LAND USE MANAGEMENT AND REGULATION IN HAZARDOUS AREAS: A Research Assessment

Earl J. Baker
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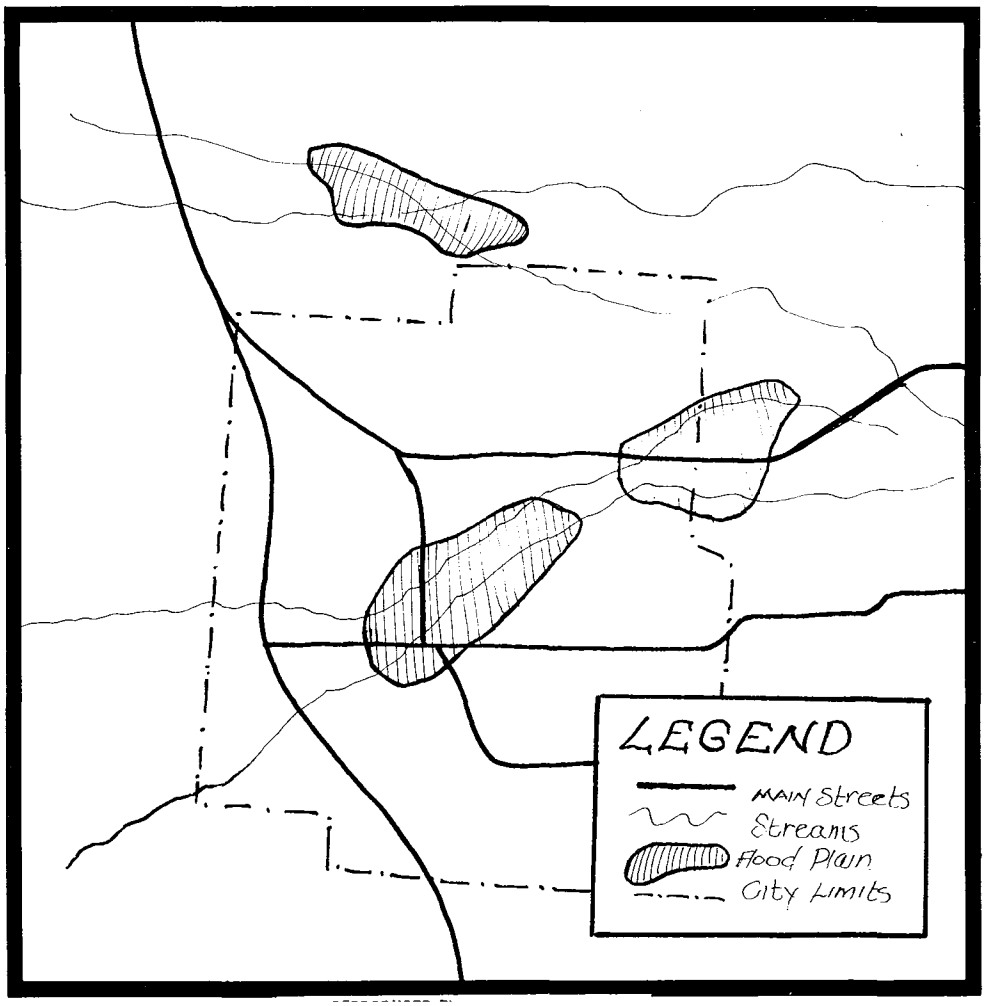

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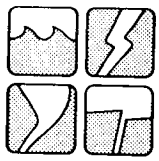

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ASSESSMENT OF RESEARCH ON NATURAL HAZARDS
AIMS AND METHODS

The Assessment of Research on Natural Hazards is intended to serve two purposes: (1) it provides a more nearly balanced and comprehensive basis for judging the probable social utility of allocation of funds and personnel of various types of research on natural hazards; (2) it stimulates, in the process, a more systematic appraisal of research needs by scientific investigators in cooperation with the users of their findings.

The basic mode of analysis is to examine the complex set of interactions between social systems and natural systems which create hazards from the extreme geophysical events. The chief hazards investigated relate to: coastal erosion, drought, earthquake, flood, frost, hail, hurricane, landslide, lightning, snow avalanche, tornado, tsunami, urban snow, volcano, and windstorms. For each of those hazards the physical characteristics of the extreme events in the natural system are examined. The present use of hazardous areas and the variety of adjustments which people have made to extreme events are reviewed. The range of adjustments includes measures to modify the event, as by seeding a hurricane; modifying the hazard, as by adjusting building or land use to take account of the impact of the extreme event; and distributing the losses, as by insurance or relief. Taking all of the adjustments into account, the impact of the hazard upon society is estimated in terms of property losses, fatalities and injuries, and systemic disruption. An effort is made to identify the directions of change in the mix of adjustments and in their social impact. As a part of this review, those forces in the national society which shape the decisions about adjustments are appraised.

Authorities in the field are consulted through the medium of literature review, workshops on specific hazards, a national conference which was held in October, 1973, and individual reviews. Where appropriate and practicable, simulations of the extreme events and of their social impacts were carried out. In selected areas scenarios of past and possible future events and their consequences are constructed.

In the light of this analysis the possible contributions of research to amelioration of the national condition with respect to each hazard are assessed. Each set of adjustments is reviewed in terms of its potential effects upon national economic efficiency, enhancement of human health, the avoidance of crisis surprise, the equitable distribution of costs, and the preservation of environmental options. Evaluation of particular research activities includes (1) the average sum of social costs and social benefits from application of a given adjustment in changing property use, and (2) reduction in average fatalities and casualties. In addition to the direct impacts of extreme events upon society, account is taken of the costs and benefits which society reaps in seeking to cope with the hazards, as in the case of costs of insurance or of control works.

In addition to calculating the average effects of hazard adjustments, an effort is made to estimate the degree to which the occurrence of a very rare event which has dramatic destructive potentialities, such as an 8.0 earthquake or a 200-year flood, would disrupt society.

Estimates also are made of the extent to which the adoption of an adjustment reduces the options of maintenance of environmental values, and the degree to which the pattern of distribution of income among various groups in society may be changed.

Research proposals are appraised in the light of the likelihood that the research undertaken could yield significant findings, and the likelihood that once the research is completed satisfactorily, the findings may be adopted and practiced by the individuals or public agencies in a position to benefit.

The United States as a whole is doing a competent job of dealing with some aspects of its natural hazards and a very ragged job of handling other aspects. The overall picture is one of rising annual property damage, decreasing loss of life and casualties, coupled with a marked growth in the potentiality for catastrophic events. On the whole, the public costs of adjustments are increasing.

The assessment reveals that very little is known about the dynamic relationships among many of the adjustments. It is difficult to predict with any confidence what the consequence of new Federal investments of initiatives will be in particular adjustments.

For each hazard a set of research opportunities deserving special consideration for early adoption is presented. In addition, three types of research which cut across the various hazards are assessed: warning systems, land management, and relief and rehabilitation.

Among the reserach basic to other aspects of natural hazards activity are: carefully planned post-audits of certain disasters by interdisciplinary teams; community observations over time of critical points (recovery policies and administration, health, mental health, and preventive measures) of change and of the effects of Federal-state-community interaction; and a clearinghouse service.

In most research fields it is noted that certain types of research which have claimed substantial amounts of public support offer little prospect of effecting a basic change in the character of the national hazard situation. In those instances there are new lines of emphasis which promise larger returns. Many of these involve more explicit collaboration of social scientists and natural scientists than has been customary in past. Wherever appropriate, the research recommendations include explicit provision for the translation of research findings into action by individuals or public groups.

To initiate effectively the desirable new lines of research will in some instances require a readjustment in legislative authority. In other cases it will require an increase in or reallocation of public funds for research. Much of it will involve changes in administrative procedures and policies of the responsible funding agencies. In many instances the effectiveness of the research will be linked strongly with the resolution of issues of public policy. These issues evolve around national land use management, financial assistance to sufferers from disasters, and the sharing of responsibility among local, state, and Federal agencies in designing and maintaining community preparedness.

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SUMMARY

A recurrent theme in dealing with all of the natural hazards is the potential of land use management to promote socially desirable uses of vulnerable areas in the United States. The rapid encroachment in the hurricane zone of the South Atlantic coast, the progressive invasion of industrialized flood plains, the design of mobile home parks without shelters against tornado, and the continued building upon land fill in areas of high seismic risk illustrate the land use changes which are occurring and which call out for sober consideration of risk involved.

For each of the geophysical hazards it is apparent that attention should be given to ways in which land use planning may contribute to effective use of the soil and water resources, candidly examining the hard political considerations that shape what a community finally does about exposing itself to risk. In each case a needed study of land use problems is closely linked with associated questions of control and protection work, warning and emergency action, insurance, and relief and rehabilitation.

Every instance in which the opportunity to affect land use patterns arises poses a question of what uses are compatible with the risk in view of the benefits to society which will derive from using the resource. Evaluating what is suitable management for any one area at one time calls for a wide set of considerations. Aside from the scientific and technical problem of delimiting and defining the quantitative importance of any risk, there arise questions of estimating social effects, legal restraints, political complications, environmental impacts, and the net economic benefits or losses.

Decisions about land use are made either by private property owners or by public owners, of which the Federal government is the major holder. Private decisions take place within the context of local regulatory and planning activities as guided by state law. The Federal role thus far has been one of providing information, managing Federal properties, and giving encouragement to state and local groups through a variety of measures such as the Department of Housing and Urban Development (HUD) planning grants, and the National Oceanic and Atmospheric Administration

(NOAA) Coastal Zone Management Program of 1972. Although strengthened Federal land use planning legislation was proposed in 1974, its enactment was delayed.

In any event, it would be a mistake to think that early initiation of such aids to national land use planning would have a major effect upon the occupation of hazardous areas unless accompanied by research along four lines: 1. Methods ahould be found to step up the pace of delimiting hazardous areas; 2. The factors affecting successful local management of hazard areas in terms of community goals need to be appraised; 3. The effects of those activities on the local agencies and property owners have not been studied; and 4. Ways of coordinating hazard considerations with other complex aspects of local planning need improvement.

Other parts are deserving of higher priority than they now receive when their possible influence upon further occupation of hazard areas is considered. In all cases where a high priority is assigned to the activity, it also is believed that the feasibility of the reserach is high. In some other cases, the need for the research is moderate, but the feasibility of carrying it out is low.

The information which is needed most widely in the management of hazardous areas is scientific *delimitation of hazard zones* and assignment of probability of occurrence to various types of events. Research is needed on ways to speed up this process as cheaply as possible. It should be accompanied by careful attention to ways of transferring the resulting information into policy decisions.

Canvass has shown that a number of legal uncertainties will dog the provisions of hazard delimitations unless they are anticipated from the outset. These include the questions of reasonable precision in delimitation of a hazard zone; suitable map scale (this is particularly important in considering possible applications of remote sensing where legally defensible resolution is not established); the credentials and authority of the delimiting agency; and the reliability of the judgments.

Thus far, little is known about how successful various local groups have been in working out regulatory and management alternatives. Except for the experience of the grading regulations and application of engineering geology to reducing landslide damages in the Los Angeles area, only casual critical analysis has been addressed to how land use management has worked. Even in that instance there are a number of unanswered questions about the economic effects and the *effectiveness* of the actions

of individual agencies. Some of the questions apply to land management with respect to virtually all of the hazards, whereas others, such as the question of subdivision regulations or tornado shelter requirements, are limited to a single hazard.

The rate of *adoption* of new land use regulations in hazardous areas has been greatly accelerated in hurricane and flood zones, but there has been virtually no review of what actually happened, or why some of the communities withdrew from participation in the Federal flood insurance program by failing to enact required land use controls.

Much of the regulatory action that has affected hazardous areas has come about through concerns with environmental quality rather than from direct identification of areas hazardous to human occupation. On the other hand, there are notable examples, such as the Colorado state legislation affecting subdivision design, and Oregon state land use planning which deals explicitly with hazard areas involved in new development within the state.

What is needed is an integration of multiple use and multiple means principles of management affecting hazard areas to insure that the consideration of hazard is only one aspect of a *coordinated* approach. In some instances hazard may turn out to be the lead aspect, in others it may be incidental to purposes such as open space preservation or wildlife management. Ways of accomplishing this integration are still understood only casually, and the need for achieving it is a repetitive theme.

The opportunity for spurring research along all of the four lines indicated above is not likely to be met by concentrating the investigations in one agency or at one level of government. A very large part of the responsibility for both activity and research rests at the local level. Each of the Federal agencies concerned with major adjustments to natural hazards should be aware of the land use management components and should include these as part of its research activities. This would include the Corps of Engineers, NOAA, Department of Interior, HUD, and the Department of Agriculture. It is to be expected that in whatever form national support for land use planning emerges, a significant sector of the new work to be stimulated by that program will focus on ways of taking account of hazardous characteristics of land as an element in integrated management.

A closer examination should be made of *Federal land use policies* as they may affect the decisions of private landowners or other units of government in dealing with hazards. The possible influence of Federal

action on use of adjacent or nearby lands needs to be recognized more explicitly.

The relation of *Federal, state and local tax structures* to decisions to locate or not locate in hazardous places should be probed. The present incentives and disincentives, as in the Internal Revenue Code, have powerful effects upon locational decisions.

Public finance policy needs evaluation from the standpoint of possible effects upon new development. States and local governments are not generally aware of the opportunities and complexities of this form of guidance to land use where the subsequent public costs for welfare or corrective works may be high.

The possible use of *housing policy and regulations,* including urban renewal, in affecting the vulnerability of settlements needs exploration. The potential savings for future relief and rehabilitation and in Veterans Administration and Federal Housing Administration loan foreclosures are large.

The effects of *relief and rehabilitation and insurance programs* upon land use also deserve examination.

CHAPTER I

MANAGING HAZARDOUS AREAS

Many communities in the United States have a natural hazard problem, whether from flood, hurricane, or earthquake. Until recently, relatively little consideration was given to land use management as a tool to protect life and property from those hazards. This volume explores some of the specific problems land use management poses as an adjustment to natural hazards. It examines the factors that enter into defining appropriate land management, including the legal considerations, and then reviews alternative levels and techniques for management. It concludes with suggestions of ways in which research could help improve the present situation.

Land use management in its broadest sense is land husbandry; the modern ecologists speak of using land consistent with the ecosystem, or in ways that do not cause violence to that ecosystem, The notions do not seem to be inconsistent. But their application may be quite divergent. In the context of this volume, land use management means more than land husbandry or eoclogical harmony. The concept is used to describe policies of land management for productive use of hazardous areas. It involves a set of institutions at the local, state and Federal level which we rely on to guide the use of private land. These include acquisition, regulation, taxation, investment, and the provision of information. As will be shown, acquisition may not always occur through the exercise of eminent domain. The land use measures usually are taken in combination with other types of adjustments such as construction projects, insurance, warning systems, and relief activity.

Chapter III deals at some length with the shadowy subject of the legal boundaries of land use regulation. Inasmuch as regulations are not always of a prescriptive sort, tax and public finance policy are examined in Chapter IV to determine their effect on land use.

Loss-abating land use management can be and is applied voluntarily by land owners. For example, a farmer may plant a hail-resistant

variety of corn. Or a homeowner near a lake subject to seasonal flooding may build his house on a higher elevation away from the lake shore. The more controversial aspect of land management is governmental regulation. The governmental role receives the bulk of attention in this report.

"The role of government. . .is to do something that the market cannot do for itself, namely, to determine, arbitrate, and enforce the rules of the game" (Friedman, 1964, p. 27). There is general agreement with Friedman that governmental intervention (regulation) should occur when the market fails. However, much disagreement arises over the point of failure. This is closely related to what one believes the "rules of the game" should be. Even if agreement is reached on this, there are problems of determining which policy or set of policies will maximize net social benefits.

Three social benefits can be expected from suitable land use management in natural hazard areas. First, a substantial reduction in the population and economic investment-at-risk can be attained. Second, a substantial reduction in the expenditures of private and public agencies for evacuation, relief, and rehabilitation can be expected. Third, dependence upon protection works can decrease. The primary problem with land use as an adjustment to natural hazards is the length of time required for the full benefits of the program to accrue. In areas that are already urbanized, the typical time span is 20-25 years.

Although communities show increasing interest in adopting land use management programs to protect life and property from natural hazards, actual adoption of such measures has been glacially slow. The most encourgaing bit of news is the gradual adoption of flood plain ordinances by communities in many states. Despite this development, many observers are alarmed at four current trends. First total annual losses are increasing and per capital losses remain constant. For floods alone, property damage is estimated at one to two billion dollars annually. Second, the cost of adjustments to natural hazards is rising. For example, the annual construction expenditures by the Army Corps of Engineers for flood control are $400-$500 million dollars. The cost of relief and rehabilitation may exceed $1 billion in a year of great disasters. Whatever the costs, there is no indication that they are decreasing. Third, it is apparent that catastrophe potential is increasing. Tropical Storm Agnes' precipitation with its conjunction of two atmospheric systems was a catastrophic event. While the level of damage

from more frequent floods is curbed and protected in flood plains, it is the rare event like Agnes that cripples an entire region of our country. Finally, there is some evidence that the poor pay more when they are hit by a natural disaster. They appear to receive a proportionately smaller share of Federal disaster relief assistance; they are not likely to be able to take advantage of tax laws; and they probably do not benefit as much as middle and upper income groups from protection and control works (see Cochrane, 1974).

It these were the only forces at work, there would be cause for alarm about our complacency in regulating land use in natural hazard areas. But as Chapter IV indicates, population growth and migration patterns probably are exacerbating land management problems in natural hazard areas. To an extent not yet measured such forces as the consumer protection movement, increasing citizen participation in public policy decision, the 1968 Flood Insurance Act, and the 1974 Disaster Relief Act may have a salutary effect in overall management of natural hazards.

If performance to date has been a bit ragged, it is not surprising. Reduction of loss of life and property from disasters is an extraordinarily complex problem. It is at least as complex as the natural phenomena themselves. The rather poor performance must be attributed in part to limited knowledge of the natural phenomena involved. Though data has been collected for over four decades on runoff from small agricultural drainage basins, the number and complexity of variables is so large that there is only a modest capacity to extrapolate the findings to other areas. A paucity of usable data has also hindered hazard mapping. Different aspects of this problem are discussed in Chapters II and III. It is obvious that the nation needs more refined data on the frequency of extreme natural events and the expected magnitude of loss before a hazard map for many areas can be drawn so as to withstand analytical and legal scrutiny. If regulations that purport to control the uses or activities a landowner can make on his land are to be enacted, the nation also needs a fair estimate of the social effects that will obtain if such regulations are not enacted. This is contingent upon predictive capacities reflected in hazard maps.

Failure to understand the natural event completely does not explain the conspicuous failure to reduce property losses from disasters. Part of the responsibility must be attributed to existing institutions and programs. For example, individuals are not required to make structural

modifications to existing buildings to render them more resistant to a recurrence of the natural event prior to disbursing funds for relief and rehabilitation. Nor for the same purpose are communities required to enact codes or regulations that would encourage individuals and businesses to upgrade their structures to protect them from a recurrence of the natural event. The feasibility of relocation is rarely discussed following a disaster. In many instances it may be the most economical alternative in terms of taxpayers' dollars saved. Moreover, the Federal agencies responsible for relief and rehabilitation have only infrequently complied with the terms of the National Environmental Policy Act.

Although the evidence is mixed as to whether current Federal assistance discourages further encroachment into natural hazard areas, there can be little question that large institutional blocks stand in the way of a coherent land use policy for natural hazard areas. Fragmentation of authority at the Federal level is one such obstacle. Some agencies have viewed their Congressional mandates very narrowly, although this may be changing. Under the Water Resources Management Act of 1974, the Army Corps of Engineers now has authority to build protection and control works that include "non-structural alternatives", i.e., the acquisition of flood plain land, and the relocating of buildings and utilities away from the flood plain. The Disaster Relief Act of 1974 has provisions for a comprehensive recovery plan and requires Federal Agencies to give explicit consideration to the National Environmental Policy Act in any relief and rehabilitation program. While the Department of Housing and Urban Development has avoided commitment to the numerous lines of investigation which might appropriately fall under its missions for disaster preparedness and prevention, the National Oceanic and Atmospheric Administration and the U. S. Geological Survey are demonstrating greater flexibility in taking on new problems.

At one time various units of government may not have had the legal authority to enact regulations guiding the uses made of land in hazardous areas. Chapter III indicates, however, most of these legal impediments have fallen by the wayside. If the regulations are carefully drawn up and a reliable hazard map is produced, there should be no serious difficulty in them withstanding legal attacks. Whether land use regulation for a particular hazard is an appropriate adjustment to the problem is another matter. Despite the lessening of these legal impediments in the last few years, there has been no great rush to adopt

regulations controlling land use in hazardous areas. It is not clear why some communities have adopted ordinances regulating land use in hazardous areas and others have not. Decisions by city and county governing bodies may be affected by the activities of citizen groups, special interest groups, state agencies and Federal agencies. Pressures for local regulations may come from open space or wildlife conservation advocates though the goals of these groups may not be consistent with loss-abating land use management in natural hazard areas.

Sound land use management also involves close coordination with the adoption of other adjustments, as well as with governmental and private activities. Proper coordination will have a major impact on the overall success of the land use program. Very little exploration has occurred in this area. We do not know if flood insurance will encourage people to locate in flood plains or to stay in them after a major disaster. Nor do we know if land use regulations for natural hazard areas might encourage the use of buildings beyond their economic usefulness. Not much has been done about bringing together engineering works, urban renewal programs and social welfare programs at a post-disaster site. The opportunities that exist for imaginative rehabilitation programs after a major disaster have rarely been exercised.

There is no question but that the national land policies towards natural hazards are in a state of flux. This is encouraging. It is hoped that this volume will act as a catalyst for research and initiate new developments in the field of natural hazards.

CHAPTER II

DEFINING APPROPRIATE LAND MANAGEMENT

Our social system is too complex to permit a judgment of land use management measures to be based solely on their ability to reduce losses from natural hazards. Many factors are involved in our evaluation of a particular land use management policy, and loss management goals need to be integrated with other planning objectives to form a concerted effort involving mutiple means and purposes.

Social Forces

Since our culture places a high value on life, an important consideration in evaluating land use management in hazardous areas is to determine how well we are protecting humans from exposure to natural hazards. If we are keeping our citizens out of highly vulnerable areas, our legislative programs might be termed a success from the point of view of reducing the population-at-risk. However, as Chapter IV indicates, more people are occupying highly vulnerable areas. On the first count, we do not appear to be doing too well.

There is strong evidence that legislation has been ineffective in dealing with social problems for families and communities affected by a natural disaster (see U. S. Senate, 1973-74). The Disaster Relief Act of 1974, particularly Sections 407, 408, 409, 410, 412, and 413 attempts to remedy some of these shortcomings.

The occurrence of a natural disaster places stress at every level of the social system--on the individual, the family, the organiza tion, the community, the region, and the nation.* A natural disaster causes disoriented behavior and physical and psychological injury to the individual. Families, community organizations, and local unites of government suffer temporary functional deterioration. Economic loss

*This is Barton's (1970) Classification.

occurs at the individual or family level, at the local and state level, and on the national level. Moreover, resources and efforts must be redirected to facilitate recovery. Proper land use management in hazardous areas can reduce the negative effects on a social system. While some losses are probably unavoidable (or their avoidance may be too costly), undesirable consequences at the individual and family levels can be mitigated, thereby reducing the demands placed on organizations, the community, region, and nation.

In addition to the primary effects of a natural disaster--the direct pecuniary, structural, and mortality losses--the crippling of some activities compounds difficulties and produces a set of secondary effects. Financial institutions, water supplies, sewer facilities, highways, public utilities and airports are services necessary to the economic life of every community. The loss of power transmission facilities has economic repercussions on the entire community. To avoid these secondary effects, land use management must consider vulnerability of essential facilities and the consequent economic disruption to the entire community when such facilities are improperly located in a natural hazard area.

The secondary effect concept suggests a more general aspect of disaster consequences--non-uniform distribution of impacts. Areal heterogeneity is implicit in the concept of some zones being more hazardous than others, but the same magnitude of hazardous elements can affect various groups of people, structures, and land uses in vastly different ways. Therefore, management of hazardous areas must determine alternative effects (primary and secondary) on various types of land uses, structures, groups, and activities.

Managing hazard zones to minimize the loss of life and property is confounded by the forces which attract people and activities to the areas. In many cases aesthetic values make habitation in hazardous areas desirable. Many people have migrated to our seashores despite the dangers from hurricanes, coastal storms and tsunamis. Others have built recreational homes on hillsides despite the threat of avalanches and landslides. Many subdivisions have been built near attractive geomorphic features that straddle active geologic faults. Aesthetic reasons combine with economic reasons to create intensive use of land in hazardous areas. These same forces act as a barrier against restricting use of hazardous areas. Custom also protracts the use of unsafe areas. Industries continue to

locate on river banks that are periodically flooded. Property owners and managers usually either underestimate the risk involved or feel that the benefits (not necessarily monetary) exceed the costs (see Kates, 1962).

For these reasons many property owners do not utilize their property in a manner likely to minimize hazard losses. Because our units of government have the responsibility to provide for the health, safety, and general welfare of the populace, some have taken measures to protect members of society when property owners have failed or refused to manage their land according to uses compatible with hazards.

Private ownership of land and the right of the individual to determine how to use his land is a powerful social institution in the United States (Clawson, 1973). Objection is not strong to regulations that prohibit individual actions that endanger the welfare of others, as, for example, a regulation prohibiting construction that results in river channel constriction. However, governmental regulations that seek to protect those who knowingly place themselves in danger are more controversial. Such regulations should withstand attack since individual economic losses affect all levels of social aggregation, and the losses of a few become losses to many. In providing for the general welfare, a government may see fit to place restrictions, within the bounds of our constitutional framework, on the rights of those living and operating in hazardous areas.

Science and Technology: Problems of Delimitation and Mapping

As noted in Chapter III, mapping is an integral and necessary part of an ordinance regulating the use of land in hazardous areas. Without a map delimiting the hazardous area, and delineation of the intensities of risk within the hazardous area, a legal attack on the validity of the ordinance would probably succeed in the courts. This section will deal in some detail with the technical problems involved in mapping hazardous areas.

Rather than mapping the hazard zone and simply determining whether a given parcel of land is in the delineated area, some ordinances have required the property owner to demonstrate that his parcel is not in a hazard zone and therefore not subject to use restriction. That approach generally has been rejected because of its inefficiency and inequity, and even in those cases where the hazard zone is not mapped, many of the same

scientific and technological problems are encountered in determining whether a given parcel is within the hazard zone.

The usefulness of a hazard map depends on the following elements:

(1) perceived need for mapping (based on probability of high losses);
(2) ability to identify hazard-prone areas and differentiate with respect to severity;
(3) costs, in both time and money, involved in mapping; and
(4) availability of personnel to conduct the mapping of a hazard.

Once the desirability of mapping a hazard is determined, the following must be analyzed:

(1) scale of mapping (local, regional, national);*
(2) who is to do the mapping (local, state, Federal, private);
(3) what technique or combinations of techniques for mapping are to be employed; and
(4) what the minimum legal requirements are.

1. Perceived Need for Mapping

At local, state or regional levels it is practicable to eliminate the need for mapping of some hazards since they have an extremely low likelihood of occurrence. From the standpoint of society's perceived concern with hazards based on their potential adverse impact, we can establish priorities for mapping. Earthquake--including tsunami--flood, and hurricane are of very high priority. Avalanche, coastal erosion, drought, frost, hail, landslide, and tornado are of a lower order of priority. Lightning, urban snow, volcano, and windstorm have a low priority relative to other hazards (see Table II-1).

2. Technique Availability

Techniques of mapping are generally either on-site investigation or remote imagery investigations. On a national or regional scale, remote imagery techniques are adequate for the accuracy required. On a state or local scale, a combination of both remote and on-site techniques is

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*In this report all scales are categorized as national, state, or local, with national maps generally suggesting a small fractional scale (1:5,000,000), regional maps a larger fractional scale.

usually required to obtain the accuracy needed.

Hazard mapping is simply a process of transferring known hazard occurrences to a map. The technique requires rudimentary cartographic skill. This kind of mapping can be done for all hazards for which there is accurate data on occurrences of the event. One problem with occurrence maps is the lack of information on unrecorded occurrences. The lack of historic data for many areas, particularly ones that have recently been settled, makes prediction very tenuous, if not impossible. Sophisticated statistical techniques are now employed to overcome the lack of historical data. These involve the correlation of existing physical properties of an area to the hazard occurrence potential. This correlation is used to predict the probability of future occurrences. For earthquakes, the existence and character of faults correlate to some degree with the probability of future earthquake occurrences. Such probability (or susceptibility) can be represented spatially on a map. The degree of correlation potential varies for each hazard (see Section 3 below).

Recently, the use of high altitude imagery (multispectral photography) has become an effective tool in mapping. The most significant development has been the launching of the ERTS-1 satellite. This satellite records imagery of the entire United States on an 18-day cycle from approximately 550 miles in altitude. The resolution of such imagery is a limitation in its use; the data ordinarily can be used only at the regional, state, or national level. The most innovative aspect of ERTS is the ability of the imagery to give large area perspectives. This is especially useful in identifying regional faulting relationships, or indeed, new faults themselves.* The practicality of using ERTS as *a single source* of hazard mapping, however, is questionable; more detailed ground truth investigations must be made to develop the accuracy generally required for a hazard map.

Another high altitude technique is the airplane multispectral survey. An example of this is the NASA U-2 plane flying at about 60,000 feet. Resolution is much better and photos can be used for state and even local hazard mapping. Again, ground truth investigations are an integral and necessary part of such surveys. A limitation of the high altitude airplane survey is the small number of aircraft equipped to do

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*Dr. Elroy Nelson of the University of Utah's Department of Geological Engineering is doing extensive research into this area.

the work.

The most detailed imagery is from low altitude aerial surveys. Such surveys are well-known and extensively used throughout the United States. These surveys identify flood plains, faults, avalanche paths, landslides and other hazards very accurately. Nonetheless, a truly comprehensive hazard map requires ground truth investigations.

There is considerable potential for correlation of physical properties to hazard susceptibility using multispectral imagery, including infrared color, and black and white photography, and the thermal band. Such data are especially useful for hazards having site-specific correlations to physical properties. These include flood, landslide, avalanche, coastal erosion, earthquake, and tsunami.

Table II-1 shows the relative availability of these techniques for each hazard. The term "ground truth" indicates primary reliance on this method for certain hazards. The term "dynamic" indicates a characteristic which acts as a limiting factor in using any aerial survey technique. The table shows that aerial photography techniques are primarily applicable to geomorphic and hydrologic hazards. Atmospheric hazards (tornado) are more amenable to historic data as a basis for long-range prediction. Some hazards, such as hurricanes, can employ both aerial photography techniques and historical data effectively.

3. Technical Applicability

The application of hazard mapping to land use management requires sufficient data substantiation for it to be used by a political decision-making body to create a defensible hazard zone area. The map must be of a large enough scale to reflect accurately the statute, regulation or zoning ordinance which depends on it. Further, the data used to develop the map must be at least as specific as the definitions in the land use plan and ordinances treating the boundaries of the natural hazard.

Accuracy of boundary delineation is relatively nigh for flood plains, based on past flood histories and reliable hydrologic data; the use of flood plain maps for zoning has been a common tool in modern land use management. The predictive capabilities of such maps are based primarily on probabilities within which variation of occurrence exists.

Coastal erosion mapping is based on a similar principle of delineating past occurrences and projecting probabilities of future

TABLE II-1

APPLICABILITY OF HAZARD MAPPING

Hazard	Perceived Need	Technical Practicability	Scale Potentials	Techniques Availability	Legal Defensibility
Avalanche	Medium	Medium	N R⓪ S L⓪	High (all techniques)	High
Coastal Erosion	Medium	High	N R⓪ S⓪ L⓪	High (all techniques)	High
Drought	Medium	M-Low	N R⓪ S⓪	Medium (mainly high alt)	Low
Earthquake and Tsunami	High	M-High	N R S L	High (all techniques)	Medium-High
Flood	High	High	N R S L	High (all techniques)	High
Frost	Medium	M-Low	N R S⓪	Low (ground truth)	Medium-Low
Hail	Medium	M-Low	N R⓪ S⓪	Low (ground truth)	Low
Hurricane	High	High	N R⓪ S⓪	Medium (too dynamic)	High
Landslide	Medium	Medium	N R⓪ S⓪ L⓪	High (all techniques)	High
Lightning	Low	Low	N R S(?)	Low (ground truth)	Low
Tornado	Medium	M-Low	N R⓪ S⓪	Medium (dynamic)	Medium
Urban Snow	Low	M-High	N R⓪ S⓪ L⓪	Medium (ground truth)	Low
Volcano	Low	M-Low	N R⓪ S⓪ L⓪	Medium (?)	Low
Windstorm	Low	M-High	N R S L⓪	Medium (ground truth)	Medium

H, ⓪ = High M=Medium L=Low N=national R=regional S=state L=local

occurrences. The major deficiency of coastal erosion maps is the lack of historical data. As settlement along our coasts continues, concentrated efforts to investigate this hazard will be vital in developing useful land use controls. Such investigations must determine the impact of settlement, on the processes of erosion, as well as the areal extent of erosion prior to settlement.

Drought, earthquake, tsunami, frost, hail, lightning, tornado, and volcano are all less amenable to assignment of probabilities of occurrence. Within this group, however, earthquake, tsunami, volcano, avalanche and landslide have a strong potential of being mapped in direct relation to distinct geologic characteristics of the land (fault lines and igneous intrusions). These known characteristics can be used to produce maps that are accurate for areas with *potential for occurrence*, even though the probability cannot be estimated accurately.

Drought, frost, hail, lightning, and tornado occurrences depend on very complex sets of physical phenomena, each one of which is highly variable. It appears that mapping of these hazards can, at best, be carried out on a regional or national scale. More specific delineation creates too great a margin of error for the map to be used in developing regulations at the local level.

Urban snow, landslides, and windstorms can be mapped for densely settled areas where specific land use regulations can be designed to accommodate these hazards. An excellent example is grade of road specification for areas of continuous heavy snow. The practicability of such mapping depends on accurate histories of past occurrences and the degree of variation in predicting future occurrences.

4. Legal Requirements

Unless a hazard map can be defended as an integral part of the legal (statutory) delineation of land uses, the role of the map is nothing more than informational. This is especially true for hazards requiring extreme restriction of use of land to minimize loss. Once an ordinance, official map, or any other prohibitive measure is adopted, any criteria used for the adoption becomes liable to legal scrutiny. If a map is one of these criteria, it must be defensible, as must the data used to generate the map. Legal defensibility depends on predictive ability. If the predictive ability of a hazard map is low, the use of the map for regulating land use is questionable. The legality of the

regulation depends heavily on the technical practicability of mapping a particular hazard.

There appears to be a positive correlation between loss potential (life and property) of a hazard and the legal acceptance of regulations governing the use of land in hazard areas. Land use limitations based on delimitation of highly destructive hazards such as avalanche or flood have been more readily accepted by the courts than limitations based on less destructive hazards such as urban snow or lightning (Kapaloski, 1974).

As the demand for more intensive use of land increases, legal challenges to the criteria used for regulating land can be expected to increase. We are now beginning to see such challenges in the courts. While this may appear to be a disturbing development, it should be kept in mind that legislatures have frequently passed compulsory regulations which are questioned by the scientific community. Despite these differences of opinion the courts have generally upheld the regulations as a valid exercise of the police power. The reported decisions indicate that even though there may be serious scientific dispute as to the efficacy of a particular regulation, as long as the court can find some rational connection between the regulation and the promotion of the public health and safety, it will be upheld.* The regulation cannot be so drastic as to deprive individuals of what the court deems to be important and fundamental liberties, particularly where the mass of scientific opinion is against the regulation, or when opinion is in an admitted state of uncertainty.**

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*The courts do not seem to look so favorably on drastic regulations that are designed to promote the general welfare, and tend to overturn them much more frequently than health and safety measures.

**See *Jacobson v. Massachusetts*, 197U.S.11 at 30(1904); *Kraus v. Cleveland*, 121N.W.2d311 at 315(Ohio, 1954) and collected cases in 43A.L.R. 453, 459-64(1954); *Buck v. Bell*, 274U.S.200(1927); and *Skinner v. Oklahoma*, 316U.S.535(1942). Bernard Schwartz in The Rights of Property (1965) at 37 defined the police power as follows:

> From the point of view of the individual, the Due Process Clause is of vital consequence as the essential shield of his rights of person and property. From the point of view of government, on the other hand, it is significant as a basic restriction upon power. In this sense, the organic provision serves to limit the authority over person and property which government otherwise possesses. It is such authority that is generally denoted by the term "police power".

5. Scale

The scale of hazard mapping depends on two major factors, the constraint of technical accuracy and the use to be made of the mapping.

The degree of technical accuracy defines the minimum limit of scale, beyond which the usefulness of the map is questionable. At a national scale, most of the hazards under consideration have been mapped, and all could be. The national scale maps are used for developing national policy such as general insurance programs, or for the location of regional centers for monitoring a particular hazard such as a weather warning service for frost. National scale mapping is also helpful in establishing priority areas for more detailed regional mapping programs. The use of national scale maps for any regulatory actions (beyond general insurance guidelines) is doubtful.

Even though regional maps are somewhat more detailed, they are primarily used for policy formulation rather than regulation. Regional maps have been drawn up to show the water basin flood cycle for the Mississippi Basin. These maps are used as guidelines to coordinate state and/or local land use management programs. Technical accuracy is not critical for either national or regional maps; it is feasible to map all hazards on these scales for general policy guidelines.

In going from national to regional scales, the degree of intra-regional differentiation must be adequate to justify the regional map. This differentiation varies for regions as well as hazards. A regional map of tornadoes in the Great Basin is useless, but for the Midwest/Plains is extremely useful (see Table II-1).

The recent upsurge in state land use planning efforts has created a demand for state-level inventories of all sorts, including natural hazard areas. On this scale, technical accuracy becomes much more important because the maps are likely to be used for state land use regulation. State maps must be sufficiently accurate to give definition to broad statutory language such as "areas of critical state concern." Because of this, the usefulness of mapping drought, frost, hail, lightning, and tornado at the state level is questionable.

At the local level technical accuracy is paramount. Local regulations governing land use are very precise and demand a highly accurate map. It is senseless to delimit land uses for windstorm areas if the predictable boundaries of occurrence were broader than the total

area to be regulated. At the local level, and to some extent on a state scale, site-specific verification (ground truth) is required for dependable maps. At present, we can map the following hazards dependably for regulatory purposes: hurricane, avalanche, coastal erosion, earthquake, tsunami, flood, landslide, urban snow and, to some extent, volcano and windstorm. Differences in data availability and reliability control the mapping of all of these hazards at the local level.

Figures II-1 and II-2 illustrate two cases of mapping hazards at national and near-national scales. Elsewhere in this report, other figures illustrate the mapping of hazards on smaller scale maps.

6. Costs

The costs of mapping depend primarily on scale, the hazard, available data, expertise of investigators, and technique or techniques employed. Since costs of mapping hazards are highly variable, perhaps the best indicators of cost are examples of known hazard mapping projects.

The Geologic Hazards Study of Morgan County, Utah, identified and mapped known past landslides and faulting in a county of approximately 200 square miles. A map on a scale of 1:24000 identified areas of susceptibility to landslides and/or fault slippage. (See Figure II-3). The total cost of the study was $30,000, of which actual mapping and field survey accounted for approximately 80%, or $24,000. The low cost reflects the existence of excellent U.S. Geological Survey and Soil Conservation Service soil and geologic surveys. Without this source data, the costs would have been much higher (Kaliser, 1972).

By way of comparison, the cost to the U.S. Geological Survey of flood hazard mapping in Metropolitan Chicago during the 1960's for 7 1/2-minute quadrangles varied from $6,000 to $10,000 per quadrangle.

These show all areas for which there is record of flooding, and are accompanied by estimates of the recurrence interval of floods of such magnitude (see Figure II-4).

The California Division of Mines and Geology has conducted mudslide analyses in Southern California at a cost of $38/mi^2 for maps with a scale of 1" = 2000 feet. Other landslide studies at scales ranging from 1" = 1584 feet to 1" = 500 feet have cost about $1,000/mi^2. Photo interpretation studies of landslide areas in California have cost as little as $3/mi^2 for maps at a scale of 1" = 1 mile. However, these studies require that the investigators be extremely familiar with the area (Cleveland, 1974). The generalized results for one study along the California coast is given in Figure II-5.

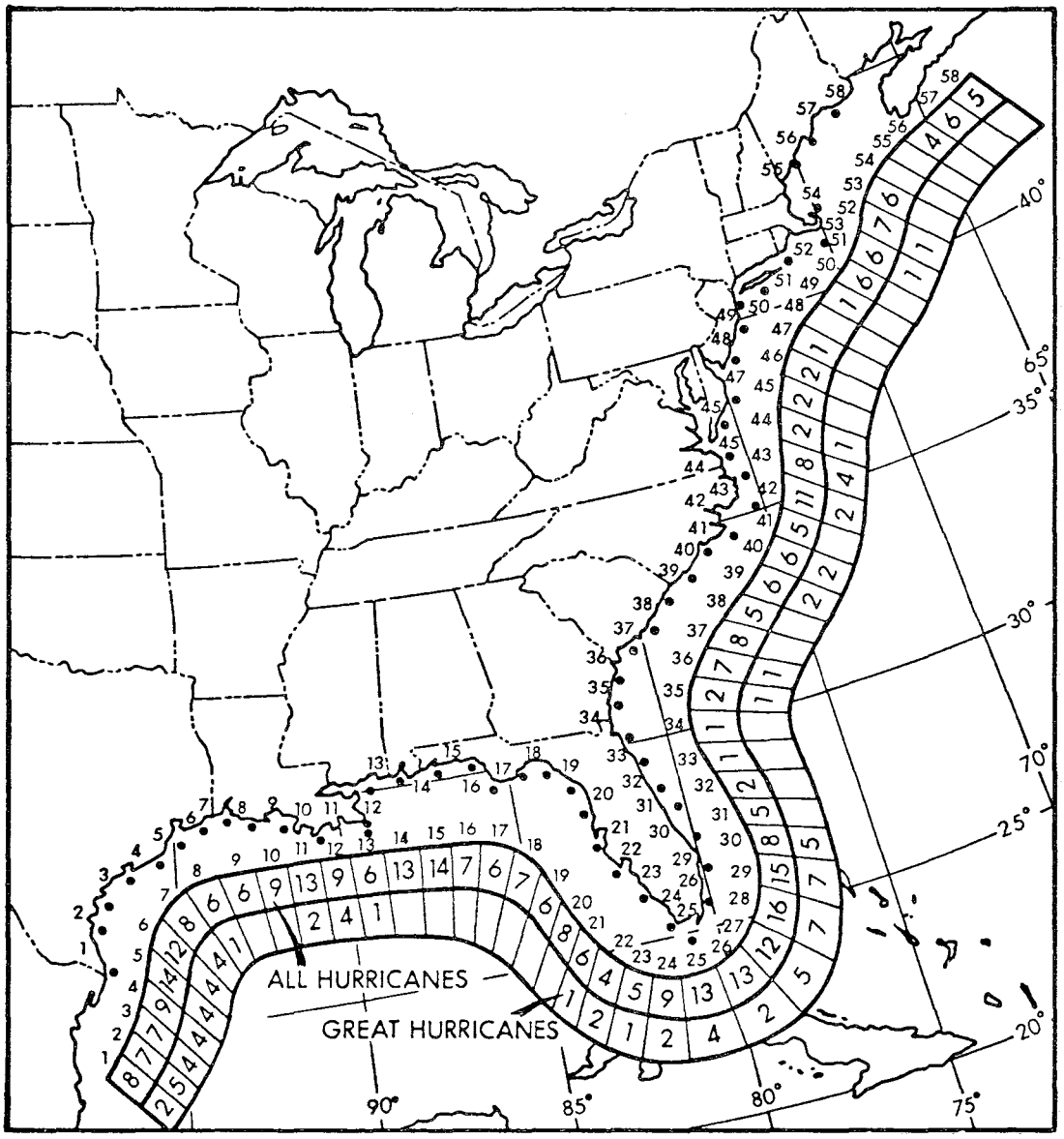


Figure II-1 PROBABILITY (PERCENTAGE) THAT A HURRICANE (WINDS EXCEEDING 73 MPH 33 m s^{-1} OR GREAT HURRICANE (WINDS IN EXCESS OF 125 MPH 56 m s^{-1}) WILL OCCUR IN ANY ONE YEAR IN A 50-MILE (80km) SEGMENT OF THE COASTLINE (after Simpson and Lawrence, 1971).

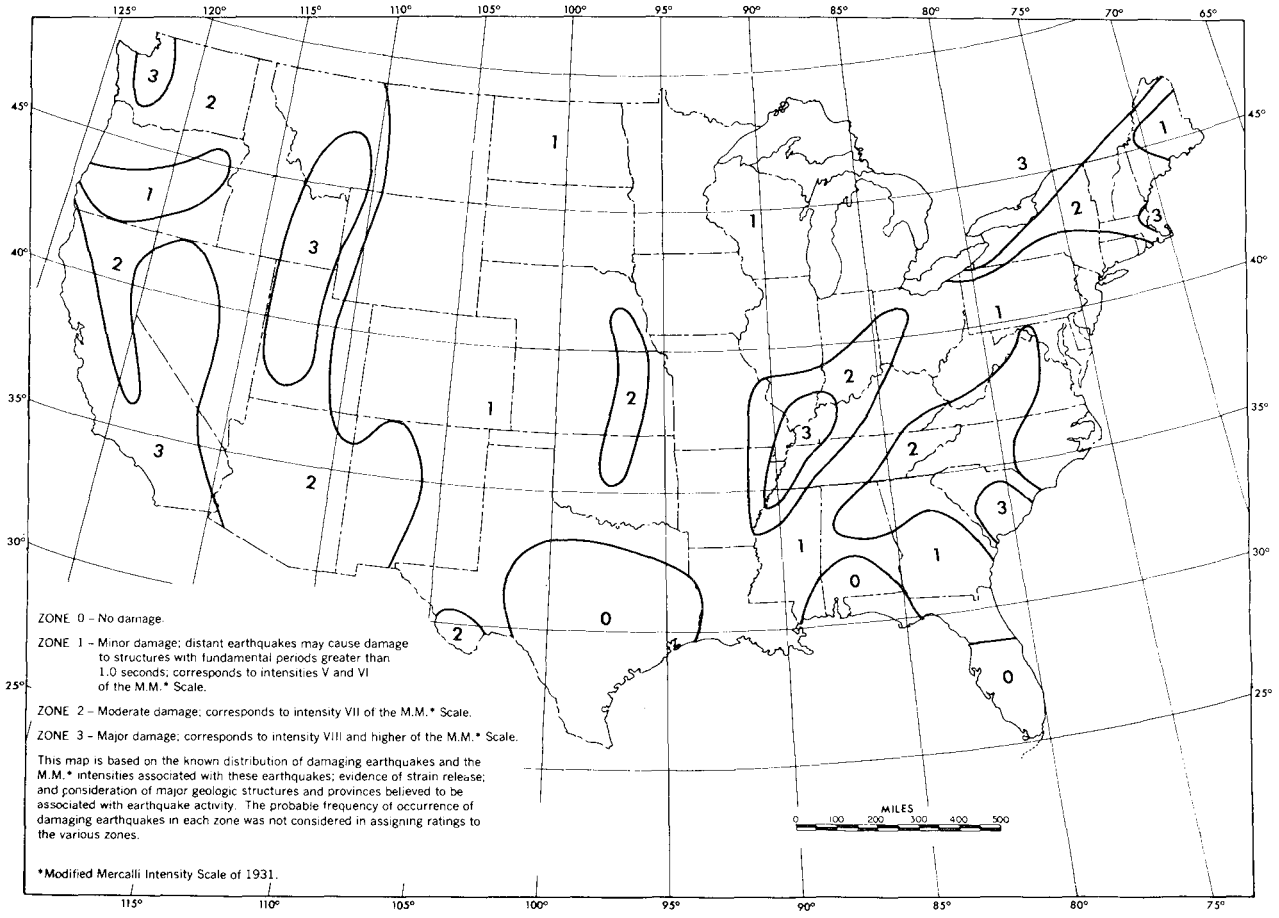
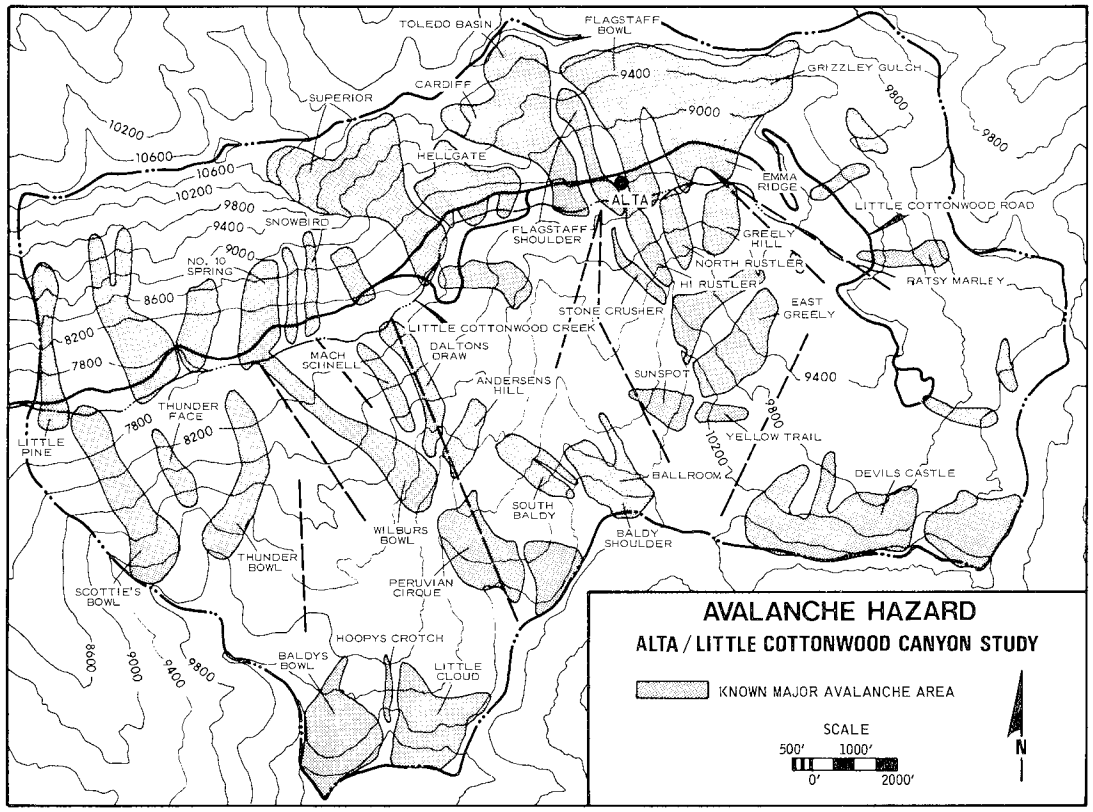


FIGURE II-2

SEISMIC RISK MAP OF THE CONTERMINOUS UNITED STATES

(Office of Emergency Preparedness, 1972, Volume 3)



(Eckbo, et al., 1973)

FIGURE II–3

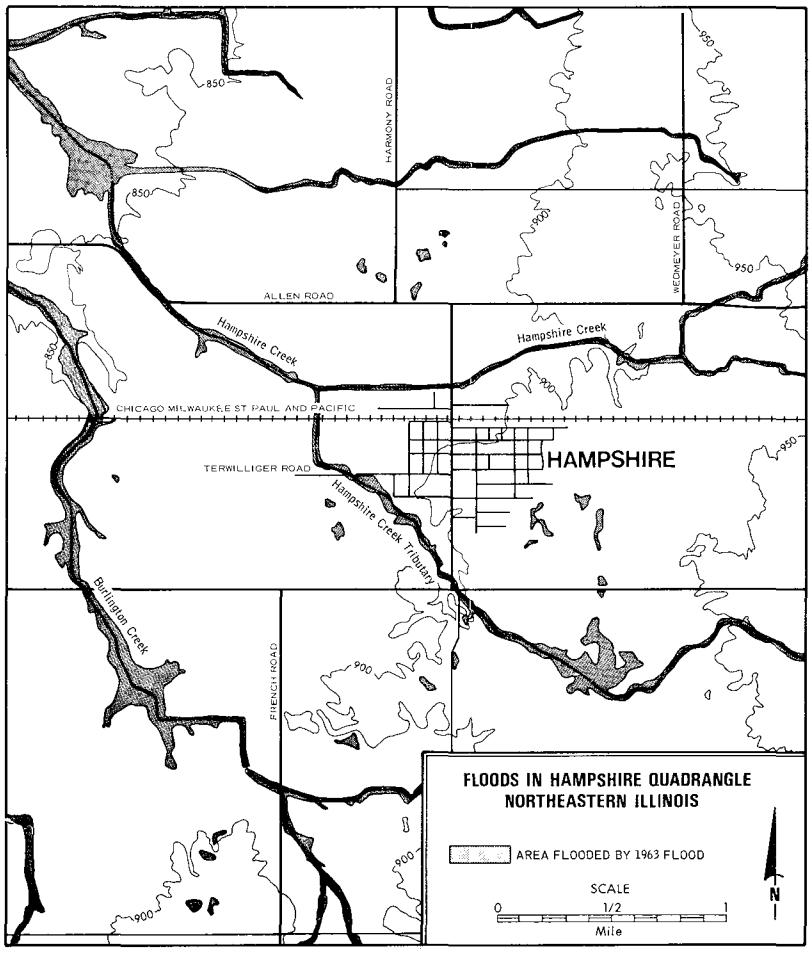


FIGURE II–4

(Mycyk and Duerk, 1972)

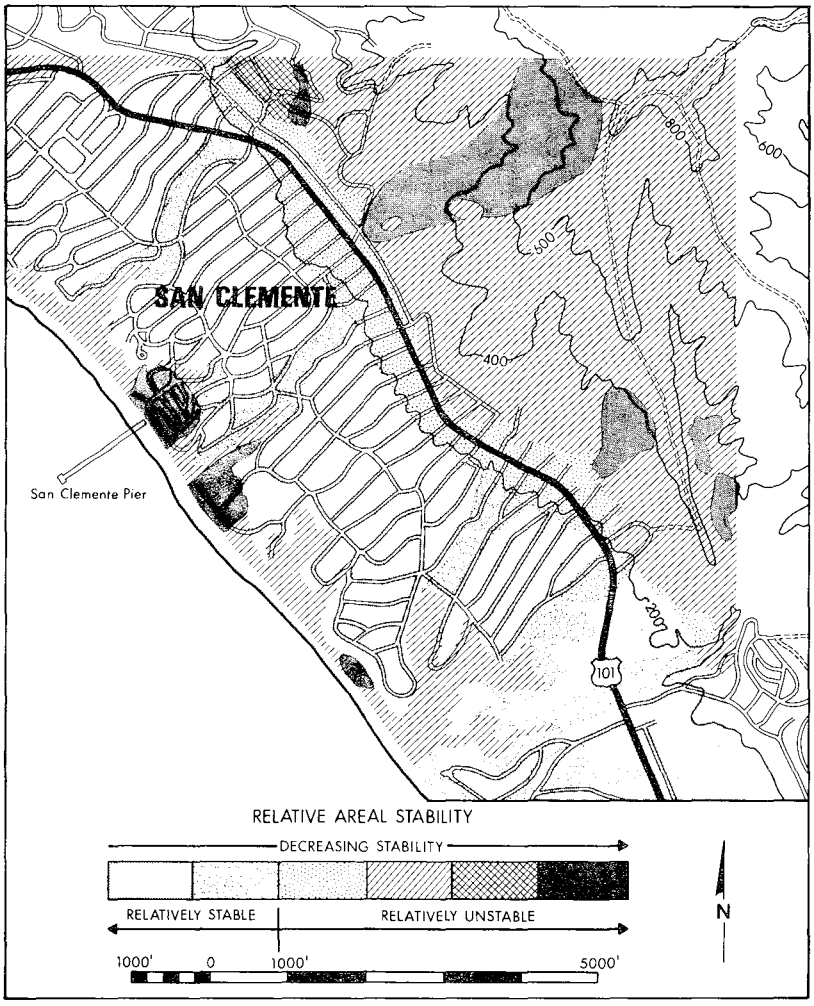


FIGURE II–5

STABILITY MAP OF SAN CLEMENTE AREA, CALIFORNIA

(Cleveland, 1967)

7. Mapping Agencies

Federal agencies do most of the mapping of hazardous areas. Such mapping is often done at the request of, or in cooperation with local and state offices. The National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey have ongoing programs to map areas susceptible to earthquakes, tsunamis, landslides, and volcanoes. NOAA is also engaged in mapping hurricane storm surge areas along the Gulf and Atlantic coasts. The U. S. Army Corps of Engineers, HUD, and the Soil Conservation Service have been mapping flood hazards for several years in virtually all areas of the United States.

The Department of Housing and Urban Development (HUD) and the Department of the Interior are sponsoring a four-year study of the San Francisco Bay area. The effort is oriented toward developing geological information relating to soil and mineral resources as well as to earthquake,. Landslide, and flood hazards. This pioneer venture seeks to provide local planning and land management agencies with data upon which programs for construction, land acquisition, and land use regulation can be based. Thus, it identifies those areas where the risk of liquifaction in times of seismic movement is significant (see Figure II-6). A somewhat similar program is under way along the Front Range of the Colorado Rockies.

The Metropolitan Chicago mapping project illustrates the cooperative approach between agencies of various levels of government. Beginning in 1961, six counties in the Chicago Metro area, the Northeastern Illinois Planning Commission, and the State of Illinois entered into an agreement with the U. S. Geological Survey to map flood hazard areas for the region. This was supplemented by flood plain information studies by the Corps of Engineers. Today almost all the area has been mapped.

Political Circumstances

Opposition to governmental restrictions on land use comes primarily from property owners. In addition, political officials are often reluctant to impose regulatory measures since reducing the economic return on a parcel of land or its assessed value can have serious fiscal repercussions on a community that relies primarily for its revenue on the property tax. Assessed property value is ordinarily lower when higher category (more intense) uses are restricted or prohibited; unless the mill levy is changed, property tax revenues received by the community should be lower with such restrictions. In some municipalities, large-scale restrictions can have a significant effect on the aggregate tax

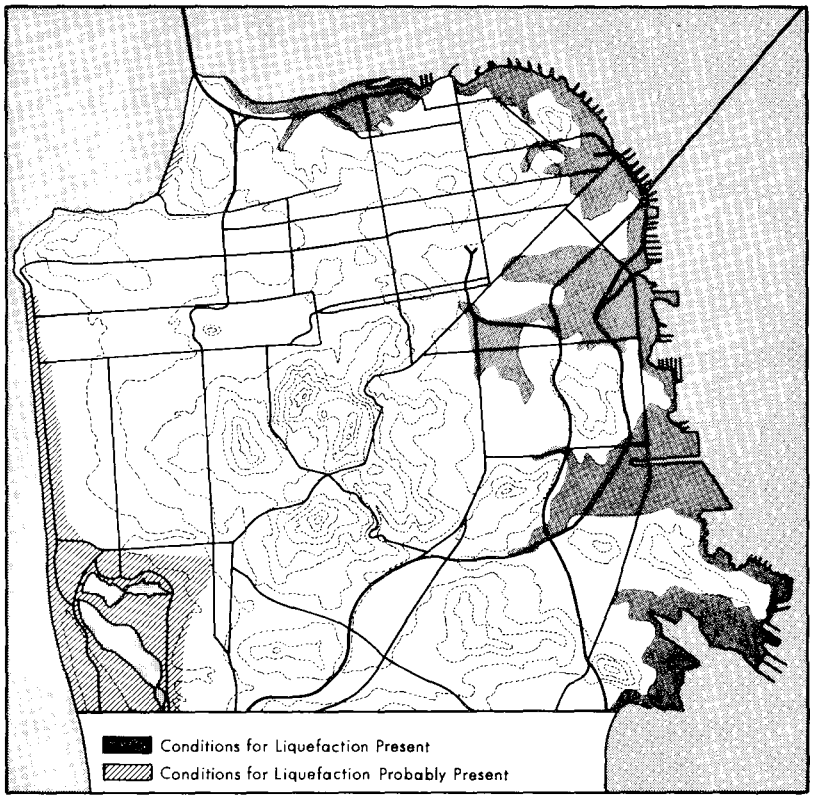


FIGURE II–6

POTENTIAL FOR LIQUEFACTION IN SAN FRANCISCO

(San Francisco Department of City Planning, 1974)

base. Rather than forego the difference in revenue, the community may permit incompatible uses. However, there are conceivable situations in which the aggregate tax base may increase as a result of land use regulation: an area with zoning regulations that would have developed the same without the regulations except for structural safeguards. The structural safeguards are likely to increase the value of the structures and, therefore, their tax return to the public coffer. In this instance, government officials might perceive the added value as an incentive to adopt regulations.

Occasionally uses that may have a broad economic impact and a negative fiscal effect on a community are precluded by regulation. In addition to lost property taxes, sales tax revenue may be lost if certain types of restrictions are adopted. In a community where basic economic activities are negatively influenced as a result of land use restrictions, the economic foundation of the community can be eroded. Some coastal communities may depend heavily on resort activities, but if land use measures restrain resort development the local treasury and community growth may suffer. These considerations are always on the minds of political decision-makers.

Political leaders must consider special interest groups. Society is composed of diverse and often competing groups, each of which is acting in its own self interest rather than in the general interest of society. Emerging policies of hazard zone management may represent more of a compromise than a consensus. This point is well illustrated by efforts in Evansville, Indiana and Carbondale, Illinois to adopt flood plain regulations. Original proposals supported by public officials and environmental groups were modified after opposition from local real estate and building associations (Simkowski, 1973). O'Riordan has demonstrated the profound influence which interest groups can have on environmental policies (1971). For many reasons, practical politicians are subject to lobbying pressure from such interest groups and must weigh such lobbying efforts when they vote on a particular piece of legislation.

Many persons object to government controls on land use because special interest groups are often involved not only in the adoption of the land use regulations, but also in the administration of those regulations by public officials. In studies of zoning board adjustment decisions in Philadelphia, Pennsylvania and Lexington-Fayette County, Kentucky, petitioners for zoning changes were substantially less successful when objecting groups were present (Dukeminier and Stapleton, 1962).

Interest groups may play positive roles by providing needed information to decision-makers. However, special interests may influence decisions in extremely negative ways such as payment of graft.

The concern over the honesty, and the analytical and judgmental abilities of political officials and administrators has led writers such as Haar (1965) and Siegan (1972) to question the wisdom of strict controls over land use. While Haar seems to favor regulation by governmental incentives, Siegan endorses devices such as covenants entered into by private land owners. For example, some covenants are perpetual agreements between individuals who buy into a subdivision, and agree to use their land only for specified purposes. Siegan argues that government regulations seldom need to go beyond building codes and some subdivision regulations, and then only to provide for the safety of inhabitants. Although several authors, notably the two cited above, have uncovered incidences of regulatory failures and private sector successes in land use management, little of the literature has addressed itself to the management of hazard zones.

Environmental Concerns

In addition to serving as an adjustment to natural hazards, restricting development in hazardous areas often satisfies general environmental goals of society. While some adjustments to hazards result in ecological degradation, often creating new problems, land use management appears to do so less often. The effect of most land use management schemes is to produce less intensive uses of land in the hazard zone and less modification of the natural environment than would occur without imposition of the management program.

Ian McHarg, in his book Design with Nature (1969), argues that natural processes often work to society's advantage and the less those processes are disrupted, the better off our society will be. He points out that cultural activities disruptive to some natural systems but profitable to man can usually be located at sites less susceptible to natural disruption without appreciably sacrificing the beneficial aspects of the activities. The net benefits of the activities can often be maximized by locating them to minimize the disruption of natural processes.

Hazardous areas often overlap with areas of valuable natural processes, unsuited to intensive human use. For example, in the coastal area of hurricane storm surge inundation, marshes, wetlands, marine grass beds, mangroves, and dunes are commonly found. Wetlands protection legislation has been generally designed to control intensive and poten-

tially harmful uses of these areas, and has tended to reduce the loss potential of the storm surge hazard.

Some hazard control programs do not use open space as part of the regulation of the hazard, and in these cases they can be environmentally harmful. A strategy in hurricane storm surge areas and flood plains is often elevation by filling, but a major concern in coastal areas is loss of wetlands by dredging and filling. In New York, from 1950-1969, almost 18,000 acres of estuarine habitat was destroyed by dredging and filling operations; in California the total was 47,000 acres; and in Florida, 169,000 acres (Council on Environmental Quality, 1971). From an ecological standpoint, when hazard-compatible land use strategies are being considered, some fare better than others.

Land uses which are least land-intensive involve open space activities such as parks, greenbelts, recreation areas, and wildlife preserves. In areas where it is possible to delineate particular hazard zones, it is often feasible to locate open space uses in hazardous areas. In response to the increasing demand for outdoor recreation and open space in urban environments, governments are placing more emphasis on providing such areas. During the period 1958-1971, municipalities and states spent more on recreation areas than on any other environmental activity except waste water treatment (Council on Environmental Quality, 1973). A recent land use task force recommended that the "limited natural supply of prime recreational open spaces, particularly beaches and other waterfront areas, should, to the maximum feasible extent, be acquired by government, preserved and made publicly accessible. . . .", and that other applicable powers available to government should also be used to encourage recreational open space land uses (Reilly, 1973, p. 19).

Flood plain parks combine the two goals of open space and hazard loss reduction. The city of Littleton, Colorado decided that rather than receive protection from floods by a channel improvement on the South Platte River it would prefer to acquire the land to be protected and use it for open space purposes. Under the Water Resources Development Act of 1974 it was authorized to apply the funds which would have been spent on engineering works for land purchase (see Figure II-7). The remaining cost was covered by municipal bonds of more than $500,000. However, there are limits to the extent to which hazard zones should be relied upon to meet the goals of open space. Types of recreational opportunities are limited, given a particular sort of hazard zone, and the

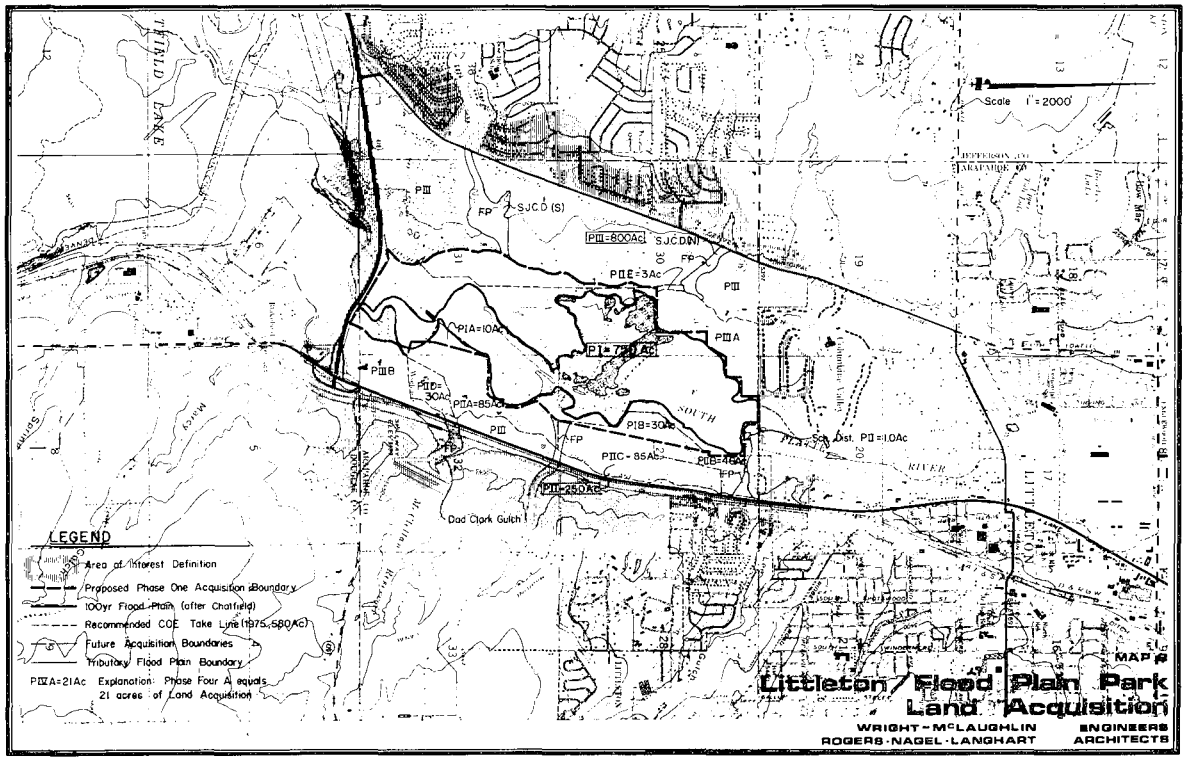


FIGURE II–7

(Rogers-Nagel-Langhart/Wright-McLaughlin, 1975)

accessibility of the area may, in effect, discriminate against certain classes of population (David, 1973).

Environmentalists argue for land use management (or regulation) in hazardous areas because it provides double benefits. Just as flood control projects provide multiple benefits, so can certain land use strategies. As with flood control, the ancillary benefits of the strategy may add sufficiently to make it desirable, whereas the primary benefits alone may be insufficient for justification. In many instances communities consider the benefits of open space the primary asset, and hazard-loss reduction benefits are auxilliary benefits.

Economic Factors

The treatment of economic aspects of hazard zone management parallels closely the previous discussions of other considerations since economic valuation is not a separate consideration, but a way of conceptualizing and dealing with many of the variables that enter into land use decisions.

Economic benefits foregone by restricting land use are counted as opportunity costs, and economic models incorporate the principle of opportunity costs of nondevelopment in evaluating flood plain management costs. James (1972), who has been a leader in urging decision-makers to consider the costs of restricting development, provides a particularly good treatment of the issue. The models often indicate that restricting uses to those which are compatible with flooding preempts economic returns which exceed the damages prevented. The President's Task Force on Federal Flood Control Policy concluded that, "It may well be that the advantages of flood plain location outweigh the intermittent cost of damage from floods" (U.S. House of Representatives, 1966, p. 13).

While economic analysis of land use in hazardous areas has been applied almost exclusively to flood plains (as have most other considerations of land use), the constraints against restricting activity appear to apply across many natural hazards. In some hazard zones, as with seashores, the potential loss in economic rent may be so high as to create an insuperable obstacle to effective land use management of any sort. Some activities benefit so immensely from being located in a hazardous area that their location elsewhere may be economically precluded. Historically, certain industries have located on the banks of rivers or the shores of lakes and oceans because of the large volume of water they need for manufacturing, cooling, or diluting and transporting

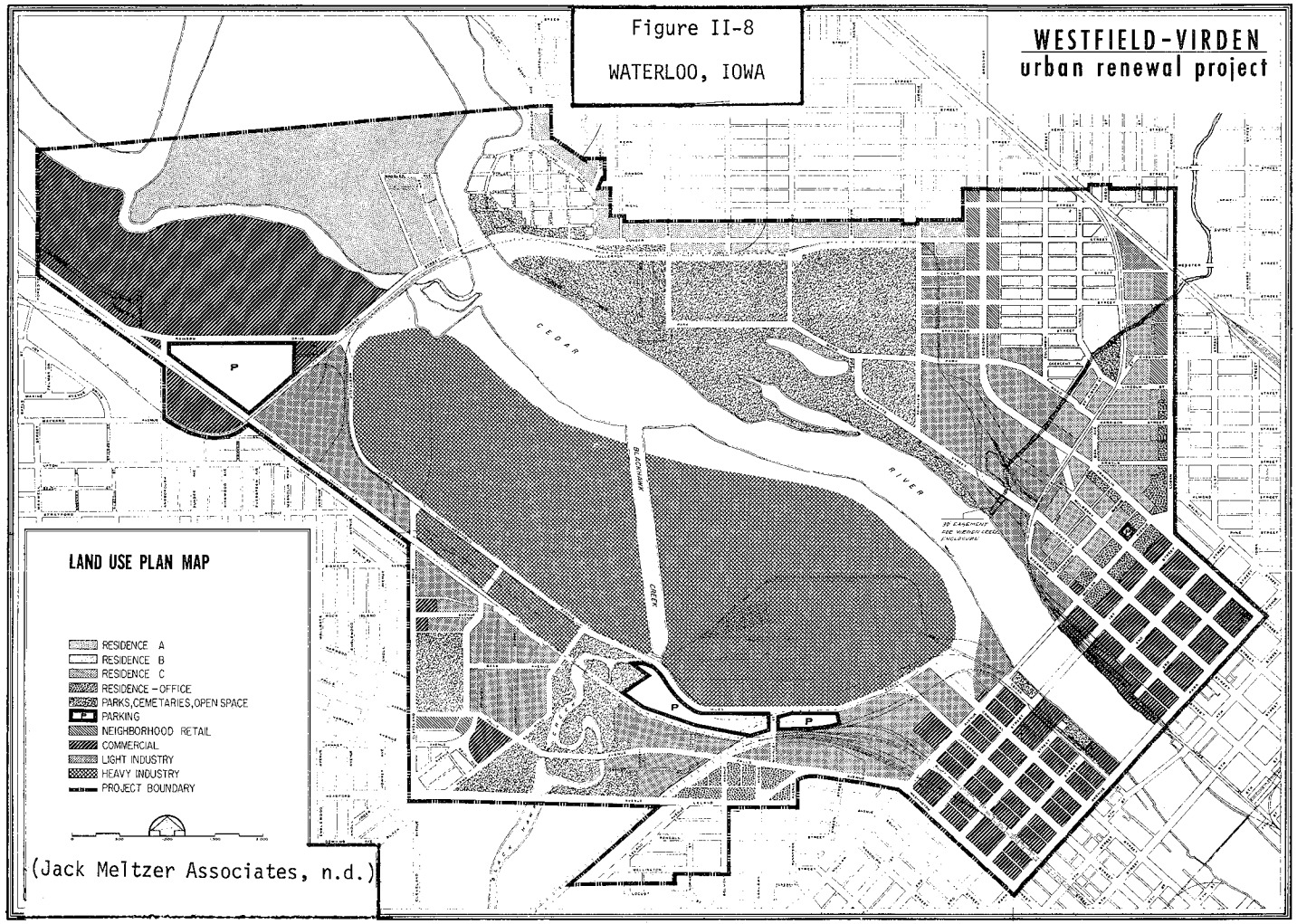
waste. Shores are also used for loading and unloading large shipments from cargo ships. Flood plains have fertile alluvial soils and are well suited for growing crops. Finally, locational advantages may exist in a hazardous area although the advantages have no relationship to elements of the hazard.

Private ownership of property must be given consideration in any proposed land management scheme. There is a conviction that a property owner has the right to profit from his investment, and this acts as a constraint on government regulation. Some economists argue that the market mechanism should determine how land will be used, and that many artificial regulations are undesirable because they cause economic distortion. If the demand for a particular activity or product is sufficient to induce the use of a hazardous area, then so be it. An extreme laissez-faire approach views economic man at his best--rational and replete with knowledge. Critics (some of whom are charged with assuming that bureaucrats are rational and replete with knowledge) question whether such a view is warranted. In response to such criticism, conservative economists seldom go beyond recommending creation of laws requiring sellers to inform the buyers about the magnitude of a hazard and the risk they are taking.

A broader economic perspective requires that benefits from occupying a hazardous area exceed total costs to society--primary as well as secondary costs. Consideration of only the benefits versus costs experiences of the entrepreneur in hazard zones fails to go beyond primary costs. Krutilla (1966) has suggested that occupance of the flood plain is "wise" only if the benefits derived by the occupant from his location exceed: (1) (all) costs imposed by damage from flooding; (2) the costs of ancillary measures employed by others in rescue, clearing, rehabilitation, or related activities associated with flooding; and (3) increases in damages his occupance of the flood plain may inflict on others due to his encroachment on the floodway (external diseconomies).

Waterloo, Iowa is an example of a community which dealt with its flood problems by combining engineering works with land acquisition, urban redevelopment, and land use regulation (see Figure II-8). While developing part of the flood plain intensively for industrial and commercial purposes it set aside other areas for recreation. The net effect for the community and for individual property owners was judged to be highly beneficial.

Zoning may be the only practicable way of accurately reflecting a hazardous area's actual economic uses by forcing the



(Jack Meltzer Associates, n.d.)

private market to internalize the costs associated with the hazard. Without such use restrictions, an unjustifiable burden is placed on the public sector in the event of hazard occurrence (White, 1959). However, it is equally important that the regulations do not impose an undue burden on the private sector. It is this dilemma which the courts attempt to resolve when rulings on the "taking" issue are made.

There is a solid and growing body of experience by state and county agencies in developing plans for use of hazardous areas in ways which promote private and public benefits without imposing heavy costs upon Federal and state governments for protection or relief. A conspicuous example is the Southeastern Wisconsin Regional Planning agency. It combines the delimitation of flood plains with inventory of other natural assets and liabilities (see Figure II-9).

The economic approach can be used to evaluate how well alternative hazard zone land use strategies are working toward achievement of societal goals. From an economic perspective, determination of the goals is possibly the most difficult problem with which to deal. Basically three criteria are used to determine hazard loss goals: (1) average annual losses, (2) catastrophe potential, and (3) equity.

Average annual losses is by far the most commonly employed criterion. It utilizes an expected value approach to temporal loss distribution. The procedure projects hazard losses for an area probabilistically over a specified time period and then determines what the average losses per year would be. There are variations in losses from year to year, but the concept is more concerned with the average (expected value) for each year in the time frame. Usually average annual losses are computed for each of several hazard zone land use schemes to determine the benefits (primarily reduction in losses) from each.

Average annual costs of each strategy can be dealt with similarly. When average annual benefits and costs of the various components of the land use schemes are determined, they may be evaluated by any of several techniques such as benefit-cost analysis or net utility function maximization. Regardless of the particular analytical procedure, however, virtually all the published economic models are based on average annual losses (see James, 1965, 1967, and 1972; Lind, 1967; Whipple, 1969; Day, 1970; Brown, Contini, and McGuire, 1972).

An alternative, or supplementary, criterion is catastrophe potential. This emphasizes precisely the concept neglected by average

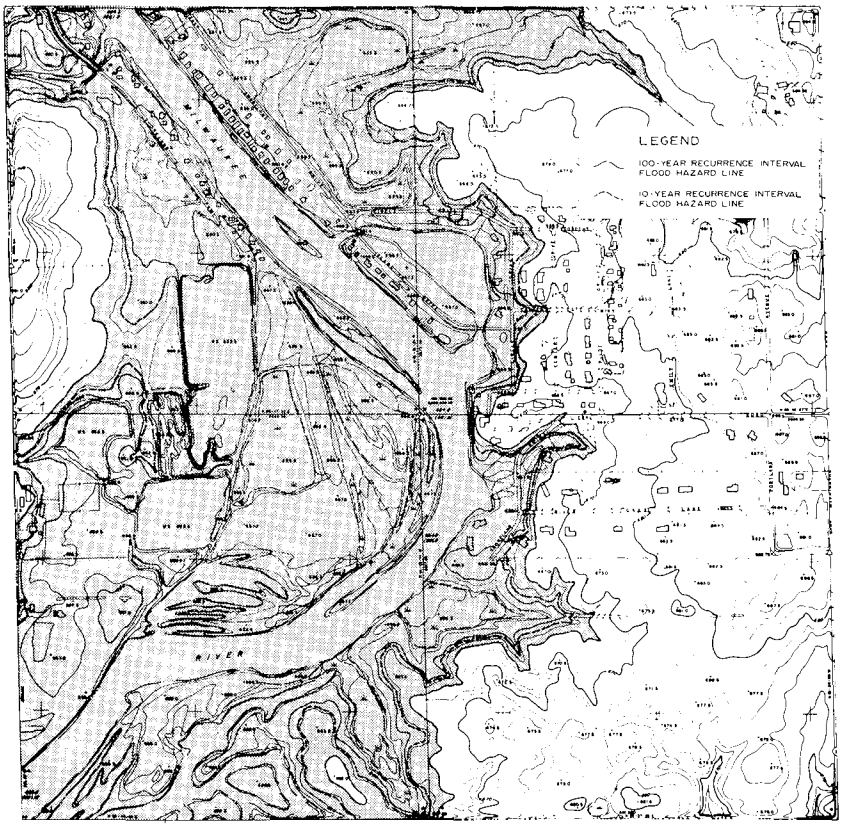


FIGURE II-9

TYPICAL LARGE-SCALE SEWRPC FLOOD HAZARD MAP

(Southeastern Wisconsin Regional Planning Commission, 1974)

annual losses--temporal variation in losses. Each of the three curves in Figure II-10 represents a different probability distribution of loss magnitudes, and each may be thought of as having a different catastrophe potential--that is, the likelihood of individual occurrences of extremely great losses is greater for curve C than B, and greater for B than A. However, because numerous instances of small losses are greater for the curves with lower catastrophe potential (low probability of high loss), the areas under them may be greater than for curves of higher catastrophe

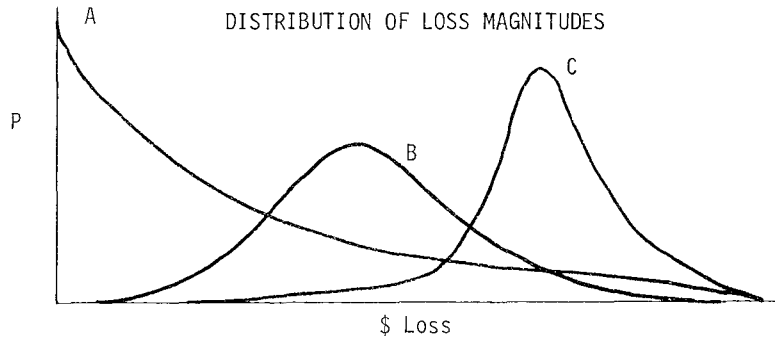


FIGURE II-10

potential. Under the average annual loss criterion, if each curve were generated by a particular land use scheme, the costs for all being equal, the strategy having the greatest catastrophe potential would be preferable.

However, it may be that society would be better off to suffer several losses of small or moderate magnitude over a given time period than to suffer a few or even one incidence of catastrophic loss. An analogy would be that an individual may prefer to have one arm broken three separate times during a 20-year period than to have both arms broken at once only one time during the same time frame. Losses beyond some threshold of magnitude may be so great that a community may have greater difficulty in recovering and regaining its pre-disaster (or desired) level of prosperity than when occurrences of smaller losses occur. Society may also bear an aversion to certain types of losses inherent in some catastrophes (gruesome deaths and injuries).

If the tolerance threshold could be determined, various economic means would lend themselves to the determination of which hazard zone management strategy would best achieve the goal of averting the specified level of loss potential. Cost-effectiveness studies, for example, can reveal which measures achieve the specified goal at least cost. The elusive problem, however, is specification of the maximum tolerable loss.

Generally speaking, land use management tends to reduce catastrophe potential. Most compatible-use hazard zone schemes, especially those emphasizing open space, have a fairly high likelihood of slight damage and low probability of extreme losses. Even with land use strategies, however, there is some point (the magnitude of the event) at which losses increase dramatically, because the strategies are designed to be compatible with hazard elements of only a specified magnitude.

Finally, society may set as a goal some distribution of losses which it deems just, equitable, or desirable (preferred) within the system affected by the hazard. For example, schemes may be devised which distribute the losses more evenly over the affected population, or which seek to minimize proportional losses to the very poor or old.

Some structures and activities (manufacturing facilities, transportation installations) may be very critical to the functioning of the community or region, and losses to them may be less desirable than losses to other facilities. If a plant that employed a substantial proportion of the area's labor force were damaged, the repercussions would be quite widespread. Similarly, if structures such as nuclear reactors were damaged they could cause secondary hazards to health, and therefore should be carefully sited. Land use management can sometimes be an effective tool in influencing the distribution of losses, especially those that are critical in our economic system.*

Regardless of the goal (or combination of goals) that is sought by society, evaluation depends on the identification and measurement of benefits and costs of the attempts. Economic valuation does very well in assessing some categories of damage, especially direct damage to structures and physical facilities. Systemic losses have been dealt with less incisively in economic analyses, but recent attempts (Cochrane, 1974) suggest that many areas of secondary effects can be dealt with effectively by economic tools such as input-output models.

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*For a more detailed discussion of the distributional aspect of hazard losses, particularly with regard to who benefits from and who pays for various hazard loss management procedures, see Cochrane (1975).

Still, there remain the "intangibles" on which many decision-makers are either unable or unwilling to place an economic valuation. There have been efforts to place pecuniary measures on some of these qualitative concerns by observing court awards for loss of life or pain and suffering (Roberts, 1973); recreation and resource economists have made inroads recently into the valuation of open spaces used for recreation (Clawson and Knetch, 1966). One concept, option value, attempts to deal with the valuation of natural environments left in a preserved state, but the idea is not adequately operational for decision-making (Krutilla, 1967).

The current inability of economics to handle sufficiently some of the considerations with which decision-makers must deal does not lessen the need for assessment of those considerations. The dilemma has given rise to endeavors to quantify things in terms totally independent of economic principles. The quality of life (QOL) concept being toyed with by the Environmental Protection Agency (1973) is one which may be of particular use in evaluating alternative hazard zone management strategies.

While some of the benefits from open space management of hazard zones may be underestimated because of inadequate tools, costs of some land use schemes also have been neglected by decision-makers. Land economists refer to the "highest and best use" of a parcel of land (Barlowe, 1972), and it is possible for such a use to be the most loss-prone. The precept is based on the concept of economic rent--the excess of a parcel's expected return over the minimum necessary to initiate the particular use (Muth, 1968)--and under a philosophy of highest use, economic rent should be maximized.

Summary

A typology of considerations in evaluating the desirability and practicability of land use management and regulation has been presented. There are no generalizations as to what considerations should take precedent over others. Goals and circumstances differ to the extent that each situation must be evaluated individually. What is best with regard to one hazard (or set of hazards) for a particular property manager or community may be quite different for another hazard and other decision-makers. There are several means by which the same end may be achieved, as well as several levels at which initiatives may be taken. The considerations set forth in this and the preceding chapter need to be integrated to aid in prescribing alternative management strategies.

CHAPTER III

LEGAL CONSIDERATIONS

Land use planning involves a constant tension between the private and public sectors. The public is interested, through appropriate regulation, in providing support to private individuals in their decision-making processes over land uses and in preventing conflict with other private individuals. The government role is manifested in two distinct ways. First, the government is a provider of services. These include such traditional items as fire and police protection, public streets, and parks and information. Second, the government performs a regulating role. The planning and zoning process is a part of the governing role whereby private conflicts are brought into a more or less harmonious resolution. The most visible part of our governing processes takes place at the legislative level. Here, the various units of government decide how public resources, both pecuniary and non-pecuniary, are to be used. The legislative level is also where private interests most commonly seek to influence the use of public resources. It is a well-known fact that the use of our public resources, both tax revenues and others, affect in a very direct way the actions of private individuals in making land use decisions. It is also well-known that the way in which public revenues are used directly affects the success or failure of a local unit's land use plan.

Private land use is primarily controlled today through the zoning power. The fundamental constitutional limitation on the use of the police power (of which zoning is an exercise) is that the requirements of substantive due process be satisfied. The traditional rule for testing the validity of a police regulation (any police regulation, whether it affects contractual, real property, or personal property rights) is fairly simple to state. Substantive due process is satisfied if the regulation in question does not unduly restrict life, liberty, or property and the exercise of these rights in attempting to promote the public health, safety, and welfare. The courts look at two questions in determining whether the regulation satisfies substantive due process

requirements. First, is the purpose of the regulation to protect or promote the public health, safety, and welfare? Second, is the regulation an appropriate means of achieving the stated purpose? The court examines the regulation to determine if there is some rational connection between the regulated or prohibited conduct and the promotion of the public health, safety, and welfare; if the connection exists, the court will uphold the regulation even though it is not the regulation the court would have adopted itself. Furthermore, though the stated purpose of the regulation may in itself be thought by the court to promote the public health, safety, and welfare, the regulation will be held to be an invalid exercise of the police power if no rational connection can be found.

As will be discussed later in this chapter, a third requirement of 1970's origin has been engrafted onto the substantive due process requirements when property rights are involved. A valid exercise of the police power cannot amount to a "taking" of private property. Whether this third requirement has any real vitality, or whether it is simply a product of confusion on the part of the courts is not clear. It is evident, however, that this fairly recent judicial doctrine has been the source of much mischief.

Legally Protectable Property Rights

Although the principles mentioned above are easily stated, their application poses many difficulties. The first question that must be answered is whether the party complaining about a particular land use regulation has a legally protectable property right. If he does not, he cannot raise any questions as to the validity of the police regulation as it particularly applies to himself, nor can he raise any question of taking, for which compensation must be made. The following examples are indicative of situations where courts may find that a complaining party does not have a legally protectable interest over property in which he is claiming an interest.

1. Flood Protection Works and the Doctrine of *Damnum Absque Injuria*

Many of the southern states have had levee and flood protection districts for many years. As a result of the construction of such levees, many landowners have brought suit against such districts for flood damage allegedly caused by the construction of such levees. Where the levee has caused neither an obstruction to the natural flow of the river, nor a

change in the natural channel of the river, the courts in the southern states have frequently found that a landowner who has suffered flood damage to his land resulting from construction of such levees is not entitled to compensation. Generally, the courts have relied on the doctrine of *damnum absque injuria* (damage without legal injury). The doctrine's reasoning can be stated as follows: while the riparian landowner may suffer flood damage to his land through construction of a levee, unless there is an actual obstruction or diversion of the natural watercourse, there can be no compensation to the damaged landowner. Although there is an injury to his land, he has no corresponding right in him because floodwaters are a common enemy against which any landowner or the public may take protective measures, without liability to another damaged landowner (see *Russell v. Lake Borgne Basin Levee Dist.*, 105So361 [La., 1925]; *McCory v. Plum Bayou Levee Dist.*, 129S.W.1097 [Ark., 1910]).

2. Alternate Theories to the Doctrine of *Damnum Absque Injuria*

Some courts have recognized the apparent theoretical weakness of the *damnum absque injuria* doctrine and have opted for judicially more palatable doctrines to deny claims for compensation by damaged landowners. The Arkansas Supreme Court, in *City Oil Works v. Helena Improv. Dist.*, 232 S.W.28 (Ark., 1921), found a drainage district not liable for damage to a landowner under particular circumstances. The drainage district had erected a new levee along a navigable river which caused the floodwaters to be raised to a higher level than before the levee was constructed. As a direct result of the construction of this levee, the land of City Oil Works between the levee and the navigable stream was flooded. The levee had been so constructed that it did not create a dam across the stream and cause the floodwaters to back up and remain upon the owner's land, nor did the levee create an obstruction in the navigable stream and interfere with the flow of the stream. The levee merely prevented the overflow of waters upon the land beyond the levee. The court stated the following in denying compensation for damage caused to the landowner on account of the erection of the levee:

> According to this record the only permanent damage appellee [landowner] sustained was that the water level was raised on account of the construction of the new levee and because his land had been left out or on the river side and that was a burden or servitude upon the land on account of its location.

Other courts have found that ground along a navigable stream is held subject to a servitude or easement for public purposes (see *Hoard v. Des Moines* 17N.W.527[Ia., 1883]; *Dubose v. Levee Comrs.*, 11La.Ann165 [La., 1856]; *Pearl v. Meeker*, 12So.490[La., 1893]).

Another line of cases has denied compensation for damage to property on the basis that the levee or other flood control measure was a proper exercise of the police power (see *O'Hara v. Los Angeles County Flood Control Dist.*, 119P.2d23[Ca., 1941]; *Sigler v. Inter-River Drainage Dist.*, 279S.W.50[Mo., 1925]; *Short v. Pierce County*, 78P.2d610[Wash., 1938]). If the courts have adopted this theory, they have also generally adopted the corollary in suits between two riparian landowners in denying recovery. The courts have generally held in such cases, absent obstruction or diversion of the navigable stream in the construction of a levee by one landowner, that the injury to the other landowner resulting from such construction is not direct, but merely consequential and therefore not compensable. This same line of reasoning has also been applied in suits between private landowners and governmental units. A more complete discussion of the police power appears later in this chapter.

3. Batture and Related Theories Affecting Title to Land Along Rivers

In Louisiana, batture is land that is non-compensable if it is "taken" (occupied) for flood control purposes since, although the landowner may cultivate such land or otherwise use it in ways that are not inconsistent with the state's paramount title to the riverbed of navigable streams, he has no title to such land and no protectable property right. Batture is defined as that part of a riverbed which is uncovered at the time of low water, but is covered annually at the time of ordinary high water (see *Boyce Cotton Seed Oil Mfg. Co. v. Red River, A. & B. B. Levee Dist.*, 107So.506[La., 1926]).

The definition of what constitutes a riverbed varies widely from state to state. In addition to the states' varying definitions of what constitutes a riverbed, the United States Supreme Court has stated some basic rules for the nation's great navigable streams.* Finally, the question of title to riverbeds is not entirely clear; where the state

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*See *Cubbins v. Mississippi River Comm'r*, 241U.S.351(1916) at 368.

is vested with or claims title to the riverbeds, there is often opportunity for regulations without regard to the reasonableness (in terms of "taking" issue) of the regulations.* For example, most western states have held that the flood plain of an ordinary stream is part of the watercourse. The courts, in defining the flood plain, have stated that it is that land adjacent to the ordinary channel that is overflowed in times of high water, from which the floodwaters return to the channel of the stream at lower stages (see *Bass v. Taylor,* 90S.W.2d811[Tex., 1936]; *Bohm v. Raikes,* 70 N.W.2d507[Neb., 1955]). If the title to the riverbed is in the state and the state courts have taken this broad view of what constitutes a watercourse, there is ample authority for the state to impose regulations on the occupance and use of flood plains without having to give consideration to "taking" questions.

4. Wetlands and Estuarine Areas

Earlier cases regulating the use of wetlands and estuarine areas did not fare too well in the courts. In rejecting such regulatory efforts the courts relied on two lines of argument. First, the courts often found the ordinance to be in excess of the legislative grant of authority. Second, the courts frequently looked at the purpose of objectives of the ordinance and found that the ordinance was not primarily designed to protect property owners from flood and innundation, but to promote the preservation of natural resources, wildlife, fishing streams and water purity (see *Morris County Land Imp. Co. v. Parsippany-Troy Hills Township,* 139A.2d232[N.J., 1963]; *MacGibbon v. Bd. of Appeals of Duxbury,* 255N.E.2d347[Mass., 1970]; and *State v. Johnson,* 265A.2d711[Me., 1970]). These cases uniformly reject the regulation of wetlands and estuarine

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*Where the courts indicate that the state may have improperly conveyed title to private individuals of lands held in public trust, of course the state would still have title to such land, because the attempted conveyance is null and void. The public trust doctrine is discussed below.

areas via the police power.*

Two recent cases, one from California and the other from Wisconsin, have approved regulations controlling private use of wetlands areas. In 1969, the California state legislature created the San Francisco Bay Conservation and Development Commission. The Commission was given authority to regulate land use along the shore line of San Francisco Bay. The Commission was directed to develop a comprehensive plan for the conservation of the shoreline and to issue or deny permits for any project involving dredging or filling in the bay.

Candlestick Properties purchased land in the Bay area which was submerged by high tide waters. It was denied a fill permit. Candlestick Properties sued, alleging that its property had been taken without just compensation. The California Appellate Court rejected this contention, acknowledging that if the regulation imposed an undue restriction on the use of private property it would be tantamount to a taking, citing *Pennsylvania Coal v. Mahon*, 260U.S.393(1922).** But the court said:

> It cannot be said that refusing to allow appellant to fill its bay land amounts to an undue restriction on its use. In view of the necessity for controlling the filling of the bay. . .it is clear that the restriction imposed does not go beyond proper regulation such that the restriction would be referable to the power of eminent domain rather than the police power (*Candlestick Properties Inc. v. San Francisco Bay Conservation and Development Commission*, 89 Cal. Rpts. 897 [Cal.App.Ct. 1970] at 906).

The court based its conclusion on the following statement:

> The legislature has determined that the Bay is the most valuable single natural resource of the entire region and changes in one part of the bay may also affect all other parts; that the present uncoordinated, haphazard manner in which the bay is being filled threatens the bay itself and is therefore inimical to the welfare of

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*Cf. *State v. Johnson* with *In the matter of Spring Valley Div.* 300A.2d736(Me., 1973). The latter case appears to seriously erode the legal justifications of *State v. Johnson*. Similarly, the Supreme Judicial Court of Massachusetts has moved to limit some of its earlier holdings invalidating ordinances protecting wetlands. See *Golden v. Bd. of Selectmen of Falmouth*, 265N.E.2d573(Mass., 1970).

**See later pages for discussion on *Pennsylvania Coal* and related cases.

> both present and future residents of the bay area; and that a regional approach is necessary to protect the public interest in the bay (*Id.* at 906).

In *Just v. Marinette County,* 201N.W.2d761(Wis., 1972), the Wisconsin Supreme Court upheld the Shoreland Protection Act requiring local governments to adopt ordinances to protect the state's waterways and lakes. Marinette County enacted a shoreland zoning ordinance based on a model act developed by the Wisconsin State Department of Natural Resources. The Justs began filling the front half of their property on Lake Norquebay in violation of the ordinance. The county obtained an injunction against the Justs, whereupon the Justs appealed.

The Wisconsin Supreme Court let the injunction stand, rejecting the Just's contention that the ordinance amounted to a taking, noting that the lakes and rivers in Wisconsin were originally clean, and that the State of Wisconsin has an obligation in the nature of a public trust to "eradicate the present pollution and to prevent further pollution." The purpose of the challenged regulation was to protect "the natural status quo of the environment" (*Id.* at 768). The court then said that the state has a special responsibility over lands near or adjacent to navigable waters:

> What makes this case different from most condemnation or police power zoning cases is the interrelationship of the wetlands, the swamps and the natural environment of shorelands to the purity of the water and to such natural resources as navigation, fishing, and scenic beauty. Swamps and wetlands were once considered wasteland, undesirable, and not picturesque. But as the people became more sophisticated, an appreciation was acquired that swamps and wetlands serve a vital role in nature, and part of the balance of nature and are essential to the purity of the water in our lakes and streams. Swamps and wetlands are a necessary part of the ecological creation and now, even to the unitiated, possess their own beauty in nature (*Id.* at 769).*

The court found that the legislative act in question was a valid exercise of the police power designed to protect "public rights." Furthermore, the court stated that the act was valid even though the Justs are restricted in using their land to its "natural uses." The court said:

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*See section below for a discussion on externality theory and its relationship to the taking problem.

> It seems to us that filling a swamp not otherwise commercially usable is not in of itself an existing use, which is prevented, but rather is the preparation for some future use which is not indigenous to a swamp. Too much stress is laid on the right of an owner to change commercially valueless land when that change does damage to the rights of the public (*Id.* at 770).

The court concluded:

> The Justs argued their property has been severely depreciated in value. But this depreciation of value is not based on the use of the land in its natural state but on what the land would be worth if it could be filled and used for the location of a dwelling. While loss of value is to be considered in determining whether a restriction is a constructive taking, value based upon changing the character of the land at the expense of harm to public rights is not essential factor or controlling (*Id.* at 771).

The court distinguished this case from *Pennsylvania Coal v. Mahon*. The distinction is weak.*

5. Conclusion

The examples given in the preceding sections are merely suggestive of existing legal authority that state and local units of government may employ without having to give any serious consideration to questions of compensation. These doctrines, while susceptible to expansion in the states that have adopted them, are not the law in many states. Batture applies only in the State of Louisiana as a result of a unique provision in the state constitution. The doctrine of *damnum absque injuria* is not the general rule adopted by most states following riparian water law. Rather, a landowner has a right to levee and protect himself against flooding only to the extent that he does not substantially increase flooding on his neighbor's property (see *Sinclair Prairie Oil Co. v. Fleming* 225P.2d348, 23A.L.R.2d741[Okla., 1949] and annotation at 23A.L.R. 2d750).

Courts have generally been more deferential in finding a property right to exist in lawsuits between private individuals, and less

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*The Supreme Court of Maryland upheld a wetlands statute similar to Wisconsin's in *Potomac Sand and Gravel Co. v. Governor of Md.*, 293A. 2d241 (Md., 1971).

receptive in finding such a right to exist in lawsuits between a private individual and a governmental body.

Even if these doctrines do not apply to a particular jurisdiction, it is always worthwhile in considering a new type of police regulation to ask whether it can be enacted without having to give regard to compensation questions. If there is no legally protectable property interest, no issue of compensation can be raised.

As we shall see, our legislative and judicial bodies are beginning to look at questions of compensation from a substantially different perspective than in the past. They are beginning to examine questions of regulating private land use with an eye to the public rights in the uses that are made or sought to be made of private land, and the costs and benefits to society of such uses.

The Requirement of a Rational Connection

1. The Nexus Requirement; Purpose Clause

If a landowner can show that he has a legally protectable interest, he may challenge the validity of a zoning regulation both in general terms and as it applies particularly to himself. In order to satisfy the requirement of substantive due process, there must be a rational connection (nexus) between the regulation in question and the promotion of the public health, safety, and welfare. If there is not a nexus, or the court finds the relationship "too remote", the regulation will be found violative of substantive due process and fail. The court will generally look for two things. First, do the regulatory standards bear a reasonably close relationship to the goals to be achieved by the regulation; that is, does the regulation in fact promote the purposes set forth in the ordinance by advancing the public health, safety, and welfare. Second, does the ordinance have a "safety valve" that will prevent individual instances of injustice resulting from the establishment of an ordinance of general applicability?

The United States Supreme Court stated the general rule regarding the acceptability of the purpose clause in a zoning ordinance:

> [T]he reasons. . .[must be] sufficiently cogent to preclude us from saying, as it must be said before the ordinance can be declared unconstitutional, that such provisions are clearly arbitrary and unreasonable, having no substantial relation to the public health, safety, morals, or general welfare (*Euclid v. Ambler Realty*, 272U.S.365[1926] at 395).

It is important that the purpose clause in a zoning ordinance, particularly one that is regulating land in a new or novel way, be carefully drawn up. This will help avoid the assertion that the regulations do not accomplish the objectives set forth in the ordinance.

In upholding a recent flood plain zoning ordinance, the Supreme Judicial Court of the Commonwealth of Massachusetts scrutinized closely the purpose clause in the ordinance. That ordinance stated its purposes as follows: (1) to preserve and maintain the ground water table*; (2) to protect public health and safety, persons, and property against the hazards of floodwater inundation; (3) to protect the community against the costs which may be incurred when unsuitable development occurs in swamps, marshes, along water courses, or in areas subject to floods; and (4) to conserve natural conditions, wildlife, and open spaces for the education, recreation, and general welfare of the public (see *Turnpike Realty Co. Inc. v. Town of Dedham,* 284N.E.2d89[Mass., 1972]).

One might also add two other policy objectives. The first is the protection of individuals who might choose, despite the flood dangers, to develop or occupy land on a flood plain. The second is the protection of other landowners from damages resulting from the development of the flood plain and the consequent obstruction of the flood flow (Dunham, 1959). It is doubtful that the Supreme Court of Massachusetts would have upheld this flood ordinance without its carefully articulated purpose clause. The purpose clause, as the court notes, clearly sets forth the reasons for the creation of the flood plain district. The court concludes, "There is no need to speculate about the 'prime purpose' of the by-law" (*Turnpike Realty* at 895).**

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*The statement of this purpose may be very important to the Western states that have adopted the appropriation system of water rights. Appropriated water rights are a form of property, and therefore entitled to protection like any property right. Where the activities of landowners come into conflict with the owners of water rights, the court is then faced with the question of balancing of these conflicting rights and an otherwise suspect ordinance may be held valid as an appropriate adjustment between these conflicting rights. This argument is even stronger where subsurface and surface rights have been integrated since questions of rates of runoff, discharge and recharge become quite important to the owners of water rights.

**The Supreme Court of Connecticut disapproved a flood plain ordinance under a somewhat different set of facts (*Dooley v. Town Plan and Zoning Commission of Fairfield,* 197A.2d770[Conn., 1964]. This case is discussed below.

2. The "Safety Valve" Requirement

Just as the Massachusetts Supreme Court made clear that the purpose clause was a vital part of the flood plain zoning ordinance, so also did it indicate that the "safety valve" procedure was a fundamental part of the ordinance. The ordinance established a permit procedure for construction on land within the designated flood plain zone, but not subject to flooding or not unsuitable for construction because of drainage conditions. The court, citing *Leahy v. Inspector of Buildings of New Bedford,* 308 Mass. 128, at 132, stated that this procedure, "was intended to prevent injustice resulting from the establishment of zoning districts based on the physical characteristics of substantial areas."

In other words, the permit procedure is an integral part of any zoning ordinance. Furthermore, without such a permit procedure the ordinance takes on the appearance of being arbitrary and capricious, particularly as it may apply to an individual landowner. Whatever the overall merits of such an ordinance--and despite the fact that a court may be of the opinion that the general effect of the ordinance will promote the general health, safety, and welfare--the ordinance will fail if the court determines that, as applied to the particular landowner before the court, the ordinance is clearly arbitrary and capricious. The permit procedure avoids this difficulty by allowing an individual landowner to make application to the appropriate authority for a variance on the grounds that his property is not subject to flooding or drainage problems.

3. Limiting Factors

There are other conditions an ordinance which is under attack must meet to satisfy substantive due process requirements. These conditions will be discussed in turn.

a. Is the Ordinance in Excess of the Legislative Grant?

There are two interrelated questions that must be answered affirmatively by a court of law when a particular zoning ordinance is under judicial attack. First, is the ordinance within the scope of the legislative grant of authority? Second, has the local governmental unit enacting the ordinance the authority to act under the legislative grant of authority?

The two examples which follow are typical of the grants or authority given to political subdivisions to enact zoning laws:

(Mass Ann. L.c.40A§2). Limitation of Particular Classes of Buildings, etc., to Specified Districts or Zones.

For the purpose of promoting the health, safety, convenience, morals or welfare of its inhabitants, any city, except Boston, and any town, may be a zoning ordinance or by-law regulate and restrict the height, number of stories, and size of buildings and structures, the size and width of lots, the percentage of lot that may be occupied, the size of yards, courts and other open spaces, the density of population and the location and use of buildings, structures and land for trade, industry, agriculture, residence or other purposes; provided, however, that no ordinance or by-law which prohibits or limits the use of land for any church or other religious purpose or for any educational purpose which is religious, sectarian, denominational or public shall be valid; and provided, further, that in regulating or restricting the size of such buildings or structures no provision of any ordinance or by-law shall be valid which requires the floor area of the living space of a single-family residential building to be greater than seven hundred and sixty-eight square feet.

For any or all of such purposes a zoning ordinance or by-law may divide the municipality into districts of such number, shape and area as may be deemed best suited to carry out the purposes of this chapter, and within such districts it may regulate and restrict the erection, construction, reconstruction, alteration or use of buildings, and structures, or use of land, and may prohibit noxious trades within the municipality or any specified part thereof. All such regulations and restrictions shall be uniform for each class or kind of buildings, structures or land, and for each class or kind of use, throughout the district, but the regulations and restrictions in one district may differ from those in other districts. Due regard shall be paid to the characteristics of the different parts of the city or town, and the zoning regulations in any city or town shall be the same for zones, districts or streets having substantially the same character. A zoning ordinance or by-law may provide that lands deemed subject to seasonal or periodic flooding shall not be used for residence or other purposes in such a manner as to endanger the health or safety of the occupants thereof.

(Colo. Rev. Stat. c. 139-60-1 and 139-60-3 [1963 as amended]). 139-60-1. Grant of power.--(1) For the purpose of promoting health, safety, morals, or the general welfare of the community, the legislative body of each city and incorporated town is hereby empowered to regulate and restrict the height, number of stories, and size of buildings and other structures, the percentage of lot that may be occupied, the size of yards, courts, and other open spaces, the density of population,

and the location and use of buildings, structures, and land for trade, industry, residence, or other purposes. Such regulations may provide that a board of adjustment may determine and vary their application in harmony with their general purpose and intent, and in accordance with general or specific rules therein contained. Subject to the provisions of subsection (2) of this section, and to the end that adequate safety may be secured, said legislative body shall also have power to establish, regulate, restrict, and limit such uses on or along any storm or floodwater runoff channel or basin as such storm or floodwater runoff channel or basin has been designated and approved by the Colorado water conservation board in order to lessen or avoid the hazards to persons and damage to property resulting from the accumulation of storm or floodwaters. Any ordinance enacted under authority of this article shall exempt from the operation thereof any building or structure as to which satisfactory proof shall be presented to the board of adjustment provided for in this article, that the present or proposed situation of such building or structure is reasonably necessary for the convenience or welfare of the public.

(2) The power conferred by subsection (1) of this section for flood prevention and control shall not be exercised so as to deprive the owner of any existing property of its use or maintenance for the purpose to which it is lawfully devoted on the effective date of this subsection (2), but provisions may be made for the gradual elimination of uses, buildings, and structures, including provisions for the elimination of such uses when the existing uses to which they are devoted are discontinued, and for the elimination of such buildings and structures when they are destroyed or damaged in major part.

(3) The legislative body of any city or incorporated town, or the board of adjustment thereof, in the exercise of powers pursuant to this section, may condition any zoning regulation, any amendment to such regulation, or any variance of the application thereof, or the exemption of any building or structure therefrom, upon the preservation, improvement, or construction of any storm or floodwater runoff channel designated and approved by the Colorado water conservation board.

139-60-3. Purposes in view.--Such regulations shall be made in accordance with a comprehensive plan and designed to lessen congestion in the streets; to secure safety from fire, panic, floodwaters, and other dangers; to promote health and general welfare; to provide adequate light and air; to prevent the overcrowding of land; to avoid undue concentration of population; to facilitate the adequate provision of transportation, water, sewerage, schools, parks, and other public requirements. Such regulations shall be made with reasonable consideration, among other

> things, as to the character of the district and its peculiar suitability for particular uses, and with a view to conserving the value of buildings and encouraging the most appropriate use of land throughout such municipality.

Both states specifically provide that a municipality may create flood plain zones. It is not always necessary that such a specific grant of authority be given, since the general purpose clause in each legislative grant of authority is sufficiently broad to cover such zoning (see *Turnpike Realty Co. Inc. v. Town of Dedham, Id.* at 896, the court citing other authority for this position). If the particular hazard zoning act in question shows some substantial relationship in furthering the general objects (the promotion of the public health, safety, and welfare) set forth in the legislative enabling act, the court will uphold the zoning law.

Some states have provided in their state constitutions broad home rule powers for local units of government.* For example, Colorado's appellate courts have ruled that under Art. XX§6 (Colorado's home rule provision) of the State Constitution, home rule cities have authority, independent of any state enabling legislation, to enact zoning ordinances (see *Moore v. Boulder,* 484P.2d134[Colo. App., 1971]; *Service Oil Co. v. Rhodus,* 500P.2d807[Colo., 1972]). However, each home rule city must look to its home rule charter to ascertain that this zoning power has not been restricted by the terms of its charter, and each home rule city must also inspect its ordinances to make certain that the procedures and regulations set forth in the zoning ordinances are not inconsistent with any of its local ordinances. However, the zoning power under the general home rule provisions in Colorado is limited by what the courts view to be of purely local or mixed, and not statewide, concern. Where mixed interests are involved, the courts have evolved a complicated set of rules in determining the validity of a home rule ordinance. Generally speaking, if the state has not spoken on the matter, the local ordinance will be upheld; if the state has spoken on the matter, the ordinance will still be upheld if the ordinance does not conflict with state statute--at least too

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*These are some of the states which provide for some form of home rule in their state constitutions: Arizona, California, Colorado, Louisiana, Minnesota, Missouri, Nebraska, Nevada, Oklahoma, Oregon, Texas, and Washington.

seriously.

Some local governmental units have enacted specific zoning regulations or building code requirements to deal with particular hazards. Alta, Utah has adopted avalanche zones, and Boulder, Colorado has adopted tie-down regulations for mobile homes to help alleviate potential damage from high winds which periodically hit the city. Boulder, being a home rule city, has authority to enact such rules under the home rule provisions in the constitution. Alta has authority to enact its avalanche zones under the state enabling act. Although neither ordinance has been tested in the appellate courts of Utah or Colorado, under the general rules set forth above each act should survive any legal attack that the ordinances are in excess of the authority granted to enact regulations of this sort.*

Except where home rule cities and counties may have independent power to act without state enabling legislation, a local unit of government cannot enact zoning ordinances without such authorization. Although many metropolitan areas have regional planning districts, these districts generally have not been given any authority by the state legislature to regulate land use. Therefore, any attempt by such districts without such state enabling legislation to regulate land use could be successfully attacked in a court of law on the grounds that the local unit does not have such authority to act.**

B. Have the Procedures for Adoption of the Ordinances and the Permit and Appeal Process been Followed Correctly?

Many of the enabling acts set forth with great particularity the procedures a local unit of government must follow in adopting a zoning ordinance. Typically, enabling acts require that zoning be in accordance with a comprehensive plan. A comprehensive plan serves several functions. First, it sets forth an inventory of present land use. Second, it provides a method for determining incompatible land uses that already exist. Third, it provides a method for dividing the community into zones or

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*See Chapter II for other discussions of these ordinances.

**See discussion above of the San Francisco Bay Conservation and Development Commission. The Commission is regional with some zoning authority.

districts. Fourth, it provides a method for regulating future growth in a manner compatible with already existing development. Fifth, the plan assists the municipality in achieving other overall goals, such as a sound financial base, economic diversity, or environmental objectives.

Usually the comprehensive plan is presented for public discussion, and after citizen input it is further modified and approved by the planning commission. After approval by the planning commission, the municipality may adopt the plan as an ordinance after further public discussion. Having adopted the comprehensive plan, the municipality can then proceed to adopt a zoning ordinance that conforms to the plan. Many enabling statutes require that a zoning map also be adopted at the time of adoption of the zoning ordinance. Failure to adopt the zoning map can be fatal to the entire zoning ordinance.

Although the adoption and amendment procedures for zoning laws vary considerably from community to community and state to state, the courts have consistently held that a failure to adhere strictly to such procedures results in an invalidly adopted ordinance or amendment having no legal effect. This rule is most frequently applied where no notice, or inadequate notice, has been given, where there has been no public hearing, or where the actual reading and adoption process has not been followed. Not only must a local governmental unit in adopting a zoning ordinance adhere to the requirements as set forth in the enabling legislation (unless home rule provisions permit otherwise), but the local unit must also adhere to its own procedures for adoption of such an ordinance. These procedures may be set forth in the state constitution or state statutes, or they may appear in the local unit's charter or in its existing ordinances. Even if the requisite procedures are followed, they may still be attacked on the ground that they offend our notions of procedural due process as the courts have interpreted the meaning of that clause.*

Once the comprehensive plan and the zoning ordinance have been adopted, an individual may apply for a variance or special permit use

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*It should be noted, however, that even though enabling acts require that zoning ordinances be in accordance with a comprehensive plan, very few courts have invalidated zoning regulations for failure to adopt a comprehensive plan. This rule has not been applied to any flood plain regulation cases.

(usually based on hardship), or a rezoning of his land (usually based on alleged change of conditions).

As noted above, the permit procedure is an important part of a zoning ordinance. Without such a procedure most courts would not uphold the ordinance as a valid exercise of the police power. However, the permit procedure is not intended to be used indiscriminately. Too free a use of the permit procedure will subject the variance or rezoning to judicial attack on grounds of "spot zoning" (see *Clark et al. v. City of Boulder,* 362P.2d160[Colo. 1961]; cf. *Turnpike Realty Co., Inc. v. Town of Dedham,* 284N.E.2d891[Mass., 1972] discussed above).

c. The Right of Reliance on Existing Zoning Regulations

Many courts have held that property owners have a right to rely on existing zoning regulations. Without any material change in the character of the neighborhood, the city cannot rezone that neighborhood (see *Clark v. Boulder, Id.; Roosevelt v. Englewood,* 492P.2d65, at 68[Colo. 1971]; *Leahy v. Inspector of Bldgs.,* 31N.E.2d436, at 439[Mass. 1941]; *Borough of Cresskill v. Borough of Dumont,* 104A.2d441[N.J. 1954]). Some municipalities have adopted this rule by ordinance.* To some extent at least, a municipality may be precluded from enacting zoning regulations on a piecemeal basis if the effect is to alter drastically previous expectations under the old comprehensive plan and zoning regulations. This problem can be overcome to some extent for communities who are enacting hazard zone regulations if the state has drawn a careful enabling statute authorizing such regulations. See, for example, Colorado's enabling statute above. Although, as indicated above, such enabling legislation is not generally necessary for a community to enact hazard

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*See Boulder, Colorado Municipal Code §35-702 (1972). The relevant section states that:

> For the purpose of establishing and maintaining sound, stable and desirable development within the city, the rezoning of land is to be discouraged and allowed only under certain circumstances as provided hereafter. This policy is based on the opinion of the city council that the city's zoning map is the result of a detailed and comprehensive appraisal of the city's present and future needs regarding land use allocation and, as such, should not be amended unless to correct a manifest error or because of changed or changing conditions in a particular area or the city in general. . . .

zones, nevertheless, such specific enabling legislation does help a local unit overcome objections that a change in the zoning regulations creating such hazard zones amounts to a confiscation of property without due process of law. Moreover, since mistake in fact is usually a valid basis for amending a zoning ordinance, an amendment creating a hazard zone based on new factual information would likely withstand judicial attack.

Although the doctrine of reliance on existing regulations is judicially well respected, the courts do not apply this rule when a comprehensive revision of the city's zoning map based on a new comprehensive plan is under consideration. The courts seem to accept the new comprehensive plan and the resulting new zoning map as conclusive evidence of a sufficient change in conditions to warrant the new rezoning.* Moreover, the courts are likely to defer to such a comprehensive revision on the grounds that this is a proper legislative function and that respect for separation of powers precludes judicial review of the new zoning ordinance. These conclusions will not vary despite a claim by a landowner that the new zoning has resulted in a substantial diminution of the value of his land.**

d. Does the Zoning Ordinance have Sufficient Standards to Avoid Charges of being Vague and Ambiguous?

To meet the requirements of both substantive and procedural due process a zoning ordinance must indicate in detail the: (1) uses that are allowable or not allowable in each zone, (2) set back requirements, (3) procedures for obtaining variances, (4) standards for granting or denying variances on which the delegated authorities are required to act, (5) procedures for rezoning, (6) standards for granting or denying rezoning requests, and (7) the hearing and appeal procedures. Failure to set forth in the ordinance itself either explicitly or by reference to the enabling act all of these necessary details will subject the ordinance to charges of being vague and ambiguous. If the ordinance does not set forth the standards upon which a variance or special exception may be

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*The Boulder, Colorado Municipal Code §35-702 (1972) so provides; no questions of mistake in the original zoning or change in conditions need be raised when a new comprehensive plan and zoning map are being considered.

**A discussion of diminution problems follows.

granted or denied, the ordinance will be subject to charges of having improperly delegated authority and charges that even if such authority were delegated properly, it was exercised in an arbitrary and capricious manner.*

Some general observations can be made concerning the adequacy of a particular zoning ordinance in satisfying due process requirements. First, as a general rule, state courts are more willing to substitute their judgment over that of an administrative agency than are the Federal courts. This is primarily due to how the courts view the level of competence of the responsible administrative agency. Secondly, courts examine closely the ordinance and the proceedings when property rights are severely affected.

The courts, both state and Federal, look for the following: (1) whether the scope and purpose of the ordinance exceed the legislative grant of authority; (2) whether there are sufficient standards in the ordinance to guide the delegated authorities in carrying out the objectives of the ordinance; and (3) whether the ways and means the ordinance attempts to resolve the problem are rational.**

Furthermore, in answering the question in (2) above, the courts notice whether: (4) the state enabling statute has said how the problem is to be handled and, if so, whether the ordinance and the action of the delegated authority conform to this mandate; (5) the delegated authority looked at the things he is supposed to in making his findings of fact and conclusions of law; (6) the delegated authority followed the required procedures in making his findings of fact and conclusions of law; (7) the delegated authority acted within the scope allowed by the ordinance and

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*Mapping of hazardous areas poses some special legal problems in that the overall validity of a hazard zone or district would appear to depend primarily on the accuracy of the mapping. Otherwise the court is likely to conclude that the hazard zone was drawn up in an arbitrary and capricious manner, and therefore violates substantive due process of law (see below for further discussion on mapping). Normally issues of vagueness and ambiguity are raised over zoning boundary lines, unclear ordinance language, or insufficient standards for the issuance of variances or special exceptions.

**Some courts might ask if there are alternatives that are less restrictive of the constitutional rights affected, but this may amount in some instances to an invasion of the legislative prerogative.

the enabling statute; and (8) the delegated authority acted within the authority delegated to him.

Finally, the courts are likely to examine the question of whether there has been an excessive delegation of authority. In looking at this question, the courts are interested in whether the governing body has stripped itself of essential legislative powers by delegating such powers to an administrative agency, an agency essentially free of the electoral process.

The "Taking" Problem

1. Background

Historical evidence does not support the contention that the draftsmen of the taking clause (the 5th Amendment, and as applied to the states, the 14th Amendment to the United States Constitution) ever intended that it apply to the regulaton of the use of land. In fact, the taking clause was directed at the purely physical act, the taking of property for public use; the intention was to prevent expropriation of property by the government without making just compensation. Furthermore, there is no evidence that any of the authors who drafted the Federal and state bills of rights considered that a regulation affecting the use of land, even when such a regulation effectively destroyed the economic value of that land, amounted to a taking. Finally, both before and after the adoption of the taking clause, extensive land use regulation was not uncommon.*

In the late 19th Century, Justice Harlan, in a famous opinion, stated clearly that a police regulation does not raise an issue of compensation, except when there has been a physical invasion of the real estate of the private owner and a practical ouster of his possession--as when a flood control project inundated a private landowner's property, requiring, in effect, that such property be devoted to the use of the

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*See Schwartz (1971); Schwartz's table indicates that none of the states debated the just compensation clause in the proposed Bill of Rights. See Sax (1964); Sax discusses the historical development of the compensation clause. The historical discussion does not give much credence to diminution of value doctrine in determining compensation cases. See also Stoebuck (1971) and Cormack (1931); Cormack develops a useful dichotomy between cases that use a purely physical concept of eminent domain and those that use a legal relations conception of eminent domain.

public.* In the particular case at hand the petitioner argued that Kansas had taken his property (a brewery) without paying him compensation when they passed a statute prohibiting the manufacture and sale of intoxicating liquors. Harlan rejected this contention:

> A prohibition simply upon the use of property for purposes that are declared, by valid legislation, to be injurious to the health, morals, or safety of the community, cannot, in any just sense, be deemed a taking or an appropriation of property for the public benefit. Such legislation does not disturb the owner in the control of his property for lawful purposes nor restrict his right to dispose of it, but is only a declaration by the state that its use by anyone, for certain forbidden purposes, is prejudicial to the public interests. Nor can legislation of that character come within the Fourteenth Amendment [the taking clause as applied to the states], in any case, unless it is apparent that its real object is not to protect the community, or to promote the general wellbeing, but, under the guise of the police regulation, to deprive the owner of his liberty and property, without due process of law (*Id.* at 668-669).

Furthermore, Harlan declared, it is not correct to "burden" the police power with requirements of compensation:

> The exercise of the police power by the destruction of property which is itself a public nuisance, or the prohibition of its use in a particular way, whereby its value becomes depreciated, is very different from taking property for public use, or from depriving a person of his property without due process of law. In one case, a nuisance only is abated; in the other, unoffending property is taken away from an innocent owner (*Id.* at 669).

Harlan clearly establishes the difference between a police regulation upon the use of property and a public taking of that property. A police regulation does not affect an individual's title to his property, and it does not result in a governmental use of private property. The test of the validity of the regulation is whether it bears a rational relationship to the promotion of the public welfare. If the prohibited use of land is, in fact, some way injurious to the community, the regulation will be upheld if it is a reasonably rational way of preventing that injury to the community.

Mugler v. Kansas, 123U.S.623 (1887).

The "physical invasion theory", however, has been discarded by the courts since the doctrine relies on the actual formal appropriation or physical invasion of a landowner's property. There are numerous cases where a taking has occurred even though the government has not formally appropriated or, physically invaded the landowner's property (see *Miller v. City of Beaver Falls*, 82A.2d34[Pa., 1951] and *U. S. v. Central Eureka Mining Co.*, 357U.S.155[1958]).

In 1922, the United States Supreme Court, in a famous case, developed a new test for deciding compensation cases. The case is *Pennsylvania Coal v. Mahon*, 260U.S.393(1922). In 1921, the State of Pennsylvania enacted legislation prohibiting the mining of coal in such a way as to cause the subsidence of, among other things, any building, structure or transportation route within the limits of a designated class of municipalities. Subsequent to the enactment of this legislation, H. J. Mahon received written notice from the Pennsylvania Coal Company which stated that the mining operations of the company would shortly cause subsidence and disturbance to the surface on which the Mahon's house sat. The company earlier had reserved the mineral rights under Mahon's land. This reservation had been carried down in the chain of title and appeared in Mahon's deed. Furthermore, there appeared an express waiver for personal injury or property damage caused by mine subsidence. This waiver also was part of the original reservation by the coal company and continued down through the chain of title and appeared in Mahon's deed.

After Mahon received the notice from the Pennsylvania Coal Company, he sued to enjoin the coal company from mining the coal under his lot in such a way as to cause subsidence or damage to his home. The case went to the United States Supreme Court.

The coal company argued two principal points in the Supreme Court. First, that the Pennsylvania statute impaired the obligation of contracts in violation of Article I, Section 10 of the United States Constitution because its right to mine the coal under Mahon's land reserved to it in the mineral rights deed had been destroyed. Second, the coal company argued that the Pennsylvania statute took its property without due process of law because the statute amounted to a public taking of private property without just compensation. Justice Holmes ignored the impairment of contract argument and concentrated on the taking issue. Holmes stated his view of the problem as follows:

> Government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law. As long recognized, some values are enjoyed under an implied limitation and must yield to the police power. But obviously the implied limitation must have its limits or the contract and due process clauses are gone. One fact for consideration in determining such limits is the extent of diminution. When it reaches a certain magnitude, in most if not in all cases there must be an exercise of eminent domain and compensation to sustain the act. So the question depends upon the particular facts. The greatest weight is given to the judgment of the legislature, but it is always open to interested parties to contend that the legislature has gone beyond its constitutional power (*Id.* at 413).

After concluding that the subsidence problem was not a public nuisance, nor was there any danger to the public safety since the coal company gave sufficient notice to Mahon that subsidence would occur on his property, Holmes concluded by saying:

> It is our opinion that the Act cannot be sustained as an exercise of the police power, so far as it affects the mining of coal where streets or cities in places where the right to mine such coal has been reserved. As said in a Pennsylvania case, "For practical purposes, the right to coal consists in the right to mine it." *Commonwealth v. Clearview Coal Co.*, 256Pa.St.328, at 331. What makes the right to mine coal valuable is that it can be exercised with profit. To make it commercially impracticable to mine certain coal has very nearly the same effect for constitutional purposes as appropriating or destroying it. [The court said that the Act has this effect.] (*Id.* at 414-415).

Justice Brandeis entered a strong dissent against Holmes' opinion. Brandeis noted that the conveyance by Mahon's predecessors of their interest in the subsurface rights was not, in fact, voluntary, but rather it was a condition imposed by the coal company on anyone who desired to purchase property in the area. Furthermore, Brandeis said that when the coal company was the sole owner of land in many mining towns (as was the case where Mahon lived), there was little mutuality in such a bargain. Brandeis then went on to say:

> The rights of an owner as against the public are not increased by dividing the interests in his property into surface and subsoil. The sum of the rights in the parts cannot be greater than the rights of the whole. . . .No one would contend that by selling his interest above one hundred feet from the surface he could prevent the State

> from limiting, by the police power, the height of structures in a city (*Id.* at 419).

Simply because the coal company reserved for itself the subsurface mineral rights, did not create a special right to compensation when Pennsylvania passed an act to regulate the extraction of coal under certain circumstances. As Brandeis says:

> Coal in place is land; and the right of the owner to use land is not absolute. He may not so use it as to cause a public nuisance; and uses, once harmless, may, owing to changed conditions seriously threaten the public welfare. Whenever they do, the legislature has power to prohibit such uses without paying just compensation; and the power to prohibit extends alike to the manner, the character and the purpose of the uses (*Id.* at 417).

Brandeis thought that a taking occurred only when the government took title to the land or made public use of a private landowner's property. The Pennsylvania statute in question did neither of these things, and even though the restriction deprived the owner of the only use to which the property could be put, it did not become inappropriate as an exercise of the police power because of this. The restriction is valid if its purpose is to protect the public from a known hazard or danger, and if the act is an appropriate means in achieving a valid purpose. The appropriate means does not necessarily mean the one that the court would have chosen, but if the purpose of the act is carried out in a not totally unsuitable manner, the court will defer to the judgment of the legislature (*Id.* at 417-418).

2. Recent Applications

Holmes' opinion in *Pennsylvania Coal* has created a great deal of trouble in the last 50 years. Although the United States Supreme Court has not expressly overruled that decision, its continuing vitality is somewhat doubtful. In *Hadacheck v. Sebastian*, 239U.S.394(1915), a case decided prior to *Pennsylvania Coal* (and not overruled by *Pennsylvania Coal*), the Supreme Court accepted a diminution of value from $800,000 to $60,000 in the petitioner's land. More recently, the Supreme Court dismissed the appeal in *Consolidated Rock Products Co. v. City of Los Angeles*, 371U.S.36(1962) "for want of a substantial federal question." Yet, the California Supreme Court in that case expressly accepted the trial court's finding that the "subject property has great value if used for rock, sand,

and gravel excavation but 'no appreciable economic value' for any other purpose, and in view of the 'continuing flood hazard and the nature of the soil', any suggestion that the property has economic value for any other use, including those uses for which it was zoned, 'is preposterous'." In spite of the fact that the zoning destroyed the economic value of the land, the California Supreme Court upheld the validity of the regulation and denied compensation to the petitioner (*Consolidated Rock Products Co. v. City of Los Angeles*, 370P.2d342[Cal. 1962]).*

In *Goldblatt v. Town of Hempstead*, 369U.S.590(1962), the Supreme Court relied on *Pennsylvania Coal* in upholding a local regulation prohibiting Goldblatt from further excavation in his quarry, and, in effect, destroying the economic value of the land. The regulation was not so unreasonable as to constitute a taking of property. This appears to be a curious following of Holmes' rule as he stated it in *Pennsylvania Coal*.

The states have generally tried to ignore the *Pennsylvania Coal* doctrine and, in effect, have stuck with Harlan's enunciation of the basic principles involved in a valid exercise of the police power as set forth in *Mugler v. Kansas*, 123U.S.623(1887). But that is not to say that *Pennsylvania Coal* has not caused a lot of confusion while the courts have tried to reconcile these two inconsistent doctrines.

The state courts have severely limited the applicability of the Federal rule stated by Holmes in *Pennsylvania Coal* through the development of the doctrine of "rock bottom" diminution of value.** In general, the state courts will invalidate a regulation only when no other reasonable use can be made of the property as it is presently zoned, and even then no compensation will be allowed if the court can find that the prohibited use amounts to a "nuisance." Despite an apparent 50% diminution in the value of his property, the Colorado Supreme Court recently upheld the validity of zoning regulation as it applied to a particular landowner's

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*Brandeis noted in his dissent in *Pennsylvania Coal* that the restriction upon property rights would not become inappropriate simply because it made the property unprofitable, citing *Mugler v. Kansas*, 123 U.S.623(1887) discussed above (*Pennsylvania Coal v. Mahon* 260U.S.393 at 418).

**The theoretical inadequacies of the diminution of value doctrine are discussed below.

property (*Nopro v. Cherry Hills*, 504P.2d344[Colo., 1972]).*

Other states appear to have gone even further (see *Consolidated Rock Products Co. v. City of Los Angeles*, 370P.2d342[Cal., 1962]). The Supreme Judicial Court of Massachusetts, in *Turnpike Realty Co., Inc. v. Town of Dedham*, 284N.E.2d891(Mass., 1972), accepted a very substantial diminution in value, although apparently not all the economic value of the land was destroyed.

The state courts have never really abandoned the old tests for determining the validity of a police regulation, and they only consider the "taking" issue when it appears absolutely necessary. The concept of the "rock bottom" test is changing rapidly, and if a municipality enacts a regulation to protect the public from a known hazard, there should be no real question of taking involved.

The taking problem is a product of the early 20th Century Supreme Court that was hostile to all sorts of regulatory measures; the Supreme Court has applied the *Pennsylvania Coal* doctrine in only one recent case, and the effect of the application seems to be an adoption of the dissenting opinion of Brandeis. Furthermore, the reasons for determining the validity of a police regulation on land in the same way as any general police regulation are much stronger today because of increased population and industrialization than at any other time in our history. The potential social harm to the community, and the detriment to the public welfare, has increased substantially by our continuing to place police regulations as they affect property rights in a special compartment in our constitutional scheme, a compartment for which there is no apparent historical justification.

The courts have relied on two other doctrines in determining whether a taking has occurred. The first of these is the noxious use doctrine. If the courts are able to find that a particular use of property is noxious, wrongful, or harmful in some sense, then the appropriate legislative authority has the power to ban such noxious uses without being required to make compensation. *Mugler v. Kansas* points up the inadequacy of this doctrine. Determining whether a brewer should be compensated for prohibiting what was formerly legal, that is, the manufacture and sale of

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*Other Colorado cases to the same effect are: *Baum v. City and County of Denver*, 363P.2d688(1961); *Bird v. City of Colo. Springs*, 489P. 2d324(1971).

beer, should not turn on current notions of moral obloquy. The doctrine beguiles the judges; its narcotic effect turns them from the real constitutional issue at hand.

The second doctrine is a more recent form of the noxious use theory. This is the cause of the harm test which in effect asserts that where there are conflicting activities between neighboring users, the one activity causing "harm" or "injury" to the other can be legally prohibited or abated without the necessity for compensation. *Hadacheck v. Sebastian*, above, is a classic example of the use of zoning to prohibit an heretofore legitimate industrial enterprise on the outskirts of a city from further operation because of residential growth around it. It has become a "nuisance" and therefore subject to regulation without compensation. Justice Sutherland defined a nuisance as "merely a right thing in the wrong place--like a pig in the parlor instead of the barnyard" (*Euclid v. Ambler Realty Co.*, 272U.S.365, at 388[1926]).

It is immediately evident that such qualitative characterizations of a problem with important constitutional dimensions cannot lead to very satisfactory results. *Hadacheck v. Sebastian* is a case in point. Outlawing the operation of a pre-existing brickyard by labeling it a nuisance does not settle the complaintant's claim for compensation; it avoids the question. Even if we are in general agreement with the court that the claim for compensation should not be allowed, we should be able to articulate this denial on the basis of some sound constitutional principle. This is no easy task as the next subsections indicate. The search for a rational foundation to determine compensation cases has proved to be fairly elusive.

3. Inadequacies of the Diminution of Value Doctrine

The diminution of value theory is probably the most prevalent test used by the courts today in awarding or denying compensation. But, as the inconsistent results of the cases previously discussed show, the diminution of value theory is also subject to criticism. First, the diminution theory assumes that every economic advantage (which can be given a value) is a property right and therefore can be taken. If it can be taken or destroyed, then it is compensable under the taking clause of the United States Constitution.

Our case law makes clear that the courts don't take seriously the proposition that everything of economic value is a property right

entitled to constitutional protection. Our courts regularly deny claims for compensation to individuals on the ground that the economic interest involved does not, in fact, constitute property, and therefore it is not entitled to constitutional protection (see *U. S. v. Willow River Power Co.*, 324U.S.502[1945]).

Moreover, our legislatures do not act as though this rule has any real validity. They regularly impose heavy burdens on particular industries, such as clean air and water pollution standards. Even when such burdens cause severe economic dislocation, the courts will not allow a claim for compensation. The courts would deny the claim because they are unable to discover any legally protectable property right.

We cannot simply ascribe these legislative prohibitions to a nuisance category; many regulations that regulate land use, both at the state and local level, simply prohibit uses that are essentially inconsistent with each other. The regulations are upheld even though there may be a substantial reduction in the economic value of the land involved. Because the diminution of value doctrine, at least on its face, recognizes every economic advantage as a property right, the courts long ago recognized it as too indiscriminate for deciding compensation cases.

The courts, cognizant of the prolifigate nature of the diminution of value theory, have consistently undermined it. They have either studiously ignored it when they have found it convenient to do so, or they have limited its application by developing a series of ad hoc devices--varieties of sophistry not unique to our judicial system.

The second major difficulty of the diminution of value doctrine is the question of what constitutes sufficient diminution to necessitate compensation. The courts have been thrashing around with this problem for a long time, and no coherent line of cases has yet developed.

There appear to be two interrelated problems in trying to develop a consistent approach to allowing or not allowing compensation when diminution of value occurs. First, the property right must be capable of precise definition. This is not necessarily an easy task, as the following examples illustrate. If an industrial facility is ordered to clean up its smoke stacks, how do we define the abridgement of the "property right" that company had to pollute the air before the regulation was enacted? Do we attribute to the value of that lost right the actual cost of the equipment purchased to bring the stacks into compliance; the

cost of installation; the additional manpower necessary for maintaining the equipment; lost profits; or lost competitive advantage? How do we value a compulsory dedication of a park by a subdivider? Do we value it as a percent of the total land he is subdividing, or a 100% loss of land that he would have otherwise been able to develop? No easy answer can be given to these illustrations.

The other interrelated problem of valuation is what constitutes sufficient diminution to trigger the compensation clause. The courts have not given any consistent answer to this. In fact, no consistent answer can be given since the test is psychologically subjective.

As a result of the theoretical difficulties of the diminution of value theory, the courts have been very inconsistent in applying it in factually similar cases where a taking is alleged. To an outside observer the taking problem has taken on a whimsical garb. This is unfortunate since very real and complex constitutional issues lie beneath the surface. The next subsection will discuss two recent attempts to overcome the problems associated with diminution of value doctrine.

4. Recent Developments in Compensation Law

There have been two recent developments which are attempts to improve on the present difficulties surrounding the law of compensation. The first is a revival of an old judicial doctrine, and the second is an attempt to provide a new theoretical framework for deciding compensation cases.

a. Public Trust Doctrine

The public trust doctrine protects public rights in certain properties, such as shorelands and parklands. The doctrine requires that such protected lands be used for public purposes, and forbids their alienation by the government unless to serve a public purpose (Sax, 1970). In *Borough of Neptune City v. Borough of Avon-by-the-Sea,* 294A.2d47(N.J., 1972), the Supreme Court of New Jersey held that Avon could not charge discriminatory user fees for entrance onto its dedicated beach since to do so would violate the public's right to equal access to all lands held in public trust.

Probably the most interesting aspects of the Avon case are the court's expansion of the public trust doctrine and the court's discussion on the limitation of the legislature to alienate lands held in public

trust. The public trust doctrine originated to protect tide-washed land for fishing and navigation purposes. The court concludes that the doctrine is expansive and includes the dedicated recreation beach above the "mean high tide." In giving broad application to the public trust doctrine, the court establishes an important precedent for future litigation between the state and private landowners involving title to land above "mean high tide" (dry beach).

The second interesting aspect of this decision is the court's extended discussion on the right of the legislature to alienate lands held in public trust. The court stated that its early decisions permitted the state to vacate or abridge public rights in tidal lands. But the New Jersey Supreme Court doubts that such a power now actually exists or ever existed, citing the leading United States Supreme Court case on this question, *Illinois Central R.R. Co. v. People of the State of Illinois*, 146U.S.387 at 453 (1892). The New Jersey Supreme Court states:

> The observation to be made is that the statements in our cases of an unlimited power in the legislature to convey such trust lands to private persons may well be too broad. It may be that some such prior conveyances constituted an improper alienation of trust property or at least that they are impliedly impressed with certain obligations on the grantee to use the conveyed lands only consistently with the public rights therein. For example, the conveyance of tide flowed lands bordered by an ocean dry sand area in private ownership to the owner thereof may well be subject to the right of the public to use the ocean waters. And whether or not there was any conveyance of tidal land, the problem of a means of public access to that land and the ocean exists (*Id.* at 54).

Even though this is dicta, the court has opened the door for a very serious reconsideration of title to the nation's shorelands and the rights of the general public to use such lands.*

The public trust doctrine requires that the area to which the public is claiming a right be capable of precise geographic delineation. However, this requirement may be irrelevant under the public trust rationale of the New Jersey Supreme Court. But that court would presumably balk at extending the public's right to use the dry beach

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*Custom, a legal doctrine closely allied to the public trust doctrine, might also be used in appropriate circumstances to vindicate the public's right to access and use of the nation's seashores (see *State ex rel. Thornton v. Hay*, 462P.2d671[Or., 1969]).

indefinitely inland.

Because of the flexibility of this doctrine, it is applicable along shorelines, rivers and streams, wetlands, and tidelands. Once the public's right along such lands had been asserted, appropriate regulations may be developed to protect the public's interest in such lands and to prevent adjacent private landowners from using their land in a manner inconsistent with the rights of the public (see *Southern Idaho Fish & Game Assn. v. Picabo Livestock Co.*, 2ELR20472[5th Jud. Dist., Idaho, June 15, 1972]).

The public trust doctrine has the effect of creating a servitude on the land in question. Such public servitudes are not generally considered conditional--they are open-ended. Unlike private servitudes, if the condition fails, the servitude does not fail. Once the public servitude has been established, there is no real prohibition against preventing a private landowner from using his land in a way inconsistent with the servitude, even to the point of prohibiting any use of the land by him. Moreover, the landowner is not likely to make a successful claim for compensation. For the same reason he will not be able to raise the question of the validity of the regulations since he cannot assert a protectable interest in the property in question.*

b. Externality Theory and Compensation

Joseph Sax, in his most recent article on taking problems (1971), has shifted the legal profession's attention away from the diminution theory to what has generally been called externality theory:**

> Particular parcels are tied to one another in complex ways, and property is more accurately described as being inextricably part of a network of relationships that is neither limited to, nor usefully defined by,

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*Recent state legislation designed to protect shorelands and estuarine areas indicates a general cognizance of the public trust doctrine by the legislators enacting this legislation (see 8 Florida Statutes Ann. c. 161 ["The Beach and Shore Preservation Act"]; Michigan Statutes Ann., §§13.1831-13.1845 ["The Shorelands Protection and Management Act"]; and Cal. Govt. Code §66600, et seq. [1972], which created the San Francisco Bay Conservation and Development Commission in 1969). See the section above which discusses the *Candlestick Properties* case that challenged the constitutionality of the California act.

**The seeds of the externality theory may be found in the legal doctrine of nuisance.

> the property boundaries with which the legal system is accustomed to dealing (p. 152).

External effects quite often are spread diffusely, affecting a large number of individuals, each individual being affected in a relatively small amount. Thus, a manufacturing plant, spewing forth smoke from its stack, has created an externality (in real economic terms) on the community at large by lowering the quality of air in that community. Many individuals are affected, but usually only to a small extent.

In applying the externality theory Sax analyzes the compensation questions raised in *Dooley v. Town Plan and Zoning Commission of Fairfield* 197A.2d770(Conn., 1964). In that case the Connecticut Supreme Court disapproved a local flood plain ordinance which prevented residential and most commercial activity on the complaintant's land. The properties involved were located approximately one-half mile from Long Island Sound. One parcel had been assessed $11,000 for sewers under its previous residential zoning classification. Moreover, the Connecticut Supreme Court was unable to find that Dooley's property was subject to flooding, noting that much of the property was on high ground and "was not under water in [the] 1938 hurricane" (*Id.* at 773). The court went on to find that there had been a substantial diminution in value as a result of the reclassification of Dooley's land, and it amounted to a taking requiring compensation.

However, Sax tackles the question from a different perspective. If one landowner's land in its natural state serves as a flood control reservoir, can he be prohibited from filling in that land and developing it even though such filling in and development may create serious flooding problems for downstream landowners? Under diminution of value theory the public would probably have to pay for the right to retain this land as a natural reservoir. But under the externality theory, the lower owners cumulatively should be treated as if they were a single lower owner. Under traditional law, in a dispute between two adjacent landowners, if the upper owner's land has historically served as a drainage reservoir or basin, then the lower owner may prevent the upper landowner from draining that water to the lower owner's detriment. The upper landowner would not be entitled to compensation. In the same way, a flood plain ordinance resolves conflicting uses of a large number of private landowners. The government is not the primary beneficiary in this type of conflict resolution; it has not taken anyone's land for its own use. Rather, the

ordinance is a resolution of conflicting interests between various landowners of the uses that may be made of the land involved. The flood plain ordinance restricts a use of a landowner's property which, if allowed, would of itself restrict the use another landowner would otherwise be able to make of his property. Furthermore, the ordinance should not be invalidated even though the burden, in terms of lost economic opportunity, falls on a single landowner. If the net benefits are greater than the losses to society in prohibiting certain uses of land, then the situation is entirely analogous to a nuisance case. If the use is declared a nuisance, it can be prohibited; the economic loss falls on one individual with no right to compensation.*

In concluding his analysis Sax makes the following observation:

> The prevailing view of compensation law has a considerable effect on resource allocation, since the prospect of having to pay compensation is a constraint on government regulation of private property. Though it may be desirable, in terms of maximizing the net product of the aggregate resource base, to undertake a particular restriction on the use of private property, compelled compensation may deter a legislature from enacting the restriction. Notice that under current law, a failure to undertake restrictions may generate costs for diffuse interest-holders for which no compensation must be paid. Requiring compensation when a conflict among competing users is resolved in favor of diffuse interest-holders, and not when it is resolved against them, inevitably skews the political resolution of conflicts over resource use and discriminates against public rights (1971, p. 160).

Both California and Wisconsin courts have applied this doctrine recently in favor of the public rights involved (see *Candlestick Properties, Inc. v. San Francisco Bay Conservation and Dev. Commun.* 89 Cal. Rptr. 897 [Cal. App.Ct., 1970], discussed above; and *Just v. Marinette County,* 201N.W.2d 761[Wis., 1972], discussed above).

However, the *Dooley* case indicates the limitations of the externality theory, even though the theory is a broad step forward in our thinking about compensation problems. First, the theory appears to require that the legislators make some sort of cost analysis of the net

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*See *Morris County Land Imp. Co. v. Township of Parisppany-Troy Hills,* 193A.2d232(N.J., 1963). The facts of this case are similar to example set forth above.

benefits to society of the resource base that is to be regulated, and the net economic opportunity cost to society (or more accurately the individual or individuals) of the regulated resource base. As *Dooley* indicates, the benefits may be too diffuse, or the burden upon a particular individual may appear to have such an obscure spillover effect that a court will find that the regulation as it applies to the complaintant's property is an invalid exercise of the police power. Moreover, this type of cost analysis is not particularly simple; in fact, because of the sophisticated judgments often required, it may be subject to easy attack.

Second, the externality theory doesn't seem to handle adequately restrictions of the sort that leave, for all practical purposes, the government as the only potential buyer. This may occur even though the regulation is obviously a resolution of conflicts between numerous property owners, and the benefits to the government are incidental. Compensation may not be constitutionally mandated; but, as a practical matter, we might want to award compensation because we consider that it is bad social policy to enact regulations that have the effect of economically ruining a small group of individuals.

Finally, the theory shifts our attention away from what constitutes a legally protectable property interest. This is a very thorny problem; our legislatures are constantly making decisions about this "boundary line", whether consciously or unconsciously. Our courts in virtually every compensation case must answer this question. Because our society is becoming increasingly complex in its economic relations, the "boundary line" is necessarily constantly shifting. Whether we can develop a framework for this shifting "boundary line" is rather doubtful.

For the present, our legislators and judges are called upon daily to decide conflicting claims. The results are not going to be satisfactory to everyone; but with the revival of the public trust doctrine and the development of the externality theory, we are moving toward a much broader concept of the public's rights in the use of private land. The doctrines provide a relatively sound foundation for determining taking cases involving complex constitutional issues. Finally, both doctrines provide legislative and judicial bodies a much broader perspective in which to examine new varieties of police power regulations. This broader perspective has an important role to play when new types of natural hazards regulations are enacted or challenged.

CHAPTER IV

ALTERNATIVE LEVELS AND TECHNIQUES FOR REGULATING LAND USE

Because the individual property owner frequently fails to manage his land in a manner compatible with natural hazards, he shifts the real costs of his use of that land to the community, state, region, and even the nation. Officials, charged with the responsibility of providing for the health, safety, and general welfare, are taking actions to guide uses in hazardous areas to prevent the shifting of these costs onto the community. The discussion that follows discusses the various techniques that may be pursued to achieve hazard zone management.

Local Approaches

State governments have typically delegated their authority to regulate land use to local units of government. Since the enabling acts were adopted permitting local units to regulate land use, almost all regulation has occurred at the local level. The justification for such delegation has been that local officials best know local problems and how to solve them (Delafons, 1969).

1. Zoning Ordinances

The earliest form of local land use regulation was zoning. This simply divides the governmental entity into units of land, or zones. Within each zone, the use of structures and land, the height and bulk of structures, the size of parcels, and the intensity (density) of use is controlled (U. S. Water Resources Council, 1971). Zoning is the traditionally preferred tool for regulating land use in areas where a definite hazard zone can be delineated, because the hazard zone can be specified and restrictions imposed consistent with the hazard. Zoning can specify what uses will be permitted, where various activities may be conducted, and establish standards, such as minimum elevations or structural prerequisites.

A simple multiple-hazard ordinance having a single zone was adopted for Little Cottonwood Canyon Utah (Alta-Snowbird Ski Resort). (See Figure II-3a). In 1973, after public meetings, hearings, and advisory committee reports, the following section was included in the Salt Lake County and Alta Zoning Ordinances:

> Natural hazards--construction of permanent structures is not permitted in areas subject to hazards such as floods, landslides, avalanches. (Section 22-9A-8, Special Regulations [Salt Lake County]).

Definition and delimitation of the zone has been completed and the exclusions applied. This is the first instance in the United States where an avalanche hazard has been incorporated into land use zoning.

A second approach to hazard regulation specifies graduated use zones. Use restrictions are more severe the more hazardous the area. For example, Warrick, Rhode Island, permits only non-commercial boat docks, beach cabanas, and open space uses in what it calls "areas of extreme hurricane danger", while a wide range of structures with first floor minimum elevation requirements are permitted in the more general "areas of hurricane danger" (Zoning Ord. 1957, B.). The U. S. Water Resources Council has drafted a model zoning ordinance for use by coastal communities which also employs a graduated use approach (1971). In the "high hazard district" only open space activities are permitted (agriculture, golf courses, parking areas), but special exception uses may be granted (for circuses, drive-in theaters, marinas). In the "general hazard district" first floor elevation and construction guidelines are established, and flood-proofed structures may be granted special exceptions.

In order to be flexible, zoning ordinances provide for the granting of variances and exceptions to normal restrictions. Variances are granted to individual property owners if the responsible board deems that the restrictions place unnecessary hardship on the person and that no economic use is otherwise possible for the land. An exception is granted if the board determines that a specific use meets all of the performance standards established in the ordinance. Although such provisions are desirable to prevent unreasonable rigidity, they are sometimes issued solely for political considerations. Such abuse undermines the spirit of the ordinance (Murphy, 1958).

2. Subdivision Regulations

Subdivision regulations establish guidelines for the division of large parcels of land into smaller lots which will subsequently be sold or commercially developed. In most cases subdivision regulations deal with large residential developments.

The subdivider is required to prepare a plat of the area to be sold or developed--that is, a detailed map showing individual parcels, streets, and other proposed aspects of the development. The subdivider is not ordinarily required to indicate hazardous zones on the plat. The regulatory board then reviews the plat and can modify it to make activities in the area more compatible with the comprehensive plan or it can refuse the development altogether. When subdivision regulations require explicit consideration of natural hazards, flooding and geologic hazards are the most common ones. Seismic risk is not often made an explicit consideration in geologic hazards (Mader, 1972). An example of an ordinance that requires consideration of natural hazards is the Portsmoutn, Virginia subdivision regulation (§ 32-12, 1961). That ordinance prohibits the subdivision of land if it is subject to flooding or other hazards, unless such hazards can be overcome by filling or special construction techniques.

3. Building and Housing Codes

Building and housing codes are regulatory measures tnat set minimum standards for the construction of structures and service facilities. The controls can be hazard-oriented. They can effectively exclude structures which fail to meet prescribed criteria for attaining compatibility with the hazard. Building and housing codes, however, apply throughout the community, unlike structural provisions incorporated into zoning ordinances. For some hazards this broad application makes zoning preferable to codes, but for others, such as earthquake or hurricane winds, the entire community may be susceptible.

Building codes are designed to help assure that structures in a hazardous area can withstand a hazard of a prescribed magnitude. The particulars of the code can establish minimum floor elevations, prohibit or restrict the use of inferior building materials, and require proper anchorage or foundation stabilization.

Housing codes, in addition to setting minimum construction standards, provide for the maintenance of structures. Housing codes can

require a partially damaged and weakened structure to be repaired to conform to minimum standards that apply to new structures (U. S. Water Resources Council, 1971).

An outstanding example of building codes is the special code formulated by the Governor's State Emergency Council following Hurricane Camille, and adopted by Jackson County, Biloxi, and Pascagoula, Mississippi. Essentially it is the Southern Standard Building Code, amended by the wind load requirements as specified in the South Florida Building Code, with a definition of a minimum flood protection elevation. The Mississippi Code defines a "critical exposure zone" as all land within 1,000 feet of the shoreline and all areas north of this having elevations of less than 12.5 feet above mean sea level. Within this zone the minimum elevation of habitable rooms must be 12.5 feet and all buildings must be able to withstand a 120 mph wind.

Considerable problems were encountered with adoption and enforcement of this code; a code enforcement program was conducted, and a national conference was held to help answer some of the questions. Many of the problems illustrate the numerous considerations necessary in evaluating land use measures. The following points were raised concerning this building code.

Both economic incentives and governmental directions are necessary. Although there is a significant amount of research into wind and water damage, it is either not directed toward practical problems, or the results are not adequately communicated to those responsible for implementing regulations (Coast Code Administration, 1972). In addition, the Coast Code Administration found that:

> The concept, not the practice, of uniform enforcement including procedures, technical interpretations and fee schedules is generally accepted by all political leaders, tradesmen and contractors. Resistance may be anticipated from well-established existing code enforcement organizations.
>
> A political jurisdiction which can independently afford even a minimum, and often inadequate, code enforcement staff will generally insist on local autonomy unless they have generally accepted a regional approach to common problems or there are strong enough pressures or incentives to offset this desire for local autonomy.
>
> The external agencies, DHUD and the insurance industry, which establish requirements for code and code

enforcement, do not have any standards or make an apparent attempt to measure the adequacy of code enforcement.

The public confidence and understanding of the need for a strong, professional code enforcement agency is diluted by:

(1) FHA, Farm Home Administration and VA having their own inspections

(2) The private mortgage lenders not requiring inspections or evidence of inspections

(3) The use of flat rates by insurance companies in all residential structures, even in high hazard areas and the use of their own inspectors on structures not subject to area ratings

(4) The system of establishing rates for fire and extended coverage insurance gives insignificant consideration to code, code enforcement, land use control and other regulations designed to prevent damage in comparison with the fire department and water system (1972, pp. 3-4).

It should be noted that these are common problems to all types of building codes.

4. Miscellaneous Codes and Regulations

There are several mechanisms available to local officials to control various aspects of land use in particular situations. Sanitary and well codes were conceived for the purpose of protecting the quality of water supply and establishing minimum standards for waste disposal. In areas where these goals might be affected by natural hazard, particular safeguards can be required to assure that water and waste facilities are located and constructed to achieve greater compatibility with the hazard.

Grading regulations exist in some communities to govern the process of smoothing or leveling a slope to the desired gradient. Boards can refuse to permit the grading of areas which are regarded as unstable or otherwise hazardous. The most common application of grading regulations is in areas of landslide, slippage, or settling potential, but they are also applied to prevent the lowering of elevation of sites or removal of protective sand dunes. Palm Beach, Florida is one of many communities that protects its dunes which serve as a natural barrier against storm surge.

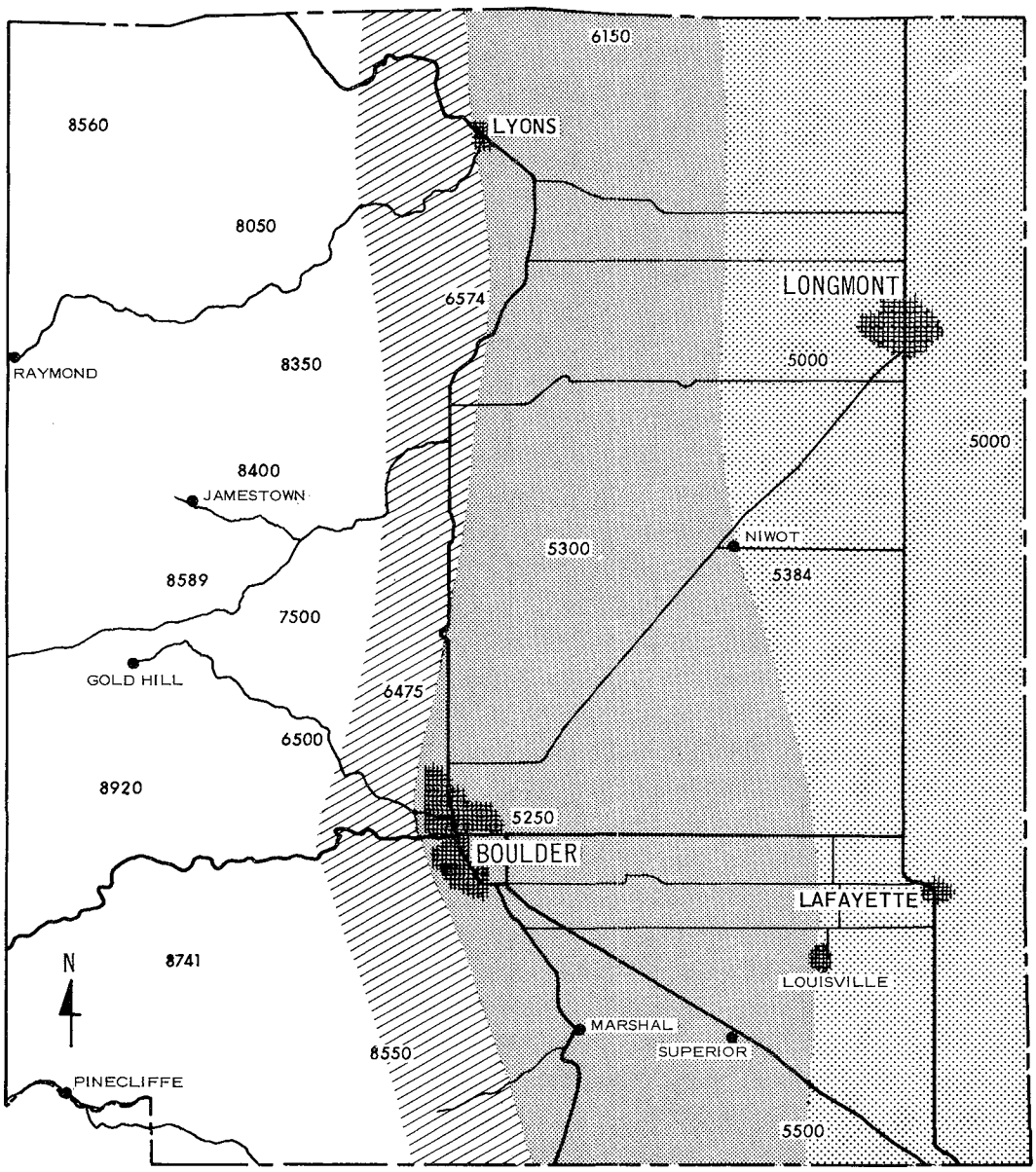
Mobile homes present special problems. This type of housing is attractive to lower income groups because the average price is $7,000-$8,000 per unit (compared to the median cost of $27,000 for a conventional home). Because of their light weight, mobile homes are very susceptible to wind damage. Such units have overturned in winds less than 65 mph. However, securely anchored homes have withstood winds of over 100 mph.

Model tie-down anchorage requirements designed by the Defense Civil Preparedness Agency for various wind velocities are considered the best practical procedure for protecting mobile homes from wind damage (National Bureau of Standards, 1973). In most areas of the United States, the tie-down equipment costs between $100-$500. The cost of installation by a professional contractor may be another $100. Wind tunnel experiments conducted at the University of Michigan for Foremost Insurance Company have shown that such proper tie-downs can reduce damage by 70-80% (Harris, 1962). However, the assumption was made that "the unit will remain intact at high wind speeds. No attempt has been made to evaluate the strength of the unit itself which must play an important part in determining the maximum wind velocity which can be sustained" (p. 29). Mobile home owners are usually advised that, even with a properly anchored home, they should seek other shelter when warned of an approaching storm.

There are presently very few communities with tie-down regulations, but an exception is Boulder County, Colorado. Boulder County has been divided into four graduated zones. The zones specify the wind pressures that mobile homes must be able to withstand (see Figure IV-1). The approach is particularly interesting because it combines zoning with building code techniques.

Laws have also been enacted to prevent encroachment in floodways (see Murphy, 1958). In addition to amelioration of direct loss potential, prohibiting channel encroachment decreases secondary effects if floodwaters are obstructed or if debris is in the path of floodwaters. Drainage codes are also sometimes imposed in flood-prone areas to reduce the likelihood of accumulation of storm waters.

The Planned Unit Development (PUD) is a fairly recent development in land use planning. The PUD provides satisfactory ways to reduce loss-propensity in hazardous areas. The PUD is based on a combination of high density structures and open space. Most PUD ordinances are passed to encourage developers to construct apartment buildings or office parks



SUGGESTED DESIGN LOADINGS

30 pounds per sq. ft.

50 pounds per sq. ft.

65 pounds per sq. ft.

50 pounds per sq. ft. (May be reduced in areas affording natural wind protection on approval)

ALLOWABLE RESULTANT WIND PRESSURES

FIGURE IV-1

MOBILE HOME TIE-DOWN ZONING MAP, BOULDER COUNTY, COLORADO, 1973

(Boulder County, 1973)

in certain areas, and to surround them with open spaces (Sussna, 1970). A PUD can be easily used to develop a unit of land with a known natural hazard in it. The hazardous area is simply left as open space. Encouragement of high density structures in combination with open space may be desirable in some situations. Miami, Florida has developed plans to use high rise buildings as temporary evacuation shelters during hurricanes.

5. Taxation

Local officials can utilize the power of taxation both to encourage compatible uses and to discourage incompatible uses in a hazardous area.

Taxation, more than any other tool, can be used in a creative way to encourage good land use management. Charles Haar has stated:

> Among the lessons taught by the American system [of land use controls], perhaps the most valuable one is that incentives often produce better results than legislative edicts (1965, p. 14).

Approximately 31 states have enacted some form of differential or use value assessment on real property. This permits assessment of certain classes of property according to the value of the current use, rather than according to the actual market value of the property. These laws typically apply to farmland, forest land, open space land, recreational land, or lands of historical, scenic, or ecological importance.

There are three variations of the preferential assessment laws. The first is the standard preferential assessment law. This simply provides for valuation according to the current use being made of the land. If the land is later converted to another use no penalty is exacted for such conversion. The second type is the deferred tax law. Land is assessed according to its current use, but when it is later converted to another use a penalty tax is levied against the land or its owner. The penalty is typically computed as the difference between taxes actually paid and those that would have been paid without the differential assessment for the last preceding three years. The third type is the restrictive agreement. This law permits the landowner and the local government to enter into an agreement to restrict the use of the land in return for differential assessment, usually for a period of ten years. If the landowner gives notice that he intends to change the use of the land at the end of the ten-year period, the land reverts to standard market value

assessment or some type of charges are imposed.

Although many states have enacted a tax preferential assessment law, they do not seem to have accomplished all the objectives they set out to do (see Hady and Sibold, 1974). The reasons are manifold. First, the laws do not always specify the objectives to be sought. If tax preference is to be given to certain types of land use activities, then specificity in the act is necessary. Second, most of the studies that have examined tax differential assessment laws seem to indicate that if the law's primary function is to direct and control urban growth, other measures in conjunction with the differential assessment are necessary, particularly to avoid "leapfrogging" urban development (Hady and Sibold, 1974). Third, because of the heavy reliance by local units of government on the property tax, the preferential tax assessment necessarily shifts the burden from one group of individuals to another. Although the average increase may be small, in some instances it may be quite large where the preferential tax assessment applies to a large proportion of the taxing jurisdiction's tax base. Finally, the standard preferential tax assessment does not penalize the land speculator. He is frequently the villain in pushing development of a parcel of land that for a variety of reasons, including its vulnerability to natural hazards, it is otherwise unsuited. The deferred tax law or the restrictive agreement may be preferred over the standard preferential assessment law.

Because of the normal uniformity of tax assessment requirements found in most state constitutions, it is doubtful that a penalty assessment on an incompatible use in a hazardous area would withstand a constitutional test. However, if a local unit is engaged in special activities that relate to the warning or protection of people and property within a defined hazardous area, there is nothing wrong in levying a special tax (it is a form of a special assessment) on the property in that hazardous area to pay for such warning or protection systems.

6. Location of Key Facilities

Growth in an area of a community, county, or metropolitan region is profoundly influenced by the location of certain key facilities and activities. The building of a new public facility such as a major highway or office building can generate growth in the area near it, while stifling development in another section of the community (Meier, 1962).

Without adequate planning, the growth which is generated may inadvertently occur in a hazardous area. Transportation arteries have instigated or accelerated development in flood plains (White, *et al.*, 1958). When a local government plans to construct a new facility, it can be located to either promote or inhibit growth in a hazardous area. Over time proper siting may attract growth away from hazardous areas. Local governments often control the location of facilities such as water lines, sewer lines and utilities. Through careful location of sewer and utility lines, municipalities can prevent uneconomic development in hazardous areas. They are encouraged to do so by provisions in the legislation reviewed in later sections of this chapter. However, such efforts can only be effective unless local decisions are supported by state land resource inventories and technical advice.

Commercial facilities such as shopping centers also spur growth and development. It is possible, through the use of zoning and subdivision regulations, to locate them away from areas of hazard potential.

Besides influencing development, certain public and private facilities are of strategic importance to an area's economy. Facilities upon which society places high reliance should be located so as to minimize the possibility of their destruction. For example, hospitals should be located away from damage-prone areas. Likewise, power generating facilities or substations should be located well away from hazardous areas. Siting of such facilities is dependent upon the hazard to be avoided, and in many instances all that may be needed are structural or engineering modifications to minimize the danger to the facility from the hazard.

7. Public Acquisition and Redevelopment

Public acquisition of land in hazardous areas, particularly in urban communities, is becoming more common. Several goals may be accomplished simultaneously through public acquisition of hazardous areas. First, it places management of the hazardous areas in the hands of public officials. Second, the land itself may be managed on a multiple use basis, providing greenbelts, parkland and recreation opportunities near centers of population. Third, such acquisition can be used as a tool in carrying out the goals of the community's comprehensive plan, particularly in controlling and guiding growth in the local area.

Public acquisition of land, especially in urban areas, is expensive. There are several possibilities for funding. HUD has a special fund for urban renewal projects to assist communities in acquiring

property damaged or destroyed by a disaster. The City of Rapid City in South Dakota was given funds to acquire real estate destroyed by the June, 1972 flood. This land will be used for greenbelt, bridle paths, bicycling and hiking trails, golf courses, tennis courts and other types of recreational activities. The Corps of Engineers and the Bureau of Reclamation have more limited funds for acquisition of private land for protection from natural hazards.

The state or local community may also finance acquisition of private land. Usually such programs are based on multiple goals. An outstanding example of a local community financing a land acquisition program is the City of Boulder in Colorado. Through the levy of a local sales tax, the City of Boulder is actively acquiring land around the city for greenbelt. One of the goals of this program is to acquire flood-prone land to prevent further development in the flood plain.

Because acquisition of the full fee title is often quite expensive, some authors have proposed the purchase of development-right easements (Barlowe, Ahl and Bachman, 1973). However, if these rights are purchased for extremely long periods of time, say fifty years, the cost can be greater than the outright purchase of the full fee title to the land. For shorter periods of time, it might be a useful tool to channel development in a metropolitan area.

State Approaches

Though state governments can take any of the regulatory actions which are outlined for local governments, state officials have been reluctant to interfere with local land use efforts in the past. The belief that local decision-makers should regulate land use is now giving way to the realization that few land use problems are truly local in nature. Many policies and actions affect an area larger than the local community. The states' increasing willingness to assert their authority to regulate land use is well-documented (Bosselman and Callies, 1971; RuBino and Wagner, 1972).

1. Comprehensive Land Use Controls

A few states have passed, and many are considering, land use bills that apply to the entire state or to generically defined areas. Hazard considerations are usually a minor part of the measures--emphasis is on environmental quality.

Comprehensive state land use legislation is two-pronged. It provides for a state land use planning program and establishes various

guidelines to regulate land use and development. Planning legislation is more common than strict controls and usually precedes regulations by several years. One example of land use planning legislation which includes hazards is the Oregon law creating the State Land Conservation and Development Commission. The Commission is charged with developing land use goals and guidelines for flood plains and areas of geologic hazards. Another example is the Coastal Coordinating Council of Florida. The Council has recommended development activities for the state's coastal zone, with special consideration given to certain hazards and environmental concerns. California has an integrated state planning approach to hazards. The California Division of Mines and Geology, in formulating the Urban Geology Master Plan for California (1973), divided the state into cells of 7.5 minute parcels and studied the role of ten hazards in planning for each cell.

The American Law Institute has prepared a Model Land Development Code which specifies guidelines for state land use planning but does not deal explicitly with hazards. Florida recently passed its Environmental Land and Water Management Act, based on the ALI model.

In establishing regulations for guiding land use, states generally deal with two categories of problems--areas of critical state concern and developments having regional impact. Both elements may involve hazardous areas. Areas of critical concern may include fast growing urban communities, historical and archaeological sites, or (more commonly) critical environmental areas. A bill considered by Washington State specifies controls for "Areas of Statewide Significance", and includes "areas of high potential for natural disaster." The Florida law, on the other hand, does not include hazardous areas under its "Areas of Critical State Concern."

Developments having a regional impact include large residential subdivisions. Such subdivisions can have repercussions on places outside their immediate area. The motivating factor behind the 1972 Florida Environmental Land and Water Management Act was a drought. The drought dramatized the danger of permitting too many activities and people to concentrate in an area having critical water conditions. The regional impact clause is supposed to prevent development that creates a negative impact. This includes water shortages (on surrounding areas) (RuBino, 1973).

Oregon has also passed a comprehensive land use planning bill. The state appears to have opted for a more fragmented approach to controls. At least seven separate bills endorsed by the administration (referred to

as the "Oregon Land Use Package") were introduced into the legislature. Each bill addresses a specific area of land use control. Some deal quite explicitly with hazards. The approach includes some of the techniques discussed below and illustrates how they can be coordinated.

2. Zoning

No state has enacted comprehensive regulations governing land use. States have permitted localities to enact comprehensive zoning ordinances through enabling acts. In some cases enabling legislation permits zoning for specific hazards. Forty-one states have authorized local governments to implement flood plain zoning. Some states have gone further and require that localities consider hazards in their zoning ordinances. California goes about this in an indirect manner. In addition to providing for coastal zone management, the state's Government Code requires that cities and counties adopt a "general plan", which must include a "seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis and seiches" (Ch. 3, Title 7, Government Code, Section 65302 [f]). The state also requires that local zoning ordinances be in conformity with the general plans (Government Code, Section 65860). Wisconsin's statute is more direct. It explicitly requires local flood plain zoning, and provides for state-imposed zoning should local entities fail to enact their own (Wis. Stat. Ann. §§59.971, 144.26, 87.30, Supp. 1970).

A more recent approach is the state-wide "zoning" prescribed in major land use legislation by Hawaii and Maine. The Hawaii Land Use Commission Act classifies all land of the state as urban, rural, agricultural, or conservation, and specifies permitted uses for land in each zone. Similarly, the Maine Land Use Regulation Commission is charged with classifying about half the state's land into protection (including flood plains and precipitous slopes), management, holding, and development districts. Each category has guidelines for permissible uses. Most major state land use legislation requires that a regional or state appeal board rule on applications for permits to deviate from legislative land use guidelines.

In 1974 the Colorado State Legislature passed a bill (1974, H-1041) requiring all communities to review their zoning maps and comprehensive plans and identify specified natural hazards of statewide

concern. Having identified these hazards, the communities are required to enact appropriate ordinances to prohibit encroachment into these areas.

Ophir, a small town in southwestern Colorado, in cooperation with the Colorado Geological Survey, prepared an avalanche study for the town site to comply with the mandate. Approximately two-thirds of the town site is located in well defined avalanche runs (see Figure IV-2). During the winter of 1974-75 two avalanches occurred. One required the evacuation of the residents of the town. Despite the hazard to the population, the town did not have the funds to set up artillery or build earthen dams to arrest or deflect the course of the avalanches. The county and the state were unwilling to put up the money for such works. As they have done in the past, the residents of Ophir continue to accept the risk of avalanche.

Without state funding, many small communities will be unable to deal effectively with hazards in their areas. The mandate of the legislation to prevent development that constitutes "a danger of irreparable injury, loss, or damage of major and serious proportions to the public health, welfare or safety" will remain largely unrealized.

3. Coastal Zone and Wetlands Controls

Another variety of legislation that regulates development in hazardous areas is the coastal areas and wetlands acts. Delaware, New Jersey, Rhode Island, Michigan, Minnesota, California, and Washington have coastal or shoreline management laws. These laws usually establish land use guidelines. Some of the acts deal with hazards. The Michigan law attempts to protect high-risk erosion areas. Other states, notably North Carolina and Florida, presently are considering broad coastal zone management legislation.

More common are wetlands protection laws. The acts are designed to prevent ecologically detrimental development of inland and coastal wetlands, marshes, tidelands, and estuaries. These areas are subject to hazards such as flood, hurricane, tsunami, and coastal erosion. Laws controlling wetland development protect man from these natural hazards. In recognition of this, some wetlands acts deal explicitly with natural hazards. A Massachusetts law provides for state review of any proposal which alters land subject to tidal action, coastal storm flowage, or flooding (Mass. Gen. Laws, Ch. 131-Sec. 40).

Another class of coastal regulations protects dunes, beaches, and other natural protective barriers. These natural barriers protect

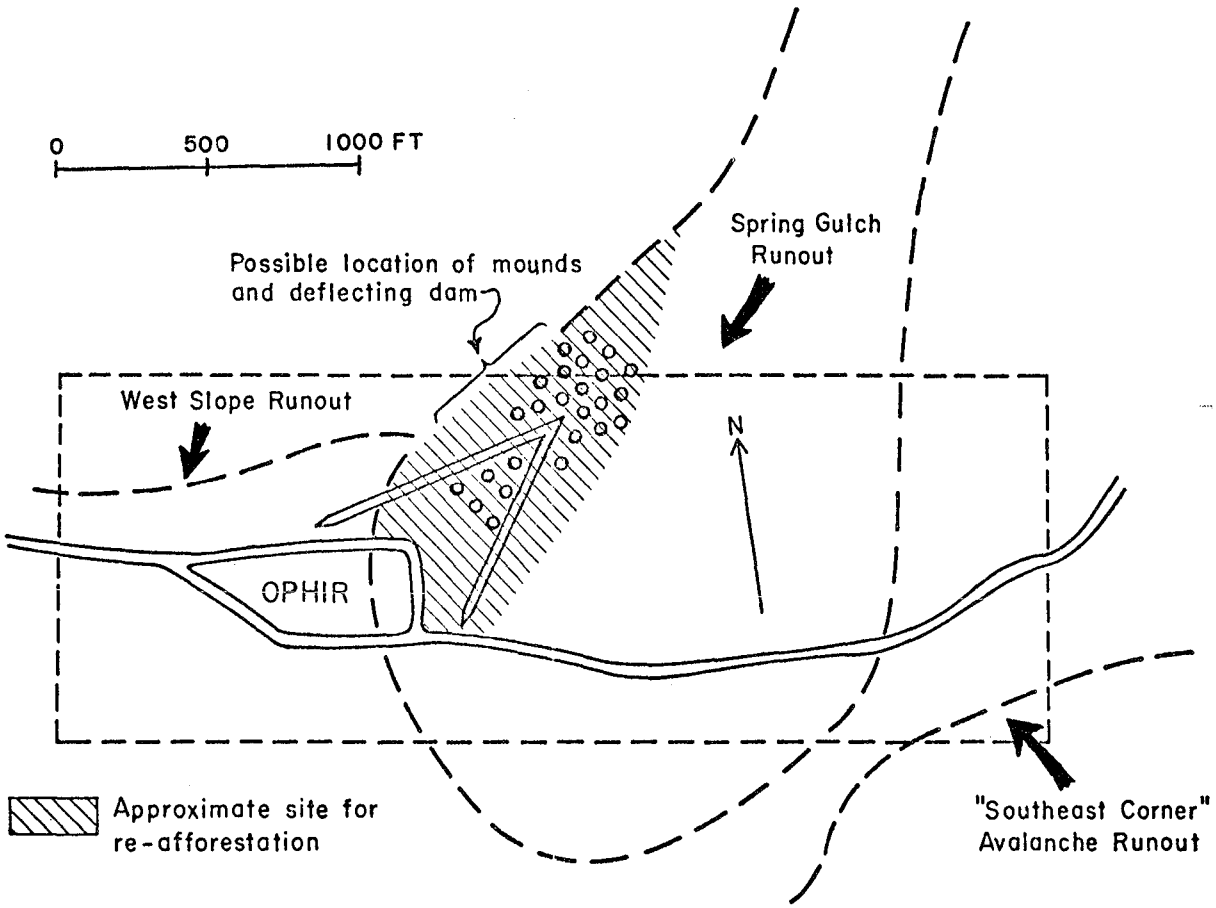


FIGURE IV-2 SCHEMATIC DRAWING OF POSSIBLE AVALANCHE DEFENSE, OPHIR, COLORADO (Institute for Arctic and Alpine Research, 1974)

man against hurricane storm surge, tsunami, and erosion. Delaware regulates the removal of sand and gravel from coastal areas (Del. Code Ann. Title 23, §§1706, 1707 [1953]), North Carolina protects against sand dune destruction (N.C. Gen. Stat. §§1043-3 to 15 [Supp. 1967]), and Florida has a beach setback requirement to prevent erosion (Laws of Fla., Ch. 70-231 [1970]).

4. Subdivision Regulations

State level subdivision controls vary greatly. Permissive legislation simply requires registration by subdividers. Although most states authorize local governments to review subdivision proposals, several states require "full disclosure" reports prior to sale of property to protect buyers from misinformation. Others, such as Florida and Michigan, make it mandatory for hazardous conditions (flood hazards) extant on the land to be specified in the reports. A few states, notably Michigan and Wisconsin, require state agency review of subdivision plats before they can be approved. Colorado requires local entities to develop their own subdivision regulations. Failure to do so results in the state establishing the subdivision regulations for the local unit. By issuing guidelines for local governments, Colorado assures that new developments do not unknowingly incur risks for property owners or the state (Rogers, et al., 1974). The emphasis is upon providing advice and counsel to local government by state agencies. In cases where states prescribe guidelines for local subdivision regulations, flooding, drainage and grading are often given attention.

5. Building Codes

Most states have passed enabling acts permitting local units of governments to pass building codes. A few states have established minimum building requirements that govern elevation, flood-proofing, wind loads, and land fill. Minnesota has recently adopted a code with extensive flood-proofing requirements, and Mississippi has passed a state code which may be modified at the local level.

6. Floodway Obstruction and Encroachment Regulations

The most common hazard that is regulated at the state level is the periodic flooding of rivers. At least 38 states have some form of regulation pertaining to licensing, inspecting, or the construction of dams, levees, or other obstructions to the floodway (U.S. Water Resources Council, 1971). The most important types of regulations are

the "encroachment lines". These are controls that prohibit new construction from obstructing the flow of floodwaters or adding debris to the flood flow. Such regulations are intended to keep development from compounding the danger of floods.

7. Facility Siting Controls

Transportation arteries, airports, or factories employing large numbers of people, may be crucial to the economy of an area. Other facilities, such as a nuclear power plant, may be a potential threat to the health of the community. In either case, these types of facilities merit special consideration and protection when dealing with hazard zone management. State action in guiding the siting of key facilities has generally been restricted to power plants.

8. Public Acquisition and Tax Relief

As part of their land acquisition programs, states can include the purchase of land in hazardous areas. State expenditures on parks have increased 12% per year since 1967, in an effort to accommodate the 7% per year increase in visitors. Acreage increased almost 6% per year (Council on Environmental Quality, 1971). Location of parks often includes hazardous areas; however, there is no evidence of a conscious effort by state recreation planners to coordinate the goals of recreational open space and hazard zone management. Some states, however, have special area land acquisition programs which provide funds for purchasing wetlands; some of these special areas correspond with hazardous areas.

A few states have special property tax relief programs to encourage the preservation of open spaces. Connecticut, for instance, provides reduced tax rates for private land used as open space, wetlands, farmland, and forest (Conn. Gen. Stat. Ann. §§7-131a-D 1969 Supp.§§). Again, however, there is no evidence that the states apply the concept deliberately to hazard zones (see Chapter III on tax provisions).

Federal Approaches

The Federal government has become involved in land use management in a variety of ways for its own lands and privately held lands. Some recent Federal activity on land use is discussed below; it is indicative of the legislation the Federal government has been enacting in recent years to affect land use by private individuals.

1. The Land Use Policy and Planning Assistance Act of 1973

The legislation grew out of a concern to provide environmental planning, but hazard considerations were incorporated. It was passed by the Senate but rejected by the House of Representatives. The most far-reaching Federal land use legislation yet proposed, the act was to provide funds (contingent on adoption of guidelines) to assist states in developing and implementing land use programs; to coordinate Federal programs and policies which have land use impacts; and to coordinate planning and management of Federal lands with adjacent non-Federal lands. Qualifying states would have had to inventory, designate, and control development in areas of critical environmental concern (pp. 9-10). The bill specifically included "natural hazard lands. . .such (as) flood plains and areas frequently subject to weather disasters, areas of unstable geological, ice, or snow formations, and areas with high seismic or volcanic activity" (p. 68), and areas of critical environmental concern. Furthermore, participating states would have had to formulate and implement a plan which includes regulation of land sales and development projects to insure that the project was not located in natural hazard areas (p. 18). Finally, the act provided that the Federal government give consideration to the protection of life and property in natural hazard areas (p. 48) in developing national land use policies. Less specific land use planning assistance bills are still being considered by Congress.

2. The Coastal Zone Management Act of 1972 (Public Law 92-583)

This law provides for coordination of Federal activities in the coastal zone and the appropriation of funds to aid states in coastal planning and research. At the Federal level, the act recognizes the need for making coastal zone management fully compatible with national land use policy. If a national land use law containing the provisions of the bill passed by the Senate (discussed above) were enacted, administration of the Coastal Zone Act would necessarily be modified so as to reflect the hazard considerations in that act.

The act provides funds for states to develop coastal zone management programs that must meet guidelines prescribed in the law. Three guidelines apply to hazards: first, the management program must establish permissible activities within the zone; second, the management program must designate critical environmental areas (coastal erosion is

specifically included in the law); and third, the management program requires that guidelines on the priority of uses in the zone be promulgated. Funds are available to aid in acquiring, developing, and operating estuarine sanctuaries. Although the act is not oriented toward hazards, states have the opportunity to build hazard considerations into their management programs and to have them funded by the Federal government.

3. The National Flood Insurance Act of 1968 (Public Law 92-213, Sec. 2), The Flood Disaster Protection Act of 1973 (Public Law 93-234), and the Disater Relief Act of 1974 (Public Law 288)

An influential factor in the recent growth of land use controls by local governments is the National Flood Insurance Act of 1968. This act provides for massive subsidizing of insurance against inundation of normally dry land areas because of: (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation of runoff of surface waters from any source, or (3) mudslides caused or precipitated by accumulations of water on or under the ground. In order for homeowners to qualify for the subsidized insurance, the community is required to adopt federally prescribed land use controls consistent with the hazards insured against. The law is directed at new construction (including major repair and improvement of existing structures) by requiring that the elevation of the lower floor of structures is not below the level of the 100-year flood level or storm surge height or that adequate flood-proofing is carried out.

As of January 1, 1974, only 3055 of the estimated 10,000 communities believed by the Department of Housing and Urban Development to have flood hazards were participating in the program. The Flood Disaster Protection Act of 1973, passed on December 31, 1973, should result in a dramatic increase in participating communities. Besides increasing the amount of coverage available (making the insurance more attractive), steps were taken to make local participation virtually mandatory. Section 202 (a) of the law states:

> No Federal officer or agency shall approve any financial assistance for acquisition or construction purposes on or after July 1, 1975, for use in any area that has been identified by the Secretary as an area having special flood hazards unless the community in which such area is situated is then participating in the national flood insurance program.

The law prohibits banks and savings and loan associations insured by Federal instrumentalities from issuing loans for construction in special flood hazard areas unless the community is participating in

the program. By virtue of these requirements, the number of communities adopting flood hazard land use management controls is certain to increase.

The Disaster Relief Act of 1974 makes participation in the insurance program more likely by tying it to Federal disaster relief assistance payments and grants to purchase insurance for public facilities.

4. The Interstate Land Sales Full Disclosure Act (Public Law 90-448, Title 14) and Securities Act Release #5347

Some consumer protection measures attempt to apprise purchasers or real property of any hazards that exist on the property. The Interstate Land Sales Full Disclosure Act requires developers of land sold on an interstate basis to register the available land with the Office of Interstate Land Sales Registration. Description of various aspects of the land is then made available to interested parties (purchasers) by that office. The seller is required to offer the purchaser access to the registered statement. The developer must include in the description of land a statement of whether any of the land is covered by water at any time during the year or is subject to floods, hurricanes, or other natural hazards. The "existence, severity, and frequency" of the hazards must be fully explained.

On January 4, 1973, the Securities and Exchange Commission put forth Release #5347 under the Securities Act of 1933. The release advised that some condominiums and other units of real estate development are considered by the Commission to be securities, and, therefore, their sale is subject to the anti-fraud provisions of the Securities Act. Units coming under auspices of the act are those that include an offer or agreement to perform or arrange certain rental or other services for the purchaser, thereby creating an investment contract or participation in a profit-sharing agreement. The disclosure doctrine makes it necessary for the seller to apprise the investor of any natural hazards on the land.

5. The National Environmental Policy Act (Pulic Law 91-190) and Management of Federal Land and Facilities

The National Environmental Policy Act (NEPA) requires all Federal agencies to consider values of environmental preservation in their spheres of activity, and it prescribes certain procedural measures to ensure that such values are fully respected. An important aspect of the law is requirement of Environmental Impact Statements (EIS) for every report on proposals for legislation and other major Federal actions

significantly affecting the quality of the human environment.

Court cases have begun to clarify the role of the EIS, and one deals very explicitly with hazards. In the case of *Silva v. Lynn* (5ERC 1654, N°73-1200 Jy 5, 1973, 1st Cir), the Court of Appeals found that the Department of Housing and Urban Development, in filing an EIS for a housing development, dealt inadequately with flooding and drainage problems known to exist on the site and that the department could not take a myopic view of the project--that is, the drainage and flooding problems did not stop at the project's boundaries.

It appears that an EIS is particularly useful where the Federal government enters into a relief and rehabilitation project. An EIs compels the agencies responsible for relief and rehabilitation to examine closely the extent of, and the type of, aid they are offering to a particular community. Such aid can have a tremendous impact on future land use in a hazardous area, and if the agencies offering such aid use an EIS as a tool in evaluating their own programs, the type and extent of aid they offer may be considerably different from present practices.*

Finally, the Federal government can directly control the use of land in areas it owns. This comprises 33% of the nation's total land area, most of which is in the western states and Alaska. Management of these lands generally has been based on the multiple use concept. Within this framework there is ample opportunity to restrict the use of hazardous areas. These include landslide areas, avalanche areas and volcanic areas. Executive Order #11296 instructs all Federal agencies to give attention to the flood hazard in planning new facilities. This Executive Order should be broadened to include other hazards as well.

6. Water Resources Development Act of 1974

The Water Resources Development Act of 1974 authorizes the Corps of Engineers to consider "non-structural" alternatives instead of building levees and other protection works on waterways. These include acquisition of flood plains for recreational, fish, wildlife and other purposes; relocation of buildings and utilities away from the heart of a flood plain to reduce flood damage potential; flood-proofing of structures; and flood plain regulation. The Corps has not yet been authorized to spend funds to implement this provision except for two specific projects. The first

*In fact, Section 405 of the 1974 Disaster Relief Act specifically recognizes the applicability of NEPA to disaster relief and rehabilitation activities with a few narrow exceptions.

provides funds for moving structures out of the flood plain in Prarie du Chieu, Wisconsin. Money is provided for both relocating structures and demolishing and replacing certain structures on another site. The second project is the Chatfield Dam project on the South Platte River in Littleton, Colorado. Money has been authorized for the development of recreational facilities immediately downstream from Chatfield Dam, in lieu of channel improvement.

Since 1972 the Corps has been conducting a variety of urban studies. The 1975 funding for these projects is $10.5 million. These studies include such things as flood control, flood plain management and information, channel stabilization, outdoor recreation built into water projects, and lake, estuarine and ocean protection. All of this activity indicates that the focus of the Corps' work is shifting away from standard protection and control projects to other types of flood plain adjustments.

7. Miscellaneous

Public land agencies are increasing their efforts to either acquire or trade for specific parcels of land they believe should be part of the public domain. The Bureau of Land Management has shifted from disposal to reservation of much of the land under its jurisdiction.

An indirect Federal tool is siting of facilities that are likely to stimulate growth and development. Military installations are an example. By carefully attempting to project the various types of growth that would occur for a proposed site installation or center, growth in a hazardous area may be averted. The location of the Kennedy Space Center spawned a lot of private land development in an area that is highly vulnerable to hurricanes. If greater consideration had been given to the natural hazard, the Space Center might have been located elsewhere, avoiding a large increase in private property and lives-at-risk.

Summary

All these regulatory alternatives have evolved over the years. They provide policy makers and planners at all levels of government with a variety of tools to choose from. Unfortunately, and perhaps surprisingly there has been very little empirical evaluation of existing legislation and programs. No one has examined whether the purposes sought by the legislative acts have been realized, nor whether there have been any adverse impacts from existing legislation and programs that have allowed mismanagement of natural hazard areas. Little is known about what factors

contribute to the adoption or rejection of land use regulations. Why have some communities and states succeeded in enacting land use controls while others have failed? Knowledge of this process could be helpful to decision-makers who are attempting to get new land use regulations adopted.

CHAPTER V

SOCIAL FORCES AND INTERACTION OF ADJUSTMENTS

Hazard considerations and techniques do not exist independently of other social trends and forces. A number of variables not indigenous to the hazard system have profound influences on it. Here we discuss three categories of such variables--exogenous forms--which are particularly relevant to land use management.

Population Trends

Increased population implies increased hazard potential if the adjustment level remains the same and if natural elements of the hazard system remain the same. When greater numbers of people and greater volumes of capital investment are subjected to given natural hazards, losses will tend to increase accordingly.

Vulnerable population and property will increase for at least another half century, as depicted in Figure V-1. The different curves result from differing assumptions of average fertility rate for the projected time period, with the fertility rates presumed to reflect social values such as number of children desired per family and health conditions such as disease rate. In support of the concept of projecting a range of populations rather than a point, Keyfitz (1972), p. 360) states:

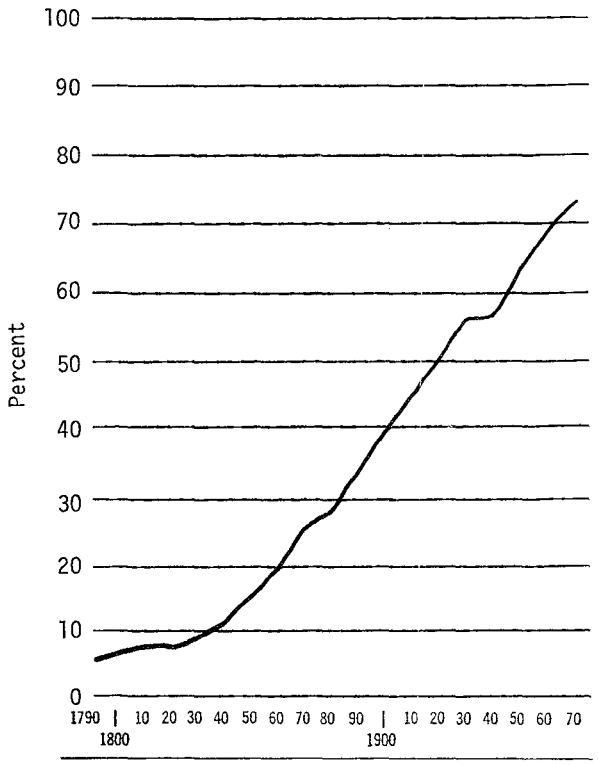
> . . .if I had to give one number, I should say 280,000,000 for the United States in the year 2000. But I would be unwilling to lay 19 to 1 odds on any range narrower than 240 to 320 million.

According to the OBERS Report (U. S. Water Resources Council, 1972), population will increase between 45.2% and 18.7% by 2020. Of more interest is the spatial distribution of people and property.

The nation's population is clustering. As Figure V-1 shows, the percent of the population residing in urban areas has grown steadily throughout history, and the trend is expected to continue (U. S. Bureau of Census, 1970).

FIGURE V-1

PERCENT OF POPULATION URBAN: 1790-1970



This trend implies an increasing catastrophe potential. Statistically, for a given number of hazardous events affecting a uniformly or randomly distributed (but non-clustered) population, the magnitude of losses per event should be approximately the same. With a clustered population, however, the variance of losses is much greater. For some events, losses will be less than those for a uniformly distributed population. Conversely, some events will result in disasters greater than those for a uniformly distributed population. Fortunately, the numbers of people in the large urban areas of the nation (greater than one million population) are not increasing at as fast a rate as they were in the first half of this century.

Land use management can aid in reducing the loss potential of the trend toward urbanization by regulating and guiding development. In fact, much of the recent land use legislation by states attempts to do

this. The 1972 Florida Land and Water Environmental Management Act, passed partially in response to conditions compounding the South Florida drought of 1970 and 1971, contains controls on "developments of regional impact" which are designed to prevent projects that would stimulate growth beyond the region's ability to accommodate it. The effect of the law is to limit the spatial concentration of people and activities.

Not only is the population clustering more, but some parts of the country are growing faster than others. Growth appears to be greatest in the West, some parts of the South (especially Florida), and parts of the Middle Atlantic region. These trends suggest little for overall national hazardousness (for example, one would be hard put to say in what regions of the United States greatest growth should occur in order to minimize the increase in hazardousness), but they do suggest that losses due to earthquakes, tsunamis, hurricanes, landslides, avalanches, volcanoes, coastal erosion, and urban drought will increase.

One trend seems particularly important. This is the migration of large numbers of people to our coastal areas. Whereas the national rate of population increase from 1960 to 1970 was 13.3%, the Gulf and Atlantic coastal states grew at a rate of 15.1%. The coastal counties of those states grew at a rate of 19.3% and the coastal census subdivisions of those counties grew at a rate of 42.5% (U. S. Bureau of Census, 1970). Atlantic and Gulf coast growth rates increased with proximity to the coast, with places nearest the shoreline growing almost four times as fast as the national average. A similar trend exists for the Pacific Coast. This rapid growth suggests a special concern for hurricanes and coastal erosion.

As discussed in Chapter IV, there are numerous land use techniques that have been applied to regulate development along the shoreline and in the hurricane hazard zone, although most were prompted by environmental concerns rather than hazard considerations. One encouraging point about the coastal growth is that rates of growth are faster along the Gulf and South Atlantic shores than along the North Atlantic. This is encouraging from the point of view of adjustment, because 71.7% of the South Atlantic and Gulf coasts is undeveloped, whereas only 29.8% of the North Atlantic shore is undeveloped (Corps of Engineers, 1971). Where growth threatens most, the potential for the adoption of effective land use controls appears greatest.

There has also been an increase in recent years in the employment of land use controls for other hazards. Therefore, it is possible that the rate of increase of losses from natural disasters may not keep pace with population trends.

Social Values and Guidance

In recent years public concern has surfaced and asserted itself in at least five interrelated areas which have bearing on the management of hazardous areas: (1) consumer protection, (2) environmental impact, (3) recreation demand, (4) property rights, and (5) agricultural land. These social issues are implicit in other discussions of land use management, but their relevance will be explicitly treated here.

We have seen a growing emphasis by special interest groups, the public, and government on the rights of the consumer to be protected against faulty or unsafe products, and misinformation or omission of relevant information about products offered for sale. Although the more spectacular and well-known examples of consumer protection have concerned items such as automobiles, the concept has also been applied to land and facilities.

One function of building codes is to assure minimum levels of safety for occupants and buyers of structures. Several other land use measures discussed earlier are consumer-oriented: subdivision regulations guard against the development of property in a manner which could result in undue endangerment to buyers; the Interstate Land Sales Full Disclosure Act requires that buyers be apprised of information about the vulnerability of property to hazards; and the Securities and Exchange Commission can require disclosure of hazardous conditions which may affect the value of condominiums and other properties sold as securities.

Growing public participation in planning and legislative activities is a result of the consumer movement. This has found its way into hazard zone management. Public hearings are used as a means for the public to make its views known to lawmakers, and their popularity is increasing. Planners, too, are recognizing the need for public input. For example, the Northeastern Illinois Planning Commission recently organized the Storm Water Conference where decision-makers (elected officials) met to discuss the problem of disposing of stored floodwaters. A significant part of the input at the meeting was information gathered from meetings with flood victims in their own communities and from a

telephone poll (Rockwell, 1973). There has been a notable increase in citizen participation in local land use control decisions (Levin, 1969; Renter, 1971).

The environmental movement has had considerable influence on land use legislation. Environmental legislation often has had the effect of regulating development in hazardous areas. At the Federal level there have been a host of legislative efforts (notably the National Environmental Policy Act) which affect hazard zones to varying degrees. States have passed general land use laws (often containing provisions for "areas of critical environmental concern" and, less often, hazard zones), coastal zone protection laws, wetlands preservation laws, and other miscellaneous environmental legislation.

Local governments have been active in solving environmental problems. However, more often their role has been one of providing open space, greenbelts, and parks to accommodate the expanding demand for outdoor recreation. State and Federal agencies are also involved in the acquisition of land for recreation; frequently, acquired open space includes a hazardous area. Because the land is publicly owned, loss-prone uses can be excluded. A liability of the recreation/open space demand, however, is that vacation homes, condominiums, and related facilities are becoming more popular in mountain regions and near the seashore, where recreational and aesthetic opportunities abound. These areas, however, are often subjected to avalanche, landslide, hurricane, and coastal erosion. The need for land use controls may be exacerbated by the development of recreational homes.

All these environmental, recreational, and open space concerns have caused a re-examination of the "land ethic." For years land use has been regarded as a commodity, but now it is coming to be recognized as a resource in which all of society has a vested interest. The following passage is from The Quiet Revolution in Land Use Control:

> Basically, we are drawing away from the 19th century idea that land's only function is to enable its owner to make money. One example of this change in attitude is that wetlands, which were once characterized as "useless," are now thought of as having "value." As we increasingly understand the science of ecology and the web of connections between the use of any particular piece of land and the impact on the environment as a whole we increasingly see the need to protect wetlands and other areas that were formerly ignored. . . .

> The new attitude toward land can also be seen reflected in the increasing concern about its scarcity (Bosselman and Callies, 1971, pp. 314-315).

The re-evaluation of the use and value of land has led to a readjustment of the popular view of "property rights", the legal treatment of which is discussed in Chapter II of this volume. Governmental intervention into the management and use of private property historically has been constrained by an attitude that owners should be able to do whatever they wish with their land as long as they do not unreasonably or adversely affect the welfare of others. The public view of reasonable and direct effects has changed as the concept of property rights has changed. Some of our recent legislation reflects these changes.

One recent task force on land use policy believes that our legislation is lagging behind current social values:

> Our examination of the takings issue has persuaded us that there are two principal problems involved. The first stems from the many judicial precedents (including some from the U. S. Supreme Court) that date from a time when attitudes toward land, natural processes, and planning were different than they are today. Many precedents are anachronistic now that land is coming to be regarded as a basic natural resource to be protected and conserved and urban development is seen as a process needing careful public guidance and control.
>
> The second principal problem is widespread misunderstanding of the constitutional language and its interpretation. Ignorance of what higher courts have actually been willing to sustain has created an exaggerated fear that the restrictive actions will be declared unconstitutional. Such uncertainty has forestalled countless regulatory actions and induced numerous bad compromises (Reilly, 1973, pp. 146-147).

Nevertheless, land use regulations--inside as well as outside of hazardous areas--have been accelerated by the new land ethic and will continue to be so affected.

Open space land uses are generally less loss-prone than intensive land uses. Agriculture is one such open space use. In the past decade new concern with maintaining land in agricultural uses has arisen. As urban areas expand to the edge of agricultural land, economic pressures have forced the conversion of farm land to more intensive uses. Proponents of protecting our agricultural land have raised several important arguments. Agricultural uses provide buffers between urban places which may be desirable from an environmental standpoint, such as protecting

aquifer recharge areas. It may be reckless to allow the total amount of agricultural land to fall below a certain level either nationally or regionally. Finally, urban sprawl may be taking the "better" agricultural land, leaving less suitable land for farming and causing marginal land to be brought into cultivation.

There may be valid economic arguments against these concerns, but they will not be dealt with here (see Vogel and Hahn, 1972). The important thing is that some segments of society have determined (rightly or wrongly) that agricultural uses should be encouraged and preserved through tax inducements and other means. This may reduce the loss potential from disasters since much agricultural land is located in hazardous areas, particularly in flood plains.

In summary, social values and guidance changes have mixed bearing on hazard zone management. Some forces are acting to increase the need for land use controls, but others are acting to make such controls less necessary. The trends must be evaluated with respect to their net benefits to society, not just their relationship to hazard losses.

Public Finance Policies

In the arena of land use management, public finance policy is a critical element in the success or failure of such efforts. If public finance policy is not coordinated with a community's land use management scheme, one will likely undermine the other. If a community builds water and sewer lines to the line of a flood plain zone, the pressure for extending such services into the flood plain may be irresistable. Similarly, the location of an industrial zone too close to a hazardous area will, in time, generate pressure on the municipality to extend its services into the hazard zone to allow expansion of the industrial zone into the hazardous area. The location of highways, particularly interchanges, too close to a hazardous area will also generate pressure from developers to permit construction in the hazardous area.

1. Planning

Until the last five or ten years, public financial support for land use planning has been directed at the local level. State land use management programs have only recently begun.* At the local level, funds

*See Chapter IV.

have come from direct appropriation of state revenue and/or matching planning grants to local governments through the U. S. Department of Housing and Urban Development 701 Programs. Many states have now appropriated funds for planning at the state level; an example is the Florida Land and Water Environmental Management Act. State support appears to be on the increase. At the Federal level, many programs are aimed at fostering sound land use management. While not exhaustive, the following list gives examples of the more prominent planning programs:

(1) Federal Land Use Policy Planning Act [pending]
(2) Coastal Zone Management Act
(3) U. S. Department of Housing and Urban Development 701 Program
(4) Land and Water Conservation Planning Grants
(5) Water Resources Development Act

The trend within the large Federal land management agencies (U. S. Forest Service, Bureau of Land Management, National Park Service) is toward more land use planning. This is a reflection of the increased demand for the use of such land, and the recognition by those managing such lands of the value of planning.

2. Acquisition

Acquisition has not been as extensive as planning. However, there are several noteworthy Federal programs which provide funds for acquisition of land. Again, while not exhaustive, the following list is representative of current Federal acquisition programs:

(1) U. S. Department of Housing and Urban Development Open Space Program
(2) U. S. Department of Housing and Urban Development Urban Renewal [some aspects]
(3) Land and Water Conservation Act
(4) Historic Preservation Act
(5) Water Resources Development Act*

Just as the Federal government is increasing its expenditures for public lands, so also are many states. Several state laws have been enacted for purposes of acquiring land for public use, and these states are appropriating large sums of money for such land purchases.**

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*This act is discussed in some detail earlier in this work.

**Florida has appropriated $500,000 for acquisition of critical environmental areas.

At the local level some interesting programs have been enacted. One example is the Boulder, Colorado, open space or greenbelt program funded by an optional sales tax. Boulder's experience indicates that if an acquisition program is to have a significant impact on land use, it must be tied into a carefully articulated comprehensive plan that is implemented by appropriate regulations. Part of such a plan must include the location of highways, utilities, sewer and water lines and public buildings.

Land Use Management and Alternative Adjustments

Seldom is a single adjustment the only appropriate one. Managers must decide which adjustment or mix of adjustments best suit their goals. When a site is prone to more than one hazard, the situation may be more complicated; the best adjustment for one hazard may be quite different from the one for the other hazard.

With any pair or combination of adjustments, one interacts with another's appropriateness, necessity, and efficiency. It is difficult to draw detailed conclusions regarding the interrelationships because they vary from hazard to hazard. However, some generalizations regarding the interaction of land use management with each of several other classes of adjustments seems feasible.

1. Control and Protection Works

Most studies about the interrelationships of control works and land use management have been carried out on floods, but even those conclusions are not universally accepted (see White, *et al.*, 1958). Regardless of the hazard, if control and protection works are built, they are engineered to withstand a certain magnitude of hazard. If the rare, large event occurs, the structure may not be designed to control the elements of the hazard, and activities situated in the hazardous area become victims of the event. With the control work, losses will be less frequent, but when losses occur, they may be greater than if no protective work had been built.

Land use management can complement a control work to prevent unwise encroachment in the protected area. Some optimum level of protected land to be managed under restricted conditions must be determined. In some cases, if that optimum level is near 100% of the protected land, the management scheme may completely obviate the need for the control

work. Economic models such as Whipple's (1969), however, have indicated that a combination of land use measures with control works yields a better solution than either adjustment by itself. The results of a refined model that measures ecological and environmental benefits and costs may shift the combination further in one direction or the other.

2. Structural Modifications

Modifying facilities structurally is, in effect, a form of land use management. A facility which is structurally modified to withstand the effects of hazardous elements indigenous to the area may be considered a compatible use of the land. One form of land use regulation is to require buildings and other facilities in a hazardous area to be constructed to be compatible with the elements of the hazard.

3. Warning and Emergency Actions

The ability of forecast and warning systems to provide adequate time for emergency actions in anticipation of a hazard event varies considerably with the hazard. Hurricanes, for example, are predicted reliably enough to assure at least six hours of daylight lead time before the storm arrives. Earthquakes, on the other hand, cannot be predicted accurately enough for the warning to have any effect. Even the best predictions of hurricanes, however, have their greatest payoff in savings of human lives; the bulk of property losses is not averted by warnings.

Land use management schemes ordinarily do not exclude all human activity from the hazard zone. Warnings are still needed, even when good land use management is in effect. Neither adjustment should function alone.

4. Insurance

Insurance distributes the losses among risk-takers. To make *subsidized* insurance effective, however, land use requirements are a necessity. Otherwise, the subsidy, in effect, would be a grant to users of hazardous areas.

5. Relief and Rehabilitation

Relief (the immediate provision of disaster-related services) and rehabilitation (restoration and maintenance of the community and its components) after a hazard event can be facilitated, but not replaced, by land use management techniques. By reducing the loss potential (and

presumably, actual losses), land use management eases demands on relief and rehabilitation activities during the post-disaster period.

Land use schemes are seldom designed to avert all losses. Post-disaster services will still be required even if land use measures are adopted. Land use managment is designed, like control works, to cope with a particular magnitude of hazard. It is a mistake to assume that that magnitude will not sometime be exceeded.

6. Conclusion

Little of a quantitative and specific nature can be said about the interaction of land use management with other adjustments. To maximize the effectiveness and efficiency of the adjustment process, and particularly to facilitate the general planning apparatus, more needs to be known about these interrelationships.

An increased understanding of the role land use management can play in reducing life and property loss from natural disasters is vital if we are to avoid crippling economic dislocations. With increasing property losses from disasters and the consequent escalation in Federal expenditures for relief and rehabilitation, the Federal government is beginning to look closely at less conventional adjustments that appear to hold some promise of reducing Federal budgetary expenditures for disaster activities.

CHAPTER VI

RESEARCH OPPORTUNITIES

There are many considerations to land use strategies beyond that of loss reduction, and they need to be integrated and measured more cautiously than has heretofore been the case. Similarly, there are numerous alternatives available for managing hazard zones which need to be evaluated more thoroughly and considered in various combinations. Some legal and policy issues are still unresolved; our concept of property rights is changing. Environmental policy is in a state of flux. These issues must be monitored carefully for their relevance to hazard zone management.

Judgments growing out of the analysis in the preceding chapters are brought together here to suggest what appear to be the more promising lines of research. The proposals promise results that could improve the effectiveness of national and local use of our lands located in natural hazard areas. While it is true that the results of such investigations might not bring the anticipated benefits, the adoption of proper land use management in natural hazard areas seems to be so vital that failure to explore the problems will probably result in an increasingly heavy burden on relief and rehabilitation activities.

Needed research is of two basic types. First, we propose four research areas which can be evaluated somewhat differently with respect to each of 15 hazards. The feasibility of the research, the extent to which such research is currently underway, and the recommended priority of the research varies from hazard to hazard. A second category of proposals includes five research areas which are essentially cross-hazard in nature, that is, the approaches to and findings of the research need not vary among hazards. The research can be approached independently of consideration for a particular hazard.

None of these proposals are to be treated as separate entities. They are part of a broad attack on scientific, economic, and social problems that are associated with natural hazards. Furthermore, the research recommendations necessarily overlap with one another to some

degree. The reader is reminded that there exist specific collateral proposals for research in other volumes of this series.

Hazard-Specific Research

1. Areal Delimitation Methodology

Areal delimitation of hazardous areas is necessary before any land use regulation can be enacted. Chapter III discussed numerous tecnniques currently used for mapping hazard zones. Other mapping techniques are currently under investigation. Hazards vary with respect to the present ability of scientists to map them.

One particularly promising avenue for investigation involves utilizing more fully the potential of remote imagery from earth resources satellites. Flood plains may be delimited more quickly and accurately by employing satellite imagery keyed to correlations by soil type, surface slope, and vegetative cover. Other information such as seismic and geologic features, can be extracted from the imagery with some small increments in technical capacity. Integration of these data with computer simulation models could result in significant payoff in delimiting hazardous areas. Hurricane storm surge has been successfully mapped in recent years through this approach.

Current research emphasis on areal delimitation methodology is greatest for flood, earthquake, landslide, hurricane storm surge, and coastal erosion. Present expenditures for investigations of the type recommended here are less than $100,000 annually for each of those five hazards. Funding should be increased to three to five person years* annually for each of these hazards, and should be maintained over the next four or five years. Earthquake and hurricane storm surge should receive priority, followed by flood, landslide, and coastal erosion. Avalanche, volcano, windstorm, and possibly hurricane wind merit secondary attention. Some of the research findings for one hazard will have utility for other hazards. Coordination of research and exchange of progress reports among investigators is essential.

In assigning priorities for hazards, we consider (1) feasibility of the research, (2) present level of development of delimitation

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*A person year is the amount needed to support one research worker, including staff and travel, for one year; currently $60,000.

methodology, and (3) property and lives at risk. The first two components in the evaluation are presented in Table VI-1. Priority ratings also appear in the table.

The National Oceanic and Atmospheric Administration, Corps of Engineers, Geological Survey, Soil Conservation Service, and National Atmospheric and Space Administration should have major responsibility for this research. Private and university research groups should supplement the agency research.

2. Adoption Factors

Chapter II and III enumerated the various components which may enter into a decision regarding the adoption or rejection of a given hazard zone management strategy. We know very little, however, about the actual considerations involved, or how the considerations have been weighted when communities or states have considered enactment of land use regulations. It is known that real estate developers often attempt to influence hazard zone land use decisions, but the extent to which their influence is felt is not known. We also do not know how strategies employed by advocates in favor of and in opposition to restrictive land use policies have fared.

When the Flood Disaster Protection Act takes effect on July 1, 1975, it will provide an excellent opportunity to monitor the decision-making apparatus of numerous communities. As of September 15, 1974, there were 26 communities which originally had expressed a desire to participate in the flood insurance program, that had either withdrawn or had been suspended by the Flood Insurance Administration for failure to enact the required land use controls. This was a decrease from 43 on January 31, 1974. It is apparent that several communities have reversed their policies since January. These communities would be interesting subjects for "post audit" inquiries.

The same three types of criteria used to determine priorities for areal delimitation research are applied to adoption and summaries appear in Table VI-1. Current research into adoption factors is minimal, with only a smattering of studies such as Simkowski's (1973) and Emmer's (1974) having been undertaken. Flood, hurricane storm surge, landslide, and possibly coastal erosion and earthquake should receive priority attention. Two to three person years annually over perhaps ten years should be funded for flood and hurricane storm surge, and one to two person years

TABLE VI–1

FEASIBILITY, PRESENT LEVEL, AND PRIORITY OF RESEARCH BY HAZARD

EVALUATIVE CRITERIA	RESEARCH AREAS	Avalanche	Coastal Erosion	Earthquake	Drought	Flood	Frost	Hail	Hurricane storm surge	Hurricane wind	Landslide	Lightning	Snow	Tornado	Tsunami	Volcano	Windstorm
FEASIBILITY	Delimitation	●	●	●	○	●	○	○	●	◪	●	○	○	○	●	●	◪
	Adoption	◪	◪	●	○	●	○	○	●	◪	●	○	○	◪	◪	○	◪
	Effectiveness	◪	◪	●	○	●	○	○	●	◪	●	○	○	◪	◪	○	◪
	Coordination	◪	●	◪	●	●	○	○	●	◪	●	○	○	○	●	◪	◪
PRESENT LEVEL OF RESEARCH	Delimitation	◪	●	●	○	●	○	○	●	◪	●	○	○	○	○	○	○
	Adoption	○	○	○	○	◪	○	○	◪	○	○	○	○	○	○	○	○
	Effectiveness	○	○	○	○	●	○	○	○	○	○	○	○	○	○	○	○
	Coordination	○	○	◪	◪	◪	○	○	◪	○	○	○	○	○	○	○	○
PRIORITY	Delimitation	◪	●	●	○	●	○	○	●	◪	●	○	○	○	◪	◪	◪
	Adoption	◪	●	●	◪	●	◪	◪	●	◪	●	◪	◪	◪	◪	◪	◪
	Effectiveness	◪	●	●	◪	●	◪	◪	●	◪	●	◪	◪	◪	◪	◪	◪
	Coordination	◪	●	●	●	●	○	○	●	◪	●	○	○	○	◪	◪	◪

SCALE *

● denotes High ◪ denotes Moderate ○ denotes Low

*See text for discussion and quantitative specifications

annually over the same period should be spent on landslide, coastal erosion, and earthquake. Large-scale, integrated research on the adoption process as it applies to other hazards does not appear feasible at this time.

This research should be delegated to non-government research groups in positions to monitor land use regulation decisions in their local areas over time. A reserve of funds should be held for research as prime opportunities present themselves. In the short run, several groups (coordinated with interested Federal agencies, the Council of State Governments, and the League of Cities) should undertake post-audit investigations in communities that have recently made hazard zone regulation decisions.

3. Effectiveness Evaluation

Despite our ability to cite examples of regulatory and management alternatives employed at various levels of government, we can say very little about how successful the strategies have been in achieving their desired goals, or what other effects they may have had. The only major exception is the effect of grading regulations and engineering geology on reducing landslide damage in Los Angeles. Even in that case, it is difficult to be certain which actions are responsible for these savings. Equally important, there is no way to determine what effects other than landslide loss reduction resulted from the grading and engineering requirements.

For each of the hazards treated in this volume, communities, states, and regions (through Federal impetus) that have adopted land use controls should be investigated to determine the effects and effectiveness of the regulations. A study of these entities should have controls for various characteristics (urbanization, economic growth) that might skew the conclusions of the investigation. After determining the effects of the land use strategies, the locales should be compared with a group of similar entities that have not enacted such regulations.

In addition to assessing the success of regulations in reducing losses of lives and property-at-risk, the social impact of these regulations should be investigated. Employment, social amenities, environmental quality and open space, and welfare of individual property owners are among some of the possible impacts that may be beneficial or detrimental to the welfare of the community.

Because of their frequency, flood, hurricane storm surge, coastal erosion, landslide, and earthquake need immediate attention. At least three person years per hazard annually for two years should be funded for post-audit investigations of sites that have had some type of controls in effect for a minimum of one year. Funding should continue at a rate of one to two person years annually over a five year period to monitor the effects of regulation over a long period of time. Table VI-1 summarizes the evaluation. The division of labor for this research should be similar to that for study of the adoption factors.

4. Coordination of Measures for Enhancement of Integrated Planning

Throughout this volume we have stressed that hazard-loss reduction is only one consideration in the management of hazard zones. Moreover, hazard zone management is but a single aspect of the general planning and management process. Indeed, much of the regulatory action relating to hazardous areas has come about because of concerns with environmental quality, rather than as a result of identification of areas hazardous to human occupance.

Research is needed to develop programs of imaginative quality that combine the diverse objects of different programs for urban areas. At present, urban renewal is virtually the only Federal program available to communities that are attempting to regulate land use in natural hazard areas. Usually urban renewal money becomes available only after a natural disaster has struck. Urban renewal is frequently inappropriate as a method of combining urban programs with land use management in natural hazard areas.

Until we develop a more comprehensive view of the interrelationships of various Federal, state, and local programs, we cannot really expect to understand the dynamic interactions involved in the adoption and the social effectiveness of land use measures. While we are able to recognize that certain forces appear to be highly undesirable in managing natural hazard areas (urban sprawl), these forces are a result of a complex series of laws and administrative regulations that bind together political, economic, and social decisions. The unravelling of these interrelationships is a necessary step in comprehending the dynamics of adoption and the effective management of land in natural hazard areas.

There have been sporadic efforts to combine diverse goals in hazardous area management. Flood plain parks are a conspicuous example. Siting of highway overpasses to avoid places where strong winds are funneled, and siting power plants away from zones of high seismisity, are not uncommon. In the 1973 Florida legislative session, a bill setting up statewide flood plain (riverine and coastal) land use zones was introduced. Its author felt that the bill would be an excellent way to achieve the environmental goals of several proposed wetlands and coastal zone bills.

Planning is likely to assume an increasingly important role in shaping public policies and environmental strategies. A sample of communities and states that have tried integrated planning approaches should be studied to assess the role hazard concerns have played in the development of policies and the actual programs that were adopted. Such investigation should include an analysis of how natural hazard concerns could have been better integrated into the programs that were adopted. It is suggested that integrated land management programs that incorporate hazards as an element in the management program have been under-utilized. There is scant evidence that overall planning has tried to combine elements of social planning, transportation planning, facility siting natural hazards, recreation and natural resource uses into a set of consistent land management policies.

Organized research into the co-ordination of planning and policy tools for developing integrated management programs of hazardous areas is practically non-existent. This is not to suggest, however, that planning groups have not given the problem considerable thought. Research efforts are needed to assess methodically possible combinations and linkages of available strategies, perhaps through a systems modelling approach. Simulations could be run in the laboratory, and "real world" examples could be collected and integrated into "ideal" solutions.

Some results may be attainable in the short run, but taking account of the shifting policies of public agencies, the impacts of the exogenous forces which shape those policies, and the intricate administrative obstacles to policies pushes the effort into a long run endeavor.

This type of research is feasible for all hazards with the possible exceptions of frost, hail, lightning, snow, and tornado. Coastal erosion, drought, earthquake, flood, hurricane storm surge, and landslide should each be allocated funds on the order of twenty person years each,

distributed over a ten year period. Avalanche, tsunami, volcano, windstorm, and hurricane wind should be allocated funds of five to ten person years each over a ten year time span.

Some of the funds should be allocated to a cross-hazard approach. A major part of the cross-hazard effort should include an ongoing examination of existing statutes and regulations that affect public and private land use decisions. The investigative findings of social, economic and political forces should be translated into any proposed changes in existing statutes and regulations.

Non-government research units should probably bear the brunt of the research responsibility, but numerous Federal agencies and organizations should be involved in some capacity. The Department of Housing and Urban Development, the Environmental Protection Agency, and the Council of State Governments are but a few examples.

Cross-Hazard Studies

1. Examination of Federal Land Use Policies

While the Department of Interior and the Department of Agriculture have taken a much closer look at their management programs of Federal lands in recent years, there is little evidence that these agencies have examined their land management programs as the programs may affect the decisions of private landowners or other units of government in regulating land use. Just as the Army Corps of Engineers has discovered that its control and protection works may have a broad impact on the use of flood plains, similar decisions to develop Federal lands for recreation or to extract natural resources can also have a large impact on the development of private lands in adjacent or distant areas. Without consideration of these interactions, uneconomic use of land in natural hazard areas may occur.

Investigation of the interactions of Federal land management policies with private land use decisions should continue for at least five years. Such an effort should be based in a non-government group, but in close coordination with the Federal agencies that have responsibility for managing our Federal lands. A thorough review of existing legislation and regulations should be undertaken to determine the impacts of our existing management policies on private land use decisions. While it is recognized that some major revisions of statutory authority for the Department of Interior and the Department of Agriculture for managing our Federal lands

is underway, nevertheless, it is strongly felt that research of this sort, if it were undertaken immediately, would have a large impact in the shaping of this legislation. No less than 30 person years should be committed to this important research.

2. Examination of Federal, State and Local Tax Structures

Careful consideration of our Federal, state and local tax laws is needed to determine the incentives and disincentives for locating in natural hazard areas that exist in our tax structure. The lack of coherent tax policy towards uneconomic use of natural hazard lands poses enormous difficulties in adopting and managing a meaningful land use program for these areas. Furthermore, as this volume has indicated, there may exist other strong disincentives in our tax laws that act as obstacles to the adoption of land use regulations in our natural hazard areas. The casualty loss provisions in the Internal Revenue Code and our relief and rehabilitation programs are conspicuous examples. While the motives for such legislation may be beyond reproach, whether they actually encourage people to move into natural hazard areas is an important unanswered question. Finally, as is so often the case in our tax laws, questions of equity appear to be of some importance: (1) who presently is benefiting from our tax laws; and (2) what would happen if we were to change our property tax laws, our casualty loss deductions and our relief and rehabilitation programs.

Investigation of our tax laws as they affect our programs towards natural hazards, either beneficially or adversely, is very urgent. We do not even know the extent of Federal income tax deductions for casualty losses claimed as a result of natural disasters. No less than 20 person years over five years should be allocated for such research. There exist several private research groups that specialize in the study of our tax laws at both the Federal and State and local levels. Such a research group might appropriately carry on such a research program in conjunction with the Internal Revenue Service and the Council of State Governments and the League of Cities. The findings of the research should be translated into appropriate legislation at all levels of government.

3. Examination of Public Finance Policy

Examination of public finance policy as it affects land use decisions in natural hazard areas is virtually non-existent at all levels

of government. Except for Executive Order 11296, the Federal government has given scant consideration to the siting of Federal facilities in natural hazard areas. Federal projects, such as highways, do not ordinarily consider the impact they might have in encouraging people to move into natural hazard areas. State and local units of government haven't done much better. Until the recent enactment in some states permitting state engineers to review subdivisions for obvious geologic hazards, the states exercised virtually no control over development of land in hazardous areas. The states still have not recognized that they can control much undesirable development through a coordinated public finance policy. The controlled development of highways, governmental services, state water resources, electrical energy resources, recreational facilities, and institutions of higher learning will affect the development of land within the state in a vital way. Local units of government have rarely considered what impact providing local utilities, fire and police protection, and other governmental services may have in regulating growth at the local level.

New programs are being initiated to develop orderly communities that do not violate the environment. TVA, for example, has launched a program to develop a series of rural villages in Tennessee and Alabama that will be strategically located so as to halt rural sprawl. Crucial to the success of such a plan is a firm determination by local units of government to resist the pleas of strip developers for local services.

Investigation of public finance policy offers great potential to bring order to our sprawling cities and to prevent further encroachment into our natural hazard areas, and should be pursued with great vigor. It is estimated that no less than 50 person years over ten years will be necessary to conduct an adequate survey of our public finance policies. The research should be conducted by a private group with broad contacts at all levels of government. The findings of the research should be disseminated on a continuous basis, and appropriate legislation should be drafted to implement the findings. National seminars of Federal, state and local officials should be held annually to exchange new information, proposals, and experimental programs.

4. Examination of Housing Programs

The expanding Federal roles in the home construction industry, in the financing of homes through VA and FHA loans, and in a variety of

urban renewal projects deserve special evaluation of their impact on development in natural hazard areas.* Because of the large sums of money put into these programs annually, they are the fundamental shapers of our urban communities.

A modest investment of six person years over two years by a private group in conjunction with the Federal agencies responsible for the various housing programs could result in the development of significant regulations that would control the construction of housing developments onto known hazardous areas. The potential savings to the government are very large in terms of reducing the need for future relief and rehabilitation operations.**

5. Effects of Relief and Rehabilitation Activities and Insurance Programs on Land Use Management Programs

Initial investigation of problems of land use in natural hazard areas has uncovered strong indicators that Federal programs may be working in ways that are actually encouraging people to locate in hazardous areas. We need to know what type of relief and rehabilitation programs may be used in conjunction with other measures to guide the course of development in the nation's natural hazard areas while assuring an efficient and sensitive response to the needs of disaster victims. The means of harmonizing these programs is not yet apparent, but the wide ranging

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*VA and FHA have approximately $10 billion allocated for fiscal year 1974-1975 for two major mortgage purchasing programs. Approximately $6.6 billion is for VA and FHA "tandem" mortgages and about $3 billion is for conventional mortgages. The "tandem" program makes loans through the National Mortgage Association (a Federal agency, nicknamed Ginny May) and the Federal National Mortgage Association (a private corporation, nicknamed Fanny May) buys the paper. The interest subsidy, presently about 2 1/2 to 3% below conventional bank loans, is the difference between what the home buyer pays and what the mortgage buyer receives.

The $3 billion forward commitment program of the Federal Home Loan Mortgage Corporation is channeled through commercial banks and savings loan groups for the purchase of conventional mortgages with no discount points. The subsidy is direct, with interest rates presently at 8 3/4% on 90% and 95% loans.

**An accurate estimate of potential savings is not possible. We do not even have data on losses sustained by the VA and FHA from foreclosures on home loans resulting from destruction of real property due to natural disasters. In terms of these agencies' portfolio management programs these losses can be expected to become a much larger uncontrollable item in the future unless present trends are changed.

implications of the 1974 Disaster Relief Act should be closely watched, since it will put many theories to the test.

As another volume in this series indicates, our experience with flood insurance has not been satisfactory to date. At present, a thorough examination of insurance is in progress; however, a special investigation needs to be conducted to assess all-risk insurance. It would deal with the whole range of natural hazards. We need to compute the actual or expected costs of each adjustment to the government and to individuals; how each adjustment shifts benefits and costs to or from the individual land owner; in what ways an all-risk insurance program may encourage or discourage wise use of land in natural hazard areas; how an all-risk insurance program might be structured to discourage uneconomic use of land in natural hazard areas; and if an all-risk insurance program is to be adopted, who should administer it.

Investigation of the relationship between relief and rehabilitation programs and land use programs in natural hazard areas for a period of five years at a cost of four person years annually seems warranted. The impact of insurance on land use management programs should be a part of comprehensive investigation of all-risk insurance. It is estimated that at least five years at a cost of two person years annually are necessary to investigate the impact of all-risk insurance on land use management programs.

Summary

Because of recent concern about environmental quality, the United States has experienced a wave of efforts to prescribe socially desirable land use strategies. Refinements in regulatory and evaluatory techniques for achieving these land use goals have been accomplished, and the social and political climates until recently were ripe for enactment of laws and programs dealing with land use. The role of hazardous areas in the movement has generally been a secondary one, but not necessarily unimportant. There is a major opportunity for efforts in managing hazard zones to benefit from the present circumstances. There is also a large opportunity for such efforts to make valuable contributions to the more general goal of wise land use management.

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