sections cover design standards for the closure assemblies, frames for openings, use of closures for shafts and fire resistivity of closures. Special applications of closure assemblies are specified where buildings may not be frequently or continuously occupied.

Chapter 8 covers the intentional flooding of buildings with either potable or flood water for the purpose of balancing internal and external loads. Regulations for flooding with potable water prescribe the use of

automatic devices for filling and draining spaces, storage of sufficient water for the purpose in the event water supply service is disrupted, and provision of an automatically operated back-up system using flood water. Automatic flooding and drainage systems using flood water are specified with respect to capacity, sequence of filling, and venting of trapped air. Provisions are included to require systems for emergency flooding of waterproofed areas to maintain structural integrity in the event design flood levels are exceeded.

Chapters 9 and 10 govern the design and use of floor, wall, and ceiling systems and their constituent materials for buildings and structures subject to floods. The regulations restrict flooring systems and materials according to vulnerability of various types and prescribe classifications on that basis. Wall and ceiling materials are treated with respect to both finishes and structural constructions upon which they depend and are classified according to susceptibility to damage. All classifications of vulnerability are related to suitability for use in connection with the overall floodproofing classifications.

Chapter 11 addresses the types of contents permitted and protection requirements for contents in spaces of buildings or structures subject to flooding. Contents are restricted on the basis of hazard to public health, welfare of property owners or occupants and/or vulnerability to loss. Contents are divided into seven classes according to the degree of floodproofing required to protect them from becoming hazards or losses. Descriptions of the classifications indicate whether items are prohibited in the flood hazard area in all cases, prohibited in building spaces below regulatory flood levels, require protection by one or another classification of floodproofing or are unrestricted. A listing of classifications is given for typical items.

Chapters 12 and 13 deal respectively with requirements for electrical systems and mechanical systems for heating, air conditioning, ventilating, and plumbing. Electrical system requirements prescribe location of main power service, location of stationary and portable equipment, design of normal and emergency circuits, emergency lighting requirements and use of battery operated lights as well as restrictions on submersible equipment and wiring, elevators, and electric heating equipment. Design of heating, ventilating and air conditioning systems is required to comply with restrictions concerning location of equipment, automatic shutoff of fuel supply and provisions for internal flooding. Plumbing systems, including sanitary and storm drainage, water supply, sewage disposal and others, are covered with respect to material selection, prevention of backflow, use of sewage holding tanks, protection against contamination, and location of system components.

The final chapter of the report presents and explains some practical aspects of floodproofing and shows, by examples and diagrams, the effect of flood-related loads on structural elements. Critical aspects of a flood are discussed including depth, velocity, duration, rate of rise and fall,

length of advance warning, debris load and degree of wave action. Flood damages are discussed with respect to their nature and cause. Loads caused by floods on various structural elements are discussed. Considerations affecting the use of closures are described. Geographic, topographic and other factors pertinent to site selection, building elevation and use of dikes, levees and floodwalls are described. Stress is placed on a total approach in floodproofing and the effect of "the weakest link" in the system. The development of standard operating procedures (owner's contingency plan) for mobilizing and implementing flood proofing measures is recommended.

Chapter 14 also includes numerous illustrations of construction details, techniques of using closures of various types, assembly and fastening methods, and backflow prevention devices.

Kusler, Jon A., Lee, Thomas M., ed. by Spicer, Richard. Regulations for Flood Plains. Report No. 277, Planning Advisory Service Memos, American Society of Planning Officials, Chicago, Illinois, February, 1972 (65 p. and bibliography).

The report provides a basic introduction to major elements of a community policy toward flood plain management with emphasis on local flood plain zoning ordinances. The need for flood plain management is reviewed and a summary of the principal federal actions taken to aid and complement actions by states and local units toward that objective is presented.

Flood plain management goals are discussed in broad context based on the principal that land should be allocated to its most appropriate use from the viewpoint of the community as a whole. Economic, environmental and other tradeoffs affecting allocation of land use are identified. Major objectives for regulations to minimize flood damages are stated, namely:

1. Protect adjacent upstream, and downstream private and public landowners from direct and substantial increases in flood damages;
2. Minimize unjustified costs to governmental units caused by development of flood-hazard areas;
3. Prevent victimization and fraud; and
4. Reduce risks to the individual or his family and guests from threats to health and safety or economic loss.

A summary listing is provided of regulatory and non-regulatory techniques for avoiding losses to future uses and reducing losses to existing uses. Flood control works are discussed with respect to inadequacies associated with the level of protection provided, availability of sites and local cooperation, land costs, encouragement given development on unprotected lands, funding difficulties, interference with existing activities and environmental values, and maintenance requirements.

The relationship between regulations for reducing flood losses and utility extension policies, flood warning systems, public information programs, and other flood related programs is discussed. Zoning, subdivision regulations, building codes, housing codes, and sanitary and well codes are individually described with respect to their nature and potential use for flood damage reduction. Some potential features are itemized for each type of regulation.

A section of the report is devoted to presentation and response to commonly asked legal questions concerning a regulatory program: Questions dealt with pertain to adequacy of enabling statutes, constitutionality, validity of objectives, need for compensation, required availability and accuracy of technical data, accuracy needed in mapping, relation to comprehensive planning, and need for equal treatment of similarly situated individuals.



Steps toward development of a flood plain regulation program are presented and discussed including establishment of objectives and plans, data collection and mapping of regulatory flood plain boundaries, and calculation of the regulatory floodway. Considerable information is provided in narrative and tabular form concerning types and accuracy of needed categories of data, sources of information and data, and situations to which various types of information are applicable. A listing of general responsibilities for financing topographic mapping, surveying, flood plain delineation and other steps is also presented as a Table. General procedures for computation of regulatory floodways are included along with discussion of numerous aspects which may affect boundary establishment in specific cases including: flood discharge, increase in flood heights and velocities, need for hydraulic transitions, transportation systems, location of flood control facilities, interior drainage considerations, existing development, community comprehensive plans, plans of adjoining communities, natural or cultural features, and general legal considerations.

The report contains four examples of flood plain zoning ordinances demonstrating various approaches meeting requirements of the flood insurance program including:

1. A two district approach for an urban area;
2. A single district approach for urban and rural areas;
3. A three district approach for areas where combinations of adequate and inadequate data occur; and
4. Use of a flood-basement distribution added onto flood-fringe and floodway districts.

Ordinance provisions appropriate to each of the example approaches are provided including sections for findings of fact, statement of purposes, reference to zoning maps, establishment of zoning districts, description of zones and permitted uses, handling of nonconforming uses, definitions and others. Commentary on each example explains the purpose of various parts of the ordinance provisions. The examples and comments are extracted from models contained in "Regulation of Flood Hazard Areas to Reduce Flood Losses" developed by the authors under the auspices of the U.S. Water Resources Council. Modifications of the regulatory provisions to account for wave and erosion problems of coastal areas are presented. Basic relationships are pointed out between regulatory programs for flood plain management and those for preservation of wetlands, protection of open spaces and shorelands, control of pollution and other purposes.

An appendix to the report contains a tabular summary of the national status of flood plain regulations.

Kusler, Jon A. and Eric Strauss. Statutory Land Use Control Authority in the Fifty States. Prepared for the Federal Insurance Administration. September, 1976 (304 p.).

The report summarizes and analyzes statutes authorizing local units of government and state agencies to adopt zoning regulations, subdivision controls, building codes, and special flood hazard regulations. Emphasis is upon land use control legislation authorizing regulation of flood prone areas. The report also examines case law interpreting the general scope of enabling authority and lists and annotates flood plain regulation cases. The referenced statutes represent much of the general and special land use control enabling authority in the fifty states. In addition, home rule powers authorized through constitutional provisions, special statutes or charters are briefly considered.

Part I of the report contains discussion of selected issues and conclusions pertaining to the scope of statutory enabling authority, including a summary of statutory approaches and case law interpretation from the fifty states. Principal conclusions concerning the scope of authority of particular regulations are that:

1. Zoning and subdivision regulations are more frequently used for control of flood plain uses than are building and other codes;
2. Forty-three states have expressly authorized local governments to adopt regulations for flood hazard areas or drainage control purposes;
3. In most cases, enabling statutes authorize adoption of flood plain regulations as part of broader zoning, subdivision controls, or building codes;
4. Home rule units of government may have sufficient authority to adopt flood plain regulations without express authority;
5. Local units of government may generally adopt flood plain regulations by reference only if authorized to do so and if the referenced materials are existing portions of the published public record at the time;
6. Building codes and subdivision regulations may refer to a flood map and include minimum flood elevation and zoning ordinances can include flood elevations and floodproofing requirements but zoning provisions cannot be indiscriminately placed in subdivision control ordinances or building codes;
7. Resolutions of local legislative bodies adopted without notice and hearing are generally invalid for land use control unless specifically authorized;

8. Zoning enabling statutes often exempt agricultural uses, existing uses and governmental uses;
9. Local governmental units may not adopt extraterritorial regulations unless specifically authorized to do so and counties cannot regulate incorporated areas within their borders;
10. Interim regulations can be used in certain areas and circumstances to freeze the use of land for limited periods;
11. Adoption of flood plain regulations generally requires prior adoption of a master or comprehensive plan;
12. Flood plain regulations can be adopted as an amendment to broader regulations in most cases;
13. Requirements for adoption of regulations vary from place to place and include majority vote of local governing body, referendum, state approval, and approval by towns of county zoning; and
14. State regulations generally do not preempt more restrictive local regulations unless there is clear statutory provision for such preemption.

Part II provides a detailed description of enabling acts specifically authorizing state or local regulation of flood hazard areas. It also provides examples of enabling authority which may be useful to states in adopting new flood-related statutes or amending existing statutes. A table shows statutory references and brief summaries of specific flood drainage regulatory language in local enabling statutes. Five examples of statutory amendments or special acts authorizing local flood plain regulations are presented including:

1. An example of brief amendment to the purposes section of an enabling statute to specifically authorize flood plain regulations;
2. An example of a more extensive separate act specifically authorizing local flood plain regulations; and
3. Three examples of amendments or special acts authorizing regulations for flood insurance purposes.

A table is also included which provides statutory references and brief summaries of statutes establishing state level flood plain regulatory programs. Six examples of acts authorizing direct state regulation or state standard-setting for flood prone areas are presented including:

1. One direct state regulation of floodway and flood plain areas;
2. One example of direct state regulation of floodway areas with state standard-setting for local regulation of flood fringe areas;
3. Two examples of state standard-setting for local regulation of floodway and flood fringe areas; and
4. Two examples of state regulations specifically authorized for flood insurance purposes.

Part III includes an annotated, state-by-state list of flood-related land use control cases and attorney general opinions.

Part IV summarizes principal land use control powers, state by state. Four pages are provided for each state. A one page narrative summary begins each state discussion, followed by individual charts for zoning, subdivision control, and building code enabling powers. The charts and summary material cite principal statutory powers and general rules of statutory interpretation. Where several statutes have been adopted by a legislature authorizing a class of local government (e.g., cities, counties) to exercise land use control power and the class has the option of selecting from among such statutes, the report only references the statute with broadest scope. The report does not cite special local land use control authority for sanitation, plumbing, fill and grading and similar subjects unless it has specific reference to flood hazards. Land use control powers of soil conservation districts, flood control districts, and other special districts are also not cited unless they expressly relate to floods.

United States Water Resources Council. Regulation of Flood Hazard Areas to Reduce Flood Losses. Vol. I, Parts I-IV, Vol. II Parts V-VI. U.S. Government Printing Office, Washington, DC (938 p.) (undated).

The report covers selected issues in the regulation of private and public land uses to reduce flood losses and presents draft statutes and local ordinances for regulation of land uses in hazard areas. The report focuses upon the use of regulations to guide adjustment of individual land uses in meeting flood threats and to avoid flood damages. The report does not suggest that land use regulations alone are sufficient for flood plain management. Rather it treats regulations as a tool to be used generally in conjunction with other techniques for managing flood-prone lands.

The report is in two volumes divided into six parts, five of which are further subdivided into chapters. Volume One (containing Parts I through IV) explores selected issues in regulation of private and public land uses as a tool of flood plain management. It focuses primarily on basic regulatory issues and riverine flood problems. Volume Two explores in more detail techniques of regulating subdivision of lands in flood hazard areas (Part V) and regulating coastal flood hazard areas (Part VI). It builds, with only minor repetition, upon Volume One. Each of the six parts is designed to be informative and useful on its own as well as in relation to the whole.

The studies on which both volumes of the report are based were undertaken by the University of Wisconsin's Center for Resource Policy Studies, School of Natural Resources, College of Agricultural and Life Sciences, in cooperation with the Water Resources Council, the Corps of Engineers of the Department of Army, the Soil Conservation Service of the Department of Agriculture, the Department of Housing and Urban Development, the United States Geological Survey of the Department of the Interior and the Tennessee Valley Authority. The studies drew heavily upon existing books, periodicals, statutes, and ordinances relating to regulation of land uses in flood hazard areas. Consultants, interviews, telephone conversations, and questionnaires were used to explore technical and administrative aspects of flood hazard regulations with policy and constitutional implications. An extensive search of legal texts and case reports throughout the Nation was made to discover legal decisions relating to the use of regulations for flood loss control. Those discovered and the decisions of courts in analogous contexts were thought sufficient to allow prognostication of judicial reaction to particular flood hazard area regulations.

Part I of the report "Conclusion," is based upon the studies contained in Parts II-VI. A bibliography, included with Part I, lists selected references to flood plain regulation literature. The following 27 conclusions, each accompanied by discussion, are presented in Part I:

1. Regulations to guide land uses in flood hazard areas can play an important role in reducing flood losses to future construction.

2. Uncontrolled development in flood hazard areas results in increased flood heights and recurring flood damages to unprotected uses;
3. Flood plain regulations can help assure that benefits of proposed uses at flood-prone sites exceed costs;
4. Engineering works are inadequate, unnecessary or undesirable, in some instances, to reduce flood losses;
5. Substantial flood damages may occur in riverine and coastal flood hazard areas;
6. Provision for and protection of an adequate floodway should be a primary objective in regulating use of riverine flood plain lands;
7. Control of land uses in high-hazard areas which may damage other lands should be a primary objective of coastal regulation;
8. Designation of minimum flood protection elevations should be a second principal objective in regulation of riverine and coastal low hazard lands;
9. Flood hazard regulations may play a useful role in reducing losses in any part of the country;
10. Reduction in flood losses should be one among many goals in managing flood-prone lands;
11. A variety of regulatory tools adopted at State or local levels is needed in reducing flood losses;
12. A combination of regulatory tools is necessary to control carefully development in floodway areas or coastal high hazard areas and to set minimum protection elevations for low hazard lands;
13. Land use regulations must be appropriately combined with other flood plain management techniques to reasonably minimize flood losses;
14. Regulations have greatest potential in avoiding flood losses to new uses, not in controlling losses to existing uses;
15. Regulations can be effectively combined with flood modifying works, land treatment measures, "flood conscious" governmental policies in extension of public services and public works, flood warning systems, voluntary floodproofing, and flood insurance;
16. Flood plain regulations are subject to the same general legal requirements as other land use controls;

17. The power to regulate flood plain land uses must be found in the general or special language of enabling statutes;
18. Courts generally determine only the specific constitutionality of enforcing land use regulations against a complaining landowner and not the general constitutionality of regulations as applied to all landowners;
19. Widespread judicial support can be found for regulations which require that those who use lands be responsible for actions which substantially harm public or private interests;
20. Flood plain regulations must be based upon sound data to meet constitutional requirements;
21. Flood plain regulations often provide for general rules which apply to all uses and additional case-by-case evaluation of certain special uses;
22. Whenever possible, flood plain regulations should be part of comprehensive water and related land use management programs;
23. Regulations must balance private and public rights to withstand attacks that the regulations "take" private property without payment of just compensation;
24. In some instances, public purchase rather than stringent land use regulation or construction of flood control works may be the most desirable technique for avoiding future damages or reducing losses to existing uses;
25. Regulations cannot reduce all losses;
26. Adoption, administration, and enforcement are essential steps for successful flood plain regulation programs; and
27. Regulation of flood prone areas might be either an exclusive function of state agencies or of local units of government, but a conjunctive state and local effort seems desirable.

Part II discusses statutes adopted by State legislatures authorizing State agencies or local units of government, or both conjunctively, to enact riverine and coastal flood hazard area regulations. Draft statutes with explanatory comments are included to assist States seeking legislation to reduce flood losses and to promote the most suitable use of lands. The draft statutes represent several approaches thought to be reasonable, practical, and legally sound. However, the reader is advised that other legislative approaches may be equally desirable or preferable in a given instance and that the draft statutes should be carefully tailored to meet the special needs of a State.

Draft materials include:

1. Alternative versions of a statute which authorizes a State agency to:
  - A. regulate general development in flood hazard areas if local units of government fail to adopt satisfactory regulations;
  - B. regulate flood hazard areas independently of any local effort; and
  - C. aid local units in regulating flood hazard areas;
2. Several draft statutes to supplement existing zoning and subdivision enabling acts to specifically authorize local units of government to adopt flood hazard area regulations.

The report notes that the attractiveness of each of the draft alternatives to a State will depend upon the preexisting statutory and ordinance provisions, operational programs, and legislative preferences and that while each of the alternatives has advantages and limitations, adoption of a conjunctive State-local program with the following combination of regulatory provisions will often be most satisfactory:

1. Legislative enactment of a statute authorizing a State agency to:
  - A. study, plan, and regulate selected classes of uses in all flood hazard areas;
  - B. assist local units in developing regulatory programs; and
  - C. regulate general development in flood hazard areas if local units of government fail to adopt satisfactory regulations;
2. Legislative enactment of a single broad statutory amendment to supplement existing zoning, subdivision regulation, and building code enabling legislation for the purpose of specifically authorizing local units of government to adopt regulations for flood loss control; and
3. Adoption by cities, villages, and counties of a two-district zoning ordinance delineating floodway and floodway fringe districts.

Numerous appendices to Part II provide excerpts from and examples of various state statutes and regulations and local enabling acts.



Part III discusses legal issues which arise in the regulation of flood hazard areas. Much of the discussion concerns areas prone to riverine flooding. However, the analysis of basic legal requirements is intended to apply to regulations for both riverine and coastal areas. The most important difference noted between riverine and coastal flood-prone areas is the existence of riverine "floodway areas", the stream channels and overbank lands necessary to convey flood flows from upstream to downstream areas.

The report is based in part upon a collection of State Supreme Court decisions interpreting flood plain regulations throughout the Nation, many of which are listed in an appendix. Much of the report discusses basic judicial attitude to principles and approaches which underlie flood plain and more traditional land use controls since examination of flood plain cases indicated that judicial approach to flood plain regulations is consistent with the approach to more usual controls. Cases involving traditional controls are cited.

Part III is divided into 5 Chapters. Chapter I discusses conclusions relevant to Part III, the nature of the regulatory power, and the role of courts in determining the reasonableness and constitutionality of regulations. Chapter II discusses judicial attitude towards specific objectives for regulating flood hazard areas. Chapter III concerns a variety of related issues involved in formulating and administering regulations including requirements that regulations be reasonably related to regulatory objectives and be applied without discrimination to similarly situated landowners. Chapter IV considers constitutional prohibitions that private property must not be "taken" without payment of just compensation. Chapter V considers regulation of nonconforming uses and attempts to place regulations in a somewhat broader context. Each of the Chapters II through V include conclusions pertinent to the topic discussed. They include the following:

1. Generally the power of the legislature is broad in determining what is or is not a valid police power objective;
2. Courts have usually been quite willing to sanction regulations which prevent or control uses with nuisancelike effects such as encroachment in floodway areas which may damage other properties by increasing flood heights and velocities. Courts give very considerable weight to such objectives in balancing public and private rights;
3. Courts have also been favorable to regulations for the prevention of fraud. Regulations to prevent fraud might include subdivision regulations for hazard areas, requirements that flooding threats be noted on recorded instruments, requirements that sellers or real estate brokers disclose the presence of flood hazards provisions applying to lands, or other techniques.

4. Judicial support may be found for regulations to protect public health and safety by regulating uses in flood-prone areas where private on-site water supply or waste disposal is unsatisfactory or where floodwaters may disrupt public water supply or waste disposal;
5. Some flood plain regulations have come under attack as only protecting the individual against his own folly rather than serving broader societal interests. While it is not clear that flood hazard regulations could be enacted only to protect the flood plain occupant from the consequences of his own acts, judicial precedent exists in other contexts for regulations which protect the health, safety and economic well-being of an individual and thereby the public health, safety and general welfare. Regulations may also validly promote the most appropriate use of land throughout the locality and protect, conserve, and promote the orderly and efficient development of water and land resources;
6. Regulatory programs to guide uses of flood-prone areas must:
  - A. meet 14th amendment requirements that regulations (the means) have some reasonable tendency to aid in the accomplishment of the regulatory objectives; and
  - B. meet 14th amendment requirements that regulations treat similarly situated individuals without discrimination. This principle of equal treatment applies to initial classification, administration, and enforcement;
7. Flood plain regulations must be based upon sound flood data and well-conceived policies to meet 14th amendment requirements;
8. Generally, a prohibitory approach to development control in low hazard areas is likely to be found unconstitutional;
9. Severe restrictions are likely to be upheld on fill, structures or other uses which act as nuisances by obstructing floodways or threatening public health or use of adjoining lands;
10. Regulations, standing alone, can play only a partial role in the management of flood hazard areas;
11. Regulations might be:
  - A. combined with tax adjustments to lessen the burden of stringent regulation on the landowner;
  - B. combined with purchase through use of official mapping, compensable regulations or easement purchase;

C. used to eliminate existing uses such as artificial obstructions; and

D. used to require immediate floodproofing of some existing uses.

The report cautions that the discussions and conclusions included must be approached with care since the analysis presented will require frequent updating as many new cases dealing with flood plain regulations can be expected which:

1. Define the role of regulations in protecting aesthetics and preserving open spaces;
2. Deal with innovative approaches to development control; and
3. Define the retroactive role of regulations for existing uses.

Part IV is designed to provide assistance to a planner or member of local government contemplating zoning for riverine flood hazard areas. The report discusses existing regulations throughout the Nation and sets out two draft ordinances with explanatory statements and commentary including:

1. A two-district zoning approach for riverine areas which requires engineering data to permit initial delineation of the flood plain into floodway and floodway fringe districts; and
2. A single-district zoning approach for riverine areas which can be adopted with less precise initial flood data but requires hydrologic expertise during administrative phases of a regulatory program to define more exactly flood hazards and floodway areas.

The report favors a two-district zoning approach for riverine flood hazard areas because it:

1. Provides owners of flood-prone lands with greater certainty in the use of their lands than a single-district approach;
2. Lessens the chance of arbitrary or discriminatory decision-making during administrative phases of a regulatory program; and
3. Lessens the need for special administrative expertise.

However, the report notes that a two-district approach requires sophisticated flood data and enactment of a two-district approach may not be possible or warranted for some areas such as rural recreation areas.

The draft ordinances were prepared after extensive review of case law, examination of more than 100 local ordinances, discussions with participants in local flood plain zoning programs, and questionnaire surveys. The ordinances embody many of the conclusions set out in Parts I and III.

The draft ordinances present several approaches thought to be reasonable, practical, and legally sound. However, the report recognizes that other legislative approaches may be equally desirable or preferable in a given instance and that the draft ordinances must, in any event, be carefully tailored to meet the special needs of the locality.

Part V discusses subdivision regulations to reduce flood losses. Draft ordinances with commentary are included. The ordinances require developers to overcome flood hazards which affect subdivided lands and to provide drainage facilities, roads, and other services which are protected against flood damages. The regulations are intended to prevent fraud and victimization of lot owners and to promote community well-being by assuring that subdivided lands can be safely used for their intended purposes. Specific ways cited in which subdivision regulations can reduce flood losses are:

1. Prohibiting the subdivision of lands subject to serious flooding unless hazards are overcome;
2. Requiring the designation of flood hazard areas on subdivision plats and the insertion of restrictions in purchase deeds to control lands unsuitable for dwellings or other uses;
3. Prohibiting encroachment in floodway areas by fill or structures;
4. Requiring that a portion of each lot be filled or otherwise protected to provide a safe building site with adequate areas for waste disposal (if on-site facilities are used) at an elevation above flood heights;
5. Requiring the installation of streets, sewers, water and other facilities which are flood-proofed, elevated, or otherwise protected against floods; and
6. Requiring that subdivision drainage systems be designed to prevent increased flood flows due to newly developed impervious surfaces (asphalt, concrete, roofs, etc.) and other factors.

Part VI is designed to provide basic information to a state or local unit wishing to reduce flood losses in coastal flood hazard areas. It supplements earlier sections of the report with minor repetition. Special problems associated with coastal flood hazard areas is presented along with a commentary on the ordinance's provisions. Numerous appendices to Part VI contain a collection of existing statutes, regulations, ordinances and codes for coastal areas and annotations of pertinent legal cases.

Wall, Glenn R. Establishing An Engineering Basis for Flood Plain Regulations. Thesis presented to Graduate Council of the University of Tennessee, Knoxville, TN. December 1964 (164 p.).

The report describes a study made to evaluate the hypothesis that land use controls are a desirable and legal element in any plan for flood damage reduction but must be supported by an adequate engineering basis and to propose a decision-making procedure for local officials concerning the flood problem. In testing the hypothesis, a number of legal cases are reviewed.

Opening sections of the report discuss the nature and causes of flood losses, economic impact of flooding and various structural and nonstructural approaches to flood damage reductions. Definitions are also provided for a number of commonly used terms.

The author points out that in spite of the excellent accomplishments of engineers in controlling floods by structural measures, damages have continually increased. It is noted that flood control alone is not the answer and that the search for a solution to the problem of increasing damages has resulted in a structural-nonstructural dichotomy. A preliminary conclusion is that rather than considering methods of damage reduction as alternatives to flood control, choices should be considered as an array of elements which can be combined into a damage reduction plan which might or might not include flood control, depending upon a number of variables.

Elements of flood reduction plans are discussed, particularly land use controls applied to the flood plain through regulations.

Exercise of police power for controlling land use is discussed in general with regard to its legal basis. Limitations and requirements are discussed through presentation of opinions given in relevant cases. The various opinions cite the suitable purposes of use of the police power to be "comfort, safety, general welfare of society, public health, morals, prosperity, convenience, public business safety, orderly development, efficiency, economy, peace and quiet, and law and order". Cases are also cited in which courts have acted to prevent individuals or groups from acts injurious to themselves. Zoning is discussed in particular with respect to its legal basis and constitutionality.

A review is presented of major legal discussions concerning flood related land use regulation which are available in the literature along with brief summaries of their conclusions. Based on those earlier reports and on specific court cases, the legal trend toward expansion of the nuisance concept into fuller and more specific agreement with zoning to regulate flood plains is described. Cases and legal discussions indicate flood plain regulations will be upheld if founded on a sound and reasonable basis.

Development of the engineering basis for regulations and related decisions is discussed including description of the complexity of attaining adequate perception of the hazard by the public and local officials. Flood damage surveys translating varying flood heights into damage values are cited as information which is extremely helpful but not an essential part of the engineering basis. Essential engineering information for that purpose and to substantiate flood plain regulations are identified and described including:

1. Flood history;
2. Topographic data including:
  - A. detailed information on type and density of existing development;
  - B. valley and stream cross sections;
  - C. profiles of the stream bed and banks;
  - D. other information on prominent features in the flood plain; and
  - E. adequate maps;
3. Hydrologic data including:
  - A. water surface profiles;
  - B. flood hydrographs;
  - C. velocities at various levels;
  - D. rates of rise and decline;
  - E. duration of inundation; and
  - F. information on past flood flows, seasonal aspects, maximum floods probable and intermediate levels of flooding suitable for community planning purposes.

It is pointed out that a fundamental problem in communities' decision-making process is selecting the basic criteria upon which the regulations will be based. Attempts to develop optimum damage criteria based on damage potential are described with the conclusion that the type of optimization searched for does not exist because of differences between communities. Alternative criteria are discussed for placing restraints upon the use of flood plain land including:

1. Maintenance of the maximum amount of open space on the flood plain;
2. Reservation of a minimum floodway;

3. Establishment of minimum flood levels; and
4. Economic criteria based on rate of damage to users of a site or rate of damages caused to others.

The report advises that in making a choice from among these alternative criteria, the decision-making body must first develop some concept of what it considers to be a reasonable degree of protection. Stress is placed on the need in the decision-making process and in the selection of criteria to recognize and evaluate limitations and to consider regulations in the context of overall long range planning for the community.

Numerous other points concerning plan formulation involving land use regulations are identified and discussed including the following:

1. While an open flood plain (approach) may be desirable in a slowly growing bedroom community, the entire flood plain is usually much too large for reservation in most cases. By using a minimum floodway concept and appropriate criteria for its selection, much flood plain land can be put to use while reducing flood risks;
2. The maximum probable flood is too conservative a basis for regulation for use by most communities, although some will find it suits their plans;
3. The maximum known flood usually is not a reliable indicator of the types of flooding to be expected and therefore not a good basis for regulation;
4. A regional flood has considerable merit as a basis for regulation, is easily understood, and has enjoyed wide use. However, regional floods are not standard when subjected to frequency analysis and methods for their determination need improvement;
5. A criterion for regulation based on levels of existing development is not a logical approach and merely maintains the status quo;
6. While frequency expressions have support from those who consider them to be a way to standardize regulations, there are several limitations to their use and those responsible for adopting regulations should understand the purpose, use, and limitations of frequency expressions before using them as criteria; and
7. There is much to be said in favor of some economic criteria as a basis for regulation but no simple means of developing an economic criterion is presently available.

Difficulties in decisions about applying regulations due to economic considerations are discussed and it is suggested that:

1. Non-economic considerations may outweigh the economic ones when planning future land use; and
2. The economics that should be evaluated are those of the community as a whole rather than the economics of individual owners or users.

The primary functions of community leaders in establishment of a flood plain regulation program are described as analysis of information, consideration of alternatives, and formulation of decisions that will be in the best interest of the community at large. A decision-making procedure is outlined for arriving at a flood damage reduction plan and which can also be followed in deciding upon criteria for land use regulations, in developing the regulations, and in resolving other problems.



Dynes, Russell R. and E. L. Quarantelli. A Perspective on Disaster Planning. Disaster Research Center Report Series No. 11. the Ohio State University. Columbus, Ohio. June, 1972 (94 p.).

Contents of the report summarize results of systematic study of behavior and response in over 100 community disasters. They describe an approach to conceptualizing disasters which is generally applicable to all situations. The report covers planning, characteristics of disaster agents, behavior during disasters, community organization and elements of response to disaster.

The following principles of disaster planning are stated:

1. Planning is a continuous process;
2. Planning involves attempting to reduce the unknown in a problematical situation;
3. Planning aims at evoking appropriate actions;
4. Planning should be based on what is likely to happen;
5. Planning must be based on knowledge;
6. Planning should focus on principles;
7. Planning is partly an educational activity; and
8. Planning always has to overcome resistance.

Focus of the report is on the social disruption caused by the physical impact of a disaster agent. The dimensions of disaster agents are identified as predictability, frequency, controllability, speed of onset, length of forewarning, duration of impact, scope (geographic and social) of impact, and intensity of impact. The relevance of each of these factors is briefly discussed [Note: a more extensive treatment of the dimensions of disaster agents is included in The Warning System In Disaster Situations: A Selective Analysis]. Time phases for disasters are also defined including pre-disaster (normal situation), pre-impact (from first warning to impact), impact (period of occurrence), emergency (period of response to disaster generated demands) and recovery. The potential for overlap of phases due to multiple and secondary threats is briefly discussed.

The types of demands on a community which occur are discussed in some detail including:

1. Demands generated by the disaster agent for:
  - A. warning efforts including detecting and predicting disaster occurrence and dissemination of warning and information on protective action;

- B. pre-impact preparations including readying human and material resources, institutional measures to lessen impact and steps to limit consequences of impact;
  - C. search and rescue including location, rescue and transportation of entrapped persons by qualified personnel having necessary equipment;
  - D. care of injured and dead including transportation to medical help, assignment of priorities in treatment, and morgue operation;
  - E. welfare measures to provide basic needs (food, clothing, etc.) of survivors and disaster workers;
  - F. restoration of essential community services such as gas, electricity, telephone, water, transportation etc.;
  - G. protection against secondary threats from damaged buildings, public health problems, fires, etc.; and
  - H. maintenance of community order to guard property, patrol danger areas, provide traffic control and assure the community's public and private resources are used for common community ends;
2. Demands generated by the response to the disaster agent including:
- A. use of traditional communication procedures and development of new channels of communications for providing information, coordination and other purposes;
  - B. continuing assessment of the situation to identify and prioritize needs for action;
  - C. mobilization and use of human and natural resources including recruitment, training, mobilization and allocation to appropriate uses;
  - D. coordination to allocate resources and responsibilities and meet requirements of non-traditional activities; and
  - E. establishment of a system of overall control and distribution of authority.

Considerable attention is given in the report to discussion of the popular concepts of disaster behavior and the differences from demonstrated behavior in disaster situations. Implications of each to planning are identified and described. The popular images of disaster behavior presented are the following:

1. People faced with great threat or danger panic, resulting in wild flight or other irrational behavior;
2. Those not acting irrationally are often immobilized, unable to cope with new realities of the situation and suffer numbing symptoms of personal trauma and longer run emotional and mental health problems;
3. Local organizations are severely limited in the ability to perform effectively due to the need to cope with the irrationality of others and immobilization of their own personnel;
4. Social disorganization and weakening of social controls caused by disasters results in surfacing of anti-social behavior characterized by rising crime rates, looting and exploitation of victims in the disaster area;
5. Community morale is very low in disaster stricken areas due to the large number of disorganized and helpless persons and groups, reluctance to rebuild businesses and industries, and departure of residents; and
6. Immediate and firm measures are necessary in disaster struck communities to prevent deterioration of the situation into personal and social chaos and local resources are generally too depleted and disorganized to carry out such measures.

The implications to planning of the several popular images of disaster behavior which are described include:

1. Undue cautiousness in formulating and issuing warnings and delay in issuing warnings until disaster is imminent or until it is assured damages from the disaster will exceed those likely to result from panic;
2. Provision for immediate outside agency help to feed, clothe and care for disaster victims is necessary to avoid catastrophe;
3. The assistance of outside agencies is required because local agency personnel are encumbered by family and other responsibilities in the disaster area;
4. In order to prevent anti-social behavior, it is necessary to allocate increased resources to security, often using military forces because the local community is overwhelmed;

5. To raise morale and assure victims of the community's future, it is important to have personal visits by important public figures and a well publicized massive aid program handled by outsiders in a better position to make balanced judgements; and
6. Natural leaders will emerge to assert strong leadership and prevent total collapse and while they may be local officials with emergency responsibilities, it is far more likely that leadership will come from persons with military experience or from outside the area.

The author's assessment, based on a large body of repeated observations by different observers in a variety of emergency situations, is that the popular images are almost totally incorrect as are the related implications to planning. Typical disaster behavior is described as characterized by:

1. Tendency of persons (excepting transients) to stay in a dangerous location rather than move, movement in family groups (even if contrary to instructions) when sudden evacuation does occur, and heightened efforts to mutual aid;
2. "Disaster syndrome" (apathy, shock, disorientation) appears only in small numbers, only in the most severe and traumatic disasters, in certain cultural settings, and only persists for short periods of minutes or hours;
3. Destruction and casualties are generally low in comparison to community resources and population and outsiders' judgement of community needs underestimate, in almost every case, the basic resources available locally and the capability of local organizations and personnel to function effectively;
4. Looting and economic exploitation are relatively rare and the incidence of anti-social behavior is usually lowered during emergencies while altruistic behavior is increased;
5. Collective morale increases over time in disaster situations; and
6. Complex patterns of local leadership and authority are able to develop into a structure suitable for coping with disaster situations without help from outside authorities.

Implications of actual social behavior have the following implications for disaster pre-planning:

1. Information concerning dangers should be promptly disseminated;
2. Plans should assume persons in impacted areas will actively respond without direction from officials;

3. Local emergency -related organizations will remain functional;
4. Massive deployment of security forces is unnecessary;
5. Post-disaster efforts should focus on relief and restoration of community services rather than efforts to raise morale; and
6. Coordination is more important than strong leadership in disaster situations and should not be directed or controlled from outside the area.

Succeeding sections of the report describe the impact of disaster agents on the social structure of the community, the process of mobilizing manpower and resources and the changed conditions for operation which exist in disasters. The elements of an organized response in disasters are discussed including the definition of organizational domains of responsibility, tasks to be accomplished and activities to implement the tasks. Types of organized responses are described according to the type of organization as:

1. Established organization carrying out regular tasks;
2. Pre-existing but expanded organization carrying out non-regular tasks;
3. Established organization carrying out non-regular tasks;  
or
4. Newly emergent organization carrying out non-regulatory tasks.

Specific issues involved in disaster planning are systematically presented including:

1. Overview of important planning considerations which include the need for:
  - A. pre-disaster consideration and tentative establishment of priorities;
  - B. specific arrangements for coordination and cooperation;
  - C. designation of responsibilities;
  - D. planning for the performance of tasks;
  - E. development of interorganizational relationships; and
  - F. development of disaster plans at the organizational, community, regional, state and federal level;

2. Typical weaknesses in disaster planning including:
  - A. failure to include arrangements for:
    - i. overall assessment of the disaster;
    - ii. disseminating emergency information;
    - iii. establishment of command post
    - iv. pre-crisis tasks concerning inventories of resources and procedures for pass systems and use of volunteers;
    - v. exercise or rehearsal of plans; and
    - vi. updating of plans;
  - B. inadequate attention to or provision for:
    - i. interorganizational coordination;
    - ii. allocation of domains of responsibility and action;
    - iii. the full range of possible disasters; and
    - iv. definition of tasks for transition from emergency period to recovery period and later to normalcy;
3. Recommendations of planning strategies concerning:
  - A. collection and distribution of knowledge about disaster agents and impacts;
  - B. encouragement of crisis-relevant organizations to develop their own disaster plans;
  - C. dissemination of knowledge concerning disasters and emergency planning;
  - D. developing and updating of plans;
  - E. inventory of crisis-relevant resources;
  - F. development of information about and links with non-local organizations;
  - G. rehearsal of plans; and
  - H. advocacy and evaluation of disaster response plans.

McLuckie, Benjamin F. The Warning System in Disaster Situations: A Selective Analysis. Disaster Research Center Report Series No. 9. Department of Sociology, Disaster Research Center. The Ohio State University. Columbus, Ohio. July, 1970 (69 p.).

The report examines what is involved in the processes making up a warning system including: collection, collation, and evaluation of threat data; provision of notification of danger and information on proper responses; and others. Processes are described in terms of psychological and sociological aspects and the influence effected by the socio-cultural framework, the historical setting, and the immediate ongoing social situation.

Warning is defined as "the transmission to individuals, groups, or populations of messages which provide them with information about (1) the existence of danger, and (2) what can be done to prevent, avoid, or minimize the danger." Distinction is made between the human components of warning and the mechanical devices such as sirens and radios which are the means of warning dependent for employment on individual and organizational action.

The effect of nine major characteristics of disaster agents are discussed with respect to their implications for warning, namely:

1. Frequency of a particular type of disaster affects:
  - A. whether people and organizations are sensitive to threats;
  - B. development of warning systems; and
  - C. general response anticipated to warnings;
2. Physical characteristics of a disaster determine the type and extent of problems which result;
3. Speed of onset, if too fast, reduces the portion of the population warned and the possibility of taking protective actions and, if too slow, may result in apathy;
4. Length of possible forewarning affects the opportunity for protective action;
5. Duration influences the type of protective action needed, content of warning messages and the possibility for coincidence with new threats and/or secondary problems;
6. Geographic scope of a disaster affects the ease of disseminating warnings, potential for coincidence with secondary threats and remaining communication, manpower and other capabilities for dealing with the disaster;
7. Destructive potential determines whether threat is to life, property or both as well as the intensity and extent of impact;

8. Gross predictability determines the potential length and kind of warning and effectiveness of response; and
9. Gross controllability affects the reluctance to issue warnings and the response to those which are issued.

The search for information initiated by recognition of a serious threat is discussed including descriptions of information collection using various means of communication, meetings and other techniques. Five key points made about collection of threat data are:

1. Information about danger cues in the environment is overwhelmingly gathered by organizations rather than individuals;
2. Many organizations are involved in varying degrees in obtaining such information;
3. Not all groups and agencies involved in the collection of threat data are equally active in seeking cues;
4. Organizations differ markedly in their ability to detect and understand indicators about possible disaster agents; and
5. Community organizations do not always seem to cover the full range of potential disaster cues.

Because multiple organizations are frequently involved in collecting threat data, information must be collated for maximum usefulness in evaluation and for incorporation into warning messages. Three important points concerning the organizational collation of incoming data are:

1. There generally does not exist one central location or point for the assembly of information about dangers that might be threatening a community;
2. Collation of threat data has to occur both within and between organizations involved in the detection of danger cues; and
3. Compiling of information from diverse sources is a collective process and subject to semantic and other problems which occur in such activities.

Matters affecting the evaluation of collected and collated information are discussed with respect to factors that enter into assessment of the reliability of the information, interpretation of the meaning of the information, and the resolution of conflicting data. Major aspects affecting reliability accorded information are discussed including:

1. Judgements about reliability are made more on the basis of familiarity with the source and what is known about the source with respect to competence in the topic and past accuracy than on the basis of the message itself;



2. Greater reliability is accorded information which is clear and includes a level of detail appropriate and useful to the evaluating organization; and
3. Individuals, groups and organizations will almost always place greater reliability on whichever of conflicting or ambiguous information supports the contention that there is no problem, particularly in the absence of:
  - A. direct visual observation of the danger;
  - B. information from what is believed to be an "unimpeachable source"; or
  - C. highly consistent pattern of providing incorrect information by one of the information sources.

The collection, collation and evaluation of threat cues forces organizational officials to decide if the general public and other organizations should be warned. Three aspects of the decision to warn are discussed including:

1. The decision to issue a warning of impending disaster has serious consequences including:
  - A. effect of failure to warn or delays in warning in the event disaster occurs; and
  - B. inconvenience, loss of time and money, needless fear and anxiety and loss of belief in future warnings in the event a false warning is issued;
2. Major responsibility for issuing warning messages is generally not clearly assigned to a single agency with respect to:
  - A. providing both information concerning the threat and describing the types of protective action which are required; and
  - B. prime responsibility for disseminating warnings;
3. Multiple factors operate in a variety of ways to influence decisions to issue a warning message including:
  - A. decision maker's judgement based on available information about whether the danger will materialize;
  - B. estimation of the time thought necessary after warning to take preventive or protective action; and
  - C. gross predictability of the disaster.

A continuum of means ranging from personal to impersonal techniques of disseminating warning messages is presented including face-to-face, telephone, loudspeaker, mass media and mechanical means such as sirens. Problems associated with each end of the continuum are identified including:

1. Time requirements, potential for distortion, and incomplete dissemination associated with use of the more personal means; and
2. Misinterpretation, inability to convey details and incomplete coverage associated with use of mechanical means.

The report describes three types of community subsystems which are set in motion when a decision is made to issue a warning of an impending disaster. They include:

1. Interorganizational subsystem made up of organizations which:
  - A. are particularly vulnerable due to the nature and concentration of people (e.g. schools and hospitals); or
  - B. have important emergency functions (e.g. police and fire);
2. Intraorganizational subsystem of the warning agency; and
3. General public alert subsystem, if it exists.

Four aspects of the content of warning messages are discussed including degree of specificity, degree of urgency, conveyance of projected consequences of the threat and implied probability of occurrence. Principal points made in the discussion are:

1. Need for specificity with respect to:
  - A. audience to which the warning message is directed to:
    - i. insure warnings (or terminations of warnings) are not acted on by unintended parties; and
    - ii. insure intended recipients recognize its applicability to them; and
  - B. nature of the threat as a basis for response;
2. Need for conveying an appropriate degree of urgency through:
  - A. explicit statements informing recipients of the urgency;
  - B. implicit inferences of urgency through description of the threat;
  - C. composition of the entire message; and

- D. context of message delivery (e.g. immediate return to normal broadcasting implies low urgency);
- 3. Importance of accurately describing the projected consequences of the threat either:
  - A. explicitly through describing the type and extent of damage expected; or
  - B. implicitly by describing the expected character of the disaster event in sufficient detail that recipients can readily visualize the consequences;
- 4. Potentially disastrous effect if the probability of occurrence of a disaster is underestimated and an inadequate response is made to a warning.

Response to warnings are discussed with respect to the effect of sociological framework, historical setting and immediately ongoing social setting on individual and group responses, the reaction of individuals and organizations to warnings, and responses to warnings later in a disaster. Discussions focus on the following as important points:

- 1. The sociological framework unique to each situation sets the tone of response and differentiates each organization's or community's response from another with respect to:
  - A. development of regular procedures for coping with disasters and standardized response to warning messages;
  - B. concept of what constitutes a threat; and
  - C. credibility assigned to warning organizations;
- 2. Historical setting is important to response in two respects including:
  - A. social time (time of day, time of week) because of effect on:
    - i. reception of warning messages;
    - ii. availability of mass media for warning as well as character and size of audience; and
    - iii. ability to visually check and confirm warnings;
  - B. expectation of disaster caused by:
    - i. prior experience; and

- ii. knowledge of the existence of potentially dangerous conditions;
3. Correct interpretation of warnings and functional response by individuals is affected by a number of social factors including:
    - A. the particular social role in which the recipient is engaged and its related responsibilities;
    - B. the interaction with others who may or may not respond to warnings in an alarmed manner; and
    - C. personal involvement through location of families, friends and/or relatives in the danger area;
  4. Individual reactions to warning messages are highly variable and:
    - A. receipt of warnings should not be equated with adequate response;
    - B. may include either protective action or efforts to confirm the threat which increase vulnerability;
    - C. extensively influenced by organizational involvement; and
    - D. sometimes accompanied by unanticipated or undesired consequences;
  5. Warnings are crucial for communities and organizations because measures to lessen the impact or consequences of disaster often require resources and specialized techniques not available to individuals;
  6. Later warnings in a disaster situation require explicit attention because:
    - A. a number of unanticipated secondary threats may be created by a disaster; some more destructive than the original;
    - B. unrelated secondary threats may occur coincident with or shortly after a disaster; and
    - C. responsibility for monitoring and warning of secondary threats is frequently unassigned.

An appendix to the report presents a case study of the warning systems operation in Topeka when a tornado occurred in 1966. Significant aspects of the observations are applicable to other types of disasters.

Owen, H. James. Guide and Checklist for Preparedness Planning in Communities Subject to Floods and Flash Floods. National Oceanic and Atmospheric Administration. National Weather Service. Washington, DC. April, 1976 (74 p.).

The Guide was prepared to assist communities and planners to assess the adequacy of existing flood warning systems and flood preparedness plans, to identify the appropriate content and detail of new preparedness plans, and to develop adequate warning systems and preparedness plans. The report is organized into five parts plus a checklist and a list of useful references.

Part I of the Guide provides a brief introduction including descriptions of purpose, background and scope. The need for a systematic approach to preparedness planning is stressed. Users are advised that the Guide is intended for community level preparedness planning for riverine flooding problems and that not all points pertinent to coastal and other types of flooding are included.

Part II provides instructions in effective use of the Guide and points out that the Guide and checklist:

1. Only identify matters to be considered and do not constitute a model plan;
2. Require the availability of a thorough and comprehensive analysis of the flood hazard; and
3. Assume knowledge of approximate warning time available and type of flood recognition system (watch/warn, self-help forecasting; or flash flood alarm) to be used.

General procedures for evaluating existing warning systems and preparedness plans are described as are those for developing a plan of study for preparedness planning and managing the preparedness planning process.

Part III is the major portion of the Guide and provides detailed identification of 22 tasks and 60 subtasks which should be considered in development of a comprehensive flood warning system and flood preparedness plan. Tasks are organized into seven plan "elements" including:

1. Warning:
  - A. flood recognition;
  - B. warning dissemination;
2. Evacuation and Rescue:
  - A. evacuation area identification;
  - B. evacuation procedures development;
  - C. reception center operations;
  - D. emergency actions;

3. Damage Reduction:
  - A. flood fighting;
  - B. utility management;
  - C. traffic control;
  - D. maintenance of vital services;
4. Recovery:
  - A. maintenance of public health;
  - B. return of service;
  - C. rehabilitation and repair;
  - D. mobilization of assistance;
5. Public Information:
  - A. community education;
  - B. emergency information;
6. Plan Implementation:
  - A. resource identification;
  - B. responsibility allocation;
  - C. coordination;
7. Plan Maintenance:
  - A. plan updating;
  - B. plan improvement; and
  - C. plan practice.

Guidance provided for each element includes a brief statement of objectives, listing of relevant tasks, and descriptions of the 60 subtasks comprising the tasks. The need is noted for multiple warning systems in communities subject to flooding from more than one source and for varying plan sophistication according to frequency and severity of expected flooding, size of population affected, and shorter warning times. Several tasks are identified as being vital in every case including those for flood recognition, warning dissemination, evacuation procedures, emergency actions, community awareness, responsibility allocation, and plan practice.

Part IV of the Guide contains general observations concerning the preparedness planning process and the effect of various factors on the nature of the plan. Among others, the observations include the following:

1. Warning Time:

- A. time required to carry out warning dissemination and evacuation depends on size and population of the area and the resources which are available;
- B. plans should be tailored so that their time for execution fits within available warning time;
- C. in the event short warning times prevent use of a comprehensive plan, first consideration should be given to elimination of:
  - i. multi-step procedures for deciding to issue warnings;
  - ii. staging of evacuations and evacuation related to secondary problems;
  - iii. relocation and removal of property;
  - iv. all but essential flood fighting; and
  - v. temporary floodproofing;

2. Flood Characteristics:

- A. vertical evacuation or "waiting out" small floods may result in loss of egress in the event of later more severe flooding and is encouraged by floodproofing; and
- B. extent of accommodations required in reception centers depends on flood duration and damage expected;

3. In the event limited resource availability prevents carrying out a comprehensive preparedness plan, first consideration should be given to eliminating the following:

- A. evacuation related to utility curtailment or other secondary problems;
- B. provision of transportation for evacuation;
- C. relocation or removal of property; and
- D. temporary floodproofing.

Communications are discussed with regard to dissemination of warnings and numerous means identified. An extensive listing of types of organizations and categories of individuals requiring special warnings is provided. Numerous suggestions are also included in Part IV concerning preparation of maps and organization of the preparedness planning document for maximum usefulness.

Part V of the Guide describes the types of assistance and information available from various federal agencies for development of warning systems and preparedness plans. It also identifies the types of state, local and private organizations which may have useful information or be able to assist in either planning or execution of the plan.



Carson, William D. Estimating Cost and Benefits for Nonstructural Flood Control Measures. The Hydrologic Engineering Center, U.S. Army Corps of Engineers. October, 1975 (112 p. and bibliography).

The report describes results of an investigation performed to support analysis of combinations of structural and nonstructural flood control measures. It focusses on procedures for estimating costs and benefits of floodproofing, evacuation/relocation, and land use regulation. The report also presents cost data from past Corps reports and discusses benefits of flood insurance. Conclusions are presented as to what constitutes an adequate analytical tool for screening nonstructural measures.

### Floodproofing Costs

Two approaches to estimating floodproofing costs are presented. The first, using equations, includes statement and explanation of various formulas including those relating floodproofing cost to:

1. Depth of flooding and total market value of all structures in the floodplain to be floodproofed;
2. Depth of flooding and market value of a specific structure; and
3. Height of floodproofing, square footage protected and cost per square foot of space.

Empirical findings of various investigations into floodproofing unit costs which are described include costs of \$920 per foot of water depth and \$.68 per foot of water depth per square foot protected. Floodproofing analyses and results from the Corps' Tug Fork Study are described. Residential floodproofing costs determined there are shown in the following table.

Ratio of Floodproofing Costs to Value of Residential Structure

<u>Condition</u>	<u>Floodproofing Height</u>		
	<u>2 feet</u>	<u>4 feet</u>	<u>6 feet</u>
Sound	0.17	0.23	0.31
Deteriorating	0.65	0.75	0.90
Dilapidated	4.50	4.90	5.30

A method for using cost tables for preliminary consideration of floodproofing is described and several tables provided including:

1. Cost for raising in place and on fill; and
2. Cost for methods which structurally exclude water.

The tables are constructed using information from various Corps reports and from the FIA report Elevated Residential Structure. Forms are provided for cost estimation.

#### Evacuation/Relocation Costs

Cost for evacuation/relocation are divided into costs for carrying out the program and costs associated with the loss of income occasioned by relocation. The costs for carrying out the program are further divided into three components for:

1. Relocation to the new site;
2. Provision of the alternative site; and
3. Restoration of the evacuated flood plains.

The Corps report for Prairie du Chien, Wisconsin, is described with respect to factors considered in determining evacuation/relocation costs and estimates of first costs involved. Factors adverse to evacuation/relocation are discussed including dense development of the flood plain, limitation of alternative sites, and location within a rapidly growing urban area. Residential and commercial evacuation costs from several Corps studies are presented in a series of tables.

The economic loss of income due to relocation is discussed. Examples are provided of the types of factors to be considered including:

1. Removal from complementary businesses;
2. Increase in transportation costs; and
3. Increased time and travel to public buildings.

#### Land Use Regulation Costs

Costs for regulation are divided into those for development and enforcement and those due to the net loss of economic advantage caused by forcing relocation. Development and enforcement costs are related through a general formula to the density of development, size of the area and scope of regulatory program. It is suggested that specific costs be determined by interviewing local officials.

Two approaches are presented for identifying economic costs of the forced relocation. One is based on the market value of land and determines cost as the difference in income with and without regulations. The second technique uses a land use simulation model to value the total benefits of flood plain management.

A brief description is provided of the approach to inclusion of a land use regulation alternative in Corps' reports for Beals Creek, Buena Vista and Charles River. The general conclusion based on these and other reports is that flood plain regulations are found to be an insufficient flood control program when considered alone.

#### Benefits of Nonstructural Measures

Types of inundation benefits from nonstructural measures are cited including:

1. Reduction in damage susceptibility through floodproofing;
2. Reduction in property at risk through evacuation/relocation; and
3. Prevention of future location of property in hazardous areas through regulations.

The report discusses benefits of regulations and points out that rational decisions to locate in the flood plain reflect locational benefits exceeding flood losses and that regulations preventing such decisions have negative benefits. Information and education is suggested as a substitute for regulation for such cases.

Several Corps reports are examined to compare the methodology used in estimating benefits with that suggested by regulation EC 1105-2-12. Development of a procedure for measuring benefits is discussed and it is pointed out that intensification and location benefits are difficult to quantify. A number of techniques for estimating inundation reduction benefits of floodproofing are presented from the literature.

A chapter of the report is given to discussion of tools for evaluating nonstructural measures. Characteristics identified for the best tool are the capabilities to:

1. Handle mixed nonstructural measures and structural/non-structural mixes;
2. Identify the most efficient measure for use at a specific point in the flood plain;
3. Use micro cost and damage functions defined for different types of development at different elevations; and
4. Aggregate information from (1) through (3) into macro cost and damage functions for input into a model for overall hydrologic and economic analysis.

Several available tools are described including the HEC-5C program for simulation of flood control and conservation systems, the Day-Weisz Model, the INTASA Simulator and the HEC DAMCAL program. All are computerized models. The Day-Weisz Model is stated as the least useful for evaluation of nonstructural mixes.

The body of the report concludes with recommendations for further research. Topics suggested are:

1. Measurement of intensification and location benefits of nonstructural measures;
2. Specification of how damage functions are modified by nonstructural measures;
3. Development of a data bank for exchange of information among Corps offices concerning data used in investigating nonstructural measures; and
4. Implications of the Flood Insurance Act for land use regulations.

An appendix summarizes information from Corps reports and other sources which was gathered during the study. Information is arranged by measure. A considerable amount of useful information on floodproofing costs is presented including detailed costs for structure elevation, sealing and other techniques. The information provides some unit costs and a means to check the reasonableness of cost estimates. Similar data concerning evacuation/relocation is collected in cost tables for removing structures, landscaping, demolition, relocation, lot improvements and other items. Cost data for land use regulation is limited to estimates of first and annual costs for regulation developed in various studies without adequate explanation to enable direct use of the data.

Sheaffer, John R., George W. Davis, and Alan P. Richmond. Community Goals - Management Opportunities: An Approach to Flood Plain Management. Center for Urban Studies, University of Chicago. May, 1970 (234 p.).

The report is in five chapters covering flood plain management concepts, analysis of urban flood plain management alternatives, operational methodology, field tests and flood plain management program issues. Emphasis is on flood plain management in urban development and redevelopment situations. Several appendices are included which present a checklist of probable management plans, model questionnaires, discussion of relocation at two sites and a map survey relating flood plain management and urban development.

The first chapter generally introduces and summarizes the remainder of the report. It also discusses four of the common concepts generally embodied in flood plain management programs including:

1. Use of multipurpose programs having flood loss reduction as only one of several purposes;
2. Use of multiple management alternatives in combination;
3. Involvement of a conglomerate of public and private interests in decision-making; and
4. Presentation of flood plain management as one part of a comprehensive plan and planning process.

The second chapter outlines a four step decision-making process for choosing among flood plain management alternatives. The first step is identification of the range of all potential alternatives. Discussion of this step includes identification of several typologies for measures and description of measures in the following categories:

Modify the flood

flood protection  
watershed treatment  
weather modification

Modify the damage susceptibility

land use changes  
flood proofing  
planned unit development

Modify the loss burden

flood insurance  
tax writeoff  
disaster relief  
emergency measures

Do nothing

The second step described involves the determination of feasible alternatives which are appropriate to the physical environment based on information concerning the flood hazard and physical characteristics of the area. Various characteristics of importance in this decision are discussed in detail.

The third step presented is the determination of which feasible alternatives remain practical after consideration of the social framework. The basis for evaluation is presented in terms of factors limiting implementation and opportunities for implementation. Factors identified as limiting implementation and discussed are:

1. Costs and financing of alternatives:
  - A. disparity between financial resources and demands;  
and
  - B. cost distribution among individuals and the public and  
between governmental levels;
2. Institutional constraints:
  - A. restrictions due to water law and legal system;
  - B. need for legislative approvals; and
  - C. need for professional administration;
3. Cultural factors:
  - A. acceptability to local residents;
  - B. preconceived view of the best choice;
  - C. differential perception of the problem among resi-  
dents of a community; and
  - D. bias toward alternatives related to a particular  
agency;
4. Preservation of flexibility:
  - A. avoidance of irreversible decisions; and
  - B. compatability with other alternatives.

Opportunities for implementation are categorized as:

1. Opportunities afforded by the cultural environment, pri-  
marily through relation to land use;

2. Financial opportunities including federal programs through HUD, HEW, Interior, Soil Conservation Service and the Corps and through local implementation devices such as tax levies, bonding, development agreements and sale of natural resources;
3. Opportunity for synergistic combination with programs which:
  - A. entail development of the flood plain;
  - B. concern other aspects of water resources development;
  - C. induce development of the flood plain; and
  - D. can be related to flood plain management.

Each of the types of opportunities are discussed and some examples provided.

The final step in the decision process is identification of the viable alternative or mix of alternatives which is best suited from a policy standpoint. Matters for consideration are discussed in terms of broad national or regional goals and local development goals. National goals described are:

1. Economic:
  - A. national economic efficiency;
  - B. regional economic development; and
  - C. income redistribution;
2. Environmental:
  - A. minimum disruption of natural environment (preservation);
  - B. environmental quality;
  - C. esthetics; and
  - D. controlling the natural environment;
3. Social:
  - A. political equity;
  - B. prestige;
  - C. acceptability; and
  - D. well-being of people.

Chapter III describes an operating methodology to elicit the information necessary to permit decisions among alternatives to be made. Types of information required for each step of the decision process are:

1. Determination of political alternatives:
  - A. state-of-the-art of flood plain management;
2. Determination of feasible alternatives:
  - A. survey of physical environment;
3. Determination of viable alternatives:
  - A. survey of cultural environment;
  - B. assessment of community structure;
  - C. perception of problems;
  - D. perception of alternatives;
  - E. analysis of programs and development trends;
4. Determination of alternatives best suited to community goals:
  - A. determination of goals-survey of community influentials;
  - B. determination of goals derived from published plans; and
  - C. determination of goals derived from development decisions.

The bulk of the chapter is devoted to discussion of the techniques for collection of the needed information including survey procedures, sample questionnaires and analytical steps.

Several case studies undertaken to practice and test the decision-making methodology are described in Chapter 5. Test sites were at Lincoln, Nebraska, Waterloo, Iowa, Atlanta, Georgia, and Muskegan, Michigan. The conclusions reached after the case studies were that:

1. Operation of the methodology in large metropolitan areas were complicated by:
  - A. the multiplicity of issues;
  - B. a diffuse decision-making structure; and
  - C. clear distinctions between policy makers and professionals;



2. The complicating factors affect execution rather than methodology and can be lessened by longer field study times; and
3. Efforts to determine the best suited alternatives will be adversely affected unless adequate time is available for identification of all of the issues and decision-making spheres.

Chapter V of the report describes four flood plain management program issues which emerged from the study related to:

1. Flood plain management and urban development and redevelopment;
2. The social implications of flood plain management;
3. The flood plain management process; and
4. Operational implications for the Corps of Engineers.

Each of the issues are discussed with respect to several relevant aspects.

Mack. Ruth P. LIF Report Phase II: Evaluation of and Recommendations for Legal, Institutional and Financial Methods for Implementing Purposes and Plans for Flood Plain Management in the Connecticut River Basin. The Institute of Public Administration. New York, NY. March, 1976 (356 P.).

The report provides a broad and extensive analysis of the legal, institutional and financial aspects of a program for flood loss reduction in the Connecticut River Basin. Part I of the report provides an overview of the project and the authors' recommendations. Part II provides background information on selected institutions including the National Insurance Program, river forecast services, state programs in the Connecticut River Basin, and regional agencies. An appendix to the report provides a summary of federal laws, programs and cost sharing provisions bearing on flood plain management.

The four general findings of previous studies of the basin were that:

1. Structural measures fail to meet the federal government's requirements for economic viability in the Basin;
2. Nonstructural methods that undertake resettlement of all flood plain residents and businesses at public expense are not cost-effective;
3. Adequate room is available for future growth in the towns and urban areas of the Basin and for relocation to flood-safe areas of structures presently in the flood plain; and
4. It will be essential to influence locational decisions of a large number of people to achieve wise use of the flood plain.

Part I of the report is divided into three chapters dealing respectively with the overview, strategies for effectuating program elements, and improvement of organizational involvement and efficacy.

Chapter I describes the previous findings and general approaches for consideration including one mixing structural and nonstructural measures and one wholly made up of nonstructural measures. A listing is provided of 5 major objectives and 33 sub-objectives for the nonstructural approach which displays the wide variety in types of nonstructural methods which can be used. Based on the indication of the tasks likely to be involved, the report discusses the implementing institutions. Three desirable characteristics of the implementation mechanism are described including:

1. Involvement of all levels of government and organizations according to capabilities rather than geographic jurisdictions;

2. Capability to undertake and implement a strategy over time rather than a static plan; and
3. Reliance upon general purpose existing institutions.

Chapter 1 also includes a brief description of the major functions of various governmental levels and the role of cost sharing in financing program implementation. Ten principles of cost sharing are stated and discussed as a basis for subsequent analyses. They include:

1. Benefits from federally financed flood prevention or damage reduction attributable to decisions resulting from inefficient or otherwise undesirable exposure to such danger should be paid for by the decision maker or at least by the community that endorses the development pattern;
2. Costs imposed on others by flood prevention methods should be subsidized by the beneficiaries of the primary protection;
3. Environmental and recreational values are properly served by cost sharing among governments that recognizes and reflects the geographic and temporal dimensions of the alternative management goals and methods;
4. Insofar as public expenditure is relevant, preserving flood plain lands in farms may well require cost sharing arrangements specifically tailored to the problem;
5. The traditional national and state concern for income distribution and intergovernmental involvement in urban renewal has applications in cost sharing for wise use of flood plains;
6. Impacts of present environmental decisions on unborn generations are appropriate concerns of the higher levels of government. Reconsideration of interest rates appropriate to these very long term horizons is one line of approach worth exploring;
7. Cost sharing should be consistent among agencies providing a similar service;
8. Cost sharing methods should have a neutral or purposely benign impact on choices between nonstructural methods and structural methods for coping with flood hazards;
9. Cost sharing methods should likewise have a neutral or purposely benign influence on selection among the

various nonstructural methods--relocation, land purchase, providing infrastructure for alternative sites, etc.; and

10. Improving the organizational and community capacity to provide the ongoing capability required, especially for nonstructural flood management, has values over and above those related to the particular site and thus is an appropriate candidate for subsidy by higher level governments.

The second chapter discusses what specific actions or policies are necessary to implement the alternative flood loss reduction programs. As an example, one program is explored which includes warning and preparedness planning, relocation and floodproofing, land use regulation, and encouragement of shifts in location patterns. Numerous aspects of each of the measures are discussed including financing, benefits, considerations in timing and variations in the general techniques which may be employed. A conclusion is presented that provision of equipment or personnel essential to improvement in the river forecasts by the National Weather Service and the development of a local competence to use this information in a productive fashion is one of the more cost effective methods of nonstructural flood plain management. Other portions of the chapter give significant guidance concerning procedures for implementation including many not generally described in engineering oriented literature. A several page listing is included which summarizes the impacts and effect of impacts of relocation actions. A section concerning mapping to support planning and implementation of nonstructural measures is also included.

Chapter 3 summarizes how the several implementing organizations can use the authorities available to them to encourage optimization of flood plain management in the Connecticut River Basin. Techniques described are:

1. Enhance the effectiveness of citizen participation through:
  - A. use of direct political influence;
  - B. use of advisory committees; and
  - C. direct participation in flood plain management;
2. Develop state programs in which:
  - A. state-local relationships have several forms (i.e., standards and responsibilities, minimum standards, two way administrative and routine review procedures);
  - B. administrative responsibility rests with a lead agency; and
  - C. interagency integration of policy assures early coordination;

3. Develop the most applicable policies on the local level through:
  - A. installation of flood warning systems and preparedness plans;
  - B. purchase of first refusal rights or development rights where land is presently in acceptable open space uses;
  - C. initiation of regulatory programs with case by case permitting of uses;
  - D. collaboration with state or federal agencies to provide adequate flood plain mapping;
  - E. use of regulations or procedures which can be based on information or procedures required for other established programs; and
  - F. use of the power of environmentally concerned citizens;
4. Realize the full potential of regional organizations to:
  - A. provide technical aid to communities;
  - B. facilitate informal citizen participation;
  - C. encourage more effective state-local interaction; and
  - D. provide financial assistance to town governments;
5. Use federal capability to:
  - A. reassert and clarify the concept of Sec. 73 of PL 93-251;
  - B. require recipients of federal subsidies to periodically demonstrate that monies are being used in conformity with the general stance concerning wise use of the flood plains;
  - C. implement the cost sharing provisions of Sec. 73 of PL 93-251;
  - D. provide cost sharing with states and others of the organizational cost of regulatory programs;

- E. increase the federal contribution to the flood insurance program to accelerate mapping;
  - F. strengthen Executive Order 11296 with respect to location of roads; and
  - G. arrange cost sharing to be neutral with respect to influence on local decisions;
6. Execution of an interstate agreement which provides for:
- A. institution of a repository for systematic reports on state or local actions affecting the flood plain;
  - B. fostering understanding and interchange among implementing units of government; and
  - C. enhancing and enabling citizen participation.

Part II of the report provides background information concerning the flood insurance program, river forecast services and preparedness planning, and institutional arrangements in the Connecticut River Basin.

The discussion of flood insurance covers the purposes of the program, requirements for participation, coverage and rates, and data requirements. Principal conclusions of the discussion are that:

1. The flood insurance program can encourage local land use planning and increase the visibility of the flood hazard;
2. Insurance subsidies under the emergency program tend to cause avoidance of areas which flood infrequently in favor of high risk locations;
3. Presently prescribed land use regulations under the emergency program tend to be so minimal as to be inconsequential; and
4. The emergency program may tend to accelerate development in the flood plain.

Flood episode management is described with respect to the present local structure for emergency action in the basin, requirements for preparedness, and the economics of warning and preparedness planning. Conclusions presented are that:

1. Preparedness of communities to cope with floods is one of the most critical elements of flood plain management;
2. Information on how to do preparedness planning needs to be assembled;
3. Emphasis in preparedness planning should be put on preventing damage rather than recovery;
4. Preparedness planning must be tailored to individual communities; and
5. Communities should have primary responsibility for setting up flood emergency operating centers.





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