

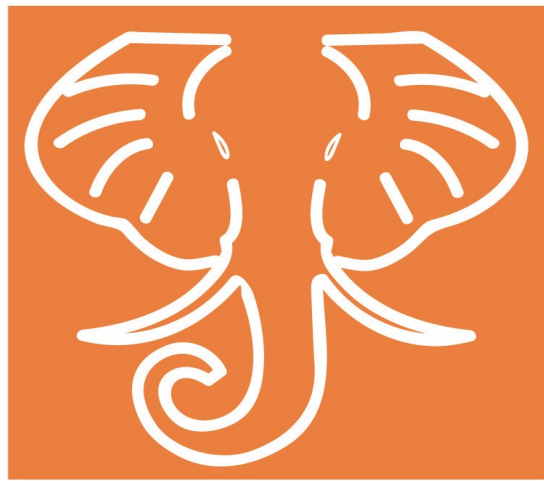
**Insurance and other programs for financial assistance to flood victims.
: A report from the Secretary of the Department of Housing and
Urban Development to the President, as required by the Southeast
hurricane disaster relief act of 1965, Public law 89-339, 89th Congress,
H.R. 11539, November 8, 1965.**

United States.

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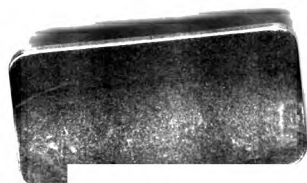
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INSURANCE AND OTHER PROGRAMS FOR
FINANCIAL ASSISTANCE
TO FLOOD VICTIMS.

A REPORT FROM THE SECRETARY OF THE DEPARTMENT
OF HOUSING AND URBAN DEVELOPMENT TO THE PRESI-
DENT, AS REQUIRED BY THE SOUTHEAST HURRICANE
DISASTER RELIEF ACT OF 1965 (PUBLIC LAW 89-339, 89TH
CONGRESS, H.R. 11539, NOVEMBER 8, 1965)

COMMITTEE ON BANKING AND CURRENCY
UNITED STATES SENATE



SEPTEMBER 1966

Printed for the use of the Committee on Banking and Currency

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STATEMENT BY THE CHAIRMAN

In 1955 and 1956 the Senate Banking and Currency Committee made an extensive study of Federal disaster insurance, and as a result the Federal Flood Insurance Act of 1956 (Public Law 1016, 84th Cong.) was enacted. Unfortunately experience indicated that the programs contained in that act were not workable.

The need for programs to provide insurance or other assistance against floods and other disasters has continued unabated. Senator Harrison A. Williams, Jr., of New Jersey, chairman of the Subcommittee on Securities, in 1962, 1963, and 1965, introduced bills calling for a study of the entire situation with a view to making such amendments as might be appropriate in the 1956 act so as to make it an effective and workable measure. These were reported from the committee and passed the Senate, but did not become law. Finally, a requirement for such a study was included as section 5 of the Southeast Hurricane Disaster Relief Act of 1965 (Public Law 89-339). The required report has now been transmitted to the Congress by the President.

As the President indicated in his message, the report provides a basis for an intensive and careful review of the entire subject on the basis of which legislative proposals may be framed and presented to the Congress. It is, therefore, desirable that it should be made readily available to the public, the Congress, and the executive branch in the form of a committee print.

A. WILLIS ROBERTSON,
Chairman.

III

**STATEMENT BY SENATOR HARRISON A. WILLIAMS, JR.,
CHAIRMAN, SUBCOMMITTEE ON SECURITIES**

Section 5 of the Southeast Hurricane Disaster Relief Act of 1965 (Public Law 89-339) directed the Secretary of the Department of Housing and Urban Development to undertake a study of various programs which might be established to help provide financial assistance to those suffering property losses in flood and other natural disasters, including disaster insurance as well as the existing flood insurance program.

This provision was based upon several efforts by the Banking and Currency Committee to have such a study made, on the basis of experience under the Federal Flood Insurance Act of 1956 (Public Law 1016, 84th Cong.). That act provided for the establishment of three programs—a Federal flood insurance program, a Federal flood reinsurance program, and a Federal loan contract program covering flood losses. Upon the enactment of that act the Federal Flood Indemnity Administration was created as a constituent unit of the Housing and Home Finance Agency. Extensive discussions were held with other Federal agencies, with State and local governments, and with the insurance industry. However, no satisfactory program was developed, and following the refusal of the Congress to grant appropriations to provide funds for the flood indemnity program, the Federal Flood Indemnity Administration was abolished, and a final report on its activities was transmitted to the Congress by the President on July 28, 1958 (H. Doc. 426, 85th Cong.). A copy of this report was printed as a part of the committee's hearings on S. 3066, 87th Congress.

Since it was apparent that the Federal Flood Insurance Act of 1956 had not provided an adequate solution to the problems involved, several proposals calling for studies of the situation were considered by this committee and were passed by the Senate: S. 3066, 87th Congress (S. Rept. 1747); S. 2032, 88th Congress (S. Rept. 634); and S. 408, 89th Congress (S. Rept. 11). The substance of these bills was incorporated in the Southeast Hurricane Disaster Relief Act of 1965.

The Department of Housing and Urban Development thereupon entered into an extensive study of insurance and other programs for financial assistance to victims of floods and related disasters. On August 8, 1966, the Secretary of Housing and Urban Development forwarded his report to the President, and on August 12, 1966, the report was transmitted to the Congress by the President. The report was referred first to the Committee on Interior and Insular Affairs, and on August 18, 1966, it was rereferred to this committee.

The concluding paragraphs of the President's message explain the reason for publication of the report:

Additional study is required before final judgment can be reached on the design of a national flood insurance program. Accordingly, I am instructing all interested Federal departments and agencies to give this report intensive

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and careful review so that detailed proposals, including appropriate legislation, may be presented to the Congress.

I also urge that the report be reviewed both by the Congress and the many interested groups and individuals throughout the Nation. The need for financial protection against flood losses to private property is widely recognized. The report will provide an excellent opportunity to give this matter thorough and informed consideration.

HARRISON A. WILLIAMS, JR.,
Chairman, Subcommittee on Securities.

THE WHITE HOUSE,
August 12, 1966.

To the Congress of the United States:

I have recently transmitted to the Speaker of the House of Representatives and the President of the Senate a report by the Task Force on Federal Flood Control Policy, entitled "A Unified National Program for Managing Flood Losses." That report discussed several problems requiring further study, including the need for and feasibility of a program of flood insurance.

Today I am transmitting a report from the Secretary of Housing and Urban Development, entitled "Insurance and Other Programs for Financial Assistance to Flood Victims." Undertaken in accordance with provisions of the Southeast Hurricane Disaster Relief Act of 1965, this report provides a significant contribution to greater understanding of this complex and difficult problem. The Secretary has prepared a thorough, well-documented report.

Additional study is required before final judgment can be reached on the design of a national flood insurance program. Accordingly, I am instructing all interested Federal departments and agencies to give this report intensive and careful review so that detailed proposals, including appropriate legislation, may be presented to the Congress.

I also urge that the report be reviewed both by the Congress and the many interested groups and individuals throughout the Nation. The need for financial protection against flood losses to private property is widely recognized. The report will provide an excellent opportunity to give this matter thorough and informed consideration.

LYNDON B. JOHNSON.

VII

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THE SECRETARY OF HOUSING AND URBAN DEVELOPMENT,
Washington, D.C., August 8, 1966.

The PRESIDENT,
The White House,
Washington, D.C.

DEAR MR. PRESIDENT: Pursuant to the directive in the Southeast Hurricane Disaster Relief Act of 1965, there is enclosed my report to you on insurance and other programs for financial assistance to flood victims, for your submission to the Congress.

The report consists of three parts: (1) a brief summary of major conclusions and recommendations; (2) the report itself, with the conclusions drawn and recommendations made; and (3) a number of appendixes containing a large body of information especially prepared for this report.

Briefly, after analysis of alternative ways of helping flood victims, the study concludes that flood insurance is both feasible and can promote the public interest. Flood insurance will complement other programs of the Federal Government dealing with floods. Flood insurance is viewed both as a means of helping the individual bear more easily the risks of flood damage to which his location often exposes him, and, equally, as a means of discouraging unwise occupancy of flood-prone areas.

The report envisages a program of flood insurance of an essentially private character, but with continued large-scale participation of the Federal Government. The Government shall have to help in measurement of flood risks in specific locations, in establishing flood insurance premium rates, and in providing financial support to the insurance companies against excessive losses on their part. Moreover, some continuing Federal subsidy will also be necessary to a comparatively small number of present occupants of high flood-risk areas. Otherwise the cost of their flood insurance will be more than they can bear; but such subsidy should not be extended to persons who propose to build new homes in such areas, for this would lead to increased total flood hazard. Subsidies to some present occupants of flood-prone areas should be viewed as part of a program of land use adjustment, aimed at ultimate reduction in the exposure to flood hazard.

This Department is ready, in collaboration with the other interested Federal agencies, the States, and private insurance interests, to develop, over the next few months, proposals for action, including appropriate legislation. The need for assistance to those suffering property losses in floods is great, and each new flood season brings new pressures from affected areas for a program. At the same time, we must recognize that the problem of flood insurance is very difficult; the private property insurance industry has been unable to solve it over the past decades, and the past Federal attempt to provide such a program has never been successfully operative.

We must make haste, but we must also build soundly; the flood problems of this country will persist and grow, and a sound Federal program must build for the long future as well as for the immediate present.

Respectfully yours,

ROBERT C. WEAVER.

IX

This report is divided into three parts: the summary and recommendations; the report itself, longer and with some supporting detail, but not highly technical; and 10 appendixes, with a great deal of detailed information, much of it developed specifically for this report and not elsewhere available, which form the foundation for the report and the recommendations. In this study, "floods" include tidal inundation and wave wash as well as riverine flooding.

AUGUST 8, 1966.

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(The appendixes attached to the report have been retained in the committee files for examination by interested persons. The table of contents for the appendixes is printed at the end of this volume.)

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INSURANCE AND OTHER PROGRAMS FOR FINANCIAL ASSISTANCE TO FLOOD VICTIMS

SUMMARY AND RECOMMENDATIONS

HIGHLIGHTS OF THE REPORT

I. Floods have several characteristics of particular importance to a consideration of assistance programs for flood victims: The timing of the next flood is unpredictable, as is its magnitude; but the probability of floods and their size over a considerable period of years is measurable; the location of flood hazards is identifiable and confined to local areas; and the average annual damage by risk zones is measurable with adequate accuracy.

Floods

When? Unpredictable.

Magnitude of next flood? Unpredictable.

Probability? Measurable; inevitable in long run.

Where? In identifiable local areas.

Average annual damage by risk zones? Measurable with adequate accuracy.

II. Broad alternatives exist for dealing with flood losses, ranging from a highly individualistic to a paternalistic approach. However, only one is really practical: a large measure of self-help, with a range of constructive public programs to assist. Unlimited public help to victims of flood disasters, who suffer property damages wherever they might be, would be self-defeating in encouraging flood plain occupancy and thus creating vastly larger problems than it solved.

Alternatives

For bearing unavoidable flood losses:

1. Every man for himself?

or

2. Federal Government bails out everyone?

or

3. Self-help and public programs?

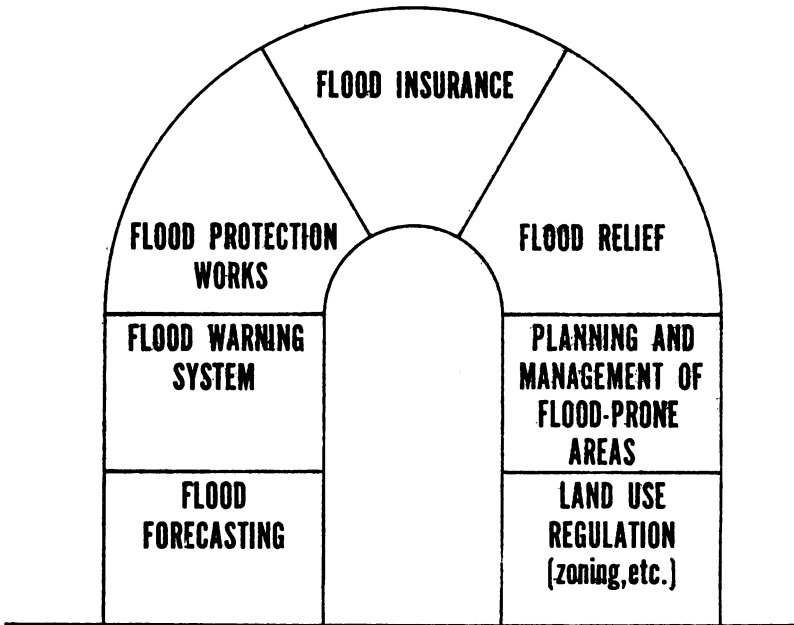
III. Man has made various responses to floods; sometimes he simply bears the losses; sometimes he is able to forecast floods a short time in advance, and to warn others to flee the danger area. He has built extensive flood protection works, at considerable cost, and he has extended help to his fellow man stricken by a flood disaster. To these tried activities, there is the possibility of adding flood insurance as a major new approach to loss bearing.

Man's responses to flood hazard

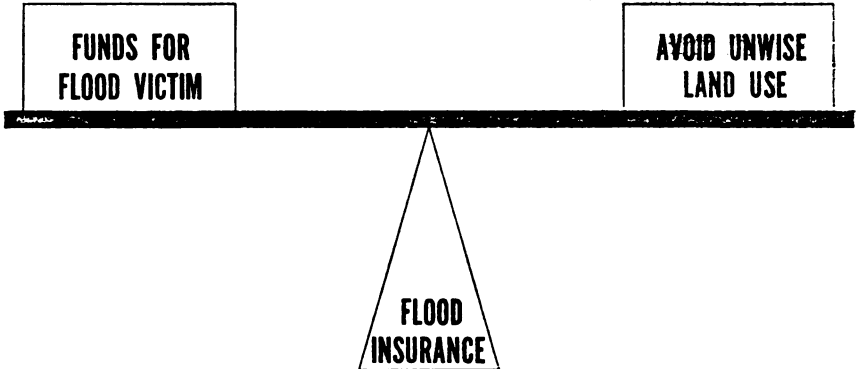
Bear losses when they occur.
 Forecast foreseeable (immediate) floods.
 Warn exposed persons of danger.
 Build protection works.
 Extend relief to victims.
 Insure against unavoidable risks.

IV. If flood insurance is to be inaugurated, it must be carefully interrelated with other flood programs. Flood forecasting, warning, protection works, relief, and land use management programs must be continued, but coordinated with and adjusted to flood insurance, and it with them. The relationship should be complementary, not competitive, with each strengthening the other to promote the national welfare.

Public flood management programs are interrelated



V. Two objectives of flood insurance are equally important: to help provide financial assistance for victims of flood disasters in order to rehabilitate their property; and to help prevent unwise use of land where flood damages would mount steadily and rapidly. Flood insurance is a mechanism which can keep both objectives in balance, without either outweighing the other.

Twin objectives of flood insurance

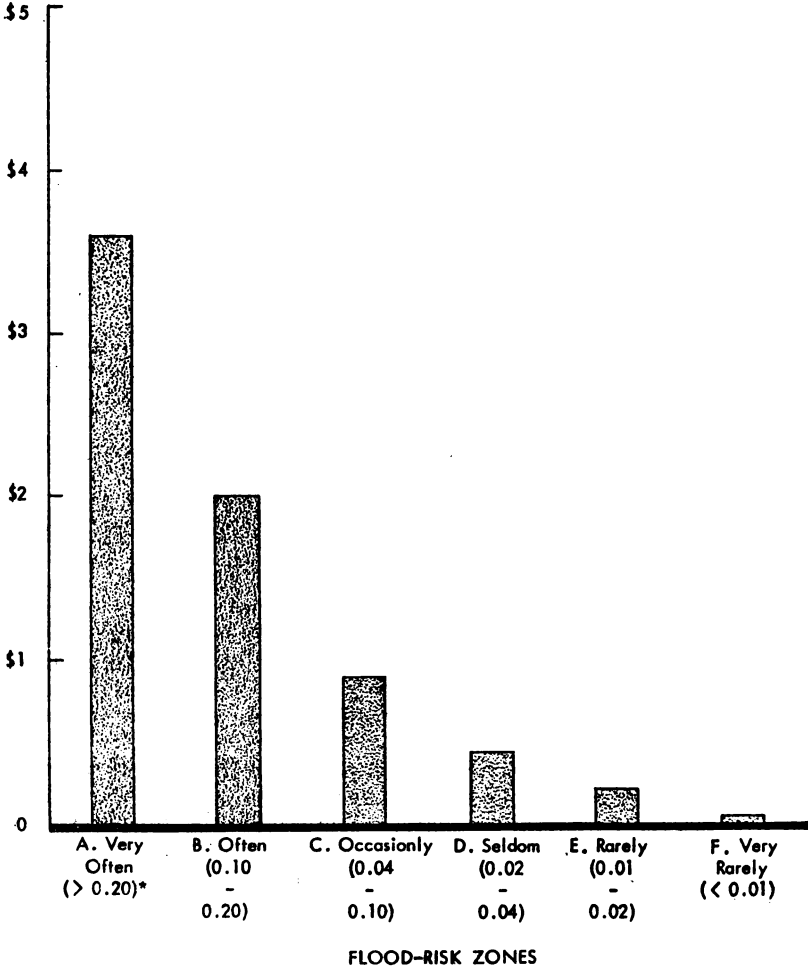
VI. Many factors affect average annual flood damages for any property in any location, but the two most important characteristics of the flood risk zone in which the property is located are the frequency of flooding and the depth of flooding.

Most property insurance is based on realized losses over a period of years; this approach is inapplicable for floods. Not only do we lack the necessary data, but flood loss is so variable from year to year that the average of even a considerable number of years may differ greatly from a truly long-term average. Instead, it is necessary to use a method which has been widely used for many years in flood protection planning and operations. This is the hydrologic approach which is based upon flood magnitude-frequency and depth-damage relationships. It can be applied to flood insurance. In addition to the major factor of location within a flood risk zone, a number of other factors may be important in their effect upon average annual flood damages in some situations.

Data on flood damages are presented in the report and particularly in appendix C for some 48 areas, where special studies were made for this report by 4 Federal agencies. The residential property in these areas shows a great variation in average annual damages from one flood risk zone to another which reflect the cost of living on the flood plain (fig. 1). Average annual damages are the estimated cost equivalent of annual premiums for insurance without taking into account administrative expenses. In zone A where floods may be expected once every 5 years or oftener, on a long-term average (the chance of flooding is 40 percent annually), the median figure of average annual damages to a structure and its contents is about \$3.60 per \$100 of value. In the next most hazardous zone, zone B, where floods will occur at intervals of 5 to 10 years over a long period of years, the median of average annual damages to dwellings and contents per \$100 of property value is about \$2. The damage rate falls steadily, from zone to zone, to \$0.90, \$0.44, \$0.21, and \$0.04, respectively.

FIGURE 1.—AVERAGE ANNUAL RESIDENTIAL FLOOD DAMAGES, PER \$100 PROPERTY VALUE, STRUCTURE AND CONTENTS, BY RISK ZONES, MEDIAN OF STUDY AREAS

RATES OF AVERAGE ANNUAL DAMAGES



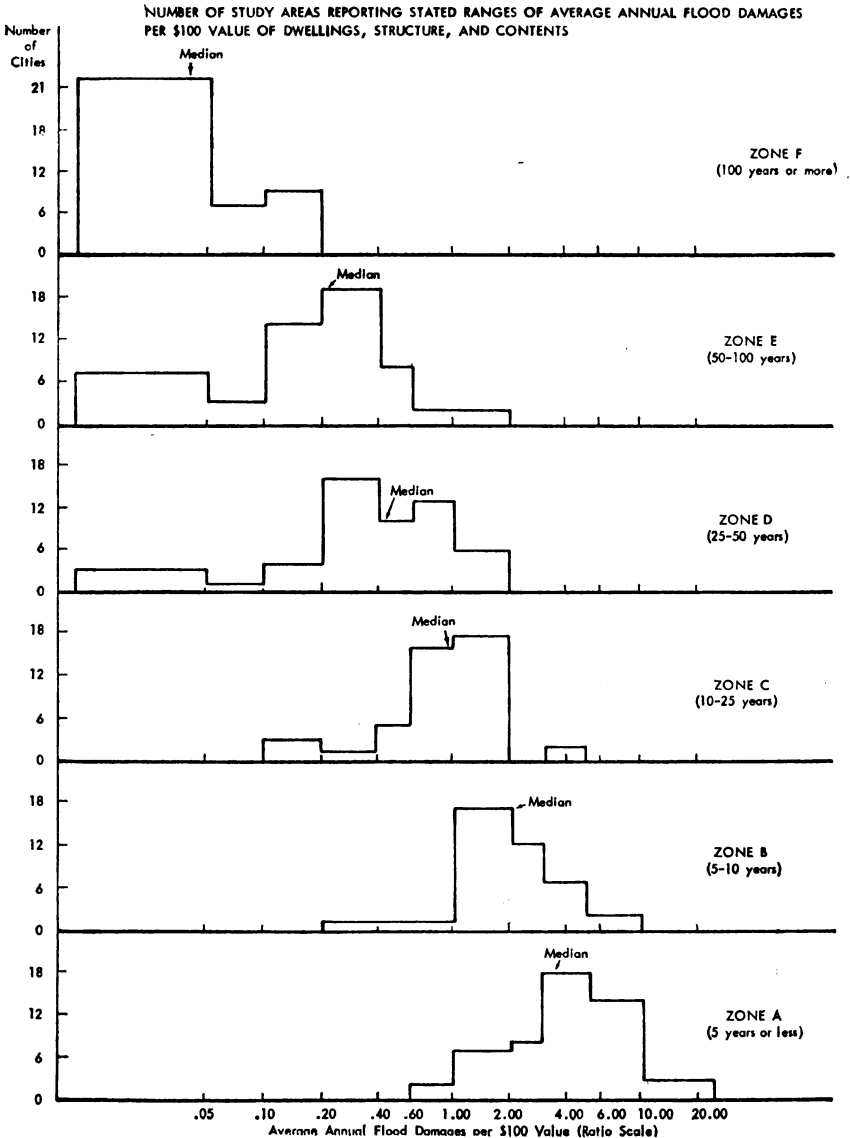
* Probably of flooding in any year

These summary figures conceal considerable differences among cities (fig. 2). Each flood-prone area has its special characteristics, and the average annual damage rate in zone A in one city may differ considerably from the damage rate in zone A in another city, even though each is flooded with equal frequency; but this is because of differences in depth of flooding. In each it will be higher than in zone B; and this in turn higher than in zone C. While there are major differences between the average of all zones A and of all zones B, yet the considerable variation in damage rates among cities means that flood insurance premiums must be established for each flood-prone

area separately. The methodology employed in this study can be readily applied in such rate determination.

Calculations based on such rates suggest that homebuilding sites which incur average annual flood damages of \$2 per \$100 or more have no value; that the property owner, before he built his house, would have been better off to have given his site away and bought another where the flood risk was small. Once his house is built, the sunk investment can be recaptured only by living there. While there are some variations in this relationship, the damage rate for zero value of sites on which homes occur will as often be below \$2 as above it.

FIGURE 2



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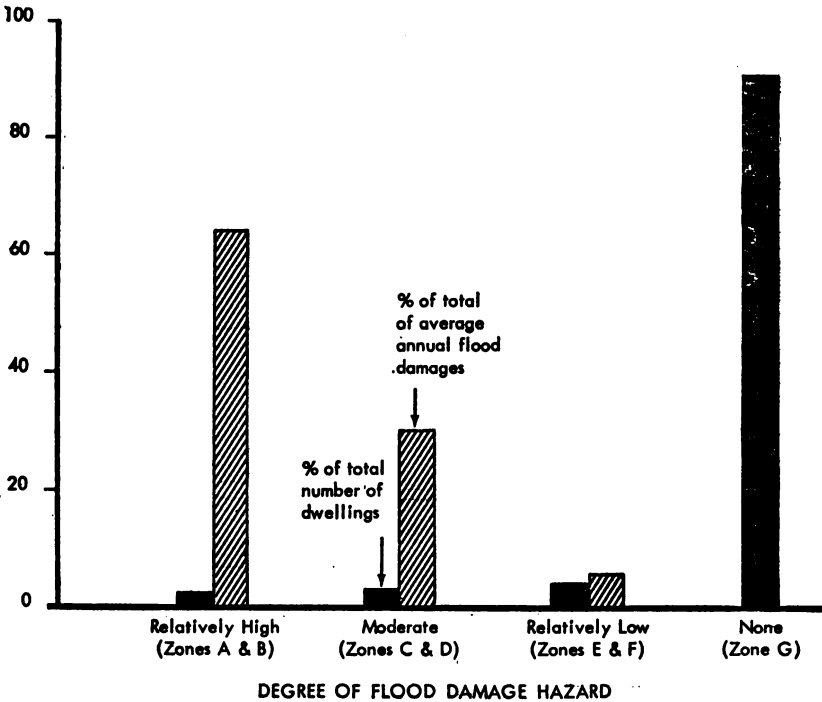
The flood damage hazard in the United States is highly concentrated (fig. 3). As few as 2 percent of all dwellings can expect to have more than half of the total average annual flood damage; less than 10 percent of all dwellings have any significant flood hazard, and the other 90 percent or more are free from any serious or measurable flood hazard. If everyone contributed equally to a flood insurance program, through a uniform premium rate, this would be quite inequitable in view of the very wide range in degree of flood risk.

Floods are notoriously erratic in timing, and this can have serious impact upon a flood insurance program, even one which is actuarially sound. In appendix H, this problem of insurance fund requirements is studied by experts in three separate reports. Even with insurance premiums that would cover flood losses over very long periods of time, it is possible to get periods as long as 20 years that would show quite large losses to the fund. Either the initial capital of the fund must be large, or some means of outside help must be devised to protect the insured.

The conclusion of appendix I is that flood insurance is as feasible as wind and other insurance now written by the private property insurance industry. The amount of information about flood risks by areas can be greater, prior to the initial writing of insurance, than the present degree of knowledge on which a great deal of other property insurance is now written.

FIGURE 3.—COMPARISON OF NUMBER OF DWELLINGS AND OF ESTIMATED TOTAL FLOOD DAMAGES, BY DEGREES OF FLOOD DAMAGE HAZARD, U.S. TOTAL

PERCENT OF U.S. TOTAL



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VII. Many people in high flood risk areas are seriously uninformed about the risks of flood damage which they face, and are grossly over-optimistic about the probability that their property will not be flooded, or expect public help to bail them out when the inevitable flood disaster strikes. A number of earlier private studies of sample areas had established these facts; a special study for this report obtained additional information. Preliminary findings from that study indicate that there is considerable interest in flood insurance. For example, most people in flood risk areas do not consider a requirement of flood insurance as a condition for obtaining a loan on property, to be unreasonable. On the basis of the evidence available, it seems probable that there is a maximum limit to the amount any large group of flood plain occupants would pay for flood insurance, even if the maximum incentives would be extended to these people to buy flood insurance. If a significant proportion of the present occupants of highest risk areas is to have flood insurance, then their premiums must be subsidized in some degree.

Partly because of the reluctance of occupants of flood-prone areas to buy flood insurance, and partly because of the time required to make the necessary hydrologic and other studies, the total amount of flood insurance in effect, even with a national program, will rise rather slowly over a period of years.

VIII. Flood insurance, of any kind and under any auspices, to be successful, must have certain basic elements (fig. 4). A prime consideration is to estimate the risks, by flood hazard zones and by other relevant situations, as accurately as possible; any misconceptions on this point will almost certainly lead to serious misunderstanding and controversy later in addition to serious financial reverses. The risk-bearer, whether private company or governmental agency, must be compensated for the risks assumed; but part of the premiums, especially in high flood risk areas, might be subsidized from the Federal Government, if it were deemed publicly desirable to do so. The policyholder should have every reasonable incentive to keep his risks of flood damage to the economic minimum. Likewise, there should be incentives for State and local governments to practice wise management of flood-prone areas, by means of such devices as effective channel encroachment laws, good land use zoning, and others. Lastly, any program of flood insurance should be continuously reappraised, to measure risks more accurately and otherwise to be brought as closely as possible into line with realities. However, such reappraisal is not simple; actual claims paid for flood losses may be misleading, for flood experience in particular years can deviate widely from the long-term average. A reappraisal of the rates will involve the same basic procedures used in setting them initially.

FIGURE 4.—ELEMENTS OF ANY FLOOD INSURANCE PROGRAM

1. Accurate estimate of risks.
2. Risk bearer must be compensated.
3. Subsidy of premiums is possible, if publicly desirable.
4. Incentives to policyholder, to reduce risks.
5. Incentives to States and local government, for wise management of flood-prone areas.
6. Continuous reappraisal.

IX. Four broad alternatives exist for the organization of a flood insurance program (fig. 5). One, that of a wholly private program, seems unlikely in view of the history of flood insurance efforts. A private industry program, with substantial Federal help, seems both a likely and desirable program, assuming that mutually satisfactory terms can be worked out between the insurance industry and the Federal Government. If this should not prove possible, a basically Federal program might be administered by the private insurance industry as fiscal agents. This would utilize the extensive organization and long experience of the latter; but there might be questions of public policy in a public program managed by a private industry. The alternative of an all-Federal program exists, but this would require the creation of a large Federal agency, with numerous local field offices.

FIGURE 5.—ALTERNATIVE PROGRAMS FOR FLOOD INSURANCE

- I. Wholly private industry: Unlikely, based on past experience.
- II. Private industry program, with major Federal help: Most likely alternative, if mutually satisfactory terms can be agreed upon.
- III. Private industry operates Government program: Perhaps more acceptable to insurance industry, but raises questions of public policy.
- IV. All Federal program: Would require relatively large Federal administrative staff.

X. A flood insurance program operated by the private insurance industry, with extensive Federal help, seems both desirable and feasible; it would require each party to assume certain major responsibilities (fig. 6). The Federal agency would make the necessary fact-finding studies; would work closely with State and local governments, and with lending institutions, to facilitate development of the program; would provide subsidies to insurance costs for existing properties in high risk zones; would provide excess insurance to the companies against excessive losses in catastrophic disasters, and would provide some form of financial backup to the companies against heavy losses in early years before reserves could be built up. It would also provide help to flood victims in their relocation after disasters, but not free indemnification of losses.

The property insurance industry, for its part, would provide the modest initial capital required, would sell and service the flood insurance policies, would build reserves against high loss years, and would bear flood risks within carefully defined limits. An appropriate tax mechanism can be found, to permit the accumulation of insurance reserves to meet claims even in high loss years.

FIGURE 6.—FLOOD INSURANCE, BY INSURANCE INDUSTRY, WITH MAJOR FEDERAL HELP

FEDERAL GOVERNMENT

Develops plans for land management of flood-prone areas cooperatively with States and local government.

Advises lending institutions and others of flood insurance availability and cost.

Encourages lenders not to loan on new property without flood insurance (unsubsidized).

Measures average flood damages by zones, establishes subsidy rates for premiums on some existing property, helps establish insurance premium rates.

Establishes excess insurance loss point, absorbs cost all higher insurance losses in any year.

Provides financial backup against heavy losses early in program.

Continues present flood relief as an interim measure but modifies conditions to prevent recurrence of relief in same spot.

Buys out heavily damaged insured properties to facilitate land use changes.

INSURANCE INDUSTRY

- Provides initial capital for flood insurance program.
- Helps establish flood insurance premiums, especially administrative cost portion.
- Sells and services flood insurance policies, including payment of verified loss claims.
- Builds financial reserves in low loss years, against inevitable high loss years.
- Bears risks of flood losses, within defined limits.

XI. If the insurance industry is unable or unwilling to participate as outlined above, then an essentially Federal flood insurance program might be developed, which the private industry would operate and manage. Private operation of Federal programs is widespread in many other parts of the total governmental structure. The property insurance industry has a widespread organization, capable of handling flood insurance along with many other existing kinds of insurance; and numerous sectors of the industry have signified their willingness to cooperate with the Government on this basis. This arrangement would operate much as the foregoing one, except that the Federal Government would provide all the capital and take all the risks. One variant of the above would be the creation of a joint Federal-private corporation, into which insurance industry firms would contribute a minor share of the total initial capital required, in return for a share in the management of the whole program. The exact terms of any Government-industry relationship, in both this and the foregoing general alternative, would have to be developed by negotiation, and would have much to do with the willingness of the industry to participate and with the fairness of the general idea.

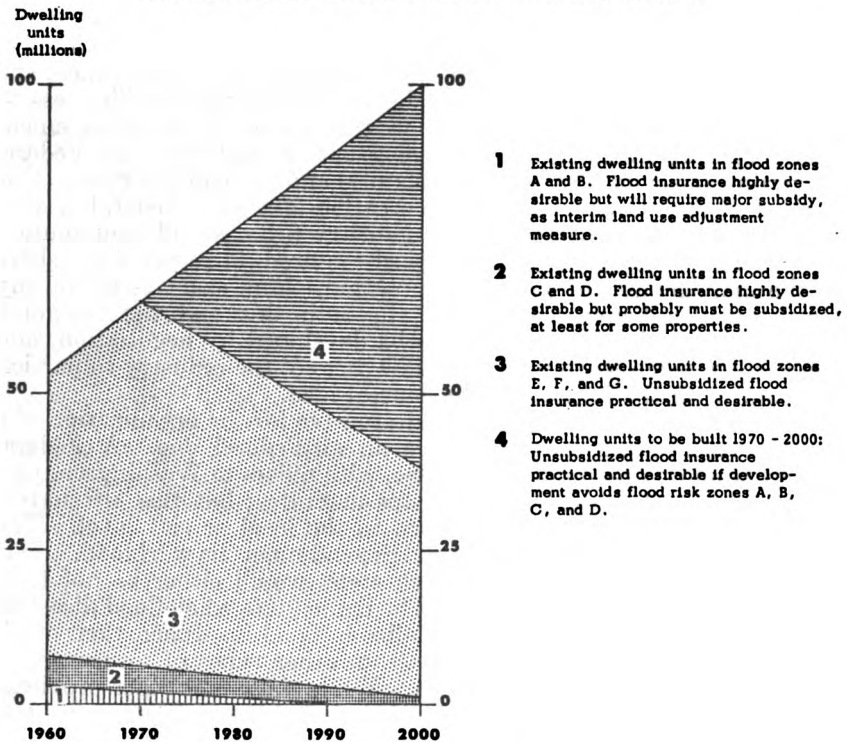
XII. A logically fourth general alternative for the organization of a flood insurance program would be an all-Federal one. A Federal agency would be required in any case, with offices in Washington, perhaps in regional centers, and perhaps in States; but this alternative would require an organization down to the local or city level. The size and staffing of local offices would depend upon the workload. Due to the erratic timing of floods, such staffs would either be not fully occupied much of the time or would be inadequate when flood disasters struck. Because they would specialize in flood insurance, their staffs would not have a volume of work from other types of insurance, as would private insurance operations. While these and other problems involved in any large Federal operation should be taken into account, yet many Federal programs today operate at local levels, in direct contact with the public served by them, and the establishment and operation of a large Federal organization today is manageable. This alternative should at least be considered, when the form of a flood insurance program is established.

XIII. A comprehensive Federal flood program should include flood insurance. More than 90 percent of all existing residences in the country have no special flood problem today, and an even larger proportion of future residences might be located in the same essentially flood-free zones (fig. 7). For these buildings with no special flood risks an unsubsidized insurance program against all perils of rising waters could be established by private insurance companies, perhaps under extended coverage.

The national concern should be to limit future flood damages without hampering future economic development; this is both possible and practical. A continuing program of assistance to victims of flood

disasters is necessary, but must be carefully interrelated with flood insurance so as not to be self-defeating. Help should be extended to flood victims in such a way as not to create even larger public expenditures in the future. The assistance to occupants of the highest flood risk areas should be viewed as an interim proposition—as part of an adjustment in land use to reduce individual and public losses from floods. A flood insurance program is a desirable part of a total Federal flood program.

FIGURE 7.—NATIONAL FLOOD INSURANCE PROGRAM FOR NEXT GENERATION, ADAPTED TO FLOOD RISKS AND LAND USE ADJUSTMENTS



RECOMMENDATIONS

On the basis of the findings in this report and in its appended studies, I recommend the following:

SPECIFIC RECOMMENDATIONS

National flood insurance program

I. A national program of flood insurance should be established with Government assistance or participation to the extent necessary to assure a workable method of pooling risks, minimizing costs and distributing burdens equitably among the property-owners protected by such insurance and the general taxpayers.

A. Such insurance should be limited initially to one- to four-family dwellings and be extended later to other property as experience indicates that insurance to be feasible.

B. The insurance program should be designed to encourage future construction in locations where there is no special flood hazard.

C. Toward this end, the Federal Government, as promptly as possible:

(1) Should identify (within 2 years) all flood plain areas, including coastal areas, which have special flood hazards;

(2) Should establish (within 10 years) flood-risk zones in all such flood-prone areas and estimate the rates of probable flood-caused loss for the various flood-risk zones for each of these areas.

D. For all properties in areas of relatively low hazard, insurance should be made available at rates deemed adequate to cover all costs, preferably, through private insurance companies.

E. For all existing properties in special flood hazard areas, insurance should be offered at reasonable premiums, with Federal payments to cover the difference if and when such reasonable premiums are less than full actuarial cost, but no Federal subsidy payments for flood insurance should be made for:

(1) Properties within flood risk zones when the full actuarial premiums are reasonable;

(2) Any new properties built in such zones after flood insurance is effective;

(3) Any property rebuilt after the effective date if substantial rebuilding is necessary following any flood disaster; and

(4) Any property substantially improved whether or not incident to a flood disaster.

State and local participation

II. The Federal Government should encourage State and local agencies concerned with land use in flood-prone areas in order to restrict future public and private investment in such areas and to take advantage of opportunities afforded by disasters, which require new investment, to channel the resulting new investment to other geographic areas.

A. During the initial period of development of the national insurance program, preference in making the necessary surveys and in initiating the flood insurance program should be given to those States and areas expressing positive interest in flood insurance.

B. Federal agencies should cooperate with State and local planning bodies in developing long-range plans for land use in flood hazard areas and in developing standards for local land use zoning in such areas.

C. The Federal flood insurance program should provide incentives to encourage State and local action by setting insurance rates which adequately reflect differences in risk due to differences in zoning requirements.

D. The Federal flood insurance agency should be authorized to assist States and localities in acquiring properties in special flood risk areas for the purpose of restricting their future use to low-risk purposes.

Private industry participation

The Federal agency administering the insurance program should be authorized to encourage and assist private property insurance companies in order to obtain their maximum participation in the insurance program consistent with effective achievement of the objectives of the program.

A. In areas of low flood hazard, the Federal Government should encourage the private insurance industry to develop a fully commercial, no-subsidy insurance program, perhaps by expanding present extended coverage insurance policies, to cover such small risks of rising waters as do exist, together with other miscellaneous risks not now insurable, such as earth slides, mud slides, and subsidence.

B. In areas of special flood hazard the Federal Government should aid any private insurance companies which wish to undertake a flood insurance program as principals (1) by assumption of all claims for flood losses beyond some specified catastrophic level in return for a reasonable payment for such excess insurance, (2) by loans at reasonable rates of interest to replenish reserves in case of early heavy flood losses before fully adequate insurance reserves have been built up, and possibly (3) by tax deferrals (rather than tax exemptions) to accelerate accumulation of adequate insurance reserves from premiums to meet extraordinary claims which are certain to occur over a long period of time.

C. The Federal flood insurance agency should be authorized to negotiate as promptly as possible with the private property insurance industry to seek a mutually acceptable basis, on standards to be determined, for a private flood insurance program with Federal help as outlined above for flood insurance in special risk zones.

D. In the event that a mutually acceptable private insurance program with Federal help cannot be agreed upon, the Federal agency should be authorized to develop a Federal flood insurance program for the special-risk areas.

Relation to existing Federal programs

IV. The present flood-related programs and activities of the Federal Government should be continued, but with modifications necessary to meet the opportunities and needs of the flood insurance program.

A. Existing flood forecasting, flood warning, and flood protection programs should go forward, including those improvements recently recommended in the Department of Commerce natural disaster warning plan.

B. The present programs of loans at subsidized interest rates to the victims of flood disasters should be modified to reflect the reduced need for such assistance because of the availability of flood insurance and to avoid any possibilities of duplication and conflict.

C. To encourage widespread purchase of flood insurance, the Congress should be requested to declare that as a matter of national policy all lending institutions entrusted with savings or deposits and under any form of Federal supervision of insurance of savings or deposits shall require in high risk areas flood insurance at unsubsidized rates on all new mortgages based on new residences, as they now generally require fire insurance; and that such flood insurance be considered in the interest of the borrowers, the lending institutions, and the savers

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and depositors; and these institutions might well encourage flood insurance by borrowers in low risk areas.

RECOMMENDATIONS REQUIRING FURTHER STUDY

Aid to flood victims

V. After insurance becomes available, uninsured victims of flood disasters should remain eligible initially for Federal assistance in the form of loans at subsidized rates of interest, but this eligibility should be limited.

A. In any area stricken by a flood disaster, the Federal Government should extend once only financial assistance to uninsured residents in the form of subsidized loans for restoration of residential property (but not for refinancing of existing mortgage debt) and only on the condition that the recipient buy and keep current flood insurance on the restored residential property at an unsubsidized premium rate as long as the loan is in force.

B. In special risk zones, the Federal Government should assist any uninsured victim of a flood disaster to relocate his home to a site where average annual flood damage is lower:

(1) Perhaps by extending the disaster loan program to aid in acquiring a home in such new location (but not in refinancing any previous mortgage debt), and

(2) Perhaps by buying up immediately after a flood any remaining equity in his home and lot (for later disposition), whenever a damage of more than 50 percent of the pre-flood value of the structure has been suffered, but

(3) In either case the victim of the flood disaster should be required to purchase and keep current flood insurance for the life of the loan in his new location at an unsubsidized premium rate.

INTRODUCTION: PURPOSE AND SCOPE

Section 5 of the Southeast Hurricane Disaster Relief Act of 1965 (Public Law 89-339, 89th Cong., H.R. 11539, approved November 8, 1965) provides the authority and the directive for this report; it reads as follows:

The Secretary of Housing and Urban Development shall undertake an immediate study of alternative programs which could be established to help provide financial assistance to those suffering property losses in flood and other natural disasters, including alternative methods of Federal disaster insurance, as well as the existing flood insurance program, and shall report his findings and recommendations to the President for submission to the Congress not later than 9 months after the appropriation of funds for this study, except that the findings and recommendations on earthquake insurance shall be reported to the President for submission to the Congress not later than 3 years after the appropriation of funds for this study.

X This report focuses on floods, including tidal inundation and wave wash as well as riverine floods. Studies of earthquake hazards are going on, under the act, but will be reported upon later. Floods are, by a wide margin, the most serious of the natural disaster hazards facing the people of the United States; and efforts to provide insurance and other means of coping with flood hazards are difficult enough at best. There are various kinds of relatively minor disaster hazards not covered by insurance such as mudflows, earth slippages, falling meteors or other materials, and others; while these may be serious to the person who experiences them, they are rare and relatively limited in their effect in the national scene. If programs of financial assistance to flood victims can be developed on a satisfactory basis, they can later be extended to the other disasters relatively easily.

ORGANIZATION OF THIS REPORT

This report on insurance and other programs for financial assistance to flood victims is presented in three parts, of greatly differing length and detail, as follows:

1. The summary and recommendations, in the preceding section, presents the major conclusions of the study briefly, without supporting evidence, and set forth the recommendations.
2. The body of the report itself, which follows, summarizes basic data, relates the facts on one aspect of floods to those on others, explores alternative programs of insurance and other measures, and reaches conclusions. The discussion in the report is not highly technical but does seek to provide new evidence and to evaluate the evidence available. Although necessarily much longer than the summary, it has been organized to facilitate rapid perusal.
3. A series of 10 appendixes bring together a substantial body of relevant data hitherto unavailable. Eleven Federal agencies prepared statements on flood related aspects of their programs (app. B). Four of these agencies were commissioned to make detailed studies of 48 local flood-prone areas, which delineate the flood hazard zones in

detail, estimate the average annual flood damages, otherwise provide the necessary basis for calculating actuarially sound flood insurance premiums, and present rates for different types of property in different flood risk zones in these local areas (app. C). A study of the feasibility of flood insurance was commissioned (app. I). Other appendixes contain statements by responsible State officials and by private insurance companies and their associations, made in response to requests for information on specific points (app. B and D). Three appendixes (C, E, and G) include special studies made by staff members of the Natural Disaster Study Group, on special problems. Others contain reports by university and other experts (app. J).

The appendixes as a whole resemble a congressional hearing, in that they are designed to elicit relevant information from interested and competent sources. These specialized reports merit and will reward the thoughtful attention of everyone interested in flood insurance and related programs. The report as a whole has been based upon them, but obviously could not include all their detail. Anyone who wishes to examine more closely the factual foundation for the report will find it in these appendixes.

This report would not have been possible without the unstinting and whole-hearted cooperation of the several Federal, State, and private groups who have contributed these appendixes. The names of the organizations and individuals are listed on each appendix or part thereof; the Natural Disaster Study Group wishes to express its appreciation to these organizations and persons for their cooperation, and to express the judgment that the whole Nation is indebted to them for their assistance.

CHAPTER 1

THE NATURE OF FLOOD HAZARDS ¹

Floods have several special features which are highly important in considering programs for financial assistance to flood victims: they are erratic and unpredictable in timing; the magnitude of any flood is unpredictable, by more than a few days or hours in advance; but the probability that floods will occur is measurable with fair accuracy. They occur in rather well defined local areas, and are inevitable in the long run, in such areas. Throughout this report, reference will be made to these characteristics of floods, for they are basic to any program which might be devised to aid flood victims.

The nature of the flood hazard is discussed in more detail in appendix A and in the remainder of this chapter. Appendix A was prepared especially for this report by the Geological Survey. Numerous professional and popular books, as well as many specialized technical reports, have been written about one aspect or another of floods, or in presentation and analysis of data about floods in some location or about some particular damaging flood. The concern of this chapter is with these special features of floods which directly and to a major degree affect any kind of insurance or other program for financial assistance to flood victims.

Inundation of flood plain by a river and inundation of tideland by an ocean are natural and inevitable. A flood plain is as much a part of the course of a river as the channel within banks which carries normal and low floods.² Tideland is part of the domain of the ocean.

The ebb and flow of the ocean tide is regular and predictable. However, the violence caused by wind or volcanic activity is unpredictable and erratic. Unpredictable and erratic too are the unique coincidences of snowmelt, rainfall, soil absorption and saturation, tributary runoff, and hurricanes which cause rivers to inundate flood plains.

There are broad geographic patterns to floods. In the Northeastern United States in late winter or early spring, a combination of snow melt and the breakup of ice in rivers may produce runoffs of 10 to 15 inches. In late summer or autumn intensive rains on already saturated soil may produce runoffs of less than 8 to 10 inches, but these may be sharply concentrated in time.

In the Northern Great Plains, late winter and early spring floods result from snowmelt in the Rocky Mountains. Less frequent and less severe are floods produced by intense summer rains. Flood-producing rainstorms are greatest and most frequent in the Southern Great Plains.

In the West, snow on the foothills of the Rockies disappears at the first thaw, while snow above 10,000 feet thaws too slowly to cause flooding. It is upon the depth of snow at the middle altitudes that

¹ Throughout this report, "floods" include tidal inundation and wave wash as well as riverine flooding.
² U.S. Senate, Select Committee on National Water Resources, "Floods and Flood Control," print No. 15 86th Cong., 2d sess., 1960, p. 1.

the unusual flood potential depends. A late thaw combined with rainfall in late spring produces runoffs of 15 to 30 inches—the maximum in the United States—but of low intensity because they are distributed over several weeks. In the intermountain deserts of the Southeast summer cloudbursts and thunderstorms produce runoffs low in inches, but concentrated in an hour or two, and discharged rapidly, often as a wall of water, down steep, dry stream channels.

Inundation and erosion of the Atlantic and gulf coast varies with the vulnerability of the topography, the height and frequency of wave crests, the height of astronomical tides normal to that time on the calendar, and "surge," or the augmentation of that normal tide by the accumulation of water transported by stresses of the wind on the sea. Beaches well stocked with sand tend to stop wave erosion short of the protective dunes, which act as a levee to inhibit massive flooding of the coastal plains. "The height and frequency of wave crests depend both upon the strength and duration of strong winds, and the fetch or distance over which the generating winds follow the waves without change of direction * * *."³ The distance which these waves will penetrate inland depends upon the rise of water levels due to storm surge. A hurricane may cause rises of more than 15 feet above normal tide. Sometimes both the origin and the path of these wave and surge producing storms may be entirely over ocean, sometimes entirely over land, and sometimes over both ocean and land.

On the Pacific coast, inundation has resulted from seismic sea waves induced by earthquakes anywhere on the Pacific coast, or in the Pacific Ocean, or on a remote Pacific island. For example inundation of Kodiak and Valdez, Alaska, and also of Crescent City, Calif., in March 1964 resulted from an earthquake in Prince William Sound.

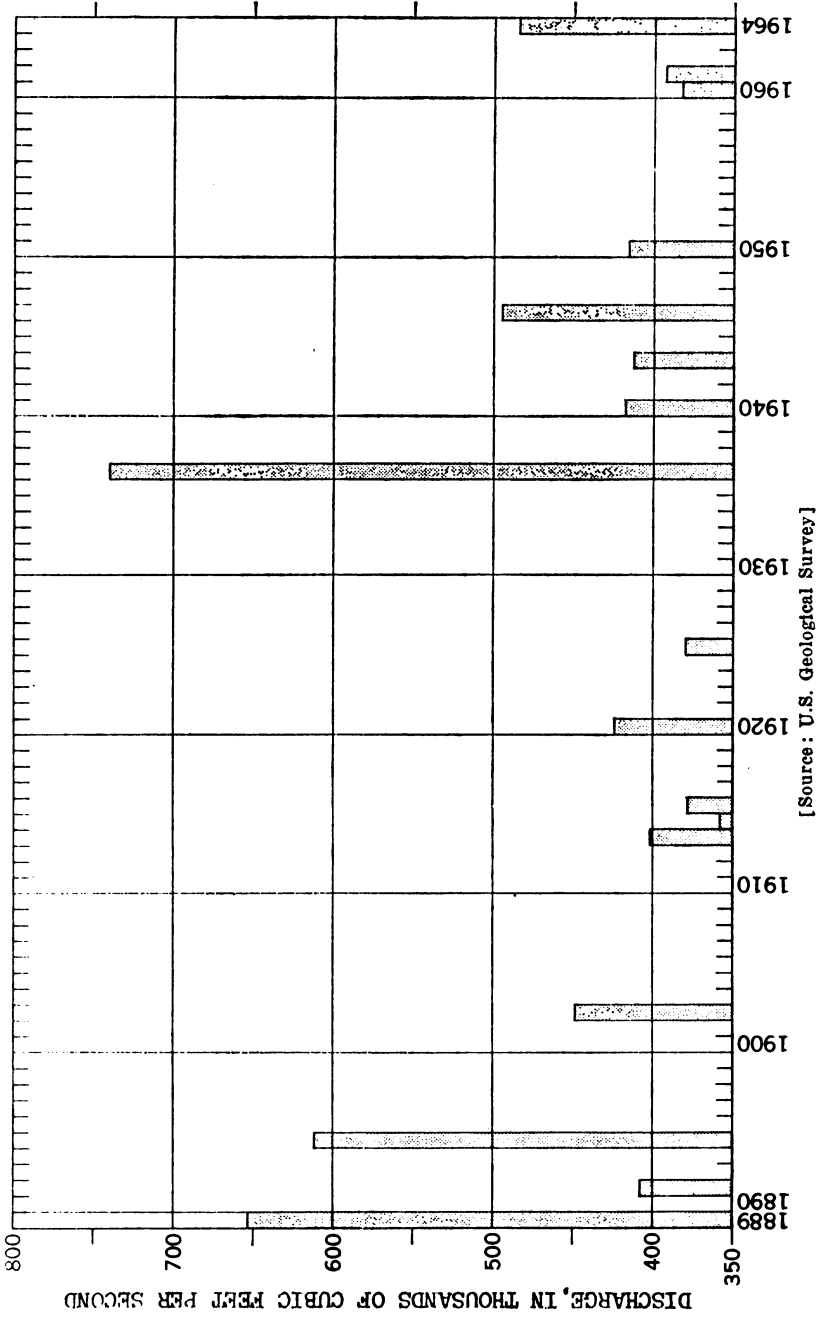
The variability of flooding on particular streams is illustrated in figure 1 for the Susquehanna River at Harrisburg, Pa. Many years, often considerable sequences of years, have had no floods; a moderately large number of years had relatively small floods; and a very few years had very large floods. This distribution is typical, although the precise timing varies greatly from one stream to another. Unfortunately, no data are available to show the time distribution of flood volumes on a national or regional basis. Data are available on flood damages regionally and nationally, and are presented in chapter 2, but flood damages depend on many factors other than flood volume, as is shown later.

The variation in size of floods does not follow the normal bell-shaped statistical curve, but rather is highly skewed. There are many small to moderate floods, some larger ones and a few very large ones. The skew character of this distribution as reflected in flood damages is considered in appendix H, in the studies by J. Robert Ferrari and Don G. Friedman. It has immense importance to the problem of flood insurance, as will be shown in later chapters.

The frequency of damaging coastal storms is also highly variable from year to year (fig. 2). Unfortunately, the measure of storm size depends on the damage it does and damage, as noted, is affected by manmade factors as well as natural ones. Some years there are few or no damaging coastal storms, in other years there may be a dozen or more major ones.

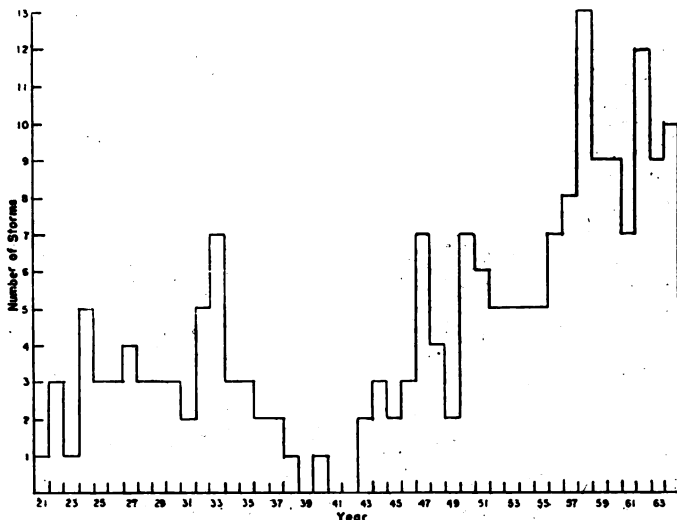
³ U.S. Congress, House of Representatives, 87th Cong., 2d sess., "Improvement of Storm Forecasting Procedures," hearing before the Subcommittee on Oceanography, Washington, Apr. 4, 1962, pp. 20-21.

FIGURE 1.—FLOODS ABOVE 350,000 CUBIC FEET PER SECOND ON SUSQUEHANNA RIVER AT HARRISBURG, PENNSYLVANIA, 1889-1964



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FIGURE 2
 FREQUENCY OF DAMAGING COASTAL STORMS
 EASTERN UNITED STATES, 1921 - 1964



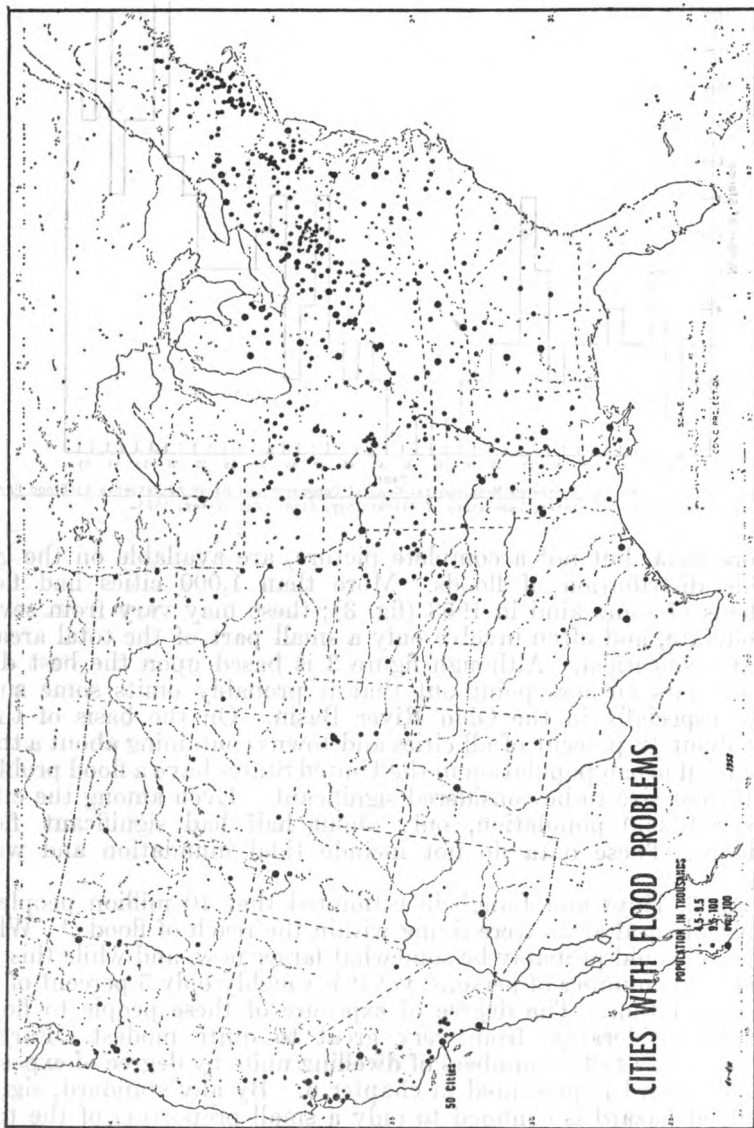
Source: Ian Burton, et al. *The Shores of Megalopolis: Coastal Occupation and Human Adjustments to Flood Hazard*. C.W. Thornthwaite Associates, Laboratory of Climatology, Elmer, New Jersey, 1965.

More data, but not a complete picture, are available on the geographic distribution of floods. More than 1,000 cities had flood problems of some kind in 1958 (fig. 3); these may vary from severe to moderate, and often involve only a small part of the total area of the city concerned. Although figure 3 is based upon the best data available, its authors point out that it probably omits some small towns, especially in the Ohio River Basin. On the basis of these data, about 12 percent of all cities and towns containing about a third of the total urban population in the United States have a flood problem of sufficient size to be considered significant. Even among the cities of over 10,000 population, only about half had significant flood problems. These data do not include tidal inundation and wave wash.

In 1955, Hoyt and Langbein estimated that 10 million people in urban and rural areas were living within the reach of floods.⁴ While the figure would probably be somewhat larger now, and while this is a considerable number of persons, yet it is roughly only 5 percent of the total population. The degree of exposure of these people to floods differed considerably, from very great to quite modest. Further information as to the numbers of dwelling units by degree of exposure to flood hazard is presented in chapter 6. By any standard, significant flood hazard is confined to only a small proportion of the total population.

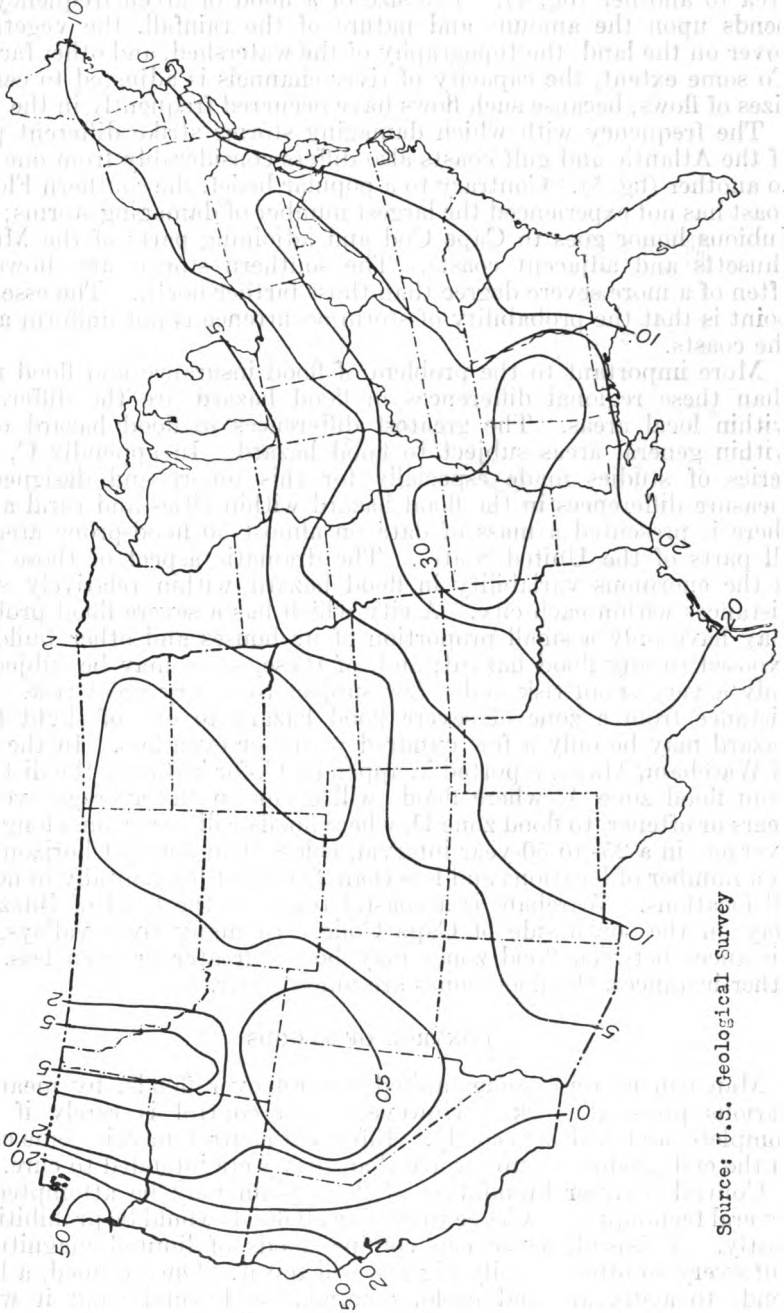
⁴ William G. Hoyt and Walter B. Langbein, "Floods," Princeton University Press, 1955.

FIGURE 3.—CITIES WITH FLOOD PROBLEMS



Source: Gilbert F. White, Changes in Urban Occupance of Flood Plains in the United States, University of Chicago, 1958.

FIGURE 4.—FLOOD POTENTIAL: THE 10-YEAR FLOOD IN THOUSANDS OF CUBIC FEET PER SECOND FROM 300-SQUARE-MILE DRAINAGE BASINS.



Source: U.S. Geological Survey

The riverine flood potential differs greatly from one region or broad area to another (fig. 4). The size of a flood of given frequency depends upon the amount and nature of the rainfall, the vegetative cover on the land, the topography of the watershed, and other factors. To some extent, the capacity of river channels is adjusted to certain sizes of flows, because such flows have occurred frequently in the past.

The frequency with which damaging storms strike different parts of the Atlantic and gulf coasts also differs considerably from one part to another (fig. 5). Contrary to a popular belief, the southern Florida coast has not experienced the largest number of damaging storms; that dubious honor goes to Cape Cod and adjoining parts of the Massachusetts and adjacent coasts. The southern storms are, however, often of a more severe degree than those farther north. The essential point is that the probability of storm occurrence is not uniform along the coasts.

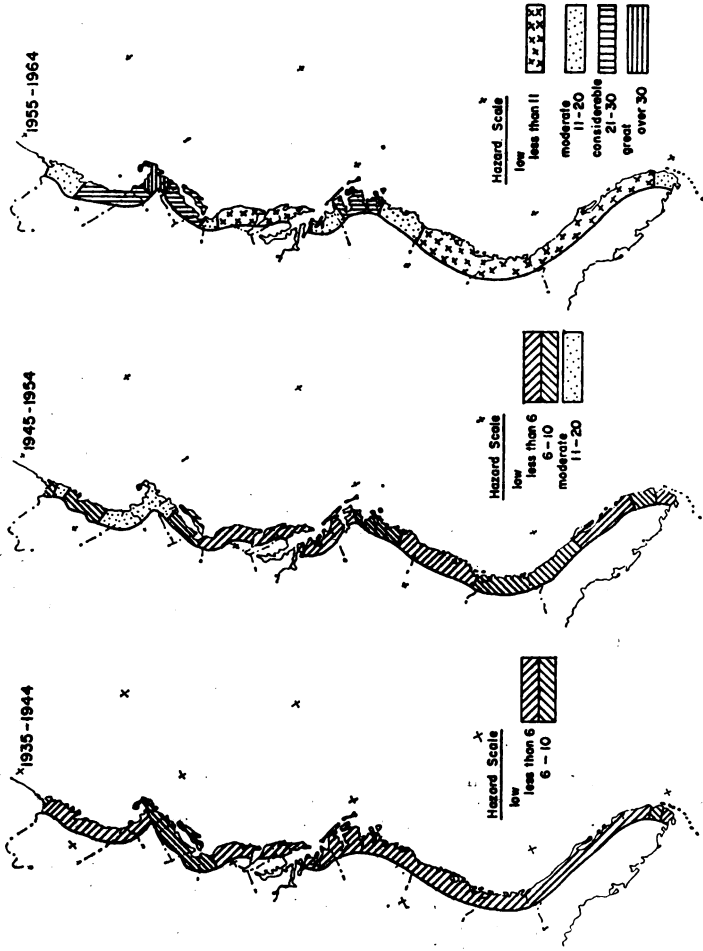
More important to the problem of flood insurance and flood relief than these regional differences in flood hazard are the differences within local areas. The greatest differences in flood hazard occur within general areas subject to flood hazard. In appendix C, in a series of studies made especially for this report and designed to measure differences in the flood hazard within cities and rural areas, there is presented a mass of data on almost 50 flood-prone areas in all parts of the United States. The dramatic aspect of those data is the enormous variability in flood hazard within relatively short distances within each city. A city which has a severe flood problem may have only a small proportion of its houses and other buildings exposed to any flood hazard; and, of these, some may be subject to only a very small risk and a few subject to a very great risk. The distance from a zone of severe flood hazard to one of slight flood hazard may be only a few hundred yards, or even less. In the case of Wareham, Mass., reported in appendix C, for instance, the distance from flood zone A, where floods will occur on the average every 5 years or oftener, to flood zone D, where floods will occur, on a longtime average, in a 25- to 50-year interval, is less than 500 feet horizontally in a number of locations and less than 2,000 feet horizontally in nearly all locations. Wareham is a coastal town, at the head of Buzzards Bay on the south side of Cape Code. In many river valleys, the distances between flood zones may be no greater or even less. In other instances, the flood zones are much wider.

CONTROL OF FLOODS

Man can exercise some limited control over floods, by means of various physical works. However, such control is rarely if ever complete, and is always costly. Efforts at control may, in some cases, in the end produce results worse than they were intended to cure.

Control of river inundation of flood plain may be attempted by several techniques. A levee to confine all floods would be prohibitively costly. A feasible levee can confine floods of limited magnitudes, but every so often a really big one will top it. Once topped, a levee tends to aggravate and prolong inundation beyond what it would have been without the levee. The same levee that held water out of the flood plain, obstructs natural drainage of water back to the channel, when the crest of the flood passes, and the height of the river falls.

FIGURE 5
REGIONS OF RELATIVE COASTAL STORM DAMAGE HAZARD



Source: Ian Burton, et al, *The Shores of Megalopolis: Coastal Occupance and Human Adjustments to Flood Hazard*. C.W. Thornthwaite Associates, Laboratory of Climatology, Elmer, New Jersey, 1965.

Another technique for controlling riverine inundation is by reduction of flood stages. Reforestation, cover crops, and other land treatment increase the rate at which precipitation infiltrates into the soil, as well as the capacity of the soil mantle to retain infiltrated water. These, in turn, damp peaks of runoff, and thereby of river levels. However, the effect is small relative to the precipitations that produce the larger floods on major rivers.

Increasing the capacity of a particular reach of channel by dredging or other techniques will reduce flood stages throughout that reach. However, by increasing the rate and concentration of the passage of water downstream, this may transfer inundation downstream.

Reservoirs are a common but costly method of reducing flood stages. With uncontrolled outlets, they temporarily retard the waters; with controlled outlets they can store their capacity until gradual release is desired.

Against inundation of the tidal plain by the ocean—

the sloping beach * * * is * * * the outer line of natural defense. Sand dunes, which normally absorb a great deal of wave energy are * * * an inner natural defense. To maintain these inner and outer defenses, groins and jetties are constructed, beaches artificially nourished, and dunes are built and stabilized. All protective works interfere with natural shore processes * * *. The shore is littered with earlier structures whose effectiveness has been obviously impaired or that have * * * created problems * * * greater than those they were intended to solve * * *.

Groins are fences stretching from the dune toward or into the ocean. Parallel groins are intended to retain and build up the beach by interfering with the lateral transport of sand—that is by trapping the sand between them. However, by so doing, groins starve and erode adjacent shore.

On the flood tide, sand naturally flows into inlets to form inner bars to navigation, and on the ebb tide it flows outward to form outer bars.

A jetty, larger than a groin, completely blocks this sand movement. A breakwater is a wall, usually of stone, up to 10 feet high, enclosing a harbor and connected to the shore. Both jetties and breakwaters starve the downstream beaches of sand.

Fences erected on dunes parallel to the shore stabilize the dunes. They trap sand as it flows from the beach. As dunes successfully build up, new fences are erected successively closer to the water. A more laborious way to stabilize dunes is to plant cover grass.

When man first settled along the shore, adequate beaches served to protect the shore developments. An occasional severe storm would cause beach erosion, the opening or the closing of an inlet, or the removal of dunes, but nature would heal these wounds during the calmer summer months. All barrier bars, being temporary wave-built features, were subject to these damages. As barrier bars were settled (by people) dunes were removed to provide unobstructed views of the sea and to provide level land. The removal of these dunes enabled storm waves to reach deep into a barrier island. Man soon discovered that some protection was needed. He turned to walls * * * as a partial substitute for the dunes he had destroyed * * *. The beach continued to retreat and large waves would cross it (the walls) * * *. While these obstructions might protect structures behind them, they have little influence in holding or protecting the beach which in the long run is the greatest asset of shore front property. * * *

¹ U.S. Army Coastal Engineering Research Center, "Land Against the Sea," Miscellaneous Paper No. 4-64, May 1964, pp. 23-33.

² "The Shores of Megalopolis: Coastal Occupation and Human Adjustment to Flood Hazard," by Ian Burton, Robert W. Kates, John R. Mather, and Rodman E. Snead, published by C. W. Thornthwaite Associates Laboratory of Climatology, Final Report Office of Naval Research Contract, Nonr 4043(00) NR 388-073, Elmer, N.J., July 30, 1965, pp. 559-560.

A revetment dissipates waves with less damage to the beach. This is a layer of stone or concrete covering the slope of a dune.

FLOOD DAMAGES DEPEND ON MAN'S ACTIONS

The monetary damage which a flood of given magnitude does, depends upon the extent of the improvements man has made within the flood-prone area.

In some cases, the same natural features which lead to flood damage also provide major values for man. For instance, location at the edge of the beach has great value for a summer cottage, yet this same location exposes the property to the probability of frequent and severe damage. Some business activities are best carried out at the river bank, where transportation facilities, ample water supply, or means of discharging wastes give unusual value to the location; but this same location is likely to have a high risk of flood damage.

Specific historical data on flood damages are presented in chapter 2, and in appendix C a great deal of information is presented on flood damages in selected local areas, and this same information is summarized in chapter 6. A growing population and a growing total economy will put increasing demands upon natural resources of many kinds. Evidence will be presented to show that flood damages have been rising, as have public expenditures for flood relief, because people have been making greater use of flood-prone areas. Many forces will operate in the future to lead toward still greater use of such flood-prone areas. In some cases, an area subject to flood hazard may still be highly economical, because it offers considerable other advantages; but this is not invariably the case. One major concern of any program for insurance and other assistance to victims of floods must be the effect of the program on the tendency toward greater use of flood-prone areas. The short distance between very high-risk areas and low-risk areas, previously mentioned, will often make economic use of some zones possible while at the same time avoiding the use of excessively hazardous zones.

With flood occurrence highly erratic and unpredictable from year to year, obviously flood damages are also erratic and unpredictable from year to year; but, since the probability of flooding in a specific location is measurable, so the probability of flood damage is also measurable in each location. These are aspects of floods and flood damage, which must be taken into account in any insurance or other programs. They are considered at greater length in the chapters which follow.

CHAPTER 2

THE NATION'S PAST RESPONSES TO FLOOD DAMAGE HAZARD

Although comprehensive and fully accurate data are lacking, the available evidence indicates that the flood damage hazard in the United States has been and is rising.¹

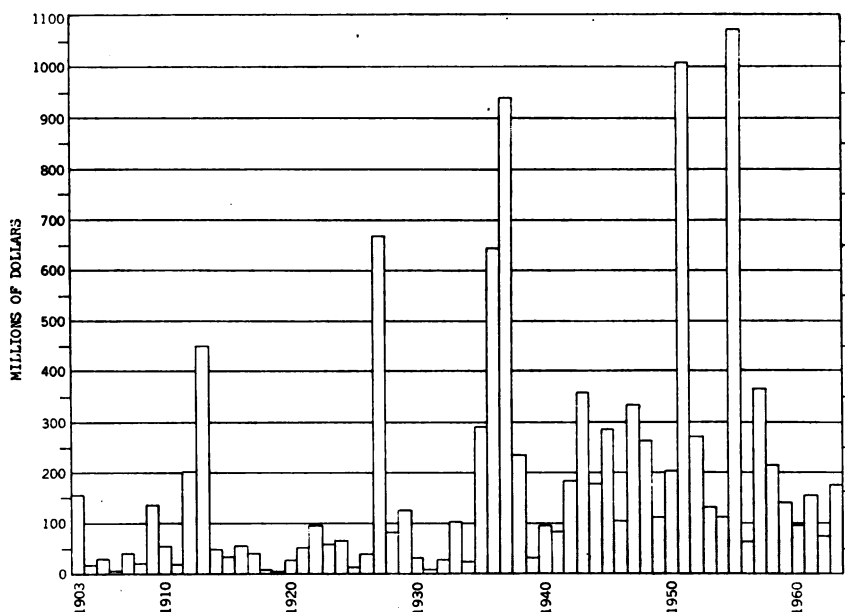
In addition to damage to buildings, there is often damage to bridges, highways, and other public facilities; in rural areas, growing crops suffer damages; and in some situations, the land itself may be damaged or actually washed away, as along the seacoast. In addition to such easily observed damages, floods may cause other economic loss in terms of interruptions to business, extra costs of living while damaged homes are repaired, and others. For some people at least, the risk of floods and the attendant possible danger to life involve further costs of a more psychic kind. In this report, attention is focused on property damage.

Given the erratic timing of floods, discussed in chapter 1, actual flood losses in any one year will only rarely coincide with the longrun average of annual flood losses. The latter have been estimated, from time to time, by the Corps of Engineers and other Federal agencies. Actual flood losses each year have been estimated by the Weather Bureau since 1902; a description of its methodology is given in that agency's statement in appendix B. This is the only statistical series covering any extended period. Briefly, the method consists of sending questionnaires to responsible local officials whenever a flood is known to have occurred, and asking them to estimate damages. These estimates include river floods only, omitting tidal inundation and wave wash, although they do include floods from rivers resulting from hurricane-type storms. There is considerable reason to believe that these estimates of flood damage are too low, even for the kinds of damages included. It is highly probable, for instance, that the hundreds or thousands of very small floods each year, when some small upstream area is briefly inundated, are not fully reported; yet the aggregate damages from this type of flooding may be large. The Weather Bureau is fully aware of the possible shortcomings of its data, but has done the best it could with extremely limited funds at its disposal. Although the resulting damages may be too low, yet the trend in damages is significant. The results are reported in current prices but can be corrected to constant prices.

In terms of 1957-59 prices, flood damages have trended irregularly upward (fig. 6). The record is notable for the occasional very high flood damages years—1927, 1936, 1937, 1951, and 1955. The chart

¹ For a comprehensive discussion of the evidence on this point, see Gilbert F. White, Wesley C. Calef, James W. Hudson, Harold M. Mayer, John R. Sheaffer, and Donald J. Volk, "Changes in Urban Occupance of Flood Plains in the United States," Research Paper No. 57, Department of Geography, University of Chicago, 1958. Although this study was able to examine the record only to the mid-1950's, available evidence suggests that average annual flood losses have become greater, not less, since that date, and additional sums have been spent for flood protection.

FIGURE 6.—ANNUAL FLOOD DAMAGE (ADJUSTED TO 1957-59), FROM U.S. WEATHER BUREAU DATA



does not include 1965, which was another high damage year. Outside of these 6 years, reported total flood damages generally did not exceed \$300 million annually, or at least did not exceed that figure by much, and in many years were less than \$100 million; but in each of these 6 years, reported total damages exceeded \$600 million in every year, and in 3 years exceeded \$1 billion. Next to the irregularity of flood damages, the most obvious fact is the upward trend. The latter can be calculated as about 5½ percent annually; this contrasts with an upward trend in total population of somewhat less than 2 percent annually, and an upward trend in real output per capita also of somewhat less than 2 percent annually. Thus, the upward trend in flood damages is somewhat greater than is due to increased population and increased economic activity. It reflects the tendency to move onto the flood plains, as population grows and economic activity increases.

Although similar data are not available for damages due to unusual tides and waves, resulting from hurricanes and other storms, such evidence as does exist suggests that a similar trend has existed there. Burton, Kates, etc., show that the number of damaging coastal storms has been increasing irregularly also. Figure 5, taken from their study, shows that the frequency of damaging coastal storms increased substantially from the 1935-44 decade to the 1955-64 decade.

People have been moving to coastal and river locations, to live, for recreation, for business, and for other reasons, at increasing rates. Many locations, not previously in demand, are now actively sought for one or another of these purposes. This trend is likely to continue, due to the same forces of growing population and increasing economic activity. If encouraged by public assumption of flood losses, this trend toward increased occupancy of flood-prone areas might accel-

erate greatly; if discouraged or limited to those locations where the genuine advantages more than offset the risks, it might be slowed down greatly. The fact that flood hazard varies so greatly within short distances, as appendix C well demonstrates, means that many of the advantages of such locations can be achieved without excessive increase in flood hazard.

INDIVIDUAL ADJUSTMENTS TO FLOOD HAZARDS

The oldest and the most common adjustment to flood hazards is simply for the individual to bear the losses—to clean up after the flood, to fix up the property as best he can, and to continue to live or do business in the old location. The extent to which this adjustment is made is unknown, but it is certainly very common, especially for the smaller floods. The large floods and those where public relief is needed get publicity, but in total the smaller ones may add up to as large or larger totals in damages and needs.

Individuals can, and do, undertake various measures to protect their structures and contents against damage from floods, especially in areas where floods are common. The buildings may be built above the level of the surrounding land, either by land fills or by putting the structures on pilings or other raised foundations. Various means can be employed to keep water out of structures, including use of sandbags around doors and other openings. Machinery can sometimes be elevated above ground floor level, or can be covered with grease when floods are imminent. Shutting off electricity before flood waters cause circuit shorts can help reduce damages; installations of check valves in sewer outlets, to prevent return sewerage flow in times of high water, can also reduce damage from this cause. These and other measures are considered in appendix F. Economically feasible adjustments of this kind are much more numerous when new buildings are erected, than they are for remodeling of older buildings. They are also more practical when the depth of flooding is low rather than high, and when water velocity is low rather than high. In rural areas, farmers can adjust their cropping programs to flood hazards.

PUBLIC ADJUSTMENTS TO FLOOD HAZARD

Government, at Federal, State, and local levels, has undertaken a number of other adjustments to flood hazards. These activities of Federal agencies, of several States, and the American National Red Cross are described in appendix B. One of the oldest and most commonly used is flood forecasting. This is a major activity of the Weather Bureau. For some kinds of floods, it is possible to forecast probable flood magnitude and timing some days in advance; this is true for any major river system, where the upstream flood of today becomes the downstream flood of tomorrow. The elapsed time between heavy rainfall and the occurrence of damaging floods affects the possibilities of forecasting far enough in advance to be useful to occupants of the flood-prone areas. In some locations, notably the more arid western regions, floods are typically flashy, with an extremely short time between flood-producing rainfall and damaging flooding. Under these circumstances, it is not possible to issue flood warnings soon enough to be of value to the occupants.

Flood forecasting would be nearly useless if it were not coupled with flood warnings. The existence and imminence of floods and damaging storms is brought to the attention of the general public in many ways. The Weather Bureau does some directly, as do some other Federal agencies; in several States, disaster organizations exist, which help to broadcast warnings of floods; and the private communications industry, over newspaper, radio, and television, also carries news about floods and warnings of impending floods. While undoubtedly further improvements are possible, a substantial coordinated program of flood warnings does now exist. The Department of Commerce, however, realizing the need for further improvements, has developed a nationwide natural disaster warning (Nadwarn) plan. This plan was developed for the purpose of improving the detection, forecasting, warning, public reaction, and planning aspects in connection with all natural environmental disasters. These include floods, tidal inundation, and wave wash, as well as riverine flooding. It is impossible to estimate exactly how much flood damages are reduced as a result of flood forecasting and flood warnings, but they are substantially lower; more important, forecasts and warnings help greatly to reduce loss of life from floods. While it may often be impossible to reduce flood damage much, even with ample warning, yet it should be possible to evacuate the threatened area and hence eliminate deaths due to floods.

Various forms of land-use planning and land-use control can be employed to reduce damages from floods. In general, these mean keeping people out of floodways, off flood plains subject to frequent and severe flooding, away from beach locations of excessive flood risk, and other ways of avoiding severe flood hazards. Zoning of land against occupancy, or against certain kinds of uses is only one such mechanism; building codes, which establish mandatory requirements for methods of building construction, are another means of keeping flood damages down; health regulations, to avoid occupancy of areas subject to frequent overflow and threats to health as a result, are another; and reluctance to approve subdivision proposals in doubtful flood-prone areas may be another. These are considered in some detail in appendix G. The situation differs greatly among the States and communities.

For numerous reasons, local efforts to prevent unwise use of flood-prone areas are not completely successful. Largely because of the erratic timing of flood losses, most nonprofessional local people underestimate the hazard of flooding. If there has been no damaging flood for say, 10 years, there is a tendency to think there never will be one, although the hydrologist may well consider the area hazardous. The nearly universal tendency is to regard flood protection works as providing more protection than they were planned to provide or in fact can provide. There are often obvious advantages in locating in some spot, and if in fact there were no flood hazard this might be an excellent location. There are always interested parties who want permission to build in such locations, and they can often be politically effective at the local level where land-use controls are traditionally exercised. Appendix G also considers the legal, planning, and other aspects of such land-use controls. While such controls are yet used in relatively few locations but should be used more frequently, yet there is a clear trend toward greater use of such measures over the past decade or so.

Overall planning and management of flood-prone areas is still relatively uncommon, yet has been undertaken in some locations. The 701 urban planning assistance program is a significant part of this Department's activities in this general field. The Tennessee Valley Authority has undertaken such planning and management, in cooperation with local government, in its region; its efforts are described in appendix B. Some local planning organizations elsewhere have also undertaken similar activities.

Several other measures help the individual to spread his financial loss from floods to the larger public. One of the most obvious is the deduction of losses or costs from flood damage in his income tax returns. Moreover, if the homeowner suffers flood damages, his ability to buy goods and services in the community is reduced, and the rest of the community suffers some loss. Homes subject to frequent flood damage are often assessed at lower values—indeed, their values are less; the community thus gets less tax revenues from such properties; but does not necessarily provide fewer public services to their occupants. When floods strike homes or businesses, delinquencies in debt payments or special terms for debts may be one outcome. The statements in appendix J suggest that this has been relatively small in the past, yet surely must exist to some degree. In all of these, and perhaps in other ways the larger community is affected by and may share in the flood losses suffered by the individual.

FLOOD PROTECTION

One obvious and very old adjustment to the hazard of floods is to build physical works of various kinds to protect a particular local area from the rising waters. At one time, most or all such flood protection works were an individual or at the most a local community responsibility. At one time, for instance, the building of levees to restrain flood waters from the lower Mississippi River was a responsibility of the individual landowner; such local efforts often failed, for they completely underestimated the size and cost of the works required.²

The Federal Government has undertaken flood protection programs for many years. For a long time, these were on designated streams only, as the main Mississippi, the Sacramento, and others. In 1936, a general flood protection act was passed; since that date, some \$7 billions have been spent by the Federal Government for flood protection, and the trend seems clearly upward, at perhaps 7 percent annually.

The various Federal and some State flood protection programs are described in the statements of the respective organizations in appendix B. In response to a questionnaire prepared in connection with this report all Federal agencies with major responsibilities for flood forecasting, flood warning, flood protection, and flood relief prepared reports on their programs. A substantial part of the Federal effort is part of multiple-purpose water programs; flood protection is one purpose of certain works, along with generation of hydroelectric power, navigation improvement, irrigation, provision of industrial and urban water supply, low flow augmentation, improvement of wildlife conditions, and—increasingly—provision of recreation opportunity.

² Robert W. Harrison, "Alluvial Empire," Delta Fund in cooperation with ERS-USDA, Pioneer Press, Little Rock, 1961.

The multiple-purpose aspect is particularly noticeable where dams and reservoirs are involved; the same storage of water can often serve several of these purposes. Adjustments in the operation of the water management program may be necessary, however, to reconcile one use with another.

Federal water development programs are generally based upon a favorable benefit-cost ratio; benefits in total or of certain kinds must exceed costs, each on an anticipated basis for the future. The benefit-cost calculation has tended to eliminate proposed projects which were not economically sound. It is a firmly established and well-recognized procedure in the Federal water program.

The sharing of costs of Federal water development projects which include flood protection as one purpose is variable. In general, the cost to the local area of that part of the total costs allocated to flood protection is usually relatively low, sometimes no more than 10 percent and rarely more than 35 percent. Under these circumstances, a Federal flood protection project is financially attractive to the local community; it gets most of the benefits of the project and yet pays only part of the costs. The Nation as a whole benefits to the extent that healthy local communities are essential to the national economy. Within the local community, the landowners most directly benefited by the Federal project which includes flood protection may pay relatively little of the local community's share of the costs. Sometimes special tax assessments will be levied against benefited landowners, but more commonly the local community costs are borne out of total community tax revenues. To the benefited individual, the Federal flood protection may thus be a windfall.

In many locations the extent and effectiveness of the flood protection has been greatly overestimated by some local people. Residential subdivisions and other developments have occurred in locations where it was asserted or implied that adequate protection was provided by the Federal works, when in fact no such protection had been planned or would be forthcoming. Instances have been encountered where developers were on the river side of the levees, yet were asserting flood protection was available. Such developments have been sold to uninformed and overly optimistic buyers. In several of the areas reported in appendix C, there apparently must have been a complete misunderstanding as to the nature of the flood hazard in the highest risk zone. Building within a highly hazardous flood location not only creates a severe flood risk to the person concerned, but may also create a greater risk of damage to others in the same general locality by interfering with the flow of the water during periods of high water. This is probably part of the explanation for the trend toward greater flood damages, previously noted.

When unwise development takes place, based upon an overestimate of the degree of flood protection actually provided, this increases demand for further protective works. With the greater degree of development of the floodprone area, it may indeed now be true that larger flood protection works are economically justified than would have been the case without such development. But the new works in turn may lead to further development also based upon an overestimate of the degree of flood protection available, and this in turn to still more demand for further protection works. The rising trend in total flood damages during the same years that Federal expenditures for flood pro-

tection have been rising suggests that flood protection works are not a complete answer to all flood problems. They have clearly prevented much flooding damage, and in their absence flood damages might have risen even more than they have. But it also appears that flood protection works have sometimes set into motion processes whereby flood damages were accelerated.

PUBLIC PROGRAMS OF FLOOD RELIEF

A further form of public adjustment to flood hazard has been the extension of relief to the victims of flood and other disasters. Public help to disaster victims is an old tradition in the United States. The American National Red Cross has been extending personal and other relief to victims of natural disasters since 1905, and has expended more than \$300 million in this way. Even earlier, individual and informal local forms of disaster help were extended. The nature of the Red Cross programs is described in appendix B. Its expenditures for flood and hurricane relief have been highly variable from year to year, because of the erratic timing of such disasters, previously noted. It has had a great deal of experience in provision of relief to individuals suffering losses in flood and other disasters.

Since 1950, the Federal Government has been aiding State and local governments in restoring essential public services after floods and other natural disasters; the statement of the Office of Emergency Planning in appendix B describes this program and presents data regarding it. Upon determination by the President that a major disaster has occurred, OEP allocates funds to States and local communities and enlists the assistance of other Federal agencies. The financial help consists of grants, rather than loans, and is for primarily community services, and is for the restoration of essential services on a minimum adequate basis, not necessarily a complete restoration to predisaster conditions. Due to the erratic timing of floods and other disasters, the annual expenditures under this program are highly variable, from less than \$10 million in some years to as much as \$100 million. They have totaled about \$360 million since 1950. An upward trend seems evident; expenditures were relatively large in 1962, 1964, and 1965.

Since 1953, the Small Business Administration has extended special loans to the victims of flood and other disasters. Its operations are described in appendix B, as follows:

* * * disaster loans in connection with floods can be made to all segments of the private sector of the economy. Included are large and small businesses, homeowners, renters, landlords, hospitals, nursing homes, churches, charitable institutions, and privately owned schools. Direct disaster loans made to repair or replace buildings or personal property are made at a 3-percent interest rate. * * * There is no legal limit to the size of an individual disaster loan. However, the maximum which can be approved is that amount needed to repair or restore the damaged or lost property. No physical disaster loans can provide funds for upgrading or expansion of facilities. * * * Disaster loans can normally, by law, have up to 30 years allowed for repayment.

Additional favorable terms can be extended in some cases. Total expenditures for flood disaster loans under this program have naturally varied greatly from year to year, reflecting the erratic timing of flood damages generally. Their total has been nearly \$300 million or, considering the somewhat shorter life of this program, about the same annual average as OEP's grants to States and local communities.

An upward trend is also apparent in process, reflecting the large expenditures in Alaska in 1964 and the large expenditures following Hurricane Betsy in the gulf area in September 1965.

Special attention should focus on these latter two disasters. In the case of the Alaska earthquake the loans extended by Small Business Administration provided for refinancing existing debts—the first time this had been done. By refinancing existing debts at 3 percent interest and allowing up to 30 years to repay the burden of those debts was greatly reduced especially since in Alaska many loans had carried 8 percent interest and had been for shorter terms; even with the new loan on top of the old debt the monthly payments were sometimes less after the disaster than before it. Presently the new SBA loans cover only repair or restoration of the property; if earlier loans existed on the same property the owner or proprietor was still liable for them, and the new loan generous as it was as to term and interest rate was still an added burden as a result of the disaster.

In the Hurricane Betsy disaster the SBA loans included special forgiveness of part of the principal or of some of the interest. Section 3 of the Southeast Hurricane Disaster Relief Act (Public Law 89-339) authorized—

* * * the Small Business Administration, to the extent such loss or damage is not compensated for by insurance or otherwise, (1) shall at the borrower's option on that part of any loan in excess of \$500, (A) cancel up to \$1,800 of the loan, or (B) waive interest due on the loan in a total amount of not more than \$1,800 over a period not to exceed 3 years; * * *

A formula was used to apply the forgiveness feature. This formula provided that the borrower would pay the first \$500, would receive forgiveness for the next \$1,000, and that the remainder of the loan over \$1,500 would provide equal distribution between pay and forgiveness up to a total forgiveness of \$1,800. Thus, an individual qualifying for a \$1,800 forgiveness would be required to secure a loan of \$3,100 or more. The act contained the same provision for agricultural loans. This is obviously a considerable assistance, especially to relatively small borrowers.

Do the more generous terms of disaster loans for the Alaska earthquake and Hurricane Betsy portend a trend toward generally more generous Federal help to victims of floods and other natural disasters, or should they be considered as special circumstances only? If there should be a trend toward greatly more generous treatment of the victims of natural disasters, certainly one of the major restraining influences on location in highly flood hazardous areas will have been reduced. If one knows that the Federal Government will make good his losses when they occur, then gambling on gains exceeding such losses offers less chance of loss and equal chance of gain, compared with the past. Risk of life and some risk of property may still remain, but the costs of location in highly hazardous areas are cut sharply. On the other hand, hearings on appropriations for these two relief operations, plus hearings on other legislation, make it clear that Members of the Congress are concerned to provide a more orderly and dependable method of dealing with disaster than special legislation when each occurs. The request for the present study is an expression of that concern.

CHAPTER 3

POLICY OBJECTIVES FOR ASSISTING FLOOD VICTIMS

Financial assistance policies in flood areas have two major objectives: (1) to help victims of flood damage to restore their homes, businesses, and other property; and (2) to minimize the future risk of flood losses in locations and situations where the risk of loss exceeds the prospect of gain from use of the site.

AID TO FLOOD VICTIMS

Persons who live or do business in flood-prone areas will sooner or later suffer flood losses. As noted in chapter 1, when such losses will occur and how severe a particular flood loss experience will be, are unpredictable; but we can measure, with rather high accuracy, the probable frequency of flooding in each flood zone, and the damages that such flooding brings. In the high-risk areas, the chance that flooding will occur in any year may be 1 in 5; in low risk areas, it may be 1 in 100, or even less.

Moreover, as will be shown in chapter 6, the flood-risk zone within a general flood-prone area which has a high probable frequency of flooding also has high damages due to floods. Likewise, a zone with a low probable frequency of flooding also has low damages due to flooding. Since flood-prone areas differ greatly in their physical characteristics, the correlation between frequency and damages is not so marked when one flood-prone area is compared with another.

Monetary losses from flooding depend upon (1) the nature of the floods experienced (depth of water, its velocity, its silt load, associated wind—especially in coastal hurricanes—and others) and (2) the kind of property affected (its value, the method of building construction, the nature and value of the contents, any special measures taken to reduce flood damage, and the like). The former is largely out of the control of man, except as he may erect flood protection works; the latter is fully within his control.

Individuals who suffer a flood loss in most cases wish to resume living and do business in the same location, regardless of the severity of the flood damage. They wish to rebuild or repair or restore their homes and businesses, essentially to their pre-flood condition. Our concern in this report is with property loss only, not with business or economic loss, nor with inconvenience arising out of flooding.

Money to restore buildings and other property may come from savings, gifts or other outside aid, credit, or insurance—or from some combination of these. If the money is available, the physical restoration of the property usually proceeds at a rate largely determined by the adequacy of local construction facilities to meet the new disaster demands. Our concern is with the necessary funds.

The primary interest of the individual who suffers flood loss is to restore his property as promptly as possible. The community has the

same interest; a flooded-out family is neither a good customer nor a good worker.

MINIMIZING FUTURE FLOOD LOSSES

Financial assistance, if made available, should do more than provide immediate help to flood victims; it should also provide incentives to minimize future flood losses, especially in high-risk areas.

People decide to live or do business in flood-prone areas for a number of reasons: (1) mistaken ideas on the degree of flood hazard, (2) unwarranted optimism that flooding will not occur while they live or do business there, (3) assumptions that the Government or someone will bail them out if or when flood damage occurs, and/or (4) deliberate judgment after a careful balancing of the risks and advantages of the flood-prone location as compared with others. In spite of the flood protection programs of the past 30 years, the average annual flood hazard is now greater than before such programs began, because people have moved themselves and their property into flood-prone areas faster than flood-protection works have been built. Many factors have been responsible for this development of flood-prone areas—the general growth of population, income, and wealth, among others; but it is also clear that the substantial separation of costs from benefits—whereby the general public bears most of the costs of flood-protection works while individual members primarily receive the gains—has been a major factor encouraging such development.

A general program of public relief to those individuals suffering flood losses would solve many of the problems of the individuals affected, but it would also provide a major incentive to greatly increased occupancy of the high-hazard flood-prone areas. The occupant would get the advantage, at the cost of the general public. Over a period of years, or during another generation, such a program of general public relief of private flood losses would lead to a vast increase in the flood loss potential. The type of assistance given should not be determined solely by the need for coping with a present and more or less clearly known hazard, but also by the need for limiting the extent of future flood losses. Regardless of who bears the costs, more flood damage means greater total costs to someone; unless these greater costs are clearly more than offset by prospective gains or advantages, then someone loses when flood hazard mounts.

It seems highly probable that total flood hazard in the United States will increase over the next several decades, even with careful weighing of the risks involved. A growing population, with higher average incomes per person, and attendant increased economic activity of many kinds will probably lead to a greater use of flood-prone areas. Coastal areas, in particular, are attractive for recreation and for living; and many rivering flood areas offer important locational advantages. Increased use of these areas, in spite of flood hazard, may well be economically rational if new occupants bear the full costs of occupancy of such areas.

CHAPTER 4

ALTERNATIVE WAYS OF BEARING FLOOD LOSSES

This chapter focuses on how future programs can be made to serve victims of flooding better, or otherwise better to serve the general public interest.

ONE POSSIBILITY: INDIVIDUALS BEAR FLOOD LOSSES ENTIRELY

At one extreme in a spectrum of possible programs to deal with flood hazards and flood losses is the suggestion that the individuals suffering such losses bear the full costs themselves, with no public help of any kind. This position is held by those who contend that the only solution to the flood problem is flood protection, and that to undertake flood protection in every locality would be too costly. In some locations in fact people have preferred to live with the flood risk rather than to have flood protection works built, even when they have to bear only part of the costs.

This was more or less the situation in the United States 100 years or so ago. The pioneer who settled in a flood plain and got flooded out had to solve his own problems of rebuilding and getting back to a normal life; or the settler along the coast whose house was destroyed had to rebuild it himself. Many owners of seashore property today bear their own risks. This is also, more or less, the situation in many foreign countries today. This "let the occupant beware" philosophy is based on the argument that since the occupant of flood hazard area seeks to secure any gains available by reason of such occupancy, he therefore should bear any losses.

This view has been largely rejected in the United States today. Despite this view, even in those pioneer times, neighbors and relatives rallied around to provide food, clothing, and shelter for those caught in a flood. Many floods have been so destructive that most individual victims could not readily perform the task of their rehabilitation alone. The community has recognized its interest in seeing them get back on their feet.

If any flooded area is declared a national disaster area today, many forms of assistance are available. The American National Red Cross will provide food, clothing, and other help of a personal nature to those who need it most. Rescue operations in severely flooded areas will be carried on by the Navy, Coast Guard, Army, and other Federal agencies. Debris of various kinds will be cleaned up by the Corps of Engineers and sometimes by other Federal agencies, whose costs are reimbursed by the Office of Emergency Planning. Public works will be restored to a minimum safe operating condition by the Office of Emergency Planning. Loans for dwellings, businesses, and farms will be provided through the Small Business Administration or by the Department of Agriculture, or by private lenders insured by the Federal Housing Administration, on much more liberal terms than are

otherwise available. These and other aids have been described in greater detail in chapter 2 and in appendix B.

As a result of these programs, whenever a major disaster strikes anywhere in the United States today, substantial public help and relief are available. However, these programs have sometimes been criticized on one or another of three grounds. In the first place, it has been said that the various programs do not deal adequately with all needs or do not deal fairly with all groups within the disaster area. Even a loan at an interest rate substantially below the commercial rate still means an increased burden on the flood victim—though he may be much better off with it than he would be without it. Unless he goes through bankruptcy, with its consequent effects upon his credit standing, he remains liable for all existing debts at the time of the disaster. Elderly people who were able to get along before the disaster are sometimes unable to carry a loan, no matter how generous it may be, to rehabilitate their home. Likewise, many small businesses may have been marginal, and the flood disaster puts them out of business, in spite of loan availability.

Secondly, much flood damage occurs under conditions that do not warrant a "disaster" designation. For example, a relatively few homes may be destroyed or severely damaged; from a national viewpoint, the loss is not of disaster proportions, though it may be a disaster to the individuals concerned. Or some occupants of flood-prone areas may suffer losses, not collectively enough to be called disaster, yet rather severely crippling to the persons involved. This may happen along the coast, if some summer homes are swept away or seriously damaged. Similarly, the total of upstream flood losses, from streams overtopping their banks, is apparently large, but the loss in any locality is small by national standards. Thus, these areas would rarely be considered disaster situations.

Thirdly, public assistance, no matter how necessary it may be and no matter how greatly it may be appreciated in a disaster situation, is repugnant to many people who value highly their independence and self-reliance. While there is a large public obligation to help in times of natural disasters, the nature of this obligation has been gradually changing, so that some potential victims of flooding are not sure where they stand. Experience in the Alaska earthquake and Hurricane Betsy may or may not imply more generous public assistance in future disasters. Some people, at least, in flood-prone areas expect public help when they are hit by the inevitable flood; realistic students of Government expect some Federal expenditures for assistance to victims of natural disasters. A difficulty is that, under the present arrangements, no one knows exactly where he stands—what he may expect, or what he is required to do.

OPPOSITE POSSIBILITY: PUBLIC BEARS ALL PRIVATE FLOOD LOSSES

At the opposite end of the spectrum of possible programs for helping flood victims bear their losses would be an arrangement whereby the general public—presumably operating through the Federal or some other level of government—would bear all flood losses suffered by individuals. If this possibility were adopted, every individual suffering flood losses of any kind would simply submit a bill to the Government and be reimbursed for his losses. This would solve his personal

financial problems; although he might still run some risk of injury or loss of life in high flood hazard areas. The program might be limited to property losses, or it might also include other losses such as those due to interruption of business. The financial risks of occupying flood hazard areas would be largely or wholly eliminated, as far as the individuals are concerned.

The money necessary to operate a program of this kind might come directly from Federal appropriations. In that case, the allocation of the ultimate financial burden would depend upon the general tax structure; or, more accurately, on what taxes would be considered unnecessary in the absence of such a program. Or this kind of a program might be financed by some form of special taxes, with proceeds earmarked for this purpose. In this case, the burden would fall on those who have to pay the taxes.

Something like the latter program has been proposed at times under the label of "flood insurance." Those who advocate it would require every homeowner or residential occupant to buy such "flood insurance" at a flat annual rate, regardless of his risk of flood damage, if any; the funds so raised would then be used to reimburse the victims of flood damage, wherever this might occur, and regardless of how much he had paid, for his "flood insurance." Those who argue for such a program emphasize the unpredictability of both the timing and geographic location of floods. Since insurance is written by the Federal Government against unemployment, ill health, and old age without calculation of differences in risk, by analogy, flood insurance should be written the same way.

A program of this kind is not, in any reasonable sense of the term, "insurance." The cost to the individual bears no relationship to the benefits he might reasonably expect from it; premiums are not related to risks. It is simply a program of taxation—and of subsidy to those persons in high hazard areas. Anything of this kind could be imposed on people only by law, as taxation. In New Zealand "insurance" covering floods and other natural disasters has in fact been made compulsory by law.

If such a program were called insurance, and were voluntary, it would surely be rejected by the vast majority of homeowners whose flood risk is nominal. It would almost surely be rejected by State insurance commissioners or by the courts as unreasonable, in the absence of a law; if an attempt were made to make it a mandatory condition of eligibility for other forms of insurance, such as fire insurance. Insurance companies would have an incentive to reject such a proposal for it would place them at a competitive disadvantage with other companies that did not insist on such insurance. Some of the associations of insurance companies and some of the State insurance commissioners, in their replies in appendix D, have emphasized the unworkability of this approach. The whole scheme would collapse unless virtually every homeowner or residential occupant could be required to pay. Short of law, it is difficult to imagine a measure that would accomplish this.

In addition to the unworkability of such a voluntary "insurance" program (1) it would be inequitable among citizens; and (2) its secondary effects would be disastrous.

Only a small percentage of all persons in the United States is exposed to any significant flood hazard. Even among this group, the

flood hazard is very unevenly distributed (as will be shown in chapter 6). As few as 1 percent of all dwellings in the United States may have as much as half the total flood hazard and 10 percent have practically all of it. If a small minority of property owners were reimbursed for their flood losses, at the expense of the large majority of property owners who have no significant risks, this would be grossly inequitable.

The equity objections to a general program of relief against all flood loss would be serious enough if we could assume that the present average annual losses were all that we would need to meet. In practice, however, a program of this kind would quickly lead to enormously greater flood losses. If the Federal Government were to insure against all risks, with relatively minor changes to each potential occupant of a flood-prone area, this would constitute an open invitation to occupy such areas. If prospective occupants of flood-prone areas, both coastal and river valley, knew that someone else was going to reimburse them in whole or in large part for any loss they suffered, they would be strongly encouraged to move onto such areas. The price of land in high hazard flood areas now is often low, compared with what it would be if the flood risk did not exist. These would be very cheap sites at present prices on which to locate, if someone else would bear the risks. A large scale program of public risk bearing would surely lead to sharp increases in process of land in flood-prone areas.

Whatever may be the present average annual flood damage, we can be fairly sure that it would increase by a factor of several times during the next decade or the next generation, if all the risks of flood damage were underwritten by the Federal Government. Expensive as it might be at the beginning, its costs would rise sharply and steadily, and needlessly.

INTERMEDIATE APPROACHES

The major deficiencies of each of these two extreme approaches makes it clear that any realistic program of dealing with flood hazards must adopt some middle ground—some private assumption of risk and responsibility, supplemented by some major public programs. The occupants of flood-prone areas must pay a considerable part of the costs arising out of their occupancy, yet some part of the costs for some types of risks may well be borne by public programs. The Federal Government can operate on geographic and time scales that individuals cannot; it can undertake projects extending over large areas and for long periods of time. The real problem is to draw the line between necessary private programs and sensible public ones. Precisely how can the different parts of each interrelate?

Independence and self-reliance are deep-seated American traits, dating back to the extended pioneer period when such traits were not only highly valued but essential for survival and success. Most people in this country today prefer to manage their own affairs, to receive the gains, if any, from their actions, and to take the consequences if things turn out badly. It is true that many people who express this attitude in practice prove eager instead to avail themselves of public programs. Also, recognition is widespread that government programs, especially Federal programs, can provide help on many problems which cannot well be dealt with in any other way. In fact, the mixture of private and public programs is almost universal in the

American economy and society today. It seems necessary for flood hazard problems also.

Such a mix of public and private programs is indeed well underway for flood assistance as the previous discussion of public aids available to help individuals bear their flood losses has already illustrated. However, too often additional public aids have been made available on an emergency ad hoc basis as stopgaps in the absence of a clear-cut overall policy. This study was authorized as the result of a growing recognition of the need for a more consistent and comprehensive approach. For example, in signing the bill last year of which the authorization for this study was a part, the President noted:

This act is the sixth law passed in 18 months for the specific purpose of broadening Federal aids for the victims of the unusually severe succession of disasters experienced since the spring of 1964. In every case, we have had to act on such legislative proposals on an emergency basis. In three of the six cases the legislation was limited to one specific disaster.

Similarly, in expressing his appreciation of the authority and funds voted for this study, the President expressed the hope that—

* * * when it is completed it will provide the basis for developing a workable program of protection for property owners in disaster areas either by extending the insurance plan of pooling the risks or by joint Federal-State sharing along with the private owners the costs of losses arising from uninsurable risks.

A. Federal-State-private loss sharing

The second of the two approaches mentioned by the President (a study of which has been specifically requested also by both House and Senate congressional committees) is a proposal for three-way sharing of disaster losses by the Federal Government, the States, and private property owners. In the specific version incorporated in pending legislation approved by the Senate in 1965 (S. 1861), the Federal Government would make grants to cover up to 50 percent of the disaster losses (within certain limits) incurred by private homeowners and businesses. State agencies would plan and administer the program in their States and pay for 25 percent of the loss, and the private disaster victims would absorb the remaining 25 percent (with the aid, if necessary, of Government loans). No grants would be payable for any loss for which insurance is available and collectible at reasonable rates, or for any loss in any State which does not have an approved plan for such assistance, and approved flood plain zoning controls or other preventive measures in force.

This approach offers several important advantages:

- (1) Aid would be available for almost all eligible property owners suffering significant property losses in States qualifying for Federal assistance.
- (2) Substantial incentives would be created for States to establish and enforce effective zoning controls.
- (3) Victims of disasters could restore or rehabilitate their damaged properties without incurring excessive debt burdens and their creditors would likewise reduce the likelihood of sizable losses.
- (4) The need for a large number of long-term Federal loans at subsidized interest rates and involving extensive administration could be largely avoided.
- (5) By comparison with flood insurance the problem of setting premiums and issuing and selling policies to a large number of policyholders would not arise.

(6) Administration of property appraisals and claims payments would be delegated to the States.

The loss-sharing approach, however, has at least three major weaknesses:

(1) The great bulk of the cost (three-quarters under S. 1861) would be borne by the general taxpayers through direct Federal and State expenditures not reimbursable from the beneficiary (except possibly in savings on other disaster aid).

(2) The present deterrents to investment in properties located in hazardous areas (to the extent permitted by local zoning regulations) would be very substantially reduced, since the Federal and State agencies would carry most of the risk. Moreover, by comparison with insurance, no premiums would be payable in advance to make the extent of the risk more readily visible.

(3) Coverage would be entirely dependent upon the willingness and initiative of the various States to enact the necessary legislation (including possibly requiring constitutional amendments) and to establish and adequately finance the State program. Like individuals, the States may not always be aware either of the extent of the hazards existing or of the potential benefits which such a plan might assure to their citizens.

In short, while loss sharing could, with necessary modifications, greatly improve protection available for property owners in times of disaster, it falls short in major respects from meeting the full requirements for an effective disaster assistance program.

B. Flood insurance

The major method of providing financial assistance for disaster-caused property losses which this study is directed to examine is insurance. By pooling risks and collecting premium from many persons exposed to the same general risks, insurance makes funds available to reimburse those who actually incur the losses at any specific time. This is the normal way in which owners of private property protect themselves against fire, windstorm, and a great variety of other hazards.

The possibility of insurance against flood hazard has been considered several times in the past 20 years; interest has risen following each major flood disaster, and waned in the relatively quiet intervening years. Studies have been made by both the Federal Government and by private industry. Practical flood insurance has proven a tough nut to crack; there are serious problems to overcome, and no practical program has yet been devised. Past difficulties should constitute grave warning against expectation of a quick and easy answer now; but the possibility of new approaches or successful combinations of insurance and other approaches also should not be excluded.

Serious public discussion of flood insurance has paralleled, with a brief lag, flood developments themselves. Immediately following the massive Kansas-Missouri floods in May-July 1951, President Truman requested funds to initiate a flood insurance program. When both appropriation committees indicated the need for broader legislative authority, such a bill was drafted and sent forward in a special message in May 1952 recommending its adoption. With the crisis past, the House Committee on Banking and Currency held brief hearings, but took no action. At that time the property insurance industry expressed its judgment that flood insurance was not feasible on a

business basis, a view derived in part from engineering studies authorized and financed by the industry.

The hurricanes and floods in the Northeast, as well as in California, in 1955, revived and broadened interest in flood insurance.¹ This led to enactment in August 1956 (exactly a decade ago) of the Federal Flood Insurance Act of 1956 (Public Law 1016, 84th Cong., 70 Stat. 1078). Although representatives of the property insurance industry had testified on the impracticability of a private flood insurance program, the industry worked closely with the Federal Flood Indemnity Administration in trying to devise a workable program under the act.² Specific proposals and requests for funds were made to the Congress in the spring of 1957, but criticisms of the terms of those proposals and doubts of their practicality led Congress to deny the requested appropriations. The Housing and Home Finance Agency abolished the Federal Flood Indemnity Administration, effective July 1, 1957, and its unspent funds reverted to the Treasury. This law remains on the books, but has not been implemented. Since it included specific dates by which certain arrangements were to become effective, it is now obsolete in part, even were there agreement to make its general provisions effective.

Interest in flood and other disaster insurance was renewed after flood disasters in 1962 and especially after the Alaska earthquake disaster of 1964. Hurricane Betsy in September 1965 provided the final impetus which led to authorization of the present study. During these years, the property insurance industry has made additional studies, in an effort to arrive at an industry consensus on flood insurance.

This capsule history of flood insurance is not intended to provide an adequate review of the considerable thought which experienced men have given to this problem, but merely to emphasize the present study is not the beginning—and certainly not the end—of discussion and debate on this very difficult and important subject.

The advantages of an insurance program are too often taken for granted, rather than explicitly recognized. Some of the most important are the following:

(1) Insurance would provide funds in adequate amounts and promptly to assure rehabilitation or restoration of damaged property to the pre-flood status or to permit comparable investment elsewhere. Once the system is set up no one with a verified claim would need to wait for legislation or appropriations, or would have to pass a means test, to be reimbursed.

(2) It would replace temporary or partial aids, such as loans at subsidized interest rates with the long-term burdens they impose on borrowers.

(3) It would involve minimum net cost to the general taxpayers, since even if some Government aid is still required, the bulk of the funds would be provided in advance by the policyholders themselves.

¹ A comprehensive report was prepared by the staff of the Senate Banking and Currency Committee ("Federal Disaster Insurance," report of the Committee on Banking and Currency, U.S. Senate, staff study, 84th Cong., 2d sess., Rept. No. 1313, Jan. 9, 1956) which provides the best and most inclusive treatment of the general problem; the specific problems it discusses are still unsolved.

² A detailed account of the history of this act and of its proposed program is not included in this report, nor is there a detailed analysis of the terms of the proposed program.

(4) It would distribute the costs of flood damage more equitably since those incurring the greatest risks in general would pay the highest premiums.

(5) Most important from the public viewpoint, it would provide much stronger incentives than now exist to discourage future investment in high-risk areas and to encourage flood proofing or other protective measures when the benefits exceed the true social costs of the investment.

This list, while not exhaustive, establishes a strong presumption that an insurance program would be the best type of assistance to flood victims.

Critics of flood insurance concentrate almost entirely on the difficulties and problems of devising a workable and effective insurance system. Some of the major problems identified are the following:

(1) Establishment of insurance would require extensive preliminary work to measure and rate probable risks for different locations and types of property and to establish a manageable rate structure.

(2) The lack of interest in insurance protection in the bulk of the Nation where flood risks are nominal, and the very high premiums which would be required in flood-prone areas would make it difficult to sell enough policies to spread the risk and expense efficiently.

(3) The administrative and selling costs would absorb a relatively large share of the total premium income.

(4) Many property owners in flood-prone areas could not afford the high premium which a full-cost rate structure would entail, and/or would regard either compulsory purchase of insurance or failure to provide insurance protection at reasonable rates on their past investment in such area as inequitable.

(5) The catastrophe risk would be much greater than for most hazards.

Most of these problems and a few others are advanced by the various representatives of the insurance industry in their answers to specific inquiries to be found in appendix D. Later chapters of this report examine the issues in more detail and suggest specific actions designed to overcome these difficulties. Appendix H contains an extensive report on the feasibility of an insurance program prepared by a leading insurance consultant. His overall verdict is:

Based on all the available information, the conclusion is inescapable that a flood insurance program, based on the standards generally recognized in the insurance industry as appropriate, is feasible. Although either a private or a governmental flood insurance program would be feasible, a joint industry-Government effort in both insurance and related fields, such as disaster relief and loss prevention, seems the most promising of the greatest good to the greatest number at least cost.³

Recommendation.—A national system of flood insurance should be established with Government assistance or participation to the extent necessary to assure a workable method of pooling the risks, minimizing costs and distributing burdens equitably among the property owners protected by such insurance and the general taxpayers.

³ John S. McGuinness Associates, "A Feasibility Study of Flood Insurance," June 1966.

Insurance of all kinds is deep in the American tradition. Members of various groups pool their risks by means of insurance. Each bears a small part of the risk, by the regular premium or periodic assessment that he pays; none is exposed to a risk of truly major loss. Insurance is costly, in a social sense, because administrative and operational costs are unavoidably incurred, and these may run as high as half of the premiums paid. But insurance is also highly productive in a social sense, because some risks inherent in life are reduced to a size that the individual can cope with.

CHAPTER 5

FLOOD INSURANCE IN RELATION TO OTHER PROGRAMS

Private and public objectives in flood insurance are not identical, though they may be complementary. The present occupant of flood-prone areas and those businesses which serve him (the construction industry, for example) want money available promptly to rebuild and to repair buildings and contents after a flood damage occurs. The primary objective from the private point of view, is to have adequate money available when flood damage occurs, so that rebuilding and restoration may proceed promptly.

The public objectives of flood insurance are twofold: (1) prompt restoration of the flooded areas to economic health; and (2) minimization of future flood damage hazard. If the latter increases then the total national economy must some way bear the increased cost. From the public point of view the secondary consequences are extremely important; the relief aspects cannot be considered alone but their bearing upon the future hazards must be considered.

Actuarially sound flood insurance can meet both public and private objectives: it provides the funds for rebuilding and at the same time it could provide the best measure of the relative costs of occupying the flood-prone areas. No program should be undertaken in the name of "flood insurance" which in practice is likely to fail to meet both the private and the public objectives.

SITUATIONS IN WHICH FLOOD INSURANCE MIGHT BE APPLICABLE

Flood insurance might be applicable in a variety of different situations. However, the cost, the benefits, and the general role of flood insurance would differ according to the characteristics of each situation.

In one case, flood protection works are impractical or are not economically justified. Sometimes there is no ready site for a flood storage reservoir; or the cost of the land alone for such reservoir, or for levees or dikes, would be prohibitively high. In other instances, the minimum scale of physically effective flood control works may be so great, and hence the cost so high, as not be worthwhile for the comparatively small development within the flood-prone area. In some of the sample areas reported in appendix C, flood protection projects have been studied and considered economically unsound or impractical. This may be the case in many coastal locations, where works to protect against tidal inundation and wave wash in the event of a severe hurricane, might be physically ineffective or unduly costly.

A somewhat similar yet somewhat different situation arises in locations where economically sound flood protection works are possible, but funds to construct them have not yet been appropriated. The backlog of authorized flood protection works for which funds are not yet available for the Corps of Engineers is relatively large; almost

half of the works authorized each year are not built for several years for lack of funds. During the interval between authorization and construction of flood protection works, insurance might provide financial protection.

There are other situations in which flood protection works might be physically effective and yet destroy the qualities of the site which give it value. This is particularly common in coastal situations. People want to locate on or near the beach to enjoy the view of the sea and to have ready access to beach and sea. Such locations are likely to have severe flood-damage risk. Sea walls or other structures can sometimes be erected, which reduce damage from flooding greatly; but they also may cut off the view of the ocean, and even ready access to it. In some cases, wave action pulls sand away from the foot of the wall, thus creating a difficult barrier to access to the sea, even for adjacent residents. In many coastal situations, local people have rejected proposals for flood protection works, for just these reasons—even when most of the cost would be paid for by the Federal or other government. They prefer unimpaired access to the beach and sea, with its attendant flood hazards, to protection works which reduce hazard but impair access. Under these circumstances, flood insurance might provide such property owners with a means of protecting themselves against severe flood losses.

Even when flood protection works are built, some risk of flood damage remains. Flood "control" is never absolute; the highest levee or wall can be topped some day, the largest dam fill to overflowing. Moreover, the greater the degree of protection, the higher the cost; and at some point, greater protection may cost more than it is worth. Insurance against the residual risk may be practical. Such insurance might be unattractive from the viewpoint of private insurance companies, for often the possible flood damage might be very great yet highly infrequent. Premiums would be relatively low in these protected areas, because of the infrequency of floods after the protection works were built, yet losses might be large when they did occur. As more and more flood protection works are built, this situation will become increasingly common.

Flood insurance cannot work miracles, nor is it costless. Insurance is a way of helping to bear costs, not a way of making costs vanish. Someone must pay for flood insurance, just as someone has to pay for every other kind of insurance.

FLOOD INSURANCE IN RELATION TO OTHER PROGRAMS

Flood insurance, along any of the organizational lines suggested later in this report or in any other form, would necessarily have to be complementary to other flood programs now existing, not competitive with them. Wherever flood protection works are economically feasible, they would generally be desirable. Under existing Federal law, all the benefits to whomsoever they should accrue must exceed all the costs. Insurance programs might serve to discourage unwise occupancy of high flood-risk areas, but in itself flood insurance would not reduce flood damages to present properties. Flood insurance can provide financial help, but protection against floods is provided by other programs; the two are complementary, not rivals.

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Likewise, flood insurance would depend upon a continuance, and preferable upon an extension, of present flood forecasting and flood-warning programs. The more effective the later could be, the lower would be the flood damages to insure against. Just as life insurance companies have found it advantageous to participate in health education programs, as a means of lowering death rates, so flood insurance programs might aid in improving flood forecasting and flood warning programs.

Land-use planning of flood-prone areas, to keep development out of areas where risks are higher than probable gains, would also be a valuable adjunct to flood insurance. Such land-use planning would not only tend to reduce the creation of new high-risk zones; it would also help to prevent the damages rising in present areas because of the effects of new structures on streamflow when floods did occur.

An effective program of flood insurance would not completely remove the need for a program of relief to flood victims, certainly not for many years, if ever. Flood insurance, is widely used, would provide financial assistance to insured flood victims. There would probably still be a need for personal relief following flood and other disasters, of the type the Red Cross now extends. But there might well be some individuals who did not have flood insurance, in spite of every effort to make such insurance universal. At best, there will be a period of years during which flood insurance is gradually extended to properties in flood-hazard areas. Many persons will not see the need for flood insurance until a flood hits with disastrous force; this is analogous to the old situation of not fixing the roof until it rains, when work on it is impossible. Relief might also take the form of loans such as the Small Business Administration now extends to disaster victims.

COST SHARING OF VARIOUS FLOOD PROGRAMS

A major consideration of every public program concerning floods is: Who bears the cost? The costs of various methods of coping with floods are borne in a variety of ways. The cost of flood forecasting and flood warning systems is nearly all publicly borne; the benefited individuals do not pay for them, except as they pay taxes generally. Such programs are similar to fact gathering, research, and education programs generally, which have traditionally been provided at general public expense for all sectors of the public interested and able to take advantage of them. As noted, by far the greater part of the cost of flood protection works is borne by the Federal Government, and nearly all the remainder is borne by State or local government. Only rarely does the benefited landowner share in these costs directly. The same is true to a considerable extent of flood relief programs, which frequently take the form of low interest rate loans. The borrower pays an interest rate roughly half of a market rate, and in other ways has terms more liberal than fully private loans. The local community which gets a grant of Federal funds to restore its public services may have to expend some of its own funds as well. In all this range of flood programs, by far the greater part of the costs are borne by the public at large, and very little by the individual victim of flood disaster.

In sharp contrast is the situation where the individual bears the costs himself—where flood protection works are absent, where flood

relief is not extended because the disaster is not a major one, and where flood forecasting and warning may have very limited value to him. As noted previously full data are not available but it seems likely that many occupants of the smaller stream flood areas and of coastal locations do bear all the costs of flood damage themselves. Even in some of the flood hazard areas along larger streams, the individuals may still continue to bear a substantial part if not all of the cost of flood damage.

How might flood insurance fit into this picture? Some specific proposals are provided in later chapters, but it should be pointed out here that the way the costs of flood insurance are assessed against occupants of flood-prone areas, on the one hand, and against the general public, on the other hand, will have much to do with public acceptance of flood insurance. If occupants of flood plains can get flood protection nearly free to themselves, but must pay for flood insurance, they will naturally choose flood protection, if they can get it. The answer to divergence in cost-sharing between insurance and other flood programs may not lie wholly in the direction of making insurance cheap; perhaps beneficiaries of flood protection and other programs can be made to bear a larger share of the costs, more nearly commensurate with the benefits they receive.¹ At the least, however, a realistic appraisal of flood insurance must consider the way in which costs of various flood programs are shared, as between the direct beneficiary and the general public.

Flood insurance would provide an efficient and easily usable mechanism for balancing the costs and advantages of increased use of any area with a flood hazard. Knowing what the cost of insurance would be, any prospective occupant could decide if the advantages outweighed those costs. If he did so, he would know the cost of locating in a flood-prone area; if he did not, it would be because the cost was a deterrent. For this rational choosing process to be effective, it is essential that the person making the choice both reap the advantages and bear the costs that would follow a decision to locate in the flood hazard area; he should pay the full premiums on actuarially sound flood insurance. Flood insurance would be particularly valuable to those prospective occupants of flood hazard areas who make rational choices based upon weighing advantages against costs.

¹ "A Unified National Program for Managing Flood Losses," report by the task force on Federal flood control policy, U.S. Bureau of the Budget, 1966.

CHAPTER 6

FLOOD HAZARD AS IT AFFECTS FLOOD INSURANCE

The foregoing chapters have provided a general introduction to floods, flood programs, and flood insurance. A major consideration for the latter, as for any kind of insurance, is the risk or hazard which is being insured against. In this chapter, the best available evidence on the nature of the flood hazard, as it affects flood insurance, is presented.

METHODS OF MEASURING FLOOD HAZARDS

Two methods of measuring flood hazard risks have been proposed (1) by using annual flood damages either in total or by regions for the United States, and (2) by using hydrologic data to evaluate the average annual damages in each flood-prone area.

The first of these methods has been appraised on numerous occasions in past years and rejected as not feasible because no completely satisfactory source of countrywide flood damage data exists. The Weather Bureau collects data on annual flood damages. (See app. B.) The methods of collection have been criticized, with justification, as giving neither accurate nor complete coverage for the United States. Damages from catastrophic events receive broad attention while damages from lesser floods are frequently unreported. The accuracy of the data has improved in recent years, but lacking funds to undertake a systematic appraisal of the losses incurred by each event, much of these data are obtained indirectly from a variety of sources. Closely associated with these deficiencies in data on flood damages in the United States is the lack of uniformity in appraising and defining direct and indirect losses. Unknown amounts are spent in relief and rehabilitation of flooded areas.

Not only are long reliable records of flood damages normally associated with other forms of insurance risk lacking, but even if available over long periods of time, either for the country as a whole or for isolated flood-prone areas, they would not provide a basis for assessing the risk to individual properties. It is readily apparent, therefore, that the general records of flood damage available for the United States, or by regions, do not provide an adequate basis for use in actuarial analysis for underwriting flooding damage risk.

The alternate approach, the use of the hydrologic data is subject to rigorous analysis and is, therefore, the approach used throughout this study. The hydrologic method uses the techniques of analysis developed and widely used by hydrologists and hydraulic engineers for many years to determine the economic feasibility of flood protection and flood-abatement projects. In such determinations of feasibility, which compare benefits from an installation to its costs, the benefits measure the damages to property that would be prevented by the proposed project. Out of this widespread use of the benefit-

cost approach have come standard techniques for integrating flood frequencies with damages to properties from flooding. There is nothing new in the method, only its application to insurance rates is of recent vintage.

HYDROLOGIC METHOD OF ESTIMATING FLOODING DAMAGE RISK

The hydrologic method uses available data on the occurrence of floods and flood damage but is considerably more sophisticated than merely averaging losses over a period of time. The method is explained in detail in appendix C and discussed in this chapter.

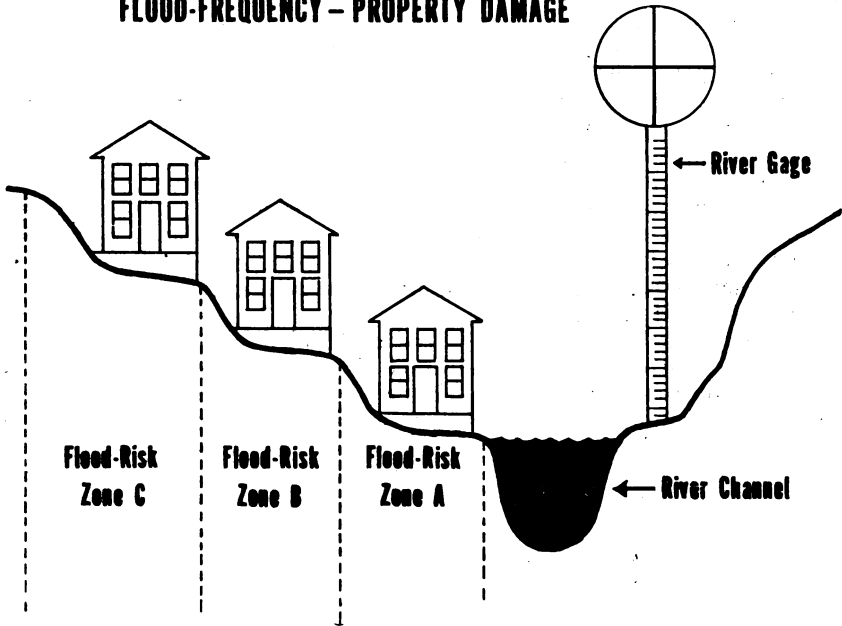
The hydrologic method employs two basic elements (1) the flood magnitude-frequency relation, and (2) the depth-damage relation to answer the two basic questions:

1. How often do floods occur?
2. How much damage does a flood of given height cause?

How often do floods occur?—Floods of different heights recur at different time intervals or frequencies. For the purpose of the current study, the flood-prone areas have been divided into zones, each zone defined by the frequency at which the zone will be flooded (partially illustrated in fig. 7) as follows:

FIGURE 7

FLOOD-FREQUENCY – PROPERTY DAMAGE



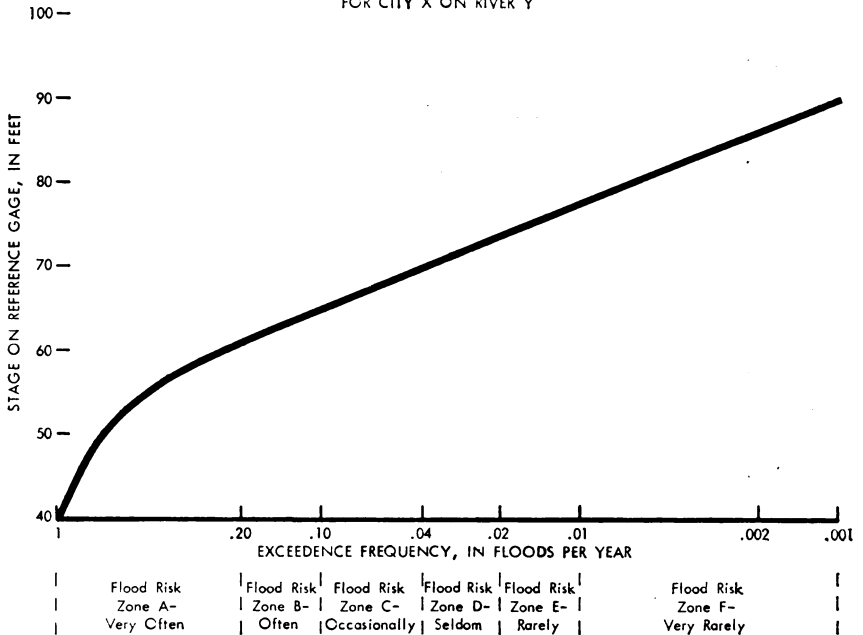
Flood risk zone	Frequency range, in years	Chance of occurrence each year (percent)	Will be flooded
A-----	(¹)	40	Very often.
B-----	5-10	13.3	Often.
C-----	10-25	5.7	Occasionally.
D-----	25-50	2.7	Seldom.
E-----	50-100	1.3	Rarely.
F-----	100+	(²)	Very rarely.

¹ 5 and under.
² Less than 1 percent.

The residence shown in flood zone A in the figure will be subject to a much greater flood risk than the residence in either B or C; the residence in B will be subject to a greater risk than C but less than A, et cetera. Thus, each risk zone is defined by a different frequency range of flooding, decreasing from the "most often" in A to the "very rarely" in F.

FIGURE 8

HYPOTHETICAL STAGE-FREQUENCY CURVE FOR CITY X ON RIVER Y



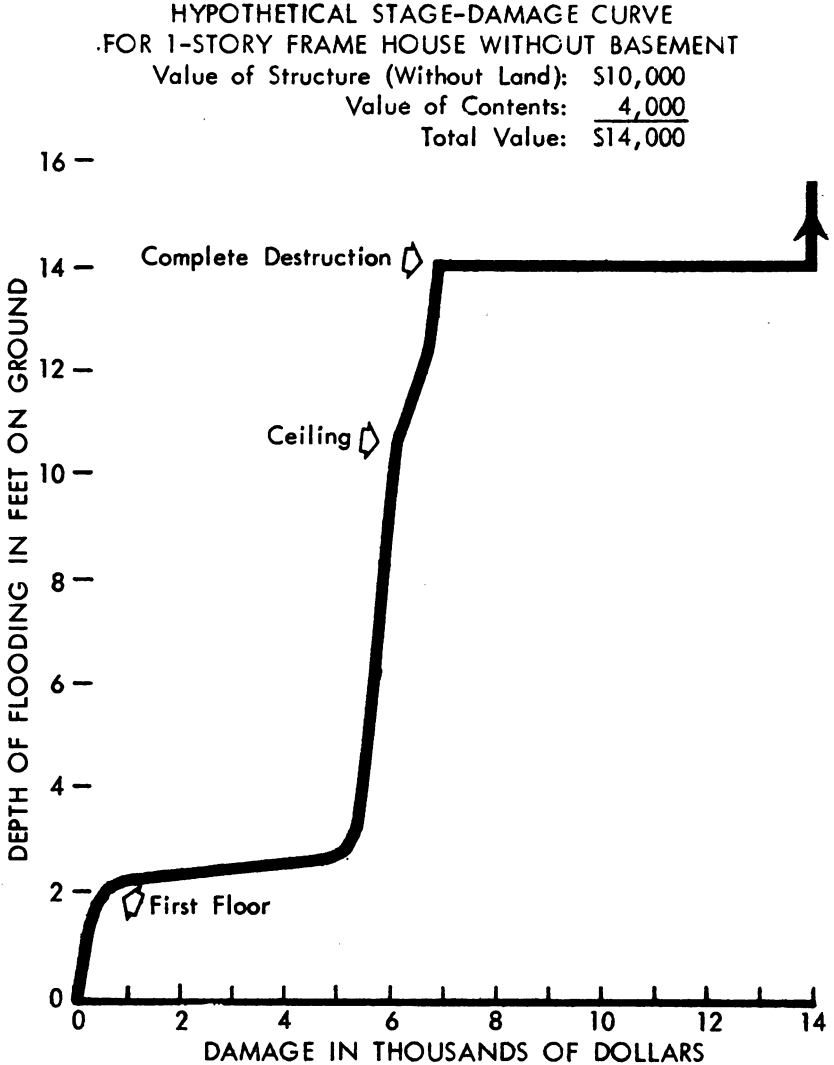
The hydrologic approach to the frequency of flooding relates the stage and time elements through a stage-frequency curve (fig. 8), which shows how often a flood of any selected height will recur, on a long-term average. In his figure, the highest flood in each year will exceed a stage of 64.6 feet on an average of once every 10 years, 69.7 feet once every 25 years, and so on.

How much damage does a flood of given height cause?—Flood frequency cannot be considered alone but must be related to damages. The damages that a property suffers are directly related to the depth of

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flooding. The residence, or other property, in flood zone A (fig. 7) will not only be flooded more frequently than the properties in zones B, C, et cetera, but will be flooded to greater average depths than in B or C, B to greater average depths than C but less than A, etc. Thus, each risk zone has a different average depth of flooding ranging from the greatest average in A to the least average depth in zone F.

FIGURE 9



The hydrologic approach relates the extent of damage to the depth of flooding through the use of a depth-damage curve. Figure 9 is an example of a depth-damage curve for a one-story frame residence without basement (value \$10,000) and contents (value \$4,000).

In the figure, if the residence is flooded to depth of 2 feet, it will suffer \$700 damage; to a depth of 10 feet, \$6,000 damage, et cetera.

The computation of the average annual damages—the basis of a flood insurance premium structure—is accomplished by combining the stage-frequency and depth-damage curves and integrating the combined relation (table 1). In the table, a 2-foot depth of flooding (col. 1) occurs at 69.7 feet on the gage (col. 2); 69.7 feet is at the 25-year recurrence level (col. 3), or exceedence frequency 0.04 flood per year (col. 4), and there is \$700 in damage (col. 6) at this depth of flooding. A sufficient number of points on the curves is computed to obtain the annual increments of damage (col. 8), and the sum of the increments shows average annual damage of \$250.25. When divided by the value of the property, \$14,000, the quotient is the rate of \$0.017875 annual damages per dollar value, or \$1.79 per hundred dollars of value for the residence in flood zone C.

TABLE 1.—Standard method of computing rate of average annual damage for 1-story framehouse, no basement, located in flood-risk zone C (recurrence interval 10–25 years) in city X on river Y; house value: \$14,000 (structure, \$10,000 and contents, \$4,000)

Depth on ground (feet)	Stage on reference gage (feet)	Frequency of flooding		Floods per year between depths	Probable damages in dollars			
		Recurrence interval (in years)	Exceedence (floods per year)		At each depth	Average	Annual increments	Cumulative
0.....	67.7	17.5	0.057143	0.017143	0			0
2.0.....	69.7	25	.040000	.007742	\$700	\$350	\$6.00	\$6.00
3.0.....	70.7	31	.032258	.004480	5,220	2,960	22.99	28.92
4.0.....	71.7	36	.027778	.007778	5,420	5,320	23.83	52.75
5.7.....	73.4	50	.020000	.006667	5,570	5,495	42.74	95.49
7.9.....	75.6	75	.013333	.006667	5,790	5,680	37.87	133.3
9.6.....	77.3	100	.010000	.008333	5,920	5,855	19.51	152.87
11.0.....	78.7	130	.007692	.002308	6,150	6,035	13.98	166.80
13.0.....	80.7	190	.005263	.002429	6,750	6,430	15.67	182.47
14.0.....	81.7	225	.004444	.000819	6,830	6,790	5.56	188.03
			0	.004444	14,000	14,000	62.22	250.25

Rate of average annual damage:

$$\frac{\$250.25 \text{ (average annual damage)}}{\$14,000 \text{ (value)}} = 0.017875.$$

Similar tables are computed for a selected property as if this property were located in every other flood zone, to establish a rate of average annual damages for each zone (table 2). The procedure is repeated for each category of property in each flood zone to establish rates of average annual damages for different types of property.

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TABLE 2.—Rates of average annual damage per \$100 of value of structure and contents for 1-story frame houses, no basement, located in various flood-risk zones in city X on river Y. (Contents valued at 40 percent of structure value)

Frequency of flooding		Annual damage per hundred dollars of value
Recurrence interval: Flood-risk zone	Exceedence (floods per year) ¹	
A: Very often (0 to 5 years)	0.40	\$14.50
B: Often (5 to 10 years) .....	.133	4.22
C: Occasionally (10 to 25 years) .....	.0571	1.79
D: Seldom (25 to 50 years) .....	.0287	.88
E: Rarely (50 to 100 years) .....	.0133	.41
F: Very rarely (100-plus years) .....	.00667	.21

¹ Level indicated is midfrequency of zone except for zone F, which is 150-year level.

Any program of insurance involves risk. A new program, such as flood damage insurance is a greater risk than a well established program having many years of experience behind it. The basic question is: Can the risk of flood damages be evaluated with sufficient reliability?

First, it should be emphasized that any estimates of flood damage risk are just that—estimates, even under the best of conditions. These estimates may closely approximate the true risks, or they may not. It is not the hydrologic method which is deficient, but the available data. The latter may be deficient, in part, because some measurements—principally, flood records—have not been made for sufficiently long periods of time or because modern experience has simply been too short in some areas. The hydrologic method and the data used in the method are readily adaptable for rate determinations. The method will yield the best possible estimates of any method known, and estimates which are fully adequate for a flood insurance program.

Data for computing the flood magnitude-frequency relations are available in publications and reports of several government agencies. Some of the agencies and many students of hydrology have published descriptions of methods used to compute flood magnitude-frequency relations. Where natural flood data are not available for a flood-prone area, peak rates of runoff can be determined by regionalization or generalization of peak rates of runoff from other areas having similar flood-producing characteristics, or, by analogy, from records of precipitation. There is a wealth of experience available which can be drawn upon to interpret the data and apply the methods.

Depth-damage relations are commonly used by governmental agencies and private organizations in assessing damages for flood-control studies. Some of the relations have been documented; for others the data will need to be rearranged, adjusted for trends, and supplemented by additional field work to adapt it to a flood hazard risk program. Where such data are not available from project studies of past floods, damages can be synthesized by transposing the data from other flood experiences having similar damage producing characteristics. In synthesizing the probable damages for flood-prone areas where flooding damage experience is not available, the probable effect of factors (inundation duration, sedimentation, velocity, etc.) other than just depth must be evaluated to insure that they represent

conditions in the area under consideration. Here again, there is a wealth of experience ready to be enlisted to assay probable damages for flood-prone areas.

Combining the damage and frequency factors into a damage-frequency relation and computing the average annual damages is but an adaptation of methods in common practice for flood-protection works. It is simply the integration of the damage-frequency relation between the frequency limits of the location of the property and zero floods per year. The upper limit is hypothetical, but the risk at any frequency level includes all floods up to the point of zero floods and therefore is included in the computations. The upper part of the risk computation is the weakest link in the computation of the rate because of the uncertainties involved in the rare frequencies of flooding in the higher elevations of the flood-prone area. The weakness lies in the extension of the flood magnitude-frequency relation above the 100-year level. Hydrologists differ on the method of extending the frequency distribution but are in general agreement that the project-type of curve has, over the years, given frequencies sufficiently conservative to insure against failure to meet the frequency demands of flood-control projects. Certainly, then, the project-type of curve can be equally adequate to measuring flood risk for flood insurance purposes. Irrespective of the system used in computing the frequency distribution, a comparison of the results indicates beyond a reasonable doubt that any differences can be resolved by consistent use of technical judgment to produce a reliable flood magnitude-frequency relation. However weak the computation of floods above a 100-year level may be judged, the damage is a small percent of the total risk in the zones of more frequent flooding; the percentage increases with progression into the zones of less frequent flooding to possibly 100 percent of the risk above the 100-year level, but the total risk decreases from a matter of dollars per hundred dollars of value in the more frequent zones to a matter of cents per hundred above the 100-year level.

The data used in the hydrologic method lend themselves to statistical techniques and analyses. Flood events at a specific location occur with sufficient randomness to warrant use of statistical techniques on that assumption. The evidenced lack of randomness between flood events on adjacent or nearby streams strengthens the hydrologic method by permitting regionalization of flood events to determine the frequency of flooding for ungaged areas; this lack of randomness may, however, incur some difficulty, though not to the degree of becoming a deterrent, to some statistical analyses, such as the behavior of the insurance reserve fund.

The data on damages are adjustable to trends in occupancy and values within a reasonable time limit. Annual costs of flood damages have increased over past years, and observers of the trend predict that damages will increase at an accelerated rate in the future. It is reasonable to anticipate that the occasional occurrence of a year of catastrophic damages will recur with increasing frequency in the future because of increase in occupancy of flood-prone areas. In any hazard risk, the program must be examined periodically to adjust the rates to loss experience. The necessary adjustments to keep the program in close focus with future trends in damage experience are well within the technical and operational procedures of a flood risk program.

The hydrologic method of computing flood hazard risks differs from the methods of analysis usually associated with other types of casualty risks. Only the technical approach is different; the results of the hydrologic method have parallels in other forms of risks. The occurrence of other forms of casualty is not predictable, but its probability of occurrence can be estimated with sufficient accuracy to permit rates of losses to be established for insurance purposes. The hydrologic method will do the same for a flood risk program. As in other forms of casualty risks, the results of the hydrologic method spread and share incurred losses over all insurers having similar probabilities of risk; the results delineate degrees of risk; and the probable average annual damages as determined by the method are a direct measure of the risk involved.

In summarizing the reliability of the hydrologic method: (1) it is the best method for estimating flood damage risk, (2) over the years it has offered strong assurances against failure of flood-protection and flood-abatement projects and will do no less for a flood risk program, (3) data are available to put into the method, (4) there is a wealth of experience available to interpret the data and apply the time-proven method to a flood risk program, (5) the method and the data both permit review and adjustments for trends and changes essential to any casualty risk program, and (6) there are no differences in the elements of analysis that cannot resolve into a consistent reliable basis for a flood risk insurance program.

MAJOR VARIABLES IN FLOOD INSURANCE PREMIUMS

The flood magnitude-frequency and depth-damage relations are the basic elements in determining the flood damage risk in a flood-prone area. There are many variable factors that affect the computation of these basic elements or enter into the computation of average annual damages, which must be considered in determining the rates of losses for a flood-prone area. Because of these variables, one or more magnitude-frequency relations must be computed for each flood-prone area, and the depth-damage relations for each class of property must be adjusted to all the variable factors peculiar to each flood-prone area.

The frequency range of exposure between the point of initial flooding and the upper limit of zero flood per year (infinite year recurrence interval) is defined by the flood magnitude-frequency relation. The vertical range may vary from a few feet on smaller streams to 50 or more feet on the larger streams. Trends in occupancy of the flood plain, encroachment on or over the stream channel or flood plain, urbanization, scouring and filling of the stream channel can vary the magnitude-frequency relation over a period of years at the same point on a stream. Thus, flood magnitude-frequency relations are similar in some respects but not in the same way because of local influences, and therefore, must be computed for each flood-prone area and tested periodically for changes.

Damages vary from one flood-prone area to another because of the many variable factors, both natural and imposed, which influence the rate at which damages are incurred during a flood. Climate, duration of inundation, high velocity, excessive sediment deposition, location, type of occupancy, and type and quality of construction are some of

the major variables in damage determinations, which must be evaluated in each flood-prone area.

Climate is the chief factor influencing the occurrence of floods (ch. 1 and app. A). It is also a major variable affecting flood damages. In the arid and semiarid sections of the country, a flood of given frequency is not as great in magnitude as it is in the more humid sections, but a flood of rare frequency can be equally as damaging in any location. In the northern latitudes, the maximum annual flood stage usually occurs on the peak of the spring melting of the winter's accumulation of snow. If the spring breakup is delayed into the period of spring rains, a flood of major proportion in both frequency and damage is likely to occur. If backwater from ice or other temporary obstruction downstream raises the flood height above the open-channel stage for the same discharge, the flood is of greater magnitude, but allowance for such an occurrence is usually reflected in the magnitude-frequency relation for northern flood-prone areas. Floating ice, when accompanied by high velocities, freezing, and frost action accelerate the damages and result in higher loss rates.

Damages by the hurricane-type storms, that range the gulf and Atlantic coasts in the summer and early fall seasons, result from a combination of high winds, higher than normal tides and surges that inundate the coastal areas, and heavy precipitation accompanying the storm, so that it is difficult to isolate any single causative factor contributing to the total damages. Damages to agricultural crops is seasonal, but also variable within the growing season as well as with the depth of flooding. Climate, then, a major factor in the cause of floods, is also a major variable between flood-prone areas in both the frequency of flooding and in damages resulting from flooding.

Duration of inundation, or the period of time required for a flood crest to rise and return to the stream channel is associated with the steepness of terrain in the contributing watershed, snowmelt floods, ice jams, and downstream constrictions. The flood crest of a mountain stream will pass in a few hours, or less, while the crest of a sluggish stream in flat terrain may last a day or even days in extreme cases. The longer the period of inundation the greater the deterioration of both structure and contents. Damages reach a maximum in a stream like the lower Mississippi River. Flood crest-damage relations must be adjusted accordingly.

High velocity, usually associated with streams having a steep gradient, increases the risk of structural damage, breakage, and loss of contents. Impingement of velocity on the outer circumference of a bend in the stream channel points to higher probable damage in close proximity to the impingement. The point at which velocity alone becomes significant is conjectural because it can be accompanied by floating debris which lodges against the structure and accelerates damage, but if velocity was the damaging influence, 2.5 feet per second is a fair approximation. If the structure is near the point of buoyancy, even a very small velocity can complete the destruction. In tsunami and tidal inundation, velocities may reach 30 feet per second or more and exceed all other factors in causing damage.

Wave wash and tidal surge are major factors in coastal and lake-shore damage, because of the mass of water driven at high velocities. As previously stated, it is difficult at times to distinguish damage by tidal inundation from the other causative factors of damage in hurri-

cane or cyclonic storms, but it is generally conceded that tidal surge is probably the greatest contributor to the total damage. A comparison drawn from the American Red Cross estimates of dwellings affected, damaged, and destroyed, indicates that the incidence of affected homes that were destroyed by hurricanes during 1949-64 was 2½ times that for riverine flooding during the same period. (See app. B for detailed data.)

Sediment in moderate amounts accompanies all inundation, and moderate costs of cleanup are common to all flood damages. Sediment deposition increases with depth and duration of inundation, and is generally associated with decreasing velocity of the flow over the flood plain. Depositions of as much as a few feet in extreme instances have collapsed floors and caused much greater than normal damage.

The location of property in a flood-prone area determines its degree of risk. In tidal and tsunami flooding of coastal areas, generally the farther the property is removed from the shore, the lower the damages. The presence of a spit or buffer zone along the shore offers some protection because both the waves and the storm generating the damaging surges diminish as they move inland. Too much confidence, however, cannot be placed in buffer zones because they sometimes fail their purpose and permit waves to race inland unobstructed and cause greater damages to the inland areas than before the buffer zones was created. Closely associated with area locations is the elevation of the point of zero damage. A difference of a few feet higher in elevation can in the case of riverine flooding reduce the average annual damages by as much as two flood risk zones or to a fraction of that for adjacent properties. In coastal areas, it is now good practice to build end anchor structures on driven piles with the first floor several feet above normal tide levels. By so doing the high damaging surges pass under the main part of the structure instead of expending their force against it. (See app. F for a statement of FHA standards in these regards.)

Type of occupancy, whether industrial, commercial, or residential, has a marked influence upon the average annual damages, and the method of determining them. Except for the type of construction, which is discussed later, the damages to the structures themselves should not vary greatly, with type of industry or business, but damages to the contents will vary widely depending upon the type of merchandise, its vulnerability to damage, techniques of handling and storing it, and the amount of fixed equipment that is subject to damage and cannot be removed in advance of the flood. Contents of grocery stores, general merchandise, and drugstores, among commercial establishments and of high-income, one-story residential property will generally show high early damage reaching a maximum with a depth of flooding of about 6 feet above floor level. In the lower end of the list are service stations, two-story residences and the like. Damages to contents should, of course, be determined independently of damages to structures.

Agricultural crops are properly a type of occupancy. Damage to crops varies not only with depth of flooding but from month to month within the growing season and also with the type of crop. The shorter stem grains and soybeans show the highest ratio of average annual damage to crop value, followed by corn and cotton, with hay and pasture grass at the lower end of the scale of damages.

Under riverine flooding the type of construction is directly related to the damages that a structure will suffer. A frame structure is subject to being floated away and becoming a total loss at some depth. Brick or masonry veneer will offer greater resistance to flood damage, and solid masonry, reinforced concrete or steel will minimize structural damage and show reductions of 50 percent or more below average annual damages for frame structures. In the high velocities of tsunami damage, however, there is little choice in the type of construction; apparently, only reinforced concrete has much of a chance of withstanding the force of such waves.

The quality of construction is a factor in rates of average annual damages, but not as much so as type of construction. Structures of lower cost construction or in relatively poor condition are more vulnerable to damage by flooding, and the rate of average annual damages, therefore, may be as much as twice that for higher quality or in good condition.

It is readily apparent from the preceding discussion of the variable factors in average annual damages, that damages must be assayed for each flood-prone area, and the task is not a simple one. Strength lies in uniform carefully determined depth-damage relations for each flood-prone area in which the effect of each variable factor has been evaluated and incorporated into the relations. For residential property, the most feasible and workable solution would be to base the relation on percent of total value, separating structure and contents; and for commercial and industrial property, on percent of value or per square foot of floor area, separating structure and contents.

PAST ATTEMPTS TO MEASURE FLOOD HAZARD FOR INSURANCE PURPOSES

A number of attempts, with varying methodology and degrees of intensity of study, have been made to measure flood hazards as a basis of flood insurance. No attempt is made here to list or review all of them, but only to include some of the major ones.

In 1956, the engineering firm of Parsons, Brinckerhoff, Hall & Macdonald made a study for the American Insurance Association, in which they updated an earlier study for the same organization, both of which, together with additional information, was published by the association.¹ Each presented a large amount of useful data, about floods in general and about specific floods in various years in different parts of the country. The approach was largely an overall one: That is, total damage in particular basins or for the nation was related to total property values in the same areas. Although a hydrologic approach was used, to a large extent, it did not attempt to define flood hazard zones as has been done in this study. Loss ratios in general, and for some typical dwellings and other properties, were calculated. The loss ratios were expressed in terms of the ratio of the annual loss to the maximum probable loss, rather than in terms of the annual average damages in relation to property value as in this study. These studies, while not leading to the initiation of a flood insurance program, apparently were influential in the insurance industry—their effect may well have been to strengthen the conviction that flood insurance was not commercially feasible.

¹ Studies of Floods and Flood Damage, 1952-55, American Insurance Association, New York, May 1956.

In late 1956 and early 1957, attempts were made to formulate a schedule of insurance premiums for flood insurance under the 1956 act.² Representatives from various Federal agencies proposed a "specific gage" approach to flood insurance premiums, which utilized the probability of flood occurrence reaching designated stages. This approach was rejected on the grounds that the necessary data were unavailable and could not be provided promptly enough, as well as because of other objections as to its complexity. A group from the insurance industry proposed a single rate of flood insurance premium (\$3 per \$100), with provision for revision as experience with the program accumulated. In the end, a compromise was accepted, with a base rate for each major river basin, adjusted further on the basis of estimated differences in flood hazard for different classes of property. A schedule of rates, according to building only and contents only, according to extent of coverage (100, 80, or 50 percent), according to region, according to building code, and with some other factors considered, was established. "But the gravest drawback of the system, undoubtedly, is the fact that it contains no recognition of variations in exposure within zones (zones here means major river basins)—except for property actually over water." These rates were never put into effect because the necessary appropriations were not provided to implement the program.

In 1965, Don G. Friedman of the Travelers Insurance Co., made some estimates of average annual flood damages to dwellings, which have become the basis of a number of estimates of flood insurance premiums.³ Using the Weather Bureau data on annual flood losses, and other data on tidal inundation and wave wash damage, he estimated average annual damages from floods (in this broader definition, used here also) to dwellings alone at \$110 million. He recognized the serious inadequacies of the data he was using, and estimated further that the probable correct figure for dwellings alone fell between \$85 and \$130 million annually. He further analyzed these data by river basins, showing that considerable differences exist in total flood hazard between one basin and another. In a later report, he estimated, as best he could from limited data, the probable variation in average annual flood damages and in necessary insurance premiums, according to the degree of the flood hazard.⁴ He concluded that 1 percent of all dwellings probably had an extreme flood hazard, 6 percent had a severe hazard, 20 percent had a moderate hazard, and 73 percent had a slight hazard; he estimated insurance premiums for dwellings in these categories in different regions, which ranged from a high of \$3.75 per \$100 to a low of 5 cents. These rates could be reduced by varying amounts, up to nearly a half, by applications of deductibles of varying amounts and percentages. Friedman's approach, while necessarily based on inadequate data, comes up with insurance premiums varying in the same general directions, but to a

² The discussion which follows in this paragraph is taken from an unpublished report of the Federal Flood-Indemnity Administration, May 1958.

³ The Flood Damage Problem As It Relates to Dwelling Property in the U.S.A., prepared for the information of the N.A.I.C. Flood and Hurricane Committee and the National All-Industry Flood Insurance Committee, January 1965.

⁴ A Method for Estimating Possible Flood Rates for Dwelling Properties, by D. G. Friedman, Research Department, Travellers Insurance Companies, March 1965.

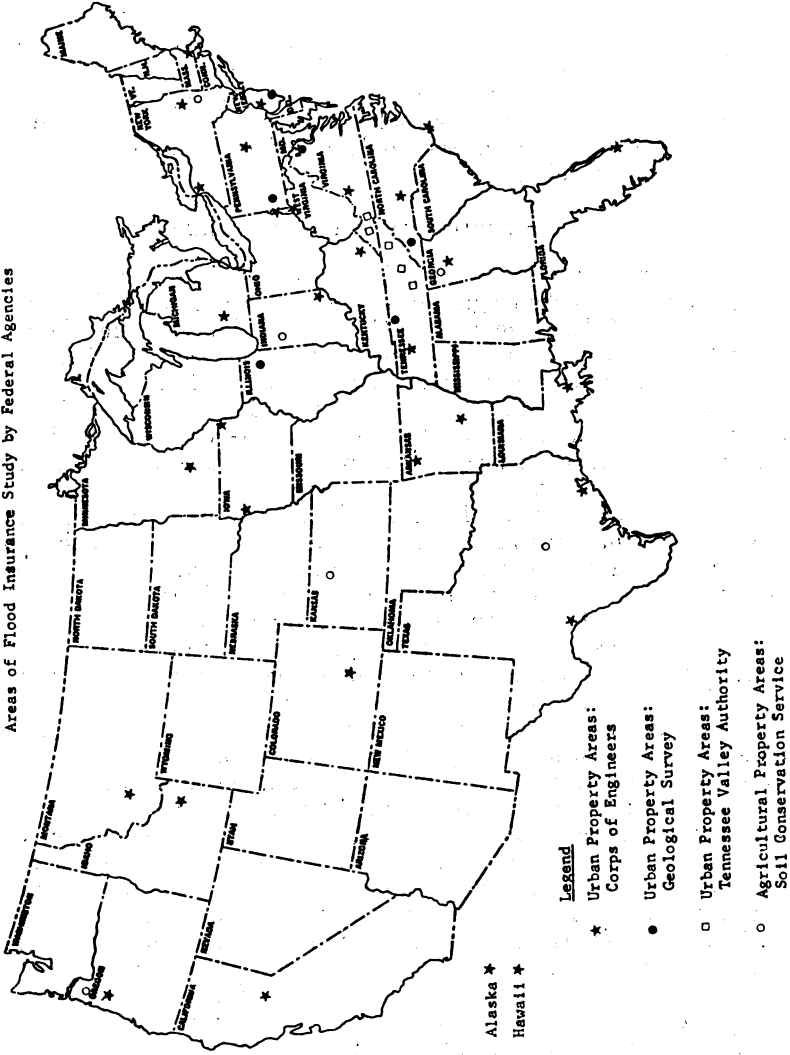
smaller degree, than the results of the current study. Others using his same estimates of average annual flood damage for the Nation have calculated flat flood insurance premiums for dwellings in the general neighborhood of 5 cents per \$100 of value. It is true that such a rate, if applied to all dwelling units in the United States, regardless of their flood hazard would produce a large revenue which might be adequate to reimburse all present flood losses to dwellings. The inequities and impracticability of this approach have been described previously; even if one were willing to ignore such fatal defects, this approach would encourage people to move into high risk areas and thus shortly require a substantially higher average premium. All restraints on use of such areas would be lifted if all risk of loss was borne by someone else.

SPECIAL STUDIES MADE FOR THIS REPORT

Four Federal agencies with major responsibilities for constructing flood prevention works or gathering and developing flood information—the Corps of Engineers, the Geological Survey, the Tennessee Valley Authority, and the Soil Conservation Service—made a number of special studies for this report, which are included in their entirety in appendix C. The studies by the Corps of Engineers, the Tennessee Valley Authority, and the Soil Conservation Service were designed to measure the location of property in relation to the flood hazard, the value of such property, and the average annual amount of damage that such property would suffer from flooding. The basic information for these purposes had already been developed in connection with specific flood protection projects proposed for installation. The Geological Survey developed similar information from a different approach to demonstrate the feasibility of determining rates of average annual damages in areas where such flood protection studies had not been made. This involved not only mapping the flood risk areas but also identifying properties subject to flood risk and measuring flood damage.

Within the time limits available for this report, it was not possible to include areas where no previous studies had been made. This means, among other things, that each of these areas had a serious flood problem; the areas are definitely not a random sample of all areas in the United States. Secondly, areas had to be chosen where the agencies concerned had manpower that could be detailed to this job. Within these limitations, some selection of areas was possible; a good nationwide distribution of study areas was in fact achieved (fig. 10). The reports in appendix C, in addition to including maps of flood areas and all the statistical data, contain a description of each area, its hydrology and flood problem, and of the methodology employed in each study. In total 48 areas were studied; of these, 6 were agricultural, and 42 primarily urban; of the latter, 6 were subject to coastal flooding and 36 to riverine flooding. The cities varied considerably in size also, as did the streams which were the source of their flooding.

FIGURE 10
Areas of Flood Insurance Study by Federal Agencies



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KEY TO FIGURE 10

Areas of Flood Insurance Study by Federal Agencies

(Illustrated in fig. 10)

CORPS OF ENGINEERS

Pilot area studies: Urban property:

1. Citrus area, Orleans Parish, La.
2. Dubuque, Iowa
3. Hilo, Hawaii
4. Lackawanna, N. Y.

5. Milton, Pa.
6. Wareham, Mass.
7. Wheeling, W. Va.

Other area studies: Urban property:

1. Atlanta, Ga.
2. Aurora, Ind.
3. Buena Vista, Va.
4. Charlotte, N. C.
5. Deer Lodge, Mont.
6. Del Rio, Tex.
7. Friendswood, Tex.
8. Grandville, Mich.
9. Harlan, Ky.
10. Harrison, Ark.
11. Henderson, Minn.
12. Idaho Falls, Idaho

13. Las Animas, Colo.
14. New Martinsville, W. Va.
15. Pine Bluff, Ark.
16. Salem, Oreg.
17. Schenectady, N. Y.
18. Sioux City, Iowa
19. Trenton, Tenn.
20. Woodlyne and Collingswood, N. J.
21. Wrightsville Beach, N. C.
22. Yuba City, Calif.
23. Bethel, Alaska
24. Pompano Beach, Fla.

TENNESSEE VALLEY AUTHORITY

Pilot area studies: Urban property:

1. Coeburn, Va.
2. Johnson City, Tenn.
3. Marion, Va.

4. Sevierville, Tenn.
5. Sweetwater, Tenn.

GEOLOGICAL SURVEY

Pilot area studies:

1. Alexandria, Va.
2. Asheville, N. C.
3. Carnegie, Pa.

4. Joliet, Ill.
5. Nashville, Tenn.
6. Ventnor City, N. J.

SOIL CONSERVATION SERVICE

Pilot area studies: Agricultural property:

1. Batavia Kill watershed, New York
2. Little Raccoon Creek watershed, Indiana
3. Little Pudding River watershed, Oregon

4. Salt Creek watershed, Kansas
5. Donahoe Creek watershed, Texas
6. Sallacoa Creek watershed, Georgia

In the six agricultural areas, the amount of the crop damage depends upon the crop grown and upon the season in which flooding occurs, as well as upon the frequency and depth of the latter. In many locations, small stream valley bottoms contain alluvial soils, naturally fertile and sometimes with excellent water holding capacity in the soil. If such valleys are small, the farmer can readily locate his buildings, store his crops, and keep his livestock and machinery out of the valley floor, on an upland location where flood hazard is nearly nil. Under such circumstances, flood damages are limited to their effects upon growing crops. In other circumstances, buildings and other valuable property are located in the valley bottoms and are subject to flooding.

In these six sample areas, average annual flood damages to crops are expressed as a percentage of the undamaged value of the crop in each area and in each flood risk within the area (table 3). For the cultivated crops, damages in the zone receiving floods of the 1- to 5-year interval, on the average, varied from less than 10 percent of the crop value, up to as high as 32 percent. Hay and pasture crops, in most areas, suffered relatively less from such frequent flooding, although there was one exception. In each of the six sample areas except one the average damages fall rapidly as the frequency of flooding declines; in a good many instances, average annual damages with floods of the 5- to 10-year recurrence interval were only half of average annual damages of floods with recurrence interval of 5 years or less. Damages declined much further, and to comparatively low

levels, for floods of less than 10 years average recurrence level. These average annual loss rates include some years when losses would be much higher from floods of the same magnitude but which took place at seasons when the crops were particularly susceptible to damage; but they also include other years when damages were much less because the floods occurred at seasons when the crops were largely matured and not readily subject to damage.

SOIL CONSERVATION SERVICE, FLOOD INSURANCE STUDY

TABLE 3.—*Flood damage to crops, in dollars per hundred-dollar value of the undamaged crop, by flood zones, small watersheds*

Crop	Zone (frequency, in years)	Batavia Kill	Little Raccoon	Little Pudding	Salt Creek	Donahoe Creek	Sallaoea Creek
Corn.....	1-5	7.77	10.72				10.78
	5-10	5.00	7.06				8.48
	10-100	1.47	1.25				5.90
Soybeans.....	1-5		15.02		25.47		
	5-10		9.58		37.93		
	10-100		8.96		7.88		
Grain sorghum.....	1-5				32.02	9.76	
	5-10				47.90	3.70	
	10-100				8.77	.97	
Cotton.....	1-5					9.97	16.56
	5-10					3.66	4.63
	10-100					1.04	2.98
Wheat.....	1-5		10.16		24.56		
	5-10		5.78		25.46		
	10-100		1.02		5.01		
Oats.....	1-5	6.76				13.43	
	5-10	3.65				4.68	
	10-100	2.67				1.63	
Onions.....	1-5			7.73			
	5-10			4.83			
	10-100			2.37			
Hay.....	1-5	3.20	3.10		25.05		
	5-10	1.62	2.90		25.34		
	10-100	.82	.76		4.67		
Sudan.....	1-5					6.54	
	5-10					2.92	
	10-100					.75	
Pasture.....	1-5		3.66		7.04	4.63	1.43
	5-10		0		0	1.50	0
	10-100		0		0	.54	0

The 42 urban areas differed greatly in size and in the degree of their utilization of the more highly hazardous flood-prone areas. In the 6 areas studied by the Geological Survey, there was a total of 5,851 structures (table 4). Of these, over 93 percent were residences, with only about 5 percent commercial and only about 1 percent industrial properties. Of the residential properties, nearly 80 percent were one-family structures, and nearly all the remainder were 2- to 4-family structures. The pattern of these six communities, therefore, is primarily residential one-family dwellings. Of the dwellings, about 9 percent were in the flood risk zone A, subject to flooding each 5 years or oftener over a long period; more than 42 percent were in flood risk zones B and C subject to flooding each 5 to 25 years over a long period. Later it will be shown that the annual flood damages in zones A, B, and C are often so high as to make residential occupancy of such areas of questionable economic wisdom. The proportion of commercial properties in zones A, B, and C was about the same as for residences—somewhat higher in zone A, somewhat lower in zone B and C. In this regard, it should be stressed that these cities were selected for study because they have had serious flood problems in the past, hence the results are not necessarily representative of all communities.

TABLE 4.—Number of structures on flood plain
U.S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY FLOOD INSURANCE STUDY

		Flood risk zone by frequency, in years												Total	
		0 to 5		5 to 25		25 to 100		25 to 50		50 to 100		Total			
		Sample	All	Sample	All	Sample	All	Sample	All	Sample	All	Sample	All		
Table 1.—Total number of residences:															
Alexandria, Va.	3	32	32	92	92	1	1	5	5	127	127				
Asheville, N.C.	0	0	1	40	91	32	343	40	870	143	486				
Carnegie, Pa.	16	52	37	104	36	643	104	370	141	141	1,513				
Joliet, Ill.	0	0	59	36	36	59	36	74	810	144	144				
Nashville, Tenn.	49	49	113	1,250	1,250	379	379	84	773	297	3,212				
Ventnor City, N.J.	26	26													
Total	483	2,328		1,089	1,089	811	811	778	778		5,489				
Table 2.—Total number of 1-family residences:															
Alexandria, Va.	3	20	20	18	18	1	1	1	1	41	41				
Asheville, N.C.	0	0	0	31	76	298	298	31	76	111	424				
Carnegie, Pa.	15	50	31	74	71	563	563	8	31	105	1,281				
Joliet, Ill.	0	0	56	32	32	56	32	59	590	132	1,332				
Nashville, Tenn.	44	44	100	996	996	326	326	59	560	237	2,472				
Ventnor City, N.J.	19	19													
Total	423	1,833		844	844	591	591	561	561		4,352				
Table 3.—Total number of 2- to 4-family residences:															
Alexandria, Va.	0	12	12	74	74	1	1	0	0	86	86				
Asheville, N.C.	0	0	1	45	45	45	45	0	0	5	5				
Carnegie, Pa.	1	2	22	9	15	79	79	28	147	32	62				
Joliet, Ill.	0	0	6	2	3	2	2	2	3	34	226				
Nashville, Tenn.	1	1	2	2	3	223	223	14	191	6	6				
Ventnor City, N.J.	7	7	12	48	48					55	647				
Total	51	362		239	239	191	191	189	189		1,032				

TABLE 4.—Number of structures on flood plain—Continued
U.S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY FLOOD INSURANCE STUDY

	Flood risk zone by frequency, in years												Total
	0 to 5		5 to 25		25 to 100		25 to 50		50 to 100		All		
	Sample	All	Sample	All	Sample	All	Sample	All	Sample	All	Sample	All	
Table 4—Total number of 5-or-more family residences:													
Alexandria, Va.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Ashville, N.C.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Carnegie, Pa.....	0	0	0	0	2	5	2	5	2	5	2	5	6
Joliet, Ill.....	0	0	0	1	1	1	1	1	3	28	5	83	6
Nashville, Tenn.....	4	4	1	1	1	1	1	29	3	28	5	83	6
Ventnor City, N.J.....	0	5	1	31	1	6	1	29	3	28	5	83	6
Total.....	9	33	6	33	6	33	6	29	3	28	5	105	105
Table 5—Commercial property—total number of structures:													
Alexandria, Va.....	22	22	0	0	0	0	0	0	0	0	0	0	22
Ashville, N.C.....	5	39	39	39	0	0	12	12	24	24	22	80	80
Carnegie, Pa.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Joliet, Ill.....	32	32	11	11	15	15	18	164	10	63	58	1183	58
Nashville, Tenn.....	0	9	11	117	15	15	18	164	10	63	115	1183	58
Ventnor City, N.J.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Total.....	68	67	15	67	15	67	18	70	10	87	115	313	313
Table 6—Industrial property—total number of structures:													
Alexandria, Va.....	20	20	1	1	0	0	1	1	0	0	21	21	21
Ashville, N.C.....	2	2	4	4	0	0	0	0	0	0	7	7	7
Carnegie, Pa.....	0	0	11	11	0	0	0	0	0	0	11	11	11
Joliet, Ill.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Nashville, Tenn.....	5	5	3	3	2	2	2	2	0	0	10	10	10
Ventnor City, N.J.....	0	0	0	0	0	0	0	0	0	0	0	0	0
Total.....	27	27	19	19	2	2	1	1	0	0	21	21	21

‡ All large industrial.

‡ Except hotels (23 in 5-100-year range).

In the 5 cities studied by the Tennessee Valley Authority there was a total of almost 2,000 structures of all kinds; of these, about 59 percent were residential units, and nearly 39 percent were commercial structures, with only a few industrial plants (table 5). All of these were riverine flooding situations. In two of the five communities, the number of commercial structures was greater than the number of residential units. These five communities were thus less heavily residential than were the studies by the Geological Survey. In these five communities, only about 2 percent of the houses were in flood risk zone A and less than 5 percent were in zone B; in contrast, more than half were in flood risk zone F, where floods will strike, on the average, at intervals of less than 100 years. The proportion of the commercial properties in the two most hazardous flood risk zones A and B was more than double the proportion of dwellings located in such zones. In this use of the flood plain, these five communities are in sharp contrast with the six studied by the Geological Survey.

TENNESSEE VALLEY AUTHORITY FLOOD INSURANCE STUDY

TABLE 5.—Number of structures on flood plain ¹

Community	Flood risk zone by frequency, in years						Total
	5 and under	5 to 10	10 to 25	25 to 50	50 to 100	100 and over	
Table 1.—Residential units (mainly 1 family):							
Coeburn.....	10	16	52	25	27	56	186
Johnson City.....	2	4	13	4	5	185	213
Marion.....	8	14	27	2	8	107	166
Sevierville.....	1	21	71	98	104	279	574
Sweetwater.....	0	1	0	3	2	29	35
Total.....	21	56	163	132	146	656	1174
Table 2.—Commercial:							
Coeburn.....	1	15	34	16	21	40	127
Johnson City.....	23	43	23	12	9	206	316
Marion.....	2	1	8	1	3	63	78
Sevierville.....	5	66	52	2	4	18	147
Sweetwater.....	9	11	10	8	11	50	99
Total.....	40	136	127	39	48	377	767
Table 3.—Industrial:							
Coeburn.....	0	0	0	0	0	0	0
Johnson City.....	2	0	2	1	0	14	19
Marion.....	0	2	1	2	1	4	10
Sevierville.....	1	2	2	0	0	0	5
Sweetwater.....	3	0	0	1	0	3	7
Total.....	6	4	5	4	1	21	41

¹ All structures on the flood plain were surveyed.

Of the 31 urban areas studied by the Corps of Engineers five are coastal and the other 26 are riverine. In 29 of these areas there is a total of about 28,000 structures of all kinds; of these, 90 percent are residences, 9 percent commercial structures, 1 percent industrial structures, and a scattering of other types.⁵ Of the residential structures (table 6), about 80 percent are single-family homes and about half of the remainder have from two to four units per structure. Of the residential units, about 10 percent are in flood risk zone A and

⁵ Data from 29 areas have been summarized; data for the other 2 areas, 1 in coastal area, are in the respective areas report.

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about 30 percent are in flood risk zone B. A somewhat lower percentage of all commercial properties is in zone A and in zone B. The total of all the areas studied by the Corps of Engineers thus has about as high an occupancy of flood risk zone A as the areas studied by the Geological Survey and a much higher percentage than those studied by TVA.

CORPS OF ENGINEERS FLOOD INSURANCE STUDY

TABLE 6.—Number of residential structures on flood plain

	Flood risk zone by frequency in years						Totals
	0 to 5	5 to 10	10 to 25	25 to 50	50 to 100	100+	
Citrus, New Orleans, La.		5,607	1,714	0	0	0	7,321
Dubuque, Iowa		18	597	130	226	29	1,000
Hilo, Hawaii	1	10	33	73	25	(1)	142
Lackawanna, N.Y.	672	688	479	205	150	(1)	2,189
Milton, Pa.		3	34	107	293	627	1,064
Wareham, Mass.	234	153	431	103	115	(1)	1,036
Wheeling, W. Va.	4	438	1,020	991	426	(1)	3,292
Atlanta, Ga.	74	28	58	11	16	(1)	185
Aurora, Ind.	45	62	44	52	17		359
Buena Vista, Va.			10	20	16		129
Charlotte, N.C.	74	58	49	58	20		346
Deer Lodge, Mont.			26	3	4	(1)	33
Del Rio, Tex.	72	82	111	57	53	214	589
Friendswood, Tex.	276	21	33	100	149		657
Grandville, Mich.	85	31	71	148	71		495
Harlan, Ky.	190	63	215	18	14	11	511
Harrison, Ark.	42	15	20	7	2	4	90
Henderson, Minn.			36	45	40	36	157
Idaho Falls, Idaho.					297	635	932
Las Animas, Colo.	12	56	521	212	96	164	1,051
New Martinsville, W. Va.	232	213	137	68	55	153	858
Pin's Bluff, Ark.	2	1	1	2	11		34
Salem, Oreg.		3	57	69	174	(1)	303
Schenectady, N.Y.	34	17	20	8	8		125
Sioux City, Iowa.	322	74	134	214	289	154	1,187
Trenton, Tenn.	7	5	9	17	22		73
Woodlynne, N.J.	66		60	44	58	38	266
Wrightsville Beach, N.C.	50	59	181	71	42	269	672
Yuba City, Calif.					349	0	349
Total	2,494	7,698	6,101	2,833	3,628	3,351	25,505

The fact that these study areas are not representative of all communities in the United States, because of their much higher flood risk, has been mentioned previously. However, they may be more or less typical in the kinds of uses made of the flood plain areas that are used. The picture which emerges from these tables is rather clearly one of heavy residential use, with modest commercial use, and relatively slight industrial use. This comparison is based upon the number of structures; a comparison based upon total value of various kinds of structures (information which is not available) would show industrial in a much higher role and commercial in a somewhat higher role, than mere numbers suggest. However, it is apparent that the more severe flood problems, as judged by these data, relate to residential use of land.

It is interesting to note that the different sample study areas fall largely into two contrasting groups, as far as the degree of use of the highly hazardous flood zone A is concerned. On the one hand are a dozen or so communities (Charlotte, N.C., Friendswood, Tex., Grandville, Mich., Harlan, Ky., Harrison, Ark., Lackawanna, N.Y., New Martinsville, W. Va., Schenectady, N.Y., Sioux City, Iowa, Wareham, Mass., Woodlynne, N.J.) where about 20 percent or more

of all the dwellings are in zone A; this must be considered a rather extensive use of such a high risk zone; especially since considerable use was usually made of the only slightly less hazardous zone B, in most of these cities. In contrast, more than a dozen other communities had essentially no use of zone A (Buena Vista, Va., Deer Lodge, Mont., Dubuque, Iowa, Henderson, Minn., Hilo, Hawaii, Idaho Falls, Idaho, Las Animas, Colo., Milton, Pa., Salem, Oreg., Coeburn, Va., Johnson City, Tenn., Marion, Va., Sevierville, Tenn., Wheeling, W. Va., Yuba City, Calif., and Sweetwater, Tenn.). Moreover, most of these same communities made relatively little use of flood risk zone B either. These two contrasting groups include most of the study areas; there were relatively few with some but not much use of zones A and B. Without more detailed study than was possible in the time limits of this study, it is not possible to state why such differences in rate of use of high hazard flood zones has arisen.

The average value of all dwellings differs considerably from one study area to another. Within each city, the relation of average values per dwelling to the degree of the flood risk is variable. In a substantial number of the study cities, the average value per dwelling is much lower in the zones of highest flood risk than it is in zones where such risks are less; there is sometimes a fairly regular and considerable decline in value of houses from one zone to another, as the degree of flood risk rises. It is not clear whether the houses in the zones of highest flood risk were low value when built, or whether they have become so as a result of repeated flooding. In some other cities, there is no consistent relationship between frequency of flooding and average value per dwelling; the houses in the zones of highest risk have about as high values as do the houses in zones of low risk. It may be that the high-value houses in high-risk zones in these cities have not yet had time to deteriorate, but evidence is lacking. In some cities, some adjustment to the flood hazard is evident; the most common is the absence of basements in houses in some cities of high flood risks.

Perhaps because the number of commercial and industrial properties in each flood risk zone is rather small or perhaps for other reasons there is no regular and consistent trend in size or value of such structures, from one flood risk zone to another. Some rather large commercial and industrial properties are located in high-risk zones; these are often valley bottoms, where the level terrain and access to transportation often favor large establishments. But small establishments are located there also, and both large and small ones are found in the lower risk zones.

Average annual flood damages, in relation to property values, differ according to the influence of several factors, but the flood risk zone within which the property is located is the dominant single factor. Differences of construction, of specific topographical and other risk zone characteristics, and other factors result in a range of risks within zones of the same flood frequency characteristics. The hydrology of the stream or coastal area may also be quite important.

In the cities studied by the Geological Survey, there was a wide range in average annual damages per \$100 of value in zone A, where floods will occur each 5 years or oftener on the average (table 7). Most of the cities report average annual damages in excess of \$1 per \$100 of value for residences (structures only, not including contents) but in five instances a lower rate is reported. The

median rate of damages in this zone is about \$1.50 for these cities. The Survey grouped zones B and C together; for them the loss range is very wide, but two-thirds of the cities have losses of less than 75 cents per \$100, with a median of about 50 cents. Different groups were used where the recurrence interval was 25 years or longer; for this whole group, there was also a very wide range, but three-fourths of the damages were less than 25 cents per \$100, with a median of about 16 cents. So many other factors entered into these data, and there are often not houses of fully comparable construction or other classifications from one risk zone to another, so that it is difficult to generalize about the effect of other factors.

DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY, FLOOD INSURANCE STUDY

TABLE 7.—Rates of average annual damages, in dollars per hundred-dollar value, by flood zone, for sampled structures

	Flood risk zone by frequency, in years				
	0 to 5	5 to 25	25 to 100	25 to 50	50 to 100
Table 1.—1-family residence, frame, 1-story, with basement:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa. ¹	2.08	1.92	0.18		
Joliet, Ill. ² .....		.95	.20		
Nashville, Tenn. ¹ .....			.02		
Ventnor City, N.J. ²	1.33	.28		0.06	0.43
Table 2.—1-family residence, frame, 1-story, without basement:					
Alexandria, Va. ² .....	.90	.19			
Asheville, N.C. ¹				1.00	.89
Carnegie, Pa. ¹	4.29	2.88			
Joliet, Ill. ² .....		.96	.14		
Nashville, Tenn. ¹	1.25	.05	.03		
Ventnor City, N.J. ²	1.14	.61		.17	.33
Table 3.—1-family residence, masonry, 1-story, with basement:					
Alexandria, Va. ² .....		.68	.23		
Asheville, N.C.					
Carnegie, Pa. ¹ .....			.03		
Joliet, Ill. ² .....			.16		
Nashville, Tenn. ¹ .....	.10	.05	.03		
Ventnor City, N.J.					
Table 4.—1-family residence, masonry, 1-story, without basement:					
Alexandria, Va. ²	21.80				
Asheville, N.C.					
Carnegie, Pa.					
Joliet, Ill.					
Nashville, Tenn. ¹	1.13	.25	.04		
Ventnor City, N.J. ² .....				.55	
Table 5.—1-family residence, frame, 2-story, with basement:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa. ¹	2.46	1.41	.27		
Joliet, Ill. ² .....		.59	.16		
Nashville, Tenn.					
Ventnor City, N.J. ² .....		.14		.12	.003
Table 6.—1-family residence, frame, 2-story, without basement:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa.					
Joliet, Ill.					
Nashville, Tenn. ¹ .....	.69				
Ventnor City, N.J. ²	1.94	.36		.08	.03
Table 7.—1-family residence, masonry, 2-story, with basement:					
Alexandria, Va. ² .....		.53			
Asheville, N.C.					
Carnegie, Pa. ¹		1.31	.14		
Joliet, Ill. ² .....		.33	.16		
Nashville, Tenn. ¹	1.54	.16	.04		
Ventnor City, N.J. ² .....		.23		.42	.01

See footnotes at end of table, p. 71.

TABLE 7.—Rates of average annual damages, in dollars per hundred-dollar value, by flood zone, for sampled structures—Continued

	Flood risk zone by frequency, in years				
	0 to 5	5 to 25	25 to 100	25 to 50	50 to 100
Table 8.—1-family residence, masonry, 2-story, without basement:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa.					
Joliet, Ill.					
Nashville, Tenn. ¹	1.88	.41			
Ventnor City, N.J. ²	.08	.39		.17	.01
Table 9.—2 to 4 family residences:					
Alexandria, Va. ²		.13	.17		
Asheville, N.C. ¹		.56			.85
Carnegie, Pa. ¹	2.92	.87	.18		
Joliet, Ill. ²		.63	.14		
Nashville, Tenn. ¹		.23	.02		
Ventnor City, N.J. ²	1.84	.48		.61	.12
Table 10.—5 or more family residences:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa.					
Joliet, Ill. ²			.10		
Nashville, Tenn. ¹	.41	.15	.06		
Ventnor City, N.J. ²		4.87		.003	.013
Rate in dollars per hundred square feet of first floor area—					
Table 10a.—5 or more family residences:					
Alexandria, Va.					
Asheville, N.C.					
Carnegie, Pa.					
Joliet, Ill. ²			1.32		
Nashville, Tenn. ¹	3.37	1.31	1.29		
Ventnor City, N.J. ²		64.11		0.06	0.19
Table 11.—Commercial property:					
Alexandria, Va. ²	25.50				
Asheville, N.C. ¹	.53	.63		.40	.48
Carnegie, Pa.					
Joliet, Ill.					
Nashville, Tenn. ¹	5.82	.27	.15		
Ventnor City, N.J. ¹	.11	.42		.19	
Table 12.—Industrial property:					
Alexandria, Va. ²	56.10	8.40			
Asheville, N.C. ¹	1.93	1.06		3.11	
Carnegie, Pa. ²		6.68			
Joliet, Ill.					
Nashville, Tenn. ¹	1.08	.41	.58		
Ventnor City, N.J.					

¹ Rates shown are for structures only.
² Rates shown are for structures and contents.

NOTE.—Carnegie, Pa.: By computations for sample residences, damages to contents average 109 percent of damages shown for structures only, costs of cleanup work average 11.5 percent of structural damage. No information on damages is available for commercial structures. Joliet, Ill.: By computations for sample residences, about 60 percent of the total damages as shown represents structural damage. No damage information is available for commercial or industrial structures. Nashville, Tenn.: By comparison of damage curves for structural damage and for damage to contents, the damage to contents for the average residence is about the same as the structural damage shown. Ventnor City, N.J.: By computations for sample residences, about 70 percent of the total damages as shown represents structural damage, 20 percent represents damages to contents, and 10 percent represents cleanup costs. No damage information was available for hotels, and table 11 does not include data for hotels.

For the TVA studies, that agency estimated what the average annual damages would have been in each zone, even when there were no structures there (table 8). A regular decline in average annual losses, as risk of flooding decreases, is evident. The rates for structures and contents combined in zone A vary somewhat from city to city, and according to class of construction, but for one-story residences average about \$8 per \$100 of value, structure and contents, and for two-story residences average about \$4; the rate falls sharply to zone B, to about

\$2.50 and \$1.80, respectively; falls again to zone C, to about \$1 and 80 cents, respectively; and again to zones D, E, and F. For each risk zone, average annual damages for one-story buildings and contents range from about 50 percent higher to nearly double those for two-story buildings and contents of the same characteristics; and most average somewhat lower for masonry than for frame buildings. For the commercial and industrial buildings, a similar progression from relatively high average annual damages in high risk zones to lower and lower rates in zones of less risk, is apparent.

TENNESSEE VALLEY AUTHORITY FLOOD INSURANCE STUDY

TABLE 8.—Rates of average annual damages, in dollars per hundred-dollar value, structure plus contents

Community	Flood risk zone by frequency (in years)					
	5 and under	5 to 10	10 to 25	25 to 50	50 to 100	100 and over
Table 1.—Residential frame, 1-story:						
Coeburn	Rate \$6.97	Rate \$3.29	Rate \$1.05	Rate \$0.72	Rate \$0.29	Rate \$0.12
Johnson City	7.10	2.58	1.34	.83	.32	.03
Marion	3.78	2.98	1.41	.81	.44	.11
Sevierville	16.30	2.03	.90	.45	.24	.03
Sweetwater	¹ 6.20	2.84	¹ 1.22	.63	.45	.02
Table 2.—Residential masonry, 1-story:						
Coeburn	16.34	2.66	.84	.51	1.33	.14
Johnson City	¹ 6.40	¹ 2.98	1.13	1.80	.63	.02
Marion	¹ 6.90	¹ 2.60	¹ 1.22	1.60	.28	¹ .03
Sevierville	¹ 5.10	2.03	.90	.45	.24	.02
Sweetwater	¹ 6.20	¹ 2.66	¹ 1.22	1.60	.45	.08
Table 3.—Residential frame, 2-story:						
Coeburn	¹ 4.30	1.62	.61	.37	.18	.04
Johnson City	4.00	¹ 1.86	1.15	1.51	.34	.02
Marion	5.67	3.24	1.04	.32	¹ .21	.06
Sevierville	¹ 3.40	1.30	.58	.28	.15	.01
Sweetwater	¹ 4.04	¹ 1.73	1.79	1.39	1.20	.01
Table 4.—Residential masonry, 2-story:						
Coeburn	¹ 4.30	¹ 1.72	1.77	1.39	.18	.01
Johnson City	2.80	¹ 1.86	1.94	1.51	1.30	.00
Marion	¹ 4.30	¹ 1.65	1.73	1.37	.19	.04
Sevierville	¹ 3.40	¹ 1.30	.58	.28	.15	.02
Sweetwater	¹ 4.04	¹ 1.73	1.79	1.39	1.20	.01
Table 5.—Commercial:						
Coeburn	64.50	8.10	7.79	4.90	4.00	1.20
Johnson City	9.80	10.00	9.10	.50	.20	.30
Marion	15.90	.50	6.70	7.40	.80	.40
Sevierville	56.50	11.80	5.90	2.40	1.00	.50
Sweetwater	36.00	5.90	3.40	1.60	1.20	.20
Table 6.—Industrial:						
Coeburn						
Johnson City	29.80		4.20	.20		.10
Marion		3.10	11.10	1.90	10.20	2.10
Sevierville	43.00	17.90	4.10			
Sweetwater	12.60			5.10		.20

¹ No units exist on the flood plain. The rates are for a typical structure at the zone midfrequency elevation.

A generally similar situation exists in the areas studied by the Corps of Engineers (table 9). Considerable variation in average annual damages per \$100 of structure and contents is apparent within each flood risk zone, yet for each city there is, almost without exception, a decline in annual damage from zone A (flooded each 5 years or oftener, on the long-term average) to zone F (flooded less frequently than once in 100 years, on the average). In zone A, a median damage rate is about \$4 per \$100, although rates in two cities are above \$20 per \$100 and in one city are less than \$1. The median rate in zone B (5- to 10-year flooding, on the long-term average) is slightly less than \$2, or

about half of the rate in zone A; but the extent of the reduction from one zone to another is not uniform from city to city. Likewise, the median rate in zone C, flooded at intervals longer than 10 years but shorter than 25 years on the long-term average, is about 80 cents per \$100. There is no city which does not show a lower rate for zone B than for zone A, nor is there any which does not show a lower rate for zone C than for zone B; but the extent of the difference varies considerably from one city to another. Similar comparisons could be made for the other zones. As the frequency of flooding becomes less, there are instances when the rate does not decline between one zone and the next less frequently flooded zone, or may even increase; in these few cases, some other factor became more important.

Since there are so many fewer commercial properties in these sample areas, the relationships are less regular. However, it still remains true that average annual losses decline in almost every instance as the frequency of flooding grows less in any city, and that the differences between zones is considerable, but not uniform.

CORPS OF ENGINEERS FLOOD INSURANCE STUDY

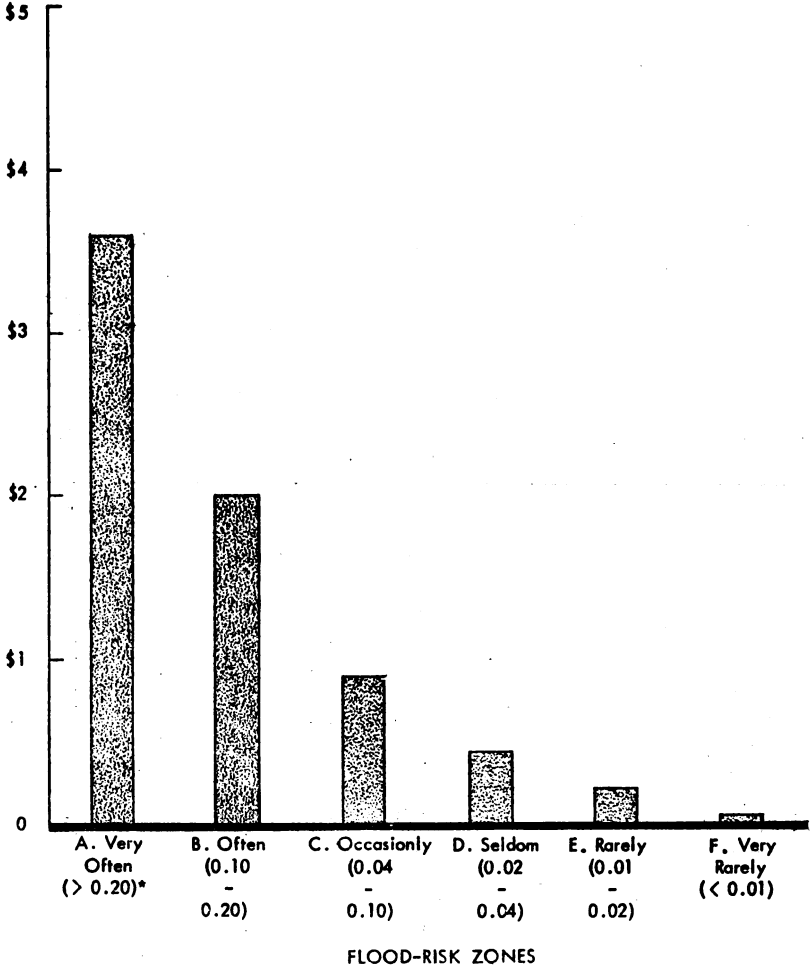
TABLE 9.—Rates of average annual damages, in dollars per hundred-dollar value, structure and contents for residential property

	Flood risk zone by frequency, in years					
	0 to 5	5 to 10	10 to 25	25 to 50	50 to 100	100+
Citrus, New Orleans, La.....		\$6.22	\$4.10			
Dubuque, Iowa.....		1.24	.96	\$0.34	\$0.10	\$0.06
Hilo, Hawaii.....	\$4.00	1.48	.70	.62	.16	
Lackawanna, N. Y.....	.64	.26	.11	.04	.04	
Milton, Pa.....		1.78	.79	.44	.25	.10
Wareham, Mass.....	8.59	4.11	1.72	.56	.24	
Wheeling, W. Va.....	1.83	1.56	1.17	1.12	.15	.08
Atlanta, Ga.....	3.56	1.04	.98	.09	.05	
Aurora, Ind.....	2.64	1.27	.59	.15	.10	.02
Buena Vista, Va.....			1.01	.73	.49	.07
Charlotte, N.C.....	2.56	.65	.19	.01	.00	.00
Dear Lodge, Mont.....			.28	.24	.03	
Del Rio, Tex.....	3.53	2.71	1.74	1.13	.47	.10
Friendswood, Tex.....	11.54	2.38	1.12	1.12	.22	.10
Grandville, Mich.....	3.07	.72	.45	1.9	.15	.03
Harlan, Ky.....	5.08	1.97	.55	.26	.18	.03
Harrison, Ark.....			1.63	.78	.36	.16
Henderson, Minn.....					.07	.01
Idaho Falls, Idaho.....					.09	.02
Las Animas, Colo.....	3.57	2.20	.77	.36	.09	.02
New Martinsville, W. Va.....	9.71	2.93	1.12	.34	.14	.05
Pine Bluff, Ark.....						
Salem, Ore.....		4.79	.67	.44	.33	
Schenectady, N. Y.....	2.96	1.90	.96	.53	.16	.19
Sloux City, Iowa.....	23.50	3.87	1.84	.74	.32	.12
Trenton, Tenn.....	22.43	6.27	3.40	1.04	.49	.03
Woodlynn, N. J.....	1.01		.17	.15	.02	.03
Wrightsville Beach, N. C.....	5.70	1.50	.71	.87	.22	.02
Yuba City, Calif.....					.52	

Recommendation.—Because for purposes of flood insurance, as for fire insurance, residential properties fall into relatively homogeneous classes more readily than do other buildings, flood insurance should be limited initially to one- to four-family dwellings and be extended later to other property as experience indicates that insurance to be feasible.

FIGURE 11.—AVERAGE ANNUAL RESIDENTIAL FLOOD DAMAGES, PER \$100 PROPERTY VALUE, STRUCTURE AND CONTENTS, BY RISK ZONES, MEDIAN OF STUDY AREAS

RATES OF AVERAGE ANNUAL DAMAGES



* Probably of flooding in any year

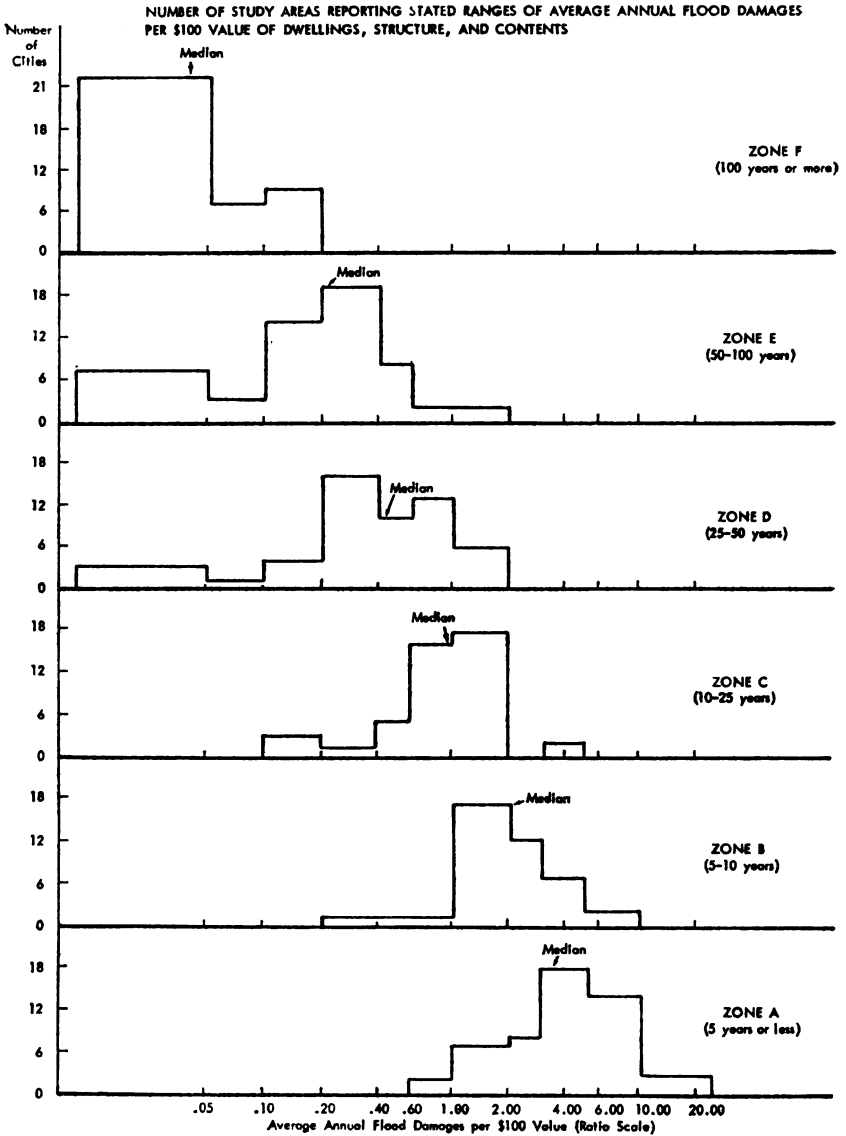
When all the risk zones in all the cities studied by all the agencies are considered as one large sample for residential structures and contents, it is possible to estimate a median average annual damage per \$100 of value for each risk zone (fig. 11). For zone A, the median rate is about \$3.60 per \$100 of value, for structure and contents; for zone B, about \$2; for zone C, about 90 cents; for zone D, about 44 cents; for zone E, about 21 cents; and for zone F, about 4 cents. It should be noted that flood insurance premiums, if flood insurance

policies were written, might properly differ from these figures both by zones and individual properties within zones. On the one hand, these are the pure loss rates, with no allowance for necessary administrative costs, which would raise them considerably—if the standard proposed in appendix D by the American Insurance Association is followed, by 43 percent; on the other hand, a deductible provision in the insurance policy would lower the rates—by about a fourth, if a \$500 plus a 5-percent deductible provision is included. Nevertheless, these average annual damages do show how greatly the risk of loss varies from zone to zone.

These median values for each zone obscure the great variation in average annual damages between cities in each flood risk zone. The variability of rates of average annual damages within risk zones is discussed in considerable detail in a study of this subject prepared by the Geological Survey and is presented in appendix C. As noted earlier, the topographical and other characteristics of a particular flood zone so affect the depth of flooding and other factors so affect flood damage, that the rate of damages in zone A in one city is not necessarily the same as the damages in zone A in another city, even though each may be flooded equally frequently. Some measure of the range in such average annual damages is found in figure 12. Although there is a regular progression of the median damages, as flood risk declines, and although the frequency distributions tend to shift gradually also, yet a wide range in damages is apparent in each flood risk zone—a range which overlaps nearly all the other zones.

These average annual flood damage data have considerable significance for the values of the properties concerned. If the annual average flood damage for a property is \$200, this is equivalent to the interest on \$4,000 investment, at 5 percent interest; if the average annual flood damages are \$500—and in a number of cities some dwellings and contents had average annual flood damages greater than this—this is equal to the interest on an investment of \$10,000. A dwelling, the structure of which is valued at \$10,000 would normally have about \$4,000 worth of furnishings and household equipment, and would normally set on a lot worth about \$3,000. It can be shown that an annual flood insurance premium of somewhat less than \$2 per \$100 on structure and contents would lend to total annual cost greater than would be required to buy and amortize a lot such as the particular kind of a house would normally have. The owner of such a lot, if he fully realized the flood hazard, would have been wise before he built his house, to have given the lot away or to have sold it for anything he could get for it, and rebuilt elsewhere; once he has built his house, he can salvage the investment in it only by living in it, or by selling it to someone else who does not realize the flood hazard. As a matter of fact, the raw land in the lot is valueless at a much lower rate of average annual flood losses; the price of the lot on which the house is built includes substantial improvements to the lot or in providing services to it, so the raw land is normally worth no more than half the price of the lot.

FIGURE 12



NATIONAL AVERAGE FLOOD DAMAGES FOR RESIDENTIAL PROPERTY

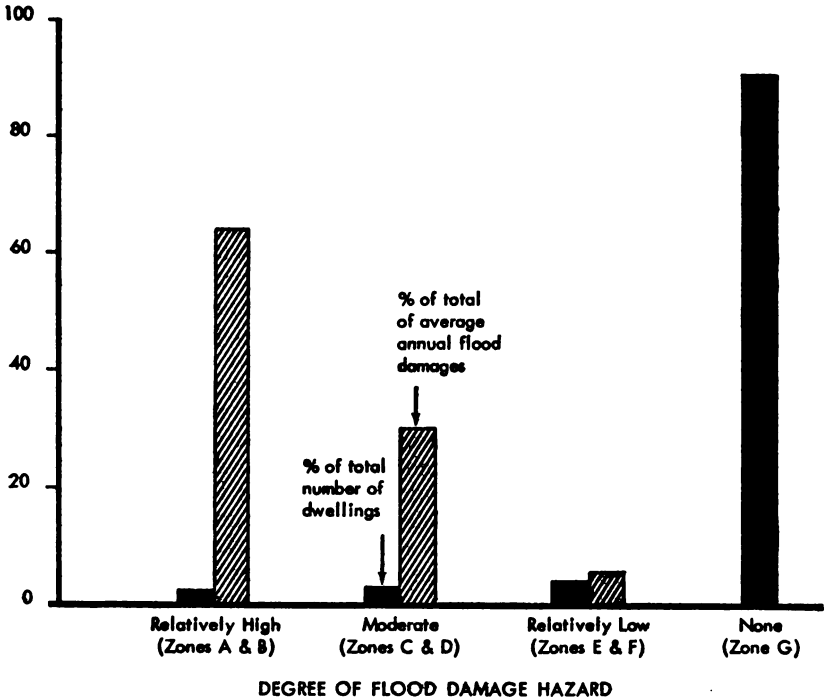
On the basis of the area studies reported in appendix C and other data, it is estimated that the average annual flood damage to dwellings is highly concentrated in a relatively small proportion of the total dwellings in the Nation (fig. 13). More than half of the total annual flood damage to dwellings arises in flood risk zones A and B, where floods will occur, on a longtime average, at intervals of 10 years or oftener, but these zones are estimated to have only about 2 percent of

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all dwellings in the United States. In zones C and D, where floods will occur at intervals averaging 10 to 50 years, over a long period of time, total damages are about a third of the national total for all dwellings, although the number of dwellings is only about 3 percent of the total. In the comparatively low flood hazard zones E and F, where floods will strike but at intervals averaging longer than 50 years, and where flood depths usually will not be great when floods do occur, total damages are less than 10 percent of the national total and number of houses less than 5 percent. In marked contrast, about 90 percent of all dwellings have no special flood risks. These dwellings may, on occasion, be damaged by rising waters of less than flood proportions, but the extent of such average annual damage will be very slight indeed, partly because it will occur at relatively rare intervals.

FIGURE 13.—COMPARISON OF NUMBER OF DWELLINGS AND OF ESTIMATED TOTAL FLOOD DAMAGES, BY DEGREES OF FLOOD DAMAGE HAZARD, U.S. TOTAL

PERCENT OF U.S. TOTAL



These estimates of numbers of dwellings in the United States by flood risk zones differ somewhat, but not seriously, from those made by Friedman, quoted earlier in this chapter. His classification of flood hazard was in descriptive terms, not quantitatively defined, hence a direct comparison is not possible. Both sets of estimates are in agreement that only a very small proportion of all dwellings have a high flood risk, and that by far the greater proportion have no measurable flood risk at all; Friedman's data seem to suggest somewhat more

houses in the moderate flood risk zones than do the results of this study. While this affects the numbers of dwellings in each category, it does not appreciably affect the distribution of total flood damages among risk zones.

The estimates in figure 13 are the best available to date, as to the extent of flood damages to dwellings according to flood risk zones. It is believed that the general relationships between numbers of dwellings and total damages by flood risk zones is essentially correct, although larger samples and further study might modify this picture in some details. Every available bit of evidence clearly points toward a flood damage hazard highly concentrated in relatively small geographic areas within cities; losses due to flooding are not widely distributed throughout the entire population.

Recommendation.—The insurance program should be designed to encourage future construction in locations where there is no special flood hazard.

TIME AND GEOGRAPHIC VARIABILITY IN FLOOD DAMAGES

Reference has been made repeatedly to the erratic timing of flood damages. Although it is common to speak of floods which occur, over a long period of time, once in each 100 years, yet in fact two such relatively rare floods can—and have—occurred in a single year in the same location. Likewise, although it is common to speak of floods with a 10-year average recurrence interval, 25 or more years could easily go by with out any flood as large as this. Chance plays a great part in the sequence with which floods occur in any given location, even though the average recurrence interval is measurable. In appendix H, three specialized studies, which address themselves to the reserve requirements of a flood insurance fund, are presented on the time and geographical variations in flood sequences.

In a situation where the average annual flood premium was set to pay all flood damages over a truly long period of years, yet there might be periods of considerable numbers of years when such premiums would fail to meet claims, sometimes by wide margins. The chances of claims exceeding premiums are greater for a single year than for a long period of time, such as 20 years. A series of simulated flood losses based purely on random variations in timing, produced substantial deficits at the end of 20 years in 9 times out of 100, even though average rates were set to equal average damages over a truly long period; in one case out of the 100, the losses at the end of the 20 years were extreme. (See report by Ferrari in app H.)

The evidence about geographical variability of flood damages is not so clear. An unusually large flood is likely to have resulted from climatic conditions which are likely to be widespread, hence severe floods are likely on more than one stream. At the minimum, it would be dangerous and unwise to assume that risks of flood damage on one stream are wholly independent in timing from severe flood damages on another stream; the wider the region considered, the greater the chance of independence. Even if flooding on one stream was wholly independent of flooding on another, yet by chance bad years could coincide on the two streams.

CHAPTER 7

PUBLIC ATTITUDES TOWARD FLOOD INSURANCE

PUBLIC RECEPTIVITY TO FLOOD INSURANCE

Any program of flood insurance must consider how property owners exposed to the flood hazard may react to the program. Since flood insurance has not generally been available, especially for residences, there is little direct evidence of public receptivity toward such a program.

Some idea of how receptive the public may be, can, however, be obtained by considering the major factors likely to influence receptivity.

For a flood plain property owner to be seriously interested in flood insurance, three essential conditions must exist:

1. He must perceive the flood hazard in such a way that he recognizes the possibility of suffering flood damage of sufficient severity to warrant taking some action.
2. He must be willing to consider flood insurance as a means of protecting himself against flood damage.
3. He must consider himself able to afford flood insurance premiums.

A brief discussion of these factors follow:

There is, as a result of investigations made in recent years, some knowledge about how flood plain occupants perceive the flood hazard.¹ These studies, based on interviews in 8 riverine and 14 coastal locations, caution that a sizable number of flood plain property managers have an overly optimistic view of the serious flood hazard they are exposed to. At the three major riverine sites studied, between one-third and one-half of the property managers interviewed did not expect flooding in the future. At the coastal locations, about one-sixth of those interviewed did not expect any future damaging storms, while another one-third expected storms but either expected no damage or were uncertain as to whether damage was likely. Since the selection of these study sites was not done randomly, these results cannot be projected for the United States as whole. Yet they do indicate that many owners of property subject to flooding do not realize the nature of their exposure.

One researcher (Robert Kates) has analyzed some of the factors related to expectation of future flooding. He found that the following factors were related to a person's expectation of future flooding:

1. His knowledge of past flooding.
2. His past experience of flooding.
3. His interpretation of local flood events.
4. The frequency of flooding at the location of his property.

¹ See especially "Hazard and Choice Perception in Flood Plain Management" by Robert W. Kates, University of Chicago, Department of Geography Research Paper No. 78, 1962, and "The Shores of Megalopolis: Coastal Occupance and Human Adjustment to Flood Hazard" by Ian Burton, Robert W. Kates, John R. Mather, and Rodmen E. Snead; C. W. Thornthwaite Associates, Laboratory of Climatology, Elmer, N.J., 1965. Also Wolf Roder, "Attitudes and Knowledge on the Topeka Flood Plain," and Ian Burton, "Invasion and Escape on the Little Calumet," in Papers on Flood Problems, ed. Gilbert F. White, University of Chicago, Department of Geography Research Paper No. 70, 1961.

Thus there are many reasons why a person may not expect any flooding in the future, even though engineers, planners, and other technical personnel recognize a flood hazard in the area. A person may not expect flooding because he has no knowledge of past flooding, because he has never personally experienced flooding, because he has an unrealistic interpretation of local flood events, or because the frequency of flooding is very low.

The willingness to consider flood insurance as a means of protecting oneself from property loss is another factor which will affect public receptivity to a flood insurance program. Some property owners may recognize the flood hazard they are exposed to but may think other means of adjusting to the flood hazard, such as floodproofing or absorbing their own loss, are preferable to flood insurance. Others may, for no expressed reason, have no interest in flood insurance. Thus, it cannot be assumed that all persons who recognize the flood hazard will be interested in buying flood insurance.

Another major factor which will influence participation by the public in any flood insurance program, where such a program is available, is the ability of the occupant of property in flood-prone areas to purchase flood insurance. Insurance ownership is related to a variety of factors, in particular, income. A national consumer study by the Insurance Information Institute revealed that while approximately 65 percent of the U.S. families have fire insurance on household contents, only 46 percent of those with incomes under \$3,000 had this type of insurance, as against 86 percent of those with incomes of \$7,000 or more who had such insurance.²

There is at present no detailed knowledge of the socioeconomic characteristics of occupants of areas subject to flooding. However, it is clear that many occupants of areas subject to riverine flooding have low incomes. In contrast, many of the owners of property subject to coastal flooding have above average income. A program of flood insurance designed with a public purpose must take into account this wide variation of ability to pay.

The importance of recognizing this variation in ability to pay is illustrated by an article in the *New York Times*, June 15, 1966, which discussed the aftermath of the tornado which Topeka, Kans., experienced in early June 1966.³ According to local authorities in Topeka, 90 percent of the losses suffered in two fashionable residential sections of the town were covered by insurance while only 20 percent of the losses in a low-income area were covered.

On the basis of the available evidence, however limited, it seems clear that many property owners in areas subject to flooding do not recognize the flood hazard they are exposed to. This is especially true where the frequency of flooding is low. Some property owners, even though they are aware of their flood hazard, may not be interested in flood insurance as a means of dealing with the flood problem. There is a wide variability in the ability of property owners to pay flood insurance premiums.

Even in those instances where flood prevention works have been installed, the amount of protection against flood damage has often been overestimated. During the last few decades flood-protection works in the form of dams, levees, floodwalls, channel improvements,

² "Insurance Statistics," 1962, Insurance Information Institute, New York.

³ Quoted in the "Congressional Record," June 15, 1966, p. 12576.

and other engineering works have significantly reduced the flood hazard in many local areas of the United States. But the hazard has not been entirely eliminated, as there is always the possibility of flood events larger than the control works provide protection for. Thus if a levee is constructed to give protection from all floods up to the 100-year flood, the levee will be overtopped by floods having a probability of less than one-hundredth. Such floods, while having a low probability of occurrence, are catastrophic in their effects. Yet large numbers of property owners in such situations fail to realize the remaining flood hazard.

Moreover, there are groups within many communities which will oppose a program of flood insurance which identifies the special flood-risk areas and which publishes rates of insurance which measure the annual cost of living in these areas. Opposition from such quarters can be an important factor in limiting the growth of a flood insurance program.

IMPLICATIONS OF PUBLIC'S ATTITUDES FOR A FLOOD INSURANCE PROGRAM

Property owners exposed to the flood hazard cannot make a wise decision about the purchase of flood insurance unless they have an understanding of the flood hazard they are exposed to. To create this understanding, any program of flood insurance should include a specific effort to inform citizens, in a manner they can understand, of their flood hazard. Any program of flood insurance must recognize that, even after property owners have been informed of the flood hazard, some may not be interested in purchasing flood insurance. Any program of flood insurance must recognize that the ability to pay flood insurance premiums varies widely among property owners in flood-prone areas.

In order to bring premium rates within the financial capacity of as many property owners as possible, every effort should be made to keep premium rates as low as possible under the flood hazard actually existing. Factors that would keep these rates low include high deductible clauses in policies, and making rates lower if supplementary measures are adopted, such as floodproofing of buildings, permanent elevation of contents, establishment of warning system, etc. In addition to these measures, it may be necessary to subsidize flood insurance premiums for existing property owners in the highest risk zones.

STUDY OF ATTITUDES TOWARD FLOOD INSURANCE

Because of the importance of receptivity to a new program of flood insurance, an effort was made as part of this study to explore a variety of sources in industry and government for evidence on this subject. Replies to questionnaires to the various organizations within the insurance industry and also to State commissioners of insurance disclose a paucity of information (see appendix D). Since information on the views of potential purchasers can be helpful in structuring a flood insurance program, the Department contracted with the National Opinion Research Center of the University of Chicago to conduct an attitude survey of flood plain property owners in selected locations. The field interviewing for this survey was completed in July 1966; the

results of data analysis are expected to be available in mid-August 1966.

The survey is being conducted in seven sites selected by the Department. These sites are among those which were studied by the Geological Survey and the Corps of Engineers in their rate determination investigations. (See app. C.) For each of the sites there is available, by flood frequency zones, an estimated rate of average annual damage computed by these agencies; comparisons between estimated rates and property owners' willingness to pay can therefore be made at each site.

The survey gathers information from two types of respondents—homeowners and small businessmen. These are the two major groups of property owners who are probably most adversely affected by floods, and they are the groups likely to be interested in Federal flood insurance, should it be made available.

The questionnaire, developed by the Department, gathers data on hazard awareness, knowledge and experience of flooding, interpretation of flood events, expectation of future flooding, and attitudes toward flood insurance and some of the policy questions involved in a flood insurance program. In addition, the respondent is asked to make several monetary estimates, including amount of damages suffered in the past, value of his building and its contents, and his willingness to pay various flood insurance premiums. Responses obtained in the survey will be analyzed by type of respondent (homeowner, businessman), by study site, and by zone in each study site. In addition, the data will be analyzed to determine the factors associated with receptivity to flood insurance.

Question is frequently raised as to the reliability or meaning of the results of an attitude survey. When the questionnaire is carefully designed, the sample carefully chosen, and the interviews made by competent people—conditions which are all met in this study—the results should be accurate and valid in reporting what the respondents think or feel at that date. If a certain percentage of respondents state that they are interested in flood insurance, this is an accurate reflection of their attitude at the time of the survey. Their later action, when confronted with an actual choice, may not conform to their expressed attitude. That is, they might actually not buy flood insurance although they had said they were interested; or they might buy it even though they had expressed no interest in it. Many factors may affect their actions; but this does not prove that the survey was wrong. Moreover, attitudes expressed in a survey might be influenced by a program planned to achieve just such changes in attitudes.

SOME PRELIMINARY RESULTS OF THE ATTITUDE STUDY

Although the final results of the attitude study are not yet available, a hand tabulation of the first quarter of the total interviews indicates that—

1. Though a majority of these respondents expect flooding in the future, a sizable minority did not. This latter result is similar to that found in previous studies mentioned above.

2. Most respondents state that they could not easily restore their property with their own money if they suffered substantial damage.

3. Over half of the respondents said they had an interest in flood insurance; a sizable percentage expressed a high degree of interest.

4. A majority of respondents considered as reasonable a requirement by lenders that flood insurance be purchased in order to obtain a mortgage loan, while only a third considered such a requirement as unreasonable. The requirement of flood insurance is considered slightly less reasonable when applied to a loan for an improvement to an existing house than when applied to a loan for new construction of a new house.

PROBABLE REACTION WHEN FLOOD INSURANCE IS MADE AVAILABLE

The actual reaction of residents of flood-prone areas toward flood insurance, assuming that it were offered, might differ from the attitudes expressed. Many aspects of the program might influence public acceptance. The degree to which the flood insurance program was publicized, the kind of information program about the nature of the flood hazards, the degree to which local public leaders endorsed and supported the program, the level of the insurance premiums, and other factors might be quite influential. In particular, the degree to which lenders of all kinds encouraged or required flood insurance as a condition of loans in high-hazard areas would have a great deal to do with its acceptance. In time, the attitude might be built up that a wise property owner had flood insurance, in the same way that a general attitude exists today that a wise property owner has fire insurance, whether required by his creditor or not. It is also easily possible that public indifference, or even hostility, toward flood insurance would not be overcome, especially if a halfhearted or ineffectual program were inaugurated for selling it.

Under any circumstances, it seems highly probable that there is some maximum amount which most property owners in flood-prone areas are willing to pay for flood insurance, regardless of their risk. It can be argued that owners in high-risk areas should carry flood insurance at any actuarial rate, because the greater the risk, the greater the likelihood they will lose all or most of their investment. However, it seems improbable that most property owners think this way; they feel that, if the current cost is high, they simply cannot "afford" flood insurance.

Although one cannot be sure of the exact relationships, it appears that there is some ceiling amount which is the most any occupant of flood-prone areas is willing to pay for flood insurance, regardless of his risk; and the maximum amount which people are willing to pay bears some relationship to the degree of their risk. In the absence of evidence such as may be forthcoming from the survey being prepared for appendix E, it seems doubtful that any considerable proportion of property owners will be willing to pay a flood insurance premium of more than \$2 per \$100 of value, and that more probably a limit of \$1 per \$100 is a maximum. It was pointed out, in chapter 6, that at the higher rate, the raw land on which the building sets has little or no value—the cost of the flood hazard eats up any rent the site might have earned. It seems probable that at rates lower than

\$1 for actuarial flood insurance premiums, people will be willing to pay the full premium.

Under circumstances most favorable to widespread adoption of flood insurance, actual participation in such insurance will increase only gradually after the insurance is initially made available. Factors such as the necessity of making surveys in flood plain areas, to determine flood-risk zones, will require some time; but the response of people in areas where the insurance is available is also likely to be gradual under the best conditions.

CHAPTER 8

PREREQUISITES OF ANY SYSTEM OF FLOOD INSURANCE

The foregoing chapters have outlined some of the constructive possibilities of flood insurance, as a means of providing the individual occupant of flood-prone areas with funds to rebuild after the inevitable disasters and as a tool for reducing the unwise use of flood-prone areas. If these possibilities of flood insurance are to be achieved, various alternative programs of flood insurance are possible; they are considered in the chapters which follow. But there are some program elements which should underlie any program of genuine flood insurance; the purpose of this chapter is to discuss these common elements.

ACCURATE ESTIMATION OF FLOOD DAMAGE HAZARD

The best possible estimate of the risk of flood losses in any location or circumstance is basic to any program of flood insurance. The occupant or would-be occupant of a flood-prone area should know the risks that he is taking; he will get flooded sooner or later, but how often and how severely? The local planning and zoning authorities, before they provide for public services such as sewers or before they allow building permits in any area, should have some idea of the hazards to which they are exposing people. The true social or economic cost of flood insurance is directly related to the extent of the hazard. The risk bearer—that is, the insurance company, or a pool of companies or the Federal Government if it is to share in the program—must know the risk assumed when a flood insurance policy is written. Every possible participant in the use of the area or in sharing either its cost or its returns has a direct interest in knowing about the risk of floods.

In chapter 6, data are presented on the methods of estimating flood risk and some data for specific flood-prone areas. At the best, the estimates of probable flood damages are just estimates. Moreover, even if the long-term average flood losses are correctly estimated, losses for a considerable number of years may deviate considerably from that long-term average. Nevertheless, estimates of probable average flood damages over a long period of years can be made sufficiently accurate to provide a sound basis for a program of flood insurance.

Of the many factors affecting the average annual flood damages for any specific property, one is dominant: the location of the property within a particular flood plain or flood-prone area. Within a flood-prone area, properties in zone A will often have long-term average flood losses 100 times or more those of properties in zone F in the same area. Moreover, the distance between the highest and the lowest risk zones may not be great in some instances—a few hundred yards, not a matter of miles. This is especially the case on seacoast properties, where just a small distance back from the actual waterline may greatly reduce the

damage when destructive storms occur. This relationship is illustrated in several of the reports for individual areas reported in appendix C.

Other factors, such as the kind of land use (i.e., for residences as compared with commercial or industrial properties), the design of buildings (i.e., wood frame as compared with brick, or no basement as compared with basement), the elevation of the structure above local land level, or the regional location of the area, or the extent of the flood protection works, and others, may each have significant effect upon the average annual flood damage, and hence upon the appropriate cost of the flood insurance. However, their effects, individually or in combination, are likely to be much less than those of the zone of location within the flood-prone area. Each flood-prone area has its own particular characteristics, and the relative importance of different factors will vary from one area to another.

When there are multiple perils involved, such as both hurricane and flood at the time property is damaged, there may be some problems in separating the causes of damage and the liability under the policies. However, these are not formidable problems and they are met and resolved by the insurance industry constantly.

Flood insurance will be difficult enough to inaugurate and administer at best, even with the most accurate estimates of flood risk. But an incorrect or biased or careless estimate of the hazard of flood damages under particular circumstances can only lead to trouble. If the true hazard turns out to be much greater or much less than anticipated, this will lead to disappointment, frustration, and conflict among some of the many parties involved.

RISK BEARER MUST BE COMPENSATED

In any program of flood insurance—as in any other program of insurance—the risk bearer must be compensated in some way for the risks he assumes. When he writes an insurance policy, he assumes a legal obligation to pay defined losses when they arise. His losses may be large, under some circumstances and in some years; though negligible in others. Typically flood losses are erratic in timing, with very large losses occurring at irregular intervals. If the risk bearer is to pay the claims that will result from flood losses, he must get the money somewhere.

This statement is obviously true for the private insurance company, but is equally true if the Federal Government undertook flood insurance. The private company must get the money to pay flood losses from premiums and reserves; it has no other source with which to pay claims. The Federal Government might indeed pay flood insurance claims out of general tax revenues, but this would raise issues of public policy including equity to those whose taxes would go to pay the losses of others. Insurance is not a fairy godmother that somehow miraculously pays everyone at a cost to no one.

Moreover, each major class of flood risk should, as far as possible, pay its own way. That is, to the extent that major differences in risk of flood damages can be recognized and identified, the premiums should be set so that policies sold in each such class meet their full costs. There will be, of course, some variation among properties in the same rate class. From time to time, proposals have been made

that flood risks should somehow be averaged over large areas—for all properties in a flood plain, or for all properties in a city, or even for all properties in a river basin or indeed the whole Nation. In the data which have been assembled for this report by the various Government agencies, it is clear that this would mean the averaging of very high risks with very low ones—differences that could often exceed 100 to 1. There are two major objections to any proposals for averaging of risks between significantly unlike zones:

1. It would be inequitable, as between occupants of one part of the flood-prone area and those in other parts. One insured would be required to meet costs much higher than were properly chargeable to his use of the area, and which could readily have been forecast in advance to be so much higher; while another would escape with costs significantly less than his true costs, which would have been equally foreseeable in advance. Since the differences would be very great, not only in relative terms but also in absolute terms of dollars per year or per month, those who had to pay larger costs would rightly object. Any normal person would object to being forced to pay several dollars a month toward someone else's proper costs of flood risk. In view of the laws in the separate States which prohibit discrimination in rates among insureds, it is highly doubtful if State insurance commissioners could approve any such averaging between grossly different flood risk areas. Letters from several State insurance commissioners, discussing this point, are presented in appendix D.

2. If somehow a single rate for insurance were set up, which covered widely different true risks of flood damage, the risk-bearer (insurance organization) would soon find he had all the bad risks and none of the good ones. This is the "adverse selection" problem which has long concerned insurance companies when they have considered the possibility of flood insurance. If a single insurance premium rate were established for a whole flood plain, when in fact the risk between one zone of it and another zone varies by as much as the figures show, the people who live in the high risk zone would buy insurance at the bargain rates available to them and the people who live in the low risk zone would not pay the excessive rates—and the insurer would wind up with only high-risk insurance policies at low premium rates, and with no low-risk policies. In this direction lies bankruptcy.

If it were true that the differences in risk rates between high- and low-risk zones were relatively small—on the order of 2 to 1, perhaps—and if it were also true that the absolute costs were small per year—say, \$1 or \$2 per month—then the administrative advantages of having a uniform rate for the whole flood area would justify it and a high participation in flood insurance could be readily achieved. Class insurance rates of all kinds normally include some range of variation among insured individuals. This situation may in fact exist when one compares only zone E, rarely flooded, and zone F, very rarely flooded, with annual flooding probabilities of 0.01 and less. Relative differences between these zones may be of the order of 2 to 1, and absolute differences in cost of the order of \$10 to \$20 annually per dwelling.

But merely to state the limited circumstances under which averaging of rates can apply is to show how impossible this would be for zones of widely different risks. Zone A, very often, and zone B, often, with net loss rates that range upward from \$2 per \$100 of property value, to as high as \$10 and even more in extreme cases, could be averaged

with zones E and F where the full risk rate is often less than 25 cents per \$100 only by the greatest inequity to all concerned. The rates to the man in the low risk area would be several times higher than his risks alone would require, while the rate to the man in the high risk zone would be a small fraction of his true rates. The disparate differences in benefits received would be so obvious to those in the low risk zones that they would not voluntarily participate.

PREMIUM PAYMENT AND RISK COMPENSATION MAY BE SEPARATED

Although the risk-bearer must be compensated in full for the risks he assumes, and although the insurance premiums should reflect the relative risks, yet the premiums might be paid in whole or in part by Federal, State, or local government, or some combination of them, and not necessarily paid wholly by the occupant of the flood-prone area or the owner of property there, if a public purpose is served thereby. The issue of who pays can be separated, from the necessity that someone pay. If occupants of flood-prone areas or owners of property cannot, or will not, pay the full costs of flood insurance there are several major arguments why in some types of cases it still might be good public policy to subsidize their flood insurance cost for some properties to some degree:

1. The persons who occupy these areas and built houses there did not understand the risks they were accepting by their acts. In fact, in some areas, families were urged to buy houses by arguments that completely misled them as to the extent of the flood hazard. Local authorities home builders, and real estate developers may have been ignorant of the true hazard, or may have minimized it in their zeal for local development; outright fraud in some areas is not impossible. The flood hazard may have increased, since the occupant located there, as a result of developments elsewhere in the flood plain or watershed.

2. Occupants and owners of property in such areas may also well point out that there was no effective public safeguard against their proposed occupancy of such land. It was zones for residential development, if local zoning was required; they or their builder got building permits from public bodies, if building permits were required; and only rarely could the prospective purchaser have found out, from a public source, what the true flood hazard was—even if he had tried to do so. Moreover, in many instances publicly-built flood protection works, often Federal works, were misinterpreted by local people—especially by real estate promoters—as providing more flood protection than they were planned to provide or in fact could provide. Residential subdivisions have been promoted claiming flood protection when the flood protection agencies had specifically excluded such areas from their plans.

3. Capital has been sunk in the properties now in the severe flood risk areas; some part of this investment can be salvaged only by continued use of the areas. If subsidization of flood premiums will help property owners maintain their properties, this may temporarily save capital, as well as helping these individuals salvage some of their sunk investments.

4. To the extent that a public obligation is recognized to provide relief when flood disasters strike, especially if they are severe, sub-

sidies for flood insurance might entail a lower cost to the Public Treasury than relief when the inevitable flood disaster strikes. The Federal programs to this end are discussed in appendix B. The occupant of the flood-prone area could carry at least some of the costs which his occupancy unavoidably creates. By having flood insurance, his needs for public relief would be reduced if not eliminated, when the next flood disaster struck.

These arguments, to the extent they are valid at all, apply best to properties and owners in the higher risk flood zones. Those people whose properties lie in zone E, rarely, and zone F, very rarely, clearly do not need subsidies for their flood insurance; premium rates which reflect their full costs are low, not only relative to such premiums in higher risk areas, but also in absolute terms. For a very few dollars per month, they can pay for flood insurance at a full cost rate, if a program is set up. Such people generally have homes in middle and upper price ranges; it is unlikely that many of them are truly low income; they can probably afford to pay the premiums. As the flood risk becomes progressively greater, the cost of premiums would rise and the ability and willingness of occupants to pay the premiums would decline; the level at which the public subsidy to flood insurance rates should begin, the degree of such subsidy, and the specific types of property to be included are among the major subjects in structuring a program.

Moreover, public subsidies to present occupants, for part of their flood insurance premiums, are defensible only as part of an interim solution to long-range readjustments in land use. The Federal Government, perhaps with State help, might help present occupants of high-hazard areas and the communities concerned to work out a long-range change in land use, which would get residences out of such high-risk zones. The process might well take several years; the essential point here is that the system of subsidization of flood insurance premiums should not prejudice such needed long-range adjustments.

The case for temporary partial subsidization of flood insurance premiums for existing properties in high-hazard zones is not valid for new properties in the same zones. If the Federal, State, or local government, or any combination of them, were to subsidize insurance premiums for new properties in such zones, this would be an invitation to every prospective occupant or builder to move into such areas, regardless of the cost to the general public. The total costs of occupying such areas is greater than the total benefits; if the individual is heavily subsidized, the costs to him may be less than the benefits to him, but in the end the total costs of flood damage are increased greatly. An openhanded program of subsidies to all present and future occupants of flood-prone areas could readily double or treble total flood damages to residential property nationally in a decade or two.

The discussion in this section emphasizes (1) flood damage risks must be borne by someone, in some way—they can't be wished away; and (2) the payment of the insurance premiums might be separated from the existence of the risk in certain carefully defined and limited situations.

Recommendation.—For all existing properties in special flood hazard areas, insurance should be offered at reasonable premiums, with Fed-

eral payments to cover the difference if and when such reasonable premiums are less than full actuarial cost, but no Federal subsidy payments for flood insurance should be made for—

- (1) Residential properties within flood risk zones when the full actuarial premiums are reasonable;
- (2) Any new residential properties built in such zones after flood insurance is effective;
- (3) Any residential property rebuilt after the effective date if substantial rebuilding is necessary following any flood disaster; and
- (4) Any residential property substantially improved whether or not incident to a flood disaster.

FINANCIAL INCENTIVES TO INDIVIDUALS TO REDUCE RISKS

Any program of flood insurance should provide financial incentives to the insured person to reduce his flood damage risks, or at the least should avoid financial incentives to him to take actions which would increase those risks. Damages due to flooding arise out of what man does in the flood-prone areas; whatever the hazard of flooding occurrence and frequency, the damage risk is to a degree within the control of the occupants of the area.

The prime measure to reduce flood damage hazard is to avoid encouraging unwarranted occupancy of the flood-prone areas. If the new occupant of such areas bears the full cost of flood insurance premiums, then he has to balance up the advantages and the costs of such occupancy. In some circumstances, it may be economic to occupy an area with relatively high hazard of flood damage, because the advantages more than offset the unavoidable costs. This may often be true for summer homes along the coast; it is the sea frontage which makes these locations valuable, but at the same time makes the risks of damage high. In many situations, however, the full costs of occupying high-hazard areas are simply greater than the probable advantages. Under those circumstances, flood insurance premiums which place the full costs on those benefiting from the location can operate to keep unwarranted occupancy to a minimum.

However, the possibilities of reducing damages in flood-prone areas go further than merely staying out of them. Several specific measures for reduction of damages in flood-prone areas are discussed in appendix F. In general, far more opportunities exist for new buildings than for old ones. By careful site planning, land development, site preparation, and by special flood-proofing measures, the monetary damage from floods can be reduced considerably. In the case of industrial and commercial property, special measures can be taken to protect machinery, equipment, supplies, and stock from damage. Some of these measures can be taken on older buildings, although both physical and economic possibilities are more limited for them. In any event, flood insurance premium rates should be adjusted downward to recognize the probable reduction in average annual flood losses due to any special flood-proofing measures; then the occupant or owner of the property can decide whether or not the gain through lower insurance rates is sufficient to offset the costs of the particular measures.

FLOOD INSURANCE AS A PART OF FLOOD PLAIN MANAGEMENT

Flood-prone areas, both riverine and coastal, are often valuable in spite of the risk of flooding. In an earlier day particularly, but yet today to a degree, rivers and coastal locations provide water transportation opportunities which may be valuable. Many industries needing a lot of water or having the need for major discharge of wastes into water, want locations bordering streams or the ocean. In more recent times, the amenity or recreation value of a seashore location for a vacation home has become increasingly important. In some cities, especially those whose original location was often dictated by river advantages, the flood-prone area may be well located with respect to the rest of the city. In these and other situations, people may wish to locate their primary home, their vacation home, or their business in a location subject to flood hazard.

The problems arise when the costs due to flood hazard are greater than the benefits due to the location. If everyone were perfectly informed and if circumstances never changed, presumably no one would ever be located where costs exceeded benefits. But merely to state these conditions reveals how unrealistic they are. Many persons have, in fact, located where flooding costs proved to be far higher than they expected when they located there. And sometimes a location which was valuable when the building was first erected there is no longer so valuable when conditions have changed. Locational values, in particular, are subject to change under the influence of new transportation methods or from other causes.

In this connection, it is useful to recall the discussion in chapter 6. Another example may help. Assume a family buys a new house and lot for \$20,000, paying 10 percent down, and puts \$6,000 worth of furniture in it; the land probably was worth \$5,000 and the building cost, including builders profit, \$15,000. Under usual home financing terms, the monthly payments, including taxes and amortization of the loan, are about \$150. Such houses have been found in some cities in zone A, very often flooding hazard, as noted in appendix C. The average annual flood damage in such areas might easily reach to \$10 per \$100 property value, building and contents both. This is \$2,100 annually or \$175 monthly—or more than the whole home financing cost in the absence of a flood risk. Putting aside for a moment the question of the occupant's willingness to pay any such cost, is it economic for him to do so, or economic for the public that he should be in a place where the full costs are so high?

Applying this damage rate merely to his initial equity in the property, would equal \$200 annually, or \$16.67 monthly. Assuming that he could move his furnishings to another location, a borrower might wonder why he should pay a higher insurance premium than this. He might conclude to move off, after he discovers what his true risk is, and let the mortgage holder have the house. The possibility of an impaired credit rating might rationally lead someone to pay somewhat higher charges, but how much more? Likewise, attachment to a home might also lead to some willingness to pay somewhat more than would be strictly economic for him to do. But it seems highly probable, under these very high risk but not unknown conditions, that many buyers of dwellings will be loath to pay for flood insurance to protect their lender's interest, unless they have been required to do so as a

condition to the loan; and, even then, there is surely some upper limit beyond which they will not pay.

From the viewpoint of local public responsibility, a somewhat different calculation but a not greatly different end result emerges. In this example, the monthly debt service and tax payment proportionately attributable to the building lot is \$50; if the average flood damages in this site cost \$50 per month, the land has no value. A monthly flood insurance premium of \$50, or an annual one of \$600, under these conditions is equal to a rate of \$2.86 per \$100 value of building and contents. At this insurance rate, the community would be well advised to require or foster home development elsewhere, whatever the land there cost. In fact, since a considerable share of the price of a city lot represents capital investments to bring streets, water, sewers, and other service facilities to it, the raw land price is much lower—often half or less of the lot price.

Calculations of this kind suggest that an annual flood insurance premium of about \$1.50 to \$2 per \$100 property value must be approaching the limit of economic rationality for dwellings, and perhaps for other property also. Under special circumstances, the maximum rate might be higher; but in some locations and circumstances it might be lower. If the true risk cost for flood insurance plus necessary administrative costs gets up to this general level, the land should be in some other use, over the long run. A more practical operating limit may well be nearer \$1. In the short run, with the investment in the present buildings already made, continued use of existing dwellings makes economic sense from a public policy viewpoint. Although the owner with a high mortgage may not be willing, or able, to pay a high flood insurance premium, the Nation is better off for him or someone else to use this dwelling than to abandon it. Some subsidy—to the owner nominally, but really to the lender as well—may therefore be necessary and desirable in the short run—and in this connection, “short run” may well be 25 years, until the present building is no longer readily habitable. If exposed to the heavy flood loss of this example, the house will age quickly.

The situation differs considerably when the flood insurance premium is lower. At the other end of the flood risk scale, Zone E—Rarely, and Zone F—Very Rarely, have damage rates in most areas of 25 cents or less per \$100 value. Administrative costs of insurance have to be added, but a deductible provision in the policy would lead to lower rates. A rate of 25 cents per \$100 value for the house and furnishings in the foregoing example would mean an annual cost of \$52.50, or a monthly cost of about \$4.40; only modestly cheaper land, or modest advantages from this location, or a combination of both, would make this rate economic both to the individual and to the public. As the rate rises in Zone D—Seldom, costs rise and may become high in relation to values; in Zone C—Occasionally, the situation is much less favorable and often will be uneconomic for dwellings.

Overall programs, public and private, for management of land and other resources in flood-prone areas, must take account of these differences in risk, and the relevant insurance premiums can be a valuable guide to decisionmaking. Given the hazard of flooding, as measured by the insurance premium, what is the best use of a particular tract of land? It is highly unrealistic, even misleading, to talk about “flood plains” or “flood-prone areas” as if all parts of each plain or

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area were alike; as noted repeatedly, the hazard varies greatly between zones and in some instances the zones are quite narrow.

The best management program for a particular flood-prone area may be a system of flood protection works; but the limit to their rational cost is suggested by the difference in insurance premiums with and without them. If flood damage is unavoidable, then insurance is a means of protecting against such losses. Where the unavoidable loss is high, the best longrun solution may well be a shift in land use—from residential to industrial, or to recreational, or simply as overflow land to help contain floods. If the city has long-range economic and land use plans, and if it takes actions to implement those plans over a period of years, substantial changes in land use can be made over such a period without severe hardship on anyone. Zoning, building permits, extension of public services, and other public actions can gradually shift use out of one area and into another. If such public plans are sound and well known, they provide guides to private investment which can work toward the same end. If there are summer or other homes along the coast in extreme hazard areas, they can be used as long as present buildings stand but not rebuilt or substantially remodeled in the same spot after the inevitable storm loss or destruction.

In this connection, it should be noted that subsidies to present occupants of flood plains, either in the form of assistance in meeting the flood insurance premium or in some other form, may be more costly to the Government agency extending the subsidy than would outright purchase of the property. There are situations where the Federal subsidy of flood insurance premiums over, say, a 20-year period could have a current dollar value grossly exceeding the value of the property. In such cases, it would be cheaper to buy the property outright. A flood insurance program should allow its administrator flexibility in determining the least costly means of achieving the desired end results of financial protection and incentive to relocation. A similar least cost analysis should also cover situations involving less than catastrophic or complete damage. The cumulative effect of small payments under a subsidized policy should be carefully considered prior to any restoration payment as it may prove more economical to encourage or require relocation before a given property is rendered totally obsolete by floodwaters.

Management of flood-prone areas, in this broad sense, obviously goes beyond flood insurance alone. But, by whomever it is offered and however it is structured, flood insurance should be viewed as a facilitating, not as a neutral or obstructing force toward long-range land use adjustments. To serve in this way, there must be frequent and significant interaction between the flood insurance organization and other public and private organizations. Moreover, the flood insurance program must be kept sufficiently flexible to adapt to the overall flood plain management program, whenever this can be done without serious harm to the insurance program as such.

ACTIONS BY STATES AND LOCAL GOVERNMENT

Any program of flood insurance should offer every reasonable financial incentive to States and local governments to adopt and to enforce channel encroachment laws and to adopt and enforce land

use regulations, or zoning, and building codes or building permit regulations which help to reduce flood damages. To the extent that States and local units of government adopt and enforce such laws and regulations, the total flood hazard will be less, and the flood insurance premiums can be lower. Appendix G surveys the extent to which State and local governmental bodies have the authority and have used it, to adopt such laws and regulations.

The Federal agency responsible for the Federal flood insurance program, assuming that one is authorized, and the private insurance companies, assuming that they have a major role in the flood insurance program, should use whatever means they can to persuade both State and local governments to adopt and enforce such laws and regulations, as is stressed in chapters 9 through 12. Aside from, or in addition to, any general hortatory efforts, however, differences in flood insurance rates which will reward the citizens of governmental units with good laws and regulations will provide an effective political force to this end.

Any State which lacks an effective channel encroachment law has or soon will have building encroachment onto the flood channel of some of its streams. Business firms are particularly likely to extend their structures into the actual streambed, or at least into the floodway which naturally existed before heavy use of the area began. Such channel encroachment not only creates a danger of damage to the property concerned; by its effect upon the flow of the floodwaters, it may well increase the flood hazard to other properties. In extreme cases, floodwaters may be diverted considerably from their normal channels, bringing damage to properties that otherwise would have escaped them. Likewise, dwellings or other buildings in a flood plain, where they should not be, not only encounter heavy flood losses themselves, but they may often worsen the flood hazard for other properties. Additional construction under these conditions may further exacerbate the situation, and should be restrained by appropriate land use regulations.

The Federal Government, to the extent that it promotes or helps to finance flood insurance, clearly has a duty to encourage or persuade States and local government into effective action on these problems. In every field where major Federal help has been asked and extended, the stimulative effect of the Federal program has been one of the major considerations in its approval by the President and the Congress.

Private insurance companies are not under the same obligation to serve as instruments of public policy, vis-a-vis the States and local governments. But the flood insurance rates which they help to establish or which they propose could reasonably take account of the differences in cost which would be associated with unwise land use practices or with the absence of effective legislation and regulations. A difference in flood insurance premiums would surely be an effective force.

Recommendation.—The Federal agency administering the flood insurance program should work closely with State and local agencies concerned with land use in flood-prone areas in order to restrict future public and private investment in such areas and to take advantage of opportunities afforded by disasters, which require new investment to channel the resulting new investments to other geographic areas.

The Federal insurance program should provide incentives to encourage State and local action by setting insurance rates which

adequately reflect differences in risks due to differences in zoning requirements.

The Federal flood insurance agency should be authorized to assist States and localities in acquiring properties in special flood risk areas for the purpose of restricting their future use to low-risk purposes.

LAND USE CONVERSION IN HIGH RISK ZONES

The longrun solution to the flood damage problem in the highest flood risk zones will often be a conversion of the land to other uses, as noted previously. One further point should be made on this subject: authority and funds should be available to public agencies to participate in this process.

When dwellings or other property are completely destroyed or are severely damaged—when, say, the cost of restoration is greater than the present value of the damaged structure—it may be economically rational to buy the property from the owner, applying the insurance to the purchase price, rather than paying him the insurance for restoration of the structures. If a building has been destroyed or severely damaged once, the odds are high that its replacement will be destroyed or severely damaged in another severe flood at some future date. The risk exposure that led to one destruction will surely lead to another, the only question being, when?

In some situations, funds now available could be used to purchase land in high flood hazard areas in and around cities. Federal funds are available under the Department of Housing and Urban Development urban renewal programs to buy properties after a flood disaster and under that Department's open space programs as well as the Department of the Interior's land and water conservation fund to help acquire land to be retained for open space. While these Federal funds would have to be matched in some degree by State or local funds, the latter are also available in some States. These funds could only be used for the purpose of buying out high hazard flood areas if the resulting land had value for open space and recreation purposes; but this requirement would often be met. However, the cost of this land might be relatively high and there might be some reluctance to use these funds for this purpose.

A Federal flood insurance agency which had both authority and funds to buy land or interest in land in high hazard flood areas after floods had destroyed or severely damaged the buildings there, could promote relocation out of the severe flood risk area. Sale by owners would be voluntary, but the alternatives open to them would necessarily be costly and unattractive. If subsidies had previously been extended for flood insurance premiums on existing but not on new property, then the destruction of an existing building and the necessity for complete rebuilding would end that subsidy. The rebuilt building would be "new", both physically and as far as flood insurance subsidy was concerned. While Federal loans at lower cost than private loans might be extended as a form of flood relief, following a flood disaster, yet they should be conditioned upon the purchase of flood insurance against the next disaster. If the area is truly one of high flood risk, such flood insurance at unsubsidized rates would indeed be costly.

A Federal flood insurance agency, under these conditions, might offer to buy the whole property, applying against the purchase price whatever flood insurance payment was due; the seller could take these funds and locate elsewhere; and the Federal agency could convert the land to other uses. In the past, efforts to relocate people from high flood risk areas have been only indifferently successful; one necessary step is promptly to erase the old damaged buildings or their wreckage as completely as possible, and to convert the area promptly to another use. This is where long-range, land use plans for the city and the flood areas would be particularly useful. Sometimes the cleared areas could be used for parks, sometimes merely for overflow land, but sometimes for industrial or other uses. They need not remain in public ownership, but might be sold, subject to restrictions against future unsuitable uses. If flood insurance is to be correlated with other public and private programs for management of flood-prone areas, it is essential that the Federal flood insurance agency have these legal powers and finances.

Recommendation requiring further study.—In special flood risk zones, the Federal Government should assist any uninsured victim of a flood disaster to relocate his home to a site where average annual flood damage is lower:

- (1) Perhaps by extending the disaster loan program to aid in acquiring a home in such new location (but not in refinancing any previous mortgage debt); and
- (2) Perhaps by buying up immediately after a flood any remaining equity in his home and lot (for later disposition), whenever a damage of more than 50 percent of the pre-flood value of the structure has been suffered; but
- (3) In either case the victim of the flood disaster should be required to purchase and keep current flood insurance for the life of the loan in his new location at an unsubsidized premium rate.

PROGRAM REEVALUATION

Flood insurance programs, like any other public or private programs, should learn from experience. A periodic reevaluation of the flood insurance program, at frequent intervals, seems to be essential. This cannot be done simply by comparing premium collection and claim payments over some decade or other period; this method may work for fire insurance and some other types of property insurance, but it can be very misleading if applied to flood insurance. For reasons discussed in chapter 6, the flood hazard must be judged in terms of a timespan much longer than 10 years. Losses in one decade might average far below, or far above, truly long-term average annual losses; the appropriate time interval for flood insurance is vastly longer than the appropriate time interval for other property insurance.

Nevertheless, flood experience in a particular decade, when combined with all previous experience and when properly analyzed, is highly valuable. By the same methodology outlined in chapter 6 for the initial estimate of flood hazard and premium rates, new estimates can be made, taking full advantage of the more recent experience. As more experience accumulates, the nature of the flood hazard in any particular area can be measured with greater and greater accuracy. Moreover, if further development occurs in the flood-prone area—

and this might well be economic, if the expected benefits were greater than the estimated costs—new estimates of flood damage susceptibility would be required.

In addition to a simple reevaluation of flood hazard in areas covered by flood insurance, many special studies would be necessary, if the flood insurance program were to operate as efficiently as possible. At various points in this report, including in its appendixes, attention has been called to deficiencies in our present knowledge. These could gradually be corrected, as the program was placed in operation. The kinds of studies needed are not pure research, but more applied replied research or management operational studies.

If the Federal flood insurance agency had the authority and the funds to make these studies, either with its own staff, or by contract with other Federal agencies or with private firms or with State agencies, this would provide a vehicle for such studies. This study of flood insurance has revealed a great deal of useful information in many public agencies, but frequently this information has not been analyzed for its meaning to flood insurance. Since this information was collected for other purposes, this is not surprising. But it seems clear that a Federal insurance agency should have the responsibility, the authority, and the funds to make or have made the best possible studies to help guide the insurance program. An insurance program will involve such considerable sums of money, public and private, that any improvement in the program will warrant the expenditure of any reasonable sum of money in study.

CHAPTER 9

ALTERNATIVE PROGRAMS OF FLOOD INSURANCE

The foregoing chapters have described the nature of the flood hazard, and have made a case for flood insurance. Floods are unpredictable in timing and in severity, but average impact over a long period of years in each locality and flood risk zone is measurable. The response to flood hazard in the past has been varied, including simple acceptance of risk, construction of flood protection works, and methods of flood forecasting and flood warning; and, when the inevitable disaster struck, some form of public relief was provided in many cases. Flood insurance has twin objectives: to provide funds for those suffering disasters, and the encouragement of sound land use programs which restrict development to locations where the advantages more than compensate for the flood risks. Flood insurance, if practical and workable, has many advantages in each purpose.

The purpose of this chapter is to explore briefly four major alternative ways in which flood insurance might be organized, assuming that a flood insurance program is adopted as a desirable approach to the flood problem. The general characteristics of any flood insurance program were outlined in chapter 8, and all apply here. The first alternative is discussed in this chapter. Each of the other three alternatives is then taken up in a following chapter, in more detail. While only four major alternatives are discussed, each has several variants and, in some respects, intermediate or hybrid programs might be devised. But the broad alternatives should help focus attention on the major issues.

AN INSURANCE INDUSTRY FLOOD INSURANCE PROGRAM

A logically first major alternative is for a fully private and fully self-supporting flood insurance program, operated and managed wholly by private insurance companies, in a manner roughly comparable to the fire insurance programs which they operate today. Under this alternative, the insurance industry would estimate the flood risks and thus the premiums necessary to support a flood insurance program; to avoid the financially disastrous consequences of adverse selection, premiums would have to vary according to risks in each zone; would offer policies, presumably through its established connections with agents and brokers, to anyone interested; collect premiums, pay takes on them, and pay dividends to its members or to its stockholders, if it could earn them; receive and pay claims for flood damages; etc. The individual exposed to a flood hazard would take out insurance, or not, as he chose. Government, whether Federal, State, or local, would not participate in this kind of flood insurance program at all.

Merely to state, even in these very summary terms, the nature of this flood insurance alternative, is to suggest how unrealistic it is. Its lack of realism lies in three facts:

1. The property insurance industry has generally refused to write this kind of insurance in the past, especially for dwellings, in the belief that an adequate actuarial basis for such insurance was lacking, and that public interest in such insurance was too low. It seems reasonable to conclude that private insurance companies would have moved into this field of insurance, as they have moved into many others, if the basis for profitable business had existed—or if they thought it existed. Some of the property insurance industry may be more willing to write flood insurance today than it was in the past, including the relatively recent past (see app. D for a statement of present insurance industry views). But it still seems highly unlikely that the industry will, or can, embark upon a flood insurance program wholly upon its own.

2. However, even if the private property insurance industry did offer flood insurance on dwellings and other structures on a sound actuarial basis, this alternative would be unrealistic from both a public and a private point of view because participation by occupants of flood-prone areas would be too low. Those whose risks are highest, who most need flood insurance, would tend to reject it because its costs to them would seem too high. The basis for unsubsidized private flood insurance, under extended coverage policies, may well exist for those properties exposed to a relatively low flood risk, as was noted previously; but even these people will need considerable nudging if they are to buy flood insurance. For those people whose risks are high, unsubsidized flood insurance premiums would be so high that most would refuse to take it, even with some pressures from lenders or others. In fact, as noted, economically rational action in some locations would be abandonment of existing properties rather than payment of the full insurance rate.

3. Still further, an ambiguous but substantial public liability for relief when the inevitable flood disaster strikes would still continue, even though flood insurance were available but had not been purchased by those most in need of it. The nature of this public liability for relief to disaster victims has been considered previously. It will depend in part upon the scale of the particular flood disaster and somewhat upon the dramatization of the suffering in the disaster. Nevertheless, some measure of public responsibility for relief of disaster victims does exist; let another severe flood or hurricane strike anywhere, and the American Red Cross will be extending personal relief and the Federal Government is likely to be providing generous loans or other aid to flood victims: A flood insurance program which perfectly met private business standards might yet fail to meet broad public objectives.

Because this alternative seems so unrealistic, both in terms of likelihood and of desirability, it is not considered further.

**A PROGRAM OF FLOOD INSURANCE BY PRIVATE INSURANCE INDUSTRY,
WITH MAJOR HELP BY THE FEDERAL GOVERNMENT**

This alternative will be explored in more detail in chapter 10, but may be briefly described here. Under it, the property insurance industry would provide necessary initial capital, write flood insurance policies, collect premiums for them, invest and manage any reserves that might be built up, and pay and verified flood damage claims.

The Federal Government would work with States and local government in devising and applying suitable legislation and in planning the management of flood-prone areas; would encourage occupants of flood-prone areas to buy flood insurance, and would encourage fiduciary lending institutions not to loan in such areas without flood insurance; would establish the flood insurance premium rates, and pay subsidies to these premiums for existing properties where the costs were more than occupants could reasonably pay; would provide financial backup of some kind to the private insurance firms, against the hazard of early heavy flood losses, before reserves could be accumulated; and would provide excess insurance coverage against flood losses of catastrophic proportions, beyond some defined level. All these and related aspects of the operation of this broad alternative are considered in more detail in chapter 10.

PRIVATE INSURANCE INDUSTRY OPERATES A FEDERAL FLOOD INSURANCE PROGRAM

A next logical step, in the progression of alternatives from all-private to all-public flood insurance, would be for the private companies to serve, in effect, as fiscal agents for the Federal Government. With its extensive business structure which reaches into every locality, the private insurance industry—using that term in the most inclusive sense—has the capacity and competence to operate an essentially public flood insurance program.

Under this alternative, the property insurance company would write flood insurance policies, collect premiums, and settle claims for flood damages, more or less as in the foregoing alternatives; but it would do so, largely if not in the full legal sense, as an agent for the Federal Government. The latter would provide all or most of the initial capital required, would receive from the private companies that portion of the premiums which represented risk of flood damage, would bear the cost of all flood damage claims, and would absorb all the risks. The Federal Government would still have some of the same functions as previously described, in terms of working with State and local government; of encouraging occupants of flood-prone areas to buy flood insurance, including encouragement to credit institutions; of establishing flood insurance premium rates and rates of subsidy to existing occupants where full costs would be prohibitively high; of differentiating premium rates into a risk portion which would be paid into the fund and into an administrative portion which the companies would retain (and presumably pay taxes on, and dividends from, if any profits ensued); and others. This alternative is described in further detail in chapter 11.

One major variant of this alternative or the previous alternative might be mentioned briefly at this point. Instead of the Federal Government putting up all the initial capital, the private insurance industry might provide part of it; some form of joint Government-industry arrangement—possibly a joint corporation—would have to be created. If they put up part of the capital, the companies would naturally wish to share in administration of the joint corporation or other structure. Risks of loss might be shared in proportion to the source of the capital, or more heavily on one partner or the other. Many difficult and complex problems of relationship between the

private and the governmental parts of the joint venture would arise. This variant would seem desirable only if the private industry were unable or unwilling to put up all necessary initial capital, as called for in the second major alternative, yet was unwilling to accept the limited role as operating agent, called for in this third alternative. Even then, the public advantages and disadvantages would have to be considered carefully.

AN ALL-FEDERAL PROGRAM OF FLOOD INSURANCE

The second and third major alternatives involve some degree of collaboration between the property insurance industry and the Federal Government, and major problems inevitably flow out of such collaborative arrangements. Some of these problems would be eliminated, but others would arise, if an all-Federal program of flood insurance were undertaken. This alternative will be explored more fully in chapter 12, but its main outlines can be sketched here, for general comparison with the three foregoing major alternatives.

Under this alternative, an agency of the Federal Government would operate a flood insurance program. It would have all the problems of working with States and local governments, of persuading occupants of flood-prone areas to buy insurance, of establishing insurance rates and degrees of subsidy to existing property, and of estimating and absorbing losses from flood damages, which would arise under either of the two foregoing major alternatives. There would presumably be no problem of initial capital, except for the necessary legislation authorizing an appropriation and/or borrowing power from the Treasury for this purpose; nor would there be a problem of income taxation on net premium income since it would be Federal funds that were involved. Moreover, the Treasury is able to assume the risk of flood losses that might occur in any catastrophic flooding, if the Nation is willing for it to do so. In all of these and in perhaps other ways, this alternative would eliminate some problems that would arise under other alternatives.

This alternative will involve other special problems and policy issues which are discussed in more detail in chapter 12. The risks of "political" intervention—such as private pressures to establish flood insurance rates in a particular area lower than the probable risk demands—would surely not be absent; but similar risks might be encountered in the other major alternatives where Federal and industry collaboration is involved.

SCOPE OF FLOOD INSURANCE PROGRAM

Irrespective of which of the foregoing alternative forms of flood insurance might be initiated, other questions arise as to its scope. Flood insurance might be available to all property exposed to a flood hazard, regardless of its ownership (private or public), and regardless of the kind of property (residential, commercial, industrial, public service, other), at one extreme of inclusiveness. Or its availability might be limited to privately owned property only; this would exclude property of State and local government. Or initially it might be limited to residential property, small business establishments, and agriculture crops. Later it might be extended to larger commercial,

industrial, public service, and other miscellaneous kinds of property. Whatever might be the decision on scope within the foregoing alternatives, flood insurance coverage might further be limited to some maximum amount per structure or per property owner. The 1956 Flood Insurance Act, for instance, limited insurance coverage to \$10,000 per residential unit and to \$250,000 per structure for any other kind of property. Flood insurance might be extended to building structures only, or to buildings plus contents. It might include a deductible provision, under which the property owner sustains some amount of flood loss. It might provide for varying degrees of coverage, at the option of the property owner, but with premium rate adjusted accordingly. That is, it might include only the first \$5,000 of flood damage loss, with the owner assuming the risk for larger losses. In all of these, and in perhaps other ways, the scope of the flood insurance program could be varied, if desired; each set of these variables exists without respect to the decision about the general organization of the flood insurance program, along the lines of the four major alternatives or some variant of them.

CHAPTER 10

FLOOD INSURANCE PROGRAM BY PRIVATE INDUSTRY, WITH MAJOR HELP BY THE FEDERAL GOVERNMENT

This is the second of the four major alternatives for flood insurance, briefly described in chapter 9. It is a wholly realistic alternative (see appendix I). It has several advantages, including the use of the expertise and the extensive organization of the private insurance industry, and the greater financial strength of the Federal Government to cope with the unusual hazards. It also has several major problems, mostly arising out of the necessity of close working relationships between the industry and the Government.

On a number of points, the discussion here is still in somewhat general terms because the exact form requires negotiation between the industry and the Federal Government. If there is agreement as to outlines, then specific details can be hammered out. Since this alternative rests upon the cooperation of the property insurance industry (as broadly defined), the final form of the Government-industry relationships will necessarily depend in part upon industry views and positions. While these have been explored to some extent in appendix D, the insurance companies and associations did not have any specific proposals before them when they prepared their replies in that appendix. The fairness of this general alternative, and its attractiveness to the insurance industry, will depend in considerable part upon specific figures on such matters as degree of Federal subsidy, degree of Federal incentive to occupants of flood-prone areas to buy insurance, the specific point at which the Government absorbs excessive flood losses, and others. These will have to be explored further in a way that is impossible in this report.

Recommendation.—The Federal flood insurance agency should be authorized to negotiate as promptly as possible with the private property insurance industry to seek a mutually acceptable basis, on standards to be determined, for a private flood insurance program with Federal help in special risk zones, as outlined in this chapter.

ROLE OF THE FEDERAL GOVERNMENT

Implementation of this general alternative would require enabling legislation, either an extensive revision of the 1956 act or a wholly new act, to provide for the role of the Federal Government. The discussion which follows describes how the program might operate under such legislation; naturally, the final form of the legislation might differ from the description here, and hence the program would have to operate differently, at least to a degree. This section is based upon what seems to be desirable attributes of a Federal flood insurance law.

The Federal legislation would have to provide some administrative organization, and some authorization of funds, to carry out the Federal

side of this arrangement. The legislation might be quite specific or might give considerable flexibility to the flood insurance organization. Under this general alternative, continuing annual appropriations or other access to Federal funds would be necessary. The exact form of the law, of the administrative organization, and the amount of the appropriations are all extremely important in their effects upon the precise program which can, or will, be carried out. At this point, however, it is assumed that the law and the appropriations will be adequate to carry out the functions and operations as described, without getting into too much detail as to precise arrangements.

The administrator of the Federal flood insurance program would make its availability and its provisions known to State and city officials and to private groups in flood-prone areas. Some expression of interest in flood insurance from State and local authorities would be necessary before a program could be inaugurated in a local area. Their cooperation will be necessary in various aspects of the program, and they should take some responsibility for bringing the flood insurance program to their area, or for not doing so. The flood insurance program, as outlined in this chapter, will inevitably bring both some pressures on occupants of flood-prone areas and some rewards to them; and its absence in a particular area would result in severe financial loss to individuals when the inevitable flood strikes. State and local governments could thus participate with the Federal Government in the decision to extend, or not to extend, flood insurance to a particular area.

Recommendation.—During the initial period of development of the national insurance program, preference in making the necessary surveys and in initiating the flood insurance program should be given to those States and areas expressing positive interest in flood insurance.

When State and local governmental officials ask for a flood insurance program to be introduced in their area, the Federal administrator should work with them on such matters as channel encroachment legislation and its enforcement, land use regulations (zoning) and effectuating ordinances, and the like. The broad concept of management of flood-prone area, to encourage economically sound land uses over a period of years and to remove or change uneconomic use, should be considered fully. Appropriate information should be released to the general public on these points. Obviously, the Federal administrator could not compel any State or unit of local government to adopt his proposals, but he could indicate that flood insurance premiums would necessarily vary according to the degree of flood hazard, and that this in turn is closely related to channel and flood plain encroachment. The fact that the insurance premiums would be higher in the absence of effective channel encroachment laws and of flood plain zoning would, if generally known, provide an incentive for public support of such measures.

The 1956 act gave the commissioner of the flood indemnity agency the authority to refuse to issue flood insurance in localities lacking in adequate land use zoning provisions. This seems a measure whose value may be questionable; while it may provide the administrator with a bargaining measure, its drastic character tends to make it unworkable in some instances. Moreover, many States lack the legal power under their constitutions, or have not granted power to localities, to adopt specific flood plain regulations. Variation in flood

insurance premiums, in response to differences in land use controls which have a measurable effect upon the flood damage hazard, seems both fairer and more likely to be effective.

Land management programs for flood-prone areas should be fully interrelated with other public programs, such as the provision of open space, transportation plans and developments, urban services generally (including such matters as extension of sewerlines), urban renewal, urban beautification, and others. If a long-range land use plan for the flood-prone area exists—as it should in any progressive modern city—then the flood insurance program can be made to help in the achievement of that plan. The administrator might well bring considerable incentive on a city or community to prepare such a long range plan, if one does not already exist. Where such a plan did exist, the administrator should be hesitant to adopt any action which would hinder its fulfillment.

It will be incumbent on the Federal flood insurance agency to develop criteria for land use management of flood-prone areas. Such criteria should be comprehensive and flexible enough to meet varying local conditions. The wide variety of measures used to meet this problem is reviewed in appendix G. Every encouragement and incentive should be given to local authorities to adopt and enforce land use regulations in conformity with the national criteria.

Recommendation.—Federal agencies should cooperate with State and local planning bodies in developing long-range plans for land use in flood hazard areas and in developing standards for local land-use zoning in such areas.

All of the foregoing is to suggest that the administrator's powers should be extensive but discretionary, and that the program should be flexible to meet local conditions. In some cities, ample building sites out of the flood plain are available, and it would be practical to shift some forms of land use out of the more hazardous flood-prone areas. In other cities, especially along the sea coast, there may be few or no locations without appreciable flood hazard, and land-use changes are accordingly more limited.

After such request from and such cooperative planning with State and local authorities as the administrator thought necessary and practical, he would designate a particular area as eligible for flood insurance. In order for a flood insurance program to be operative, he would need basic information on the degree of the flood hazard in various local zones. By the methods outlined in chapter 6 and in appendix C, average annual flood damages in various locations, for various land uses, for buildings of different types of construction and different elevations above ground level, and for other circumstances would be estimated as the basis for flood insurance premiums. This would require some expert personnel and some time, but the requirements on each of these scores do not seem too great. Other factors will also operate to put the flood insurance program into effect gradually, even when available on a national scale, and it seems probable that the determinations of flood hazard can proceed as rapidly as necessary.

The administrator would announce publicly that flood insurance was available in specified areas, and he would so notify lending institutions, encouraging them not to make mortgages in flood-prone areas on new properties without also requiring flood insurance. He

would further announce that flood insurance for new properties would not be subsidized by the Federal Government. He would also announce the availability of flood insurance to local building permit offices, urging that building permits not be issued in highly hazardous areas and that special flood-proofing measures be required where these were appropriate. The latter is now the practice in some areas exposed to flood hazards, and the effect of the flood insurance program would be merely to make more general what is already practice in most alert cities.

Based upon the data available to him, which he would also make publicly available, the administrator would announce for each local flood-prone area the average annual flood loss rates which he was prepared to subsidize for specified classes of existing property within each zone: and he would also announce the degree of subsidy he was prepared to extend to each. On the one hand, effective rates to occupants of flood hazard areas cannot exceed some ceiling, or these people cannot or will not buy the insurance; on the other hand, Federal subsidies should be no more generous than necessary. In announcing these annual flood damage rates on which he was prepared to pay subsidies, the administrator would be going far toward setting the actual insurance premium; this is considered later in this chapter.

The administrator could not be indifferent to the scale of administrative costs that would be included in the flood insurance premiums in the policies written by private companies. The ability or willingness of occupants of flood-prone areas to pay for flood insurance applies to the total premium, administrative cost as well as loss portion. If the Federal subsidy were large, in some situations it might exceed the loss portion of the premium and this be, to a degree, a subsidy of the administrative cost of the insurance company. The companies will be performing a real function in writing and servicing flood insurance policies, and they must be paid for it; yet public policy demands that they not be overpaid. In no other aspect of this co-operative Federal-industry approach to flood insurance will more difficult problems arise than in this matter of reasonable administrative cost and profit. A national scale of charges per policy might be established; for instance, a minimum amount per policy plus a small percentage of the face value of the policy or of the premium, or some other arrangement. State insurance commissioners might well insist upon approval of any premium rates, especially since the same companies would generally be writing other forms of insurance to which Federal subsidies did not extend.

The administrator of the Federal flood insurance program would be authorized to establish an "excess loss point" above which the Federal Government would absorb all flood claims. The insurance companies could be required to pay a reasonable annual sum for this assistance. If claims in some year rose much higher than average claims, the Federal Government would absorb the losses above some point. This would take care of the catastrophic flood situation, or years in which losses run several times higher than average. Not only should such provision be made for individual high-loss years, but also for a succession of high-loss years. That is, there might be a period of 3 to 5 years, or even longer, when losses for the whole period would run substantially higher than average, in spite of the fact that no single-year loss was extreme.

One major problem would arise in defining the level beyond which the Federal Government would absorb excess losses. Perhaps the easiest way would be in terms of the relation of losses to that part of the annual premiums which represents pure loss risk. That is, the excess loss point might be defined as losses of some multiple of average annual premium representing loss risk. Losses due to catastrophic floods can be extremely high, as appendix H shows; the higher the ratio of the excess loss point to annual premiums, the less frequently will it be encountered. A different approach would be to define the excess loss point in terms of flood magnitudes and frequencies; for instance, losses due to floods in excess of the standard 100-year flood might be absorbed by the Federal Government. Such a standard might be harder to apply, particularly as between different companies and regions.

The excess loss point and Federal absorption of greater losses might be made operative on an insurance company by company basis, or on a pool by pool basis. That is, the administrator would deal with various companies and pools and, when losses rose above the agreed-upon relation between losses and premiums (risk portion), he would reimburse each company or pool for the excess losses. This would provide a guarantee to each company or pool that its losses could not exceed some defined point. There is some precedent for this in the Price-Anderson Act which provides for indemnification of claims arising out of a nuclear accident to an atomic power reactor operated by a private utility company. The Government provides a maximum of \$500 million of indemnification per incident over and above the underlying financial protection provided by private insurance pools. This private insurance, required by the Atomic Energy Commission, varies according to the size of the reactor. The maximum amount of private insurance per reactor which is available from the private insurance pools is \$74 million.

The higher the excess loss point were set, the less would be the Federal Government's responsibility. To hold administrative costs within reasonable limits, the administrator might well establish some minimum figure of insurance per company or per pool with which he would deal. If available even for a small volume of business, the absorption of losses above the excess loss point would be a substantial aid to the smaller insurance companies in dealing with the very erratic timing of flood losses. In the absence of some guarantee which would be practically helpful to small companies, flood insurance might be fatally risky for them.

In addition to provision of excess insurance above the excess loss point, the Federal Government would almost surely have to provide some backup to insurance companies against early heavy losses. There has been a good deal of discussion of the necessity of building up reserves to take care of losses above average; the idea is sound. But it should be recognized that the heavy losses might come early—even in the first year of flood insurance—before any reserves could be accumulated. To the extent that these early heavy losses exceeded the excess loss point, as described above, the Federal Government would absorb the excess losses; but, short of such a point, losses might well exceed the risk-loss portion of the insurance premiums at any time during the early years. If the excess loss point were set relatively high—at 3 instead of $1\frac{1}{2}$ times risk-loss annual premiums, for in-

stance—the losses might be severe, yet the Federal Government would not step in as bearer of excess losses. Unless the insurance companies were to set up very large initial capital funds, these early heavy losses could easily lead to serious operating deficits beyond the capacity of the insurance companies to bear.

The Federal Government would almost surely have to provide some kind of financial backup against the chance that early flood losses would be larger than average yet below the excess loss point. Not only might losses be relatively high in one year, but in a succession of years they might total well above average. In the event that losses were only average or lower, the Federal financial backup would not be used. The Federal financial backup might take the form of loans to the insurance companies, secured only by their commitment to continue issuing flood insurance; over a long period of years, premiums would be high enough to bear losses, and the early deficits could be repaid. This might be called a form of “negative reserves”; that is, not only might reserves be built up in years of low losses for use in the inevitable years of high losses, but credit might be used to provide reserves for high loss years and then repaid in years of lower losses.

Recommendation.—The Federal agency administering the insurance program should be authorized to encourage and assist private property insurance companies in order to obtain their maximum participation in the insurance program consistent with effective achievement of the objectives of the program.

In areas of special flood hazard the Federal Government should aid any private insurance companies which wish to undertake a flood insurance program as principals (1) by assumption of all claims for flood losses beyond some specified catastrophic level in return for a reasonable payment for such excess insurance; (2) by loans at reasonable rates of interest to replenish reserves in case of early heavy flood losses before fully adequate insurance reserves have been built up; and possibly (3) by tax deferrals (rather than tax exemptions) to accelerate accumulation of adequate insurance reserves from premiums to meet extraordinary claims which are certain to occur over a long period of time.

A degree of Federal subsidy to flood insurance premiums for existing properties in high flood risk zones has been proposed earlier in this chapter. If the damage following a flood was not too great, the assistance of the Federal Government, through loans or otherwise, might be extended to help restore the dwelling, and still retain the subsidy available to existing buildings. However, if the damage were so extensive as to require substantial rebuilding of the dwelling, it should come under the new-construction, no-subsidy classification. This would force the property owner to reconsider the advantages of this location against the flood risks inherent in it, and in many cases might lead to a relocation in a less hazardous area.

In practice a great deal of the flood insurance would be written after a flood in a particular area, of course with no retroactive applicability. As noted in chapter 7, many individuals and many communities are unaware of their flood risk, or try to pretend that such risks do not exist, or hope that the next flood will not strike them. In the popular press and elsewhere, there is much talk about wholly unanticipated or completely unexpected floods; the floods in question

may have been unanticipated and unexpected by people who base their knowledge of floods on relatively short personal experience, but floods in most areas are neither unanticipated or unexpected to competent hydrologists and engineers. Convinced that the flood hazard is small, many individuals and communities will not buy flood insurance, and in fact many opposites being offered in their area, because this would clearly call attention to the degree of the flood hazard, and this would tend to depress land values in the affected areas. However, let one of these "unexpected" floods strike, especially if it is severe, and nearly everyone will cry for relief, including Federal help. It is at that point that flood insurance, against the inevitable next flood disaster, may be most sought by people in an area. This may appear to be locking the barn door after the horse is stolen; but this analogy breaks down, because there is another horse, and another horse, yet to be stolen in the future. Management of flood-prone areas must be looked at in a longtime perspective—much longer than 1 year, or even one decade. While existing buildings stand and are usable, they may well be used; but when they have to be rebuilt at large cost to someone, careful consideration should be given to rebuilding elsewhere.

A flood relief system might also be criticized on the grounds that it unduly rewards the present occupant of flood-prone areas who refuses to buy flood insurance. This argument asserts that the present occupant avoids the cost of flood insurance until the flood, after which he gets some measure of flood relief. But this argument overlooks several important facts. First of all, if the form of Federal relief is a loan at half or some other fraction of market interest rate for the purpose of restoring or rebuilding his house, the borrower still has the old loan to repay at the old interest rate, unless he goes through bankruptcy. The new loan, although generous, is on top of the old one. Had he bought flood insurance before the flood, with a subsidized insurance premium because his house was an existing structure in a high risk area, he would have had considerable financial help to rebuild.

The administrator of the Federal flood insurance program should have authority and funds to buy out heavily damaged properties, after a flood disaster, if their owners are willing to sell. If the dwellings were already insured under flood insurance, then the payment for the damaged house or dwelling would be its market price (preflood) minus the insurance; if flood insurance had not been available in the area, then extension of relief for a new house takes the form of helping salvage investment from the old one. In any case, the land so involved would be converted to other uses—open space, recreation, floodways, etc.—and would either be transferred to local governments or sold to private individuals subject to land use restrictions. Heavily damaged or totally destroyed buildings will almost always be located in high hazard flood zones, where the long-term adjustment is for a change in land use. On the one hand, the owner of the heavily damaged building would have to pay for flood insurance at an unsubsidized rate, as a condition for a new loan with which to rebuild or restore in that location; on the other hand, some assistance could aid him in getting out of where he had been, into a new and less hazardous location.

The foregoing presents, in general, the role of the Federal Government under this alternative of private industry flood insurance with

major Federal help. Many details would have to be worked out. The discussion has been in somewhat normative or subjective terms, on the assumption that if legislation is enacted it would permit or require the programs as discussed. This discussion of the role of the Federal Government has assumed a certain role on the part of the private insurance industry, which we now examine explicitly. Perhaps the single most significant aspect of this alternative would be the necessity for a close and continued coordination between Federal Government and private industry.

ROLE OF INSURANCE INDUSTRY

The general alternative of flood insurance considered in this chapter calls for a close cooperative working relationship between the insurance industry (using that term in its most inclusive sense) and the Federal Government. While the latter may propose certain working relationships, the industry will have to accept them, if they are to be effective. In what follows in this section, certain activities and relationships are proposed, which should be the subject of negotiation between the industry and Government. Various groups within the private property industry were asked a number of questions, the answers to which are presented in appendix D; but the industry did not have before it any specific proposals when those questions were asked, hence its replies could not be directed specifically toward the proposal of this chapter. The discussion here outlines a program for the insurance industry which seems to fit well into the broad arrangement of an industry-conducted flood insurance program with extensive Federal help; but it is one which this report suggests, not one which the industry has proposed or accepted.

The property insurance industry, like any sizable group, has different ideas among its membership on many of the issues involved in flood insurance. Competitive forces within the industry would probably tend to force all firms to participate in flood insurance, if any significant proportion of the firms did so. Today there are many complex competitive relationships among different parts of the industry—between large and small insurance firms, between mutuals and old-line companies, between insurance firms and agents, and others. Many agents like to write insurance for a firm which handles all types of risks; they sell fire, extended coverage, and other insurance. If some firms offered flood insurance in an area where there was a demand for this kind of insurance, then other firms would be under strong pressure to do likewise; otherwise, they would lose not only this kind of business but other kinds of insurance also. Thus, it seems probable that essentially *all* of the property insurance industry, or practically *none* of it, will write flood insurance.

Under the general arrangements of this chapter, the property insurance industry would provide all the initial capital required to begin writing flood insurance. The necessary amount of initial capital is considerably reduced by the various forms of help from the Federal Government, outlined earlier in this chapter—the mapping of flood risk zones and the establishment of average annual damages, the subsidization of flood insurance rates to a full actuarial level for those who otherwise could not afford to pay them, the low interest loans for losses up to the excess loss point, and the assumption of losses

beyond the excess loss point. Moreover, under the most optimistic assumptions, the program will begin modestly and only gradually develop. Under these conditions, it seems probable that the initial capital required might be in the range of \$75 to \$100 million for a program of flood insurance limited to one- to four-family dwellings. As the program grows, and as it is extended to other types of property, additional capital will be required. This is less than 1 percent of that total policyholder's surplus of all firms in the property insurance field of \$17 billion. If all property insurance firms participate in flood insurance, it would seem possible for the industry to provide the necessary initial capital.

The insurance industry would surely provide its estimate of necessary administrative costs of flood insurance; some of the replies in appendix D do this. State insurance commissioners would probably have to approve the total premium. The Federal agency, since it would be offering to subsidize flood insurance premiums for some existing properties, would naturally have some interest and concern over the level of administrative costs. In practice, one would expect a continual consultation between Federal agency and private industry on this matter of flood insurance premiums, and their two components of pure risk portion and administrative cost portion.

The property insurance industry would sell flood insurance policies, under the general plan of this chapter, as it sells other types of property insurance. Presumably agents and other local representatives would be used, much as is the case for fire insurance. The publicity which the Federal agency would give to flood insurance, and the encouragement it would provide to the occupants of flood-prone areas by restrictions of credit for new construction unless flood insurance were purchased, should assist in the sale of flood insurance by private firms. After a flood, there would clearly be new interest in flood insurance; the problem would lie in keeping such new flood insurance policies current over a longer period of years.

The insurance companies or pools would have the major responsibility for managing any reserves created out of current flood insurance premiums which exceeded current flood damage claims and administrative expenses. Flood losses will be less than average in perhaps 9 years out of 10, thus leading to a surplus of premiums over claims in those years. If flood insurance premiums are to be constant or only slowly changing from year to year, then reserves must be built up in low loss years for use in high loss years. Some quantitative estimates of this problem have been presented in appendix H. The time periods concerned are far longer, and the size of desirable reserves is far greater, than for fire or other property insurance of the same face value; but the management problems of reserve funds are basically the same.

A major problem in this connection is the taxation status of flood insurance premiums, both Federal income taxes and State taxes of various forms. If the premiums are fully subject to tax, then they must either be even higher to achieve the same level of reserves; otherwise reserves grow more slowly and the ability of the insurance companies to meet heavy flood losses would be diminished. Faced with this prospect, various industry groups and others have proposed some form of exemption of net premium income from taxation; one such proposal involves the creation of a joint industry-Government fund, which is considered later. However, there is very substantial opposition to the extension of any further forms of tax exemption.

A different approach might be taken toward the matter of reserve accumulation. The point has been made repeatedly in earlier chapters that flood losses are highly erratic in timing; they do not average out over such short periods of time as 1 year, or 5 years, and not necessarily even over 10 years, although the longer the time period, the greater is the likelihood that losses will approximate a truly long-term average. The point has thus been made that one cannot properly consider flood insurance premiums and claims in an annual context; a much longer period of time is required. One way to meet the reserve accumulation problem would be to write flood insurance for much longer periods of time than the typical 3 years of a fire insurance policy, and treat a policy as in the nature of a contract between insurer and insured, which would not be fulfilled until the term was up. Thus, flood insurance policies might be written for periods as long as 10 or 20 years; the premium would be for the whole period but installments would be paid annually, and the total premium might be subject to adjustment within limits during the period; installment payments in excess of annual claims would be considered as payments into reserve, against a future liability, not to be considered earned until the period was up.

The forms of Federal help to the private insurance companies or pools of companies, described earlier in this chapter, would require some form of agreement, or contract, between the Government and the industry. This contract might well specify that the company or pool would continue to write flood insurance over a period of years, and that its contract with Government and with individual policyholders would not be considered fulfilled until the end of the period. This would further emphasize the longer term nature of the flood insurance policy.

In order to build up relatively large reserves to meet an infrequent but severe loss, it may be necessary to amend the Internal Revenue Code so as to permit companies to make a special deduction for additions to an extraordinary loss reserve. An amendment of this kind, could also eliminate any special tax advantage from this unusual deduction.

In considering the erratic nature of flood losses, it should also be recalled that the Internal Revenue Code provides for carryback and carryforward of losses, for 3 and 5 years, respectively. That is an insurance company or pool suffering large losses 1 year could not only deduct those losses from its earnings that year, for tax purposes, but also for the 3 preceding and the 5 following years. If the company had sufficient surplus to survive a flood disaster year, these provisions for spreading tax losses over several years would operate much as do accumulated reserves. If the companies lacked sufficient reserves, then the ability to borrow from the Federal Government under these circumstances might be highly important to the company or pool.

Another approach to the problem of reserve accumulation would be to amend the tax laws to permit a longer than normal period for carryback and carryforward of losses on flood insurance.

Insurance companies have at least two objections to longer term policies than the usual 3 years. If flood insurance is to be made part of the same policy or otherwise closely associated with fire or with extended coverage insurance, then it would almost have to be of the

same 3-year length. This might be the situation in low-risk areas, where rates could be low and insurance against floods included as part of extended coverage. The advantages of long-term policies would be greatest in high-risk areas. The other objection is that the companies do not want to be stuck with an unalterable premium schedule over a long period of years, especially for flood insurance which some regard as somewhat untried and speculative. The latter objection could be met by provision for periodic reexamination and revision of premium schedules.

In any case, if flood insurance were a condition for new mortgages for new building construction, the lender could insist that the flood insurance policy be maintained as a condition of keeping the loan current, just as lenders now require that fire insurance policies be kept up. In fact, the insurance policy should probably be retained by the lender, payments of premium installments on it made by him, and the monthly payment of the borrower be adjusted to amortize the periodic sums in much the same way as debt service, property taxes, and hazard insurance are handled by them today. Presumably, either insurer or insured would have the right to cancel the insurance, under stated conditions, but not otherwise. Under these circumstances, it may seem to make little difference whether a flood insurance policy is for 10 or more years, with provision for rate readjustment and even for cancellation under defined conditions, or whether it is for 3 years or even for 1, with renewal by the lender for the account of the borrower more or less automatic.

An alternative approach to the income tax problem is through the vehicle of a tax-exempt corporation which would administer the flood insurance program and in which the Federal Government had a proprietary interest. This interest would in part be shared by private insurance companies wishing to participate as principals in the operation of a flood insurance program. Their interest would be evidenced by purchases of shares of beneficial interest equivalent to their capital subscriptions. This corporation would administer the insurance fund out of which claims for flood damages would be paid to policyholders.

The resources of this fund could in part be established by the initial capital subscriptions from the Federal Government and the participating private companies and in part by the accumulation of reserves from net premiums. The net premiums would be calculated as gross premiums charged the policyholder less operating expenses of the private companies. The latter would not include any allowance for expenses of settling claims. In addition to these resources, the corporation would have authority to borrow funds from the Treasury similar to that which is now available to other Government corporations such as the Federal Deposit Insurance Corporation and the Federal Savings and Loan Insurance Corporation.

Participating insurance companies would write flood insurance policies in much the same way as they now write other property insurance. Upon writing a policy the private company would sell or assign the policy at cost to the corporation with an agreement to repurchase the policy in the event of a claim for indemnification. The company would thus be in a position not only of selling and servicing the policy but also settling the claims. The price at which the policy would be sold or assigned would be the gross premium

charge less selling and servicing costs incurred by the participating private company. The price at which the policy would be repurchased in the event if a claim would be the amount of the claim plus the expenses of settling the claim. Thus the fund would be paying the cost of writing the business and also paying the cost of the claim and expenses. Net premiums would go into the fund and together with the capital resources of the fund would be available for payment of claims. The income of the corporation administering this fund would be exempt from Federal income taxes. By the devices of sale assignment and repurchase of policies at cost, the private companies would not be subject to Federal income taxes on net premium income. However, distributed investment earnings on the shares of beneficial interest in the corporation fund owned by the participating private insurance companies should probably be subject to Federal income tax payment.

The capital and premium accounts of each participating company would be segregated and claims for indemnification and settlement expenses would be charged against each account up to a certain proportion. The excess over this amount would be covered by the Federal Government's account. Participation by the private companies would be arranged so that as many as wished to participate could be accommodated. By the same token, but perhaps only after some specified period of time, withdrawal from participation by individual companies would also be permitted, subject to conditions which would protect the interest of the Federal Government; on withdrawal, the company's equity interest would be redeemed. In considering this alternative, two questions may well be asked: Is the mixed corporation approach compatible with the assumption of responsibility for the flood insurance program, which is the distinguishing characteristic of this alternative? And would the case for tax exemption of the mixed corporation be weakened by the assumption of significant operating responsibility by the private companies? The answers to these questions are not necessarily negative, but they do demand consideration.

In any event, it does appear that the problem of reserve accumulation can be solved in some way.

If any means is devised for accumulating premiums into reserves without tax liability, then careful provision must be made for use of these reserves after they have reached the estimated required level, or in the event that the company ceases to write flood insurance. In the first situation, the company would immediately begin to pay taxes on all further premiums. In the second case, taxes should fall due on the accumulated reserves, to prevent a windfall to the company which ceased to write flood insurance.

Under the flood insurance program described in this chapter, the insurance companies would receive claims for damages from floods, investigate them, and pay the eligible claims, just as they do for loss claims under fire or other property insurance. The administrative structure of the insurance industry is well suited to this task, as the replies in appendix D state. The claims would have to be paid, over a long period of time, out of that portion of the total insurance premium which represented risk of loss. In the short run, for 1 year or even for several, claims might well be less than premium collections, in which case reserves would build up. They might be more

than premium collections, in which case claims would have to be paid out of capital reserves, or from surplus from past premiums, or from the Federal Government absorbing claims beyond the excess loss point, or by Federal help in meeting losses before reserves were built up. The insurance companies would incur costs in servicing flood insurance policies, and these would have to be paid out of that portion of the total flood insurance premium which represented administrative cost. Some companies might succeed in operating at a profit under the same rate structure which other companies would find profitless or even onerous, but in this respect flood insurance is not different from other forms of property insurance.

As noted, any portion of that part of the annual insurance premium which represents risk of loss and which was not used to pay flood damage claims any year, would go into reserves against future claims. As a matter of fact, in most years there would be some money going into reserves, if the average premiums were correctly set in the first place; losses will be less than average most years but far above it in a few years. The insurance companies have had extensive experience in management of reserves, and flood insurance presents few, if any, new problems in this respect.

While it is highly desirable that considerable reserves be accumulated for the inevitable high-loss year, yet there are also limits to the size of a rational flood insurance reserve. The maximum desirable reserve should probably be defined as some multiple of annual premiums (or of that portion marked for losses)—say, 2 or 3, or some other number of times the risk portion of the annual premiums. The size of the desirable reserves might well be defined as the same as the excess loss point, discussed previously, beyond which the Federal Government would absorb all additional losses. In this way, if reserves had been built up to this point, high losses in any year could be paid out of reserves, up to the level of the reserves, and then the Federal assistance would take care of the remainder. As noted previously, this arrangement would apply not only to high losses in one year but also to cumulative losses over a period of years, should these occur, where the cumulative deficit ran beyond the excess loss point.

Both Government and industry would wish to reexamine the whole premium rate structure, subsidy, excess-loss point, and other features of the financial arrangements at intervals, certainly every 10 years or more frequently. However, such reexamination should not be limited to a mere comparison of total premiums received and total claims paid. Serious gaps might show up between premiums received and losses paid—in either direction, from large deficits to large surpluses—and yet this be no proof that the basic rate structure was in error. Flood losses are too erratic in time always to expect a close balancing within each decade. Instead, the reexamination should repeat the steps by which the rates were determined initially; full use should be made of the whole period of record, and of the best hydrologic analysis.

An illustrative numerical example may help to make these general ideas clearer. In the discussion which follows, certain figures and relationships are used, but actual experience might differ greatly, and the specific details of cost sharing at different loss levels will have to be worked out. Suppose that private insurance industries as a whole or as a pool commit \$75 million in initial capital to writing flood

insurance on 1- to 4-family dwellings; suppose further that annual premium payments are \$25 million, as a pure loss rate with additional amounts to cover administrative costs, and average annual claims for flood damages over a truly long period are also \$25 million, so that there is neither deficit nor surplus over this long period. Now let us see what may happen in a particular year. Assume that the program has been in operation a few years, with less than average flood damages, so that reserves of \$20 million have accumulated. Assume now that a major flood disaster strikes somewhere, or perhaps in several watersheds, with total insured claims reaching \$150 million.

In payment of these claims, the insurance companies or pool would first use the \$25 million annual premiums for that year, then draw on the \$20 million accumulated reserves, thus meeting \$45 of the \$150 million total claims. Assume further that the Federal Government has agreed to assume all claims in excess of three times annual premium payments; in this example, the excess loss point would thus be \$75 million, and the Federal agency would reimburse the companies or their pool for the remaining \$75 million claims above this excess loss point. But this would still leave \$30 million of the claims not met by the combination of current premiums, accumulated reserves, and Federal assumption of loss above the excess loss point. Suppose further that it be agreed that the companies or their pool would be required, under circumstances such as these, to draw on their initial capital, but not beyond one third of it, to meet claims. This would provide another \$25 million; but \$5 million of claims would still remain unpaid. This might be met by a loan from the Federal flood insurance agency, with future premiums as security or as the means of repayment.

If a set of circumstances such as here described did come into existence, and if they were met as described, this would obviously leave the companies or their pool in poor shape to meet another flood emergency the same year or in the next year; their reserves would be gone, they would have drawn on their capital as far as was prudent, and they would have a small debt to the Federal agency. In the event of another disaster soon, greater reliance would have to be placed on the Federal agency to assume claims above the excess loss point and for loans. On the other hand, a series of relatively low loss years would enable the loan to be paid off, capital to be restored, and reserves to be built up again.

The possible combinations of flood damages over time are nearly infinite in number; this example illustrates only one such possible combination. Even if annual premiums are correctly set to reflect average annual damages over a long period of time, there are many possibilities for variation in the relation of initial capital to annual premiums, for establishment of the excess loss point, for the amount of capital to be used after premium reserves are exhausted, for relation of loans to other factors, and still other possibilities. In view of the erratic character of flood damages, the arrangements must be flexible and capable of dealing with a wide variety of situations.

DIVISION OF RISK

Under the general alternative for flood insurance outlined in this chapter, the financial risk of flood losses would be divided three ways: to the occupant of the flood-prone area, to the private insurance industry, and to the Federal Government.

The extent of the risk of flood loss which the occupant of the flood-prone areas would bear, would depend upon the precise terms of the flood insurance policies. If the policy had a loss-deductible provision, then the occupant bears some risk. A deductible of \$500 and 5 per cent (figures suggested in 1957, under the 1956 act) would leave the occupant bearing from one-fourth to one-third of the total flood risk; interestingly enough, the proportion which the occupant would bear under this deductible is almost the same, regardless of the rates applicable to his particular risk zone. If some ceiling were placed on the maximum amount of insurance per property (the 1956 act did have such ceilings), then occupants would carry losses in excess of this ceiling. Owners of low-value property would have no risk due to this factor, whereas owners of high-value property would have considerable risk. Flood insurance policies might also permit owners of property exposed to flood risk to take out insurance for only part of the value of the property; in that case, the owner would carry his own insurance for the remainder. Premiums would, of course, vary according to the proportion which he insured against.

The insurance companies would take all risk of flood losses, above those which the occupants of the flood-prone areas retained and below those which the Federal Government assumed. In return for assuming these risks of loss, the insurance companies would be paid flood insurance premiums. The full premium, on the best actuarial basis possible for estimation, would be required of all new occupants of flood-prone areas, as a condition of flood insurance, which in turn might be required as a condition of credit in such areas. Part of the premium might be subsidized by the Federal Government for existing properties where the full costs exceed the ability of occupants of the flood-prone areas to pay; but this should be regarded as strictly an interim affair, pending the day when land use changes removed dwellings and other uses from excessive risk zones.

The Federal Government, under the general alternative of this chapter, assumes risks of flood losses in several ways. It provides excess insurance, beyond some excess loss point, against the truly catastrophic floods, or against a succession of severe flood loss years. The insurance companies would know that their losses in any year or in any succession of bad years could not exceed some figure—a figure which in itself would be unfavorable for them, but not spelling bankruptcy or acute distress. Given the real possibilities of extreme floods, this ceiling on maximum losses could be extremely important. The Federal Government would also bear some risk in its provision of financial backup against early heavy losses from flood insurance—against the possibility that flood losses in the first years would greatly exceed average.

This backup might cost the Government nothing, or it might cost a great deal, depending upon the pure change of the timing of flood losses. A third kind of cost to the Federal Government, under this general alternative, would be the subsidization of the high flood premiums in the highest risk zones for some existing property. To some extent, this subsidy of flood insurance premiums would merely replace the obligation of the Federal Government to extend relief to people in these areas, when the inevitable flood disaster strikes. If applied as outlined in this chapter, this latter form of Federal aid would diminish, as land use changed removed properties from these zones of excessive risk. The Federal Government might well incur some costs in assisting such land use changes. In addition to all the foregoing, the Federal Government would incur some modest administrative costs, in measuring the flood risk by zones in each flood-prone area and in applying the program generally.

CHAPTER 11

PRIVATE INSURANCE INDUSTRY OPERATES A FEDERAL FLOOD INSURANCE PROGRAM

The property insurance industry may be unwilling to carry out a flood insurance program, even with major Federal help, such as is outlined in chapter 10; if so, other alternatives must be considered. One would be to establish an essentially Federal insurance program, but to ask the property insurance industry to administer it, more or less as administrative or fiscal agents for the Federal Government.

There are several reasons why the property insurance industry might be reluctant to undertake a flood insurance program on its own, even with the major Federal help outlined in chapter 10. It might feel that it could not, or should not, provide substantial initial capital. Considering the fact that the companies in this industry are constantly negotiating rates for all kinds of insurance with State insurance commissioners, and that any admission that they had capital which could be used to initiate flood insurance might be taken as evidence that their rates for other forms of property insurance were either too high or at least ample, some hesitation on the part of the industry to provide capital for flood insurance is understandable. However, the fact that the amount of capital required to inaugurate flood insurance is so small in relation to policyholders' surplus, as shown in chapter 10, suggests that this concern need not be overriding.

The property insurance industry might feel that, in spite of the Federal assistance described in chapter 10, flood insurance would present it with risks too great compared with the prospect for profitable operations, and hence would decline to participate in such a program. Or it might be concerned that, in spite of what enabling legislation might prescribe, the Federal Government would not actually appropriate the funds needed to carry out its share of the arrangements. There may be additional reasons why the insurance industry would be reluctant to undertake flood insurance, even with substantial Federal assistance. The views of the industry on a number of issues are presented in appendix D.

In this connection, it should be pointed out again that flood insurance would introduce a new element into the competitive relationships that have arisen and somewhat stabilized among different segments of the property insurance industry. This industry, like any other, has many different parts—large firms and small ones, stock companies and mutuals, insurance companies and agents, and others. A degree of equilibrium has been reached among these various elements of the industry—a changing and fluid equilibrium, but nevertheless a degree of balancing of various interests and competitive strengths. Any major new form of insurance will to some extent upset or change the old equilibrium, and flood insurance will be no exception. As we noted in chapter 10, if some companies write flood insurance and seem to be relatively successful with it, all the rest of the industry

must follow soon or see its competitive position worsened. On the other hand, any company or companies which undertake flood insurance and experience serious difficulties of any kind with it, are likely to experience losses, not only in direct financial terms but also in competitive position. As is so often the case when times are changing, the very earliest innovators often experience difficulties but the laggards who change too slowly lose ground greatly, often fatally. The initiation of flood insurance on any basis cannot avoid modifying the competitive equilibrium of the property insurance industry.

Although the property insurance industry, or influential parts of it, might prefer not to undertake its own program of flood insurance, even with major Federal help, and might even refuse to participate on this basis, yet the industry or these segments of it might prefer to operate the Government's flood insurance program, rather than have the Federal Government undertake its own program with its own staff. The latter would also raise many problems for the property insurance industry, including inevitable public comparison of costs and services of the private and Government programs.

The property insurance industry has great capability to operate a Federal insurance program. The statements in appendix D all agree that the existing manpower and administrative structure of the industry could readily operate a flood insurance program. Agents are found in all but the tiniest of communities, presently selling all major kinds of insurance; the industry has long experience servicing insurance policies of all kinds; its staffs could move quickly to settle claims when the inevitable flood disaster struck some locality. For all of these reasons, there would be much to commend industry administration of the Federal flood insurance program.

INDUSTRY ROLE

Under the general alternative discussed in this chapter, the property insurance industry would sell flood insurance policies as it sells fire insurance or any other property insurance; would collect the premiums, and would deposit the pure risk portion of those premiums in a special account; would receive claims for flood damages, investigate them, and pay the verified claims. In these operations, the industry would function just as it now does for any other type of property insurance—indeed, it is precisely because it could service flood insurance just as it now does other property insurance that this alternative has real advantages.

The policies which the companies would thus sell might bear only the name of the insuring company; or they might indicate that these policies were supported or backed up by the Federal Government as well as the fact that they were policies of the company involved; or conceivably, they might be policies of a Federal flood insurance agency, merely sold and serviced by the private companies. From some points of view, it would matter a good deal which of these arrangements was adopted; from other viewpoints, it would make little difference.

One matter of some concern, from the viewpoint of public policy, is how the general public and more particularly the insured persons would view the operation. If only the company's name were on the policy, would they regard it as a strictly private affair, and possibly blame companies for what were in fact decisions of the Federal agency?

Would insured persons be more confident of the policy's integrity in the event of a major flood catastrophe, if the role of the Government were clearly indicated on the policy? If the policy were one issued by the Federal flood insurance agency, but sold and serviced by the private companies, would the insured public tend to blame the Federal Government for what were in fact actions of the private companies? Possible confusion of roles, in the public mind, might arise. The legal relationships between Government and industry could, of course, be spelled out carefully and, hopefully, ambiguities or uncertainties avoided at this level.

Whatever might be the public reaction, and whatever might be the precise legal arrangements between Government and industry, yet in its broad outlines, this alternative is a cost or a cost-plus contract between Government and an industry, under which the latter undertakes to carry out certain functions for the Government. As such, it has enormous precedent. In a great many fields of public endeavor, various private industries carry out activities of highly diverse kinds for the Federal Government. There are great advantages to such arrangements: utilization of private expertise, avoidance of restrictive governmental procedures, opportunities for innovation and perhaps for profit, economies of various kinds, and others. Such arrangements have also been criticized on many grounds, of which two are perhaps primary: the private interest in the operation may not coincide with the public interest, leading to some distortion of the program; and the terms of the contract may be too generous, leading to unwarranted profits. Such criticism would also certainly arise, sooner or later, for a flood insurance program operated by private industry but essentially for Government account. This is not necessarily a decisive argument against this arrangement, but it is a factor which must also be considered.

Whatever might be the precise arrangements of this general alternative, a key feature is a central or pooled fund, into which the pure risk portion of all premiums would be deposited, and out of which all flood loss claims would be paid. Such a fund would require a relatively large initial Federal appropriation—figures of \$500 million or more have frequently been used by the insurance industry. This initial fund should be large enough to pay any flood damage claims likely to arise; some information on this point is present in appendix H. If \$75 to \$100 million is sufficient to launch the private industry in insuring 1- to 4-family dwellings with the substantial Federal help outlined in chapter 10, then probably as much as \$500 million in capital and/or borrowing power is required for the Federal agency under the arrangements of this chapter, to begin the same program. The Federal agency needs so much more initial capital because it must be prepared to meet all claims in the event of a flood disaster; it would have no one else to turn to, for claims above an excess loss point. As the flood insurance program grows, its capital and/or borrowing power must increase proportionately.

A variant of the Federal fund approach would be an initial appropriation of more modest size, with provision that the Federal corporation could borrow at Treasury, up to some defined limit, if necessary to meet heavy flood damage claims; and this in turn might be supplemented by further borrowing power, only at the discretion of the President. The 1956 Flood Insurance Act contained such features.

By use of borrowing power, initial appropriations may be smaller and yet adequate funds be available in the event of great emergency.

Determination of fair and reasonable administrative costs for the industry role in selling and servicing flood insurance policies—whichever's name or names was on them—would be a major task. No single set of cost allowances will be satisfactory to all sectors of the property insurance industry; a scale which enables some companies to live may be fatal to others, or a scale which enables everyone to survive may be quite profitable to others. Would companies be prohibited from earning profits on this type of business, either because the administrative costs were set too low, or by specific prohibition?

A particularly difficult aspect of the foregoing is to set rates which are equitable to the companies and to the Government, for small and large flood insurance policies alike. To meet the Government's objectives, flood insurance policies should be readily available to owners of relatively low valued property in high-risk zones, yet the administrative costs of doing so might be relatively high. On the other hand, a uniform schedule of administrative rates might be highly profitable for relatively large properties, where the premiums would be high. The difficulties here are not insurmountable, but they must be noted.

A major variant of the general alternative described in this chapter has been proposed in various quarters, including from some industry sources. Under it, the insurance companies would provide some portion, probably much less than half, of the total initial capital required; this would be pooled with capital provided from the Federal Government, in a mixed Federal-private corporation. The latter would then perform the tasks outlined above for performance by the Federal corporation. In return, the insurance companies would be given some measure of participation in the management of the mixed corporation. This mixed corporation could have tax exemption for the premium income, especially if a majority of the stock is held by the Federal Government, as has been discussed in chapter 10. Contrasted with the general alternative outlined in this chapter, this variant would provide a measure of industry participation; contrasted with the general alternative outlined in chapter 10, the industry would give up a sole or dominant position in management, in return for avoidance of part of the initial capital investment and in avoidance of a substantial part of the risk. While these are rather clear advantages, the idea of a mixed Federal-private corporation would involve complexities of its own.

ROLE OF FEDERAL GOVERNMENT

Under the general alternative considered in this chapter, the Federal Government would have some of the same duties and problems which were described in chapter 10, for that general alternative. The Federal flood insurance agency would have the same problems of relationships with States and local government: requiring them to request flood insurance in their respective areas, persuading them to adopt and to enforce effective channel encroachment laws and flood plain land use regulations, with appropriate differentials in flood insurance premiums if they did not, and generally working with them to develop long-range land use plans for high-risk flood prone areas. The agency would also have the problem of persuading occupants of flood-prone areas to buy flood insurance, by encouraging credit insti-

tutions not to loan money on new properties in high-risk areas without also requiring flood insurance. It would also have the problem of establishing actuarially sound flood insurance rates. In these and perhaps in other ways, the Federal agency would act under this alternative just as it would act under the foregoing general alternative.

The big difference in role of the Federal Government in this alternative, as contrasted with the previous one, is that now it would provide all or nearly all the initial capital and would now bear essentially all the risks of loss, instead of only part of them. A Federal flood insurance agency would presumably be set up, with some initial capital; this might be augmented by borrowing from Treasury, when necessary, and perhaps a second line of borrowing credit only when specifically approved by the President. The 1956 act had such provisions, and there are good reasons for them. The initial fund enables the agency to begin operations, the borrowing power gives it flexibility but without actually appropriating more money than is needed, and further discretion in the hands of the President provides further flexibility for the truly great disaster.

The insurance companies would pay the loss risk portion of the flood insurance premiums into the agency's insurance fund and all claims would be paid out of it. If full-risk premiums must be subsidized for some existing properties, then perhaps it would be better if this were done as a separate administrative and financial operation. If so, then the insurance fund of the agency might be self-supporting over a long period of years, with premiums (plus subsidies) equaling claims paid. There would still be the chance of a series of high flood loss years depleting the fund; it would be necessary to estimate this possibility in advance, and to provide adequate initial capital plus borrowing power, so that all claims could be paid promptly when due. In actual operation, the insurance companies would pay the claims to individuals but would be promptly reimbursed by the Federal agency.

If the Federal agency put up all the initial capital, received all the risk portion of premiums, and paid all the claims, then there would be no problem of income taxes levied against the annual premium income of the corporation. Assuming that the enabling legislation made adequate provisions for initial capital and lending power, there would not be an excess loss problem, since the Federal Treasury is competent to carry all the losses that might arise. However, this does not eliminate the problem of estimating the probable extent of the needed capital plus borrowing power; the Congress will surely wish to have the best possible estimate of this sum before authorizing any capital and lending power.

It can be argued that a flood insurance program under which the Federal Government provided the capital and took the risks would be more vulnerable to pressures to fix insurance premiums below cost, than would be a program of industry insurance with large Federal help. This may well be true; one cannot assume that political pressures would be absent in either case.

If the variant, discussed above, of the industry providing some of the initial capital in return for a degree of control over management of the mixed corporation were adopted, this would modify the role of the Federal Government to some degree. Difficult but not unsolvable problems of fair representation of Government and industry on

the board of the mixed corporation would arise. It is easy to suggest that such control be shared in the same proportions as the capital was supplied. But this would mean that the minority stockholder would have no control, if the majority holder chose to exercise his full powers. Presumably losses would be shared in proportion to capital supplied. However, this would not protect the companies against insurance premiums too low for the risk, nor would it provide them with protection in the years of catastrophic losses. The companies would be a part of the inner management, under the variant proposal, and this might reassure the companies as to the soundness of the whole operation.

CHAPTER 12

AN ALL-FEDERAL PROGRAM OF FLOOD INSURANCE

The fourth, and final, major alternative for organization of a flood insurance program is for an all-Federal one. In chapter 11, a Federal program to be operated by the insurance industry was outlined. The question may well arise: If the Federal Government puts up all the capital and bears all the risks, why should it not operate the program as well? Can it be expected that a flood insurance program which is operated by the property insurance industry on an agency basis will be as effective as one in which there is an equity interest? Differences in objectives and in interests between the Federal Government and the private insurance industry are inevitable and natural. A Government-operated program would presumably put public objectives first, which a privately operated one might not.

An all-Federal flood insurance program would avoid some of the problems inevitable in a joint Federal-industry program; most notable of these would be those problems necessarily arising out of the inter-relationship of two groups in a single program. The problems of determining fair administrative costs for the industry part of the program, or of determining a fair division of the risks between the two groups, and others would not be present if the whole program were in Federal hands. Elimination of these and perhaps other problems does not, of course, argue that new and different problems would not arise if the program were wholly Federal.

The greatest difference between the alternative of an all-Federal flood insurance program and either of the two foregoing forms of Government-industry cooperation would lie in the administrative problems that this alternative would create for the Federal establishment. An administrative organization, right down to the local level, would have to be created if this alternative were to be employed.

Under any alternative that involved a major degree of Federal participation, some Federal administrative organization would be required. A headquarters office in Washington would be necessary; regional offices, including a number of States or several river basins in each, would almost surely be necessary; and State organization might also be needed. These offices would have the important duties of measuring the degree of the flood hazard in different areas, presumably relying heavily upon other Federal agencies with experienced hydrologic and engineering personnel; of negotiating with States and local officials over channel encroachment laws and land use regulations; of carrying on public information work, so that occupants of flood-prone areas would know of the availability of flood insurance; of deciding upon appropriate subsidies to present occupants of high risk areas, in accordance with the law and the regulations; of working with private credit institutions, to encourage the use of flood insurance in all new loans; and other duties. The staffing and the organization of these offices are important, but the problems do

not seem more serious than those for Federal administration generally. Specific suggestions as to the size and structure of this organization are not made in this report.

But a flood insurance program operated wholly by the Federal Government would require a substantially larger organization than this. In particular, it would require local offices in every city or community of any real size, where flood hazard was important. Such offices would have to be staffed adequately to deal with local officials in every aspect of the program, and to sell and service flood insurance policies, including the adjustment or settlement of claims. Personnel with a number of specialized kinds of skills would be needed, including engineers, accountants, insurance salesmen, insurance adjusters, and others. The size of the staff would depend upon the volume of the work; no attempt is made here to estimate its size or its cost. While there would be many reasons to keep costs to a reasonable minimum, yet the public objectives of the program would be met in proportion as the volume of insurance was increased, hence staffing should be adequate to meet the needs of a growing program. In addition to a considerable organization at the local level, this alternative would require a substantially larger organization at State, regional, and national offices than would be true under the other alternatives—if for no other reasons than to cope with the larger volume of business and to manage its own internal affairs.

A special problem might arise in many smaller cities and towns. There, the volume of flood insurance might never reach a volume adequate to employ efficiently even a minimum size office. The need for various kinds of specialized personnel, even when the total volume of business was small, would tend to make the size of a minimum office rather large. Where this situation arose, costs of administration would be high, compared to the volume of business, unless some alternative could be devised. Possibly district offices, serving several small cities, might provide an answer. In the case of flood insurance in agricultural areas, if this is undertaken, perhaps offices of existing agricultural agencies could also sell flood insurance.

Creation of a substantial Federal organization for a new Federal program always presents problems, and many persons might like very much to avoid the necessity for doing so. Certainly, no one would advocate the creation of a new Federal organization unless there were good reasons for doing so—important advantages not likely to be gained in any other way. Selling and servicing flood insurance would surely be a new activity for the Federal Government, and the organizational and administrative problems should not be dismissed easily. At the same time, today the problems of establishing and managing a Federal agency, including one with local offices, are manageable. In these last few decades, the Federal Government has initiated programs of many diverse kinds, each requiring an organization capable of serving its citizens.

The substantive content of an all-Federal flood insurance program and many of its problems would be very similar to those the Government would have under the other alternatives. There would still be similar problems of relationships with State and local government, of relationships with private credit institutions, of encouraging residents of flood-prone areas to buy insurance, of establishing reasonable premiums to cover the risks inherent in each location and also the

necessary administrative costs, of establishing subsidies for existing properties in high risk areas, of helping individuals and communities with land use problems after flood disasters, and others.

If the program were an all-Federal one, there would be no problem of taxes on insurance premiums, and reserves would only be a matter of having adequate borrowing power at the Treasury, to pay any claims that might arise. The best possible advance estimates would be needed, of course, as to the magnitude of the costs of the program. The fact that costs in any year, or even over a period of several years, might vary greatly from long-term average costs, cannot be over-emphasized. In average or lower flood loss years, premiums would be high relative to claims paid, but in a few years claims would greatly exceed premiums; moreover, the high loss years might come early in the program. This could be disturbing to anyone who did not properly appreciate the erratic timing of flood losses.

An all-Federal flood insurance program would still present some problems to the private property insurance industry. This would particularly be the case with the industry's relationships to insured property owners. Comparisons between the Federal flood insurance and industry insurance against fire, wind, and other risks would inevitably be drawn, not always accurately or fairly. Some would seek to criticize the Federal programs by pointing out their deficiencies as compared to the private ones; others might make the reverse comparison, in each case selecting those facts or those incidents which conformed to their preconceptions. It is almost inevitable that a few instances of conflicts between programs will arise, particularly in the gray areas of liability, however well designed each may be. Some critics would be eager to seize upon such instances, to the discredit of one or another of the programs.

If there were an all-Federal program of flood insurance, but insurance against wind damage remained a private insurance industry program, then after major hurricanes there would be difficult problems of determining how much of the damage was due to wind and how much to water. This problem will always arise to a degree, but it might be exacerbated if one insurer were Government and the other were a private company. However, this problem has already been encountered in private insurance and should not interpose an insurmountable obstacle.

The alternative described in this chapter is not recommended as a first choice method of operation of a flood insurance program, assuming that a satisfactory method of operation along the lines described in chapter 10 can be agreed upon. The reasonable interests of the insured property owner, the insurance company, and the Federal Government would have to be reconciled; but this does not seem impossible. Although not a first choice, the alternative described in this chapter has sufficient merit as an alternative form of organization, to justify authorization in the enabling legislation for the Federal flood control program. If this alternative is available, and if mutually satisfactory relationships with the insurance industry cannot be worked out, then a method of providing flood insurance in a wholly Federal program would exist.

Recommendation.—In the event that a mutually acceptable private insurance program with Federal help cannot be agreed upon, the Federal agency should be authorized to develop a Federal flood insurance program for the special risk areas.

CHAPTER 13

A COMPREHENSIVE FLOOD PROGRAM INCLUDES INSURANCE

The five preceding chapters have dealt with one aspect or another of flood insurance in some detail; at various points, reference was made to the relationship of insurance to other aspects of a comprehensive flood program. In chapter 4, the broad alternative ways of helping the victims of flood disasters were discussed. Discussion of a comprehensive flood program is not considered in detail in this chapter.

DELINEATION OF FLOOD HAZARD AREAS

The first step in a comprehensive flood program is the delineation of the special flood hazard areas of the United States. Various Federal and other agencies now have a substantial amount of data on such areas. It has been estimated that an intensive program by the Geological Survey, Coast and Geodetic Survey, and cooperating agencies could delimit all special flood areas, including coastal flood hazard zones, in a 2-year period and with a total expenditure of \$3 million.¹ This would consist of a simple delineation of the areas with special flood hazards. All other areas would have no special hazards, although some slight possibility of damage from rising waters and related damages might exist for occupants of these other areas.

The next major step would be the delineation of the various flood hazard zones, within the flood plains and other areas subject to special flood risks. This would generally parallel the kind of flood risk zone delineation reported in the 48 sample area studies of appendix C, which is more difficult and requires much more detail than merely separating the areas of unusual flood risk from those with little or no such risk. But there is also a great deal of data now available, in many areas, which would be directly usable for this purpose; and several of the Federal agencies have programs underway which can contribute to this end.

It has been estimated that the Corps of Engineers, with the assistance of other Federal and State agencies, could do this for all flood-prone areas (coastal as well as riverine) in 10 years at a total cost of \$60 million.² A good deal of this outlay is already budgeted or planned for the ensuing decade. The areas so delimited could be chosen on a priority scale as needs dictated. Such a delineation of flood hazard zones, within the generally flood-prone areas, could become the basis for flood insurance as well as for other kinds of flood programs.

¹ A Unified National Program for Managing Flood Losses, report by the Task Force on Federal Flood Control Policy, U.S. Bureau of the Budget, 1966.

² Op. cit.

Recommendation.—The Federal Government, as promptly as possible—

- (1) Should identify (within 2 years) all flood plain areas, including coastal areas, which have special flood hazards;
- (2) Should establish (within 10 years) flood risk zones in all such flood-prone areas and estimate the rates of probable flood-caused loss for the various flood risk zones for each of these areas.

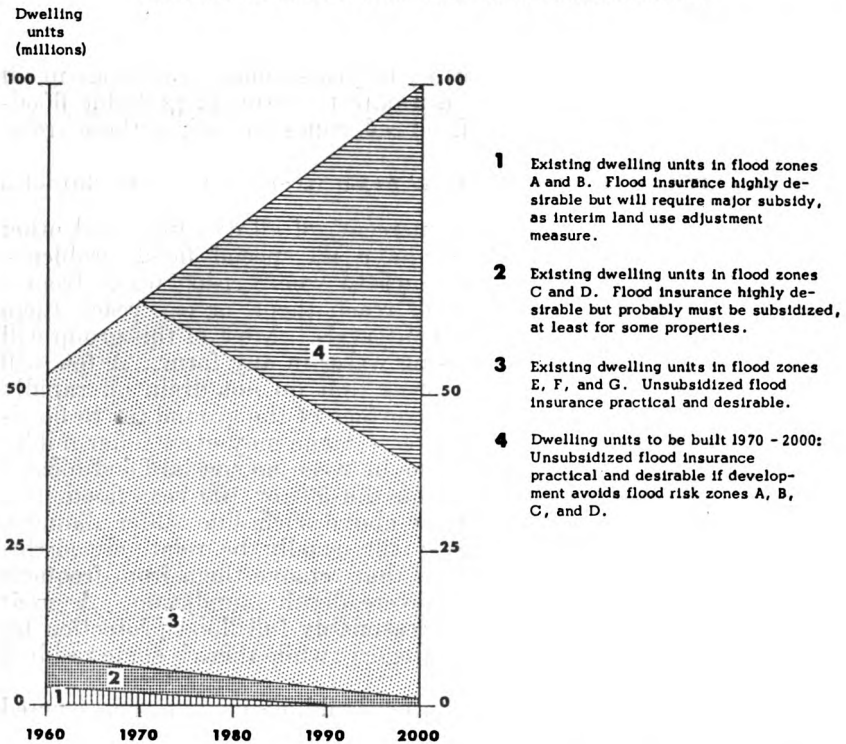
VAST MAJORITY OF DEVELOPED AREAS HAVE NO SPECIAL FLOOD PROBLEM

The vast majority (perhaps 90 percent) of all dwellings and other structures in the United States have no special flood problems. (See fig. 13 in ch. 6.) They are located where rising water from a flooding river or from tides cannot reach them, or can reach them only to minor degree at infrequent intervals. Most of this group will never suffer any damage from rising water in any form. A few will suffer damages, due to severe storms that do not drain off rapidly enough, or to flowing water on the surface of the ground, or to flood-impeded sewers, or from other causes. Some may even suffer mildly from a rarely severe flood; if the line between no special flood hazard and flood hazard areas is drawn on the 50- or 100-year flood line, then only in rare cases will those above such line suffer damage. But the extent of their damages will usually be relatively slight, because the same locational factors that remove them from frequent flooding also put them above a severe depth inundation. A great many of the areas provided with reasonably full flood protection by Federal works fall in this general category; while there is some residual risk, it is slight.

Nearly all future dwellings and other buildings could be constructed where the flood hazard is equally small or absent. In the United States, as many new homes will be built during the next 35 years as now exist; total city population and total city area will each nearly double by the year 2000 (fig. 14). New dwellings and other buildings could be located where the flood hazard is very small or negligible; or they could be so located as to magnify greatly the present flood hazard. Some new buildings may indeed properly be located where flood hazards are high, if there is a careful balancing of costs and advantages from such location. In particular, some people may wish to locate near the sea, to take advantage of the sand and water for recreation or for other purposes, in spite of the hazards.

National policy should be concerned to limit future flood hazards without at the same time limiting national economic development. Primarily, this means keeping people out of the damaging and costly high hazard flood zones. The restricted size of such high hazard zones, described in earlier chapters, is extremely important to recognize here. It will not be necessary to abandon or avoid major regions, or whole cities or counties, or other large areas, in order to avoid most of the severe flood hazard zones. Locally, modest changes in selection of building location can usually greatly reduce flood hazard. The location problem can be measured in terms of yards or rods, not in terms of miles. By avoiding flood hazard zones A and B completely, and by staying out of flood hazard zones C and D unless there are strong advantages in such locations, the total flood hazard of the future can be kept to limited proportions.

FIGURE 14.—NATIONAL FLOOD INSURANCE PROGRAM FOR NEXT GENERATION, ADAPTED TO FLOOD RISKS AND LAND USE ADJUSTMENTS



The foregoing might be described as a dynamic approach to flood hazards. It emphasizes the favorable aspects in the present situation—the fact that most present structures do not have a flood problem now—and the possibilities of guiding future development to minimize flood hazard in relation to economic advantages of different locations.

For the areas with no special flood hazards, as these might be delineated, an unsubsidized private program of flood insurance is practical; such insurance could well be made a feature of the extended coverage now available to homeowners and others. The full actuarial cost would be low. The insurance companies could well include damage from every form of rising waters as part of extended coverage, on an optional basis, outside of the special flood risk areas. Lenders, insurance people, public officials, and others could urge the purchase of such insurance upon owners of buildings. While the risk would be low, still some slight risk would exist which might be serious for the person who suffered loss, and the cost would be low. It should be good business both for insurance company and for property owner.

Recommendation.—For all properties in areas of relatively low hazard, flood insurance should be made available at rates deemed adequate to cover all costs, preferably through private insurance companies.

In areas of low flood hazard, the Federal Government should encourage the private insurance industry to develop a fully com-

mercial, no-subsidy insurance program, perhaps by expanding present extended coverage insurance policies, to cover such small risks of rising waters as do exist, together with other miscellaneous risks not now insurable, such as earth slides, mud slides, and subsidence.

While most new building construction could stay out of high hazard flood zones, as these can be delineated, yet it is neither possible nor desirable that every new building stay out of such areas. There are circumstances when the advantages of location in a high hazard zone are so great that it may be sound private and public policy to locate there, in spite of the hazard. The special situation along the seacoast has been mentioned; its advantages, especially for recreation, are very great. There may be other situations where other advantages also outweigh the high costs involved. The essential consideration is that the person who decides to build in a high hazard zone shall be aware of the costs, shall count them in his decision, and that he knows he shall bear the full costs. If the builder in the high hazard area gets the benefits from such location while the general public pays the costs—as would be the case under “insurance” which forced everyone to pay a flat rate so that the losses in high risk areas could be paid—then the balancing of costs and advantages is nullified.

A rational balancing of costs and advantages of locating in high-hazard zones would be achieved if every such locator purchased flood insurance at an actuarially sound rate. He could judge if the advantages were worth the costs; and when the inevitable flood disaster struck, he would have the funds wherewith to restore or rebuild if he wished, and the Federal Government would not have to extend him relief or other assistance. If all lenders on new building construction were to require flood insurance, especially in high-risk areas, this would be a powerful force in getting such insurance into effect. This would seem to be in the interest of the lending institutions and of the borrowers, as well as of the general public. The higher the rates the more in their interest to have insurance, for the higher would be the risks. To meet these objectives of balancing costs and advantages, insurance for new buildings should be on an unsubsidized basis. The Federal Government should not subsidize the insurance for such new properties.

Recommendation.—To encourage widespread purchase of flood insurance, the Congress should be requested to declare that as a matter of national policy all lending institutions entrusted with savings or deposits and under any form of Federal supervision of insurance of savings or deposits shall require in high-risk areas flood insurance at unsubsidized rates on all new mortgages based on new residences, as they now generally require fire insurance; and that such flood insurance be considered in the interest of the borrowers, the lending institutions, and the savers and depositors; and these institutions might well encourage flood insurance by borrowers in low-risk areas.

COORDINATED FEDERAL FLOOD PROGRAMS

The varied nature of Federal, State, and private programs to cope with floods have been described in earlier chapters. By and large, such programs should be continued, and generally strengthened, not replaced or diminished, if flood insurance is inaugurated. The whole system of flood forecasting and flood warnings, for instance, should be extended and strengthened in every reasonable way, if flood insurance

is put into force. The objective of flood forecasting and flood warning is to help people get out of danger, and to enable them to take any practical measures to reduce their flood damages. Both of these purposes have equal force after a flood insurance program is in effect.

Likewise, flood protection programs will surely be continued, even if flood insurance is operative on a wide scale. If the benefit-cost analysis is rigorously applied, then flood protection is fully economic. Construction of a flood protection work reduces the risk from flood damage; often it will move an area from flood risk zone A or B to zone F or lesser risk. Whereas an area would have a special risk prior to a flood protection works, after it, there might be no special flood hazard. In fact, the reduction in the flood insurance premiums that would have to be charged, on a fully actuarial risk basis, might well provide a good basis for judging the economic soundness of the proposed flood protection works.³ If the local beneficiaries of the flood project are to bear part of its cost, their share might be related to the reduction in flood insurance premiums.

Even with a fully operative form of flood insurance, there would still be a need for a Federal program of financial assistance to the victims of flood disasters—but a program carefully geared to the terms of the flood insurance program. First of all, until flood insurance were everywhere effective, relief would be necessary when floods hit. If the requirement of local support for a flood insurance program be insisted upon, this may well delay operation of an insurance program in some areas for several years. In any case, some time would be required to make the necessary studies upon which the flood insurance rates would be based. And, realistically, not everyone will buy flood insurance when it is available, in spite of every incentive and in spite of substantial Federal subsidy for present properties where the risks are high.

Recommendation.—The present flood-related programs and activities of the Federal Government should be continued, but with modifications necessary to meet the opportunities and needs of the flood insurance program.

Existing flood forecasting, flood warning and flood protection programs should go forward, including those improvements recently recommended in the Department of Commerce natural disaster warning plan.

The present programs of loans at subsidized interest rates to the victims of flood disasters should be modified to reflect the reduced need for such assistance because of the availability of flood insurance and to avoid any possibilities of duplication and conflict.

When flood disasters hit in the future, personal relief by the Red Cross will almost certainly continue to be necessary. Property relief or assistance might also well be extended to uninsured flood disaster victims once. That is to say, the Federal Government might give aid to help a flood victim rebuild once, but not to do it repeatedly. If the occupant is located where he will suffer repeated heavy loss, he should be required as a condition of aid to rely on flood insurance for the future.

If the extent of the damage suffered were less than say, 50 percent of the value of the structure, then loans or other assistance could be

³ For a recent statement of these possibilities, see John V. Krutilla, "An Economic Approach To Coping With Flood Damage," *Water Resources Research*, vol. 2, No. 2, second quarter 1966.

extended, and the occupant still get a subsidy for the insurance premium rate on the restored property. If, however, the extent of the aid were more than 50 percent of the value of the structure, then the rebuilt structure could be classed as a new one, and therefore not eligible for subsidy to the insurance premium. He might still get aid, in the form of a loan at low interest or in some other way; but if he chose to rebuild in this same spot, he would be required to carry flood insurance, at an unsubsidized rate, as part of the price for this aid. If he chose to relocate elsewhere, he would be eligible for the same amount of assistance in the new location. It should be borne in mind that, if he had a mortgage on his house in the old location, he would still be liable for that debt, even if his building were destroyed. If he chose to relocate, he could be given further help by public purchase of any remaining value in his old structure and site.

Recommendation requiring further study.—After insurance becomes available, uninsured victims of flood disasters should remain eligible initially for Federal assistance in the form of loans at subsidized rates of interest, but this eligibility should be limited.

In any area stricken by a flood disaster, the Federal Government should extend once only financial assistance to uninsured residents in the form of subsidized loans for restoration of residential property (but not for refinancing of existing mortgage debt), and only on the condition that the recipient buy and keep current flood insurance on the restored residential property at an unsubsidized premium rate as long as the loan is in force.

The insured property owner would almost certainly be better off than the uninsured one, when a flood disaster struck, in spite of the costs of the insurance and in spite of the aid that might be extended the uninsured owner. The uninsured owner might, it is true, get a low-interest loan or in some other way be assisted by the Federal Government; but, if he previously had a mortgage on his property, he would still have this hanging over him; and, even if his property had been clear of debt, he would have lost its value. If he had had flood insurance, he would have funds to pay off his old debts and to rebuild or to relocate. Whether insured or not, he should be eligible to receive Federal help in relocation, if he should choose that; and if rebuilding involved in excess of 50 percent of the value of the property were necessary, then he should thereafter not be eligible for subsidy on his flood insurance premium.

Flood insurance should be an integral part of a comprehensive Federal program. It should also be part of the personal programs of occupants of flood-prone areas. It may be argued that occupants cannot afford to pay the necessarily high costs of flood insurance in high-risk zones. It can equally well be argued that, on the contrary, the higher the risk and hence the higher the premium, the less the occupant can afford to be without flood insurance. If the risk is really high, he will be struck by flood disaster sooner or later—and, the higher the risk, the sooner the disaster, on the average. If he were an occupant of the flood-prone area when the flood insurance program went into effect, he would be eligible for subsidy on his flood insurance premium. The Federal Government would, in effect, be helping to bail him out from a past locational decision which put him into a high-risk zone. Even where the flood insurance premiums were somewhat lower, flood insurance would still be a good buy. And for new

construction, flood insurance would offer both a chance to appraise flood risk accurately and to protect against any risk that seemed worth incurring in order to get the advantages of the location.

INTERIM ADJUSTMENTS IN HIGH HAZARD AREAS

The occupancy of high risk flood zones is often uneconomic; the costs to the individual and to the general public exceed their respective prospects for gain. As such, this occupancy should be regarded as an interim situation, to be corrected over a period of time.

It is not possible to give a single figure above which the flood risk is so great as to make the site uneconomic. As was pointed out in chapter 6, a home building site which has flood risk such that an actuarially correct insurance premium would exceed \$2 per \$100 of value is almost surely uneconomic in the long run, in the sense that both the occupant and society would have been better off if he had built somewhere else. At that rate, the annual flood insurance premium for a \$10,000 house with \$4,000 worth of contents would be \$280, or about \$23 per month. A house of this value for the structure, and the additional value of the lot, could be financed normally for about \$100 per month or less. The monthly financing cost for the lot alone would be less than the flood insurance cost. It is on this basis that the judgment is expressed that the site has no value when the rate is this high. It should be recognized that there are situations where a lot will have an unusually high value, in relation to the value of the house upon it, and under these circumstances a somewhat higher rate may be endurable. This situation might arise at an especially desirable seafront location, for instance. But it is also possible, and on the whole more probable, that at insurance rates less than \$2 per \$100 the site will be worthless.

Some dwellings and other buildings are located where the full actuarial insurance rate (including administrative cost or loading) is \$2 per \$100 or higher; the best estimate, based upon the data in chapter 6, is that less than one-half million dwellings fall in this category. For these properties, the past investment in the dwelling is a sunk cost; its worth can be realized only by continued use of the property, usually for the use originally intended. There is both a public and a private gain in utilizing such value as such structures possess; a flood insurance program, as outlined above, would facilitate such utilization of structures of this kind. It would also provide material assistance to the owner of the property, enabling him more readily to extract from the structure some of his past investment in it. But prime considerations for public policy are to avoid multiplication of this type of uneconomic private investment with its attendant public costs, and to encourage relocation into less hazardous zones.

Dwellings and other buildings everywhere must in time be replaced. In a high hazard flood area, the life expectancy of any building is relatively short. Many buildings in such locations are destroyed every year; wooden ones float away, and others are undermined or the walls cave in. Still others are so severely damaged that substantial reconstruction is necessary. Moreover, when a really bad flood hits, it is not an occasional house that is so severely damaged, but all or a substantial proportion of the houses in a locality. A major flood is always a major decision point; one must reinvest somewhere, either in

this location or elsewhere. In either case, substantial amounts of new capital are required. Someone, either the past owner, a new owner, a lender, or a public agency, must provide that new capital, from past savings, insurance, or other sources. A definite decision must be reached, to make that new investment in the old location, or in a new one.

If the local community has a long-range land use plan, which includes shifting the use of the high hazard flood-prone areas to some less easily damaged use, then a major flood becomes a major opportunity as well as a disaster. The old land use has been wiped out or severely modified in any event, and new capital must be secured from some source. This is a prime opportunity for a fresh balancing up of costs and advantages from a particular site. Moreover, the greater the flood risk, the more frequently will such decision points arise, on the average, and the greater will be the need for new capital.

With flood insurance and the other flood programs outlined above, it would be possible for any community to make major changes in land use, over a period of years, so as greatly to reduce its losses from floods, and at the same time to accomplish this with a minimum of hardship to the victims of the flood disasters. It might indeed take some years, from 25 to 50 in some cases, to accomplish such land use changes; but the economic and land use life of a community goes on over long periods of time. It is not necessary to make every adjustment at once, if the machinery is geared to produce desired changes when opportunities arise.

As noted previously in this chapter, this is a dynamic approach to flood problems and their minimization over time. Growth and change are vital parts of the national scene; changes in land use, and in buildings, can and will occur in any event. The Nation is not stuck forever with such uneconomic resource situations as exist today. A national program should be designed to take advantage of the dynamics of our total economy.

THE FORM OF FLOOD INSURANCE

A great deal of attention, especially within the private flood insurance industry, has been focused on the form or organizational structure of any proposed flood insurance program. While this is undoubtedly important, especially to the insurance industry, yet on the whole it seems a secondary concern. The prime concern should be with the objectives of flood insurance, its relationship to other flood programs, a sound land use objective and sound insurance terms, including rates which reasonably well reflect risk. Unless these prime considerations are adequately met, no form of flood insurance can be successful; if they have been met, more than one alternative for organization is possible.

Several alternative forms of flood insurance organization were discussed in chapters 9 through 12; of those alternatives, the one outlined in chapter 10, of a private industry program with substantial Federal help, seems best, if a mutually satisfactory basis of operation can be agreed upon between the Federal Government and the insurance industry. Such a form of organization would use the large and competent organization of the insurance industry. The Federal Government would subsidize insurance premiums in the high risk areas, up

to an actuarially sound rate, and would eliminate some of the costs and risks for the industry. The latter would be required to put up some capital, but an amount which should be manageable, and to take some risks, but relatively limited ones. The industry would be buying a wealth of experience in operating a flood insurance program at a relatively low cost of required initial capital.

While this form of organization seems desirable and also seems practical, it should be stressed again that this is the view of a public agency, not of the private industry concerned. The latter may not regard this alternative as reasonable. While a mutually satisfactory agreement must be reached between industry and Government, if this general alternative is to succeed, yet it must be recognized that the Government, acting as the representative of the general public, has its obligations also. No agreement should be accepted merely because it is acceptable to the insurance industry; it should also protect the interests of the whole public, and of the people who will be encouraged to buy flood insurance. If such a mutually satisfactory agreement cannot be reached, for a private industry flood insurance program with major Federal help, then the Government should consider other alternatives.

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