# PROCEEDINGS: INTERNATIONAL SYMPOSIUM HOUSING AND URBAN DEVELOPMENT AFTER NATURAL DISASTERS

# *POST DISASTER RESPONSE AND MITIGATION OF FUTURE LOSSES*

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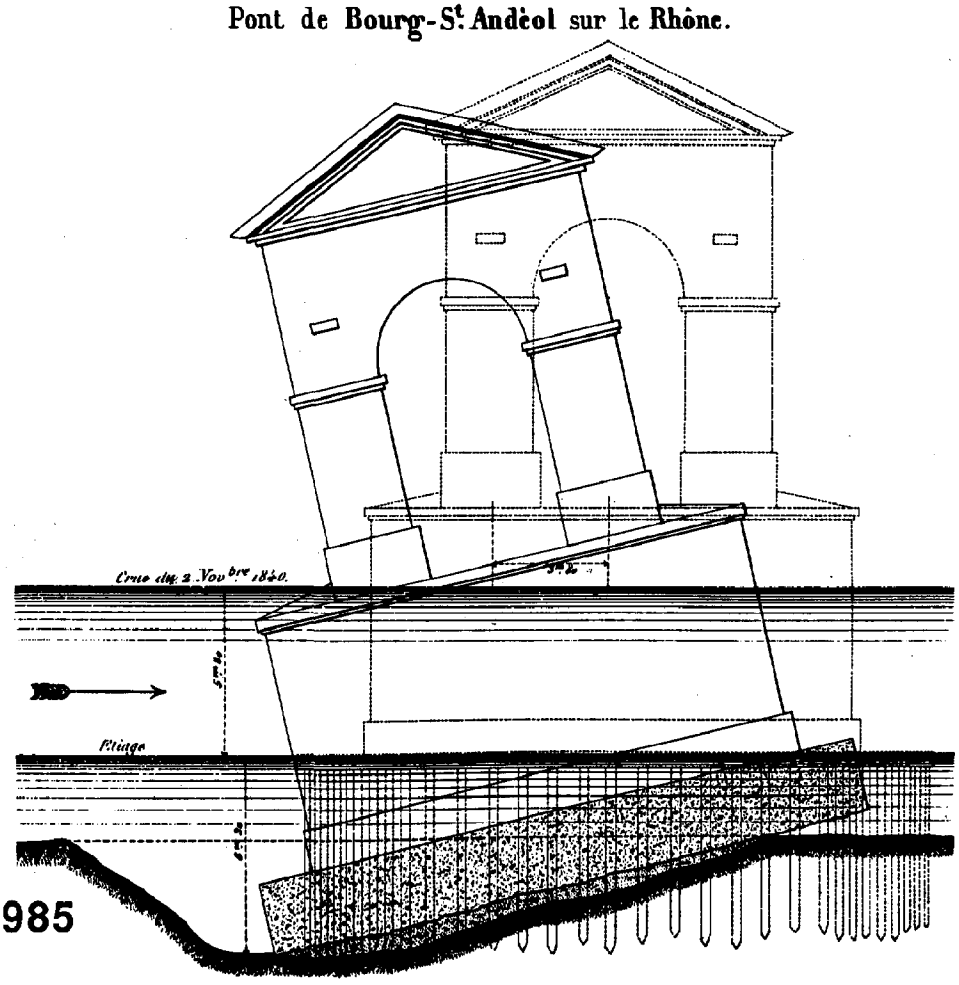


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**October 23-26, 1985**
**Miami, Florida**

**Jon. A. Kusler (Ed.)**

**American Bar Association**
**Special Committee on Housing and Urban Development Law**

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Proceedings of an International Symposium

Housing and Urban Development
After
Natural Disasters

# Post Disaster Response and Mitigation of Future Losses

*Miami, Florida*
*October 23-26, 1985*

**Edited by Jon A. Kusler, Esq.**

Conducted by
**The American Bar Association**
**Special Committee on Housing and Urban Development Law**

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# *Foreword*

The primary goal of this international symposium was to critically examine post disaster response efforts to floods and earthquakes in the U.S., to identify strengths and weaknesses in those efforts for mitigating future losses, and to suggest measures for strengthening those efforts including research priorities.

A secondary goal was to compare U.S. efforts with those of selected developed and developing nations, to identify commonalities and differences in mitigation strategies, and to suggest measures for strengthening mitigation on the international scene, with particular reference to legislative needs.

The symposium gathered together in Miami eighty experts from twenty nations. Considering the many countries represented, there was a surprising degree of agreement on problems with existing approaches and measures needed to strengthen post disaster mitigation.

Loss of life and property due to flood, earthquake and mudslides and landslides was high in 1985: Over twenty-four thousand died as a result of volcanic activity and mudflows in Columbia; 10,000 deaths and billions of dollars in property damage resulted from earthquakes in Mexico; over three billion dollars in property losses resulted from the six hurricanes that made landfall in the continental United States; several hundred lives were lost due to a mudslide in Puerto Rico; a major earthquake levelled one portion of a city in the Soviet Union; major flooding occurred in Brazil and Argentina; repeated cyclones destroyed 16,000 houses in Figi; and serious flooding occurred in India.

Such events provide political and financial opportunities for reducing future vulnerability if long- and short-term policy commitments to mitigation are made at all levels of government and the lessons learned from these and past events are applied in rebuilding and reoccupation of hazard areas. Explicit commitments and incentives are needed to counter the tendency to return to the status quo. Without such commitments, the cycle of losses, rebuilding, and more losses which is all too common will continue.

Since the Second World War, considerable progress has been made by governments and private organizations in both the U.S. and internationally in relieving the immediate suffering caused by floods, earthquakes, landslides and other natural disasters through improved rescue, medical care, temporary housing, and food services. Warning systems and multipurpose structural works such as dams and levees have been constructed in many areas of the developed and developing nations. These have reduced loss of life and, to a lesser extent, property damages. Some progress has also been made in reducing losses to new structures and structures totally destroyed by floods, earthquakes, and winds, particularly in urban areas, through mapping and building codes. But repair and rebuilding for the 80-90 percent of the structures damaged but not destroyed in most hazard events continues to occur with little effort to reduce or "mitigate" future losses. As a consequence, this development and much of the new development not constructed consistent with mitigation guidelines is equally vulnerable to hazards.

For example, few of the more than 6,000,000 buildings at risk from flooding the the U.S. including most of those actually damaged by flooding during the last decade have been retrofitted to reduce future potential losses. The severe economic impact of damage and repair without mitigation and further damage is illustrated by FEMA's estimate that 2% of the repetitively damaged structures insured by the National Flood Insurance Program contribute 40% of the value of the total claims -- about $100,000,000 per year.

Inadequate mitigation after disasters is a problem world-wide. Most governments lack legislation or incentives for mitigation. Governments inevitably provide relief once disasters occur. But no government has adopted comprehensive mitigation policies with regard to post-disaster repair and rebuilding or pre-disaster prevention. Without careful guidelines, coordination mechanisms and incentives, relief may encourage rather than reduce future similar losses at the same location.

Losses are increasing in many areas of the world including some areas of the United States due to a combination of rapid urbanization and population growth in riverine floodways, coastal beaches and islands, hillsides subject to mudslides and other ground failures, and earthquake zones. The poor, who often occupy these areas in and at the margins of cities, suffer most when disasters occur and have the least ability to absorb losses.

Not all future hazard losses can be prevented nor is it economically efficient or politically expedient to incorporate hazard reduction measures in all rebuilding (or new building). But even simple and cost-effective mitigation measures such as rebuilding with less water damage prone materials in flood hazard areas are often ignored.

We hope that you will find the many excellent papers stimulating and useful in strengthening your own disaster preparedness or post disaster mitigation efforts.

# *Acknowledgements*

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The American Bar Association Special Committee on Housing and Urban Development Law supervised this project. Penelope Ferreira, staff director for the committee and Mary Ellen Vollbrecht, symposium coordinator, handled administrative matters, and provided guidance on many aspects of the program. Without them, the project would have been impossible.

Finally, the many excellent speakers and panelists who made this symposium possible are to be thanked and Kathleen Whalen, Gayle Brooks and Kim Matthews who provided able typing and editorial assistance deserve much credit.

Sincerely,

Jon Kusler, Esq.
Principal Investigator

# Priority Recommendations

Chapter 16 contains a more detailed list of recommendations.

STRENGTHENING MITIGATION IN THE U.S.

Much of the legislative framework needed for post flood mitigation is already in place in the U.S. this is less true for earthquakes and other types of hazards. Emphasis in strengthening post-disaster mitigation in the U.S. should be upon implementation of flood-related legislation and extending mitigation lessons and strategies from floods to other types of disasters.

Priorities for federal agencies, states, local governments, and research institutions to strengthen post disaster mitigation include:

1. Develop and publish guidelines for retrofitting partially damaged structures in all major types of disasters (floods, winds, earthquakes, land failures, etc.) and prepare and publish simple "how to do it" manuals. Some of this research is already underway in FEMA, the Corps of Engineers, and Universities. This research should be continued and the results broadly disseminated.

2. Revise the nonconforming use provisions in federal guidelines for flood insurance and in state and local regulations for all types of disasters to require incorporation of damage reduction measures in repairs where damage is less than as well as greater than 50% of value. Such provisions would not necessarily require rebuilding to reduce damage potential but would emphasize more modest damage reduction measures (materials, utilities, contents, etc.). Such expanded requirements should be linked to easy to read "how to do it" manuals and guidelines. Such requirements should also be linked to insurance surcharges for repetitively damaged structures. The surcharge would not apply if mitigation measures were installed.

3. Extend the federal post-disaster team concept to nonflood disasters and establish state and local teams. State and local members should be appointed to federal teams on a more regular basis. The establishment of parallel local and state teams is also advisable. The formulation and distribution of team recommendations should be expedited. Additional training in mitigation assessment should be provided for team members. A national cadre of experts for teams should also be assembled.

4. Revise the rate structure of the National Flood Insurance Program. Surcharges should be provided for multiple loss structures and incentives for retrofitting only partially damaged structures.

5. Specially allocate (through Congressional or OMB action) a portion of federal disaster assistance funds and flood insurance premiums to mitigation activities (e.g., 20%).

6. Apply consistent subsidies and cost-sharing. Consistent government subsidies and cost-sharing requirements should be applied to both structural and nonstructural post disaster mitigation approaches (e.g., dams, floodproofing, construction of levees) so that local governments and disaster victims do not simply choose the technique which is most heavily subsidized.

7. Better disseminate "how to do it" information concerning mitigation approaches to hazard area decision-makers. Better dissemination of information is needed concerning the possible reoccurrence of specific hazards, what can be done to reduce future losses, and the benefits of such actions. Such dissemination is key to improved post disaster mitigation by governments, architects, engineers, banks, developers, and hazard area occupants. There is a serious gap between those who know what can be done (a small group of experts in the country) and those who make and carry out most post disaster decisions.

8. Place greater emphasis in government and private programs upon mudslides, mudflows, and landslides. Mudslides, mudflows, landslides, and other ground failures are among the natural hazards causing the greatest loss of life and property damage in the U.S. Areas subject to such potential ground failures have not been extensively mapped nor have development guidelines been formulated or adopted for most areas. Enhanced management efforts should be undertaken by federal agencies, university, and private organizations including mapping, regulation, warning systems, and other management.

9. Enhance local government and hazard occupant "self-help" and local "coping" mechanisms. Government and private disaster policies should be revised (where necessary) to more fully encourage landowner and local government self-help. Measures to encourage self-help may include better involvement of locals in post-disaster teams; consistent local cost-sharing requirements for disaster assistance; improved training of local governments and hazard area occupants; preparation of guidebooks and other educational

measures for building design and retrofitting of existing structures; training of local builders and bankers; construction of demonstration projects; adoption of insurance incentives for buildings constructed or retrofitted with mitigation measures; and incorporation of mitigation guidelines and conditions in grants, loans, and other forms of assistance.

10. Develop improved procedures for assessing and categorizing structures and infrastructure after disasters according to degree of damage and mitigation potential. More selective and improved moratoria and building repair guidelines as well as technical assistance and allocation of grants and loans should be based upon these categorizations.

11. Encourage the integration of hazard mitigation into long-term economic and land use planning. Such integration could be encouraged through revised planning guidelines; conditions attached to grants and loans; training efforts for developers, bankers and planners; and more extensive involvement of land planners and financers in post disaster planning and assessment teams.

12. Conduct additional post-disaster research and assessments to determine the effectiveness of alternative mitigation approaches. Additional implementation-oriented, detailed studies should be conducted after disasters to determine the effectiveness of mapping, marking, structural design measures, emergency response, and other techniques.

## STRENGTHENING POST DISASTER MITIGATION IN OTHER COUNTRIES

Virtually all of the problems or limitations upon post disaster mitigation encountered in the U.S. also occur in other nations. Additional constraints on funding and expertise are particularly serious in developing nations. The recommendations for strengthening post-disaster mitigation in the U.S. suggested above are valid for most developed and developing nations.

However, priorities will differ for other nations depending upon the status of mitigation legislation, available financial resources, status of land use control mechanisms, degree of foreign financial assistance, available engineering, and architectural expertise, and other factors.

Some additional recommendations for strengthening international efforts by governments and international relief organizations include:

1. Adoption by governments and international relief agencies of explicit, long term disaster mitigation policies. New legislation or policies with clear and long-term post-disaster mitigation and disaster prevention goals and containing bindings statements of policy is needed in most nations. Such legislation or policies should, in addition to stating clear long-term goals, authorize:

a. A disaster assistance agency or team of agencies to conduct rapid assessments after a disaster to identify the boundaries of hazard areas and severity of risks, damages to structures and infrastructure, and mitigation options;

b. A natural resource agency to more formally map and mark hazard areas;

c. An agency to adopt policies and regulations requiring incorporation of disaster mitigation measures in repair of buildings and infrastructure;

d. One or more agencies (education, natural resource) to conduct education and provide technical assistance for landowners, local governments, members of the building trades, banks, and other decision-makers.

e. A disaster assistance or other agency to require the incorporation of disaster mitigation measures in long-term rebuilding and economic development.

f. One or more agencies to provide financial incentives (e.g., grants, loans, subsidized insurance, income tax incentives) for landowners and local governments to encourage mitigation in post-disaster contexts.

2. Priority-setting in hazard mitigation. Governments with limited funds and expertise should carefully establish priorities for allocating limited disaster relief and mitigation funds to address the highest risk hazard areas and the individuals most in need of help.

3. Post disaster mitigation teams. Governments and private relief organizations might make use of the U.S. post flood disaster mitigation team concept. Such teams could include representatives of international relief organizations and consulting experts as well as agency and local government representatives.

4. Greater emphasis upon mitigation rather than relief in post-disaster assistance efforts. Governments and international relief organizations should allocate a portion of relief funds to long-term mitigation and should request financial and technical assistance for long-term mitigation.

5. Care not to disturb local economic activities. It would appear particularly important in developing nations that relief efforts (domestic and international) not undermine local agriculture and other economic activities needed for long-term recovery.

6. Enhancing self-help. Where funds are scarce (as in many developing nations), it would appear particularly important that governments and international relief efforts encourage disaster victim and local government self-help. For example self-help flood warning systems and efforts to provide assistance in building reconstruction by supplying a portion of the

materials have worked well in some contexts such as reconstruction of public buildings with hazard resistant design can serve educational and leadership as well as hazard reduction goals.

7. Enhanced "simple" mechanisms for information transfer. Marking of hazard areas, the training of local builders, demonstration projects, and simple "how to do" guidebooks are needed to educate hazard area occupants.

8. Greater emphasis upon nonstructural alternatives. Developing nations should, like their developed nation counterparts, place increased emphasis upon nonstructural mitigation approaches such as warning systems incorporation of hazard protection measures in building design rather than very costly dams, floodwalls, etc.

9. Formulation and adoption of hazard reduction guidelines for housing, commercial and industrial development and infrastructure. Engineering guidelines tailored to local materials and conditions are needed for many nations and regions. Special attention should be given to major projects located in hazard areas.

10. Research. In developing as well as developed nations, research is needed by governments, universities, architectural and engineering societies, and builders concerning the short- and long-term effectiveness of various mitigation approaches and strategies. See a more detailed list of research needs in Chapter 16.

11. Pre-Disaster preparedness. Post disaster mitigation cannot and should not be separated in government and private programs from predisaster preparedness and planning. Disasters often provide the opportunity for adoption of long-term mitigation measures including pre-disaster preparedness for the next hazard event due to the high level of interest in mitigation and multiple sources of financing.

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CHAPTER ONE

# *IMPEDIMENTS TO MITIGATION*

# Impediments to Mitigation

*Jon Kusler, Esq.*
*Consultant to the American Bar Association*

## INTRODUCTION *

Natural disasters (including drought) kill an estimated 115,000 individuals annually and affect over 40 million (Wijkman and Timberlake, 1984). Impacts often spread geographically far beyond the disaster area and may endure for many years. Economic and political instability as well as pain and suffering may result. For example, governments in Nicaragua and Guatemala were undermined and toppled due, in part, to dissatisfaction with government responses to major earthquakes.

Traditionally national or federal government response to disasters in the United States and elsewhere has been "relief" oriented. Emphasis has been upon rescue, emergency food and water, medical care, and temporary housing.

When the disaster is large, typically all levels of government share in the response whether or not they have adopted, prior to the disaster, specific disaster legislation, plans or policies. The issue is not whether governments will respond to disasters -- they inevitably do -- but whether this response will meet disaster victims' short-term and long-term needs, whether this response will support or undermine efforts to implement broader economic and social goals, and whether this response will lead to a continuing cycle of building, disaster losses, rebuilding and repair in the same location, and more losses.

Disaster victims and governments have several choices for rebuilding and repair after a disaster:

1. Repair damaged infrastructure and structures in situ without hazard protection in which case further damage will occur with the next hazard event;

2. Repair or rebuild damaged structures incorporating hazard-resistant designs, providing partial or total protection;

3. Implement warning systems and evaluation plans to reduce loss of life and injury and movable goods;

4. Relocate the structures, infrastructure and hazard prone activities to less hazard prone areas; or

5. Construct hazard reduction measures such as sea walls, dams, and levees (effective only for floods, mudslides, erosion).

Despite a growing international awareness that a particular disaster event will eventually reoccur or be exceeded at a particular site, the first alternative -- repair and rebuilding without incorporation of improved building design is by far most common.

Repair without mitigation is not, in itself, a sign of poor decision-making. The costs of mitigation need to be compared with the benefits. This is not easy since costs and benefits are hard to quantify, particularly where loss of life may be involved, and long-term benefits and costs are hard to project. Decision-making is also often driven by other factors which may (arguably) be equally valid as economics -- humanitarian concern, disaster victim desires, and short-term profit or political needs.

Despite practical reasons for repair without mitigation in some contexts, incorporation of simple, cost effective damage reduction measures such as the use of materials with low damage potential are often possible but ignored.

## POST-DISASTER MITIGATION IN THE U.S.

Incorporation of mitigation measures in post-disaster recovery and repair in the U.S. has taken place primarily after flood disasters. Disillusioned with escalating flood damage, despite the expenditure of over $7 billion in federal funds alone, the U.S. Congress in 1968 adopted the National Flood Insurance Act to help "spread" flood losses and to encourage new construction and rebuilding consistent with development guidelines. In 1973 the Act was amended, in effect, to mandate flood insurance by requiring that communities enroll in the Program if they wished to qualify for disaster assistance, loans, or other types of federal assistance in the floodplain. As a result of the 1968 and 1973 Acts, 17,000 communities have adopted minimal floodplain regulations and have enrolled in the National Flood Insurance Program. Program guidelines for community programs require that communities adopt regulations for repair and expansion of existing structures when

*This introduction is based upon a literature review. See bibliography of the Chapter and articles cited in selected bibliography by Mary Ellen Vollbrecht in the Appendix of this proceedings.

"substantial" improvements occur. Substantial improvements are defined to include repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50% of the market value of the structure either (a) before the improvement or repair started, or (b) if the structure has been damaged and is being restored, before damage occurred.

No repairs or upgrading of damaged structures are required by the regulations unless the 50% figure is exceeded. Flood insurance rates do not usually increase no matter how many times a structure is damaged.

Federal disaster insurance has not been made widely available for other disasters. However, in an attempt to mitigate future losses once a disaster occurs, Congress incorporated section 406 in the Disaster Relief Act of 1974 which makes disaster loans and grants to states and local governments for all types of disasters on the condition that recipients evaluate hazards and adopt mitigation measures.

In 1979 Congress appropriated funds to the Federal Emergency Management Agency to begin acquisition of repetitively damaged and high risk flood areas subject to the National Flood Insurance Program. Although very modestly funded, this program embodied still another to mitigate future flood losses -- acquisition and relocation.

Finally, in 1981 the Office of Management and Budget issued a memorandum to ten federal agencies to create federal flood disaster teams after federally declared disasters to survey disaster areas and make recommendations for mitigation within 15 days.

At local and state levels, some efforts have been made to incorporate mitigation measures in post-disaster response (Kusler, 1982); see also Table 1. These have principally related to flooding -- and have typically taken the form of flood and erosion control measures. However, some broader efforts have been made to mitigate future losses from earthquakes, mudflows, subsidence, and other disasters, often pursuant to broader community planning programs. Most of these have occurred only after severe disasters. The mitigation measures have also usually been applied only to destroyed or seriously damaged structures. Other structures have simply been repaired.

## INTERNATIONAL EXPERIENCE

As with the U.S., there are many examples in both developed and developing nations of the construction of structural mitigation measures such as dams, levees, and sea walls constructed after major floods. For example, the Dutch and English undertook massive efforts to strengthen sea walls and levees after the floods of 1955 including the construction of a $2 billion flood gate on the Thames. The Japanese have constructed an estimated 20,000 engineering works to reduce landlides and mudslides. The Swiss have constructed many avalanche control measures.

Efforts have also been made to implement flood warning systems in most nations.

Control of land uses in hazard areas through regulatory approaches are far less common on the international scene although flood regulations have been adopted by some communities in England and Australia. Regulations establishing minimum standards for earthquake resistant design have been adopted in Italy, Turkey, Mexico, Chile, Venezuela, and other countries although most codes apply only to large cities or major structures. Much of the rebuilding and new construction in high risk areas throughout the world makes no adjustment for hazards.

## IMPEDIMENTS TO DISASTER MITIGATION

Opportunities for mitigation are created by disasters. Disasters raise public awareness. Both governments and private individuals share a common interest in reducing future loss of life, injury, and property damage. Relatively large sums of money may be available for rebuilding due to domestic appropriations and international relief. Where structures have been totally destroyed, there is opportunity to start over and "do it right" to accomplish not only hazard reduction goals but broader land planning and economic development objectives.

Why, then, is incorporation of hazard mitigation measures in reconstruction so rare in both developed and developing nations?

-- Media attention and mitigation efforts focus almost exclusively on destroyed or seriously damaged structures. Total destruction or serious damage to more than 10-20% of affected structures is uncommon in even the most severe floods, hurricanes, or earthquakes. Media and disaster attention and mitigation efforts typically focus on this small percentage -- often located near the epicenter of an earthquake; the wave zone of a hurricane; or the velocity and deep inundation zone of a river floodplain. But most of the damaged dwellings, infrastructure, and economic activities (such as agriculture) are located in other affected areas. Repair and reoccupation usually occurs without mitigation.

-- Lack of clear long-term mitigation goals or procedures. In the U.S. and internationally, only limited legislation has been adopted promoting long-term mitigation. Most legislation is relief-oriented and makes no mention of long-term reduction of future hazard losses. Clear articulation of mitigation goals in national legislation and policies is needed if the tendency to return to old ways of financing and construction are to be countered. Lack of legislation may actually limit mitigation where disaster assistance is available only for reconstruction to preexisting standards and funds cannot be used for hazard resistant design which is more expensive.

-- Inadequate standards and simple "how to do it" guidelines for building reconstruction and repair. With little exception, building codes

focus upon new construction, not the repair of existing buildings to reduce potential future losses. It is often impossible or impractical to incorporate these design alternatives or specifications desirable for new development into repair. Standards and guidelines specifically drafted for repair and reconstruction are needed.

-- Inadequate incentives to encourage incorporation of damage reduction measures in reconstruction and repair. There are few immediate financial incentives for long-term mitigation. For example, the National Flood Insurance in the U.S. offers little incentive for loss reduction in repair since insurance is usually at the same rate no matter how many times a structure is damaged. Disaster assistance in the U.S. and elsewhere also offers little incentive for long-term mitigation.

-- Inadequate dissemination of information. Disaster victims, banks, local governments, insurance companies, and others making repair and reconstruction decisions often have little knowledge of mitigation options.

-- Lack of leadership. The post disaster scene is often dominated by relief-oriented individuals and organizations such as civil defense agencies, national guards, church groups, and private organizations with little expertise or interest in long term mitigation. Natural resource and water resource agencies with some expertise in mitigation may play a role but until recently, most engineers and other experts had training only in structural hazard reduction techniques such as dams, not selective non-structural mitigation techniques such as retrofitting buildings and warning systems.

-- Inadequate engineering, architectural, hydrologic expertise after a disaster to assess hazards and formulate rebuilding mitigation options. Lack of expertise is a particularly serious problem for rural areas and developing nations.

-- Inadequate land use control mechanisms. In some states and communities in the U.S. existing buildings cannot be regulated pursuant to existing statutes and regulations which exempt or "grandfather" such structures. In developing nations, much of the development in urbanizing areas is also not subject to regulations or cannot practically be regulated due to lack of land ownership information, low literacy rates, and broadscale squatter settlements.

-- Emphasis upon relief. Both developed and developing nations and private relief organizations emphasize disaster relief. Long term repair and mitigation rarely receives much attention.

-- Critical data-gathering, planning, and decisions fail to occur in the immediate post-disaster context. Time is of the essence after a disaster if mitigation measures are to be incorporated in repair and rebuilding. Rapid and informed data-gathering planning and decision-making (within three to six weeks) are needed but rare. Prior to the establishment of post-disaster mitigation teams in the U.S., rapid definition of mitigation options was uncommon. Even now definition of mitigation options and regulations or incentives to help implement those options are somewhat limited. As a result, too often victims return to their homes and start repair. Businesses reopen. Repair and reconstruction occurs without consideration of future losses.

-- No constituency for "mitigation" during building repair and long term recovery. Often national leaders and local groups including some disaster victims are enthusiastic about mitigation immediately after the disaster. This enthusiasm may continue for 6 months to a year. But after that, the disaster is often discounted as "not likely to happen again" and rebuilding without mitigation occurs.

-- Hazard and other information maps are lacking, inaccurate, or at too small a scale. After a disaster, detailed maps and other data of the sort needed for repair and rebuilding are often lacking. Maps are needed not only identifying the boundaries of hazard areas but the magnitude of the specific hazards (depth, velocities, erosion potential, etc.) within such areas.

-- Problems with coordination. Coordination problems in relief and recovery efforts are common in both developing and developed nations with little definition of common long term mitigation goals by participating organizations. Once the emergency is over, separate agencies, levels of government, private relief groups, and disaster victims follow different courses.

-- The possibility of a state, national, or local long term "bailout" discourages local mitigation. A study several years ago concerning innovative local floodplain management programs in the U.S. concluded that few if any communities were willing to tightly regulate new development, renovate existing development or otherwise mitigate future potential losses as long as there was a prospect of federally financed (usually 100% financing) flood control works for the area. The possibility of free long term aid and "bailout" appears to discourage local action wherever it occurs.

-- Financing without consideration of future losses. Long term rebuilding and new development in hazard areas is largely financed by development agencies, institutions, and banks with little supervision or input from disaster mitigation agencies and little expertise in mitigation. Massive losses may later incur and the debtor, individual, group, or nation may be unable to finance or find great difficulty in financing repairs.

-- Plans prepared for rebuilding after a disaster are often untimely, impractical, or politically unacceptable. Public plans prepared for rebuilding after major disasters are often only partially implemented or not implemented at all due to deficiencies:

- They are prepared six months, a year, or

more after the disaster and after much of the repair has been completed.

- They are either too grandiose and impractical or, on the other hand, lack sufficient vision.

- They are prepared without adequate local and private sector input, undermining their political acceptability.

- They are prepared without recognition of the limitations on implementation such as budgetary restrictions.

- They are not tied in with longer term growth and economic development plans and trends.

## THE PAPERS WHICH FOLLOW

Speakers in this symposium were asked to make recommendations for overcoming these problems and implementing post disaster mitigation strategies. The papers have been grouped into sixteen chapters addressing various issues and approaches.

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TABLE 1

**Examples of Post-Disaster Mitigation in the U.S.**
- prepared by Mary Ellen Vollbrecht

**Klamath, California**

In 1964, severe flooding washed away all but two buildings in this northern California town. Emergency regulations prohibited all rebuilding in the floodway. Compliance with the regulation was a condition of the agreement for obtaining federal help to build a new town site.

**Hilo, Hawaii**

In a 20 year period, tsunamis twice caused estimated damages of over $25 million. Following the second event, a seven month building moratorium was adopted. A relocation project was planned. 388 parcels were acquired creating a 310 acre open space zone along the shore.

**Baltimore County, Maryland**

The county's periodic severe flooding culminated with events causing $85 million in damages between 1972 and 1976. In response, the county adopted zoning, subdivision regulations, and building codes stronger than those required by the federal government and began a staged acquisition program for clearing the floodplain and creating greenways for flood prone areas.

**Lycoming County, Pennsylvania**

This county has suffered repeated severe flooding which was particularly costly in Tropical Storm Agnes in 1972 along the more than 2200 miles of streams, including 38 miles of the Susquehanna River. The county has adopted a strong subdivision ordinance which is administered by the county for municipalities without their own ordinances. A relocation program, floodproofing education, and an extensive volunteer flood warning system make up the county's comprehensive program.

**Gulf Shores, Alabama**

Hurricane Frederic in 1979 damaged or destroyed 500 structures by wave action and 10-12 foot storm surges. New regulations require protection from wave heights in addition to elevation to the 100-year surge height. Some properties have also been acquired.

**Avalon, New Jersey**

A 1962 "nor'easter" destroyed much of this barrier island town's dune system. In addition to aggressively enforced regulations, snow fences and beach grass plantings have been used to reestablish the dunes. The entire beach front has been acquired.

**Soldier's Grove, Wisconsin**

A severe flood in 1978 inundated the whole town, causing $52 million in damages. Public education began and federal funds were aggressively sought. The entire downtown has been relocated to a floodfree site. The new town was dedicated in 1982 with the floodplain converted to parkland.

**Scottsdale, Arizona**

In this arid region, periodic flash flooding has caused severe flood damage. As a result, land in the 100-year floodplain was acquired for a greenbelt. Floodplain regulations require developers to prove that new construction will not increase 100-year flood heights.

**Austin, Minnesota**

Flash flooding in 1978 resulted in a Presidential disaster declaration. A citizens' task force was formed and federal funds were obtained for acquisition and relocation. New, strengthened regulations were adopted. Long range plans call for a river park corridor.

**Dallas, Texas**

This rapidly growing large city suffered repeated severe flooding in the mid 1960's. Stringent floodplain regulations were adopted, based upon large scale accurate maps. Subdivision regulations require dedication of floodplain lands. Many properties have been acquired and relocated and much of the floodplain placed in public ownership.

**Galveston, Texas**

By the time Hurricane Alicia hit the Texas coast with 10 foot storm surges, the Baytown Subdivision had already subsided to less than two feet above mean high tide (a result of groundwater withdrawal). Alicia destroyed most of the homes in Baytown. Using Section 1362 relocation funds, most Baytown properties have been acquired and the residents moved to upland sites.

**Lake Elsinore, California**

Long term lake level fluctuations caused severe recurrent damages. In 1980, over 255 properties were inundated. Interim regulations with a built in "buffer zone" and a Governor's interagency task force were the first steps in mitigation. A more restrictive permanent ordinance has been adopted. An acquisition program has acquired and relocated many flooded structures.

**Scituate, Massachusetts**

The blizzard and flood of 1978 devastated the seashore. Private damages alone were over $172 million. A building moratorium was adopted, followed by more restrictive coastal construction regulations. Some structures have been acquired.

**Anchorage, Alaska - Earthquake**

In 1964, perhaps the strongest earthquake to strike North America in recent time destroyed 30 blocks, including nearly 1,000 dwelling units in Anchorage. Mitigation experiences were mixed. Interim building regulations and federal funds enabled relocation and structural protection from landslides in areas already slated for urban renewal.

TABLE 2

**Examples of International Post-Disaster Mitigation Efforts**
— Prepared by Mary Ellen Vollbrecht

**Managua, Nicaragua - Earthquake**

Seventy percent of Managua's 420,000 residents were left homeless following the 1972 earthquake. Typical of cities in the developing world, Managua was a rapidly growing mix of ancient and modern. Earthquake resistant building codes were adopted. Repair was prevented in a central portion of the city. However, there were serious problems with mitigation efforts. The primary lesson learned was that relief efforts may provide the only resources available for mitigation activities and must be fairly administered.

**Naples, Italy - Earthquake**

An estimated 300,000 people were left homeless and 3,500 killed in the 1980 earthquake that shook much of southern Italy. Many factors complicated and disorganized relief, especially in Naples. Lack of implementing regulations and lack of coordination between levels of government were major obstacles to mitigation. Nevertheless, a positive experience was the "cantiere simultaneo" or local construction cooperative organized by a dedicated architect in his home town. Also, improved codes and a disaster relief administrative framework were adopted.

**Central Guatemala - Earthquake**

In 1976, an earthquake shook Guatemala's central highlands, one of the most densely populated areas in Central America. 25,000 were killed and 90% of all structures were destroyed. Development officials of private organizations were able to channel their resources into an earthquake resistant rebuilding program. Local materials and labor were used. Budget flexibility and a high degree of citizen participation led to considerable success.

**Belopman, Belize - Hurricane**

The population of this small nation is concentrated on its Caribbean sea coast. Over 10% of the population required temporary housing in the aftermath of Hurricane Hattie in 1961. Three different types of housing provisions were made: temporary housing, rural relocation, and urban relocation. The capital was relocated inland to Belopman. The project was done over ten years with significant, effective input from the government workers (who were the primary relocatees).

**Tokyo, Japan - Multiple Hazards**

Tokyo has suffered nearly every type of natural disaster over the last 100 years. To protect its extremely high density and relatively immobile population, the Japan Disaster Countermeasures Act of 1977 integrates disaster preparation and responsibility into government activities at all levels. Strong national leadership in planning, uniform neighborhood level organizations and revenue generating mechanisms especially for mitigation are special features of this comprehensive program.

**Al Asnam, Algeria - Earthquake**

In 1980, the most recent in a long history of earthquakes struck along the populated corridor in Algeria. Eighty percent of the buildings in a six square block area of central Al Asnam collapsed, including the police station, city hall, and the main hospital. Earthquake resistant building codes had long been in place but not updated or enforced. The primary lesson learned at Al Asnam was the need for continuing education of government officials and architectural/construction professionals in mitigation and seismic resistance methods.

**Gediz, Turkey - Earthquake**

Three severe earthquakes within 15 months cost Turkey five percent of its total national budget in relief and recovery efforts during 1970. For the residents of Gediz, the central government constructed a new town on a more seismically stable site. But the mitigation effort was only partially successful. Without an interdisciplinary approach of public participation, the new site had flooding problems and the new houses were unsuitable for cultural reasons. The old town has been reoccupied.

**Los Angeles, California - Earthquake**

Destructive earthquakes have occurred repeatedly in Southern California. Following severe earthquakes, the California legislature adopted building code requirements which first applied to public school construction, hospital construction and function, and elevator safety. All unreinforced masonry buildings are now regulated for seismic resistance. Construction within 50 feet of a fault line is prohibited. A pre-earthquake plan for post-earthquake rebuilding has been prepared to suggest critical land use changes which may be made following significant damage.

# CHAPTER TWO
# *PERSPECTIVES ON MITIGATION: DEVELOPED AND DEVELOPING NATIONS*

This chapter examines some of the progress and problems with post disaster mitigation. It begins with two papers from the U.S. The first by Samuel Speck provides an overview of post-disaster mitigation issues and opportunities in the U.S. Rutherford Platt examines the evolution of U.S. post-flood mitigation policy.

David Alexander next addresses the Italian post disaster mitigation experience following the 1980 earthquake.

Two papers by Scott Luther and Daniel Torrealva follow, addressing disaster mitigation in the Dominican Republic and Peru.

A final paper by Richard Krimm addresses the transfer of mitigation techniques between developed and developing nations.

The six papers included in this chapter have been selected to raise major issues in mitigation and present varied points of view.

# Overview of Post Disaster Mitigation Issues and Opportunities: The U.S. Experience

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## OPPORTUNITIES FOR HAZARD MITIGATION

Hazard mitigation is the conscious evaluation of the impact of a hazard and the implementation of measures which eliminate or reduce our vulnerability to its effects. Three opportunities may arise to intervene in the course of a hazard: (1) before the hazardous condition occurs or is created; (2) before the effects of the hazard become significant; or (3) after serious effects of a hazard have been experienced.

Action to prevent a hazardous situation is of course desirable. Such actions as planning for hazardous effects of construction, manufacturing, or development can take place before a pipeline is built, before a chemical is produced or before a flood plain is developed. Often, however, society fails to consider the impact of a potential hazard and take action to prevent or avoid it. The problem of disposal of hazardous wastes, for example, has become one of the great problems of this decade because of failure to take preventive action.

The second opportunity for mitigation is after the hazard has been created, but before it has significant impact. Action at this point is usually difficult since public perception of the danger potential is low and costs are high. An example addressing potential effects of a hazard occurred in 1982 at Times Beach, Missouri, following the discovery there of high levels of dioxin. The Environmental Protection Agency determined that all residents and businesses in this community of almost 1,000 properties would have to be relocated. This commitment was based on the potential for harm rather than tangible evidence of the adverse effects.

Another example of risk recognition prior to disaster involves the large number of reinforced masonry buildings in earthquake-prone U.S. cities. Most of these buildings predate earthquake-resistant building standards and delineation of hazard zones. Retrofitting or replacing buildings is very costly; but it may be the only approach to save lives.

The third and final opportunity for reducing or avoiding hazard vulnerability is, ironically, after the occurrence of disaster. Historically, great progress has been made in mitigating hazards after some damage has occurred. Such progress has been possible for a number of reasons. In many cases, unforeseen or unsubstantiated consequences of the hazard are visible. The public's and decision makers' perceptions of the vulnerability or risks are suddenly high. The occurrence of an incident creates substantial political support or demand for public action to correct hazardous conditions.

Such a cause-and-effect relationship has spawned most hazard reduction legislation. The original Federal Disaster Relief Act was the result of Hurricane Camille in 1969. The Act was revised in 1973 following the loss of life and property from Hurricane Agnes; the flooding in Rapid City, South Dakota; and the Buffalo Creek dam collapse in West Virginia. The 1984 tragedy in Bhopal, India sent shock waves regarding the threat from hazardous materials through the United States and prompted legislative and administrative response at all levels of government. The 1985 earthquake in Mexico City also impacted the American scene. Congress immediately held hearings to find out what could be learned from the disaster. On the local level, the Los Angeles City Council upgraded safety standards by reducing from ten to four years the amount of time for retrofitting buildings constructed prior to adoption of earthquake-resistant standards.

## INTEGRATED EMERGENCY MANAGEMENT SYSTEM

The Federal Emergency Management Agency (FEMA) has developed a management approach to enhance state and local government activities in pre- and post-disaster management, including hazard mitigation. We call it the Integrated Emergency Management System or IEMS.

IEMS is a multi-hazard approach to emergency planning which stresses the interrelationships of capabilities, techniques, and systems for emergency preparedness, response, recovery, and mitigation across the broad spectrum of hazards that may affect a community. This functional approach to comprehensive emergency management was funded last year (Fiscal Year 1984-85) by Congress with over $90 million of civil defense funds in direct program and training support to states and local governments. The IEMS approach consists of three primary components which communities and states must include in their programs to qualify for funds: hazard identification, capability assessment, and multi-year development planning.

Hazard identification is an inventory of all hazards present in a state or locality. Each hazard is measured in terms of frequency and severity, cumulative effect, and populations, lifelines and facilities at risk both now and in the future years.

Capability assessment requires a state or locality to review its current capabilities for preparing for, responding to, recovering from, and mitigating against the effects of the identified hazards. After determining current capabilities, the jurisdiction determines what is required to achieve a reasonable and adequate level of capabilities to address the hazards. This assessment would consider, for example, the adequacy of emergency communications or existing warning systems or evacuation plans.

Underlying the capability assessment should be the consideration of the need for and potential impact of hazard mitigation. It would probably be impossible, for example, in densely populated cities to have adequate fire response capabilities were it not for electrical and construction codes which are designed to reduce the risk of urban fires. This balance between preparedness and mitigation in the area of fire safety is continuously changing as new and more complex sources of fire hazard are introduced into the environment and as more fire resistant construction techniques or materials become available. What is most important to note is that emergency preparedness capabilities can be enhanced by taking hazard mitigation actions.

Finally, the results of the first two steps are combined into the multi-year development plan. This plan identifies needed improvements in emergency management capabilities in order of priority based upon hazard vulnerability and capability shortfalls. It provides a long-term blueprint for improvement of capabilities in an orderly manner.

## PRE-DISASTER MITIGATION PLANNING

FEMA, within the context of IEMS, also supports a variety of specific pre-disaster planning activities for hurricanes, earthquakes dam safety, and floods. These hazards have unique aspects that must be addressed separately and in addition to an overall functional planning approach. A strong emphasis must be placed upon hazard mitigation in each activity.

An example where specific mitigation can play a vital role in reducing future losses is earthquake preparedness. The 1985 earthquake near Mexico City demonstrated that partial or total collapse of structures was the main cause of earthquake-related deaths and injury. This reinforces the need to incorporate seismic resistant design provisions into state and local building codes throughout the high seismic risk areas of the country. Approximately one-third of FEMA's appropriation under the National Earthquake Hazards Reduction Program is devoted to the development and dissemination of such seismic-resistant design provisions applicable to new buildings, existing hazardous buildings, and to "lifelines". Recommendations are being disseminated to design professional, code groups, and state and local officials. The sooner this type of earthquake mitigation is accepted and enforced, the sooner the earthquake threat within the United States will be reduced.

The Community Assistance Program under FEMA's Flood Plain Management Program is another example of pre-disaster mitigation. Under this program, technical assistance is provided to flood-prone communities for the purpose of assisting those communities in adopting flood plain management regulations and in managing local flood loss reduction programs.

Since 1974, Disaster Preparedness Improvement Grants have been available to states on a matching basis for natural hazard preparedness activities, including mitigation. FEMA will provide under this program up to $25,000 to each recipient, which then must be matched and used for preparedness activities to build awareness of existing hazards and how they can be addressed.

A final example of FEMA's pre-disaster planning is a multi-hazard project under the Comprehensive Emergency Preparedness Program. This project initially looked at mitigation techniques for the different types of hazards (dam safety, landslide, and earthquake) that existed in a specific area in Utah. This specific study is now completed, and the project has been expanded to four other areas in Utah. To date we have spent approximately $250,000 on the project. The findings of the project will determine whether this multi-hazard approach is applicable to other areas of the country.

## RESISTANCE TO POST-DISASTER MITIGATION PLANNING

While mitigation opportunities arise after a disaster, so too, do obstacles to adoption of post-disaster mitigation requirements.

Often action is hindered by public sentiment that victims have been "punished" enough by the disaster without local governments imposing new or upgraded standards for repair and reconstruction. This causes resentment. Furthermore, community spirit and pride brought out by adversity results in a tremendous push to "get back to normal" as quickly as possible. In short, people want to build their community back to what it was before the disaster.

The perception by victims that mitigation is punishment can be compounded when any effort is made to enforce multi-hazard mitigation. For example, victims of a flood may understand the need for flood resistant design in rebuilding, but may resist the imposition of additional earthquake building standards.

## FEMA'S POST-DISASTER MITIGATION PLANNING PROGRAMS

It is difficult for communities and landowners to make momentous and timely mitigation decisions following a disaster. Land

use patterns and building standards often cannot be changed in the hectic period following a disaster without some kind of rough plan or statement of intended policy. Consequently, a community benefits from having a mitigation plan or strategy prior to a disaster. FEMA's experience indicates that when problems of hazard vulnerability are anticipated and solutions considered in advance, the chances of successful mitigation rise significantly. Two notable examples of this are the downtown redevelopment plan of Estes Park, Colorado, which was expedited by a flood; and the flood plain evacuation program of Baytown, Texas, which was expedited by a hurricane.

FEMA funds a modest Hazard Mitigation Assistance (HMA) program which provides funds to states and localities for such advanced planning of post-mitigation action. This program is targeted to specific communities which have both a history of disasters and failure to achieve significant progress in reducing hazard vulnerability following those disasters.

The HMA program allows communities to develop and put in place programs and strategies that can be activated following a future disaster. Each program is intended to complement the community's ongoing hazard reduction activities and achieve significant risk reduction as part of the disaster recovery process.

Mitigation after flood disasters is formulated by the federal post-disaster mitigation team process established in 1980. Pursuant to this process, FEMA activates and directs federal/state interagency teams following major flood disasters. The teams provide rapid assessment of causes of flooding, impacts and opportunities, and alternatives for mitigation to feed into the recovery and restoration actions of all agencies. The interagency team must prepare a report consisting of a skeletal recovery/mitigation plan within 15 days of the disaster. This report is intended to establish joint post-flood recovery policies for all agencies and stress cost-effective and nonstructural mitigation measures. Given the success of federal/state assessment teams in post-flood disaster mitigation, FEMA is considering expansion of this approach to other hazards.

As a condition of disaster assistance from FEMA under the Federal Disaster Relief Act, Amendments of 1974, communities seeking assistance are also required to evaluate the hazards in a disaster area and take appropriate measures including safe land use and construction practices to mitigate the hazards. Section 406 of the Act states a recipient of disaster funds must adopt a mitigation plan for <u>all</u> hazards, not just the one that caused the disaster declaration. FEMA does not withhold disaster assistance until this requirement is met, but it does require the impacted state and local governments to prepare a hazard mitigation plan within six months following the event.

## MITIGATION ESSENTIAL TO EMERGENCY MANAGEMENT

The comprehensive post-disaster hazard mitigation plan is developed to supplement, complement, and update comprehensive emergency management planning already underway or completed in accordance with the Integrated Emergency Management System. This completes the cycle in developing state or community preparedness since the post-disaster hazard mitigation plan is also used as an evaluation of ongoing procedures for emergency planning and risk management. The mitigation plan serves as a blueprint for future changes and improvements in hazard management policy which is based on actual disaster experience.

If a post-disaster plan is lacking, the next best approach is to take quick action following a disaster to assess causes and impacts and to identify alternative approaches to restoration and recovery before the apparatus of recovery is set in motion. Obviously, the larger the disaster, the longer the immediate response phase lasts for search and rescue. This may provide additional time for assessing impacts and options before reconstruction.

In Mexico City, discussions are now being held on whether to allow redevelopment of damaged areas and on the adequacy of building codes and enforcement. Such discussions are appropriate for the period following immediate response, but before large-scale restoration begins.

## STATE AND FEDERAL MITIGATION EXAMPLES

There are many good examples of state preparedness begun with post-disaster hazard mitigation planning:

In Connecticut, the Governor specifically tasked most of his agency heads to carry out recommendations of the state post-disaster hazard mitigation plan;

The Governor of Colorado established a special legislative committee to formulate legislative proposals for carrying out that state's post-disaster hazard mitigation plan;

And the plan developed by the State of Utah for FEMA following multiple flooding, landslide, and lake rise disasters has formed the basis for millions of dollars in state appropriations for damage reduction projects for the Great Salt Lake area. In addition, a state/local task force is meeting regularly, under the guidance of the state hazard mitigation officer, to plan future development of the Great Salt Lake shore.

On the Federal level, when any construction project or financially assisted project over $5,000 is planned in a flood plain area, an elaborate eight-step process must take place in determining the project's feasibility. This process involves reviewing mitigation measures and elevation levels as well as questioning whether the project should be undertaken at all if there are no feasible locations outside the hazard area.

## FUTURE PROBLEMS WITH HAZARD PREPAREDNESS AND MITIGATION

Preparing for hazards can save lives and protect property, particularly if plan provisions are incorporated into a community's emergency preparedness plan. Despite good intentions, however, some types of hazard preparedness and mitigation can also increase problems unless a total approach to mitigation is implemented.

Successful preparedness planning can serve as a "catch 22". For example, success in implementing evacuation plans for hurricanes may lead to over-confidence and complacency. Hurricane Gloria demonstrated that people will respond to warnings and evacuate in the face of danger. The small loss of human lives in that hurricane, however, may lure some coastal dwellers into complacency. As a result, people may not evacuate or they may wait until it is too late during the next hurricane. This false sense of security may also lead to more building in coastal areas, thereby increasing the population and hazard vulnerability and complicating future hurricane evacuations.

Focusing on mitigation of a single hazard can make population centers and facilities vulnerable to other hazards. For example, not long ago one community sought to move its hospital's operating room to the hospital basement to assure greater survivability from an earthquake. Then it was pointed out that if the earthquake occurred, the dam upstream from the community might break, flooding the hospital's operating room. Clearly, we must adopt a multi-hazard planning approach that takes <u>all</u> potential hazards into consideration.

Finally, certain hazard-prone communities have been and will continue to be repeated beneficiaries of federal dollars flowing from the Disaster Relief Act under the National Flood Insurance Program. How much and for how long should taxpayers subsidize citizens who knowingly place themselves in high-risk areas? Are repeated subsidies for hazard-prone communities actually negating hazard mitigation? If so, what additional hazard mitigation strategies are needed?

# Evolution of Post-Flood Mitigation Policy in the United States

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## INTRODUCTION: THE COST OF FLOODING

Inland and coastal floodplains occupy 140-180 million acres or six to eight percent of the total U.S. land area (U.S. Water Resources Council, 1977). Despite the flood peril, these areas are estimated to contain at least 6.4 million structures (U.S. Congress, 1975, p. 232). Ten million people were estimated to live in flood risk areas by Hoyt and Langbein in 1955. That figure has probably doubled by 1985. Six million are estimated to live within reach of a hurricane storm surge (American Meteorological Society, 1976).

Costs of flooding are difficult to estimate and compare over time but are generally believed to be rising nationally. In 1966, the Task Force on Federal Flood Control Policy (U.S. Congress, 1966) estimated average annual flood losses to be $1 billion. A decade later, the U.S. Water Resources Council (1977) estimated this figure to have more than doubled to $2.2 billion (in 1967 dollars). In August 1983, Hurricane Alicia, a medium-sized storm system, inflicted damage estimated between $750 million and $1.65 billion on the Houston-Galveston region of Texas (National Research Council, 1984).

Lives lost and physical or mental traumas are not included in these monetary estimates. Some 5400 people died in floods between 1925 and 1979. While deaths per year fluctuate greatly, Arnell (1984) identifies a slight upward trend in loss of life due to floods since 1960.

A different measure of flood costs to the nation is the total of federal outlays for disaster relief and recovery. The writer has estimated such costs for Fiscal Year 1979 to have been approximately $1.2 billion (Platt, 1979). The following year, a special flood policy committee of the National Science Foundation (of which the writer was a member) estimated FY 1980 federal flood costs to be $1.8 billion (NSF, 1980). This was equal to nearly one-half of the total federal flood costs of $4 billion for fiscal years 1973 through 1978 (in constant dollars). Whatever the actual level of flooding, it was clear in 1980 that the cost of recovery from floods to the federal government was rising significantly. It was also becoming apparent that federal assistance, in the form of loans, grants, and low-cost flood insurance, was itself stimulating reinvestment in hazardous locations.

## EVOLUTION OF PUBLIC RESPONSE TO FLOODS

Public response to flood disasters may be traced through four chronological periods: (1) the Pre-Federal Period, (2) the Structural Flood Control Period, (3) the Unified Management Period, and, since 1980, (4) the Post-Flood Mitigation Period (Platt and McMullen, 1980; Arnell, 1984). It should be emphasized that earlier solutions are seldom abandoned entirely. Rather, approaches and programs from earlier years usually continue to co-exist with new policies, sometimes in uneasy juxtaposition.

### Stage I: The Pre-Federal Period (1789-1928)

Before the 20th century, response to floods in the United States was largely the responsibility of private landowners, local governments, and states (Hoyt and Langbein, 1955; White, 1969). Collective efforts to control flooding through construction of levees evolved through locally financed districts in the Lower Mississippi Valley. The federal government was seldom involved in 19th-century flood management except for the conveyance of many million acres of wetlands to states for drainage and reclamation under the "Swamp Land Acts" (Harrison, 1961, p. 68).

Federal involvement with floods eventually emerged from its long-standing concern with navigation. In 1879, Congress established the Mississippi River Commission to address navigation and reclamation problems along that river. Inevitably, the Commission was soon in the business of assisting local boards with levee construction and maintenance, ostensibly to benefit navigation. In 1917, Congress authorized the Corps of Engineers to undertake flood control measures along the Mississippi and Sacramento Rivers.

### Stage II: Structural Flood Control (1928-1968)

In April 1927, the lower Mississippi River reclaimed its floodplain. Levees were breached in some 200 locations and approximately 18 million acres in six states were inundated. Damages were estimated to reach $284 million and the flood took at least 313 lives (Hoyt and Langbein, 1955). The federal government responded to the disaster with the enactment of the Lower Mississippi Flood Control Act of 1928. The Act established a dominant federal role in the reconstruction of levees and the provision of diversion floodways. According to Hoyt and

Langbein (p. 261), the 1928 flood proved to be a turning point in national flood policy:

> Few natural events have had a more lasting impact on our engineering concepts, economic thought, and political policy in the field of floods. Prior to 1927, control of floods in the United States was considered largely a local responsibiliby. Soon after 1927, the control of floods became a national problem and a federal responsibility.

This federal response took the form of large-scale engineering structures to control flood waters: dams, reservoirs, levees, channel improvements, and shore protection works, as authorized by the Flood Control Acts of 1936 and 1938 and their sequels. By the mid-1960's the federal government had spent about $10 billion on 900 projects nationally (U.S. Water Resources Council, 1968, 5-2-2).

The need for a rational and comprehensive approach to flood planning was elaborated by the Water Planning Committee of President Roosevelt's National Resources Board (1934, p. 260):

> To minimize the menace of waters and to promote their greatest usefulness are objectives worthy of the highest intelligence and other energies of the Nation. The problem is an engineering problem; not merely of physical engineering but of cultural engineering -- of planning a future civilization. All that engineering has taught us in respect of planning must be brought to bear on this great problem.

The Water Planning Committee's advice, however, was ignored due to three countervailing factors: (1) the Great Depression, (2) a series of devastating floods between 1935 and 1938, and (3) politics (Platt, 1986). Roosevelt's $4 billion public works budget set off a "pork barrel" stampede in Congress with each member competing for a share of the funds. The President's call for acceptance of "National Planning" as a prerequisite to the allocation of such funds was lost in the in the shuffle. The only limit to political "log rolling" was a requirement in the 1936 Flood Control Act that stipulated as a condition of federal funding that the net benefits of a project must exceed its anticipated costs "to whomsoever they may accrue". In the absence of clear procedures for benefit-cost analysis however this requirement was long honored more in the breach than the observance (Krutilla and Eckstein, 1958).

By 1950, non-federal contribution to the combined costs of local works and reservoir construction would amount to only seven percent of the total flood control budget (Leopold and Maddock, 1954, p. 102). In the absence of a meaningful basis for cost sharing, states and local interests encouraged the structural approach while giving little attention to alternative measures within their own sphere of authority such as floodplain zoning. In 1950, the President's Committee on Water Policy noted that although "flood zoning...has great verbal support...almost nothing is done about it (Gray, 1956)."

The policies established in the 1928, 1936, and 1938 flood acts prevailed until 1968. During this period flood loss reduction was a federal responsibility, discharged through structural means, and usually in a political rather than a comprehensive planning context.

## Stage III: Unified Floodplain Management (1968-present)

The attention of Congress was redirected to flood issues by a series of devastating coastal storms: Carol and Hazel in 1953, Connie and Diane in 1955, Audrey in 1957, Donna in 1960, the "northeaster" of March, 1962, Hilda in 1964, and Betsy in 1965. Collectively taking more than 1,100 lives and causing several billion dollars in property damage, these presented a new kind of flood threat against which a riverine-oriented structural flood program was largely ineffective. Federal disaster assistance rose from $53 million in 1953 to $237 million in 1965 (Platt, 1986).

In 1966, the Task Force on Federal Flood Control Policy (U.S. Congress, 1966) identified three shortcomings of national flood policy: (1) inadequate recognition of the nature of the flood threat and limitations of engineering works, (2) virtual exclusion of means other than river control, and (3) inadequacy of cost sharing by nonfederal beneficiaries. It called for an "integrated flood loss management program" involving federal, state, local, and private initiative.

Congress enacted the National Flood Insurance Act in 1968 (PL 90-448, Title 13). The National Flood Insurance Program (NFIP) is now a primary vehicle of federal policy with respect to flood losses. It addresses two interrelated objectives. First, it seeks to reallocate a portion of the burden of flood losses to all occupants of flood hazard areas through the mechanism of insurance premiums. Second, it seeks to mitigate rising flood losses by discouraging unsafe building practices in floodplains (Platt, 1976). This second objective is sought to be achieved through (a) appropriate land-use controls to be exercised by state and local governments, (b) higher insurance premiums for new structures than for existing structures in floodplains, and (c) selective acquisition of floodprone property and relocation of victims after a flood (under Section 1362).

Since 1973, the NFIP has grown dramatically. As of June 30, 1984, 17,629 communities were participating in NFIP, of which 10,519 were in the "regular program" and the rest in the emergency phase. Policies in effect numbered 1.9 million and payments made to flood victims as of the end of 1983 amounted to $1.8 billion on 315,000 claims (Federal Emergency Management Agency, unpublished data).

## Stage IV: Post-Flood Mitigation (1980 - ?)

The decade of the 1970's witnessed rapid

transformation of U.S. flood policy towards unified floodplain management (U.S. Water Resources Council, 1979). The adoption of floodplain zoning and the concomitant availability of flood insurance marked a significant departure from prior reliance upon federal flood control structures. But this new emphasis upon nonstructural management involved a major pitfall - decentralization of responsibility from the federal government to myriad nonfederal authorities including states, special districts, counties, municipalities, and private owners. Since most watersheds and floodplains are shared by many of these units of authority, it has been necessary to develop intergovernmental arrangements for achieving consistent policies and practices regarding a common stream or floodplain. To date, experience in developing such intergovernmental arrangements has been uneven (Platt and McMullen, 1979; Platt et al, 1980).

Another problem has been the difficulty in applying certain nonstructural measures such as floodplain zoning to already developed floodplains. Burby and French (1981) have identified a "paradox" that communities most eager to adopt regulations are those where regulation is already too late. A related problem is the tendency for local governments to seek restoration of the status quo ante upon the occurrence of a flood disaster. Local governments are often reluctant to use their powers to discourage building or rebuilding of floodplains particularly in the wake of a disaster. Official commitments to building a bigger, better, and more prosperous city after a flood seldom contemplate or admit the certain recurrence of floods in the future. Just as San Francisco referred to its 1906 earthquake as the "San Francisco Fire", local officials of flood-ravaged communities publicly discount the prospect of repeat disasters (Thomas and Witts, 1971; Haas, Kates, and Bowden, 1977; Platt, 1979; 1982).

The potential for repetitive losses is not a trivial concern. Between 1972 and 1979, about 1900 communities (including counties) experienced two or more presidentially declared major flood disasters. Of these, 351 communities were declared three times, 46 on four occasions, and 4 experienced five major flood disasters in seven years (Federal Emergency Management Policy, unpublished data).

1980 marked a further turning point in national flood policy, as reflected in diverse initiatives to promote post-flood mitigation. These included: (1) the OMB Directive and Interagency Agreement, (2) implementation of Section 406 of the Flood Disaster Protection Act of 1974, and (3) funding of Section 1362 of the National Flood Insurance Act to acquire properties which are deemed subject to "chronic flooding". The evolution of post-flood mitigation in theory and practice is described in more detail below.

## HAZARD MITIGATION REQUIREMENTS

### Legislative Measures

Although the concept of post-flood mitigation did not become operational until 1980, it was the subject of several legislative provisions and academic research projects during the preceding decade. Mitigation before the fact was an important element of the National Flood Insurance Act of 1968. Section 1361 of that act authorized the Secretary of Housing and Urban Development (now the Administrator of the Federal Emergency Management Agency) to:

> develop comprehensive criteria designed to encourage, where necessary, the adoption of adequate state and local measures which, to the maximum extent feasible, will -- (1) constrict the development of land which is exposed to flood damage where appropriate, (2) guide the development of proposed construction away from locations which are threatened by flood hazards, (3) assist in reducing damage caused by floods, and (4) otherwise improve the long range land management and use of floodprone areas,...

Section 1362 of the Flood Insurance Act specifically addresses the post-flood context. This section authorizes the purchase of real property which (1) was located in any flood-risk area, (2) was covered by flood insurance, and (3) was damaged substantially beyond repair by flood while so covered. Thus Congress as early as 1968 anticipated the problem of repetitive flood insurance payments on the same property. However, the authority to acquire such property was not funded until 1980. By the end of 1984, 317 parcels of real estate had been acquired under Section 1362 at a cost of $15.6 million (FEMA unpublished data).

Another post-disaster mitigation element of the National Flood Insurance Program is the "substantial improvements" provision. As expressed in program regulations published October 26, 1976, participating communities must apply current floodplain management regulations to new construction and "substantial improvements." The latter include "any repair, reconstruction, or improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure..." This effectively suspends the "grandfather clause" which normally would allow replacement of nonconforming structures after a disaster. Thus, reconstruction of buildings damaged by more than half their pre-flood value must conform to applicable land use, building code, and elevation requirements. The regulation is not limited to insured properties nor to damage due to floods. It would thus appear to be a potent tool for removing nonconforming structures from floodplains, whatever the cause of their loss.

As already mentioned, the Flood Disaster Protection Act of 1973 (PL 93-234) required flood insurance as a condition to approval of federally related financing for acquisition or improvement of structures in identified flood hazard areas. Section 202(a) of that act prohibited "any

financial assistance for acquisition or construction purposes "in flood hazard areas" unless the community in which such area is situated is then participating in the national flood insurance program." The Act defines federal assistance to include "any form of loan, grant, guarantee, insurance, payment, rebate, subsidy, disaster assistance loan or grant." Thus, federal disaster assistance for reconstruction of any kind is denied communities which do not participate in NFIP -- about 3,000 communities in 1984.

In the Disaster Relief Act of 1974 (PL 93-288), Congress enacted a sweeping revision of federal disaster assistance procedures. Section 406 of this act expressed the first explicit Congressional mandate for a post-disaster hazard mitigation assessment:

> As a condition of any disaster loan or grant made under the provisions of this act..., the state or local government shall agree that the natural hazards in the areas in which the proceeds of the grants or loans are to be used shall be evaluated and appropriate action shall be taken to mitigate such hazards, including safe land use and construction practices,..

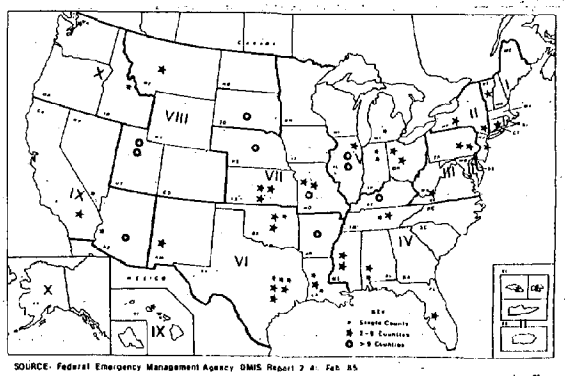
Section 406 applies to any form of natural disaster, not only to floods. But according to Holmes (1981): "Section 406 probably has greater potential for eliciting conformity with federal floodplain use standards in already developed floodplains [than the NFIP]." However, Holmes notes that "implementation of Section 406 was delayed by the inexperience of the Federal Disaster Assistance Administration (FDAA) with the concept of disaster mitigation." FDAA finally issued administrative regulations for Section 406 in 1979. Section 406 reports are due 180 days after a disaster declaration.

## Administrative Measures

In 1979, a year of many floods, the writer prepared a report for the U.S. Water Resources Council (Platt, 1979) which documented problems in federal post-flood disaster assistance policy. On July 10, 1980, the Office of Management and Budget issued a Directive to twelve federal agencies ordering them to formulate a procedure for identifying opportunities for mitigating future flood losses in the process of disaster recovery. This led to an interagency agreement signed December 15, 1980 by the twelve agencies (FEMA, USDA, Army, Commerce, Health and Human Services, Education, HUD, Interior, Transportation, EPA, SBA, and TVA). The purpose of this agreement was to establish interagency "hazard mitigation teams" (HMT'S) under the leadership of FEMA in each federal region to evaluate mitigation opportunities immediately following the issuance of a Presidential Major Disaster Declaration involving flooding. The HMT would prepare a preliminary "hazard mitigation assessment" (HMA) within 15 days after the date of the Declaration, to be followed by a 30-day detailed HMA and a 90-day progress report.

By September, 1984, the HMT process had been activated in response to 59 Presidential flood-related Disaster Declarations (Fig. 1). The series of HMA reports flowing from these investigations provides a unique body of data

MAJOR FLOOD DISASTERS 1980 - 1984
(Presidential Declarations)




SOURCE: Federal Emergency Management Agency, OMIS Report 2.4, Feb. 85

relating to the causes of flood damages and recommended means of alleviating them. Such measures include land acquisition and relocation, improved flood warning systems, improved mapping of hazard areas, land-use controls, and in some cases, local structural measures. However, the jury is still out as to whether these recommendations are being followed and, if so, whether they are exerting a salutory effect.

Between October 23, 1981 and September 18, 1985, 97 Presidential Disaster Declarations were issued involving total federal funding commitments of $686 million. By contrast, the first seven months of FY 1986 (October, 1985 - April, 1986) yielded 19 disaster declarations with a federal cost of approximately $413 million. Such a surge in disaster losses, largely comprised of flood damage caused by Hurricanes Gloria and Juan, underscores the need for effective mitigation measures in the wake of actual disasters. Each flood, coastal or inland, must be viewed as a learning experience. This axiom finds recognition in the FEMA hazard mitigation team process.

But more is needed. The studies and recommendations produced by the hazard mitigation teams are useless unless acted upon by federal, state, and local authorities and private landowners. Implementation requires (1) legal authority, (2) funding, and (3) political will. Normally legal authority is not a problem, except that territorial limitations may impair the geographic scope of actions that may be taken by a particular unit of government or landowner. This limitation indicates the need for intergovernmental arrangements by which multiple authorities may act cooperatively, e.g., to acquire floodprone land which straddles political boundaries.

Funding is a more common obstacle to achieving mitigation following a disaster. Private and local finances are likely to be

overcommitted by the disaster itself. Money for the additional expense of acquiring property, relocating businesses and homes, expanding bridge openings, etc., is usually unavailable locally. A few metropolitan areas such as Chicago, Denver, and Los Angeles have strong regional special districts which may act creatively to mitigate future flood losses (Platt, in press).

State funding for post-disaster mitigation is conspicuous by its absence in most cases. States receive modest funding from FEMA to provide technical assistance, including advice on post-flood mitigation. Occasionally, a statewide remedial program may be established in response to a particular disaster, as in the case of Colorado's dam safety inspection program created after the Lawn Lake Dam Failure in 1982. Some states provide funding assistance for open space acquisition which may be used in floodplains, e.g.: Massachusetts' Self-Help Program and New Jersey's Greenacres Program. Aside from occasional ad hoc appropriations for specific mitigation projects, states otherwise contribute little to post-flood mitigation.

Federal disaster assistance, when released by a Presidential Declaration, takes many forms and serves diverse purposes. Forms of assistance include direct grants (with or without non-federal cost sharing), low interest disaster loans, flood insurance payments, and in-kind assistance such as temporary housing. Federal disaster programs are administered by diverse agencies with varied missions, e.g., Department of Transportation (highways and bridges), Environmental Protection Agency (sewer and water facilities), and the Army Corps of Engineers (flood control works, emergency debris removal, etc.). Overall, federal disaster assistance in the 1970s emphasized restoration of the status quo ante in preference to reconstruction. It is not yet clear, as stated above, whether this built-in bias against mitigation has been alleviated in light of the hazard mitigation team process. But recent budget deficits and Gramm-Rudman cuts suggest that whatever federal policy may be, funding for mitigation is still scarce.

A recent Congressional law with important implications for hazard mitigation is the Coastal Barrier Resources Act of 1982 (CBRA). This is not a spending measure; to the contrary, it withholds spending of federal funds which would encourage development on undeveloped coastal barriers (as designated in the law). This "spending limitations" approach to hazard mitigation represents a bold departure from prior practice of subsidizing development in flood hazard areas and then subsidizing recovery from the inevitable floods. But the CBRA approach applies largely to undeveloped land.

Funding mitigation measures in developed communities requires similarly imaginative new approaches. Now that the National Flood Insurance Program is self-financing (out of premium revenues and barring catastrophic losses), it is timely to consider establishing a National Flood Mitigation Fund. Such a fund could be created out of profits in the National Flood Insurance Fund, as augmented perhaps by revenues earmarked from other sources, following the examples of the National Highway Trust Fund and the Land and Water Conservation Fund. A National Mitigation Fund could supplement general disaster assistance by financing measures recommended in HMT post-flood reports. If administered on a cost-sharing basis, states would be encouraged to establish counterpart funds, perhaps obtained from a slight increase in title recording fees or other sources relating to land development.

Even with adequate legal authority and funding, a third prerequisite of post-disaster mitigation is political will. Popular sentiment following a natural disaster, fueled by media coverage and elected office-holders, favors immediate restoration of the status quo ante, except "bigger and better." The term 'better' should become a synonym for 'safer'. The experience of Rapid City, South Dakota after its 1972 flash flood demonstrates the salutary results of civic determination to eliminate the conditions which result in repeated flood disasters in a community. Better understanding by local officials of the physical nature of flooding, the range of adjustments available, and the forms of legal and financial measures available to accomplish alternative adjustment is prerequisite to the achievements of more Rapid Cities. Indeed, with sufficient political will, legal and financial constraints will be overcome.

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# The Italian Experience with Earthquake Preparedness and Disaster Relief

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## INTRODUCTION

A permanent governmental structure for emergency management and scientific coordination emerged belatedly in Italy with the creation in 1982 of a Ministry for Civil Protection, but many dilemmas have yet to be solved. These include the level of state indemnity for private losses, the content and purpose of the national macroseismic questionnaire, and the degree of autonomy given to regional, provincial, and local governments when formulating emergency plans.

In Italy disaster relief funds made available by central government have been small relative to the need for them. This means that communities affected by disaster are in essence competing for disbursements made by the Ministry from each year's reservoir of funds. The magnitude of the disaster appears not to be the only factor governing success in obtaining relief money; the level of media publicity given to the event is important, as is the presence or absence of a local political structure capable of liaising effectively with central government and also producing a workable reconstruction plan.

Currently efforts are being made in the Italian parliament to develop a complete structure for disaster relief, involving all levels of government, as well as voluntary organizations, the armed forces, and scientific bodies. The extent to which preparedness should be devolved is being debated hotly, especially as the local and national authorities can so easily become adversaries when relief funds are scarce after disaster.

This article will evaluate the natural hazards situation in Italy, together with the nature of state intervention, preparation, and mitigation. The main emphasis will be on earthquake hazards, as these are the most widespread and potentially the most devastating that the country has to face.

## NATURAL HAZARDS

Natural Hazards -- principally earthquakes, landslides, floods, and avalanches -- pose a significant threat to about 70 percent (c. 210,000 sq. km) of Italy (Alexander, 1985). Natural disaster has claimed many lives in that country: about 135,000 people have been killed this century (Solbiati and Marcellini, 1983). Italian earthquake disasters occur on average once every 4.8 years (Ganse and Nelson, 1981), and 32 percent of the population lives in the roughly one quarter of Italian municipalities that are classified as "at high seismic risk" (CNR, 1981a).

About 90,000 people are believed to have died in the 1980 Straits of Messina earthquake and tsunamis, while in 1915 an earthquake killed 32,000 inhabitants of Avezzano and its surroundings in the Abruzzo Region (see location mag, Fig. 1). The 1980 earthquake in Irpinia, central-southern Italy, occurred where two previous tremors, in 1930 and 1962, had provoked damage and casualties (Provincia di Napoli, 1981). The 1980 disaster caused 2,735 deaths and 8,842 injuries, left more than 200,000 people homeless and caused damage in 637 municipalities spread over 23,000 sq. km (Ventura, 1984a). Many of the emergency relief provisions for the 1976 Friuli, N.E. Italy, earthquakes (in which 927 people died; Geipel, 1982) were rapidly adapted for the 1980 disaster in the South. The final estimate of the cost of damage was $5.0 billion (at U.S. $1.0 = 1,950 Italian lire) and reconstruction and social welfare programs absorbed about 3 percent of GDP over the period 1981-84 (Regione Basilicata 1982-3).

The message of these observations is clear: seismic vulnerability in Italy is high, both in terms of numbers of casualties and susceptibility of the built environment to damage. From 1900 to 1950 an average of 2,300 Italians died each year in natural disasters. This figure has since reduced to somewhere between 650 and 1,000 casualties per year (Gasparini and Stucchi, 1979). In part, this reflects the replacement of traditional building techniques (the low-strength masonry building; Hughes, 1981) by modern ferro-concrete construction; and it also reflects improvements in awareness and emergency procedures. But disasters of the magnitude of the 1980 Messina and 1915 Avezzano earthquakes have not occurred since the last war, and it may simply be a matter of time before the average post-war casualty and damage totals are raised.

## HISTORICAL DEVELOPMENT OF EARTHQUAKE RELIEF

Italy has an unusually long and detailed documentary history of earthquakes and other natural hazards (Barratta, 1901), including some detailed information from Classical times.

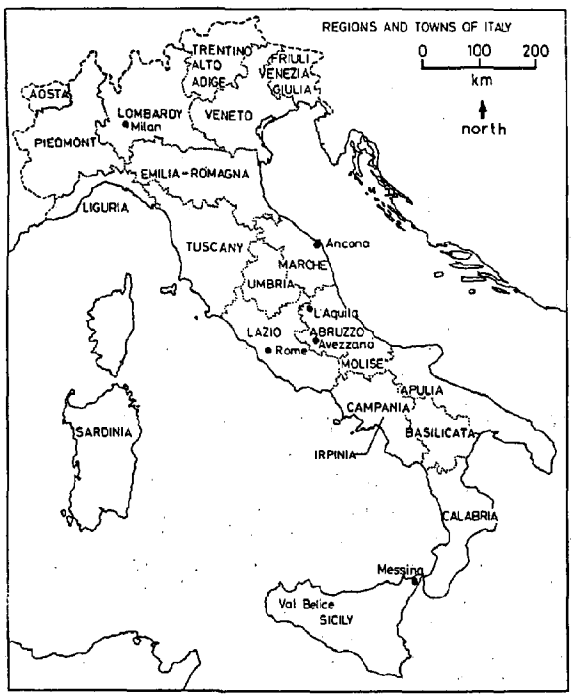



Figure 1: Location map

Perhaps the first seismic emergency to provoke widespread and systematic government intervention was that of Calabria, 1783, in which 30,000 people died and 400,000 were made homeless (Gasparini and Stucchi, 1979. However, little was done officially to ameliorate the effects of disastrous earthquakes in the mid-1850s (Mallet, 1862). The 1908 Messina earthquake provoked an argument between those (including the leading seismologist of the day, Giuseppe Mercalli) who argued for a stricter attention to, and regulation of, relief and reconstruction measures, and those who argued, using the tenets of the liberal economists, that the matter would resolve itself according to market forces (Solbiati and Marcellini, 1983).

Essentially, until the early 1900s, most earthquake relief in Italy was locally organized and relied on private donation. But the major earthquake that struck Avezzano, in Abbruzzo, in 1915 led to massive financial subsidies by the state. Furthermore, some temporary accomodation set up after this disaster lasted as long as 56 years (Canosa, 1981). Government policy in the period 1951-80 was to rely on extraordinary measures (rather than prior preparedness) applied after the disaster and only to reduce suffering during the post-impact phases. Burton, Kates, and White (1978, Ch.6) regard this as the lowest level of disaster policy-making that a national government can instigate.

In 1968, 14 low-energy earthquakes occurred in Val Belice, W. Sicily, damaging more than a dozen settlements (Haas and Ayre, 1970). About $512 million were eventually spent on reconstruction, but to relatively little effect: many of the 40,000 temporary dwelling units constructed with these funds were still in use 15 years later. Political machinations and corruption are blamed for the absolute inefficiency of the reconstruction in Val Belice (which has become a national **cause celebre** and 33 legal cases have ensured over construction problems (Di Giovanna, 1974).

Other instances of potential litigation over the quality of construction and maintenance of buildings damaged by earthquake have been thwarted by the slowness with which seismic building codes have been extended to newly-discovered risk zones, for example, in Lazio, Marche, and Campania Regions, which were affected by damaging earthquakes in 1971, 1972, and 1980, respectively, but which received 'seismic' designation only in 1983 (Geologia Tecnica, 1983).

The 1976 Friuli and 1980 Irpinian earthquakes essentially represented the last such events in which government could rely entirely on post facto aid (Comissariato Straordinario, 1981). National Law no. 546 of 8th July, 1977 granted $2,050 million over ten years for reconstruction in Friuli (Norsa, 1979). The objectives of this expenditure were, first, to save from destruction and also repair 3,000 damaged buildings, and secondly, to restore housing and employment to those who had lost them. The main problems experienced here were lack of a clear-cut definition of the disaster area, dispersal rather than concentration of government expenditure, the inflexibility of laws and plans, and the effect of inflation on funds (Cavallo, 1979). Very special measures had to be instigated to pay for the estimated $10.9 billion of damage caused in 1980 (Alexander, 1982, 1984). The 1980 earthquake occurred at a time when the whole organization of research, relief, rehabilitation, and mitigation in Italy was poised to change. These changes include the following:

## SEISMIC RESEARCH IN ITALY

In 1976 the National Research Council of Italy (CNR) funded a series of major research endeavors, involving collaboration among universities and research institutes, and including the "Progetto Finalizzato Geodinamica" (PFG) project for research in the 'protection against earthquakes' sector (CNR, 1980, 1981d). This five-year program (1976-81) was intended to improve the stability of geophysical research by more even funding. The project included structural geology studies, the compiling of seismic risk, magnitude and frequency maps, neotectonic maps, and seismotectonic maps for the entire country. It also involved local seismic zonation studies and the creation of mobile and fixed monitoring networks.

A critical report on the PFG appeared at its conclusion in 1981, and made the following points (CNR, 1981d):

(1) Progress to date (1981) was insufficient in both scope and achievement.

(2) The scope had been set too high for the - utterly insufficient - resources.

(3) Land-use planning, seismogenesis, the seismic performance of historic structures and the nature of tsunami hazards had either been ignored or only very recently studied in Italy.

(4) The various organizations suffered from duplication of effort, confusion of aims, and lack of direction.

(5) Founding new organizations (for example, an equivalent of the U.S. Geological Survey) would involve restructuring, and in some cases abolishing, all other organizations in this field and would take too long.

(6) One overall plan of coordination was needed. The work should be divided up between the various organizations, whose roles should be clarified. The National Geophysical Institute should run the national seismic network and collect macroseismic data on specific earthquakes. The CNR should deal with publicity and public education in this field. The Seismic Service of the Ministry of Public Works should be restricted to making studies for the updating of anti-seismic norms and laws, while geotechnical and microzonation studies should be carried out under the auspices of regional authorities.

This report reflected contemporary government thinking that the PFG should be superceded by a more permanent Earthquake Defence Group (GNDT), which was set up under National Law no. 874 of 22 December, 1980, with bases in Rome and Milan. The GNDT had, according to its director, "the scope of addressing, coordinating, promoting, and developing studies and actions of seismological or geological character, or related to engineering science applied to earthquake defence, and to furnish scientific advice to ministries, regional and local authorities, and public and private bodies (CNR, 1981d).

Certain sectors of the GNDT were effectively heir to the 1976-81 "Geodynamics" project. For example, the "Seismogenesis and Seismogenetic Regions" section was empowered to search for "active geological structures" and, based on their identification, to establish "priority zones for seismic research and fieldwork". Short-term seismic prediction measures (principally radon and helium monitoring, spring discharge monitoring, tiltmeter studies and gravimetric surveys) were only to be used "to distinguish active from inactive (geological) structures", not for making rapid predictions of individual seismic events. This was a wise decision, in that Italy is apparently not yet willing to finance a comprehensive network of instruments dedicated to short-term prediction.

## THE 'SPECIAL COMMISSARIAT' AND MINISTRY FOR CIVIL PROTECTION

At various times during the past, Italian governments have appointed officials with special responsibility for overseeing disaster relief. Law no. 996 of 8th December, 1970 (the main disaster relief legislation, Fig. 2a) provided for a Government Relief Commissariat, to be located in the region affected by any given disaster, and a Director General of Civil Protection, to be based at the Ministry of the Interior in Rome. (Herein, 'civil protection', 'civil defence', and 'earthquake relief and mitigation' are synonymous.) This ad hoc arrangement was utilized directly after the 1976 Friuli and 1980 Irpanian earthquakes, except that the "Extraordinary Commissioner' of government relief bore a more direct responsibility to the Minister of the Interior than Law no. 996 prescribed (Commissariato Straordinario, 1981).

Essentially, the Commissariat in the regions affected by the November 1980 earthquake had to be prorogued so many times - and the government had to deal concurrently with so many disasters - that it made eminent sense to found a permanent Ministry for Civil Protection. This came into being on 1 August 1982, with a personnel of about 100 and a Minister without portfolio (Camera dei Deputati, 1982). The ultimate aim is to decentralize activities, plans and stocks of equipment to the regional and municipal authorities. This objective is clearly a long way from being achieved, in that in 1985 only 5 out of 20 regions (Emilia-Romagna, Lombardy, Piedmont, Trentino-Alto Adige and Tuscany) had autonomous plans to combat natural hazards, while municipal plans had in no way reached a state of national coordination.

## EVOLUTION OF A LEGAL AND FINANCIAL STRUCTURE

### Legal Structure

Like most other countries, Italy has had to evolve a legal structure to regulate the processes of relief, resettlement and reconstruction following the impact of natural disasters. As a generalization, it is fair to say that the main stimulus to legislation in this field has been the disasters themselves: for example, the principal disaster relief law (no. 996 of 1970), which evolved during the aftermath of the 1968 Sicilian earthquakes, had no regulations governing its application until after the 1976 Friuli and 1980 Irpinian earthquakes had galvanized parliament into further legislative action. The dates of enactment of particular laws often fall within the aftermath of particular disasters, but the overall volume of legislation approved within any one period has tended to respond to the cumulative impact of disasters that occurred in fairly rapid succession, thus sustaining public demand for a response from parliament. The pace of legislation has also followed the growth of media coverage of disasters, and of their economic and social impact. Hence, prior to 1900 laws governing disaster relief were very rarely issued in Italy. In the first half of the present century such laws were enacted on average once a decade. Over the period 1951-79, however, 17 disaster-related laws appeared, and 1980-84

produced 39 laws and over 700 ordinances, or temporary laws (Commissariato Straordinario, 1981; Camera dei Deputati, 1982).

It is rapidly coming to pass that each disaster in Italy that has repercussions at the national level requires a law to regulate resettlement and reconstruction afterwards (Cavallo, 1979). The principal scope of such a law is:

(1) to enable ordinances to be made in the disaster area;

(2) to enable public funds to be granted to aid relief, resettlement and reconstruction, and to identify the source of such funds within the budget;

(3) to identify by name those municipalities that have suffered damage, in order to qualify them for state aid;

(4) to define the objectives of state aid;

(5) to identify the procedure by which citizens and communities can apply to the government for repair funds;

(6) to set limits to state aid (e.g., in millions of lire per square meter of damaged property); and

(7) to set up regulatory commissions to ensure equity in the distribution of state aid.

In practice the deadlines governing applications for funds are often extended. Communities are required to have valid and functioning urban plans before government money can be utilized for the purposes of reconstruction, and this often requires adjustment or reformulation of such plans to accommodate the effects of disaster. Such adjustment may take several years to complete. The most important and comprehensive law of this kind is no. 219 of 14th May, 1981, whose 85 articles will probably serve as a model for much subsequent legislation (Consiglio Regionale della Basilicata, 1982). This law dealt with reconstruction after the 1980 Irpinian earthquake, and the time limits on funding that it set had to be prolonged by two years, giving municipalities until the end of 1984 to formulate reconstruction plans.

Law no. 996 of 1970 established the civil protection structure that served for the next ten years, during which some significant natural disasters occurred (although its operational structure was only established in full by Presidential Decree no. 66 of 6th February, 1981). The 1970 law gave a planning role to committees at the regional level, and an operative and executive role to an Interministerial Committee of the central government (Fig. 2a).

This law had some serious drawbacks. It did not include the armed forces, which were managed entirely separately (the government's relief commissioner could only request the help of the armed forces, not direct their role in relief work). It encompassed disaster prediction and prevention, as well as relief and rehabilitation, but did not say how the former were to be accomplished. It did not regulate or coordinate the activity of voluntary relief workers, and, finally, it did not allow a role for mayors and local communities.

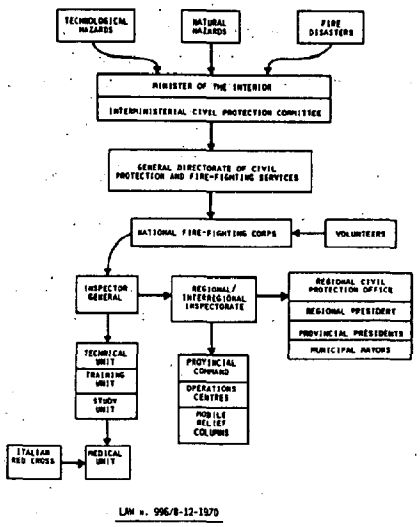



Figure 2a: 1970 Civil Protection Law

Over the period 1980-84 civil protection in Italy underwent a series of improvements:

(1) The speed of legislation increased immeasurably when compared with previous periods.
(2) Funds became available for immediate use in a crisis, without having to resort to parliamentary procedures to obtain them.
(3) It became possible to make ordinances immediately.

Hence government action was relatively prompt and efficient after the summer 1984 Sardinian forest fires outbreak, and the July 1985 Val di Fiemme, N. Italy, dam burst (La Stampa, Turin, 23 July, 1985). Much of the confusion and lack of information that once occurred directly after national catastrophe has been eliminated, although the organization of disaster relief is still highly centralized in Rome; and the region, province, and municipality have as yet no formal role to play in this structure.

The brevity and instability of successive Italian governments meant that the 1970 law

required the presentation of at least four bills to parliament, over a 20-year period, before being passed. Four bills have already been formulated to create the new civil protection law (Camera dei Deputati, 1982, 1983a, 1983b, 1983c). All of them seek to create a full-scale national structure for disaster relief and mitigation, involving all levels of government, from the local to the national, scientists, volunteers, charities and the armed forces (Fig. 2b). However, those bills sponsored by right-wing and centrist parliamentary groups argue for a centralized chain of command, while the bill proposed by left-wing groups envisages a devolved chain of decision-making. The only fundamental conflict of interest is in the amount of authority to be delegated to regional and local governments.

In part the civil protection bills sought to consolidate the national structure that was already coming into effect piecemeal as a result of ordinances and governmental decrees. Essentially, the civil protection bureaucracy was to be strengthened and amplified greatly, for example, by dividing it at each level of government into a policy-formulating committee and an operative or executive committee, each with an individual director. It remains to be seen whether a single law will emerge, or whether measures will continue to be implemented piecemeal.

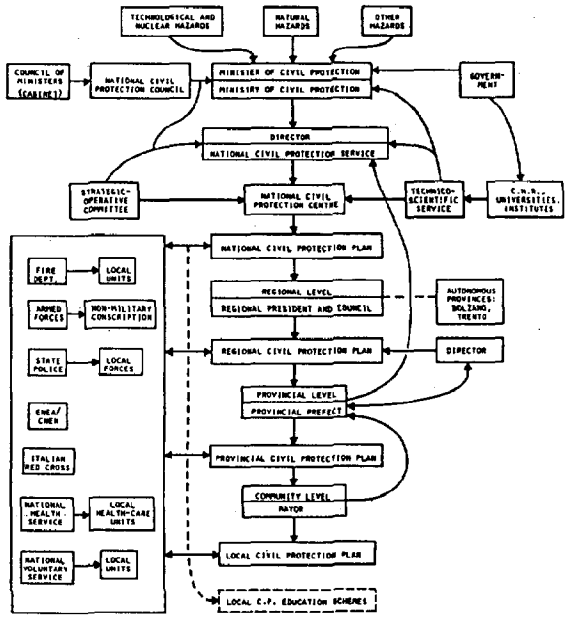



Figure 2b: 1982-83 Civil Protection Bills

Financial Measures

Government expenditure on relief and reconstruction after the 1976 Friuli and 1980 Irpinian earthquakes was so substantial ($2,050 million and $1,950 million, respectively) that in 1982 the Ministry for Civil Protection was endowed with a reservoir (serbatoio) of funds that would be renewed as the exigencies of disaster depleted it (but for 1983 it only consisted of $92.3 million, far short of demand). Decree-Law no. 159 of 26th May, 1984 granted $410 million to the 1984 earthquake-affected areas of central Italy, but only one-tenth of this sum was to be made available during 1985. Hence the chief problems of financing relief, rehabilitation, and reconstruction in Italy after natural disasters are the scarcity of funds with respect to demand for them and the delay in payment once central government has granted them to a disaster area.

## EVOLUTION OF A STANDARD MACROSEISMIC QUESTIONNAIRE AND DAMAGE SURVEY

Macroseismic questionnaires play an important role in Italy during the aftermath of an earthquake disaster. They have several functions:

(1) Questions can be matched with descriptions of damage effects listed in intensity scales. Isoseismals can thus be drawn and related to the geophysics of earthquake source mechanisms (CNR, 1981c).

(2) Individual building surveys -- of the sort that provide input to a macroseismic study -- may act as legal certification that a building is damaged to a certain degree and thus requires a particular technique of repair. This will qualify the owner for repair funds, if these are available.

(3) Statistical summaries of the degree of damage to individual dwelling units in any given settlement will qualify that municipality for inclusion in a list of settlements to receive government aid for reconstruction. Commonly, individual reconstruction laws list settlements as "epicentral" (thus qualifying for maximum aid) or "extra-epicentral" (less damaged -- sometimes also divided into two broad categories of damage, II and III). The exact number of settlements in each list is determined on the basis of many house-to-house surveys.

(4) Engineering observations related to the precise nature of reconstruction may be incorporated into the survey results for a particular building.

There is an increasing tendency to merge macroseismic survey (for scientific purposes) with damage survey (for administrative and engineering reasons connected with compilation of reconstruction lists). This makes eminent sense, in that it is extremely difficult to duplicate accurate building surveys during a chaotic aftermath situation. However, separate questionnaires are still used by the National

Geophysical Institute (ING), National Research Council Earthquake Defence Group (CNR-GNDT), and often by individual regional or municipal authorities.

The value of a macroseismic survey is that it provides a basis for reconstruction, a post hoc assessment of the vulnerability of the built environment and corroboration of the expenditure of seismic energy from place to place. In general, since the 1970s there has been a marked increase in the complexity of post-earthquake damage survey in Italy. Questionnaires have proliferated and have often conflicted in their aims or duplicated the work. Wide variations are likely to exist in the reliability of such surveys, yet nothing is being done (in 1985) to improve that reliability. Standardization is lacking, too many agencies are surveying the same damage (often with inappropriate or ill-chosen detail) and no guidance is available as to how many questionnaires are needed to obtain a representative sample from each site.

However, the aims of macroseismic and damage surveys have been greatly clarified during the last five years. There is also much need for creating a single, national questionnaire, serving several needs efficiently and effectively.

## THE CURRENT STATE OF DISASTER AND RECONSTRUCTION MANAGEMENT IN ITALY

### Before Disaster Strikes

Article 20 of Law No. 741/1982 adopted the new seismic vulnerability classification of Italian municipalities proposed by the National Research Council's Applied Geodynamics Project (PFG). Funds were to be supplied by the government, through the Ministry of Public Works, to institute vulnerability reduction programmes in those municipalities classified at risk from earthquakes. Anti-seismic building codes were to be applied for the first time in towns that had been newly added to the list. In some cases the change was dramatic: for example, the Marche Region in central Italy had only 10 percent of its municipalities classified seismic in 1980 but 90 percent were eventually included in the CNR's 'low risk' seismic category (CNR, 1980). Clearly a major alteration in the official vision of national seismic vulnerability had taken place, on the basis of the PFG's data.

The same national law also provided for regions to make their own laws for the prevention and reduction of seismic risk. The objectives of this measure were, first, to develop more accurate research into historical seismicity, using archives and local historical sources. Secondly, to create risk maps and geo-tectonic maps at the local scale, that could benefit vulnerable communities on an individual basis. Thirdly, effort would be concentrated on saving the existing heritage of ancient — and often dilapidated — buildings, beginning by conducting the first proper census of architectural patrimony. The principle of devolving authority to the regional level (and below) is undoubtably the right one, as it guarantees involvement by the people who stand to benefit directly from earthquake mitigation. However, much depends upon the level of interest in the problem at the regional and local level. The southern region of Basilicata set up its first seismographic network in 1985, whereas the central region of Marche (which is less at risk than Basilicata) has had one since the earthquakes at Ancona in 1972. Other regions have not yet involved themselves in this way (Boschi, 1984).

### The Emergency and Resettlement Phases

It can fairly be said that prompt government response to earthquakes post-dates the 1980 Irpinian disaster, in which delays in early relief became a national scandal (Alexander, 1982). Automatic transmission and interpretation of seismic data, coupled with better communication between the National Geophysical Institute and Ministries of the Italian government will now enable an almost instantaneous response to an emergency, instead of the previous procrastination.

However, during the next phase of a seismic emergency, much depends on the way in which macroseismic questionnaires are used. For example, it is estimated that 70 percent of the evacuations (of 38,000 people) carried out in Abruzzo following the May 1984 earthquakes were not necessary after survey had verified the safety of buildings (Fig. 3a). Reducing the scale of the emergency thus depends on rapid and accurate survey, upon the results of which municipal mayors must act with alacrity to cancel unnecessary evacuation orders (MPC, 1984). The experience of Abruzzo suggests a diverging pattern of (a) in some settlements, precautionary total evacuations regardless of distance from epicentre, and (b) in others, evacuation only of those occupants of dwellings presumed damaged, involving declining proportion of evacuations with increasing distance form the epicentre (Fig. 3b).

In Abbruzzo in 1984 mayors tended to adopt one of two approaches to the problem of damage. The mayors of towns that are heavily dependent on tourism tended not to restrict access to the damaged town centre, in order to discourage cancellations by tourists, who might become alarmed at the apparently high level of damage. By contrast, the mayor of Barrea, an agricultural settlement in L'Aquila Province, had the entire centre of town enclosed in wooden barricades and imposed an 8pm curfew. This had the dual effect of drawing attention to the damage at Barrea and permitting a full-scale comprehensive reconstruction plan to be drawn up, ready for the arrival of government funds.

Regardless of which of these two strategies they adopted, the mayors of the seven 'epicentral' municipalities in Abruzzo formed an alliance to resist any demands upon the state for reconstruction funds by the other 191 municipalities that claimed to be damaged. Hence, as a general rule, the post-emergency phases of an Italian seismic disaster can be seen

Figure 3a
EVACUATIONS AFTER THE ABRUZZO MAY 1984 EARTHQUAKES

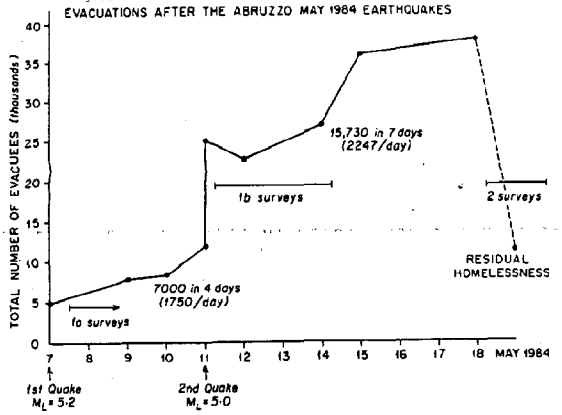
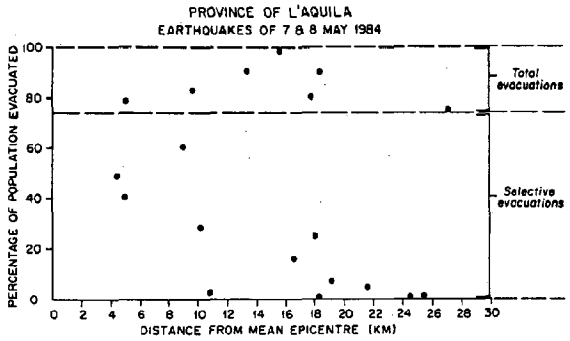



Figure 3b




to involve a free-for-all, in which it is in the interest of local politicians to exaggerate the level of damage to a community in order to compete effectively for reconstruction funds.

### The Reconstruction Phase

One effect of natural disasters in Italy has been to change the original meaning of urban planning, which was to regulate new additions to urban areas, rather than regulate the quality of reconstruction (Ventura, 1984b). Two new forms of urban plan -- the detailed plan for a particular zone (Piano Particolareggiato) and the reconstruction plan (Piano di Recupero) have appeared as vital ingredients in the process of repairing earthquake damage. An elaborate system of laws (e.g., No. 726 of 1982) has been evolved to combat increasing mafia-style corruption in the building trade, which the immense opportunities associated with post-earthquake reconstruction have stimulated greatly (Alexander, 1984).

Experience in the 1980 Irpinian earthquake zone suggests that damage to towns located near a significant epicentre may not begin to be repaired until, perhaps, four years after the disaster. Time is socially necessary to reconstruction planning. Delays between the end of the emergency phase and the start of reconstruction do not necessarily mean inefficiency (as the newspapers would often have us believe), but may be necessary to reformulate or adapt urban plans, to allow proper public consultation over their content, and to have them formally approved. In general, then lessons of reconstruction in Italy are that it has to be carefully managed and that government must honour its pledges to provide funds, within the deadlines that it sets itself. Generally speaking, a small to medium size earthquake disaster will generate reconstruction that lasts 12-15 years (e.g., Ancona, 1972, magnitude 4.7; Friuli, 1976, mag. 6.4). A large catastrophe (e.g., Irpinia, 1980, mag. 6.8) or a badly-managed situation (e.g., Belice, W. Sicily, 1968, mag. 4.1-5.4) will generate reconstruction lasting 20-25 years, or even indefinitely, if funds are not well spent.

## THE FUTURE OF NATURAL HAZARD MANAGEMENT IN ITALY

Levels of awareness, public involvement and scientific research with respect to earthquake hazards have all increased during the 1980's. It seems reasonable to assume that present trends in Italian hazard management will continue. The Ministry for Civil Protection will become larger and better established; seismic norms and zonation will continue to be upgraded. The regional and local levels will continue to increase their involvement, although not perhaps to the desirable level of having full-scale local mitigation and evacuation plans in every vulnerable community. Natural hazards will continue to claim an increasing share of national wealth, although perhaps fewer victims than in the past. Legal measures and macroseismic surveys will continue to become standardized, but may not lose any of their complexity.

Unfortunately, there is no sign of any reappraisal of the national attitude to state intervention in disaster aftermaths. More, rather than less, state aid is tacitly considered desirable, without really questioning this assumption. There is no sign of a shift in government policy from allowing the general taxpayer to foot the natural disasters bill, to encouraging the at-risk population to subsidize their own risk through mandatory insurance. Natural hazards insurance in Italy is virtually non-existent and does not look imminent: therefore, the government must bear the cost of disaster. However, government does not seem to have examined whether this is anything more than merely a political expedient.

Over the period 1982-84 36 earthquakes occurred that caused damage up to intensity VIII on the Mercalli-Cancani-Sieberg scale. The level of government involvement in the aftermath here was unduly high -- partly "to be seen to be doing something" and partly to test out the newly

acquired national hazards management structure. One must conclude that the response -- in terms of relief, resettlement, and reconstruction aid -- rather than the geophysical magnitude or seriousness of the damage, governs the importance of the event in the public eye.

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# Natural Hazard Mitigation in Developing Countries

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## THE DOMINICAN EXPERIENCE

The Dominican Republic is one of the most disaster prone countries in the Western Hemisphere and susceptible to a wide variety of natural hazards. Because of its terrain and climatic conditions, the country is subject to both heavy rainfall and severe drought. Nearly every year flash floods damage crops, infrastructure and energy producing installations as well as marginal settlements. Periodically droughts also cause extensive damage to the agriculture and in 1975 the losses in crops amounted to approximately RD $10,000,000.00 which, for the Dominican Republic, is a substantial sum.

Geographically the island is situated on the northern edge of the Caribbean Plate alongside a major fault, the Cayman Trench, and is criss-crossed by numerous and active secondary faults. Though there are frequent earthquake tremors, most produce little damage. Only cyclically (approximately every 70 years) do major earthquakes occur, as is shown by the following:

| DATE | APPROXIMATE DAMAGE |
|---|---|
| Dec. 2, 1562 | Destruction of the cities of Santiago and La Vega. |
| Sept. 8, 1615 | Destruction of the city of Santo Domingo. |
| May 9, 1673 | Severe damages to the city of Santo Domingo. |
| 1691 | Destruction of the city of Azua. |
| Oct. 18, 1751 | Destruction of the cities of Azua and El Seybo. |
| May 7, 1842 | Destruction of the cities of Santiago and La Vega. |
| Aug. 4, 1946 | Destruction of the city of La Vega and Nagua. |

This last earthquake of 1946 was of a magnitude of 8.1 on the Richter Scale.

Without a doubt the most dangerous natural hazard that affects the country are hurricanes with all their manifestations such as sea surge, flooding, and high winds. Geographically the Dominican Republic is situated on the northern side of the hurricane corridor that extends from the Atlantic Ocean to the Gulf of Mexico. In the last 25 years alone the country has been subject to 9 major hurricanes causing damage valued in the hundreds of millions of pesos and loss of life in the thousands. A synthesis of these and other major events are shown in the following table:

| HURRICANES | DATE | APPROXIMATE DAMAGE |
|---|---|---|
| San Ramon | July 1552 | Loss of a fleet of Spanish galleons laden with gold bullion. |
| Lilis | 1849 | Extensive damage through-out the country. |
| San Severo | Nov. 1909 | Extensive damage through-out the country. |
| San Zenon | Sept. 1930 | RD $12 million - 4,500 deaths. |
| Katie | Sept. 1958 | |
| Ines | Sept. 1963 | RD $10 million - 200 deaths. |
| Flora | Oct. 1963 | RD $60 million - 400 deaths. |
| David | Aug. 1979 | RD $890 million - 2,000 deaths. |
| Frederic (Tropical Storm) | Sept. 1979 | (included in the above) |
| Allen | Sept. 1980 | RD $ 56 million |

Hurricanes David and Frederic hit the Dominican Republic in a span of five days of one another and caused destruction of a little less than one third of the Gross National Product (G.N.P.) of the country for that year. At that time Hurricane David was judged to be the most powerful and extensive hurricane of the century with winds of up to 250 kms per hour. The direct effects can be synthesized by the following:

| | |
|---|---|
| Death | 2,000 persons |
| Homeless | 100,000 families |
| Material Damages | RD$890 million |
| - Agriculture | RD$354 million (37% of total production) |
| - Housing | RD$181.4 million (100,000 houses destroyed) |
| - Education | 15,750 schools damaged (85% of the total) |
| - Industry | RD$158 million |
| - Infrastructure | RD$133 million |
| - Commerce | RD$110 million |
| - Other | RD$48 million |

The indirect effects are more difficult to measure and sometimes longer lasting than the direct effects. Some of these are:

- Instability in the balance of payments
- Increase in the fiscal deficit
- Increase in inflation
- Interruption in the distribution of income and wealth
- Interruption in the educational process
- Health related side effects due to the decrease in the level of nutrition
- Psychological side effects

## MISUNDERSTANDINGS REGARDING POST-DISASTER MITIGATION

Despite the severe impact of these disasters on the economy and well-being of the country, relatively little is being done to prepare for, prevent, or mitigate the effects of future hazard events. This is due, to a large degree, to misperceptions and misunderstandings with regard to natural hazards:

- A misunderstanding that natural hazards are few and far between and consequently should receive little attention or be ignored.

- The lack of understanding that disasters (in contrast to the hazard) can be prevented, the impacts of hazards can be mitigated, and that mitigation measures can be incorporated into development planning at little extra cost.

Perhaps the major reason why mitigation is not receiving attention is the fact that the Dominican Republic is, and has been for some time, immersed in an economic crisis of such proportions that the institutional sector is primarily concerned with its own survival with little or no time or resources for disaster prevention and mitigation.

## NATURAL HAZARD MITIGATION IN DEVELOPING COUNTRIES

It is widely recognized that natural hazards are not, in and of themselves, disasters, but agents that transform a vulnerable condition into a disaster. The Dominican Republic is not alone. In the Third World the condition of vulnerability is the result of its state of poverty, caused to a large degree by the following factors:

- The debt crisis
- Population growth
- Mass urbanization
- Political instability

This situation is prevalent in so many developing countries. It differs in countless ways from that which exists in the industrialized world, making the transfer of mitigation experiences and technology difficult though not impossible.

## RECOMMENDATIONS

As a result of the experience of the Instituto Dominicano de Desarrollo Integral, Inc. (IDDI) in working in natural hazard mitigation and related fields in the Dominican Republic it is possible to formulate certain recommendations that would aid in implementing future mitigation measures. These are:

1) The best way to confront a disaster is to prevent it, and if that is not possible, at least reduce the risk of one occurring. Or as the well known saying goes: "An ounce of prevention is worth a pound of cure."

2) The most effective way to prevent or reduce the risk of a potential disaster is to incorporate natural hazard mitigation and disaster prevention measures into the on going development planning and programs. No true development is possible in hazard prone areas if these measures are not taken into account. (In the Third World, "development" is the elimination of vulnerability).

3) Natural hazard mitigation programs are most effective if they are long term, comprehensive and multi-sectorial or integral in their approach. It is necessary to incorporate elements of education, income generation and others to ensure the objectives are successful. Also random, unrelated hazard mitigation activities are not enough when what is needed is a logical, sequential approach.

4) The natural hazard mitigation programs should be in accordance with the social, economic, and cultural reach of population it is to benefit. This assures that they penetrate the culture and are acquired and learned by the people.

5) The natural hazard mitigation programs should utilize local resources as much as possible. These include local labor, materials, and economic resources.

Though these observations may seem obvious, they have been borne out by practical experience in the Dominican Republic. They may, therefore, be valuable to those who wish to embark on natural hazard mitigation activities in fellow Third World countries.

# Post-Disaster Housing Reconstruction and Economic Development in Peru

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## INTRODUCTION

The problem of rural housing has not been seriously studied nor discussed at the government level in Peru. Although population and housing censuses provide some data on the conditions of housing in the rural areas, such information is not specific enough to determine real needs, nor the options to improve housing quality in such areas.

There has been little official participation in the subject of rural housing, so there is a lack of experience in this field. Nevertheless, interesting and helpful mitigation actions have been undertaken in housing reconstruction in rural communities affected by natural hazards (earthquakes, floods, etc.). The experience from these isolated actions needs to be summarized in order to make possible effective and permanent action.

This paper describes a housing reconstruction project in northern Peru after the 1983 floods due to the "El Nino" phenomenon. The objective of this project was to implement and disseminate improved construction technologies through instruction, training, and technical assistance in rural communities.

## PROJECT DESCRIPTION

### Background

Between November 1982 and June 1983, six months of heavy rainfall caused the most dramatic series of flooding of this century along the coastland of northern Peru. Most of the damage (estimated in US$ at 1250 millions) was to agriculture, highways, bridges, and industrial installations. Therefore, Government interest after the disaster centered upon reconstruction of those sectors of the economy. No specific program was established for housing reconstruction despite the loss of homes (mainly adobe) by thousands of rural people due to the heavy rainfall and flooding.

International institutions such as the Agency for International Development (AID) supported programs for the relocation of towns and reconstruction of houses, which, in part, filled the gap with regard to low income housing. Certain state participation was required, involving Rehabilitation and Reconstruction Offices in housing programs. In addition hand labor was required from the people participating in those programs.

### Mitigation Techniques

The Catholic University of Peru has spent twelve years studying, through several research projects, ways to improve the seismic resistance of adobe houses. These studies have resulted in practical design recommendations for application in the field. The most important recommendations include the inclusion of a mesh of cane inside the adobe walls and the addition of straw and coarse sand to the mud used as mortar. These recommendations needed to be disseminated in the field and further tested. Consequently part of a research project funded by AID's Office of Foreign Disaster Assistance (OFDA) included a pilot project for the dissemination of the technology in the northern area of Peru.

### Project Development

The dissemination activities were centered in three rural towns and one main city of northern Peru (Chiclayo). The project lasted one year from June 1984 to May 1985 during which the following activities were performed:

- Preparation of teaching and dissemination materials.
- Dissemination lectures at several levels: engineers and architects, local builders and users.
- Training local builders through SENCICO (National Training Institution for Construction Workers).
- Socioeconomic study of involved rural communities.
- Elaboration of the technical file for the construction of houses (list of material and budget estimates).
- Technical assistance during the construction stage.
- Transference of technology to local institutions that can continue the application of the new technology.

## ANALYSIS AND EVALUATION OF EXPERIENCES

Even though the objective of the program was the implementation and dissemination of a new technology through its application in the field,

as one might expect success depended not only on the technicities of the new system, but on the conditions that said technological change required of the implementation program, and vice versa. It is also necessary to distinguish conditions for implementation which arise from an emergency, in contrast with more permanent conditions.

The program results in the three rural towns, in terms of house units built with the new technology, were quite different. In one of them (Canasloche) not a single house was built with the new technology, in the second one (Tupac Amaru) only 14 houses (10%) used the new technology, and in Chochope, 69 houses (69%) used the new construction by the end of the project.

There are several reasons for these differing results. The most important was the local economy. Canasloche and Tupac Amaru are located some 4 kms. apart in the same area near the coast. Agricultural activity here had not been yet restored to normal after the floods. In Chocope, located at a different site and at a higher altitude, agricultural activity was almost normal and the people had a more stable economic situation.

Another important reason was that Canasloche and Tupac Amaru were closer to the main city of Chiclayo (40 kms) and therefore had permanent contact with regional authorities, who could easily promise additional aid. This created expectations in the people, who assumed a passive attitude. In contrast, the residents of Chochope, which is 100 kms from the main city, are more independent and prone to taking action by themselves.

It is also important to note that the technological innovations represent an increase in the cost of the house both in terms of materials and workmanship, and even though the materials were provided by the project, the participants had to assume increased labor costs.

Finally, most of the technological innovations are oriented to improve the seismic resistance of adobe houses and there was not a strong awareness of seismic risk, since that region has not suffered a strong earthquake in 40 years.

## CONCLUSIONS AND RECOMMENDATIONS

Several conclusions and recommendations may be offered:

- Strengthened adobe construction is a real possibility for rural areas, despite the damage suffered by this type of housing due to natural hazards. But it must be shown not as a forced solution for the poor, but as an authentic alternative.

- Permanent and massive actions toward mitigation in rural housing require the support and participation of the State. Official regulations for this type of construction are necessary.

- The housing policy of the new Peruvian administration includes support for the use of traditional rural materials. However, the technological knowledge is found only in the universities and research institutes. There is a large demand for information concerning improved technology by the governmental housing institutions. This makes necessary an enhanced dissemination process.

- Including mitigation measures represents an increase in the cost of a house unit that cannot be afforded by low income people. Any project for implementation of these mitigation measures must be related to a development program which can cover such costs.

- The technological solution and the administrative system should be sufficiently flexible to make possible wide participation of the community in the mitigation program. This has to be done at the stage at which decisions are first taken. This will determine not only the way communities participate in the program, but the conditions in which their lives develop in the future.

- Laboratory research is needed to develop criteria in the field: the size of the house, space design, and even material and details of the construction system, without diminishing the house's qualities.

## ACKNOWLEDGMENTS

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# Transferring Mitigation Techniques Between Developed and Developing Nations

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When one talks of transferring hazard mitigation techniques to developing nations, one is confronted with skepticism and disdain. It is said that developing countries are concerned about hunger, debt, housing, and a multitude of other problems, and that mitigation of the effects of natural hazards, which often are rare phenomena, do not have a high priority in the day-to-day problems facing developing nations.

However, despite this negative reaction, natural hazards are a severe problem in developing nations and these problems affect both their economy and political stability. Examples are the devastating cyclones in Bangladesh which have caused economic problems for that country, and the earthquake in Managua, Nicaragua which contributed to the downfall of the government.

## TRANSFER OF TECHNIQUES

It is often difficult to convince a developing country that a hazard mitigation program is needed, at the same time developed countries may be reluctant to assist in such an intangible project. For the transfer of hazard mitigation techniques, the developed nation must be willing to commit its engineers, architects, and planners to mitigation, along with financial support. The recipient country must then demonstrate a willingness to implement mitigation measures. If neither developing or developed country is willing to make the necessary financial sacrifices there still may be other ways to promote mitigation. For example, the World Bank, the International Monetary Fund, and the United States Agency for International Development could promote hazard mitigation as a condition of their loans and assistance to developing countries. Diplomats and other emissaries can provide some education concerning hazard mitigation techniques if they are taught to do so. This could be particularly successful after the occurrence of a disaster. In the United States, we have a unique opportunity to assist Third World countries with organizations like the Peace Corps which could train their staff to teach hazard mitigation in developing countries.

If hazard mitigation techniques are to be transferred, they must be kept simple. This can mean the elevation of structures in flood plains, the siting of buildings away from known hazard areas, use of tie downs in construction, and warning systems.

Relatively simple education about the hazard and examples of how to mitigate could save lives and property. Illustrated cartoons or other forms of entertainment which could be given to the population of a developing country are one approach. Many Latin American countries have published excellent illustrations on simple practices of hazard mitigation. In Jamaica, the government has published hazard mitigation materials and has designed courses on disaster preparedness which are shared with other nations in the Caribbean.

The transfer of education materials from one country to another is a major means of promoting hazard mitigation techniques. The exchange of hazard mitigation information through international conferences like this one and the one held in Jamaica last November are examples.

Very often two nations can become involved in a joint effort to mitigate the effects of natural disasters on the lives and property of their citizens. Although both the United States and Mexico are developed countries, the procedures used in the U.S/Mexico Project on Hydrometeorological Phenomena in the Brownsville/Matamoras area can be a prototype that could be applied between a developed and developing nation.

## U.S./MEXICO PROJECT

In 1980, the governments of Mexico and the United States signed an agreement on cooperation in cases of natural disasters. To carry out the objectives of the agreement, a Mexico/United States Consultative Committee was established. The Consultative Committee then established a Subcommittee on Hydrometeorological Phenomena to develop a work plan for the prevention of, mitigation of, and response to natural disasters caused by hydrometeorological phenomena. The Subcommittee was told to develop a work plan within one year and submit it to the Consultative Committee for review. The Subcommittee members, who are scientists, engineers, architects, planners, and program managers, met in the United States and in Mexico to develop the work plan which was approved by the Consultative Committee at a meeting in Mexico city in October, 1984.

The Subcommittee created working groups of federal, state, and local representatives from each country. These working groups meet on an

informal basis during the year in order to carry out the tasks of the work plan and then meet biannually with the Subcommittee for guidance and direction. An annual progress report is made to the Consultative Committee. The six working groups are:

The Scientific and Technical Information Working Group;

The Vulnerability Analysis Working Group;

The Emergency Planning Working Group;

The Preparedness and Mitigation Working Group;

The Public Information and Education Working Group; and

The Border Coordination and Local Government Working Group

The Scientific and Technical Information Working Group was assigned the tasks to evaluate the frequency of occurrence and other characteristics of tropical cyclones and related hydrometeorological phenomena, and the design of tracking, forecasting, and warning systems.

The Vulnerability Analysis Working Group is responsible for studies of the area exposed to hazards and for evaluation of the risk, as well as the vulnerability of human life, property, and production. This includes the development of a methodology to evaluate the vulnerability of structures and persons in the area. This information is necessary for mitigation and recovery measures.

The Emergency Planning Working Group is responsible for drafting the plans and procedures for response and recovery needed as the result of tropical cyclones and related hydrometeorological disasters.

The Preparedness and Mitigation Working Group is responsible for evaluating, integrating, and disseminating, among professionals, authorities, and the community-at-large, the techniques for reduction of the effects of disasters resulting from hurricanes, tropical storms, and other hydrometeorological phenomena. The group is also responsible for the improvement of policies for land use. The dissemination method will consist of the publication of manuals and technical guidebooks and in the undertaking of workshops which will include the presentation of manuals and guides. The workshops will be given by technical experts.

The Public Information and Education Working Groups is tasked with the responsibility to design and implement systems and procedures for educating and providing information to the community. This will include education of public officials, exchange of bilingual public information, and the development of preparedness activities.

The sixth working group is the Border Coordination and Local Government Working Group which is responsible for the design of mechanisms and procedures for support and relief of disaster. Although this task is designed for two countries with a common border, it could be revised to apply to countries that are not adjacent to each other. When two nations develop such a plan, there must be contributions to the plan by both nations. The plan must be realistic in terms of funds and technicians available to work on it. And lastly, there must be a commitment to the plan from the highest level of government down through the bureaucracy.

We can succeed in bringing hazard mitigation strategies to all nations as long as there is mutual cooperation, patience, and a desire to save lives and protect property.

# CHAPTER THREE
# *MITIGATION TECHNIQUES*

This chapter outlines techniques for reducing hazard losses in both post and pre-disaster contexts. It begins with a paper by David Brower and Timothy Beatley which examines "growth management" techniques and coastal storm mitigation. The techniques and suggestions for implementation in this paper are applicable to other hazards.

The second paper by William Kockleman more specifically examines techniques for reducing mudflow and mudflood hazards. He stresses the need for solid data as a basis for mitigation.

The third paper by Mary Lydstadt focuses upon mental health services after a disaster.

Walter Hays considers mapping (microzonation) of earthquake hazards in Algeria and development of seismic-resistant design criteria.

The final paper by Martha Blair addresses the transfer of mitigation techniques among various types of hazards.

# Growth Management and Coastal Storm Hazard Mitigation

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## HURRICANE HAZARDS AND URBAN GROWTH

Hurricanes produce strong winds, wave action, and flooding in coastal communities. People are often killed or injured, buildings are destroyed, the natural environment altered, and social and economic activities suspended (Beatley, Brower, and Godschalk, 1984), Brinkmann reports that between 1925 and 1970, over 5,000 people were killed and $7.5 billion in property damaged by hurricanes in the United States. The Wiggins Company has recently estimated that the annual wind and surge damage from hurricanes may reach $5 billion by the years 2000 (Wiggins, 1979).

Estimates of damages from recent hurricanes support these figures and suggest that, if anything, they are conservative. For example, Hurricane Frederic in 1979 wreaked approximately $1.7 billion in property damages to the coasts of Alabama, Mississippi, and Florida (U.S. Army Corps of Engineers, 1981); Hurricane Alicia, a relatively small storm in August of 1983 produced some $1.5 billion in damages to the Texas coast (U.S. FEMA, 1983); and even smaller and less dangerous storms such as Hurricane Diana, which struck the North Carolina coast in 1984, caused significant damages and disruption.

While the number of deaths from hurricanes has declined, the amount of property damages has risen steadily. This is the result, primarily, of a dramatic growth in coastal areas in recent years, especially on barrier islands -- the coastal environments most vulnerable to storms (see Baker, 1979; French, 1979). Coastal development is occurring in the most hazardous locations (e.g., see Burton, Kates, and Snead, 1969; Lins, 1980). It has been suggested that the number of deaths associated with hurricanes may again begin to rise, as urban areas find it increasingly difficult to evacuate residents (Brinkmann, 1975). To compound these problems, the vast majority of coastal residents have not experienced a serious hurricane, creating a false sense of security (Herbert and Taylor, 1975). This suggests that many, if not the majority of coastal residents are not concerned -- or as concerned as they should be -- about the hurricane threat.

What follows is a brief review of the mitigation options available to coastal localities, with a particular focus on growth management. Section II reviews the range of responses available from the construction of seawalls to requirements for more stringent building codes. It argues that many of the more traditional approaches to mitigation are costly and ineffective and that localities should consider growth management as a means of mitigating coastal storm hazards. Following this is a description of the six major categories of growth management tools and techniques. Section III addresses the rise of growth management tools and the achievement of growth management objectives during reconstruction following a coastal storm. Finally, Section IV provides some closing thoughts.

## COLLECTIVE ADJUSTMENTS TO THE HURRICANE RISKS

In dealing with the risk arising from natural hazards, several basic approaches can be taken: risks can be avoided, they can be reduced, they can be spread out or more evenly distributed over the population, or they can be simply ignored. Several approaches have become popular in response to hurricane risks: insurance payments from the federal flood insurance program; the provision of post-disaster assistance, usually by state and federal agencies; the construction (often with federal funding) of structures, such as seawalls, revetments, and groins, which reinforce the coastal environment; and adoption of building codes and construction standards which require that coastal buildings and facilities are able to withstand hurricane forces. Facilitating evacuation through the preparation of local evacuation plans is an additional common approach to risk reduction or avoidance.

Structural approaches to hurricane protection -- either strengthening the shoreline through seawalls, groins, jetties, and so on, or strengthening buildings themselves through more stringent construction standards -- are the traditional approaches and are dominant in many coastal areas. These approaches, however, have fundamental drawbacks. Many localities simply do not have the legal authority to enact building codes. Moreover, building codes often provide only minimal protection, and increasing the stringency of building requirements may be quite costly. Engineered buildings may be better able to withstand storm forces, but their location in high hazard areas (e.g., close to an eroding beach) creates the need for structural protection. Moreover, while such buildings are stronger, they are not necessarily immune to hurricane destruction (Pilkey et al, 1983;

Salmon, 1984).

Permitting unrestricted shoreline development with the notion that seawalls and other protective structures will be built to guard against hurricane forces is an extremely expensive approach and one which may have only limited effectiveness. The Galveston seawall, for example, despite its immense costs, is only designed to protect against a medium-sized hurricane (a category 3 on the Saffir-Simpson index; see Neumann et al, 1978), and has virtually eliminated the beach. Beach nourishment, either in conjunction with structural measures or by itself, can be used to replenish beach materials, but again this is an extremely expensive option and one which provides only marginal and usually very short-term protection from storms and ocean flooding.

Any hurricane hazard mitigation response must be based on an understanding of the natural dynamics of the coastal environment. In recent years, tremendous growth and development has occurred on barrier islands. They have been shown to migrate (Kaufman and Pilkey, 1977) due to a complex set of natural dynamics (e.g., washover processes, littoral drift, inlet formation, dune and beach dynamics) and are modified by storms and hurricanes. Coastal erosion as a result of normal offshore littoral patterns, the occurrence of hurricanes and storms, and the general sea level rise, make development along the shores of barrier islands particularly tenuous. Structurally oriented solutions are designed to resist and combat these natural processes and are very costly and in the long run largely ineffective (see Pilkey et al, 1980).

Growth management can be defined as a system of programs and policies designed to influence, either directly or indirectly, the location, density, timing and/or type of development occurring in a community (see Brower et al, 1984; Godschalk, Brower et al, 1979). Six categories of such programs can be identified: (1) land use planning, (2) development regulation, (3) land acquisition, (4) taxation and other fiscal incentives, (5) public investment policy, and (6) information dissemination. Each of these techniques can be used to orient or direct development away from the most hazardous locations. It should be noted that in the short term, growth management will not be helpful in coastal communities like Miami Beach, where high risk areas have been completely developed. However, in the longer term, such communities could use growth management to direct redevelopment and reconstruction should a devastating hurricane occur (see Section III of this paper; also McElyea, Brower, and Godschalk, 1982).

### Land Use Planning

Land use plans can provide a rational basis for land use decisions. A community's land use plan serves as the guiding framework and formulation for orienting growth and development, by identifying community goals and objectives, development scenarios, and various strategies and means for their achievement. Typically such plans provide a community-wide picture of desirable patterns of development and growth and appropriate activities and uses to be permitted in particular sectors. More general and less specific than a zoning ordinance, a land use plan may establish, for instance, that high hazard areas in the community should be reserved for recreational uses or for low density development. The plan may designate these hazard areas and then provide a set of policies and standards for controlling development in them. Local plans may result in the reduction of storm hazards in their overall effect, or they may contain specific hurricane and storm hazard mitigation components. The Development Plan for Sanibel Island, Florida, for example, explicitly considers -- indeed contains as a central feature -- the reduction of hurricane and storm hazards.

Under North Carolina's Coastal Area Management Act (CAMA), coastal localities are now required to include hurricane hazard mitigation components in their land use plans. The CAMA regulations require that these plans consider and include the following:

(i) a local damage classification scheme consistent with those of federal and state assistance agencies

(ii) the establishment of local damage assessment teams

(iii) consideration of the establishment of a "recovery task force" to oversee the reconstruction process and any policy issues which might arise after a storm disaster

(iv) the establishment of guidelines for post-disaster repair and reconstruction, including but not limited to:

  (a) timing and completion of damage assesments

  (b) the timing and imposition of temporary development moratoria, and

  (c) the development standards to which repairs and reconstruction shall conform

(v) the establishment of a schedule for staging and permitting repairs and reconstruction according to established priorities assigned to the restoration of essential services, minor repairs, major repairs, and new development

(vi) the determination of which local agency is to implement the policies and procedures contained in the post-disaster plan

(vii) establishment of policies concerning the repair and possible relocation of

public utilities and facilities (Sec. 203 (9)(6))

In the relatively brief period in which this requirement has been in effect, some 15 coastal localities have developed such plans. the Town of Nags Head, for instance, has delineated general mitigation goals and specific mitigation policies which will serve to guide future development decisions in ways which will reduce these hazards (see Brower, Collins, and Beatley, 1984).

Reconstruction plans can serve, on the one hand, as general guidelines for making decisions about redevelopment following a storm, or on the other hand, may constitute very detailed instructions about which uses and site-specific areas and parcels will be permitted to be rebuilt and in what ways. The North Carolina reconstruction plans which have been developed thus far focus largely on the decisionmaking process following a storm, and the necessary institutions and components of that process. The plans, to a lesser extent, provide specific policies and information about where redevelopment should be permitted or not permitted, and under what conditions and requirements (see Beatley, 1985).

Under Florida's 1985 growth management law, coastal localities are required to address coastal storm hazard mitigation and to develop post-storm reconstruction plans and policies.

### Development Regulation

The primary growth management tools are those which regulate the location, amount, density, and type of development in a coastal community. Basic types include zoning and subdivision regulations, and various specialized applications of these standard regulations. Conventional zoning ordinances control the type of land uses allowed in particular parts of a community (e.g., residential, commercial, recreational) as well as their intensity (e.g., bulk, height, floor area ratio, setback provisions). As a result, zoning provisions can control the amount and type of property exposed to hurricane hazards. For instance, recreational and other low density uses may be the most appropriate activities to be permitted in high risk areas (e.g., high wave and erosion areas). Restricting such areas to low density activities will substantially reduce the amount of property at risk.

A relatively common and effective approach under this category is the requirement that new construction be setback a certain distance from the ocean's edge. In North Carolina, for instance, new multifamily structures located in Ocean Erodible Zones (oceanfront areas) must be setback a distance of 60 times the annual erosion rate in that area. The State of Florida has recently passed legislation which requires structures to be setback beyond a thirty year erosion line.

Subdivision regulations govern the conversion of raw land into subdivisions and the improvements made during this process. Subdivision regulations usually control the configuration and layout of development. They may operate in ways similar to zoning to control the amount and density of development as well. Site plan review and other requirements of the subdivision regulations can provide the opportunity to orient development sites in ways which minimize risks from storms. For instance, subdivision regulations could require that dwellings on lots in hazardous areas be sited to maximize their distance from the ocean.

Subdivision approval might be made contingent upon mitigative actions, such as the protection of dunes, wetlands, and natural vegetation. Builders could also be required to "cluster" structures on the safest portions of a parcel, to minimize exposure to storm hazards (e.g., see Whyte, 1968 for a general description of the clustering concept, and Urban and Regional Research, 1982, for its application to hazard reduction).

A promising alternative is to protect the option of moving a structure back from the ocean by requiring lots which are sufficiently deep for this purpose. Such areas could be considered analogous to the "repair" areas often required for septic tanks.

Many of these techniques may be appropriate following a hurricane or severe storm. A moratorium on reconstruction can give a locality time to determine how it wishes to redevelop, and actions it can take which will minimize the impacts of the next storm. (This is discussed at greater length in Section III).

### Land Acquisition

One very effective approach to reducing storm hazards is to prevent the development of hazardous land by public acquisition of that land. Several types of acquisition are possible. Fee-simple acquisition involves obtaining the full "bundle of rights" associated with a parcel of land. Undeveloped lands could then be maintained for open space, or other public recreational uses. (See Field Associates, 1981; Kusler, 1979). Another alternative is to purchase a less-than-fee simple interest in the land, in which owners of hazard-prone lands sell only their right to develop the land (e.g., the landowner is paid the fair market value for this right and agrees to leave the land in an undeveloped state in perpetuity).

Another approach involves the purchase of damaged structures, and/or the relocation of structures out of the hazardous area. While an expensive approach, relocation programs have been undertaken in several localities to avoid future disasters (e.g., David and Mayer, 1984; Adler and Jansen, 1978).

## Taxation and Other Fiscal Incentives

A growth management system may also include attempts to influence patterns of growth through the use of taxation and other fiscal incentives. The use of differential property taxation, for instance, is founded on the theory that reducing the property tax on undeveloped land will decrease holding costs and increase the profitability of current uses. This will increase the ability to resist pressure to convert to more intensive uses. Almost every state has a provision for some form of differential property taxation (e.g., Coughlin and Keene, 1981; Keene et al, 1976). The uses which are typically eligible are farm and forestland, open space and recreational uses. But if applied in coastal hazard areas differential taxation could reduce the amount of property exposed to storms.

Another taxation approach is to assess hazard areas development for the full cost of its location in the hazard area (e.g., the reconstruction of public facilities, public search and rescue services, disaster assistance and other services following a disaster). One example is "special benefit assessments". This technique is commonly used to charge property owners for the installation of curbs and gutters, or the improvement of roads, drainage, and sewer and water services. Such assessments are typically tied to a geographically delineated district in which property owners receive a substantial benefit in excess of the general benefits received by the public at-large (Hagman and Micszynski, 1978). Applying the concept to hurricane hazard management, a community would delineate areas in which "special storm services" are provided, and hence subject to the special assessment.

A variation on this theme is the impact fee. Here the levy may be designed to recoup the impact of a project on the community-at-large -- impacts that may extend beyond the immediate environs an requirements of a development project (see Stroud, 1978). For instance, while a special assessment may be levied to cover the immediate costs associated with the floodproofing of sewer and water service, an impact fee might assess broader and perhaps more diffuse consequences, less clearly related to specific services or benefits received by a site of development. Rather, it is less an issue of benefits received, and more an issue of the negative impacts on the community created by the development which must be mitigated. For example, the jurisdiction might levy an impact fee according to the extent to which a new project reduces the overall ability of the community to evacuate in the event of a hurricane. While it may not be designed to cover the costs of a specific improvement or set of improvements by which the particular development will benefit in a unique and special way, it is designed to require the developer (and presumably future residents who purchase these properties) to compensate the public for the costs associated with development in a hazard area.

An increasingly popular device which can be used to reduce the extent of development in hazardous areas is the concept of transferable development rights (e.g., see Costonis, 1973; Carmichael, 1974; Rose, 1975). Such an arrangement would permit the transfer of development rights from a high hurricane or storm hazard zone to a non-hazardous or "safe" zone in another part of the jurisdiction. Such a system could either be voluntary or mandatory. Under the latter, a locality would simply zone the storm hazard area so that fewer units of development are allowed (or prohibit new development entirely), and the owner of land within this zone would then be permitted to transfer all or some of this unused development density to parcels in designated safe areas, or to sell these on the open market to others who own land in areas designated for development. The locality would then permit increased levels of development in the "safe" zone as a result of possessing extra development rights; thus a natural market for the transfer of these rights is created. A voluntary approach would simply present this transfer as an additional option for the landowner -- a way of maintaining the land in its undeveloped use if the landowner wishes. The landowner in this case would still have the option of developing his land, or selling it for development purchases.

## Public Investment Policy

Development patterns are influenced by decisions concerning the provision of public facilities such as roads, sewers, and water services. A locality can develop an explicit capital facilities policy designed to avoid high hazard areas, thus reducing the amount of development and property at risk. This will become an effective deterrent, however, only if development in high hazard areas is dependent upon -- or deems highly attractive -- the existence of these facilities. For instance, if the development is able to obtain water through individual wells, and disposes of wastewater through septic tanks, a reorienting of sewer and water facilities by the locality will do little to impede growth in hazardous zones.

Redirecting capital facilities, and thus the development which accompanies them, into "safer" areas of the community can be facilitated through several means. One is the clear delineation of an urban service area or district, in which the community agrees to provide certain facilities and services.

Public investments also include structures and buildings ranging from town halls to schools to police and fire stations. It may be possible to locate these in areas which are less susceptible to storm forces, thus reducing the amount of property-at-risk, and by constructing them to certain specifications, it may be possible to use them as storm shelters.

Decisions about how to rebuild public facilities and capital investments following a storm may also have a tremendous impact on the extent to which damages from the next storm are

reduced. For instance, a community may decide that a road located in a high hazard area and heavily damaged from a hurricane should not be rebuilt. Such reconstruction decisions will also, of course, influence private decisions about how and where to rebuild following a storm.

### Information Dissemination

Classical economic theory supposes that the more informed consumers are, the more rational and allocatively-efficient their market decisions will be. This implies an additional set of mitigation strategies which aim primarily at supplementing and enlightening individual market decisions regarding the hurricane and storm threat. Several approaches can be taken.

The first approach is to use mechanisms which effectively inform potential consumers of the risks associated with the location (e.g., in a high hazard district). This can be done in several ways. Real estate agents might be required to inform prospective buyers about the potential dangers from storm forces. This approach was proposed in Texas, but was not enacted due to opposition from real estate and development interests (e.g., Texas Coastal and Marine Council, 1981). This approach has been used in California in an attempt to inform prospective homebuyers of the risks of living near earthquake fault lines (Palm, 1981). Under Florida's new growth management legislation, prospective buyers of land and property seaward of the coastal construction control line must be informed of this fact (Hopping et al, 1985).

Another approach is to institute programs which attempt to directly educate the housing consumer about storm risks. This might take the form of brochures and other materials distributed to new and prospective residents of the community, informing them of the nature and location of storm hazards, and information about what to look for in a new home or business structure (e.g., elevation and floodproofing). For existing residents, this approach may be one of educating them about actions which can be taken to enhance the integrity of their existing structures (e.g., installing "hurricane clips") and reducing future property damages.

Another approach is to attempt to reduce storm hazards by increasing information on the "supply side". This might take the form of construction practice seminars for coastal builders and developers, introducing both conventional and innovative approaches both to building and designing structures, and to siting and planning the orientation of buildings in vulnerable locations. This approach was proposed as a primary mitigation stragegy following Hurricane Alicia in 1983 (U.S. FEMA, 1983). The success of such a strategy, however, depends essentially on the integrity of builders and developers, and those who are conscious of storm threats are probably already planning their projects accordingly.

## GROWTH MANAGEMENT DURING RECONSTRUCTION

Post storm reconstruction places unique decision-making pressures and demands on local officials. Special institutional arrangements are needed to effectively cope with them.

### Post-Storm Damage Assessment

Critical to public decisions concerning post-storm reconstruction is an early and clear understanding of the magnitude, type, and causes of damages from the storm. One approach is to form a damage assessment team in advance of the storm that comes into existence immediately following the storm. Procedures for estimating and documenting the extent and nature of storm damages are established in advance of the storm (e.g., damage assessment forms, field guides).

The damage assessment team might be assigned the following responsibilities (Brower, Collins, and Beatley, 1984):

(a) to assess the extent and location of storm damage to public and private structures and facilities and to the natural environment;

(b) to document the type and location of storm forces, including the identification of the following:

1) incipient inlet areas

2) high wave action areas and areas of high erosion

3) high flooding and overwash zones.

(c) from the above information, to determine, to the extent possible, the likely causes of damage (e.g., faulty construction, proximity to an incipient inlet).

The damage assessment team(s) would collect this information and present it using a damage area delineation scheme. The damage team should also be asked to compare the actual damages incurred in the community with the hazard maps available prior to the storm.

The precise composition of this damage assessment team will depend upon the resources and expertise available in the locality. It might include some of the following individuals:

- planning director
- building inspector
- engineer
- tax assessor
- public works director
- real estate agents/appraisers

- environmental scientist/individuals familiar with coastal dynamics and processes.

In their storm hazard mitigation plan for Ocean City, Maryland, Humphries and Johnston (1984) propose the creation of three different sets of damage assessment teams. An initial damage assessment team is the first in the field, providing an initial inspection of damages to be completed in a couple of hours and uses it to determine if an emergency should be declared, if a redevelopment moratorium should be enacted, and if state and federal disaster aid should be requested. The second stage involves a more detailed assessment of damages utilizing different teams to assess different types of damages (e.g., private residences, mobile homes, etc.). A third team will accompany federal and state damage assessment teams and will assist in the preparation of damage survey reports required for obtaining disaster assistance.

Recovery Task Force

A task force created to supplement the normal local decision making process has been used successfully in several post-disaster settings. The North Carolina Coastal Management program urges localities to consider the creation of such a group. For instance, the Onslow County (1984) hurricane hazard mitigation and post-disaster reconstruction plan proposes a recovery task force with the following responsibilities:

(1) Review the nature of damages, identify and evaluate alternate program approaches for repairs and reconstruction, and formulate recommendations for handling community recovery.

(2) Recommend to the County Commissioners the declaration of a moratorium on repairs and new development.

(3) Set a calendar of milestones for reconstruction tasks.

(4) Initiate orders for repairs to critical utilities and facilities.

(5) Recommend the lifting of a moratorium for minor repairs.

(6) Recommend the lifting of a moratorium for major repairs to conforming structures.

(7) Evaluate hazards and the effectiveness of mitigation policies and recommend the amendment of policies, if necessary.

(8) Initiate negotiations for relocations and acquisitions of property.

(9) Recommend the lifting of a moratorium on major repairs (with approved changes to conform).

(10) Participate in federal hazard mitigation planning.

(11) Recommend the lifting of a moratorium on new development.

The primary function is to receive and review the damage assessments and analyses of post-storm circumstances, and to compare these circumstances with mitigation opportunities to discern appropriate areas for post-storm policy change and innovation. Where needed, it can review alternative mechanisms for bringing these changes about and go about harnessing internal and external resources for achieving these ends. Essentially then, a primary function of this group is comparing contingent factors and circumstances (physical, economic, political) with mitigation opportunities, and to arrive at and implement a set of post-storm policies. Such a task force could also undertake a similar process for non-mitigative objectives and opportunities. The other goals considered during reconstruction decision making might include the following:

(1) enhancement of local recreational and open space opportunities; enhancement of public access to beach and ocean;

(2) enhancement and restoration of local natural ecosystems;

(3) reduction of traffic congestion, noise, and other transportation-related problems;

(4) enhancement of the long-term economic vitality of the local commercial and industrial base;

(5) others.

The composition of this body also presents a question. Several options exist. One possibility is to assign these responsibilities to a completely new group of individuals, perhaps broad-based in its representation of community interests. This group might be composed of the following:

- one or more elected officials;
- planning director or planning department representative;
- public works official
- one or more representatives of the business community;
- representatives of adjoining communities.

Such a group would have the advantage of a fresh perspective on development opportunities in the locality as well as perhaps a stronger political base. A major issue in this case is the extent to which this body is directly accountable to the elected governing body or has

some degree of independent decision-making authority.

Another option is to assign these responsibilities primarily to the local planning board. This would have the advantage of capitalizing on the knowledge of the development process and would release the elected board from many of these decisions (at least at a detailed level of consideration), which is highly desirable given the number and gravity of decisions these individuals typically face in the aftermath of a hurricane.

Another option is simply to place these reconstruction opportunities squarely in the hands of elected officials. This option has the advantage of placing reconstruction issues and decisions in the hands of those officials who will ultimately be responsible for their implementation. This may be more politically expeditious, as well. A major disadvantage is that elected officials are typically faced with myriad decisions in the storm aftermath, and it may be appropriate to reduce rather than add to their decision-making responsibilities.

Humphries and Johnston (1984) propose several recovery and reconstruction committees. A Disaster Recovery Task Force would oversee recovery decision-making and would perform many of the supervisory tasks mentioned above. In addition, a Property Acquisition Committee would be established which would have responsibility for recommending properties for acquisition after the storm. A Permitting Task Force would be formed which would assist in the management of the permit process. Finally, a Property Owner Notification Committee would be established to inform non-resident property owners of damages incurred by the property and the post-disaster situation.

### Delineation of Damage and Hazard Zones: The "Triage" Concept

A primary task of the damage assessment team is to delineate damaged areas in conjunction with the reconstruction task force. A three-tiered delineation based upon severity of damage would function much like a "triage" does in emergency medicine: "major", "moderate", and "minor". Damaged areas would be designated, perhaps according to the following damage criteria:

(a) major damage areas: where buildings experience damages amounting to 50% or more of their fair market value;

(b) moderate damage areas: where buildings experience damages amounting to over 20% but under 50% of their fair market value;

(c) minor damage areas: buildings receiving damages of less than 20% of their fair market value.

The triage suggests that a community delay reconstruction in major damage areas (at least in the short term), focus its resources on rebuilding in less damaged areas, and give a little time to the consideration of alternative reconstruction plans for areas which were totally destroyed. The bulk of the task force's immediate attention should be directed to determining whether structures in moderate damage areas ought to be allowed to rebuild and if so, under what conditions. In addition, existing designation of local hazard zones (e.g., flood hazard areas) should be reviewed and modified to reflect changes in natural processes and topography and new knowledge gained about these processes. For example, if a new inlet has been created, this should be designated and considered by the task force or governing body when making reconstruction decisions.

The triage damage zone concept, while largely untested, has been incorporated, in one way or another, in a number of local disaster planning programs (Rogers, Golden, and Halpern, 1981; Onslow County, North Carolina, 1984; see Haas, Kates, and Bowden, 1977, for a general description of this idea).

### Temporary Reconstruction Moratoria

After the storm a locality may be besieged with requests by individuals to rebuild. Typically the pressure to rebuild is great, and local governments are not prepared to deal with either the substance or the number of these requests. One approach to this problem is the declaration of a temporary moratorium on rebuilding, alluded to earlier. This would provide sufficient time for the local damage assessment team to do its job and the task force to consider appropriate mitigation opportunities. Once the damage assessment is completed, the moratorium can be lifted for less damaged areas. A time limit to the moratorium, such as six months from its initial designation, is probably advisable.

### Taking Advantage of Redevelopment Opportunities

The extent to which redevelopment opportunities can be captured in the aftermath of a hurricane will depend in large part on the nature of the damages incurred (Cibrowski, 1981), and the pre-disaster planning. That is, if destruction is widespread in terms of the number of structures affected and the extent of damage to each structure, then substantial changes in land use patterns will probably be more feasible. The greater the variation and mixture of these damages, the less likely are major land use changes during reconstruction.

The extent and size of this damage area may in turn determine the type and magnitude of the mitigative opportunities. Moving urban settlement away from high storm hazard areas will simply not be possible where the damaged area is relatively small, but less ambitious programs may be more successful in these circumstances (e.g., the purchase of individual damaged sites for use as open space).

It is important to remember that hurricane damage may open the possibility of changes in land use patterns which are responsive to local objectives not necessarily directly related to hurricane hazard mitigation. Destruction from a hurricane may provide opportunities to advance these objectives, and the locality should be prepared to act quickly to capitalize on them. The recovery task force can serve as the body which oversees and advances this "target of opportunity" process. Again, the reconstruction process should be guided by the reconstruction policies and redevelopment plans formulated before the storm.

## CONCLUSION

This paper has introduced the concept of growth management as an alternative reaction to hurricane and coastal storm hazards. We have argued that this approach to hazard reduction is the most sensible and cost-effective in may coastal localities. While it may not be appropriate in jurisdictions which contain hazard zones which are already heavily developed, growth management measures are appropriate where hazardous areas are not yet developed. A variety of growth management tools and techniques are available, ranging from conventional zoning to public acquisition of undeveloped land. It is important to remember that the selection of measures will depend upon the unique economic, political, and ecological situation of each coastal locality. Growth management measures will be most effective if they are considered and developed as a system, with measures reinforcing each other.

It is important to place hurricane and coastal storm hazard mitigation in the context of other local planning and development objectives for several reasons. First there may be opportunities to advance other community goals and objectives. While it may not be feasible to purchase high hazard parcels solely to reduce the extent of property at risk in the community it may be possible when it is determined that such lands are needed for open space and recreational purposes. These overlapping objectives together make it feasible. Second, coastal storm hazard mitigation should be balanced against other public goals. For instance, a locality may permit a certain activity or development in a high hazard storm area if these risks are relatively small and are counterbalanced by other amenities and project features which are highly valued by the public.

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# Some Techniques for Reducing Mudflow and Mudflood Hazards

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## INTRODUCTION

Many of the techniques for reducing landslide hazards available to planners, engineers, and decision makers are applicable to mudflow and mudflood hazards. Some of these techniques, such as public acquisition of hazardous areas, are well known to the planning profession. Others, such as control structures, are commonly used by engineers. Still others, such as warning signs and regulations, are obvious and practical, but require maintenance and enforcement. Still others are innovative and untested when applied to mudflows, but have been successfully used in solving flood, landslide, and soil problems. These and other landslide reduction techniques are shown in Table 1 under the general headings of (1) discouraging new development, (2) removing or converting existing development, (3) providing financial incentives or disincentives, (4) regulating new development, and (5) protecting existing development.

The techniques may be used in a variety of combinations to help solve both existing and potential hazard problems. In the case of flood problems, Kusler described 75 case studies of hazard-reduction programs. Most include various combinations of two or more techniques, such as restrictive rebuilding regulations combined with acquisition for a mudflow area; rebuilding moratoriums and more detailed regulations combined with monitoring and warning systems, posting of signs, and partial acquisition; and ample setbacks from bluffs subject to erosion combined with acquisition and citizen education (Kusler, 1982).

## DESCRIPTION OF SOME TECHNIQUES

Disclosure -- Preparing hazard information for nongeologists and enacting hazard-disclosure laws can make people aware of mudflow and mudflood hazards. Furthermore, disclosing these hazards at the time of purchase can alert property owners to potential danger and loss. For example, to provide for protection against flood losses through a federally subsidized flood-insurance program, the United States Congress requires lenders to notify prospective borrowers that the real estate being mortgaged is located in a flood-hazard area, as identified by the Federal Insurance Administrator. To provide for public safety from earthquakes, the California Legislature requires a seller or his agent to tell the prospective buyer that the real estate is located within an official fault-rupture zone, as delineated by the State Geologist (Hart, 1985).

Disclosure can also be required at the local level. For example, in the ordinance enforcing on-site geologic investigations before construction, the Santa Clara County (California) Board of Supervisors requires that all sellers of real estate lying partly or wholly within the County's flood, landslide, and fault-rupture zones provide the buyer with a written statement of the geologic risk (Santa Clara County Board of Supervisors, 1978).

To help Realtors (members of the National Association of Real Estate Boards) comply with these federal, state, and county disclosure laws, five local boards of Realtors in the San Francisco Bay area prepared street maps showing some or all of the flood, landslide, and fault-rupture zones. The five maps cover one entire county and parts of three others, and include more than 50 cities. In addition, the San Jose (California) Board of Realtors designed a form to be attached to a real-estate contract to comply with the county disclosure ordinance.

Discontinuance of Nonconforming Uses -- When new or amended land-use zoning regulations are enacted, they often result in some existing land uses becoming nonconforming. Nonconforming uses are defined as those that exist at the time a zoning ordinance is adopted or amended, and do not conform to the new ordinance. For example, if an ordinance prohibits new residences within a hazardous area, those residences existing prior to the ordinance become nonconforming.

Zoning or other land-use ordinances may provide that nonconforming uses may be continued but cannot be extended or enlarged. They may stipulate that, if the current uses are discontinued for a designated period, any future use must conform to the ordinance. Regulations may also require that total structural repairs or alterations over the lifetime of a nonconforming building be limited to a percentage of the assessed or market value. Legislation may also eliminate nonconforming uses by providing for their amortization over a reasonable period of time. Model ordinance provisions and comments on the discontinuance of existing land uses are described in A Model Land Development Code by the American Law Institute.

Removal of Unsafe Structures -- Government agencies can remove structures damaged by mudflows and mudfloods by applying their public-nuisance-abatement powers. Section 203 of the 1985 Uniform Building Code by the International Conference of Building Officials, adopted by many cities and counties, indicates how this can be done:

> All buildings or structures regulated by this code which are structurally unsafe or not provided with adequate egress, or which constitute a fire hazard, or are otherwise dangerous to human life are ... unsafe. Any use of buildings or structures constituting a hazard to safety, health, or public welfare by reason of inadequate maintenance, dilapidation, obsolescence, fire hazard, disaster, damage, or abandonment is ... an unsafe use.
>
> All such unsafe buildings ... are hereby declared to be public nuisances and shall be abated by repair, rehabilitation, demolition, or removal ... .

This power gives many communities that have adopted similar provisions in their building codes the authority to remove any damaged structures. For example, the 1978 Bluebird Canyon (southern California) landslide required timely demolition and removal of 22 damaged homes; the owners refused to sign agreements allowing their homes to be demolished. The Laguna Beach (California) City Council "felt that appeals by landslide victims could prolong actions needed to protect habitable properties surrounding the landslide area from the effects of approaching winter rains... . The City Manager, with confirmation from the City Council, declared a nuisance to exist... . and ordered the demolition... . Demolition began two weeks later..."

Table 1. Some techniques for reducing landslide hazards

| |
|---|
| **Discouraging new development in hazardous areas by:** |
| Disclosing the hazard to real-estate buyers |
| Posting warnings of potential hazards |
| Adopting utility and public-facility service-area policies |
| Informing and educating the public |
| Making a public record of hazards |
| **Removing or converting existing development through:** |
| Acquiring or exchanging hazardous properties |
| Discontinuing nonconforming uses |
| Reconstructing damaged areas after landslides |
| Removing unsafe structures |
| Clearing and redeveloping blighted areas before landslides |
| **Providing financial incentives or disincentives by:** |
| Conditioning federal and state financial assistance |
| Clarifying the legal liability of property owners |
| Adopting lending policies that reflect risk of loss |
| Requiring insurance related to level of hazard |
| Providing tax credits or lower assessments to property owners |
| **Regulating new development in hazardous areas by:** |
| Enacting grading ordinances |
| Adopting hillside-development regulations |
| Amending land-use zoning districts and regulations |
| Enacting sanitary ordinances |
| Creating special hazard-reduction zones and regulations |
| Enacting subdivision ordinances |
| Placing moratoriums on rebuilding |
| **Protecting existing development by:** |
| Controlling landslides and slumps |
| Controlling mudflows and debris flows |
| Controlling rockfalls |
| Creating improvement districts that assess costs to beneficiaries |
| Operating monitoring, warning, and evacuating systems |

Legal Liability -- American jurisprudence recognizes civil liability for death, bodily injury, property damage, emotional distress, and economic loss, any of which may be caused by a landslide. Those potentially liable include the former owners or their agents, present owner, developer, tract engineer, soils or geotechnical engineers, consulting engineering geologists, architect or building designer, contractor, governmental entities, adjoining property owners, or any combination of these parties. The potential liability and adverse judgments should serve as a disincentive to those who may develop hazardous areas. Sutter and Hecht, supplemented by McGuire, discussed the types of lawsuits that injured parties may bring against those alleged responsible for their losses:

- Fraud -- a former owner advises the purchaser that a house is "in perfect condition" when cracks (caused by recent ground failure) had been repaired and repainted.
- Negligence -- a neighbor changes the natural drainage, thus causing a landslide.
- Strict Liability -- a mass producer and seller of lots improperly cuts, fills, and compacts earth to create a building site.
- Breach of Warranty -- parties to a real estate sales agreement insert an express guarantee of soil and geologic stability, which is otherwise.
- Failure to Comply with Regulations -- a developer or subdivider fails to perform the geologic investigations required by a state statute or local ordinance.
- Public Negligence -- a city grading or building inspector fails to perform periodic inspections of the lot grading or building construction to ensure that the work complies with the municipal code (Sutter and Hecht, 1974).

In a 1984 massive-earth-movement damage case, the California Court of Appeals First District has held that it is the duty of a real-estate broker selling a house to conduct a reasonably competent and diligent inspection of the property and disclose to the buyer any defects revealed by the inspection.

The California State Constitution as interpreted in various court decisions guarantees that the appropriate unit of government pays for what amounts to an after-the-fact condemnation of private property that it either took or damaged for a public purpose. This theory or remedy of inverse condemnation was substantially broadened by the California Supreme Court when it held that it was irrelevant whether Los Angeles County could have been expected to foresee a disaster after it did road grading at Portuguese Bend in

Palos Verdes; homeowners won $7 million in damages. Recent court decisions are placing increased responsibility for landslide losses on public agencies in Palos Verdes, Malibu, Pacific Palisades, and other southern California communities. One of the plaintiff's attorneys in a multimillion dollar series of lawsuits in Malibu's Big Rock Mesa argued that "the county should have designed a water system that would have withstood earth movements, rather than breaking ... and dumping water into already saturated clay and sand." A Los Angeles County Superior Court very recently ruled that the County should pay damages for a $2.3 million home destroyed in 1983. This is the first of 230 lawsuits; estimates of total damages range from $100 million to $500 million.

Grading Ordinances -- Grading ordinances can be used to ensure that excavating, cutting, and filling of landslide areas are designed and conducted in such a way as to avoid cutting into the toe of a landslide, removing lateral support, surcharging the landslide head, or otherwise reducing its stability. Such goals can be obtained by grading regulations designed to:

- Require a permit prior to scraping, excavating, filling, or cutting any lands.
- Prohibit, minimize, or carefully regulate the excavating, cutting, and filling activities in landslide areas.
- Provide for the proper design, construction, and periodic inspection and maintenance of weeps, drains, and drainageways, including culverts, ditches, gutters, and diversions.
- Regulate the disrupting of vegetation and drainage patterns.
- Provide for proper engineering design, placement, and drainage of fills, including inspection and maintenance.

The 1985 Grading and Excavation Code, Chapter 70 of the Uniform Building Code published by the International Conference of Building Officials and used as a model or adopted by many local governments, requires a permit for most types of grading; section 7006(c) states that:

> When required by the building official, each application for a grading permit shall be accompanied by two sets of plans and specifications, and supporting data consisting of a soils engineering report and engineering geology report. The plans and specifications shall be prepared and signed by a civil engineer when required by the building official.

Hillside-Development Regulations -- Some communities have adopted regulations to limit the amount of development (building sites per acre) that may take place in hillside areas; sometimes these regulations are incorporated into the grading or zoning ordinances. The regulations usually include a formula for determining the density of development that will be permitted for a given steepness of slope.

Hillside-development regulations can be used both for safety and aesthetic purposes. Controlled development conserves the views, and lower densities reduce exposure to hazards. Proper grading procedures, such as correct excavation and fill practices, are imperative to assure slope stability. Without them, the potential for landslides remains the same for individual sites; with them, the number of adversely affected sites is reduced. An engineering geologist is needed to assist the local government planner in making an accurate judgment about where density restrictions and other regulations can be useful. The steepness of the slope is not solely the determinant of slope stability; lithology and geologic structure also must be considered.

Examples include hillside-development standards by Simi Valley (California) City Council which are applicable to lands in residential zoning districts having slopes of 10 percent or greater, and the environmental hillside districts created by the Cincinnati City Council which contain at least four of the following characteristics:

- Slopes of 20 percent or greater.
- Existence of Kope formation.
- Prominent hillsides which are readily viewable from a public thoroughfare located in a valley below a hillside identified in the Cincinnati Hillside System.
- Hillsides which provide views of a major stream or valley.
- Hillsides functioning as community separators or community boundaries as identified in a community plan accepted and approved by the city planning commission.
- Hillsides which support a substantial natural wooded cover.

Land-Use Zoning Districts and Regulations -- Land-use regulations are an accepted method for controlling development. They provide direct benefits by restricting future development in hazardous areas and by limiting the expansion of existing development already in those areas. The types of zoning districts that best suit landslide areas include agricultural, open-space, conservancy, park, and recreational land-use zones. Such districts can be developed to permit grazing, woodlands, wildlife refuges, and public or private recreation. Provisions can be incorporated into district regulations to prohibit specific uses that could trigger landslides or that would be vulnerable to landslide damage. Prohibited uses might include clear cutting of trees, road construction,

dwellings, off-road vehicles, irrigation, liquid-waste disposal, and the permanent sheltering or confining of animals.

For example, geologic hazards, including landslides, mudflows, and unstable or potentially unstable slopes, have been declared by the Colorado Legislature to be matters of state interest. To assist communities in designing land-use regulations, the Colorado Geological Survey prepared model **Geologic Hazard Area Control Regulations** for adoption by counties and municipalities. The model regulations permit only the following "open" uses in designated geologically hazardous areas:

- Agricultural uses such as general farming, grazing, truck farming, forestry, sod farming, and wild-crop harvesting.

- Industrial-commercial uses such as loading areas, parking areas not requiring extensive grading or impervious paving, and storage yards for equipment or machinery easily moved or not subject to geologic-hazard damage.

- Public and private recreational uses not requiring permanent structures designed for human habitation such as parks, natural swimming areas, golf courses, driving ranges, picnic grounds, wildlife and nature preserves, game farms, shooting preserves, target ranges, trap and skeet ranges, and hunting, fishing, skiing, and hiking areas if such uses do not cause concentrations of people in areas during periods of high-hazard probability.

District regulations also can be designed to reduce the density of development. For example, the San Mateo County (California) Board of Supervisors created a resource-management zoning district to carry out the objectives and policies of their open-space and resource-conservation plans. The district regulations limit the number of dwellings in zones with unstable slopes to one unit per 16 hectares (40 acres) and require geologic site investigations to ensure that the reduced development is located in safe areas. The lower net number of dwellings permitted may then be clustered at a higher density in the nonhazardous areas.

Special Hazard-Reduction Zones and Regulations -- Some communities put overlays of hazard zones on their basic land-use zoning-district maps. The hazards shown on the overlays are then used to supplement the basic use and site regulations found in the zoning ordinance. Such regulations can be designed to:

- Preserve vegetation, maintain drainage, control off-road vehicles, avoid the most hazardous areas, require clustering of dwellings, and reduce development densities.

- Prohibit certain operations that increase loads, reduce support, or otherwise cause instability of slopes -- operations such as filling, irrigating, disposing of solid and liquid wastes, and removing the toe of a landslide.

- Prohibit certain uses -- storage of radioactive, toxic, flammable, and explosive materials -- that could cause serious health and safety hazards if released by landslide movement.

The Portola Valley (California) Town Council has developed criteria for permissible land uses in the least stable and most stable areas shown on its map of potential land movement. For example, roads, houses, utilities, and water tanks are prohibited in certain zones. The Town Council also requires use of the same criteria in administering the town's zoning, subdivision, site development, and building ordinances. The Portola Valley Town Council subsequently adopted additional regulations that reduce the maximum number of dwellings permitted in areas of potential land movement.

The King County (Washington) Department of Planning and Community Development has mapped landslide areas. The King County Council has provided in its zoning ordinance relating to these hazard areas that:

> No building permit, grading permit, shoreline substantial development permit, conditional use permit, unclassified use permit, variance, rezone, planned unit development, subdivision or short subdivision shall be granted for development on any Class III landslide hazard area unless King County determines, upon review of a soils study completed by a qualified soils engineer or engineering geologist, that the proposed development together with any required conditions to mitigate adverse environmental impacts can be safely accomodated on the site and is consistent with the purposes of this ordinance. The soils study shall include specific recommendations for mitigating measures which should be required as a condition of any approval for such development.

Other examples are provided by Kusler -- regulations for high-risk erosion along the Lake Michigan shoreline (Lincoln Township, Michigan), for mudflow hazards (City of Burbank, California), and for flood-related erosion and debris flows (City of Palm Desert, California) (Kusler, 1982).

Subdivision Ordinances -- Regulating the design and improvement of subdivisions is another way to prevent or control the development of landslide areas. A dilemma occurs when government officials approve a subdivision, accept public rights-of-way, extend utilities, and then attempt to impose zoning and other regulations that would prohibit further development. This dilemma can be avoided by adopting a subdivision ordinance designed to:

- Require the delineation and designation of landslide areas on subdivision plots and certified survey maps.

- Require dedication or reservation of landslide areas for public or private parks or other community purposes; and require dedication of, or easements along, those waterways necessary for adequate drainage.

- Require that public and private roads, bridges, utilities, and other facilities be located or designed and constructed to avoid landslide areas or to withstand anticipated movement.

- Select road and utility alignments and grades to minimize cuts and fills.

- Prohibit the creation and improvement of building sites in landslide areas.

The Southeastern Wisconsin Regional Planning Commission has prepared a model subdivision ordinance relating to various flooding, soil, and geologic problems. It can be adapted to landslide hazards. The model ordinance has been adopted by many local units of government; these ordinances have been in effect for over 15 years without successful legal assault.

Rebuilding Moratoriums -- Temporarily prohibiting rebuilding or construction of new development in areas after a landslide or severe ground failure may be used as an interim measure. This technique provides the local unit of government with time to prepare plans for removing unsafe structures, constructing retaining buttresses, adopting grading or zoning ordinances, or acquiring unstable land and relocating its former occupants. Examples of rebuilding moratoriums include one by the Rancho Palos Verdes (California) City Council for an area shown on their "landslide moratorium map"; one for the City of San Bernardino (California) for an area damaged three times by mudflows; and another for Cowlitz County (Washington) for the mudflow area of the Toutle River.

Assessment Districts -- If it becomes necessary to stabilize landslide areas, construct control or protection structures, or to repair damaged public facilities, the costs can be assessed wholly or in part against the owners of the lands that will benefit. The California Legislature (1979) passed the Beverly Act which provided for the formation of Geologic Hazard Abatement Districts. When created, these districts are authorized to acquire real estate; acquire, construct, operate, manage, or maintain improvements; and pay for such improvements. Improvements are defined as "any activity necessary or incidental to the prevention, mitigation, abatements, or control of a geologic hazard." Such hazard is defined as "an actual or threatened landslide, land subsidence, soil erosion, or any other natural or unnatural movement of land or earth." A district consists of an area specifically benefited by, and therefore subject to, a special assessment to pay for the improvements. Abalone Cove Landslide Abatement District, the first district in California, was formed by the Rancho Palos Verdes City Council.

## ANALYSIS OF SOME TECHNIQUES

Very few systematic evaluations have been made of adopted hazard-reduction techniques, even fewer for landslides specifically. No rigorous benefit-cost studies have been conducted, although a few intensive evaluations have been made for flooding and some other hazards which may be applicable to landslides. Analyses by Slosson and Krohm have shown substantial reductions in landslide failures and site damage because of the adoption and enforcement of more modern grading codes in the City of Los Angeles.

A.W. Martin and Associates performed an analysis of 13 techniques for protecting development in landslide areas. Their study, made for Allegheny County, Pennsylvania, found that "the cost of preventing and controlling landslides is often prohibitive... . Avoidance is highly recommended for individual dwelling lots."

After an investigation of the damages and losses from the January 1982 mudflows in Northern California, the California State Board of Registration for Geologists and Geophysicists (1982) generally concluded that:

> a large degree of responsibility for slope failures rests with units of the state and local governments... . A significant step forward would be requiring local governments to use the services of a licensed professional, either as a staff person or consultant, in the review and approval of geologic reports. The responsibility for reducing future loss of property and life from mudflows requires the full cooperation of the city government, professional geologic community, and the State Board of Registration.

In the case of flooding, Sheaffer and Roland, Inc. concluded that "experience to date indicates that the current approach to correcting nonconforming uses through zoning mechanisms is not effective. Nonconforming uses, particularly residences, are allowed to continue even when they are substantially damaged unless they are purchased." Surveys of state and local programs conducted as part of a study by Kusler (1982) support their conclusion.

Evaluations of those techniques used for disclosing fault-rupture zones and the processing of loans may be relevant to flood hazards. For example, prerequisites for effective disclosure of hazards by real-estate sellers include a seller's or real-estate agent's knowledge or integrity, a buyer's awareness of the potential danger or financial loss **before** making the commitment to purchase, and a buyer's concern about hazards as related to his or her other

priorities. According to a study by Palm of disclosure of official fault-rupture zones by real-estate agents in Berkeley and part of Contra Costa County, California, these prerequisites are often lacking.

Remedial public works to protect existing development is costly and can be self-defeating. It may encourage development by leading the public to believe that landslide problems have been eliminated, not simply reduced. Intelligent landslide-area management and regulation are sill needed for effective hazard reduction. With regard to cost, Brooks (1982) notes that:

> The cost of public works has increased sharply in the last decade. Not only has the cost of construction increased by a factor of about three over the last decade, but the cost of borrowing (expressed as the interest rate paid by government) has also tripled. Therefore, the annual cost could have increased between three and nine times, depending on the length of the repayment period. Thus, there are strong economic incentives to consider and use other approaches.

## A PREREQUISITE FOR THE USE OF ANY TECHNIQUE

A prerequisite for the successful use of any hazard-reduction technique is the availability of adequate, detailed hazard information that is in a form usable by nongeologists; and its communication to those planners, engineers, and decision makers who will, or who are required to, make use of such information.

The preparation of reliable landslide-hazard (susceptibility) maps can be expensive and is at a relatively early stage of development and testing. Examples of the type and detail of hazard maps adequate for county (1:24,000) and regional (1:125,000) planning and decision making include the slope-stability maps used in the United States at scales ranging from 1:12,000 to 1:100,000 show:

- mudflow hazards and paths in Los Angeles County Flood Control District
- potential for earthquake-induced landslides in Santa Clara County, CA
- potential rockfalls in Jefferson County, CO
- "mudslide" - risk zones in Southern Ventura County, CA
- slope stability during earthquakes in San Mateo County, CA
- landslide-prone areas in West Virginia
- landslide-hazard areas in King County, WA
- mudflow inundation for the Cowlitz and Toutle Rivers, WA
- debris-flow hazards for the Las Vegas Southeast Quadrangle, NV
- slope stability in Fairfax County, VA
- areas most susceptible to landsliding in Beaver County, PA
- susceptibility to landsliding in Marin and Sonoma Cos., CA
- potential for debris flows along the Wasatch Front, UT

A recent statute enacted by the California Legislature (1983) requires the State Geologist to develop maps of landslide hazards in urban and urbanizing areas. This **Landslide Hazard Identification Act** provides that the California State Mining and Geology Board, in consultation with the State Geologist, develop guidelines for the preparation of the maps, and priorities for those areas to be mapped. About $300,000 in new funding annually became available on July 1, 1984, and the California State Division of Mines and Geology began mapping five high-priority areas at a scale of 1:24,000 (1 inch equals 2000 feet).

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# The Realization of a Seismic Microzoning Study in the Chlef Region of Algeria Following the 1980 El Asnam Earthquake

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## INTRODUCTION

### Seismotectonic Setting

Algeria is part of the African tectonic plate, one of about twelve rigid segments of the crust and upper mantle comprising the Earth. These plates are typically 80-100 km (50-60 miles) thick and move continuously over the interior of the Earth. They move with velocities ranging from a fraction of a centimeter to several centimeters per year. Although the movements seem slow, they can add up to 50 km (30 miles) in 1,000,000 years, a short time geologically. The plates are separating in some locations and converging in others. In the case of the African plate, it is in the process of colliding on its northern boundary in the vicinity of the Mediterranean Sea with and being overthrust by the Eurasian plate. As a result, earthquakes, a wide belt of folded mountains (the Atlas Mountains), and a zone of crustal shortening having a width of about 400 km (250 miles) are being produced in Northern Algeria along the collision zone. Reverse (or thrust) faults trending east-west to east-northwest approximately parallel to the collision zone are common in Northern Algeria. Past studies of the seismicity and tectonics of Northern Algeria have shown that 70 percent of the region has the potential for experiencing earthquakes of magnitude 7 or greater.

### The Triggering Event and Its Effects

In the past 250 years moderate to large earthquakes have impacted Northern Algeria at least a dozen times. The most notable recent historic earthquake occurred in 1922, 1934, 1954, and 1980. The magnitude 7.3 El Asnam earthquake that occurred on 10 October, 1980 served as a reminder that the tectonic processes along the collision zone of the African-Eurasian plates are still active. The extent of the social and economic impacts of the El Asnam earthquake demonstrated that Algerian buildings and other facilities are potentially vulnerable to the recurrence of damaging earthquakes.

The 1980 El Asnam earthquake severely damaged buildings and lifeline systems in the Chlef region, killed 2,700 people, injured several thousands more, and critically affected all levels of economic development in the region. Many buildings suffered partial to total collapse and several thousand people were left homeless. The social and economic impacts were felt throughout the entire nation.

The El Asnam earthquake demonstrated that the economic and social impacts of a large earthquake in Northern Algeria are very devastating and showed that additional loss-reduction measures are needed in Northern Algeria to reduce the potential losses expected in future earthquakes. The epicentre of the magnitude 7.3 El Asnam earthquake was about 10 km (6 miles) east of the city of El Asnam (now called Ech Cheliff). The earthquake occurred on the Oued Fodda fault system, an active 47 km long (28 miles) reverse fault. The Oued Fodda fault ruptured the Earth's surface over a distance of about 35 km (21 miles) in the earthquake. Liquefaction and landslides occurred at sites in some areas. Although the characteristics of the ground shaking were not recorded on strong motion accelerographs, experts estimated that peak ground accelerations in excess of 0.5 g occurred at sites in the epicentral area. Engineers conducting post-earthquake investigations in the Chlef region concluded that the level of vertical acceleration exceeded the level of horizontal acceleration and that the two large forces acting together were a major factor in causing severe damage to buildings.

In October, 1980 when the El Asnam earthquake struck the Chlef region, about 1,000,000 persons (i.e., 5% of the population of Algeria) were living in the region. Thirty percent of the population was living in 95 urban centers, the largest being Ech Cheliff, Khemis, Miliana, Ain Defla, and Bou Kadir. Between 1954 and 1980, the population of the city of Ech Cheliff had increased from 18,000 to 130,000, primarily as an outcome of the industrialization process which began in the 1970's. The continued rapid growth and concentration of the national assets of Algeria in the northern part of the country calls for a national program to reduce potential losses from future earthquakes.

## MITIGATION MEASURES

### Seismic Microzoning

Seismic microzoning, the division of a region into zones expected to experience the same relative severity of earthquake ground shaking, surface fault rupture, and ground failure, was undertaken as an essential part of the Algerian

national program to reduce potential losses from future earthquakes. Microzoning maps were envisioned as a tool to plan for reconstruction and redevelopment in the Chlef region and to guide earthquake-resistant design of new buildings and the strengthening of existing buildings. Preparation of seismic microzoning maps is a complex technical task which requires research to determine answers to the following questions: 1) Where have earthquakes occurred in the past? 2) Where are earthquakes occurring now? 3) Why are they occurring? 4) How often do earthquakes of various magnitudes occur? and 5) What are the nature and extent of the physical effects that would be expected from earthquakes of various magnitudes within a given exposure time. The research on seismic microzoning requires a multidisciplinary team.

## International Tender

The responsibility of the seismic microzoning of the Chlef region was entrusted to L'Organisme de Controle Technique de la Construction (CTC), a part of the Algerian Ministere de L'Urbanisme, de la Construction, et de L'Habitat. CTC created a special organization to carry out its responsibilities. In March, 1982, CTC requested assistance from UNDP to prepare an international tender soliciting contractors having expertise in seismic microzoning.

The tender was prepared by CTC with Unesco assistance. It had two broad requirements: 1) to conduct regional-scale and urban-scale studies leading to a technical methodology that could be used to produce seismic microzoning maps for nine specific urban areas of the Chlef region, and 2) to transfer technology on seismic microzoning from the contractor to Algerian scientists, engineers, and planners.

To supplement the capability of their staff in seismic microzoning, CTC requested technical assistance from UNDP and Unesco to evaluate the seven proposals that were received in the international tender. These proposals were evaluated technically in Algeria during the period 31 August to 30 November, 1982. Three experts were sent by Unesco to assist CTC and their Algerian partners in evaluating the proposals and formulating a "checklist" of technical questions (see Appendix I) to use in the oral interviews with each potential contractor. The purpose of the "checklist" was to clarify the technical issues, sources of uncertainty, and potential conservatism of the technical methodology as well as to determine the experience and proposed plans of each contractor for transferring the seismic microzoning technology. One "checklist" was used in August, 1982 in the oral interviews with each of the seven international organizations submitting a proposal. This procedure provided a uniform, fair, and impartial basis for initiating the same discussion with every proposer. By means of this process three contractors were selected for final negotiations. Each contractor was asked to respond to another set of questions prior to additional interviews in November, 1982. The interviews in November with the three finalists led to the selection of the firm of Woodward Clyde Consultants (WCC) as the contractor. CTC requested UNDP to assist them in the control of the seismic microzoning study. A project document was approved by UNDP in August, 1983, one month after commencement of the project.

The overall cost of the microzoning study was approximately $2,000,000.

## Technical Objectives of the Project

The American firm of Woodward Clyde Consultants (WCC) was contracted to accomplish the following technical tasks in the Chlef region, starting in May, 1983 and ending in July, 1984:

i. Delineation of the relative severity of the primary and secondary physical effects of earthquake ground shaking, surface fault rupture, and ground failure. These physical effects were to be represented probabilistically in terms of exposure times (for example, 50 years) and probability of nonexceedance (for example, 90 percent).

ii. Specification of recommendations for realistic earthquake-resistant design methods and construction and land-use practices. When implemented, these procedures would enable new and existing buildings in the Chlef region to be more resistant to ground shaking from future earthquakes.

## Objectives of Transfer of Technology

The firm of WCC was also contracted to transfer technology on seismic microzoning to Algerian scientists, engineers, and planners. Transfer should aim to:

i. Increase significantly the technical knowledge and capability of CTC and their Algerian partners to implement the results of the seismic microzoning study and to conduct additional seismic microzoning studies in other parts of Algeria without foreign assistance.

ii. Provide a practical and sound technical basis for improving earthquake-resistant design and construction and land-use practices in Algeria.

## Technical Activities

The work plan of WCC was organized into four activities; three technical activities and one activity involving transfer of technology. The three technical activities evolved serially over a four month period and encompassed the twenty-three tasks described below. Each task was designed to produce specific outputs needed in another part of the seismic microzoning study.

Evaluation of Seismic Hazards on a Regional Scale (a map scale of about 1:1,000,000).

This part of the microzoning study established the physical parameters of the region needed to assess the earthquake hazards of ground shaking, surface fault rupture, and ground failure. It included the following tasks:

Task 1: Compilation of historical seismicity catalog and map.

Task 2: Performance of neotectonic studies (mapping, age dating, and trenching) to extend the information on recurrence times derived from the historical seismicity data.

Task 3: Preparation of photogeology map.

Task 4: Preparation of a seismotectonic map showing the location of active faults.

Task 5: Preparation of a map showing seismic source zones, specifying the magnitude of the maximum earthquake and the frequency of occurrence of earthquakes in each source zone.

Task 6: Specification of the characteristics of near-field ground motion (peak amplitude and spectral composition).

Task 7: Specification of regional seismic wave attenuation laws, including their uncertainty.

Task 8: Preparation of probabilistic ground-shaking hazard maps in terms of peak ground acceleration, exposure times, and probability of nonexceedance.

Task 9: Creation of regional data bases (for example, aerial photography, hydrogeology, lineament maps, and drill logs) and documentation of computer programs for analysis of the data.

Microzoning of Urban Areas in the Chlef Region (a map scale of about 1:5,000).

This part of the microzoning study integrated the seismotectonic and other physical data acquired in the regional study (Part 1) with site-specific data acquired in each of 9 urban areas (Ech Chleff, Bou Kadir, Sendjas, El Karimia, Oued Sly, El Attaf, El Abadia, Oued Fodda, Ouled Ben Abdelkader) to produce seismic microzoning maps. The primary technical tasks included:

Task 10: Acquisition, synthesis, and integration of existing and new geological, geophysical, and geotechnical data to characterize the soil and rock in the Chlef region in terms of their physical properties and the response expected under various levels of ground shaking.

Task 11: Estimation of empirical soil transfer functions in each urban area with consideration of the amplitude, frequency composition, and level of peak ground acceleration.

Task 12: Preparation of probabilistic ground-shaking hazard maps for each urban area in terms of peak ground acceleration exposure times, and probability of nonexceedance. These parameters can be correlated with the current Algerian building code (RPA 1981) and land-use plans.

Task 13: Specification of the dynamic amplification factors for soil column that are typical of each urban area.

Task 14: Preparation of a map showing the potential for surface fault rupture in each urban area.

Task 15: Preparation of a map showing the potential for liquefaction in each urban area.

Task 16: Preparation of a map showing the potential for landslides in each urban area.

Task 17: Preparation of a map showing potential secondary effects (for example, flooding) in each urban area.

Task 18: Preparation of a map synthesizing all of the potential seismic hazards in each urban area.

Task 19: Evaluation of the distribution of damage in the 1980 El Asnam earthquake.

Recommendations for Land-Use, Building Codes, Construction Practices, and other Related Matters

This part of the microzoning study used the analysis and synthesis of the physical data (Part 1) and the seismic microzoning maps prepared for the 9 urban areas (Part 2) to produce specific recommendations. The tasks included:

Task 20: Evaluation of the building code currently used in Algeria, identifying options for modifications that incorporate the scientific and engineering lessons learned from the 1980 El Asnam earthquake.

Task 21: Evaluation of regional and urban land-use practices in Algeria, identifying options for alternatives to current practices that might increase the quality.

Task 22: Evaluation of construction practices for new buildings in Algeria, specifying options for alternatives to current practices that might be more effective.

Task 23: Evaluation of the current practices used in Algeria to repair and strengthen existing buildings, suggesting options for alternatives to current practices that might be more effective.

Transfer of Technology

Activities to accomplish transfer of technology were planned so that they would complement the three technical activities described above. The activities of WCC to accomplish transfer of technology included four primary tasks:

Task 24: Formation of counterpart working groups within CTC and WCC to increase technical interaction (see Appendices I and II).

Task 25: Conducting field trips and technical seminars.

Task 26: Visiting and interacting with Algerian scientists, engineers, and planners, both in the United States and Algeria.

Task 27: Interacting with the Unesco Control Board, the technical advisors to CTC, throughout the 14 months of the seismic microzoning study.

## REGULATORY OR POLICY STANDARDS FOR THE STUDY

### Control board

To ensure that all of the objectives and outputs of the seismic microzoning study of the Chlef region would be achieved, CTC requested assistance from UNDP and Unesco to create a Control board. Simultaneously with the selection of WCC in May 1983 as the contractor for the seismic microzoning study, a Control Board was created to provide additional technical assistance to CTC in the realization of the seismic microzoning study of the Chlef region. The purpose of the Control Board was to give technical advice and assistance to CTC and their partners from other Algerian Ministries. The Control Board consisted of a chairman from the United States and 15 experts having knowledge and experience in all aspects of seismic microzoning. The Control Board began its work at the same time as WCC. The experts represented 7 countries (England, Japan, Portugal, Switzerland, Turkey, United States, and Yugoslavia). In addition to supplementing the capabilities of CTC and their Algerian partners, the Control Board provided a practical way to incorporate worldwide experience in seismic microzoning. Although seismic microzoning has been developed in countries throughout the world, no standard methodology has yet emerged. Several different acceptable methodologies have been proposed and implemented in a number of countries including: the United States, Japan, the Soviet Union, Turkey, Greece, Mexico, Yugoslavia, and the Philippines. Members of the Control Board had knowledge of all the available methodologies and were able to help CTC evaluate the results of WCC within a broader context.

### Mission of the Control Board

The mission of the Control Board was defined in June, 1984 in a planning meeting attended by CTC, other Algerian Ministries, and Unesco personnel. The following tasks were identified:

i. Participate in meetings with CTC, the Algerian partners, and WCC to review WCC's plans, data, technical reports, maps, and recommendations. The purpose was to ensure that a) the technical methodology being applied in the seismic microzoning study of the Chlef region was reasonable in terms of the state-of-the-art and the state-of-practice and b) that the outposts or products were usable.

ii. Identify and discuss the technical issues associated with the microzoning study of the Chlef region in the context of Algerian and worldwide experience. The purpose was to resolve to the extent possible various technical issues that can lead to overconservatism of seismic microzoning maps. Maps that are overconservative are difficult to implement because of economic and political factors.

iii. Evaluate the seismic microzoning maps of the 9 urban areas to ensure that they were useful. The purpose was to make certain that the maps could be integrated with the Algerian building code and regional and urban land-use plans.

iv. Accelerate the transfer of technology to Algerian scientists, engineers, and planners by convening "training workshops" on topical studies on seismic microzoning. The purpose was to expose Algerian scientists, engineers, and planners to a wide range of technical issues and perspectives. By scheduling the training workshops two days prior to each of the meetings between CTC and WCC to review the data, technical reports, and microzoning maps, Algerian participants gained both general and specific knowledge about seismic microzoning. The training workshops also reinforced concepts presented in the seven technical seminars organized by WCC by giving another perspective on the same technical subject.

### Accomplishments of the Control Board

The Control Board completed its work in July, 1984. All of the objectives and outputs of the seismic microzoning project were realized through the combined efforts of WCC, CTC, and the Control Board. The Control Board contributed to the success of the seismic microzoning study by ensuring that the outcomes of the study were beneficial to CTC and their Algerian partners. The Control Board enhanced the transfer of technology by convening 5 training workshops in August and December, 1983 and January, May, and July, 1984. From 25 to 45 Algerian scientists, engineers, and planners participated in each workshop. Special training materials and problems were developed by the Control Board for each workshop and distributed to the participants. Training aids were given to CTC after each workshop. A glossary of technical terms used in seismic microzoning was provided in French and English to facilitate communication. Members of the Control Board provided CTC with a technical library of seismic microzoning. At the conclusion of each workshop, participants were given a questionnaire and evaluated the workshop, indicating whether or not their training needs were met. The questionnaires from all of the workshops provided a basis for evaluating the increase in knowledge of the participants and for obtaining their suggestions. The staff of CTC assisted the Control Board in each of the five training workshops, lecturing and assisting in the translations from English to French and French to English. Members of CTC, WCC, and the Control Board worked together as a team in the last training workshop. Certificates signed by the lecturers were given to the participants after each workshop to express appreciation for their participation and to stimulate interaction and exchange of ideas.

## UTILIZATION OF RESULTS

### Application of Microzoning Methodology

The results of the seismic microzoning study in the Chlef region have been utilized in a number of ways. For example, in early 1984, the CTC staff applied the technical methodology to conduct a preliminary seismic microzoning study of Ouled Fares. Ouled Fares, located northwest of the Chlef region, was not one of the urban areas studied in detail by WCC. In addition, geologists from CTC and other Algerian ministries organized a field trip in May, 1984 to identify and characterize active faults in the vicinity of Algiers in a preliminary way. Evidence of young active faults having the potential for generating large earthquakes like the 1980 El Asnam earthquake was found along the coast near Algiers. Characterization of these faults is an essential part of future work that is needed for defining seismic source zones and calculating regional ground-shaking hazard maps in the Algiers region. The idea of a national conference was conceived by CTC and the Control Board to complete the transfer of technology on seismic microzoning.

### National Conference on Seismic Microzoning

CTC organized and convened a National Conference on Seismic Microzoning in October, 1984 to share its knowledge of seismic microzoning with others. The conference, which coincided with the 4th anniversary of the El Asnam earthquake, brought together more than 100 participants, including representatives from 10 foreign countries. By preparing, presenting, and publishing technical papers on seismic microzoning studies of the Chlef region and other parts of the world, members of the CTC staff and their partners in other Algerian Ministries increased their technical understanding of seismic microzoning. A proceedings of the conference was published. Two important processes were begun: 1) the process of transferring technology to other Algerian scientists, engineers, architects, and planners, and 2) the process of developing a political constituency for changing building codes and construction and land-use practices.

Six Algerian scientists and engineers (4 from CTC and 2 from CNAAG) participated in the Eighth World Conference on Earthquake Engineering held in July, 1984 in San Francisco, California. The world conference brought together experts from more than 100 countries. CTC staff presented 4 technical papers in the conference which was documented in an 8-volume proceedings containing papers on all aspects of seismic microzoning.

CTC is currently deploying instruments to establish a network of 90 strong motion accelerographs throughout Algeria. These instruments will provide valuable information needed for research and resolution of important technical issues such as attenuation, duration of ground shaking, and the effects of soil and rock on ground shaking. The network will complement the seismicity network in Algeria operated by CNAAG.

## CONCLUSIONS AND RECOMMENDATIONS

### Benefit to Algeria

The seismic microzoning study produced a better technical understanding of earthquake hazards in the Chlef region and increased the capability of Algerian scientists, engineers, and planners to increase and to apply their technical knowledge. It provided answers to the following questions: 1) Where have earthquakes occurred in the past? 2) Why are they occurring? 3) What physical effects (hazards) are associated with each earthquake and how severe are they? 4) How often do they occur? and 5) What are the options for reducing losses from these hazards?

The seismic microzoning study in the Chlef region provided the following benefits:

i. Creation of an improved regional model of the seismic hazards for the Chlef region. Seismic source zones as well as "active" and "inferred active" fault zones were

identified.

ii. Establishment of the maximum level of peak ground acceleration (0.35-0.55 g) expected to occur in 9 urban of the Chlef region within an exposure time of about 50 years. These values of peak acceleration have a probability of nonexceedance of 90% in a 50-year period. Criteria such as these are typically used throughout the world when devising seismic design provisions of building codes. Peak ground accelerations for two other exposure times (approximately 5 years and 20 years) and a 90% probability of nonexceedance were also calculated to give additional perspectives for assessing the ground-shaking hazards to buildings and other facilities.

iii. Construction of seismic microzoning maps for 9 urban areas in the Chlef region. These maps give realistic estimates of the relative severity and special variation of ground shaking, earthquake-induced ground failure, and surface fault rupture as a function of exposure time.

iv. Specification of recommendations for improving building codes and construction and land-use practices.

v. Production of a technical methodology for seismic microzoning that can be used in conjunction with the results of other microzoning studies being conducted throughout the world. These methodologies will provide a technical basis for seismic microzoning studies in other parts of Algeria and for identifying specific research studies Algerians can undertake to increase the state-of-knowledge in Algeria.

vi. Increasing the technical knowledge of Algerian scientists, engineers, and planners through the process of transfer of technology used by WCC and the Control Board. The procedures that were used in the seminars and training workshops conducted by WCC and the Control Board provided a model which can be used to train other Algerians. The technical library on seismic microzoning and the training aids are a valuable new resource.

vii. Creation of a network of strong motion accelerographs to acquire ground motion data from future earthquakes in Algeria. These data can be used in earthquake-resistant design of buildings and other facilities and will be useful to other Ministries in Algeria.

## Recommendations

The successful completion of the seismic microzoning study of the Chlef region in 14 months demonstrated that the technical capability exists in Algeria to microzone other parts of the nation. The following actions are recommended:

i. Formation of working partnerships between CTC and other Algerian Ministries (for example, ANAT, CNAAG, and others) to accomplish future microzoning studies.

ii. Identification of another part of Algeria that needs to be microzoned (for example, the Algiers region) and initiation of the planning process.

iii. Use of the ground motion data recorded on the strong motion accelerograph network to resolve technical isues concerning attenuation, duration of shaking, and ground response.

iv. Participation in post-earthquake investigations in other parts of the Mediterranean region to gain experience and data.

v. Collection of additional seismotectonic information throughout Algeria to define recurrence times of faults and maximum magnitudes and recurrence times for discrete seismic source zones.

vi. Creation of a national data base containing data needed for seismic microzoning.

vii. Implementation of the results and knowledge gained from the seismic microzoning study of the Chlef region. The initial effort should be directed to making changes, as appropriate, to the building code and construction and land-use practices.

viii. Initiation of training designed to increase the number of Algerians who are experts in seismic microzoning.

ix. Creation of the Algerian Institute of Earthquake Engineering and Applied Seismology.

Accomplishment of these actions will serve to establish Algeria as a leader in seismic microzoning.

## APPENDIX 1

### List of Questions Used to Create a "Check List" For Use in Oral Interviews with Each Potential Contractor

A. Interviews With the Seven Contractors who Responded to the International Tender (August, 1982)

1. Describe in detail each technical product (maps, reports, computer programs, etc.) you plan to deliver during the seismic microzoning study. Indicate the schedule for delivery of each product.

2. Describe in detail the procedures you plan to use during the 16-month

microzonation study to transfer the technology for seismic microzoning to Algerian scientists, engineers, and planners.

3. Describe the criteria you will use to evaluate whether or not you have been successful in developing and transferring a technical methodology for seismic microzoning at the end of the study.

4. Describe in detail the "state-of-the-art" technical methodology for seismic microzoning you plan to use, emphasizing:

   - The procedures you consider to be unique or especially innovative technically.

   - The procedures you consider to be at the forefront of the state-of-the-art.

   - The procedures you consider to offer a savings of time and money.

   - The procedures you consider to have the least technical controversy. The procedures you consider to have the greatest technical controversy.

5. On the basis of what you presently know about: a) the seismotectonics of Algeria, b) the lessons learned from the 1954 Orleansville and 1980 El Asnam earthquakes, and c) the anticipated outcome of the microzoning study of the Chlef region, what do you anticipate will be the most urgent research needs after the seismic microzoning study has been completed?

B. Interview with the Three Contractors Selected as Finalists (November, 1982)

1. As you know, there is no standard methodology for seismic microzoning. Current methodologies, like yours, are based on various combinations of:

   - use of primary data from past earthquakes,

   - neotectonic studies, emphasizing trenching and other techniques,

   - drilling, geophysics, and soil testing, and

   - use of computational models such as SHAKE.

   a. In your opinion, does it matter which methods are used in the seismic microzoning of the Chlef region?

   b. Why do you feel that your methodology is the most appropriate?

   c. What would make your methodology obsolete in 5-10 years?

   d. Acknowledging that you want the final maps for the Chlef region to have the smallest possible level of uncertainty, describe the sources of uncertainty in your methodology for constructing a probabilistic ground-shaking hazard map. Will your methodology ensure that the level of uncertainty in the final map is as small as possible?

2. Transfer of technology is extremely important to CTC; therefore, please describe your capability and willingness to meet the following priorities:

   a. Priority 1: Appointment of a liaison person in your office to ensure that efficient interaction and communication takes place throughout the study.

   b. Priority 2: Provision of on-the-job training for about 5 CTC staff members in Algeria.

   c. Priority 3: Organization and implementation of about 7 seminars that emphasize problem solving in Algeria.

   d. Priority 4: Establishment of a reference library containing relevant articles in seismic microzonation.

   e. Priority 5: Arranging for travel for Algerians in the contractor's country.

   f. Priority 6: Cooperation in the publication of technical papers that are produced in the study.

   g. Priority 7: Provisions of interim guidelines for land use and preliminary plans for siting of 90 strong motion accelerographs in Algeria. both are needed in the first 3-4 months of the study. They can be modified as the study progresses.

   h. Priority 8: Provision of peer review for the seismic microzonation study of another urban area performed by CTC.

# Facilitating Mitigation Through Mental Health Services After a Disaster

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## INTRODUCTION

This paper first identifies several basic concepts pertaining to psychosocial response to emergencies. Then it presents a model of disaster related behaviors. There follows a discussion of mental health interventions and preventions for families and neighborhoods.

### Basic Concepts in Psychosocial Response to Emergencies

The key constructs used to understand how individuals respond to disaster include **stress** resulting from the crisis, **social supports** at time of crisis, and **coping skills** of the individual victim.

Some of the most significant work related to individual response and disasters comes from theoretical formulations about stress. Dohrenwend and Dohrenwend (1981) link stressful life events to health and mental health consequences for individuals. The authors offer several hypotheses about these linkages. One is a hypothesis of straightforward cause and effect: stressful life events result in adverse health changes. Two more hypotheses concern the exacerbation of stressful life events by social and personal dispositions; the combination of factors results in adverse health changes. A fourth hypothesis proposes that symptoms of adverse health changes lead to stressful life events, which, in turn, increase the degree of adverse health changes. Lystad (1985a) adds to the above paradigm the cultural definition of cause and effect; i.e., culturally defined and conditioned perceptions of what is stressful. This cultural factor can increase stress, which then leads to adverse health changes.

Still further theoretical formulations about stress are disaster specific. They focus on the event itself, and on individual, social, and cultural responses to such emergencies. Frederick (1980) and others have theorized that technological disasters create more mental stress than do natural disasters because they are defined, not as originating from God, but as originating from man. Still other theoreticians differentiate among phases of a disaster; Baker (1964) differentiates between more frequent immediate psychological effects of the disaster experience and less frequent long term consequences of disaster for the individual. Others have looked at the magnitude of the disaster. Kastenbaum (1974), for example, hypothesizes a significant difference between those disasters which affect the individual's whole environment and those which affect only a part of it.

Human service workers have little control over factors in the environment which cause stress among clients. Their efforts thus are focused on increasing the social supports and coping skills of these persons so that they are better equipped to manage the stress and are less at risk for emotional problems. With regard to social supports, Taylor (1978) has constructed hypotheses regarding the importance of political, economic, and family interactions and supports in disaster. His variable, political supports, refers to functions served by public figures at disaster sites. Economic supports are defined as financial institutions which provide funds in aid of recovery of the community. Family supports refer to the functioning of family members in warning system evacuation and extended family assistance.

Barton (1969) points to the existence of a two-part emergency social system to support the emergency victim. Identification of the first part is based on an exploration of individual patterns of adaptive and nonadaptive reactions to stress, particularly the motivational basis of varying types of helping behavior (e.g., altruism and close relationship to the victim).

The second part of the system is the community's formal organization. Here Barton broadens his initial discussion of the individual basis of helping behavior by examining a community model of the same.

Theoretical formulations which relate individual coping responses to mass disaster events focus on perception, personality characteristics, and social behaviors. Slovic et al (1979) look at the perception of risk in disaster situations. They hypothesize that those persons who perceive the risk as great are more likely to heed warnings and to take some individual action to avoid or ameliorate consequences than those who do not. In the case of technological risks, those who perceive the risk as great are also more likely to blame the government for politics which allow the risk to occur.

Cohen and Ahearn (1980) point out that coping is partially dependent on one's emotional or psychological tools, those personal characteristics of individual strengths and

weaknesses. These individual resources include one's ability to communicate, one's sense of self-esteem, and one's capacity for bearing discomfort without either disorganization or despair.

Lystad (1985a) looks at those aspects of coping which are dependent upon one's social behaviors, one's ability to seek support, understanding, and aid in problem resolution. Her work shows that disaster victims are better able to handle the losses of loved ones and property if they are well integrated into a social matrix of family, friends, and neighbors who are able to provide immediate assistance of comfort, food, clothing, housing, and physical care at a time of crisis.

## DISASTER RELATED BEHAVIORS

Mental health professionals experienced in disaster work usually define the post-disaster period in terms of several phases related to the emotional responses of disaster victims as they experience and cope with the crisis (Cohen and Ahearn, 1980; Farberow, 1979).

The first phase usually occurs at time of impact and in the period immediately afterwards. Emotions are strong, and include fear, numbness, shock, and confusion. People find themselves being called upon and responding to demands for heroic action to save their own and others' lives and/or property. Altruism is prominent, and people cooperate well in helping others to survive and recover. The most important resources during this phase are the family, neighbors, and emergency service workers of various sorts.

The second phase of disaster generally extends from one week to several months after the disaster. There may occur change in appetite, digestive problems, difficulties in sleeping, headaches. Anger, suspicion, and irritability may surface. Apathy and depression may occur, as well as withdrawal from family and friends and heightened anxiety about the future. On the other hand, also found among those who have survived, even with loss of loved ones and possessions, is a strong sense of having shared with others a dangerous experience and having lived through it. During this phase, supported by the influx of local, state, and federal agencies who offer all kinds of help, the victims clear the debris and clean out their homes of mud and wreckage. They anticipate that there will soon be available considerable help in solving their multiple problems. And emergent community groups which develop from the specific needs caused by the disaster are especially important.

The third phase of the disaster, generally lasting up to a year, is characterized by strong feelings of disappointment, resentment, and bitterness if delays occur and the hopes for, and promises of, governmental aid are not fulfilled. Outside agencies may pull out and some of the indigenous community groups may weaken or disappear. During this phase there may be a gradual loss of the feeling of shared community found earlier as victims concentrate on solving their own individual problems.

The last phase, of reconstruction, may last several years if not the remainder of the lives of some victims. During this time the victims of large-scale disasters realize that they will need to solve the problems of rebuilding their own homes, businesses, and lives largely by themselves, and they gradually assume responsibility for doing so. The appearance of new buildings replacing old ones, the development of new programs and plans, can serve to reaffirm the victims' belief in their community and in their own capabilities. When such positive events are delayed, however, emotional problems which appear may be serious and intense. Community groups -- political, economic, religious, fraternal -- with a long-term investment in the community and its people become crucial elements to successful reconstruction.

## MENTAL HEALTH INTERVENTIONS

The available research findings confirm that natural disasters can result in severe mental health problems, and do among approximately ten per cent of victims. It is evident that such problems must be addressed on community, state, and national levels. Experienced mental health workers have discussed several principles to be kept in mind in assisting the victims of a major disaster (Cohen and Ahearn, 1980; Farberow, 1979; Lystad, 1985b). The first principle is that the target population is primarily normal. Victims have been subjected to severe stress and may be showing various signs of emotional strain. This transitory disturbance is to be expected and does not necessarily imply mental illness. People do not disintegrate in response to disaster and they do respond to active interest and concern.

Another principle is that disaster workers should avoid mental health labels. Many persons are unable to accept, and will actively refuse, help for "emotional problems". The aim in most cases will be to provide human services for problems which are accompanied by emotional strain. It is important then not to use words which imply mental illness, terms such as counseling, therapy, neurotic, and psychotic.

A third principle is that workers must be innovative in offering help. Each disaster is unique and requires adaptive responses if help is to be provided more effectively. Consequently workers should abandon the traditional approach and apply outreach procedures involving casefinding in the community and at various disaster centers.

A final principle is to fit the mental health program into the community in order to have it accepted. The program director will want to plan neighborhood get-togethers and the like to discuss community concerns and to set priorities for recovery. For the local citizenry the sense of participation in decision making will be very useful. Selection of workers, both professional and nonprofessional, from the community in which the disaster has occurred has

an additional advantage for the workers themselves. When the victims of a disaster are able to participate fully in their reconstructive and rehabilitative activites, the recovery from the disaster may be much quicker and the long-term effects less serious.

These and other strategies are described in greater detail in three useful training manuals for mental health workers dealing with disaster victims: Cohen and Ahearn (1980), Farberow (1979), and Farberow and Gordon (1981).

Intervention and prevention programs need careful evaluation; knowledge development in this field is critical for emergency planning in the future on national, state, and local levels.

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# Transfer of Mitigation Techniques Among Types of Disasters: Factors Affecting Mitigation from Earthquakes, Floods, Volcanoes, and Ground Failure

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## INTRODUCTION

The ability to transfer techniques for reducing the impacts of natural hazards from one type of natural hazard to another depends, in part, on the characteristics of the hazard. This paper outlines six general categories of hazard mitigation techniques, selected characteristics of four types of natural hazards, and how those characteristics affect the applicability of mitigation techniques to each of the hazards. The intent is to provide an introduction to some of the conditions influencing the transfer of techniques from one kind of natural hazard to another.

In outlining the factors, we draw primarily from our experiences, first, in the practice of city and regional planning in California communities, and second, in research conducted over the last twelve years on ways to mitigate natural hazards, primarily through improved planning practices. As urban and regional planners, we believe the presence of natural hazards should be accounted for in decisions about the uses of land, whether these uses are decided prior to a disaster or as a part of reconstruction. Land uses are an important determinant of the severity of natural disasters. In fact, disasters are disasters because they damage or destroy what man has built.

Planning as a means of mitigation is effective primarily for those disasters which are, at least to some degree, locationally predictable. For example, it is possible to define, with considerable precision, those areas of a community which are susceptible to riverine or coastal flooding. However, it is not possible to distinguish areas of a community on the basis of tornado risk. We know in probabilistic terms the regions of the country that are most likely to experience tornadoes, but within any region, and particularly, community, we cannot say that one area is more hazardous than another. The four hazards considered in this paper -- floods, earthquakes, volcanoes, and ground failures -- are all geographically predictable, but the precision of predictability varies greatly and, hence, the usefulness of the prediction for land use planning.

Land use planners typically view hazard mitigation as one of many factors to consider in recommending land uses. In our experience working with local governments in California, we rarely find a community willing to plan and regulate land uses solely to mitigate hazardous conditions. Effective mitigation usually involves actions which also carry out other community objectives. A flood plain may be left undeveloped not only to prevent future flood losses, but also to protect riparian habitats, water recharge areas, or prime agricultural lands; or to provide a scenic greenbelt or a level area for parking. The more elements built into the rationale for a given action, the more likely it is to be taken. Building such rationales is the accustomed role of the planner.

Most of our experience in both research and application of research has been in the United States. Thus, our conclusions are most applicable to the institutional and governmental context found in this country. However, our limited experience with foreign disasters indicates considerable opportunity for transfer of techniques across national boundaries. The specific administrative procedures, locus of decision making authority, and economic and social resources vary from one country to another, but the objectives and principles of hazard mitigation are similar. Also, disasters do not respect national differences. Earthquake intensities can be just as high in San Francisco as in Mexico City. The damages may differ in scale and pattern, but the natural, physical forces afflicting the areas are essentially the same. Natural hazard mitigation, at any level, is the process of contending with such forces -- movements of tectonic plates, magma, water, ground, and air.

## MITIGATION TECHNIQUES WHICH CAN BE TRANSFERRED

The list of mitigation techniques which have been tried or suggested is long. The following is a description of six categories of actions which can be taken to mitigate the effects of natural hazards. Table 1 is a summary of the categories.

Control the Hazard. This encompasses attempts to control, modify, or transfer the hazard itself. Examples are cloud seeding and other efforts to modify weather and construction of dams, dikes, revetments, jetties, groins, seawalls, and other engineered works to control, deflect, or transfer excess water away from specific areas. The notion that a hazard can be controlled strongly influences our perception of mitigation. This category of techniques is most often associated with flood hazard mitigation. A

Table 1. CATEGORIES OF TECHNIQUES TO MITIGATE NATURAL HAZARDS

| Mitigation Technique | Examples |
|---|---|
| Control Hazard | seed clouds; build dams, levees; jetties |
| Build to Withstand | adopt/enforce seismic codes, elevate buildings |
| Control Land Use | restrict building/occupancy, relocate, purchase |
| Redevelop/Rehabilitate | change use or occupancy; retrofit, floodproof |
| Modify Site | grade; fill; compact; dewater; drain |
| Warn/Evacuate | remove people at risk from hazardous areas |

clear distinction is usually made between structural and non-structural approaches to mitigation. Often, the potential for control is really an illusion, meaning little more than the ability to shift the problem elsewhere. Classic examples are efforts to control coastal flooding and erosion. The technical, scientific ability, or even potential, does not now exist to control earthquakes or volcanoes.

Build to Withstand the Hazard. Frequently there is no feasible alternative to building within a hazardous area. Then, it is important that buildings be sited, designed, and built to withstand the hazard. This is especially true of critical facilities, lifelines, and high occupancy structures. Damages from earthquake ground shaking can be substantially lessened by applying seismic codes to buildings; similarly, losses from flooding can be reduced by elevating buildings located in flood prone areas. It is much less costly to build new structures to an appropriate code than to bring old buildings up to code. There is no way to construct functional buildings which can withstand the worst effects of a volcanic eruption or a large landslide.

Control Land Use. This category involves the potential for avoidance of natural hazards through consideration of risk prior to deciding how to use or reuse hazardous sites and areas. Examples of techniques in this category include: general/comprehensive/master plans, land use regulations (zoning, subdivision, site design, project review procedures), decisions based on environmental impact assessments, and public acquisition of land, easements, and development rights. Controlling land use is an effective approach for mitigating hazards affecting definable areas especially before they are developed. It is also an effective means to mitigate against future damages from recurring disasters in rebuilding after a disaster.

Redevelop and Rehabilitate. Mitigating risk from natural hazards in already developed areas is very difficult. The primary tools are redevelopment, where an area is cleared and rebuilt with new buildings and often new uses, and rehabilitation, where the resistance of buildings to natural disasters is increased. Redevelopment is a useful mitigation approach when it also meets other community objectives. Redevelopment is a very effective mitigation approach, both before a disaster and as a part of reconstruction after a disaster, to the extent that it reduces occupancy or improves building resistance in a hazardous area. Rehabilitation involving the strengthening, flood proofing, or in other ways structurally modifying existing buildings to mitigate hazards is often carried out as a part of redevelopment. Like redevelopment it is most effective when multiple objectives can be accomplished with the building rehabilitation. Historic restoration and rehabilitation can be combined; however, in some cases, these objectives are incompatible.

Modify the Site. This category of mitigation techniques includes means of modifying or adapting a site for an intended use (as opposed to finding a less risky site for the use). This is similar to attempting to control the hazard. The measures may be effective in protecting single building sites from potential hazards. Often this is accomplished by shifting the problem elsewhere. Drainage, grading, removal of unstable soils, planting, dewatering, compacting, and filling are all means of overcoming possible hazardous or adverse conditions of a site, usually prior to development.

Warn and Evacuate. This approach can reduce loss of life and injuries in the event of a natural disaster, but is not effective in significantly reducing property damage. It is often the only viable approach to mitigating natural hazards, like tornadoes, which do not have predictable impact areas.

## CHARACTERISTICS OF THE HAZARD WHICH AFFECT USE OF MITIGATION TECHNIQUES

Several characteristics of natural hazards affect the potential for transferring mitigation techniques from one type of hazard to another. Key ones are: frequency; predictability of location, time and impacts; and the potential for catastrophic losses. Table 2 is a summary of these characteristics as they usually pertain to the natural hazards of flooding, earthquakes, volcanoes, and ground failures.

Frequency. This characteristic is an important determinant of the political acceptability of mitigation efforts. A community is usually willing to commit more economic resources to forestall losses from a hazard which causes

Table 2. CHARACTERISTICS OF NATURAL HAZARDS

| | Frequency | Predictability | | | Catastrophic Potential |
|---|---|---|---|---|---|
| | | location | time | impacts | |
| Floods | moderate-high | high | annual % chance | high | moderate |
| Earthquakes | moderate | low-moderate | cyclic/uncertain | moderate | moderate-high |
| Volcanoes | low | low | cyclic/uncertain | low | high |
| Ground Failures | low-high | low-moderate | associated with other hazards | low-moderate | low |

repeated damage than from severe, but rarely occurring disasters. As frequency increases, so does the list of acceptable mitigation approaches.

Predictability. Predictability has three aspects which are important to the selection of hazard mitigation techniques - location, time, and impacts. The ability to predict all three with accuracy would greatly increase the likelihood of effective mitigation.

Predictability of Location of the areas at risk varies greatly from hazard to hazard. Flood plains can be quite precisely defined; areas subject to volcanic hazards can be only generally defined. Maps showing hazardous locations vary in scale, detail, and accuracy. The delineations are usually based on interpretations and represent relative differences in the level of risk. A "high risk" designation on a map of potential landslide hazards could mean a very different level of exposure than a "high risk" designation on a map of potential volcanic hazards. If a hazardous area is well-defined, all six categories of mitigation techniques shown in Table 1 could be applicable.

Predictability of Time involves questions of "when", usually expressed in terms of probability or recurrence intervals. Riverine flooding occurs with a reasonably predictable regularity which allows the risk to be expressed in terms of an annual probability (1% chance of a 100-year flood). This allows thresholds for public actions to be established so that areas of comparable risk from flooding can be treated similarly. On the other hand, some hazards appear to occur cyclically, like once every 100 or 1000 years. The more time that has elapsed since the last event, the closer you are to the next one. Earthquakes and volcanoes seem to follow this general pattern.

Predictability of Impacts of a hazard is the ability to determine what is likely to happen. This is closely related to prediction of location. It helps to know not only the area that is likely to be impacted, but also the nature of the impact. Natural disasters are complex events with many ways of causing damage. With flooding it is usually possible to predict the height and speed of floodwaters at a given location which would occur with a 100-year storm. The impacts of a volcanic eruption, on the other hand, are difficult to predict. An eruption may trigger lava flows, mudslides, avalanches, pyroclastic flows, phreatic blasts, and ash falls. Predicting which of these hazards is likely to impact any given area within a general zone of risk is difficult.

Improved predictability with respect to location, time, and impacts enhances opportunities for effective mitigation. The more clearly the problem can be defined, the more clearly the path to reducing the potential impact can be seen and thus, taken.

Catastrophic Potential. Volcanic eruptions are rarely small, local events; landslides are rarely regional disasters. The potential for catastrophe, even when the probability is very low, affects the acceptability of mitigation measures, although the nature of the effect is uncertain. In general, it appears that irrational over- or under-responses to risk are more likely if a hazard is perceived as catastrophic.

## RELATIONSHIPS BETWEEN CATEGORIES OF MITIGATION AND NATURAL HAZARDS

Techniques that are effective in reducing the impacts of one natural hazard are not necessarily applicable to other hazards. Table 3 summarizes the usual relationship between the five general categories of mitigation techniques and the four types of natural hazards. Comments regarding the techniques which are typically used to mitigate each type of hazard follow.

Floods. All six categories of mitigation techniques can be effective in mitigating flood losses. Flooding is the only hazard (of the four) which is susceptible to control of the hazard itself. Historically, control has been the main approach taken in this country. The continuing increases in losses from flooding in spite of significant expenditures for control have highlighted the need to consider more seriously the other categories of mitigation. Land use controls can effectively mitigate flood damages and are especially appropriate because the areas prone to flood damage are usually good candidates for low intensity uses for several other reasons.

Table 3. EFFECTIVENESS OF TECHNIQUES TO REDUCE LOSSES FROM SPECIFIC HAZARDS

| Mitigation Techniques | Floods | Earthquakes | Volcanoes | Ground Failures |
|---|---|---|---|---|
| Control the Hazard | yes | no | no | sometimes |
| Build to Withstand | yes | yes | no | no |
| Control Land Use | yes | yes | yes | yes |
| Modify the Site | sometimes | sometimes | no | yes |
| Redevelop/Rehabilitate | yes | yes | no | no |
| Warn/Evacuate | yes | sometimes | yes | sometimes |

Earthquakes. At present, earthquakes cannot be controlled. The most important means of reducing losses are controlling land uses, building to withstand earthquake forces, redeveloping parts of cities with old, unsound buildings and strengthening unsafe buildings. Earthquake-triggered fault rupture affects quite small areas adjacent to faults, which often can be located precisely. In such cases, restricting or relocating development on the fault is the most direct and appropriate means of mitigation. Areas prone to liquefaction, landsliding, and other ground failures can be generally delineated. Evaluation of the hazard potential prior to development or redevelopment of such areas should be routine, especially for major construction projects. Damage arising from ground shaking can be most effectively mitigated through careful design and construction of buildings taking into account the site ground conditions. Earthquake generated tsunamis are addressed through a world-wide warning system. Losses can be averted through control of land use in designated run-up areas.

Volcanoes. Options to mitigate the effects of volcanic eruptions are more limited than for the other natural hazards. The frequency and predictability of volcanic eruptions is low, yet the potential for catastrophe is very high. Volcanoes, like Mount St. Helens, usually exhibit signs of imminent eruption. Thus, an effective mitigation technique is to restrict entry and evacuate a sizable area around a volcanic vent upon indication that an eruption might occur. More certain is the control of land uses on and around active volcanoes. There are no ways to control volcanic eruptions, "volcano-proof" buildings, or modify a building site to mitigate potential damage.

Ground Failures. Ground failures include landslides, debris flows, avalanches, rock falls, and other massive disturbances of the ground surface. The key to mitigation is expert assessment of the potential. The potential can usually be identified through analysis by a geotechnical professional of topographic, soils, and geologic maps, aerial photographs, and other generally available information. Where a potential for ground failure exists, development can be limited or regulated to avoid hazardous sites. Sometimes, site modifications can alleviate the hazard. However, detailed site investigation is needed to determine the feasibility of mitigation through site modifications. Ground failures frequently accompany flooding, earthquakes, and volcanic eruptions, and most often are dealt with in the context of another hazard.

## CONCLUSIONS

(1) Planning approaches to natural hazard mitigation - controlling land use and redevelopment and rehabilitation - are effective for all four hazards considered in this paper.

(2) One attractive aspect of planning approaches to natural hazard mitigation is that the expertise to plan is usually available to communities - planning is part of "business as usual". To incorporate hazard mitigation as an objective in local planning processes does not usually involve major changes in the way a community functions.

(3) The planner, if appropriately educated and trained, can make sure that natural hazards are considered, among other factors, in evaluating competing claims for uses of land. The planner can bring good sense and balanced judgment to issues of natural hazard mitigation, placing them in the context of overall community objectives.

(4) The more that is known about the hazard - when, where, how often, what impacts, etc. - the more techniques are applicable to mitigate the impacts. More mitigation approaches are available to alleviate flooding problems than earthquake, volcano, or ground failure problems. The least defined of these hazards, volcanic eruption, is the most difficult to mitigate.

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## RELATED LITERATURE

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# CHAPTER FOUR
# *LOCAL GOVERNMENT PERSPECTIVE*

In both developed and developing nations, national (or statewide) organizations often play the major role in providing immediate, large scale relief after a disaster. But local governments and private landowners play the principal roles in long term repair and rebuilding. It is unfortunate, therefore, that so little attention is usually paid to training, providing incentives to, and otherwise assisting local governments.

Large influxes of disaster assistance, experts, loans, and other types of assistance to a local disaster area may undermine local leadership. The following scenario is common:

- For a short time after the disaster, community leaders play a large role in rescue, shelter, comforting disaster victims, bringing in food and blankets, etc.

- This influence is diminished as the National Guard, national police, military, etc. take charge and as large numbers of experts and disaster relief workers under the control of other agencies and organizations arrive and provide food, loans, and policing at a scale not possible at the local level. Dominance by such outside groups continues as long as their physical presence and huge influx of dollars, supplies, etc. continue.

- The influence of local leaders again increases. But, ironically, local leaders are now often blamed for lack of preparedness and for many of the inequities and problems caused by the outside groups such as lack of equity in distribution of relief benefits, separation of families and neighbors in temporary housing, etc. Local leaders are often accused of a failure to "lead" in situations where they could not possibly hope to do so given the resources, number of personnel, and legal authority of the outside group.

- Challenges to local leadership are then common with new leaders often at least temporarily assuming power. This complicates any attempt by state and federal organizations to formulate recovery plans because the original community leaders are so often forced out of office, requiring renegotiation with new leaders.

- Finally, well into recovery, community leadership may stabilize with a return to power and influence of some of the previous leaders.

Local governments are often overwhelmed in the immediate post disaster context and do need outside assistance. But they equally need technical and financial assistance in to facilitate and encourage long term rebuilding.

This chapter begins with an overview paper by Claire Rubin outlining post-disaster opportunities on the local scene.

Next Philip Berke and Kim Luedke examine, in greater detail, local recovery from hurricane Alicia in the Houston/Galveston area of the U.S.

Thomas Hirsch, in the third paper, raises important issues with regard to selection of mitigation options and the role of local governments and hazard area occupants.

Finally, Eve Grundfest examines local government response from flash flooding in the Big Thompson Canyon in Colorado and examines the use of scenarios to help raise local government awareness with regard to hazards and possibilities for mitigation.

# Post-Disaster Opportunities: The Local Scene

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## INTRODUCTION

Local mitigation planning during the recovery period after a major disaster is considered here in light of: (a) timing of the mitigation planning and implementation efforts, (b) the steps and functions involved, (c) opportunities for mitigation, and (d) some practical advice based on observations from local experiences in the U.S.

### Timing

Timing of post-disaster mitigation depends on such factors as the type and magnitude of the disaster and the capability and sophistication of the jurisdiction(s) affected. The duration of the near-and long-term recovery phases varies considerably. For example, after the 1983 earthquake in Coalinga, CA, the recovery phase began nearly immediately, because virtually all the buildings that were not seismic-resistant were levelled by the earthquake. It was a case of "instant mitigation" in which the existing building codes included seismic-resistant construction standards. Consequently recovery began almost immediately.

In contrast with a swiftly devastating earthquake, a riverine flood may prevail for weeks. In such a case, re-entry and reconstruction decisions must wait until floodwaters recede. For example, in Marin County, CA, in 1982 when extensive land and mud slides occurred, the roadways were clogged intermittently for many weeks, delaying the removal of debris. In short, the response and recovery phases are not clean-cut.

### Key Functions in the Post-Disaster Period

Because time frames cannot be generalized, it is valuable to discuss mitigation activities in terms of functional relationships and to appreciate the interconnectedness and the sequences of events. Generally, in the early weeks after a disaster both the local public and private sectors begin restoration and reconstruction activities.

While the time span for the early recovery efforts can readily be shown, it is not as easy to depict the web of relationships and interactions among government officials at all levels; citizens; business owners and managers; and consultants, such as architects, engineers, and planners - all of whom are engaged in some segment of recovery activities. Managing the many facets of recovery is both a science and an art; some aspects can be taught and others are learned the hard way, via experience.

### Opportunities for Mitigation

The opportunities exist for mitigation in the immediate post-disaster context, but mitigation requires both effort and local support for action. Typically, local attention is focused mainly on near-term activities, such as search and rescue and emergency response. It is easy to underestimate the number of simultaneous demands and decisions that must be made soon after a disaster. For one thing, a different cast of actors is needed to accomplish recovery. In the recovery period there is more need for community planners, public works staff, grantspersons, while the public safety officials have only a minor role.

Secondly, interorganizational, intergovernmental, and international relations are at an all-time high level of activity, just when local leaders are the least ready to cope. To effectively deal with the interorganizational relations that are essential to an expeditious recovery requires great skill in leadership, including the ability to delegate authority and responsibility needed to respond to and recover from a major disaster, and to anticipate and cope with many simultaneous demands.

Mitigation measures are numerous and many can be implemented before or after a disaster event. As a ready frame of reference, seven major categories of mitigation measures are listed below:

(1) vulnerability analysis
(2) land use regulations
(3) public information
(4) warnings and predictions
(5) insurance
(6) structural (including building codes and standards)
(7) tax abatements, loans, grants

Specific mitigation techniques vary for each kind of disaster event (e.g., hurricane, earthquake, flood). Thus it is hard to generalize about mitigation. Clearly, multiple hazard

mitigation planning and implementation is a complex, difficult task.

Mitigation planning is usually more effective if done in the pre-disaster period, yet most often it gets done in the post-disaster period. During the post-disaster phase public policy interest and support are often greater for such endeavors. Educating the public as well as public officials is a topic worthy of separate discussion.

In the U.S. the recent use of hazard mitigation teams (HMTs) has been an effective way to promote recovery and mitigation recommendations offered in the early phase following flood-related disasters. The combination of local/state/ federal scrutiny is valuable in that it allows for varying perspectives on the hazards and hazards potential in an area. HMTs have had a positive effect on post-disaster mitigation, but their effectiveness is limited by their inability to achieve follow-through on their recommendations. Efforts are hampered both by lack of financial resources they can control and lack of monitoring and enforcement capabilities. Further, in the U.S., the use of HMTs has been limited to water-related disasters.

## LESSONS LEARNED IN THE U.S.

Of the 14 experiences observed, not one community did well in the post-disaster period without preparedness efforts and/or experience. In other words, an unplanned or ad hoc response to a disaster situation does not work well.

I would like to briefly relate some of the major findings with respect to effective recovery processes that we have observed. In this case, I am using the term "effective recovery" to mean one that includes attention to mitigation measures against similar future events.

At the community level in the U.S. three major elements contribute to efficient recovery:

(A) Local leadership
- political
- administrative

(B) Ability to Act
- administrative
- technical
- resources

(C) Knowledge of What to Do
- emergency management capability
- hazard specific experiences

All three components are necessary to ensure an efficient community recovery. No one element is necessary and sufficient. But (A) and (B) paired are sufficient to ensure an expeditious recovery. Element (C) is not essential initially, but it is very helpful; it can be acquired quickly once (A) and (B) are in place.

There is a complex interaction between mitigation and recovery, suggesting some trade-offs occur between the two sets of activities in the post-disaster period. Following a disaster a community usually strikes a balance (whether intentionally or unintentionally) between a recovery and mitigation investments to achieve protection from future similar disasters. One of the findings of our recent empirical research was that "Guiding recovery on the basis of a future image of the community rather than simply on near-term expediency appears to produce better long-term results" (Rubin, 1985:43). Further, it appears to be politically costly for local leaders to do so; they need help in guiding community recovery and mitigation. It is essential to examine state and federal policies and programs to be sure that they help, not hinder, effective local recovery that includes significant mitigation efforts.

Mitigation can be viewed as a sub-category of federal and state relations by local governments in that it means a different set of decision rules for local government, and it can have an effect on local choices. The need for mitigation plans may change the demand structure at the local level during the recovery period. For example, the National Flood Insurance Program in the U.S. has a special set of requirements for local governments that participate. Implementing mitigation measures in the post-disaster period is often a complex exercise in intergovernmental relations. The correlation between mitigation and the previous disaster experience is not as clear as might be expected.

In the book Community Recovery from a Major Natural Disaster (Rubin et al, 1985) we listed a series of actionable propositions, many of which are pertinent to post-disaster mitigation planning. Some action recommendations for mitigation planning, adapted from the above-mentioned book, are outlined below:

Leadership Propositions:

1. Decide soon after a major disaster what you want to do and who you want to participate in the planning and implementation of the major mitigation efforts.

2. Since the quality of intergovernmental relations is of paramount importance to an effective recovery (which includes attention to mitigation), it is necessary to attend promptly and efficiently to the many intergovernmental activities entailed in recovery after a major disaster.

3. If a heavily damaged area is viewed as a site for "instant urban renewal", a broader perspective and a wider array of reconstruction options will be maintained during the recovery planning process.

4. At the community level, vision of what the community could be and should be after the disaster is an important attribute of effective leadership.

5. Strong, capable leadership increases the likelihood of getting more resources for repairing the damaged systems and structures in the community.

Ability-To-Act Propositions:

1. The resources of the federal government are critical to a successful recovery after a major natural disaster.

2. While some dependence on external resources is to be expected after a disaster, a heavy dependency on external resources (whether financial or specialized personnel) can cause a loss of local control and long delays.

3. Local administrative and technical mechanisms as well as resources available before the disaster usually contribute significantly to an expeditious recovery effort.

4. Administrative staff, governmentally-employed consultants, and others may be able to bring valuable insights and suggestions to the attention of local public leaders if they are tapped for advice.

5. Although a city and a county may each possess useful capability, unless they have planned effective coordination they may not be able to interact and function effectively post-disaster.

Knowledge Propositions:

1. Public officials in communities with known hazards, or ones at chronic risk, should determine before a disaster what procedures, requirements, and benefits are contained in the state and federal disaster assistance programs for response and recovery.

2. In addition to identifying sources of assistance, it is essential to request assistance and resources with as much specificity as possible.

3. There is a need for realistic preparedness plans for all phases of a disaster. Such plans must be broad, flexible, and workable.

## SUMMARY

Many of the most effective actions after a major disaster regarding recovery with serious attention to mitigation of a similar disaster in the future are counterintuitive. Consequently, it is essential to think about them and to plan accordingly in the pre-disaster period. Important concepts to consider are the following:

- The tendency to "tough it out" and rely on local talent and resources is not the most effective and efficient way to recover.

- Just when local operations are intense, help is likely to be offered from all levels of government. State/provincial, regional, national, and perhaps international organizations are hovering or intruding. It is necessary to organize appropriately in order to use resources and skills as they are offered and at the same time to resist unneeded or unwanted supplies and personnel.

- When people everywhere are clamoring for the restoration of structures and systems as they were prior to the disaster, do not overlook opportunities for needed improvements or community betterment.

- Presently, too much disaster learning is achieved in hindsight. Such knowledge also can be acquired from education, training, or by hiring a knowledgeable and/or experienced person. More attention to education and expertise is long overdue.

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# A Regional Appraisal of Local Recovery From the Hurricane Alicia Disaster

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## INTRODUCTION

In August, 1983, Hurricane Alicia struck the upper Texas coast during the early morning hours. Although Alicia, which came ashore near Galveston, Texas (see Figure 1) was not a strong hurricane (peak gusts of 115 mph) the area of maximum winds in the storm crossed the large metropolitan area of Houston-Galveston, placing the area's network of expensive structures, buildings, and lifeline facilities at risk. Storm surge reached a maximum height of 10 feet above mean sea level in Galveston Bay and caused severe damage to communities along the Gulf of Mexico and inland bay shorelines. Alicia was recorded as the second most costly storm ever to strike the United States.[1] Alicia caused property damage of over one billion dollars in 1984 dollars (National Research Council, 1984). Tallies of the death toll resulting directly from Alicia vary from 10 to 20.

This paper provides a regional appraisal of local response during the post-disaster recovery period. There are two principal programs communities use to respond to disaster. First, land use planning programs deal with long-term reconstruction and mitigation issues by attempting to influence the location, design, and density of development in hazardous areas. Second, emergency response planning programs are concerned with identifying problems that might arise during the disaster and subsequent coordination of the immediate recovery activities of public and private groups and individuals.

The research upon which this paper is based focuses on four key questions:

1. What are they key problems encountered by communities during the hurricane disaster recovery process?
2. What is the perceived effectiveness of hurricane land use and emergency response planning programs?
3. What post-disaster actions were taken by communities to improve these programs to reduce future storm risks?
4. What are the factors that influence the political acceptability and administrative feasibility of these programs?

## SURVEY

### Methods

To gather information about local response, a mail questionnaire was sent to land use and emergency planners in local jurisdictions within the primary impact area of Alicia. The area that experienced the most powerful hurricane forces was generally within 30 to 40 miles of either side of the storm track. This area was generally contained within evacuation and contingency zones illustrated in Figure 1. These zones were delineated to identify high risk areas prone to hurricanes in the Houston-Galveston metropolitan area as part of a regional hurricane evacuation study (Ruch, 1981). Communities in these zones are part of federal and state initiatives designed to assist local governments in developing hurricane emergency response and mitigation programs. Thus, the survey enables us to not only examine local programs but also the results of federal and state efforts.

A questionnaire was sent to land use and emergency planners in 43 local jurisdictions. Respondents from 42 jurisdictions completed the questionnaire.[2] In each case prime respondents completed the questionnaire with input from other local staff or elected officials.

### Overview of Local Response

The survey included a list of 10 potential problems that communities may have encountered during post-disaster recovery efforts (Table 1.) Respondents were asked to identify those problems their jurisdiction had experienced. The most frequent and dramatic problems cited by respondents tended to be directed toward emergency response as opposed to land use and redevelopment. Debris removal and restoring public utilities, particularly electric power, were cited by a majority of respondents. About one-third reported problems with inability to communicate with citizens, difficulty in distributing food and medical aid and extensive disruption in economic activity. The remaining five recovery problems were cited by a small percentage or none of the respondents. Notably, poor quality of development was cited by only three percent of the respondents and none indicated that redevelopment in hazardous areas was a problem.

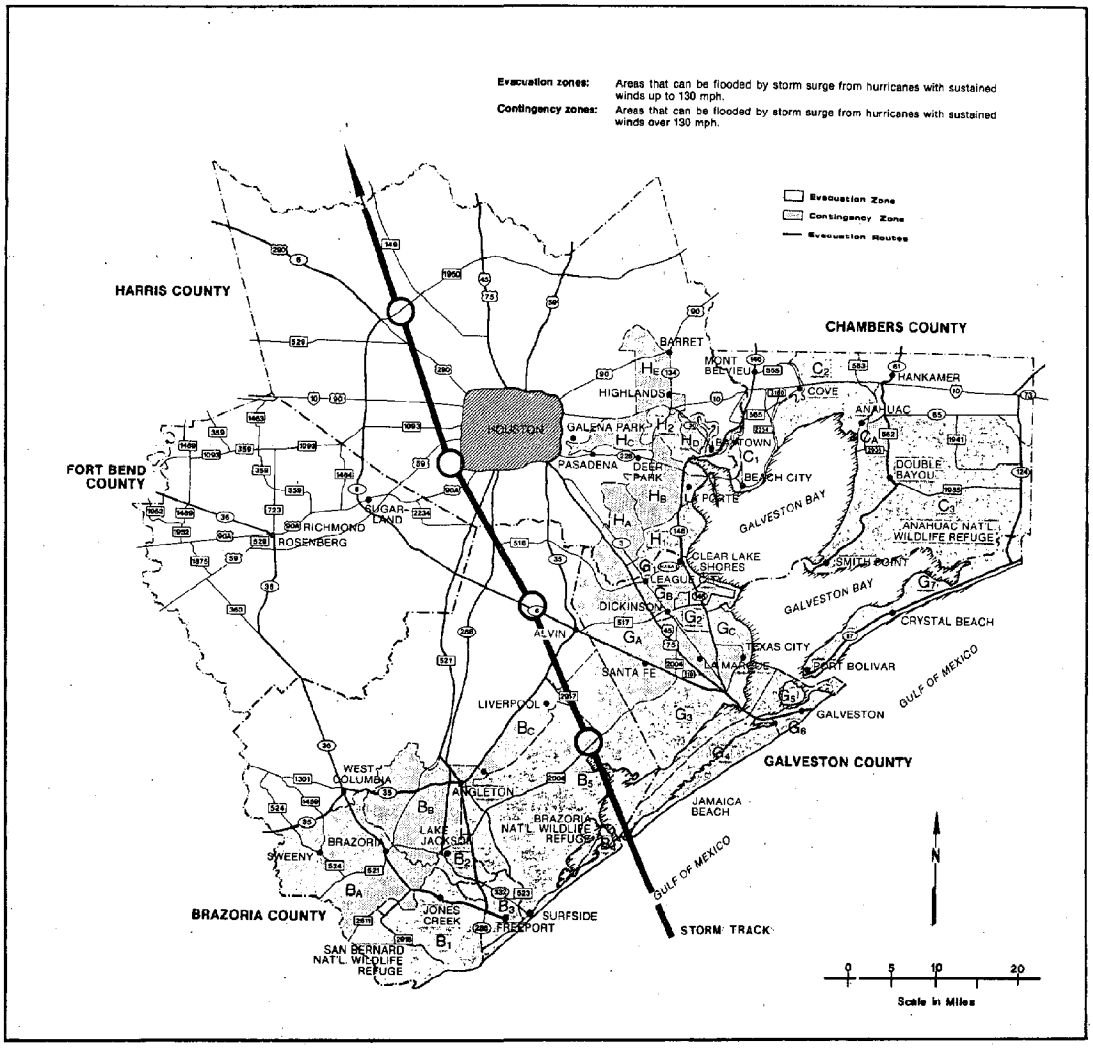


Figure 1: Houston Galveston Metropolitan Area, Ruch 1981.

Table 1: Problems Encountered During The Post-Disaster Recovery Effort

| Problem | (Frequency) | Percent |
|---|---|---|
| Debris Removal | (35) | 90 |
| Difficulty in Restoration of Utilities | (28) | 72 |
| Inability to Communicate with Citizens | (13) | 33 |
| Difficulty Distributing Food and Medical Aid | (11) | 28 |
| Extensive Disruption of Economic Activity | (11) | 28 |
| Traffic Congestion in Stricken Areas | (9) | 23 |
| Inadequate Emergency Shelter Facilities | (4) | 10 |
| Lack of Coordination with other Local Jurisdictions | (3) | 8 |
| Poor Quality of Redevelopment | (1) | 3 |
| Intensive Redevelopment of Hazardous Areas | (0) | 0 |

## Effectiveness of Land Use and Emergency Response Planning

Respondents were asked to rate the effectiveness of both land use and emergency response planning programs. Given the greater concern with emergency response problems it is not surprising that the majority of respondents viewed land use planning to be effective in reducing future storm risks (59 percent) while less than half (36 percent) viewed emergency response as effective (Table 2).

Table 2: Effectiveness of Land Use and Emergency Response Planning

| Planning Program | Overall Response[1] (Percent) | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Land Use Plans | 4 | 8 | 29 | 28 | 31 |
| Emergency Response Plans | 15 | 15 | 34 | 25 | 11 |

n = 42

1. Scale range : 1 - did not reduce hazards at all, to 5 - greatly reduced hazards.

## Post-Disaster Innovation

Catastrophic events can trigger local governments to more effectively deal with future hazards. We wanted to know if Hurricane Alicia triggered local innovation in the form of modifying and adopting more vigorous land use and emergency response measures to reduce future storm risks. The questionnaire contained a list of land use and emergency response measures communities can use to reduce risk posed by a hurricane. Respondents were asked to identify what measures were modified or adopted since Hurricane Alicia made landfall.

Table 3 indicates that 34 percent of the respondents indicated that their communities modified or adopted emergency response measures, while Table 4 shows that only 16 percent indicated that their communities had modified or adopted land use measures. Responding planners reported more stringent flood elevation and storm resistant standards as the most frequent type of change in their communities' land use planning programs. Measures that usually require change in land use intensity patterns, such as zoning and subdivision ordinances, plans, and land acquisition programs, were adopted or modified infrequently. There were no changes in public facility location programs, development incentives and hazard disclosure requirements. The most frequent changes in emergency response planning programs included widespread local purchase of two-way radio communication systems to rapidly and accurately provide changing and detailed instructions to the public, maintaining contractual agreements for debris removal equipment with the public and private sector, purchase of computer software and hardware to compute hurricane evacuation times, and establishing procedures for contacting power and telephone companies for repair schedules.

Table 3: Emergency Management Measures Modified or Adopted As A Result of Hurricane Alicia

| Measure | (Frequency) | Percent |
|---|---|---|
| Information for Emergency Decisions | | |
| Procedure to Compute Evacuation Time | (3) | 8 |
| Organization | | |
| Procedure to Identify Evacuation Actions Taken by Other Governmental Authorities | (1) | 3 |
| Procedure for Contacting Power and Telephone Companies for Repair Schedules | (3) | 8 |
| Communication | | |
| Public Address System | (1) | 3 |
| Television | (2) | 5 |
| Radio | (2) | 5 |
| Citizens Band Radio | (2) | 5 |
| PIES Two-Way Radio | (8) | 21 |
| Telephoning Residents | (2) | 5 |
| Organized Citizen Contact | (2) | 5 |
| Finding Equipment | | |
| Private Contractors | (3) | 8 |
| Other Local Jurisdictions | (3) | 8 |
| Retail and Rental Dealerships | (2) | 5 |
| State Agencies | (3) | 8 |
| National Guard | (3) | 8 |
| Communities that Made One or More Changes | (13) | 34 |

Table 4: Land Use Management Measures Modified or Adopted As A Result of Hurricane Alicia

| Measure | (Frequency) | Percent |
|---|---|---|
| Building Design | | |
| Storm Resistant Building Standards | (3) | 8 |
| Flood Elevation Requirements | (3) | 8 |
| Land Use | | |
| Zoning | (0) | 0 |
| Special Hazard Zone Ordinance | (0) | 0 |
| Subdivision Regulations | (1) | 3 |
| Plans | | |
| Comprehensive Plan | (2) | 5 |
| Storm Component of Comprehensive Plan | (1) | 3 |
| Recovery Plans and Policies | (0) | 0 |
| Land Acquisition | | |
| Land Acquisition for Open Space/Parks | (1) | 3 |
| Relocation of Existing Development | (0) | 0 |
| Public Facilities Location | | |
| Location of Public Facilities Outside Hazard Areas | (0) | 0 |
| Development Incentives | | |
| Preferential Taxation for Open Space Uses | (0) | 0 |
| Density Transfer from Hazardous Site to Less Hazardous Site | (0) | 0 |
| Hazardous Disclosure | | |
| Hazard Disclosure Requirements | (0) | 0 |
| Communities that Made 1 or More Changes | (6) | 16 |

Factors Associated with Local Recovery Efforts

To explore the relationships between perceived program effectiveness and community characteristics, political acceptability and administrative feasibility measures this section summarizes the results of bivariate analysis. We examine four sets of measures or independent variables which influence two dependent variables: the effectiveness scores of land use and emergency response planning. The four sets of independent variables include: community characteristics, political and administrative obstacles, priority of storm hazards, and local innovation. Since our sample represents the entire population, tests of significance are inappropriate. Thus, Table 5 illustrates independent variables and their associations with the two dependent variables.

The strength of associations of community characteristics differ between land use and emergency response programs. The greater the population and staff size, the greater the perceived effectiveness of emergency response planning. The level of damage to residential development has a weak negative association with both planning programs.

Associations of political and administrative obstacles differ considerably between land use and emergency response planning programs. Emergency response planning is perceived to be a more effective approach to reducing storm risks as local political obstacles intensify. This is particularly true for lack of interest by public officials and opposition by real estate interests. In contrast, with the exception of opposition to industry, the effectiveness of land use planning decisions declines as political obstacles intensify. As obstacles to implementation become more serious, particularly inadequate data and qualified personnel, the effectiveness of both programs declines. These implementation obstacles, however, show a strong negative association with effectiveness of land use planning, but a weak association with emergency response planning.

Table 5 also indicates that when communities place hurricane hazards high in priority on local political agendas the perceived effectiveness of land use and emergency response planning increases. Land use planning, however, is more strongly associated with local priority than emergency response planning. Finally, communities that have adopted changes in both types of planning programs following hurricane landfall are more likely to perceive their programs as less effective during the disaster recovery process.

Table 5: Measure of Association, Dependent Variable: Program Effectiveness Score

| Independent Variable | Gamma Coefficient | |
|---|---|---|
| | Emergency Response | Land Use |
| Community Characteristics | | |
| Level of Damage | -.05 | -.14 |
| Number of Staff | .21 | .08 |
| Population Size | .25 | .07 |
| Obstacles | | |
| Legal Restraints | .14 | -.11 |
| Lack of Qualified Personnel | -.19 | -.48 |
| Lack on Interest By Public Officials | .20 | -.26 |
| Opposition by Real Estate Interests | .27 | -.30 |
| Opposition by Incustry | .15 | .08 |
| Lack of Citizen Interest | .14 | -.12 |
| Inadequate Data | -.26 | -.61 |
| Priority | .10 | .47 |
| Post-Disaster Innovation | | |
| Changes in Emergency Response | -.22 | -.23 |
| Changes in Land Use | -.22 | -.18 |

n = 42

SUMMARY AND CONCLUSIONS

Four conclusions can be drawn from our survey results:

1) The most widespread problems encountered during recovery efforts were related to emergency response, particularly debris removal and restoration of electric power. Problems associated with land use planning, including reconstruction in high risk areas and poor quality of reconstruction, were not generally viewed as key problems faced by communities. These findings extend support for other research which indicates that at the time of the disaster immediate and pressing problems generally are given higher priority than reducing future risk through mitigation efforts (Rubin, 1985). Mitigation issues during the long-term recovery period must compete with everyday local issues and are generally of lower priority on local political agendas as time since the disaster event increases (Rossi et al, 1982).

2) Not surprisingly land use planning was viewed as more effective than emergency response planning in reducing storm risks. This finding appears logical as the most effective means to reduce or eliminate risks is to prevent development in hazardous areas. Emergency response actions are attempts to minimize population and property loss only after the disastrous event occurs.

3) Although land use planning was viewed as more effective in reducing storm risks compared to emergency response planning we conclude that change in emergency response measures was more politically acceptable and administratively feasible for several reasons. First, survey results showed that emergency response problems were more salient compared to land use problems during the recovery process. Communities tend to give more attention to resolving problems of high

salience. Second, implementation of land use planning measures were more closely tied to availability of local resources than implementation of emergency response measures. Third, as local political obstacles intensify enactment of more stringent land use controls becomes more difficult and communities place more emphasis on improving emergency response planning programs. Additionally, the level of priority on local political agendas has a stronger relationship with land use planning.

Our conclusion is supported by the fact that twice as many respondents indicated that their communities modified or adopted emergency response measures during the post-disaster recovery period compared to those communities that made changes in land use measures. Further, of those communities that made changes to land use measures, the changes were generally marginal, that is, building design revisions as opposed to more drastic changes, such as relocation of development or reduction in development density in hazardous areas.

4) Given the conclusions suggested above we conclude that improved emergency response measures and more hurricane resistant construction requirements may lead local officials and the general public to believe that communities can survive another major storm without sustaining loss of life and major damages. This impression can lead to less support for long-term mitigation measures since officials and the public believe that their communities are no longer in danger. A number of communities with growing populations in the study area do not have evacuation route capacity to meet evacuation demand. The potential for a severe hurricane making landfall on an unevacuated population will continue to increase if long-term mitigation measures are not taken.

## RECOMMENDATIONS

We offer three principal recommendations:

1) More attention should be paid to mitigation through local land use planning programs. If reducing the potential loss of life and extra-local disaster recovery expenditures is a goal, federal and state governments should play a stronger role in providing incentives for communities to consider mitigation during the disaster recovery process. Incentives might include federal funding when mitigation opportunities arise after a disaster. Since the cost of disaster recovery is shared by various levels of government and the private sector, so should the cost of mitigation be considered as a shared responsibility. In addition, states should assist communities in overcoming political pressures by requiring communities to enact land use regulations. Such state action will be largely ineffective, however, unless ample implementation resources are made available by states to communities.

2) Reducing storm risks is only one of many objectives that come into play during local recovery after a disaster. Greater success in enacting land use regulations for long-term mitigation will come if risk reduction objectives are linked to furthering other community objectives, such as environmental protection, open beaches and aesthetics.

3) Communities faced with the possibility of a hurricane landfall on an unevacuated population should consider identifying structures that would protect residents from wind, surge, and wave effects. These facilities could be used as vertical shelters and would be safer than an evacuee's own home or car. The vertical shelter concept, however, requires further research to answer the many problems that have so far hindered implementation. Studies are currently underway to address such problems (Ruch, Stubbs, Berke, and Miller, 1985 and Tampa Bay Regional Planning Council, 1985).

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## NOTES

1. Alicia's coastal property damage was exceeded only by that of Hurricane Frederic, which came ashore near Mobile, Alabama in 1979.

2. We sent questionnaires to 50 jurisdictions in November, 1984. A questionnaire was sent to each planning director of the 19 communities within the study area that have an urban planning agency and to each emergency planning director of all 50 jurisdictions. (Under Texas law every county government and incorporated municipality must have an emergency planner and an emergency plan). Sixteen land use planners and 43 emergency planners returned questionnaires. We compared responses of the land use and emergency planners within the same jurisdiction. Additionally, we compared the responses or emergency planners in jurisdictions without land use planners to responses of land use and emergency planners in the same jurisdictions. We found no appreciable differences among the three groups of planners in our comparative analysis. We subsequently used the responses of 26 emergency planners and 16 land use planners from 42 jurisdictions. Eight jurisdictions did not have a respondent. We eliminated the responses of eight emergency planners so that the eight jurisdictions having responses from both land use and emergency planners not be overrepresented in the results of our descriptive analysis.

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# Post Disaster Land Adjustments: Who Decides... For Whom?

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## SOLDIERS GROVE

Located in Southwestern Wisconsin's "Driftless Area", the village of Soldiers Grove is a small, rural community which grew up along the Kickapoo River and later developed chronic and serious economic and flood problems. At its own suggestion and under its own leadership Soldiers Grove embarked upon a course of comprehensive community revitalization highlighted by the relocation of its downtown to high ground in new, energy efficient and solar-heated facilities.

While the Congress had authorized the Army Corps of Engineers to build a set of levees at Soldiers Grove for local protection under the LaFarge Dam project, the village initiated development and a nonstructural relocation alternative and requested that its plan be substituted for the levees. The federal government wouldn't agree. Following a 1% flood in 1978, the village refused traditional federal disaster relief insisting that the relocation plan be carried out. This time federal funds were forthcoming.

Four flood plain management elements were incorporated into the community's revitalization plan: 1) continued eligibility for flood insurance, 2) zoning which prohibited new flood susceptible development, 3) floodproofing of the flood fringe, essentially one residential neighborhood, and 4) evacuation of the floodway, including village acquisition and clearance of 47 parcels comprising virtually all of the businesses, municipal buildings and some residences, to be reused as open recreation space.

Prior to this project, the common wisdom had been that economic development could not be achieved without sacrificing the environment, or environmental protection without sacrificing economic growth. Soldiers Grove demonstrated that resource conservation practices are economically stimulating and supportive of sound community development practices.[2]

## ISSUES

### How Do We Measure Success, in Dollars, Cubic Yards, or People's Lives?

Nonstructural projects put the primary emphasis on people and their quality of living, supplanting the traditional and more easily quantified monetary property damages due to flooding. This makes comparison of different types of flood control difficult and, moreover, introduces into flood plain management qualitatively different planning considerations, techniques, and participants.

For nonstructural projects, evaluation criteria include such diverse factors as the integrity of infrastructure, the vitality of the community's economics, public health, soil conservation, recreation, the quality of housing, and wildlife habitats. While federal programs may be narrowly focused on flood damage reduction and the costs of emergency services, from a local official's point of view many of the other considerations are more a daily concern and considered first. To be workable, therefore, planning for flood control and flood damage reduction in nonstructural schemes must incorporate shared roles among persons of diverse agencies and viewpoints.

### When You Do Something <u>For</u> People, Usually You're Doing it <u>To</u> Them

The practice of community development necessitates a very different attitude among planners than traditional public works planning. A far greater amount of communication is involved which emphasizes translations of technical information and lay attitudes and requires the sharing of resource allocation decisions by program managers with community members.

This decision sharing is necessary to avoid first developing a plan typically impacting drastically on people's ways of life and then announcing it to them, with all the adverse reactions that the media delight in publicizing. It is also necessary to include the affected people in the planning process because of the increase in quality and relevance of the planning solution which comes out of good community development practice. Communities and people are not homogeneous and it is arrogant for nonlocal planners to assume they know all the factors and interaction dynamics without intimately involving those affected by nonstructural projects in the project designs. Planners need to be much more expert in "process" and let local persons determine the plan's content; after all, who lives with the results long afterwards?

The basic notion of community development

practice involves a breakdown of "we versus them" and a substitution of "us" locally in the resultant neighborhood, town, etc., and also in the process of change that includes the planners, the resource managers, and the residents as a development team. All team participants are enriched and empowered in contrast to the stress and burnout associated with traditional nonparticipating (and frequently confrontive) project development.

### Timing - When To Make Plans and When to Act

Carrying out nonstructural programs in post-disaster circumstances is difficult enough without needing first to conceptualize and evaluate alternative recovery plans. The post disaster impulse is to restore and in the U.S. until recently restoration was encouraged by the public disaster assistance.

Pre-disaster planning is key to post-disaster implementation. Then the time and calm setting is available to go through the group process of settling differences, owning responsibilities, and marshalling resources to bring about a creative planning process. As a result there will be trust building among the team members which will be valuable during implementation when unplanned circumstances are inevitably encountered.

In a post-disaster setting which has not had prior planning, the diversity of local and nonlocal interests, the shock, and the urgency of action combine to make significant land use changes unlikely.

## CONCLUSIONS: THE INTRODUCTION RESTATED (IN CASE YOU MISSED IT)

As community developers and floodplain managers, at Soldiers Grove and elsewhere, we are involved with **revitalization**, which means to put life back into or to once again bring life out of.

We are all creatures of habit; we live in patterns. Our personal lives and our physical communities reflect this. The patterns are not static; as individuals we mature and grow old and communities do so as well. Nor are the patterns always healthy, and for many communities with historical associations with rivers and lakes and oceans, living and working in flood prone areas is no longer an invigorating pattern but a life threatening situation.

At Soldiers Grove it was recognized - in the relative calm of economic distress but not yet flood disaster - that individual and community losses were inevitable but not unmanageable and flood plain management became one more element in a comprehensive plan of land use adjustment based on community revitalization. Put together over two years by members of the community, university extension personnel, professional consultants, and scaff from state and federal agencies, a plan was prepared and the community was ready to act when the inevitable disaster occurred.

From an archaic position next to the river and in economic distress, the community has achieved nearly complete 1% flood protection, resolution of other serious threats to public health and safety in housing and community facilities, community redevelopment and economic revitalization, effectiveness of governance, wise energy management and environmental enhancement.

## NOTES

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2. Further detail on the Soldiers Grove community revitalization program is available in coordinated booklet and slide-tape form, under the title "Come Rain, Come Shine", from the Wisconsin Department of Natural Resources, Bureau of Water Regulation and Zoning, Madison, Wisconsin.

# The 1976 Big Thompson Flood Recovery in Today's Colorado Context

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## BACKGROUND ON THE BIG THOMPSON FLOOD

On July 31, 1976, the Big Thompson Canyon was filled with tourists. It was the Saturday of the weekend commemorating Colorado's Centennial and the last holiday weekend before school began. That night a flash flood ravaged the canyon, causing the worst natural disaster in terms of lives lost in Colorado state history.

The Big Thompson Canyon is one of the more scenic canyons in the Rocky Mountain region. U.S. Route 34 runs through the canyon, adjacent to the river in many spots. It is the main link between the plains near Loveland and Rocky Mountain National Park. Approximately 600 full time residents, 1200 seasonal residents and 700 tourists were taking advantage of the three-day weekend commemorating the Centennial to enjoy the beautiful canyon when the flood struck. Flooding was caused by a heavy rain, over 10 inches in four hours, which fell over a 70 mile area in the central portion of the Big Thompson watershed between 6:30 pm and 11:00 pm (Maddox et al, 1977).

One hundred and forty-four people died in the flood. The flood destroyed 316 houses, 45 mobile homes, and 52 business structures. Seventy-three additional residences suffered major damage, and hundreds more required extensive mud and silt clean up.

## THE BIG THOMPSON RECOVERY PROCESS AND PROBLEMS

No flood plain regulations were in effect in the canyon prior to the flood. No maps had been prepared. The Big Thompson Canyon was not a high priority for mapping by the National Flood Insurance Program. After the flood, Larimer County adopted a 6 month moratorium on rebuilding, despite considerable local opposition by canyon residents. During the 6 month moratorium, maps were prepared. The state and local government had some breathing room. In 1977 the county adopted permanent regulations controlling development in the 100-year flood plain and limiting the reconstruction of structures damaged over 50% of their market value before the flood. After flood plain ordinances were passed and enforced, officials agree that the moratorium met its goal of allowing time for the completion of hydrological analysis. The only criticism concerned delays in decisionmaking.

The county also developed a plan to acquire 166 parcels at pre-flood values (a total of $2,969,000 including relocation and rehabilitation). Pursuant to this plan, a total of 123 parcels were acquired on a voluntary basis at a cost of $2,200,000. However, the buyout plan was only partially implemented since 9 people would not sell. Many of the less seriously damaged homes were rehabilitated at homeowner or public expense. Some were floodproofed. The roads and bridges destroyed by the flood were rebuilt at a public cost of $24 million (Kusler, 1982:272).

There were some drawbacks to the recovery. Some can be accounted for by the scale of the disaster, some by the perception of the public about the nature of the victims (they were perceived incorrectly as second home owners), others by the fact that the brunt of the flood damages occurred in unincorporated Larimer County and the political framework necessary for pressing for rapid recovery centered on the towns at either end of the canyon, Loveland and Estes Park. Rebuilding the road appeared to have a higher priority than assisting individuals who had lost their homes.

In light of the fact that 11 people died in their cars alone, signs were later placed in Big Thompson Canyon and other Front Range Canyons advising motorists to get out of their cars and climb to safety in the event of a flash flood.

## BROADER IMPACTS OF THE FLOODING

A variety of other measures were adopted in Colorado, stimulated in part by the Big Thompson flooding and other flood events. In the past 10 years there have been 9 Presidentially declared disasters due to flooding in Colorado. Floodprone areas have been identified in 212 cities and towns in all 63 Colorado counties. In 1985, Colorado adopted a new hazard mitigation plan to help address these problems. Boulder has a sophisticated warning system reported elsewhere (Gruntfest, 1985). Similar efforts are being initiated in Western Colorado and in the Pikes Peak region.

Unfortunately, in Colorado and elsewhere flooding still prompts interjurisdictional discussion more than preparedness planning. From the national and international perspectives, many recovery and reconstruction studies have been completed since 1976 (e.g., Haas, Kates and Bowden, 1977; Geipel, 1982; Cuny, 1983; Rubin,

1985). The Big Thompson flood, while not causing direct impacts to other locations in Colorado, has had peripheral impacts:

Estes Park Dambreak 1982. When a dam broke in Rocky Mountain National Park in July 1982 inundating downtown Estes Park, recovery and reconstruction were speedy and mitigation planning was integrated into the recovery efforts. This was due, in part, to the experience of Larimer County with Big Thompson. One major difference between the Big Thompson and Estes Park recovery efforts was the prompt 15 day report from FEMA which made specific recommendations as to how Estes Park could make the town less vulnerable to future flooding. FEMA insisted on mitigation planning as a condition of assistance. Losses were also rather small in comparison to Big Thompson. The city looked forward rather than backward in its recovery and reconstruction efforts. One week after the flood the visitor count had returned to pre-flood levels (Gruntfest, 1985:46).

No official building moratorium was adopted. Two unofficial ones were imposed on properties where acquisition pursuant to Section 1362 were being considered. Individual property owners did not make any changes to their damaged properties.

One of FEMA's recommendations was that the bridge construction be standardized. Standards were set in less than one month. Now a trip through town shows the standards were met, as all the bridges are identical (Callahan, 1985).

Manitou Springs. Due in part to a broadened awareness of flash flood problems, Manitou Springs, Colorado is now developing a mitigation plan in preparation for flash flooding (Gruntfest, 1985). This innovative process of pre-flood/post-flood planning, the Manitou Springs Flood Hazard Mitigation project, was funded by the Federal Emergency Management Agency in early 1985.

Manitou Springs is located at the base of Pikes Peak, immediately west of Colorado Springs. The year-round population is about 4500 people. During the summer thousands of tourists stay in and around the town.

Land use in the town is constrained by geography. The town is located along several streams. Most of the remainder of the town sits on steep slopes above the flood plain. There is little land available for development that is not subject to either flooding or slope problems. Consequently, downtown Manitou Springs is built along the streams, and the flood plain is almost totally developed. There are 850 buildings located in the main historic district and more than 150 of these are in the flood plain. Shops, hotels, homes, and restaurants sit astride or are built partially in the floodway.

The community has had limited experience with flooding in recent memory although serious floods have occurred in the past 75 years. Manitou Springs participates in the National Flood Insurance Program but only 32 policies have been purchased. A large portion of Manitou Springs is recognized as a national historic district.

In developing a mitigation plan for Manitou Springs the most effective and innovative plans from around North America were examined. Flood hazard mitigation strategies and funding prospects for each option were reviewed, and recommendations for adoption and implementation in Manitou Springs were studied. Because public awareness is essential, a slide tape presentation of the likely effects of a 100-year flood in Manitou Springs was prepared and made available for ongoing public education. Recommendations included in the plan were:

- Organize a local emergency operations plan;
- Develop a warning system;
- Educate the public;
- Survey flood plain buildings;
- Encourage floodproofing;
- Promote flood insurance purchase;
- Lobby for an urban drainage district basin-wide;
- Initiate a memo of understanding concerning historic buildings;
- Clear channels; and
- Form a council to implement recommendations.

With the plan Manitou Springs is attempting to iron out problems before a disastrous flood occurs. Efforts are not without controversy or resistance but with a good deal of commercial support. The notion of win/win prevails. The town leaders perceive benefits in being prepared.

## WHAT HAS BEEN LEARNED SINCE THE BIG THOMPSON FLOOD?

If the Big Thompson flood were to occur today, the response in the canyon would reduce loss of life and property damage. A warning system has been implemented. Local emergency preparedness officials anticipate that motel owners and campgrounds would take responsibility for warning their clients. There would be enthusiasm and more confidence about buyout possibilities. The community is better informed about the prospects of flooding. Fewer bridges now exist to catch debris.

If the flood occurred elsewhere in Colorado, mitigation measures taken in advance and recommended immediately following the disaster would also have positive results in terms of reduced loss of life and prospects for reduced long term vulnerability to flooding.

A Symposium to assess what has been learned since the Big Thompson flood was held July 17-19,

1986, in Boulder, Colorado. The goals of that Symposium were to outline research and policy needs based on accomplishments, new questions, new technology, changes in hazard vulnerability and experiences elsewhere. One of the major topics for discussion at the Symposium was whether the flash flood vulnerability in the Big Thompson canyon and the nation has increased or decreased overall since 1976. Also, the Symposium carefully examined the long term ramifications of the disaster as an "opportunity" for improving overall mitigation.

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# A Scenario for a Hypothetical 100-Year Flood for Manitou Springs, Colorado

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## INTRODUCTION

Scenarios are effective devices for increasing awareness and educating decision-makers of the possible consequences of a disaster. They should not be viewed as forecasts of the future. The following scenario of a hypothetical 100-year flood with and without prior mitigation was prepared to help decision makers in developing a flood mitigation plan for Manitou Springs.

Public awareness and public education are needed in order for the residents of Manitou Springs to have a realistic perception of the hazards which face them. Local authorities should implement a modest education program concerning the flash flood potential.

The scenario has three interrelated objectives: first, to simulate the magnitude, characteristics, and distribution of human casualties, structural damage, and disruption of social systems likely to occur in Manitou Springs during a 100-year flash flood at its current level of preparedness; second to show the capacity of existing emergency procedures for reducing the flood's impact; and third, to give examples of possible flood mitigation techniques that would heighten awareness, reduce stress, and reduce damage potential to the city's social system (Erickson, 1975:75).

The loss of life and property from floods has become the number one natural hazard nationwide in recent years. In Colorado alone 275 communities are subject to flooding. This represents approximately 150,000 people now living in Colorado's flood plains.

It has been nearly twenty years since a devastating flood has been witnessed in the Pikes Peak Region. We cannot predict whether the next flash flood will strike today, this year, or years from now - we only know that it will, in fact, occur.

## SCENARIO WITHOUT MITIGATION

The day of the scenario is typical for the Colorado Front Range. The weather forecast calls for a chance of afternoon thunderstorms. An accumulation of thunderheads over Manitou Springs and the entire Pikes Peak Region is not cause for alarm to the residents and tourists of Manitou Springs on this warm, summer afternoon.

At 3:30 pm the sky has blackened and rain is beginning to fall in the mountains.

By 4:30 pm the storm has unleashed its fury over the Fountain and Ruxton Creek drainage basins. The heavy rain causes many picnickers and campers in higher elevations to seek shelter or head for home.

Only light rain is falling in the lower elevations, causing little concern.

By 4:45 pm the National Weather Service issues a general flash flood watch for El Paso County. The watch is transmitted by local radio and television stations about fifteen minutes later:

> "The National Weather Service has issued a flash flood watch for valleys and low-lying areas of El Paso County until 7:00 pm."

Motorists traveling on Ute Pass are having difficulty keeping control of their vehicles during the steady downpour. One car is washed off the highway.

By 5:00 pm the thunderstorm has intensified and shows no sign of moving out of the area. The town of Cascade reports three inches of rain in the last half-hour. Flooding is beginning to occur on the east side of Manitou Springs.

At 5:25 pm, the National Weather Service sends out a flash flood warning:

> "The National Weather Service has issued a flash flood warning effective until 10:00 pm for persons in Teller, El Paso, and Freemont Counties in Colorado. Heavy rain was indicated by radar to be moving into these counties at 5:10 pm. Woodland Park in Teller County reported two inches in thirty minutes."

The police department sends two patrol cars out to warn people to the south of Fountain Creek of the threatening flood. No officers are sent to the opposite side of the creek because of the life threatening situation (Greenham, 1985).

The sky over Manitou Springs has become black, interrupted only by flashes of lightning. The intense rainfall is causing numerous rock and mud slides along the canyon walls and highway, trapping people trying to escape by car.

Flooding has already cut off the upper junction of Highway 24 and Manitou Avenue. Several cars are floating along the road in low-lying areas.

Many residents and business owners, however, continue to discount the warning, feeling secure within their own walls. This instills a false sense of security in their guests and customers.

One resident of the Fountain Creek Adult Apartments - which borders the north bank of Fountain Creek - seems unconcerned:

> "I've lived in this apartment for four years and have never seen that water rise more than two feet. It's (the creek) not a threat to my property."

By 5:45 pm all residents of the Fountain Creek Apartments must be evacuated to the Manitou Springs High School.

The first crashing wave of flood water hits Manitou Springs at the upper reach of Ruxton Creek. Because the channel is lined with concrete in its upper stretch, its flow is restricted and its velocity is increased.

The portion of the channel that flows beneath the Iron Springs Chateau Melodrama is unable to retain the flow, sending a six foot surge of water through the main dining room:

> "We could hear the rushing water but were advised not to drive out. All of a sudden the wall gave way and the river went right through the dining room; people and tables were thrown into a heap on the other side; there was nothing we could do to help them."

Seventeen lives are lost.

Power shortages become numerous as lines are torn down.

Numerous bridges cause damming with sudden surges of water as they eventually give way. Cars, animals, and other debris fill the advancing waters.

A crashing wall of water hits the western reach of Fountain Creek just upstream from town. Three motels are inundated as Fountain Creek rushes beneath and through their structures. Some tenants escape by climbing the hill behind the motels. Nineteen others are swept to their deaths.

By 6:00 pm an official evacuation program has begun. Because the city has no pre-planned routes to safety, the project is chaotic and inefficient. Colorado Springs' officials are having difficulty entering Manitou Springs due to the severe flooding. Flood water in the overbanks is exceeding ten feet in depth and flow velocities are now exceeding fifteen feet per second.

Confusion over warnings and evacuation procedures are overloading the few telephone lines not down. Some people are still unaware of the flood's speed and strength, spending a fatal length of time collecting valuables and pets.

> "I was taking pictures for the local paper when I noticed a woman with one arm wrapped around a post and the other around her dog. She was lucky she was so near the bank or I could never have pulled her out. The strength of the stream was overwhelming."

A mother and her three children try to escape from their drifting car when a giant wave sweeps the car and the three children away. All three children are killed (Gazette Telegraph, 7/25/65).

In most areas the creek is cresting at least nine feet above the stream bank (U.S. Army Corps of Engineers, 1984a). Side canyons and tributaries are flooding -- the powerful water is destroying cars, bridges, homes, and any other obstacle that gets in its path.

Older structures located along and over Fountain Creek suffer the most damage as the flood reaches its peak. The numerous businesses and tourist shops that lie parallel to the creek and to Manitou Avenue are demolished as the creek roars past, engulfing them. Video and pinball machines from Arcade Amusements are left in a chaotic mass of debris, leaving the proposed Manitou Mall area devastated.

The historic Episcopal church is inundated and all its contents destroyed.

The Manitou Springs fire and police departments face further difficulties as a crushing force of water knocks down the support beams for City Hall, causing the back half of the building to collapse into Fountain Creek. Luckily, the building had been evacuated because of its location to the creek.

Another victim is claimed on Ruxton Avenue as he and his sister try to escape their home.

> "We heard the water and eventually rocks and boulders hitting the side of the house. We saw that the creek and road were now one huge river and tried to get out and climb the bluff behind us. My brother was trapped between the outside wall and a giant wave of water...and then I couldn't even see him anymore." (Gazette Telegraph, 6/20/65).

Gas and electric lines are destroyed causing power outages and small explosions. Sanitary sewage lines fill with pressure, blowing manhole covers and spewing raw sewage into the floodwaters. The hazard of disease now adds its threat to the city.

Some cottages and motels found along the lowland flood plain are washed away; others are dislocated.

The next few days are spent recovering bodies and providing shelter and food to the homeless. Victims are difficult to identify as their bodies were badly mutilated by the river and identification and clothing were stripped off

by the powerful flow. Cars were totalled and washed miles downstream. Mud and debris fill the entire Manitou Springs area.

Ninety-seven people were known to die in Manitou Springs and many others are still missing. Few are injured; there are only survivors or non-survivors. No one drowns in such a disaster but rather is killed by the powerful blows of water and debris. Structural damages within the city are in the multi-millions and clean-up costs will further escalate the total (U.S. Army Corps of Engineers, 1985).

## POST-MITIGATION SCENARIO

It is a typical summer afternoon on the front range. Manitou Springs is experiencing the characteristic afternoon showers that show no hint of escalating into a torrential flash flood.

By 4:00 pm the recently implemented satellite warning system notifies city officials that a massive thunderhead is nearing Manitou Springs.

At 5:15 pm the alarm sounds, notifying the residents and tourists of Manitou Springs that a flash flood will, in fact, hit the city in approximately seventeen minutes.

The workshops attended by business owners, city officials, and residents prior to flood season prove beneficial in educating these people to take prompt, positive action to the flood event. Evacuation routes were pre-planned and practiced so few residents hesitate in moving to higher ground.

There is little chaos except for the excitement of the flood itself.

Monthly debris clean-up of the channels cut back on back-water damming, although numerous footbridges still hamper the stream flow. Residents on both sides of Fountain Creek are notified, either by the flood alarms themselves or by radio, to evacuate. Most respond to the reliable warning system -- knowing it is only sounded in the event of a severe flash flood. The heightened awareness of the community makes all citizens more confident about their ability to respond to the warning.

Although saving lives is the primary benefit from the flash flood warning system, some property damage is prevented through emergency floodproofing.

City Hall, the Fire Department, and the Police Department have been relocated out of the floodplain as part of the Manitou Springs Flood Hazard Mitigation Plan. These buildings now serve as the central network for all communication and emergency activities.

Personnel at the utilities and water departments are notified so that power and gas lines can be shut off. They are also informed of possible pressure increases in the sewage lines. Thus, any major damage of utility lines does not cause a threat to the community.

The partial greenbelt running alongside Fountain Creek provides an open area for swelling streams to flow. Although the greenbelt also serves to beautify the Manitou Springs area, its most beneficial purpose is served today.

Signs indicating evacuation routes are located throughout the city, directing people to head for safety by foot rather than car - a far safer alternative.

Prior to the flood season, Manitou Springs Police Department developed a list noting the addresses of all elderly and handicapped persons living in the city so that they can be aided during the evacuation.

Manitou's effective pre-hazard policies for flash flood situations save this city and its citizens.

# CHAPTER FIVE
# *THE ROLE OF THE PRIVATE SECTOR*

Governments provide much of the immediate rescue and relief after a disaster but occupants of areas, builders and subdividers, banks, and private relief organizations make most of the ultimate land reuse decisions in both developed and developing countries. Government influence quickly wanes except for infrastructure and some financing.

The need to encourage private sector self-help has been broadly recommended by researchers and the negative impacts of some types of relief on such self-help has been criticized (e.g., the affect of excess supply of food on local food production). Nevertheless, conscious and well thought out government policies to maximize private "self-help" are rare. Some progress has been made in encouraging private mitigation by conditioning disaster assistance and, in the U.S., by requiring rebuilding consistent with federal flood insurance standards if structures are damaged more than 50% of their value.

This chapter includes two papers. The brief treatment afforded this topic does not reflect its importance. But, only a portion of those presenting papers at the symposium submitted papers.

The first by Roy Popkin identifies private sector opportunities for mitigation and stresses the importance of careful involvement of the private sector in relief and preparedness. The second by David Godschalk examines the use of "negotiated land development" to achieve hazard mitigation. With negotiated development private and public sectors bargain over specific land policy. Negotiated development is both an educational and decision-making process which has considerable potential for hazard mitigation.

# Facilitating Mitigation Through Housing and Other Emergency Services in the U.S. Provided by the Private Sector

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## INTRODUCTION

The question of whether the emergency relief activities and recovery assistance provided by the private sector provides opportunities for hazard mitigation is a thorny one. The private sector activities seem to offer both incentives and disincentives and, paradoxically, they may both be part of the same package.

First, what is the "private sector?" Generally it has been thought of as the non-governmental relief agencies, but in actuality it is much broader. To look at the question of hazard mitigation facilitation intelligently, one has to recognize that the private sector is many sectors: the relief agencies, of course, the insurance industry, financial institutions, developers, and the disaster victims themselves. Each has a stake in hazard mitigation, although it may be a negative stake.

Historically, assistance to disaster victims from the voluntary and private sector has worked against mitigation as relief agencies tended to provide both temporary housing and permanent homes (through help with repair or replacement of damaged houses) at the original homesite or as close as possible. Even emergency government efforts such as bringing in numbers of mobile homes usually placed the victims in hazard areas (where else could you find flat land after most floods, especially in mountainous areas?), and then those temporary locations tended to become permanent.

Because every effort is made to expedite the assistance-giving process, there has been until recently little regard for the hazard mitigation potential of a given situation. The two major non-governmental sources of such help are the voluntary agencies like the Red Cross and the insurance companies. It was not until the advent of the flood insurance program, with its Section 1362 floodplain relocation program that the voluntary agencies began assisting families to relocate in any appreciable numbers. At Times Beach, for example, the Red Cross took the view that families would be assisted in remaining in the area only if some governmental agency granted them a building permit. This was a backhanded way of saying help would be available only for relocation. But such help has also been forthcoming at Lake Elsinore, in Tulsa, and other places where relocation became, by necessity, official government policy.

This represents a considerable departure from time-honored policies based on the concept that a community's plan for rebuilding was usually restoration of the status quo insofar as possible. SBA loan regulations are another area in which government policies can get in the way of private sector support for relocation, for the Agency requires fifty percent or more damage to a home before it will lend money for relocation. That puts two parts of the private sector -- the victim and the relief agency -- between a rock and a hard place and leaves the hazard mitigation relocation advocate there along with them.

The insurance industry, with quick payoffs, can inundate an area with ready cash that becomes another pressure on victims to rebuild as fast as they can, especially since they can afford to. The insurance adjusters, obviously, want to settle quickly to keep their costs down. And, of course, banks want some kind of rapid solution to the mortgage-holder's problem because they expect him to go right on paying his monthly payments even if he doesn't have a house left. The stake of developers in restoration of areas in which they hope to build is obvious.

## POTENTIALS FOR MITIGATION

That, in brief, is the downside. Properly educated in the potentials for hazard mitigation -- which means knowing what the hazards are beforehand -- the private sector can be a strong factor in fostering a hazard mitigation mentality at the community level. The act of preparing for an emergency response is opportunity number one. The kind of hurricane evacuation planning that goes on in Florida, Texas, Alabama, Louisiana, the Carolinas, and Virginia is a case in point. First, it identifies the hazard areas in a rather public way. Then it identifies public shelter facilities which, in turn, now requires in some states engineering checks of proposed shelters. So, secondly, the need for retrofitting buildings to make them storm resistant, or the very fact of their vulnerability, is another dent in the consciousness of the public and community leaders. Such emergency preparedness - whether it be in relation to coastal storms, adjacency to rivers or earthquake faults, or related to the site of a nuclear power plant - can be used as an instrument of hazard mitigation sensitizing.

But success depends upon the insurers, the relief agencies, and the other private sector components being kept in the picture from information and planning perspectives so that

when a disaster provides the opportunistic moment (especially in terms of the availability of government funds) and the FEMA hazard mitigation team makes its formal recommendations, the mind-set, and perhaps even enabling legislation and potential funding are in place, ready for the necessary moves.

Publications on flood plain planning show more than 30 communities have already built acquisition and relocation into their flood hazard mitigation planning. There is at least an even chance that future efforts along these lines might succeed, especially if the informational and sensitizing aspects are built into disaster planning, insurance ratings, urban renewal and other developmental plans, and if the consciousness of citizens' associations that become the Horatios defending the bridge against mitigation can be pre-recruited on the side of whatever kind of mitigation methods are needed.

The voluntary relief agencies can play another important role because they represent a tremendous constituency. The Red Cross, for example, has over two million active volunteers; some of the religious groups are considerably larger. What's more, they own and operate tens of thousands of buildings, many of them in hazardous areas. A Red Cross team making a movie about the New Madrid fault found that in Tiptonville, Tennessee, every church, school, or other building that might be used in an earthquake relief operation was constructed of unreinforced brick and masonry. All of them would collapse or be severely damaged if the New Madrid earthquake reccurred.

The private sector, then, can act as bellwethers by publicly espousing the cause of retrofitting, by building new structures in safe locations, by incorporating the latest state-of-the-art codes and methods, and by providing to people living in hazardous areas a steady flow of information and counselling that will prepare them for relocation if and when the question becomes a matter of public policy.

Strengthening the roles of private relief agencies will not necessarily be easy. The voluntary agencies get their funding from public contributions. Heavy contributors have real estate, financial and other interests that may oppose a hazard mitigation approach, especially in communities where the tax base is fragile and there is no place within the community to relocate dozens or hundreds of homes. In some communities, the private agencies will be pressured to stay out of such controversies, and in many circumstances probably will. Nevertheless, it should be remembered that the University of Massachusetts study of what influentials felt about various natural hazards-related problems found that the Red Cross, civil defense and insurance agents as a bloc supported hazard mitigation and were concerned about hazard issues. Add to this the past activities in this arena by groups such as the League of Women Voters, the Sierra Club and other environmentalists, the Nature Conservancy, and the academic community, and there is a potential foundation on which to build.

Unfortunately, the name of the relocation game is, "you can't go home again", and this runs up against the centuries-old tradition of "home". Every time there is a major disaster, TV shows us the elderly couple saying, "we've lost everything", or the young couple, or the middle-aged couple saying the same thing. And behind them on camera is a damaged or devastated house. No one says that the house shouldn't have been there in the first place; no victim curses the person who sold him the house in the first place; no one calls for the scalp of the public official who signed the building permit.

This means that even though disasters, per se, offer opportunities for post-disaster mitigation tied to relief and rehousing, the seeds have to be sown beforehand. When a community goes through its emergency planning process, it needs to put developers and bankers and insurance company people on the planning committees, and conduct the committee meetings in public view. Interestingly, when Dr. Dennis Miletti (now at Colorado State), Dr. Eugene Haas, and others were involved in a research effort about the socio-economic aspects of earthquake prediction, the study's advisory committee, composed of representatives of the relief agency, banking, construction, and academic communities, fed a lot of the findings back into their systems even before the study was completed. But to accomplish this kind of result on a community level, with hazard mitigation in mind, requires careful strategizing by the community leadership and by planners and emergency services agencies. And in such strategizing, the private sector can play an important role, especially since most of the kinds of private sector groups that might be involved are generally seen as conservative and hence could not be shrugged off as radicals.

## CONCLUSIONS

Summing up, the relief planning process can be used to promote hazard mitigation even if the act of emergency relief itself, based on rapid meeting of humans needs, might seem to work against mitigation. If the relief agencies know in advance that the second phase - restoration and rehousing - will depend on mitigation decisions, they can plan for that and adjust their long-range plans. Private voluntary agencies can also act as bellwethers, using their own buildings and building plans as examples of mitigation in action. Insurance agencies should be urged to factor mitigation activities into their rate and claims payment structures and processes. Banks, too, could require mitigation steps as a condition of a loan, or even as a basis for deferring payments in a post-disaster context.

There are many private sector opportunities for fostering hazard mitigation in disaster preparedness and relief, but they will have to be developed carefully, and almost community by community. Nevertheless, the private sector should - must - be included in the hazard mitigation planning and implementation process.

# Negotiated Land Development and Hazard Mitigation

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## INTRODUCTION

An emerging growth management approach is "negotiated development", where the public and private sectors bargain over case-specific land use policy with each agreeing to do something with and for the other in the context of a specific development (Kirlin, 1985). Exploration of the potential of this new approach for hazard mitigation is the purpose of this paper.

## THE RISE OF NEGOTIATED LAND DEVELOPMENT

The traditional model of development regulation is based on rule application. Under this model, a developer proposes a project plan to a local government, which judges its acceptability according to the degree of its conformity to existing policies, plans, and development regulations. The government acts first at the policy and plan levels to establish comprehensive rules and standards under its police powers. Then individual developers act at the project level to request approval of their proposals under these rules and standards.

Negotiated development is increasingly used as a supplement to the traditional rule application model. In negotiated development, the rules and standards are drawn to leave room for and to encourage bargaining over the specifics of projects. Rather than sequential and separate public and private planning, the government and the developer act together to plan and agree on conditions for individual project design and construction, within general policy and plan guidelines. In some, but not all, cases, the projects may even be jointly developed under various forms of public-private partnerships, such as Urban Development Action Grants (Freilich, 1985).

The rationale for negotiated development is based upon several features of contemporary growth and governance:

- Fiscal constraints on the public sector, such as Proposition 13 in California and Proposition 2 1/2 in Massachusetts, have limited the ability of governments to pay for the infrastructure needed to support new development projects.

- Suburban employment center growth, such as that in the high-tech corridors of Fairfax County, Virginia, and the "Silicon Valley" area of California, has placed new demands on public facilities originally designed for low density residential areas.

- Mixed-use development, combining office, commercial, and residential uses, has shown the need for flexible standards that allow creativity in design and site planning in order to realize the potential of specific land parcels and environmental configurations.

- Increased complexity, delays, and uncertainty in development permit processes based on rule application, including a rash of costly and time-consuming legal challenges, have led to a search for more reliable and certain ways of reaching agreements between governments and developers over acceptable projects.

Negotiating development is a different task than applying rules. It raises important issues of accountability, equity, finance, and law. Despite these issues, negotiation is increasingly used by local governments to accomplish objectives not easily achieved under traditional development regulations:

- Development Agreements have been used in California to overcome fiscal limitations and vesting provisions that threatened to block desirable development projects (Kirlin and Kirlin, 1982).

- Linkage requirements have been enacted in Boston, San Francisco, and Santa Monica to mitigate the impacts of office and commercial development through provisions for related housing and employment actions.

- Conditional zoning has been used in North Carolina, Illinois, Maryland, and other states to overcome the uncertainty as to which of many permitted uses will occur under standard zoning designations.

- Conditional development permits have been used in Florida and elsewhere in order to ensure the protection of fragile environments, such as wetlands, from proposed development.

## APPLYING NEGOTIATION TO HAZARD MITIGATION

My proposed application of negotiated land development to hazard mitigation relies upon the concept of linkage between increased development and increased mitigation needs, and upon the technique of a hazard overlay district in which development approval is conditioned upon an approved mitigation agreement.

If the concept of development/mitigation linkage is accepted, then technical analyses can delineate the cross impacts. Just as the housing needs linked to new office construction and the transportation needs linked to new residential construction can be calculated, so can we calculate the hazard protection needs linked to new development in hazard areas. For example, in coastal flood hazard areas, new development requires increased evacuation capacity, warning capacity, disaster relief capacity, and recovery capacity. Future mitigation costs can be estimated from historical data, adjusted for inflation.

Hazard overlay districts can be applied over existing zoning and other regulations to identify the locations where mitigation agreements must be negotiated in order to proceed with development. The boundaries of these districts would be defined through hazard analysis. For example, in the coastal area, the hazard overlay district might be based on the location of Velocity Zone (as mapped under the Federal flood insurance program) combined with areas subject to high erosion (such as North Carolina's Ocean Erodible Areas of Environmental Concern).

Hazard mitigation agreements could take a variety of forms. In the simplest version, conditions imposed on new development could involve monetary contributions to a revolving mitigation fund which would be used by the government to meet various hazard reduction needs. Another form might entail actions, on-site and/or off-site, by the developer to mitigate future risks. For example, the developer might agree to add another travel lane to an evacuation route or bridge, to move a coastal access road back from the shore, to concentrate project densities in the least vulnerable areas of the site, or to plan building lots at twice normal depths to allow structures to be moved back from encroaching hazards. Special conditions could be negotiated for post-disaster reconstruction, including open space dedication in destroyed areas.

## RECOMMENDATIONS

The emerging practice of supplementing traditional development regulation tools with negotiated development offers considerable promise for hazard mitigation. To bring this new technique on line, I recommend:

1) Funding by Sea Grant, FEMA, NSF, and other agencies of linkage studies for various types of hazards, to demonstrate the mitigation needs of development within hazard areas.

2) Development of model hazard linkage ordinances and enabling legislation to establish the legitimacy of negotiated development agreements based on hazard mitigation as a public purpose.

3) Conduct of monitored demonstration projects to explore the feasibility of negotiated mitigation agreements.

Since negotiated development has proven itself as an idea "whose time has come", there is no reason why mitigation should not take advantage of the benefits which it offers.

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# CHAPTER SIX
# *POST DISASTER MITIGATION SURVEYS*

Hazard and damage data are needed to formulate mitigation options. Can or should particular structures be repaired or can it be razed and rebuilt? Is relocation practical? Might various hazard reduction measures be used in particular ways?

This chapter contains three papers addressing post disaster data-gathering and the formulation of mitigation options. The first, by James Mitchell describes the National Academy of Sciences/National Research Council post disaster surveys and their application for mitigation purposes.

The second, third and fourth by Laurence Zensinger, Leo Eisel, and Les Bond examine federal post-flood disaster teams in the U.S. Such a post-disaster team, which operate with a specific mitigation mandate and within a short time period, have operated with considerable success (despite some shortcomings) and offer a model for post-disaster assessment for other hazards in the U.S. and in other developing and developed nation contexts.

Several types of hazard and damage-related data are needed to determine mitigation needs and options in a disaster context: identification of the hazard area, relatively precise assessment of the severity of the hazard (e.g., flood heights, velocities, duration) within the area, and assessment of the severity of damage to individual structures and infrastrucutre, crops, and other activities with the hazard area.

Generation of this data is often difficult. It requires considerable hydrologic and engineering expertise and must be generated at a time when government staff are busy with relief.

Much of this data must be gathered quickly since recovery operations often obliberate much of the relevant evidence. The data must be relatively precise. For example, a general analysis of flooding after a disaster is of limited value in determining specific protection elevations, special reinforcement needs for high velocities, special piling requirements for erosion, etc.

# National Academy of Sciences/National Research Council Post-Disaster Surveys: Their Applicability for Mitigation Purposes

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## INTRODUCTION

For the past twenty years the Committee on Natural Disasters and its predecessors have organized study teams that conduct post-disaster surveys in the United States and abroad. These investigations are primarily intended to secure so-called "perishable data" about extreme natural processes and the performance of technological and human systems. They are generally initiated within one week of a disaster occurrence, while material evidence is still available and personal recollections of the event and its aftermath are fresh in mind. Results of the surveys are published in a series of committee reports that are distributed to researchers, disaster professionals, and public agencies in at least 38 nations. This paper describes the Committee's work and assesses the utility of its surveys for improving hazard mitigation policies and practices.

## COMMITTEE ON NATURAL DISASTERS ACTIVITIES

At the outset is should be noted that the Committee on Natural Disasters is a research body. Although its reports frequently identify mitigation problems and evaluate the effectiveness of protective structures or other hazard adjustments, neither the Committee nor its parent body, the National Research Council, have direct responsibility for the formulation of hazards policies or the management of hazard protection systems. To date their function has been one of information collection and dissemination in support of hazard mitigation goals. In that sense, the Committee is part of the scientific advisory apparatus of the U.S. government.

It is also important to remember that the Committee is not the only body that conducts post-disaster surveys. Others in the United States which perform that function include: Earthquake Engineering Research Institute; Natural Hazard Research and Application Information Center; Disaster Research Center; Federal Emergency Management Agency; National Weather Service; Army Corps of Engineers. At the international level the U.S. Agency for International Development and the United Nations Disaster Relief Organization also issue summary reports of specific disaster experiences. All of these groups have made significant contributions to understanding disaster processes and the performance of socio-technological systems, but the Committee on Natural Disasters may well conduct the most systematic, comprehensive, and authoritative post-disaster surveys.

The Committee is administered by a small permanent staff, but its fifteen members are unpaid professionals from various disciplines, each of whom serves a three-year term. The study teams that carry out the post-disaster surveys are also made up of highly qualified but unpaid volunteers who donate their time and professional expertise. The Committee's development and operation have been reported elsewhere and only a brief review is necessary here (Kennedy and Israelsen, 1984).

## EVOLUTION AND STATUS

The National Research Council has a long-standing interest in the subject of disasters. For example, studies of the impact of strategic bombing on civilian populations were initiated during World War II and have led to the creation of several committees focusing on problems of disaster relief (National Research Council, 1979). A separate, more technical initiative was begun after the Alaska earthquake of 1964 when President Johnson suggested there was need for a comprehensive study of Alaska's experience with a view to providing improved protection against future earthquakes (National Research Council, 1970, vii). A wide ranging Committee on the Alaska Earthquake was subsequently established by the National Academy of Sciences (1964) and the National Academy of Engineering set up a similar Committee on Earthquake Engineering Research (1965). One unit of the Earthquake Engineering committee, known as the Committee on Earthquake Inspection (1966-1971), eventually evolved into the National Research Council's Committee on Natural Disasters (hereafter identified as the Committee).

In the Committee's early years (1966-1970), post-disaster surveys were undertaken from a narrow earthquake engineering perspective. Thereafter a wide range of hazards has been addressed. In 1980, the Committee was reorganized and expanded to include a broader spectrum of disciplinary perspectives. Until 1984 funding was provided by the National Science Foundation (NSF). Since then the responsibility for support has been shared by NSF, the National Oceanic and Atmospheric Administration (NOAA), and the Federal Emergency Management Agency (FEMA). At present, the Committee includes ten engineers, two natural scientists and three

social scientists.

Table 1 illustrates the distribution of disaster events for which surveys have been published. In addition to earthquakes, floods, hurricanes, tornadoes, landslides, coastal erosion, tsunamis and dam failures have received scrutiny. To date 41 reports have been published of which 37 have been prepared by study teams based on their field experiences. The other four reports consist of records of conferences convened to document special disaster experiences (3) and a comparative analysis of (generic) lessons learned from three of the Committee's recent hurricane studies (National Research Council, 1985). Five additional reports are in progress including studies of Hurricane Elena and earthquakes in Chile and Mexico City. Earthquakes comprise the majority of all reports (52%) but floods, hurricanes, and other coastal events have received most attention since 1981 (i.e., 11 of 20 studies completed or ongoing). More than one third (16) of the studies involve foreign area disasters. Almost all of the latter deal with earthquakes and have been carried out jointly by the Committee and the Earthquake Engineering Research Institute (14).

Largely because of budgetary limitations, not all disasters receive scrutiny. The chief selection criterion is availability of important information that will probably not otherwise be recovered and reported. Teams are sent to foreign disasters only when data and experience are believed relevant to U.S. hazards management. In practice, the Committee has ignored virtually all foreign disasters apart from earthquakes in urban settings.

A great deal of potentially useful scientific information has been gathered in the survey reports compiled to date. Have these findings been put to good use in improving mitigation practices? No systematic attempt has yet been made to answer that question.

TABLE 1

Reports Published by the Committee on Natural Disasters

| | Type of Disaster | | | | | |
|---|---|---|---|---|---|---|
| Year | Earthquake | Tornado | Dam Failure | Landslide | Flood; Coastal Storm | Hurricane |
| 1968 | 2 | | | | | |
| 1969 | 1 | | | | | |
| 1970 | 2 | 1 | | | | |
| 1971 | 3 | | | | | |
| 1972 | 2 | | 1 | | | |
| 1973 | 3 | | | | | |
| 1974 | NO REPORTS PUBLISHED | | | | | |
| 1975 | 2 | 1 | | 1 | | |
| 1976 | NO REPORTS PUBLISHED | | | | | |
| 1977 | 1 | | | | | |
| 1978 | 1 | | 1 | | 1 | |
| 1979 | NO REPORTS PUBLISHED | | | | | |
| 1980 | 1 | | | 1 | | |
| 1981 | 1 | 1 | | | | |
| 1982 | 1 | | | | 2 | |
| 1983 | 1 | | | | | 1 |
| 1984 | 1 | | | 1 | 4 | 1 |
| 1985 | 0(2)** | 2 | | | 0(1) | 0(2) |
| TOTALS | 24(52%) | 5(11%) | 2(4%) | 3(7%) | 8(17%) | 4(9%) |

**Figures in parentheses are ongoing studies.

Judging by the report distribution lists and the steady flow of requests for additional copies that emanates from organizations and individuals, it is clear that much information reaches its intended audience. However, a great majority of these potential readers are drawn from federal agencies in the United States; professional scientific and technological organizations; private engineering or consulting firms; and university faculties. Other U.S. and foreign groups that might benefit from reading the reports are underrepresented. They include: state and local public officials; managers of utilities; public interest groups; mortgage, insurance, and investment organizations; planners and developers; mass media; and private individuals.

Even if reports were distributed to a broader audience, this does not guarantee that they will be read or their recommendations implemented. Although there have been no comprehensive evaluations of the effectiveness of mitigation recommendations made by post-disaster survey teams, one recent case study illustrates some of the problems (Mitchell, 1985). In the weeks and months following Hawaii's hurricane Iwa (November 23, 1982), five groups of experts and local officials - including the Committee on Natural Disasters - published dozens of recommendations for improved hurricane protection. By early 1985 approximately 20% of these recommendations had received at least some public discussion but few had been acted on. However, most of the action was in the form of studies and data gathering exercises rather than agreed and implemented changes in policy or practice. Moreover, the bulk of these limited reforms has been directed toward upgrading disaster preparedness and improving the security of lifelines. Most disaster mitigation and prevention measures are noteworthy by their absence.

## ANALYSIS

The Committee's emphasis on post-disaster studies is grounded in two assumptions: (1) valuable scientific information can be gathered immediately after disasters occur; and (2) disaster protection can be improved by applying this information. Both assumptions are widely accepted by hazards scholars (Sherretz and FitzSimmons, 1982) but the Committee has tended to stress its information acquisition role rather than its potential contributions to hazards policy and management.

Although few doubt that supervision of post-disaster surveys should remain the Committee's main activity, it is unclear how far such surveys should go beyond evaluating the performance of structures and human systems toward making recommendations for changes in mitigation policies or practices. A narrow interpretation of the Committee's function emphasizes collection and publication of perishable data. This view holds that scientific investigations of limited duration and scope may identify important long term technical or societal problems, but cannot

resolve them. In contrast, some external reviewers have suggested that the Committee broaden its work to include: (1) provision of guidance to hazard research, policy, and management agencies; (2) analyses of cumulative experiences that grow out of individual disaster surveys; and (3) closer attention to the concerns of mitigation professionals such as building code officials, emergency operations planners, architects, and engineers (Committee documents, 1985). FEMA representatives indicate that Committee reports are used to inform policy directions and activities in hazard mapping, standard setting, flood insurance, and hazard mitigation planning. Timely presentation of survey results is of the essence for these tasks and reports need to be released quickly to achieve maximum beneficial effect on mitigation decisions taken in the wake of disasters.

In an effort to upgrade the usefulness of its reports to mitigation interest groups the Committee has initiated several changes in procedures. These affect both the activities of individual study teams and the general direction of Committee research. Two actions are designed to speed the transmission of survey findings. Teams are encouraged to prepare and release preliminary reports of their findings as soon as they complete field work. This has recently been done by the joint Committee on Natural Disasters-Earthquake Engineering Research Institute team that visited Mexico City (1985) and aired its findings on national television after testifying before a U.S. Senate Committee. Brief introductory Executive Summaries are also now required in all reports so that major findings and recommendations can be quickly absorbed by agency decision makers. A third action is designed to highlight major repeated findings from the cumulative body of survey experience. Each year it is planned to issue a report that presents a general analysis of one type of hazard from this perspective. Finally, in an effort to disseminate post-disaster survey results to an international audience, Committee members have begun to transmit major findings to conferences and meetings of overseas mitigation specialists (e.g., Taiwan, Beijing).

## RECOMMENDATIONS FOR ACTION

National Research Council post-disaster surveys can contribute to improved disaster mitigation by: providing public and private decision makers with independent evaluations of existing mitigation measures; by identifying local mitigation issues; and by presenting evidence pertinent to the resolution of those issues. Timely and dispassionate analyses of mitigation concerns are rarely available in stricken communities that are preoccupied with tasks of recovery and rehabilitation.

To reap maximum benefits from these surveys a number of changes in procedure followed by the Committee on Natural Disasters and other groups are suggested:

(1) The Committee should consider **broadening existing guidelines for post-disaster study teams** beyond acquisition and interpretation of perishable data about disaster responses to include guidance on addressing mitigation issues in the field and in study reports.

(2) The potential utility of existing Committee surveys could be increased by **encouraging study teams to communicate their findings, immediately and directly, to local disaster specialists and decision makers in impacted areas** as well as to broader audiences.

(3) The Committee could also significantly improve the data base for foreign disaster mitigation by **undertaking surveys of all types of overseas disasters** instead of restricting attention to earthquakes.

(4) In addition to its primary work on realized disasters, the Committee should consider devoting resources to **limited studies of extreme events that do not produce disasters.** Such investigations may provide additional information about successful mitigation practices.

(5) The Committee may also wish to consider issuing **periodic summary follow-up reports on mitigation opportunities exploited or ignored** in the wake of disasters for which reports were published and mitigation recommendations made.

(6) Some disasters attract many different types of survey teams; others receive little attention or systematic documentation. There is need for **improved coordination and liaison among all organizations and individuals engaged in post-disaster surveys.** This might take such forms as: joint meetings; agreements for exchange of information; overlapping team memberships; establishment of a clearinghouse for this function.

(7) Relevant **international agencies, professional and scientific organizations and governments** that possess formal or informal responsibilities for improving disaster mitigation **should evaluate the utility of post-disaster surveys for their purposes and should take appropriate steps to adopt necessary supporting measures.**

## RESEARCH PRIORITIES AND NEEDS

Two research tasks are necessary at this time:

(A) A **hindsight analysis of the uses to which data and recommendations contained in Committee surveys are put** should be undertaken. This might distinguish between research and

applications uses and between short term and long term uses. It should also assess alternative strategies for maximizing the value of information collected by future surveys in the context of mitigation programs. A broad evaluation of the usefulness of all types of quick response surveys and studies would also provide valuable data for improving mitigation.

(B) In addition to existing generic studies of lessons learned from surveys of similar events (e.g., hurricanes), the relative success of specific mitigation devices or strategies that are exposed to dissimilar events (e.g., tornadoes, earthquakes, floods) should be evaluated. A versatility profile for typical successful and unsuccessful mitigation measures might then be developed.

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# Post-Flood Interagency Hazard Mitigation Teams: Their Accomplishments and Prospects

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## INTRODUCTION

For the past five years (1980-1985), a group of twelve federal agencies has participated in a post-flood hazard mitigation process designed to reduce vulnerability to future floods and promote nonstructural flood damage prevention measures. This paper describes the rationale and objectives of this activity, evaluates its effectiveness to date, and speculates upon some changes in the process which the author believes are occurring and will continue to occur in response to trends in national government emergency management, and environmental policy.

## THE INTERAGENCY AGREEMENT FOR COMMON POST-FLOOD HAZARD MITIGATION PLANNING

In July of 1980, the United States Office of Management and Budget directed twelve federal agencies to develop procedures, through an interagency agreement, to accomplish the objectives of planning to avoid future flood losses and encourage wise use of the nation's floodplains. The agencies (Departments of Agriculture, Housing and Urban Development, Interior, Education, Commerce, Health and Human Services, Transportation, Environmental Protection Agency, U.S. Army Corps of Engineers, Small Business Administration, Tennessee Valley Authority and the Federal Emergency Management Agency) were directed to establish procedures which would:

- seek to avoid redundant or competitive expenditures,
- coordinate federal technical assistance and other program resources and encourage the packaging of federal program elements to promote the use of nonstructural measures for flood loss reduction,
- provide for the development and dissemination of information on the packages of federal program assistance available, and
- encourage the preparation of pre-disaster plans for reducing future flood losses and encouraging wise use of flood plains, as well as post-disaster plans under the authority of Section 406 of the Disaster Relief Act.

In December of that same year, the twelve agencies signed the "Interagency Agreement for Nonstructural Damage Reduction Measures as Applied to Common Flood Disaster Planning and Post-Flood Recovery Practices". Under this somewhat imposing title, the agencies created a post-flood disaster planning process consisting of the following four major components:

1. Assessment of the extent and nature of damage immediately following a flood,
2. Identification of riverine and coastal high hazard areas in which federal investment to repair or replace structures and facilities should be avoided and the relocation of people and structures out of these areas encouraged.
3. Identification of flood plain fringe areas in which federal assistance should seek to mitigate hazards through the floodproofing of structures, forecasting/warning/evacuation plans, flood plain regulations and development and redevelopment policies, and
4. Preparation, within 15 days, of a hazard mitigation report recommending specific recovery actions to be taken by each federal agency and non-federal level of government. Federal agencies are required by the OMB directive to conform their actions to the recommendations of the report to the fullest extent practicable.

There were a number of underlying reasons for creation of a process of post disaster teams which would make hazard mitigation recommendations during a brief period immediately following a flood disaster. First, while there were regulatory and structural flood management programs, little was being done to take advantage of opportunities presented by disasters to correct problems of flood vulnerability. These opportunities include a heightened perception of flood risk (often accompanied by calls for corrective action) and the reinvestment that must take place to repair or reconstruct damaged facilities. Conversely, the rebuilding process begins quickly following disasters. In order to have any impact on this process, recommendations to modify the location or design of facilities must be available quickly.

Another underlying purpose for interagency post-flood disaster planning is the need to coordinate and maximize the impact of federal disaster assistance provided by the various agencies. In the absence of a coordinating mechanism, federal resources were not being focused in areas in which they could do the most good in terms of flood prevention.

Finally, this process was an attempt to institutionalize nonstructural approaches to flood damage reduction. It stressed nonstructural measures at a time, immediately following a flood, when they would be most likely to be feasible and attractive. While there are clear authorities for structural flood control projects of all types, planning criteria tend to favor structural projects over non-structural projects. OMB saw this process as a means of providing an institutional framework for nonstructural measures.

## EFFECTIVENESS OF HAZARD MITIGATION TEAMS TO DATE

The impacts of hazard mitigation activities recommended and implemented following flood disasters are difficult to measure. Many actions, such as development or modification of building codes or land use plans, only take effect over long periods of time. For these actions, a four year period of record is clearly inadequate as a basis for evaluation. In addition, if flood prevention strategies are effective, their manifestation is rarely noticed since flooding without damages is not as newsworthy as flooding with damages.

A measure of the success of post-disaster hazard mitigation proposals, however, is the extent to which they have raised the issue of flood prevention in the context of recovery from a flood disaster. There is a growing body of evidence that hazard mitigation team reports prepared following flood disasters have influenced the allocation of resources between recovery (i.e., rebuilding the community as it was prior to the disaster), and long term measures intended to result in flood damage prevention. An independent study of community recovery from natural disasters conducted by Rubin et al (1985) noted this effect. This study examined in detail recovery from 14 disasters of various kinds since 1980. It concludes, in part, that "in all cases in this study at which an HMT was present, greater local interest and emphasis on flood hazard mitigation was obvious" (Rubin et al, 1985, p.24).

Rubin identified three major benefits resulting from HMT's and the preparation of 15-day reports. The first benefit is improved federal/state/local relations through participation of state and local representatives on HMT's. The team's recommendations create a framework for expectations. State and local officials can become aware of both the issues that federal agency representatives view as important and the resources (and constraints upon those resources) that may be available to help with recovery and mitigation efforts. By clearly identifying flooding problems that should be addressed, the reports have created some conflict with state and local officials who are nervous over issues of liability. In the long run, however, surfacing these issues has reduced overall potentials for conflict. Another benefit the study cites is the sense of immediacy for addressing mitigation issues early in the recovery process brought about by the 15-day report. Finally, the study suggests that the process has resulted in the formation of a cadre of state and local hazard mitigation experts. This is evidenced by the appointment of full time hazard mitigation coordinators in several states, and a high level of participation in FEMA sponsored hazard mitigation training courses (Rubin et al, 1985, p. 24).

The most significant impact, by far, of the post-flood HMT's has been a marked improvement in the quality of long range flood hazard management by states. Since the enactment of the current disaster act amendments in 1974 (Public Law 93-288), state and local recipients of disaster assistance have been required, as a condition of that assistance, to evaluate the hazards in the disaster area and to take appropriate measures to mitigate those hazards. In fulfillment of this requirement, FEMA regulations require preparation, by state and local governments, of a hazard mitigation plan or plans (the so-called "Section 406 plan" after the section of P.L. 93-288 which requires hazard mitigation as part of the process of disaster assistance).

There was a noticeable improvement in the quality of Section 406 plans following introduction of the post-flood HMT concept. State and local natural resources and emergency planners, who were asked to participate on the teams, were provided with a natural starting point for their planning processes. In reacting to the recommendations for state and local action contained in the 15-day reports, state and local governments have begun to address short and long term flood prevention measures that might not otherwise have come to their attention. An unpublished review of hazard mitigation team reports and recommendations conducted by the Government Accounting Office (GAO) confirms this point. Of the 554 recommendations from the 23 disasters which GAO analyzed, over 85% had been either implemented, partially implemented, or were undergoing further study. A majority of these recommendations involve some kind of state or local action. Many of the required actions were set forth in greater detail and formulated into strategies, with timetables and identification of resource needs, in the Section 406 plans. At least a dozen states have, within only the last three years, embarked upon comprehensive, multi-hazard mitigation planning programs as a result of the stimulus provided by Section 406 and the interagency hazard mitigation team process.

## TRENDS AFFECTING THE FUTURE OF POST-FLOOD DISASTER HAZARD MITIGATION TEAMS

There are a number of trends in the areas of emergency and natural resources management which suggest that hazard mitigation considerations

will play an increasingly important role in flood disaster recovery in the United States. The most important of these, not surprisingly, is the need to adjust to reduced levels of federal spending. If cost-savings and efficiency in use of federal disaster recovery funds were important in 1981, they are more so today. It is not unlikely that, as pressure increases to reduce federal outlays for disaster assistance, congressional oversight will focus upon the effectiveness of federal disaster assistance programs in limiting future vulnerability to hazards and damages.

Another factor to consider is the absence of appropriations over the past few years for initiation of new structural flood control projects. This is also due, in part, to budgetary conditions, but is related to other factors as well, including environmental concerns. As jurisdictions around the country begin to realize that the levee, floodwall, reservoir, or channel improvement project they have been counting on to solve their flooding problems is in competition with many other such projects for the declining revenues available, less costly nonstructural adjustments to reduce flood vulnerability may become more attractive.

Finally, a number of factors are combining to shift leadership responsibility for flood hazard mitigation from the federal level to the state and local level. FEMA's adoption of 75-25 cost-sharing for the repair and reconstruction of damaged public facilities has made state and local governments much more sensitive to damage prevention concerns. With reduction in funding levels for many other federal domestic programs over the past five years, many forms of federal assistance that used to be available following disasters are either no longer available or are greatly reduced in scope. What discretionary funding exists for undertaking innovative post-disaster hazard mitigation programs is either state funding or federal funding provided in the form of block grants subject to a great deal of local control on how the money shall be used. With reduced federal financial commitments for post-disaster recovery and hazard mitigation, federal hazard mitigation teams will begin to play a technical assistance role, in contrast to the "coordination of federal resources" which characterized early team activities.

## SUMMARY/CONCLUSIONS

Interagency Post-Flood Hazard Mitigation Teams have, since their inception, not only provided an effective means of coordinating federal disaster assistance following floods and focusing such assistance on mitigating flood problems through nonstructural means. In addition, and probably more importantly, they have helped to institutionalize flood mitigation planning, both after floods and on a continuing basis, at both state and local levels. Factors affecting the future of this endeavor, including the limited resources that will be available in the future for repetitive repair and reconstruction of flood damaged facilities, will increase attention to and the feasibility of nonstructural flood prevention measures planned and implemented following flood disasters.

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# The Effectiveness of Hazard Mitigation Teams

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## INTRODUCTION

The concept of a hazard mitigation team was formulated in 1978 at the Water Resources Council as an outgrowth of President Carter's water policy review. The concept originated from a simple idea: Instead of building everything back exactly the way it was before the flood, why not do it differently and avoid the use of federal and other governmental subsidies to encourage rebuilding of equally vulnerable development.

This original idea was fleshed out in the Office of Management and Budget memo of July 10, 1980 from then Director of OMB, Jim McIntyre to 14 cabinet secretaries and agency heads. This memo directed these agencies to enter into an interagency agreement that provided for federal leadership and participation in interagency, interdisciplinary, and intergovernmental hazard mitigation teams.

This interagency agreement was signed on December 15, 1980 during the waning days of the Carter Administration. This agreement provided the specifics for the responsibilities and formation of the hazard mitigation teams and detailed specific tasks, including publication of Hazard Mitigation Reports.

Based upon this interagency agreement, FEMA prepared a manual of procedures. Hazard mitigation teams were sent into the field beginning in mid-1981. The first hazard mitigation reports dated from mid-1981.

## RESPONSIBILITIES

The principal role of the hazard mitigation teams is to identify opportunities for breaking the cycle of damage, reconstruction of structures, and more damage. The teams are inderdisciplinary, intergovernmental, and interagency. Members often have expertise in a wide range of subjects ranging from hydraulics to housing to evacuation. They also include a wide range of disciplines: geology, civil engineering, structural engineering, etc. Members of local and state governments are also included on the teams. The teams are led by a designated team leader from the Federal Emergency Management Agency.

Basic responsibilities of the team are to react quickly after a disaster, make necessary field trips and collect data, develop options for breaking the cycle of damage and reconstruction, analyze these options, and produce a report. The initial report must be produced within 15 days. A follow-up report must be produced within 90 days to determine what action has been taken.

The team process applies pressure to team members to look beyond the constraints of their individual agencies and levels of government and find opportunities for flood hazard mitigation. The objective is to quickly identify opportunities and publish a report while opportunities to break the cycle of damage and rebuilding still exist.

The 15-day report is submitted to the FEMA regional director who does not have strict approval power over the report but does have responsibility to comment and coordinate implementation activities.

## EFFECTIVENESS OF THE TEAMS

Wright Water Engineers undertook a preliminary evaluation of the hazard mitigation teams for the Federal Emergency Management Agency in 1983. This analysis consisted of (1) evaluation of four case studies and (2) development of a questionnaire which was sent to approximately 200 federal team members and 100 state team members. The results of this analysis provided a good indication of the status of the program as of late 1983.

Major findings from this analysis indicated that the program was functioning reasonably well and that the original goals of the OMB memorandum and the interagency agreement were being met. Further analysis of recent interagency hazard mitigation reports produced for Hurricane Elena (1985) indicate good quality reports with innovative thinking.

## RECOMMENDATIONS

Several recommendations can be offered for improving the effectiveness of the team. These are based upon the questionnaire analysis:

1. Perhaps the most serious deficiency in the hazard mitigation team process is the general lack of adequate follow-up and responsibility for implementation of team recommendations. This concern was originally identified in the Flood Hazard

Mitigation Team Manual and is apparently still a problem. One possible way to remedy this would be to place more initiative and responsibility on the Washington office of FEMA to insure adequate follow-up. This could be accomplished by putting more emphasis on the 90-day report and making it an integral part of the follow-up procedure.

There also needs to be some field work done, or at least contacts made, with local officials to determine the fate of the recommendations.

Another mechanism to provide more effective follow-up and implementation monitoring may be to play upon the self-interest of the agencies. The 90-day report could provide a good opportunity for the various agencies to gather data concerning potential benefits and costs or benefits foregone through the implementation, or non-implementation, of various hazard mitigation measures and recommendations. These data could be used to support agency initiatives.

2. Another deficiency in the current hazard mitigation team process is the lack of local involvement in the hazard mitigation teams. The solution to this problem may be for the hazard mitigation team leader to work more closely with the states under his/her responsibility. By working with an individual or agency in each of the states, the hazard mitigation team leader is faced with a reasonably small number of important contacts. State leaders can, in turn, relate to local governments.

3. There is a continued problem that too few of the team members formulate recommendations. There also appears to be a general reluctance by team members in many cases to make recommendations for which there are no federal agency programs or apparent sources of funds for present implementation. It is very important that the federal recommendations produced by the hazard mitigation team not be limited to recommendations for which the team is certain that funds exist for implementation.

   Team leaders must take responsibility for insuring that the recommendations are the product of thinking and analysis by the entire team and not merely a small subgroup after the majority of the team has gone home.

4. In the course of both the case studies and the questionnaire analysis the importance of training became apparent. Trained team members are able to contribute significantly more than the untrained team member and the benefits of adequate training are rapidly apparent in the results of individual teams.

# Improving the Hazard Mitigation Process: One State's Perspective

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## INTRODUCTION

The Interagency Agreement for Non-Structural Damage Reduction Measures became effective on December 15, 1980. Since that date Arizona has suffered three flood disasters which warranted a Presidential disaster declaration. In each of these disasters the work of the Federal team, the 15-day report, and the State's hazard mitigation plan in response to the Section 406 requirement have been effective in improving federal/state/local mitigation efforts. Furthermore, it appears that the effectiveness has improved as time has passed, with the federal and state agencies becoming more accustomed to the process and, perhaps, more aware of the power of the process. There is also a feeling, at least, that the Interagency Agreement has led to better compliance with Executive Order 11988 and the State has much better access to the federal agencies, leading to better coordination of immediate post-disaster mitigation efforts.

## THE FEDERAL EFFORT

There is a basic problem of fragmentation in disaster management. Despite rather broad authority granted to emergency management agencies during and after a disaster, other agencies quickly return to a "business as usual" mode. Disaster response and mitigation interfere with their normal operations. The only hope to modify this orientation is to make mitigation part of their normal operation (to the greatest extent possible) rather than simply a response to a particular disaster. This is happening more at the Federal level than at the State level.

The incorporation of mitigation into normal operating procedures should be further encouraged within each agency. A permanent team member and alternates should be designated, and mitigation should be included in their job descriptions. It may be desirable to designate different persons for different types of disasters. For example, in the largest of the flood disasters in Arizona, the Arizona District Hydrologist for the USGS served as the representative for the Department of Interior. He was invaluable in that capacity, but would obviously be less suitable for a brush fire disaster in Southern California.

Our State mitigation effort in 1983 was far less organized than the Federal effort. Because of personnel changes, the Arizona emergency management agency had no trained hazard mitigation officer, and the representative from the water resources agency had limited experience with the Federal team. Even so, the State had an acceptable level of input to the Federal team's deliberations and report. However, the State's 406 plan could have been better written and implemented. The State now has a permanent Hazard Mitigation Officer in the emergency management agency.

## IMPROVING THE STATE RESPONSE

State mitigation efforts could be improved by the establishment of a permanent hazard mitigation team at the state level. Such a team should include representatives from all agencies which have responsibilities in flood plain management, structural flood control, housing, economic planning and development, fish and wildlife, ecology, coastal zone management, wetlands management, water quality, sanitation, transportation, state lands, and any other areas which apply to hazard mitigation. The team should be chaired by the State Hazard Mitigation Officer.

Such a team should be established by executive direction if the team members are to speak for their agencies and commit resources to mitigation. The State of Maryland has recently established such a team. The Federal agencies and the other states should monitor the effectiveness of Maryland's efforts to see if it is a model which can be followed elsewhere.

The Federal Emergency Management Agency (FEMA) and the states command a lot of power over local jurisdictions during and immediately after a flood disaster. The primary tools for post-disaster mitigation are the repair and reconstruction of public facilities, relocation of flood plain uses, floodproofing and elevation of flooded uses, and control over future development of floodprone areas.

Through their funding of 75% of the repair and reconstruction of public facilities, FEMA has generally done a good job in encouraging mitigation for public uses. However, relocation has generally been a nightmare to flood plain residents, communities, and state and federal agencies. The primary reason for this is that no one has yet said that, as a matter of policy, they will take responsibility for relocation. The process is fragmented among agencies at all levels of government. One exception to this is the recent

relocation of a large number of residents in Tulsa, Oklahoma. Here the city took the initiative to make funds and high level staff available to ensure fast and effective relocation. Tulsa's actions may serve as a model for future relocation projects elsewhere.

Floodproofing, elevation, and regulation of future development in flood plains remain primarily local responsibilities within a framework of state and federal minimum standards. The financial clout of FEMA and the states might be more effectively used to promote these types of mitigation. FEMA is bound by the letter of their regulations, and frequently seems to overlook the intent. With a little more flexibility they might be able to pressure the states into adopting and/or enforcing higher standards. For example, communities are required to manage flood plains which are not delineated on their Flood Insurance Rate maps using "the best available information". FEMA therefore has no effective performance measure for flood plain management in these areas. The State, however, may have authority to establish management criteria for such flood plains. Pursuant to disaster assistance powers and responsibility to reduce disaster costs, FEMA might reasonably require a State to adopt such criteria and require the community to adhere to those criteria for future development.

States which share the 25% non-federal portion of public assistance funding within their communities also have a powerful tool to use for mitigation. They can, for instance, require communities to adopt and enforce regulations or standards which exceed the minimum Federal requirements as a condition of state disaster assistance. Such standards might reflect regional needs such as flood elevations reflecting future watershed conditions, channel meander or ice jam elevations.

## SUMMARY

In summary, the federal agencies have all or most of the tools they need to promote or require effective mitigation after flood disasters. They could benefit from better training of interagency team members, and they might use their financial clout more effectively. States would benefit from the establishment of interagency hazard mitigation teams and better use their financial clout. Both of the latter will probably require executive direction.

- In the presentation of this paper, the author wishes to make it clear that the views expressed are his own and do not reflect any policies of the State of Arizona or the Association of State Floodplain Managers. It is based on the experience of three flood disasters in Arizona, for which he served as the State Hazard Mitigation Officer for one. This paper also draws from the presentations at the symposium and the discussions which followed.

# CHAPTER SEVEN
# *CONDITIONING GRANTS AND LOANS*

The conditioning of disaster assistance, insurance, or other forms of private or public assistance subsidies upon mitigation is politically difficult but perhaps the most promising single approach to strengthen mitigation efforts. To be successful, conditions must be based upon a realistic evaluation of the hazards and mitigation options. To be enforceable, conditions must include long term legal commitments: those giving the assistance must be in a position to legally require compliance or repayment if conditions are not met.

This chapter begins with a paper by Carl Cook discussing efforts of the U.S. Federal Emergency Management Agency to condition hazard mitigation assistance. He suggests that to be successful, conditioning must be carefully tailored to objectives, time frame and sponsorship of the project.

Frank Thomas, in a second paper, discusses the successes and failures of the Executive Branch in the U.S. to encourage flood mitigation in federal projects and federally funded projects through a floodplain management executive order.

David Godschalk next discusses the effectiveness of National Barrier Island Legislation adopted in the U.S. to withdraw federal development incentives for certain barrier islands. Such withdrawal of subsidies for selected areas goes beyond simple conditioning of assistance. A forth paper by Marguerite Whilen suggests that a withdrawal of subsidies should be combined with a more positive effort to define development areas and to establish development quotas.

A final paper by Fred Cole examines the conditioning of grants upon mitigation in the international scene. He points out not only the benefits of conditions but some of the practical problems with conditioning efforts and suggests the need for planning mitigation in advance of disasters to help establish effective conditions when disasters occur.

# Lessons on Conditioning of Hazard Mitigation Assistance

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## INTRODUCTION

The term "conditioning," when applied to financial support of natural hazard mitigation projects, is defined as those actions which must be accomplished by the sponsoring or receiving agency in order for the granting organization to provide the requested assistance. For structural flood control projects, in the United States, such as dams, dikes, and levees, typical conditions for Federal support of a project are a small financial contribution, adequate acquired land, and continued maintenance. For non-structural projects, such as property buy-outs and relocation, the conditions usually consist of assurances that no development will be allowed in the newly opened area and that this area be used for open space purposes such as parks or wildlife refuges.

This paper examines some problems that have arisen involving conditioning of assistance for flood hazard mitigation projects in the U.S. and abroad. It concludes with recommendations to minimize these problems. The discussion begins with a series of examples which demonstrate failure of conditions attached to a number of projects.

## PROBLEMS

In many of the projects I have observed both in the United States and abroad, there is a universal reluctance to attach strong conditions to financial assistance. It appears that the granting agencies are afraid of being offensive to local sponsors. This timidity towards tough conditions is due to two causes. First there is often uncertainty as to the legal and political basis for attaching conditions. This uncertainty is often not warranted, but nonetheless exists. Perhaps it rises from a belief that project support at the Federal level is an entitlement. The second assumption is one of fatalism. That is, whatever conditions are imposed have a marginal chance of being enforced. Whether based upon experience or a notion that political realities may overwhelm careful crafting of conditions, the success of conditions is not expected.

Actual lack of authority by a grantor agency is illustrated by the case of the levees along the Kootenai River in Boundary County, Idaho. Though these levees were really "owned" by the local flood control district, repeated flood fights by the Corps of Engineers had produced levees whose composition was largely material placed by the Corps on the levees. Subsequent to the levee construction, the Libby Dam was built on the Kootenai River upstream of Boundary County in Montana. This provided so much protection in Boundary County that 8 to 10 feet of freeboard existed on the levees. Shortly after I began a Flood Insurance Study for the County, I was informed that local landowners were removing the freeboard on portions of the levees in order to provide fill material for agricultural purposes. Since this removal, whether or not allowed by regulations, had the ultimate affect of diminishing the degree of flood protection, both the Federal Emergency Management Agency (FEMA) and the Corps objected.

In the end, neither the County, nor FEMA, nor the Corps felt it had any legal basis to halt the removal. There was sword rattling by the Corps and FEMA but no action. The issues here were two-fold. First, even though hundreds of thousands of Federal dollars had been spent building the levees, the Corps retained no authority over them. Secondly, the assumption that the levees would be maintained ad infinitum was simply that, an assumption.

In Sfax, Tunisia, a levee system had been constructed along both banks of the Oued Maou (dry river bed). In one section of the left bank levee, a blow out section was installed. This was a weak link section which was designed to fail before the integrity of the system was threatened by overtopping or failure. The sponsor of the project was the Department of Sewage and Water Supply. One of the conditions attached to the financing was that the area immediately outside the blow out section remain undeveloped since this area could be subject to sudden and severe inundation.

In 1982, a severe flood occurred. As the levee system approached failure, the blow out section failed, as it was designed to do. Tragically, a heavy residential had been built in the outboard area and several hundred people were killed. The basic fault in the system was that the sponsoring agency for the levee project was assured by the grantor that the area would remain undeveloped. However, the sponsor had no control over the issuance of building permits and so had no control over development. In fact, even the City agency responsi-

ble for such permits admitted that because such a high percentage of the buildings were built by squatters without permits, they probably could not have prevented development.

In Oakridge, Oregon, Salmon Creek is leveed on both sides. A local flood control district is the sponsor. When a sand and gravel operator requested that he be allowed to excavate material from within the levees, the City enthusiastically replied "yes." Not only would a resident business profit from sale of the material, but the city would have its channel cleaned at no cost. All was well until the City Engineer observed one day that the City had the authority for issuing grading and development permits. However, it was the flood control district that had provided the maintenance assurance. Short of suing the city, the grantor of the project funding (the Corps of Engineers) was left holding the bag.

After the 1980 eruption of Mt. St. Helens, the Federal Emergency Management Agency purchased 19 nearly contiguous residential properties pursuant to Section 1362 of the Flood Disaster Protection Act. These properties had been covered by flood insurance and had been destroyed or severely damaged when the volcanic eruption caused the Toutle River to overflow its banks.

Part of the justification for selecting the Toutle River site was that Cowlitz County stated that they had lost all the parks along the Toutle and wanted to use these 19 properties for a park and boat launch. With this in mind, the Federal Insurance Administrator allocated one million dollars of scarce resources for the purchase of these properties. Once the transactions were completed and the property was transferred to Cowlitz County, FIA closed its backs on the project. Today, these properties are still only vacant lots. No moves have been made to turn them into recreational facilities. Though FIA has a relatively small stake in the ultimate use of these properties (other than the assurance that no structures be placed there), there exists no legal "handle" with which FIA can compel the county to use the properties as originally represented. Though the recreational goal was a small part of the justification for the project, no requirement for such a reuse was ever spelled out in the agreement.

## ISSUES AND RECOMMENDATIONS

1. Who fulfills the conditions?

If the organization which is supposed to fulfill the conditions is not the official "sponsor" of the project, then follow-up problems are possible if not likely. If a special district is formed to sponsor a project, is that same district going to be wholly responsible for the maintenance? Does the district really have the authority to regulate land use practices near the project or to keep municipal officials from granting approval for development activities which may harm the effectiveness of the project?

It is imperative that the sponsor actually have the authority, control,and ability to fulfill the conditions. Frequently, a sponsoring agency is created for the sole purpose of project sponsorship. After the project is completed, these entities frequently lose "steam," lose interest, and often lose their funding base. If this could be a possibility with a "new" sponsoring agency, the grantor should attempt to obtain a sponsor which is more stable and assured of future support. A local government is usually in a better position to undertake long-term maintenance than a special district.

2. Are the conditions clear?

If the object of a project is to keep recently "cleared" flood plain free of blockages to flows, then simply prohibiting the placement of structures in the area is not adequate. This is the condition placed on 1362 purchases by FEMA. While it does assure that no insurable building will be constructed there, it does not stop fill or vegetation accumulation. It must be clearly spelled out in the conditions if permanent protection of the conveyance area is to be assured.

3. Are the conditions well timed in relationship to the completion of the project?

Where the hazard mitigation assistance is of a "one shot" nature, such as construction of a levee or one-time buy-out of high risk properties, conditions which are commensurately short-term are easiest to fulfill. Providing local financial support is a condition which is easily verified upon completion.

However, if project conditions are long-term, the chances of compliance dwindle. The Sfax, Tunisia case is a classic example. While the project assistance (funding of the levees) was completed within 2 years, the condition of keeping the area outside the blowout section free of development required constant vigilance over a period of years. When, 8 years after completion of the project, the 1982 flood disaster occurred, demonstrating that the condition had not been met, there was little that the grantor could do.

Since the term of the assistance was short, the condition should have been commensurately short. Rather than require long term vigilance, the grantor could have required the sponsor to acquire title to the property and to put in into an active open space use such as a park. This condition could have been met within the same time-frame as the project.

4. If failure to meet a condition occurs, who is left "holding the bag?"

If there is uncertainty regarding the sponsor's ability to fulfill the condition, the possibility of failure can be dealt with in the

initial agreement. The grantor may require that another agency act, and sign, as a back-up sponsor, in the fashion of a co-signer of a bank loan. This not only provides a back-up sponsor, but may work to keep pressure applied to the sponsor by the co-signer who does not want to have to be pressed into action.

The grantor may also provide that, in event of failure to meet a condition, the grantor may itself take actions to meet the condition and charge the sponsor or those assisted by the project. Municipal governments often use this tactic for sidewalk and access maintenance. If a landowner does not provide the necessary maintenance, then the community does the job and bills the owner.

All too frequently, the grantor of assistance is the entity whose risk increases if a condition is not met. For instance, if a Corps project is not maintained and the project therefore fails, it is still the Federal government which will fight the next flood and provide disaster assistance. Obviously this does not work towards compliance with project conditions. It is, therefore, important that contingencies for non-compliance be spelled out.

The issues and recommendations discussed above appear to be only logical and require little extra effort on the part of the grantor. The paramount lesson to be learned is that much can be accomplished through the conditioning of hazard mitigation assistance. To be successful, the conditioning must be tailored to the objectives, time frame, and sponsorship of the project.

# Federal Agencies' Successes and Failures to Encourage Mitigation with the Floodplain Management Executive Order

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## INTRODUCTION

The Federal government has been engaged in flood loss reduction programs on a national scale since 1936. Federal Executive Orders have been used to direct Federal agencies to lead the nation in flood hazard mitigation by creating good examples of such mitigation in its own activities since 1966.

It is the purpose of this paper to examine the impact of Federal Executive Orders as a flood hazard mitigation tool. First, the evolution of the orders and their major elements are described. Then experiences in implementing the order are examined. Finally the effectiveness of the executive order as a mitigation tool is considered.

## HISTORICAL EVOLUTION OF THE FLOODPLAIN MANAGEMENT EXECUTIVE ORDER

In 1965 an executive office study found that national flood losses were unacceptably high and that Federal policy to reduce flood losses by encouraging development of flood control structures was insufficient. It is recommended increased policy emphasis on non-structural approaches including use of a Federal Executive Order (The Task Force, 1966). Within a year the President issued an executive order "Flood Hazard Evaluation" which directed Federal agencies to take leadership in reducing flood losses by taking action to preclude hazardous use of floodplains, applying floodproofing measures to existing facilities, and withholding from sale or attaching use restrictions to flood-prone properties (The President, 1966). Many Federal agencies adopted procedures to implement this order.

In 1975 the continued rise in flood losses led the Government Accounting Office to study progress toward implementing the Unified National Program for Floodplain Management and the Executive Order (The General Accounting Office, 1975). The study was highly critical of Federal agencies, citing little progress toward planning and controlling the uses of flood-prone lands. It focused on failures by federal programs responsible for financing and insuring new housing and it also criticized Federal agencies for lack of leadership and failure to utilize the 100-year base flood standard of the 1968 National Flood Insurance Act (NFIP). These criticisms provided impetus for the issuance of a 1977 Executive Order which superseded the 1966 order.

The 1977 Executive Order, Floodplain Management, gave stronger flood loss reduction policy and guidance (The President, 1977). Emphasis again was placed on the Federal leadership role, the non-structural approach, and the need for "A Unified National Program for Floodplain Management." The scope of loss reduction was expanded to include the environmental values of the floodplain.

An explicit strategy was set forth to avoid actions in or adversely affecting floodplains unless no practical alternatives existed. If no alternative existed mitigating action was required. Less than a year later, the Executive Branch provided detailed guidance for implementing the Order (United States Water Resources Council, 1978).

The guidance explained the substantive and procedural requirements of the Order. The procedural requirements were summarized in the following 8 step process: (1) determine if the proposed action is in or affecting the 100-year base floodplain; (2) if so, provide an opportunity for early public review of the proposed action; (3) identify alternative to the proposed action; (4) identify anticipated impacts of the proposed action; (5) take steps to minimize potential losses and to restore and preserve natural floodplain values; (6) reevaluate the alternatives; (7) make available a statement of findings and explanation of the public; and (8) make the decision to locate or not locate in the floodplain. The major substantive requirement is that Federal actions be consistent with criteria of the National Flood Insurance Program for flood hazard identification and floodproofing, i.e. Federal agencies should require of themselves no less standard than that which is required of non-Federal entities under the Insurance Program.

## EXPERIENCE WITH THE FLOODPLAIN MANAGEMENT EXECUTIVE ORDER

Experience with the 1977 Floodplain Management Order can be examined using information from a 1983 Inland Port Study and a 1984

Regulatory Review Study.

The Inland Port Study was carried out by FEMA in response to allegations that the Order and the land use regulations of the NFIP prohibited new port facility development (Federal Emergency Management Agency, 1984).

The problem stemmed from the fact that certain structural components of river ports and terminals must be sited in or adjacent water (i.e., within the 100-year base floodplain) to carry out their functions. These activities, known as functionally dependent uses, include the loading and unloading of people, goods and vessels into or from the water. The study found that the objectives of floodplain management and the economic needs of the port industry were not incompatible and the problem stemmed from misconceptions on the part of some Federal Agencies implementing the order and also port officials. It also found that the Federal agencies involved had done a poor job of explaining the process of the Order and the floodplain management regulations to the port industry. Finally, it found that the evaluation process of the Order and the variance process of the local land use regulations were sufficiently flexible to permit accommodation of these port facilities which had to be located in the floodplain.

The Regulatory Review Study was initiated in 1983 at the request of the President's Task Force on Regulatory Relief. The Federal Emergency Management Agency investigated whether Federal agencies were complying with the requirements of the Order and what impact, if any, the Order and the use of the 100-year base blood standard were having on the level of development in designated flood hazard areas (Federal Emergency Management Agency, 1984). The study found that the 100-year base flood standard was being applied and working well at all levels of government and that the standard enjoyed a wide base of support among State governors and the heads of State agencies. Improvements which were suggested focused on refinement of the 100-year base flood standard to account for regional or otherwise unique risks associated with deep or fast flowing water. The study concluded that there was no evidence to justify a change in either the level of the standard or method of review but that additional efforts should be devoted to the development of refinements reflecting unique flood hazard conditions.

Regarding Federal agency compliance, the study found 55 Federal agencies had established implementing procedures and that the programs of these agencies affected every community in the U.S. The study also found that many States had adopted executive orders or policy directives which parallelled the Federal order in philosophy and method.

Regarding procedural requirements, the study found a number of issues regarding coverage of the Order and the determination of practical alternatives. Like the Inland Port Study, this study found that in some Federal agencies and in the private sector there was the impression that the Order actually prohibited floodplain development *rather than* require an explicit thought process to evaluate proposed actions. Confusion was also evident with regard to the test of practicality. For whom was the activity to be "practicable" -- the Federal Agency, a program applicant, or both?

Issues of coverage were also raised regarding small routine actions and certain classes of actions. In the case of small routine actions, it was found that application of the full 8 step planning process including public notice of intent to take an action in the floodplain might not be cost-effective. It was further found that the use of certain thresholds or categorical exclusions could be an effective means for reducing the burden for the initiators of small actions.

Overall, the study found that considerable progress had been made by Federal agencies in implementating the Order, but that major opportunities remained for improvement and corrective actions. In particular, inconsistency was found in the application of the Order within some programs, and a need existed to train agency field staff in techniques for implementing the Order. The Order was found to be most effective when a Federal agency had complete control over an action, for example, Federal construction. Conversely the Order was least effective when applied to regulations or to the essentially private actions that received limited or indirect Federal assistance.

In conclusion, the study found that overall the Order was working well and should be retained in its present form. It recommended that Federal agencies review their implementing procedures to see if they could be streamlined to remove burdensome aspects of the process when applied to small actions and that the Federal agencies should insure that their field offices are fully informed concerning the Order and its provisions. The study singled out only 5 of the 50 agencies for explicit direction to change their implementing procedures to make them more consistent with the intent of the Order. Finally, Federal agencies were urged to correct the misperception that the Order totally prohibited floodplain development.

## THE EXECUTIVE ORDER AS A MITIGATION TOOL

After 19 years of experience with the Orders, it is useful to compare their effectiveness as a mitigation tool on the basis of the following six criteria: (1) authority, (2) coverage, (3) direction-guidance,(4) oversight, (5) program type, (6) expectations.

Authority. The 1966 Order cited its authority the powers vested in the President whereas the 1977 Order cited explicit authority in the National Flood Insurance act and in the National Environmental Protection Act. This clarification of authority provided a stronger

legal basis for the policy and strengthened the second Order as a legal instrument. Legislative authority takes precedence over administrative authority in an instance of conflict.

Coverage. Although executive orders, in general, apply only to Federal Agencies, such orders apply to all Federal agencies unless certain agencies are named as excluded or included. In practice, the 1966 Order applied to only those programs which were identified as (1) acquiring, managing, disposing of Federal lands and facilities, (2) providing Federally undertaken, financially or assisted construction and (3) conducting activities affecting land use, and licensing. The 1977 Order was stronger because its policy statement explicitly directed that all Federal agencies should take leadership and that all actions were covered.

Direction-guidance. Both orders direct Federal agency heads to take leadership to reduce losses but the second order is much more explicit in providing an avoidance and mitigagation strategy. The second order was able to prescribe specific implementing standards such as the 100-year base flood and the flood insurance program standards which were not available at the time the first order was issued. In addition, the second order provided sequential guidance and made provision for consultation assistance in the preparation of implementing procedures. The 1977 Order benefited from this supplementary guidance which was provided in much greater detail that that for the first Order.

Oversight. Options for monitoring include periodic or fixed interval monitoring by a unit of the executive office of the president, an independent agency, a line agency or the public. However, options for enforcement are generally limited to the executive office of the President and the courts. The 1966 Order utilized monitoring and enforcement by the executive office of the president. The 1977 Order utilized monitoring by the executive office of the President, an independent agency and the public. It also relied upon enforcement by the executive office of the President. Monitoring by the public through required public notice of intent to consider an action and public notice of a decision to take action affecting a floodplain has proven to greatly strengthen the monitoring process. Reliance upon certification to the Office of Management and Budget in the executive office of the President has not proven effective in the case of either order. Use of an independent agency to carry out periodic review and report has proven successful.

Program type. Individual Federal programs vary in the degree of Federal vs. non-Federal control over the decision to locate in the floodplain. Application of an executive order to Federal and federally assisted programs dealing directly with parties taking an action is most effective. Application of an order to programs where the decision party is in the private sector and distant from Federal program control is least effective. Experience based on both orders indicates that different kinds of implementing procedures need to be employed depending upon the type of Federal program.

Expectations. Every executive order is created in response to a problem which has strong proponents who would superimpose their objectives on parties affected by the order. These "superimposers" may fail to recognize that an executive order is often an administrative policy which cuts across the execution of Congressionally mandated programs (public laws). The "superimposees" may be less than enthusiastic or even subversive because they do not share the same priorities.

Nine years experience with the 1977 Floodplain Management Order indicates that provision of a consultative mechanism and some tempering of proponents expectations is necessary. For example the Floodplain Management Order affects geographic areas containing most of the wetlands of the U.S. At the time the Order was issued, many people in the environmental movement had high expectations that the order would control the development of the Nation's wetlands and some other sensitive environmental areas. Experience has tempered these expectations for both orders.

Viewed in the larger context, several conclusions may be drawn regarding the utility of an executive order as a mitigation tool. The executive order mechanism can provide a formal policy statement integrating legislatively discrete flood loss mitigation authorities and programs while focusing attention on Executive priorities. It can also specify procedures and standards to be utilized by Federal agencies. The 1977 Floodplain Management Executive Order has done all of these and been successful in motivating Federal agencies to lead national flood loss reduction efforts by setting good examples.

However the executive order mechanism does have limitations which are not always fully recognized. Executive orders cannot supersede legislative authority. They apply only to Federal agencies. Also, executive orders are only as strong as their legal bases and only as persistent as their constituencies. The Floodplain Management Executive Order has been successful because it has its source of authority in two strong pieces of legislation and its implementation has been consistently monitored by a strong constituency.

## RECOMMENDATIONS

Experience with the Federal executive order mechanism as a mitigation tool suggests the following recommendations.

1. An executive order is appropriate when:

    a. Authority for mitigation activity is legislatively dispersed among different agencies and

programs and a unifying executive policy statement is needed;

b. Clarification or establishment of national standards is needed;

c. Public awareness and participation processes need strengthening based on Federal leadership.

2. An executive order should be utilized for hazards other than flood, and in the United States, earthquake hazard appears appropriate.

3. Executive order implementation should be systematically monitored to permit documentation of successes as well as failures. Decisions to avoid high hazard locations are rarely recorded and conversely, poor locational decisions are readily visible.

4. It would be beneficial to evaluate State level executive orders and compare experience in implementing these orders with that of the Federal Floodplain Management Executive Order.

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# Effectiveness of National Barrier Island Legislation: A Strategy of Withdrawing Development Incentives

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## INTRODUCTION

A major problem of mitigation is how to reduce future urban development in known hazard areas. This problem is especially troublesome when the hazard areas are also strongly attractive for development due to physical, economic, or social reasons.

The traditional mitigation strategy in this circumstance is to enact government regulations that attempt to control future development in hazard areas. Such police power regulations limit the amount, location, type, quality, or timing of development to protect the public health, safety, or welfare.

A newer strategy is to withdraw previously available governmental incentives that encourage development. The first U.S. national mitigation policy based on this "incentive withdrawal" strategy was incorporated in the Coastal Barrier Resources Act (CBRA) which was adopted by Congress in 1982.

The purpose of this paper is to describe this new policy, to look at its impacts, and to offer recommendations for increasing its effectiveness and for extending it to other hazard areas outside the coastal zone.

## THE 1982 COASTAL BARRIER RESOURCES ACT

In enacting CBRA, Congress halted previous Federal subsidies for development in hazardous, undeveloped coastal barrier areas. The preface to the Act declared that past subsidies, such as flood insurance and infrastructure financial aid, had resulted in loss of resources, threats to life and property, and expenditures of millions of tax dollars every year.

To implement this new policy, the Act listed 186 "undeveloped" coastal barrier areas along the Atlantic and Gulf coasts, and prohibited further Federal flood insurance and federal expenditures for bridges and roads, utilities, access channels, erosion control, storm protection, community development, post-storm redevelopment and disaster relief (exempt in emergencies) in these areas. The designated areas covered some 656 miles of ocean-facing shoreline, equal to 24% of the shoreline along the Atlantic and Gulf coasts. (U.S. Department of Interior, 1983)

Under CBRA, land owners are not prohibited from building on undeveloped coastal barriers. But the cost of infrastructure and the risk of loss from coastal storms are shifted away from the Federal treasury.

### Impacts of the Barrier Island Policy

Because of the great profits to be made from coastal real estate development, CBRA alone is not likely to halt development on undeveloped coastal barriers. To make it more fully effective and insure that Federal savings do in the long run occur, reinforcing actions are needed by other public and private groups involved in coastal barrier conservation and development. (Godschalk, 1984) Key actors in this effort should include:

1. State and local governments, who must decide whether their expenditures and regulations as well as those of the federal government will be aimed at reducing development on undeveloped coastal barriers.

2. Private insurance companies, who must decide whether they will replace the withdrawn Federal flood insurance.

3. Banks and development finance agencies, who must decide how to replace required Federal flood insurance as a precondition for offering a construction loan or mortgage.

4. Conservation organizations, who must decide whether to focus their open space acquisition efforts on undeveloped coastal barriers.

5. Private development companies, who must decide whether to seek non-Federal flood insurance and infrastructure funding for undeveloped barrier projects.

There has been considerable variation in the impact of CBRA, depending on market conditions and state coastal management approaches. In general, however, private flood insurance has not yet become widely available to replace the withdrawn Federal flood insurance, and replacement of infrastructure funding by state and local governments has not occurred on a widespread basis. On the other hand, development has appeared to slow only in Florida where the state government reinforced the Federal policy by also withdrawing state infrastructure subsidies from coastal barriers and enacting barrier conservation policies. And, even in

Florida, it is difficult to separate the effects of public policy from the effects of a soft market.

## POLICY RECOMMENDATIONS

Four policy recommendations are offered, based on the CBRA experience to date:

1. Extend the coverage of CBRA to other coastal areas, including the Pacific Coast and Great Lakes, as recommended by the Secretary of Interior in his 1985 report to Congress. (Department of Interior, 1985)

2. Devise a staged incentive withdrawal strategy for the "developed" portions of coastal barriers lying in high hazard zones (Velocity Zones under the Flood Insurance Program), with the stages based on the time necessary to amortize investments in existing structures.

3. Require that states follow the Federal incentive withdrawal policy or lose their own benefits under the Federal Coastal Management program.

4. Investigate the extension of the CBRA incentive withdrawal strategy to the undeveloped portions of other noncoastal hazardous areas, such as riverine floodways, as proposed by the Colorado River Floodway Protection Bill passed by the House of Representatives in 1985.

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# Building and Rebuilding on Coastal Barriers: Conservation/Development Quotas

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## COASTAL BARRIERS

Barrier islands along the Atlantic and Gulf Coasts of the U.S. are among the most hazardous coastal areas with flood and erosion problems as well as long term mainland migration and sea level rise. Much of the area of a typical barrier island lies below the 100 year flood elevation. Barrier islands are composed of sand and marshes and are highly susceptible to overwash erosion and wind scour.

Over the last 20 years massive second home and recreational/commercial development has occurred on these islands. They have also been repeatedly battered by hurricanes and lesser storms with major property damages. For example, Hurricane Frederic in 1979 destroyed much of the first three tiers of development along a 36 mile of beach on Dauphin Island. Long term structural attempts to reduce this vulnerability have been largely unsuccessful because of the high cost of such works per front foot of protected shore and the reluctance of coastal residents and communities to destroy natural beaches. Beach nourishment has also proven extremely expensive both for original nourishment and subsequent maintenance.

The purpose of this paper is to suggest a positive approach to managing these hazardous areas both prior to and after disasters through establishment of development (and redevelopment)/ conservation quota and the implementation of such quotas through a broad range of regulatory, financial incentive, acquisition and other implementation techniques.

## REDEVELOPMENT AFTER THE ASH WEDNESDAY STORM OF 1962

In March of 1962, much of the North East coast was battered by a classic "northeaster". The Ash Wednesday storm, as it was called, lasted for three days and pounded a 300 mile stretch of coast with near hurricane force winds and high tides. The storm hit at a time when beaches are naturally more vulnerable due to seasonal changes in beach profiles. Much of the development on barrier islands along the New Jersey, Maryland, and Virginia coasts was either damaged or destroyed.

The damage incurred by many coastal property owners exceeded their capability to rebuild. The National Flood Insurance was still a concept and most of the flood damage was not covered by private insurance. As a result, many coastal property owners sold their land cheaply to either private developers or state or federal agencies. One of the largest public acquisitions occurred on Assateague Island in Maryland--the major barrier island in this state.

Before the 1962 storm, most of Maryland's ocean coast had been platted into small lots. Development was well underway in Ocean City which was located on a northern 10 mile strip of barrier island, just north of Assateague. But few permanent structures had been constructed on Assateague's 22 mile beach since there was no bridge to the island. Prior to the storm the federal government had been interested in the island as a national seashore but had been unable to implement a protection plan.

In 1965 Congress adopted legislation which included Assateague as part of the National Seashore system. In 1966 it appropriated 22 million dollars for property acquisition. During this period the state of Maryland constructed a bridge to the island to service a state-owned park which was already located there.

The National Park Service eventually acquired 3,700 parcels of land comprising 7,800 acres on the island including most of the properties damaged or destroyed by the 1962 storm. Today only a handful of privately owned lots remain. Each year more and more of the previously plotted lots slip below the sea as erosion occurs and sea level rises. There are no projects underway to retard erosion or flooding on Assateague, although there has been an investigation to determine the impact of erosion on the island park. Severe erosion rates have been reported on the northern portion of Assateague.

The federal decision to acquire Assateague was an expensive one for 1962. However, this decision is now regarded as a prudent investment in providing outdoor recreation, protecting wetlands and wildlife habitat, and reducing future erosion and flood losses. If Assateague had not been acquired, substantial redevelopment and new development would likely have occurred with enormous flood and erosion potential.

The result of the acquisition was to force new development to the northern barrier island--Ocean City. As a result Maryland now has approximately 22 miles of undeveloped barrier beaches and 10 miles of developed beaches, a 2 to

1 developed/undeveloped ratio. Intensive development at Ocean City now includes 8000 motel/hotel units, 27,000 living units, restaurants, and various recreation service industries on a 6 mile square area. It is not beautiful naturally but it provides recreational opportunities for several million visitors each year. A winter population of 5,000 individuals expands to 250,000 during the summer peak.

Ocean City is threatened by flooding and erosion, but the concentrated development and substantial tax base justifies much more intensive beach nourishment and protection than would have been possible for a 32 mile stretch of low density development. Infrastructure needs have been limited to a 10 mile area, permitting a concentration of sewers and water supply systems. Much of the recent development is of a substantial nature including major hotels and condomiums with heavily engineered foundations and first-floor flood protection measures which would not have been possible for single family dwellings. Serious questions have been raised concerning the evacuation of the island over the two bridges if a hurricane occurs in the peak tourist season but evacuation during Hurricane Gloria in September of 1985 proceeded smoothly and sucessfully.

## THE QUOTA CONCEPT: REALISM IN COASTAL RESOURCE ALLOCATION

Although unintentional at the time, public acquisition of Assateague after the 1962 disaster established a conservation/development quota for Maryland's barrier beaches of 2 to 1. Such a ratio has permitted both economic development and conservation although conservationists often consider Ocean City an abomination and some developers view undeveloped Assateague as a waste of beach resources.

Our nation's conservationists had high hopes for the Coastal Barrier Resources Act (CBRA) as a means to limit new coastal development in a comprehensive manner. However, there is now strong evidence that limitations on federal subsidies will not by themselves achieve a desired level of protection even for the undeveloped barriers. A number of these designated undeveloped islands are being developed with strictly private money. CBRA does not apply to developed barriers. It is inevitable that a major hurricane of the intensity of Gloria (or perhaps even Camille) will again hit the chain of barrier islands along the Virginia, Maryland, and New Jersey coasts, destroying much or all of the development in the first several tiers of houses along the beach and perhaps entire islands.

CBRA is, at best, a "negative" planning act with relatively weak implementation mechanisms as long as there are sufficient private funds for new development. It does not recognize the interdependencies between developed and undeveloped barriers nor does it deal realistically with economic development as well as conservation needs. It does correctly recognize (quoting from COBRA) that "A program of coordinated action by Federal, State and local governments is critical to the more appropriate use and conservation of coastal barriers." To gain state and local government support for major conservation measures, economic development needs must also be met.

But how is economic development to occur? Undeveloped barrier islands, partially developed barriers, and totally developed barriers are now being redeveloped after disasters and developed initially in a piecemeal fashion. At most planning and zoning controls are limiting the density of development and design of construction. Little by little, houses, condomiums, hotels, and other residential, commercial, and industrial developments are being constructed on all private lands. Would it not be better to fix a conservation/development ratio for all barrier beaches within a state and stick by this ratio?

Would this be politically or economically infeasible? Perhaps. Growth limits have been established by many cities throughout the nation. Sanibel Island in Florida, a barrier island, established a growth cap based upon hurricane evacuation and other factors and has designated growth and conservation areas throughout the island with considerable local political support. But there was realistic consideration of economic development needs as well as conservation. Local governments and states are willing to undertake major conservation efforts if private development can also be accommodated and there are tax revenues for conservation measures. This is not to argue for the creation of more Ocean Cities. But Ocean City is a huge revenue generator and provides thousands of summer jobs. With a $500 million assessable tax base (actual value of $1.5 billion), Ocean City has the third largest tax base in the state, only second to the City of Rockville and Baltimore City. City dwellers are at least exposed to and come to appreciate a coastal environment. These are the individuals who vote yes or no on state coastal zone management, wetland protection, and environmental bonding issues. Ocean City is the top net per capita and square mile revenue-producing entity in the State. Because development has been limited to a 10 mile strip, road, sewer, and water costs and shore protection needs have been greatly reduced.

New economic development areas in other states could provide similar concentrated facilities and services but, if properly planned, with more open space, better road access, and better protection from natural hazards through greater beach set-backs, improved engineering design for all structures, and the creation of special districts or other self-help financing mechanisms for beach protection or nourishment.

## HOW A QUOTA SYSTEM MIGHT WORK

Determining appropriate levels of additional development and redevelopment for undeveloped, semi-developed, and developed barrier resources and guiding public and private development and

redevelopment actions consistent with such levels would not be easy. For starters a state might consider the following in establishing conservation quotas for a state as a whole and then for individual barriers:

-- Health and safety considerations for individual barriers such as evacuation capability during time of hurricane, transportation, ground water supplies, and sewage capability,

-- Ecological considerations for not only individual barriers but the entire regional barrier, estuarine, marine system including wetlands, littoral zone, dunes, etc.

-- Existing development on individual islands and on the entire system within the state, and

-- Economic considerations for individual barriers and the barrier system of the state and/or region as a whole, including the need for fishing ports, future residential development for tax base, fuel delivery, etc.

From a state perspective, the whole barrier system should be considered in establishing policies for individual barriers. This would require imputs from all levels of government. The conservation/development quota would be jointly established by states, local governments, and the federal government. It could be implemented through a broad range of measures--not just federal subsidies for barriers themselves.

The real problem may come in deciding which areas or local governments are to be the "development" areas since this means local tax revenues and jobs. Establishing an overall state conservation/development ratio first may help. Such a ratio might even be voted on statewide by referrendum or by the legislature. There would then be some negotiation as to how this quota would be achieved. Natural limitations upon development or redevelopment such as erosion rates and flooding as well as access would play a major role.

Planned redevelopment after future disasters might be part of this allocation process. For example, a state might decide to limit all future development including redevelopment on a particular island, portion of an island, or specific beach area and begin immediate acquisition on a willing seller basis. A combination of regulation and acquisition might be used until the next disaster, at which time disaster and insurance funds might help complete the buyout, particularly for seriously damaged properties.

Federal incentives and acquisition monies would of course help and, in many instances, might be necessary to encourage state or local action (e.g., creation of a major recreational park such as Assateague) where the major economic beneficiaries would be U.S. citizens as a whole in contrast with a local government or state. Such monies might be made available as part of a broader federal program for barrier resources applying to all developed, partially developed, and undeveloped units.

Such a national program could work in the following way:

First, a coastal conservation quota would be established for each state. Such a quota would be based upon the factors suggested above and would be a joint federal/state/local effort.

Second, once a quota was established and approved, a revised coastal barrier development and conservation plan would be prepared for each state. Federal agencies would assist states and local communities in preparation of the plan. Similar to the assistance provided under the National Flood Insurance Program and the Coastal Zone Management Act, federal and state agencies would cooperate technically and financially in the planning process consistent with the conservation quota. High density development on smaller islands or on one portion of a large island might be preferable to low density on a larger island or an island as a whole. For development areas it would be preferable to choose sites where both environment and hazard concerns were limited.

Third, all federal financial assistance including disaster assistance appropriated for each coastal county with barrier resources would be conditioned upon proper implementation of the Coastal Development Plan. For example, if the City of Wilmington applied for federal urban renewal funds, a clearing house system similar to E.O. 11988 could reveal whether coastal conservation measures were in order. Funds would be distributed only after a satisfactory finding.

To take this a step further, perhaps all non-coastal federal financial assistance and flood insurance could be conditioned upon state and local compliance with the Coastal Development Plan.

## CONCLUSIONS

A simplistic quota approach for development and conservation of barrier resources is not without problems. But what is the alternative? Piecemeal decision-making will continue unless more or less rigid overall goals are established for barrier resources and the barrier resources (developed, undeveloped, partially developed) are addressed as a whole. Economic development is a political reality and must be accommodated.

The realities of both development and preservation must be balanced through a hard-headed process which considers natural erosion and flooding problems among a broad range of factors and the potential for redevelopment and reallocation of developed barriers after disasters. The defacto Maryland conservation/development quota achieved after the 1962 storm is an example worth considering.

# Conditioning Grants Upon Mitigation

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## INTRODUCTION

The Office of U.S. Foreign Disaster Assistance is mandated by the Congress to coordinate U.S. Government relief, rehabilitation, preparedness, early warning and mitigation assistance to foreign countries. Each of these elements may have the effect of reducing the future vulnerability of communities, so I'll step through them and describe how we attempt to condition them where practical.

## DISASTER RELIEF

Our traditional and most visible task is disaster relief. We try to serve the American people's humanitarian concern for those who have been stricken by disaster, whether natural or man-made. The immediate, life-sustaining phase of a major disaster does not lend itself to conditions. The scene at the disaster site is usually chaotic; coordination takes time to build; information is scarce and data is conflicting. The pressures on the host government and the donors are fierce. As long as there is a perception that the quicker you supply commodities and services, the more lives you save, it's tough to maintain a philosophic approach which might dictate slower, more reasoned response. When you're receiving calls from your friendly Congressperson, threatening immediate extinction of your program if you don't MOVE, your philosophical inclinations tend to dissipate. We recognize the desirability of melding relief with development strategies designed to produce disaster-free future populations. Pragmatically, we rarely have the opportunity to weave longer term concerns into immediate relief activities.

That's not to say that we can't do a better job through contingency planning and closer cooperation with disaster prone countries and other donors. We are working toward more rational and productive relief strategies. Still, conditioning relief is not currently a reasonable option.

## REHABILITATION

Short term rehabilitation - those activities which serve to return affected communities to a viable state - does offer some opportunity for conditioned response. It does not serve the best interests of disaster victims to repair housing, water supply or basic infrastructure if physical improvements will not withstand the next disaster. At this state the enormous and immediate pressure to assist victims has abated. We can apply leverage.

For example, after a cyclone hit Fiji a few years ago, a voluntary agency proposed a housing rehabilitation program for a number of the hardest hit communities. We agreed to fund this program on the condition that the rehabilitation meet design and construction specifications which would reduce future losses. The rehabilitated communities now stand a good chance of surviving the next cyclone with minimal building failures. This same approach has been used with considerable success in earthquake recovery in Colombia, cyclone rehabilitation in Madagascar and other post disaster efforts. And, the cost is quite modest.

We strongly believe that conditioning can and should be used in the broader development context. It is encouraging that some of the development agencies and lending institutions are beginning to recognize the benefits of incorporating mitigation elements in the reconstruction of the built environment following disasters

## PREPAREDNESS

Through our preparedness activities we can raise the awareness of threat and can assist disaster prone governments in planning their communities to withstand future disasters. We can condition them, if you will, to the benefits of building safety in their environments. Once they recognize these benefits, all they need is money. That brings us back to the development strategy and the need to convince development planners that prevention is much more cost effective than a cure.

## WARNINGS

Early warning relates directly to mitigation. Increasingly we have been conditioning assistance for prediction and forecasting technology upon formulation of plans for their use in the ultimate protection of people. We see a logical progression from hazard analysis (relation of historical and current physical evidence to future hazards) to vulnerability analysis (projection of how probable future

events will affect communities) to forecasting (which, in our terms, is the assessment of the probability that an event of an estimated magnitude will touch a given population within a certain period of time). Given these perceptions we can plan strategies on an optimized or worst-case basis.

## MITIGATION

Our last goal (last only because it is the newest in our strategy) is mitigation itself. Generally activities designed for the reduction of vulnerability are planned outside the context of post disaster operations. Inevitably, however, it is the major disaster which provides the opportunity to sell the mitigation message. The more we plan mitigation, in whatever phase of the disaster continuum, the easier it will be to incorporate mitigation concepts into the recovery process.

One Napoleon's generals is said to have been keen on raising olive trees. "No hurry", said his gardener, "it takes years for the trees to bear fruit". "Then", said the general, "you'd damned well better start today".

# CHAPTER EIGHT
# *INSURANCE*

Private insurance for damage from winds, floods and other natural disasters has been available in some countries such as Great Britain for many years. In 1968 the U.S. became the first country to initiate a massive, government sponsored insurance program for flood disasters which ties insurance to future availability of federal disaster assistance and federal subsidies for activities in the floodplain.

This U.S. experience indicates that subsidized insurance can be a powerful incentive for encouraging land use controls for new construction. But it also indicates that insurance may encourage land uses and discourage post-disaster mitigation where the rates do not reflect actual risk and there is no or little incentive for mitigation in repair of partially damaged structures.

Paul Simeon in the first paper, examines the use of insurance and disaster prevention plans as a mitigation measure in France.

Frank Thomas in the second paper of this chapter discusses the interplay of land use regulations, disaster assistance and insurance in the U.S.

# Use of Insurance as a Mitigation Tool in France

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## INTRODUCTION

It is only since 1976 that the French Government has given systematic thought to the preparation and implementation of a program to provide relief for the unfortunate consequences of flooding: the three aspects of this action, prevention, protection, and repair, have been studies in detail, and then integrated.

The formulation of an effective overall program seems to be close to a solution. Insurance constitutes an important element and one which will likely have a greater future role.

## BACKGROUND

It is this last aspect - insurance - and the corollaries arising from an insurance program that we proposed to develop in this paper.

However, in order to better establish the context, a few figures relating to the flood risk in France may be helpful. Nearly 5 million acres, 250,000 of which are in urban areas, are subject to flooding; they represent neary 4% of the territory of Metropolitan France. Two million people, 7,500 communes (the basic administration unit) out of the 36,500 in the country (20%), 84 Departements out of 90 (the Departement is the French equivalent of the American county) are subject to flooding. The average annual cost of damage is of the order of $400 million.

The basic national law that addresses these problems was adopted on July 13, 1982. This act covers all predictable natural risks that are not otherwise insured: floods, landslides, avalanches, and earthquakes. Floods alone are a concern to more than 70% of the local authorities which are subject to hazards.

This law, which was passed following floods that affected nearly one third of the territory of France at the end of 1981, was initially directed principally toward providing the quickest and most complete indemnification of disaster victims. The structure chosen for distributing compensation was the network of the insurance companies and their agents, which offered the advantage of being on the site and familiar with disaster problems.

At the time that this bill was being discussed by the National Assembly, on joint application by the Senate and the new "Delegated Committee for Major Risks" under the Chairmanship of the vulcanologist Haroun Tazieff, it was amended in spirit. The initial objective of systematic indemnification, with the unfortunate effects that such indemnification was likely to have on the behavior of persons under threat by reducing their sense of responsibility and encouraging them to think of themselves as assisted persons, was compensated for by the introduction of a completely original idea of "prevention". It is this idea, and its links with insurance, that we shall now discuss.

### Master Prevention Plans

The "Master Prevention Plans" (Plans d'Exposition aux Risques - P.E.R.) constitute the key point in these arrangements. The Government, via its representatives in the Departement, is the initiating body for the prevention plans. It is the Government that proposes, develops, and finally decides to implement the new procedures in each commune (in the case under discussion here) subject to flooding. It is also the Government which finances, in full, the necessary studies and services even though the cost of setting up the recommended measures is from this point on payable by those most concerned. This procedure is implemented in close collaboration with the elected representatives of the communes, which are entitled to appeal at each important stage of the planning process. But is is the central government that has the last word.

When initial examination of the plan and the various stages of the political and administrative procedure have been completed, which takes 18 months to 2 years, the P.E.R. becomes an executive document with the legal status of a "State-approved easement", binding on third parties. It must be annexed to any existing land-use document or regulations. It is subject to revision after five years. What does a P.E.R. contain?

Hazard Maps. The P.E.R. contains maps of an objective and technical nature; these are generally reproduced to the scale of 1:5000 and include the following information on a topographical background:

a) The boundaries of a number of characteristic historical floods.

b) The boundaries of two theoretical

floods: ten-year and one-hundred year, obtained by simulation of the flow of flood water on a mathematical model, calibrated with data provided from the historical floods (point a).

c) Within these boundaries, the values of the three following damage-risk parameters:

- water height
- flow velocity
- duration of submersion

The values of these parameters are calculated for a number of points, varying in density, in terms of the degree of land use and the physical characteristics of the zone (0.5 to 1 point per acre on average).

The degree of precision sought for these measurements varies with the extent and character of land use, i.e., with the average vulnerability of the properties and activities within the zone. In terms of height, it is + 20 cm in the most favorable cases.

We thus arrive at what we call a "Flood-Risk Map", which constitutes completion of the first phase of the planning process.

Vulnerability Maps. The Flood-Risk Map is then compared with and superimposed over a "vulnerability map" of the developments, equipment, buildings, and activities of whatever nature within the zone under study.

With the help of previously developed type classifications which indicate in a descriptive or quantitative manner the degree of vulnerability to water contact of various buildings, developments, and activities, a plan of sectors homogeneous from a vunerability point of view is drawn up. The public service installations which may be seriously disturbed by floods are precisely indicated. This document is known as the "Vulnerability Map".

Zones of Danger. Superimposition of the Flood-Risk Map and the Vulnerability Map for a given commune reveals the different zones of danger. We can in fact write the following equation:

Physical risk + vulnerability = DANGER.

This leads to a determination of the zones of various levels of danger indicated on this plan to 1:5000 scale. These zones are thus defined in terms of 5 criteria: frequency, water height, duration of submersion, flow velocity, and degree of vulnerability. In certain cases the season may be added (for agricultural property, tourism, etc.).

These zones are grouped togetehr in 3 major categories:

- RED zones, where the danger may be both too frequent, too intense, and too expensive for any preventive action to be reasonably undertaken.
- WHITE zones, where the danger is both sufficiently rare and sufficiently low for the risk to be psychologically acceptable or bearable.
- BLUE zones, which are intermediate between the two preceding ones. These may be diversified in terms of the regulations subsequently imposed on them.

The boundaries of these various zones are proposed by the external Technical Departments of the Central Government to the elected representatives of the communes, who discuss them and may suggest modifications. However, it is the Government that again has the last word.

Regulations. For the RED and BLUE zones thus outlined, regulations are prepared in each case. Here we come to the heart of the matter: it is this mapping of the danger zones and the regulations that accompany the mapping that constitute the new tool for prevention and for mitigation of flood damage.

These regulations, prepared by the external Technical Departments of the Central Government, are principally directed at prevention. They are essentially based on non-structural measures whose object is to change the behavior of individuals and groups faced with risk, and not to change the physical conditions of the event.

These measures concern building permits and the degree of occupation and use of land. They range from refusal of building permission to instructions with regard to how buildings should be constructed, covering all aspects. They are limited, however, with regard to existing property by social and economic considerations: the cost of the measures required for existing structures (there can also be recommendations in parallel) must not in this case exceed 10% of the market value of the property they are intended to protect. For projected developments or assets, the only limit is the economic profitability of the proposed measures.

A handbook of non-structural measures applicable in the context of the Risk-Exposure Maps has been drawn up on the initiative of the Committee for Major Risks for each of the covered risks. The external Technical Departments of the Central Government must refer to these handbooks in preparing the regulations included in the P.E.R.s. These handbooks have been drawn up by consultants who are specialists in each risk.

## ADMINISTRATION OF THE PROGRAM

How can one assess the feasibility and effectiveness of the P.E.R.s? To what extend will the P.E.R.s be prepared, promulgated, and applied? How long will this take? What sanctions will be involved?

The costs of the P.E.R. program for the four risks already mentioned has been estimated at nearly $90 million (at 1985 values). The law requires that it be executed over a period of ten

years beginning in 1984. The program is facing financing problems since the Government is asking the Insurance profession to provide two thirds of the funds: one third payable by the reinsurance bodies, and one third by the insurance companies themselves. The last third is to be paid directly by the Central Government. To date, insurance companies are still reserving their reply. Despite these problems, 620 P.E.R.s affecting 350,000 persons have already been prepared. They concern, first and foremost, flood risk (70%) and urban zones.

Legal problems may also arise due to opposition of the communes (to which recent laws have given considerable autonomy) to the imposition of land use regulations by the Government which has responsibility for public safety and wishes to retain these powers. It is certain that serious administrative disputes will occur within the next few years.

At the insurance level, coverage for the risk is automatic but not general. It is automatic because it constitutes an automatic extension of coverage from more traditional risks such as damages, fire, theft, and operating loss. This extension is provided by payment of an extra premium at a fixed rate (9%) calculated on the original actuarial premium. Thus, any person covered for one of the basic risks is automatically, and without possible refusal, covered for the risk of "natural catastrophe", for a cost that has no relation to the actual value of this risk.

This coverage is not general, i.e., all persons who run such risks are not necessarily covered against them. It is enough for them not to be covered against the basic risks (damage, theft, fire, etc.) for them not to have to pay the extra premium and therefore not to be covered against natural catastrophes.

This system, which comes more under the heading of a mutual-guarantee regime, is thus principally based on communal loss-bearing principle and less on that of liability. There are certain weaknesses in it with respect to the lack of pressure it can bring to bear on persons to initiate self-protection measures or incentive to dissuade them from acting imprudently. In particular, no clause of "bonus-malus" linked to repeated occurrence of the risk is provided at present.

In zones where no P.E.R. yet exists, disaster victims who had previously taken out insurance against one or several basic risks will be indemnified in the event of damage from natural hazard. They will be indemnified completely subject to a deductible for private persons of just under $200 and for companies at just under $600. This deductible may, in certain cases, be varied by the Insurance Company.

In zones where a P.E.R. has been promulgated, persons will have a period of five years to apply the measures required. During this period, they will be indemnified in all cases and subject to the same conditions as above. After this period, persons who have not complied with the required measures will not be indemnified.

## CONCLUSIONS

In conclusion, it cannot be said that at present insurance in France is a complete tool for prevention and mitigation of damage caused by natural hazards and, in particular, by flooding.

Insurance is, however, uniquely placed for channeling the resources necessary for indemnifying flood victims, and in this way it can substitute for direct relations between the Government and disaster victimes and between insurance companies and victims. The publicity for and knowledge of the risks that these measures are creating in groups and with individuals is developing their sense of responsibility.

This law, the original intention of which was only to provide indemnification through insurance, has led to the birth and application of the P.E.R.s, which are changing the basic behavior of the French Government with respect to action against natural hazards. Non-structural preventive measures now have validity alongside the traditional structural techniques of protection. Non-structural measures complement these techniques, or in certain cases may even be substituted for them. The methods for locating and defining risks are being refined at the same time. The future will decide - though some people are thinking about this already - whether the present communal loss-bearing regime should be replaced by a truly actuarial insurance regime, requiring prior assessment of each individual risk instead of just a posteriori expert assessment of the damage. Obviously this prospect would be more effective in combating damage. But it would certainly be more expensive and cumbersome to implement. It would probably have to be made mandatory to avoid the danger of anti-selection. The process could perhaps be undertaken in stages. In any case, it seems to us that France is moving with dynamism on the right course.

# Flood Loss Mitigation in the United States: The Interplay of Land Use Regulations, Disaster Assistance, and Insurance

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## INTRODUCTION

Nonstructural flood loss mitigation in the United States is built around a set of trade-offs between the Federal government, which provides benefits, and the local governments which enact and enforce land use regulations. Flood loss mitigation is the outgrowth of experience with land use regulations, disaster assistance, and structural flood loss mitigation programs which have evolved over time and have been brought together in the National Flood Insurance Program. The purpose of the paper is to describe the interplay of land use, disaster assistance, and insurance mitigation tools and to comment on their status.

## EVOLUTION OF FLOOD LOSS MITIGATION ACTIVITY

The Federal role in flood loss mitigation has its beginnings in the 1930's when the Corps of Engineers was assigned responsibility to provide structural flood protection works. During the 1950's the Federal government's role as provider of disaster assistance after private, local and State resources had been exhausted, began to expand rapidly. By 1965, the Federal government was faced with rapidly rising disaster assistance payments and structural flood protection costs. This led to the adoption of a policy to shift the burden of losses from the general taxpayer back to the occupants of the floodplain.

By the mid-1960's, few local governments had adopted floodplain zoning and building codes.

In 1968 the Federal government established the National Flood Insurance Program (NFIP) which made flood insurance available and used premium income to reduce disaster assistance costs. Before this little flood insurance was available from the private sector and only the owners of high risk property sought to purchase insurance.

The National Flood Insurance Program was based upon 5 major premises. First, the program was to be voluntary and insurance availability was to be conditioned upon community adoption and enforcement of floodplain management regulations (zoning ordinances), sub-division regulations, and building codes). Second, floodplain management regulations were to become more stringent and the amount of available insurance increased as more detailed flood hazard information became available. Third, community floodplain regulations would require that new structures be setback or elevated from the flooding source or built with flood resistant design and material to protect to the level of the 100-year base flood standard. Fourth, flood insurance rates would be based on the 100-year base flood standard. Fifth, structures existing in the floodplains at the time the insurance program was initiated would be insured at subsidized insurance rates, but new construction built to the standards of the regulations would be charged actuarial rates. They would, however, be eligible for a larger amount of insurance coverage.

With these 5 premises as a starting point, the flood insurance program has evolved since its inception in 1968. The first phase of evolution from 1968 to 1973, was a start up period during which the program was conceptualized and presented to the public as a mitigation tool. During this period, standards and techniques were established for mapping the flood hazard's extent, depth and velocity in coastal as well as riverine situations. Regulatory standards and rules for communities were established as were rates and schedules for insurance. However, by the end of this period, only a few thousand insurance policies had been purchased.

The second phase of evolution, 1973 to 1984, began after a major flood disaster (Tropical Storm Agnes) revealed that only a small number of insurance policies were in force. New legislation tied insurance program participation to eligibility for disaster assistance payments and to Federal financial guarantees including home mortgage money. This legislation was followed in 1977 by an executive order which tied other Federal programs to the insurance program standards and encouraged participation in the program. In 1980 a section of the Flood Insurance Act (Section 1362) was funded to permit FEMA to acquire severely damaged insured property, thereby allowing removal of some of the very high risk properties from the floodplain.

Also in 1980, a mechanism was established to create post-flood hazard mitigation teams for the purpose of assessing opportunities to guide Federal disaster assistance to take advantage of mitigation opportunities.

In retrospect, this period was marked by the development and testing of the program and the integration of mitigation tools. The major commitment of resources was on the refinement of hazard identification methods, especially for coastal communities, and the adoption of floodplain regulations by these communities. Experience also permitted the refinement and simplification of insurance rates and schedules.

The current period of evolution, which began in 1984, represents a new stage of maturity for the insurance program. The program is now beginning to function as a package of articulated mitigation techniques with incentives and disincentives reinforcing mitigation. Hazard identification activity is moving from initial mapping to maintenance phases and resource commitments to this activity are beginning to decrease. Concomitantly, recently established community assistance and compliance monitoring programs are receiving more resources and impact on community performance in the program. The insurance rate system has been stabilized and a field verification mechanism is now being implemented. The trade-off of Federal benefits for local government and private sector mitigation actions is beginning to have a major effect on flood losses.

## TRADE-OFFS OF FEDERAL BENEFITS FOR LOCAL FLOODPLAIN REGULATIONS

As indicated earlier, the central premise of the flood insurance program is a quid-pro-quo whereby Federal benefits are made available in return for local government regulation of floodplain activity and private citizen compliance with local regulations. The Federal benefits consist of those which are directly provided by the National Flood Insurance Program and those which are conditioned upon participation in the program.

Direct Federal benefits include provision of flood hazard information in the forms of maps and studies detailing the extent, depth, and velocity associated with the 100-year base flood. The availability of subsidized insurance for existing structures and actuarial insurance for new structures is a second direct benefit. Other direct benefits include eligibility for purchase of severely damaged property, and technical assistance and information on mitigation techniques.

Indirect benefits or those conditioned upon participation in the NFIP include eligibility of individual structures for Federal financial assistance or guaranteed mortgage money, eligibility for disaster assistance grants and loans to communities and individuals, and under the floodplain management executive order, eligibility for Federal flood control programs such as those of the Corps of Engineers.

Local regulations involve the adoption of floodplain ordinances which recognize the 100-year base flood standard and Federal flood hazard information maps, require setbacks from mean high tide in coastal areas and from floodways and riverine areas, elevation above the base flood elevations in most cases, the use of flood resistant design and materials, establishment and maintenance of a permitting system and its documentation, and the monitoring and enforcement of these ordinances.

Federal penalties for failure to meet federal guidelines and local program requirements may be assessed to the community or the individual property owner. Communities which are deficient in the maintenance and operation of their permitting system or allow violations of their ordinance requirements, may be placed on probation. Probation is essentially a warning and after October 1, 1986, will include a premium surcharge to reflect additional risk represented by the program deficiencies and violations. Failure to correct deficiencies and violations can result in suspension of community eligibility for the insurance program and thus the termination of both the direct benefits of the insurance program and indirect benefits associated with other programs. The impact of probationary status is largely political while the impact of suspension is both economic and political.

Penalties may also be imposed upon the individual property owners who carry out property improvements or new construction in violation of community ordinances. This may involve the assignment of increased insurance rates which can pose a severe economic penalty or may involve the denial of insurance eligibility which also can have severe economic impacts.

## THE CURRENT STATUS OF THE PROGRAM

There are approximately 6 to 8 million structures located in the floodplains of the U.S. Of these, 1.9 million are insured and a small number, 108 properties, have been denied insurance because they have been built in violation of program standards. Insurance coverage for structures and contents totals 123 billion dollars with an average cost of $225 per premium for $65,000 of coverage.

Of the 17,600 communities participating in the program, approximately 200 have been suspended for failure to adopt minimum required regulations. Seven communities currently are on probation for failure to enforce their regulations and one community is under suspension for failure to enforce its regulations.

The maturation of the flood insurance program is associated with several factors. To begin with, the program has been in place for 10 years in most communities. This means that several generations of elected officials have had experience with the program and it is now becoming accepted as a necessity despite the political difficulties of carrying out land use regulations in attractive floodplain locations.

The financial, real estate, and construction communities now have knowledge and experience with the program and are better able to adjust to the program's requirements. At the state level, floodplain management capability has been steadily increasing. States now provide considerable technical assistance support to individual communities. Most decision-makers concerned with use of floodplain lands have experience with the flood hazard maps, the building standards, and the insurance rates associated with the program and better decisions are being made.

As the program matures, two key problems must be resolved if the program is going to shift sufficient flood loss costs from the general taxpayer to the occupants of the floodplain to allow insurance premium income to approximate insurance claim payments during an average year. The goal of the program is to achieve break even or self sufficiency status by 1988, recognizing that the Federal government will have to act as a reinsurer for catastrophic flood events.

The first problem is heavy flood losses associated with structures which were built before the National Flood Insurance Program was established and thus are "grandfathered" into the program at subsidized insurance rates even though they do not meet floodplain regulatory criteria. Technical experts are now seeking to determine which methods are most appropriate for floodproofing the different types of structures, which of these are economically and politically feasible, and which incentives are available or needed to encourage property owners to modify existing structures to make them resistant to flood damages. Resolution of this problem will be incremental over the next several years.

The second problem is the heavy flood losses caused by the inadequate drainage in new urban developments. Many communities lack or have inadequate comprehensive stormwater management programs. When the National Flood Insurance Program was conceived, stormwater management was not considered a problem and program objectives were directed at mitigating over-the-bank and over-the-shore sources of flooding. Local drainage and local responsibility must be distinguished from Federal responsibility. Criteria to distinguish local responsibility have been developed for other Federal programs associated with the construction of flood control structures.

Both the existing structure and the stormwater management problems will likely be met by a further definition of Federal benefits and trade-offs involving mitigation tools. During the next 3 to 5 years, I expect both the methods and criteria for resolving these issues will be conceptualized but implementation will continue for years.

The prognosis for the flood insurance program is one of increasingly effective use of the mitigation tools. This will include incorporation of additional tools to encourage the floodproofing of existing structures and more effective stormwater management. The strategy of shifting flood hazard costs to floodplain occupants by providing Federal benefits in return for local management of floodplains will continue to be the centerpiece of flood loss mitigation activity in the U.S. Even though this strategy is successful, there will always be a residual function for the Federal government as the source of funds of last resort in the event of catastrophic flooding.

## RECOMMENDATIONS

Based on our experience to date with providing Federal benefits for local government floodplain regulation under the National Flood Insurance Program it is clear that a "benefits for mitigation" trade-off mechanism can be viable. Several recommendations are offered for implementing such a trade off mechanism in other contexts of countries.

1. Mitigation requirements must be doable and politically acceptable.

2. Since an assimilation period of 10-15 years may be required, both the Federal and local governments must prepare their programs carefully and exercise patience while acceptability is being established.

3. A mitigation technical assistance program must be undertaken and sustained to develop public awareness and demonstrate feasibility.

4. The benefits and mitigation requirements must be clearly directed at the same objective of loss reduction and proposals to incorporate other objectives could or should be reviewed with great care. Addition of other objectives can destroy or confuse the constituency supporting mitigation.

A worthy research project would be the systematic evaluation of experience with each of the direct and indirect benefits and the mitigation trade offs under the National Flood Insurance Program from 1968-1985.

CHAPTER NINE

# *BUILDING DESIGN AND DISASTER MITIGATION*

This chapter examines retrofitting needs and options in rebuilding and repair. French Wetmore first describes post-flood mitigation survey procedures developed by Illinois to identify specific rebuilding, repair and relocation options.

Douglas Lash discusses the problem of multiple loss structures in the National Flood Insurance Program and the effort of the program to develop guidance materials pertaining to retrofitting as well as new construction.

Carl Pace next examines, more specifically, techniques to modify homes and buildings to prevent floodwater damage.

Chris Jones suggests procedures for evaluating hurricane shelters and other flood resistant structures for use as refuges during hurricanes.

Carlton Ruch and his co-authors discuss the role of structures as "vertical refuges" during hurricanes where evacuation is not possible or practical.

# Post-Flood Mitigation Surveys

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## INTRODUCTION

After a devastating flood like the 1976 Big Thompson flash flood or a coastal storm surge, it is often easy to identify mitigation opportunities. When buildings are demolished, local governments can prohibit reconstruction or require that replacement buildings meet flood protection standards. Alternatively, government agencies can often acquire sites at a relatively low cost: the price of vacant lots.

This is not true for an almost flat state like Illinois which is subject to shallow, low-velocity flooding. Flooding is frequent but usually does not cause "substantial damage" to buildings. Because buildings are not substantially damaged, flood plain regulations cannot be used to mandate relocation or other protection measures. Flood plain residents are not ready or willing to voluntarily move their minimally damaged building out of the flood plain.

## ASSESSING MITIGATION OPTIONS

The most appropriate mitigation response for the majority of the flooded properties in flat Illinois is elevation of buildings or floodproofing. Because it is not easy to quickly tell what should be done for buildings that are not substantially damaged, the Illinois Division of Water Resources needed a technique to identify mitigation opportunities. This technique had to meet the following criteria:

a. It had to be simple and cheap so local officials could use it.

b. It had to be quick so it could be used in a post-flood situation before people begin rebuilding.

c. It did not need to be highly accurate, only dependable enough to be used as a first round planning effort to identify opportunities. Later, more detailed study could more fully develop the appropriate mitigation technique.

In 1983 the State of Illinois obtained Supplemental State Assistance Program funding from the Federal Emergency Management Agency (FEMA) to hire the firm of Sheaffer & Roland to prepare a building survey technique which met the above criteria. This technique would be used as an initial planning tool.

For the purposes of the study, we identified six categories of flood protection which are listed in order of providing the most protection to the least: demolition, relocation, elevation, levee or floodwall, dry floodproofing, and wet floodproofing. Sheaffer & Roland identified the key factors that determine whether a building can or should be protected by the measures. The key factors are (1) characteristics of the building and (2) the flood hazard.

Characteristics of the building include:

- general condition (unsound buildings are recommended for demolition),
- whether the building is large or small (small 1 or 2 story buildings can be moved or elevated easily),
- foundation type (buildings on a crawl space or basement can be moved and elevated easily, while buildings on slab can be dry floodproofed),
- type of siding (masonry siding can be dry floodproofed while other sidings make for a lighter building which is easier to elevate or move).

Given Illinois' riverine flood situation, we only needed to focus on two aspects of the flood hazard: velocity and depth. Data pertaining to each of these are contained in FEMA flood insurance studies. Because there are many areas in Illinois where the floodway has a low velocity and shallow flooding occurs even during the 100-year flood, we did not automatically consider every floodway as a high hazard area. We did decide that average floodway velocities of greater than 5 feet per second should be considered high hazard and buildings should not be floodproofed or protected by levees in such areas.

We were concerned with flood depth increments of 3 feet over the first floor:

- 0-3 feet meant that masonry sided buildings on slab could be dry floodproofed,

- 6 feet is the practical limit for a local floodwall or levee,

- elevation of the structure was not considered feasible at depths greater than 9 feet.

The most difficult piece of information to collect proved to be the depth of the 100-year flood over the first floor. For this we developed a technique using a hand level and known ground elevations in the survey area. This is the one part of the survey that is subject to the greatest error and several warnings are included in the manual.

Once all the field data are collected on the survey forms, the surveyor traces each building through a flow chart. The flow chart identifies the appropriate flood mitigation measures in order of preference. The surveyor is advised to plot the results on a map of the neighborhood to provide the basis for a general concept plan.

The concept plan is then refined with other available data. For example, even though the initial survey results recommend elevation or floodproofing, if a building is for sale or adjacent to a park, the most appropriate measure may be acquisition. Flood insurance claims data can be used to identify buildings that qualify for purchase under Section 1362. The survey results then need to be discussed with the property owners. In many cases interior inspections by an engineer or house mover are needed before final decisions are made.

## Testing the Technique

Following field tests in three communities, we refined the survey and published Local Assistance Series 3A, Surveying Buildings for Flood Hazard Mitigation. Following publication of the manual, I helped two small towns, Thebes and Kampsville, conduct surveys and prepare preliminary mitigation maps. In both towns we used a level on a tripod to ensure accuracy and we double-checked some of our findings with owners' recollections of elevations of recent floods. (Kampsville found the elevation data very useful for warning and evacuating residents and building contents during the Spring, 1985 flood).

The survey was also conducted for the Rome area of Peoria County by a registered land surveyor, financed by a Hazard Mitigation Assistance Program grant from FEMA. The elevation data and other survey results were entered into the county's computer and cross-referenced with property tax assessor's files.

Three communities later refined their preliminary mitigation maps with additional data. Eligibility for Section 1362 acquisition was the most important additional information. Patterns appeared showing where most of the buildings on a block should be purchased, moved, or demolished. In such cases, redevelopment plans pointed toward clearing the entire block. In all cases, public hearings were held to ensure community and property owner support.

All three communities are proceeding with redeveloping their flood plains with funding from FEMA (1362), the Community Development Block Grant, the Division of Water Resources, and local sources.

## POST-FLOOD APPLICATIONS

What about use of the survey technique in a post-flood context? At first we expected the survey to be used primarily in the post-flood situation. We expected that most communities would use it to analyze their flood problems immediately after a flood and help select the appropriate response. There are four reasons why post flood analysis is timely:

1. A flood brings federal, state, and local people from various agencies and fields together to focus their attention on the community and its flood plains.

2. Both citizens and elected officials are more interested and more willing to spend time on the flood problem and to try new solutions.

3. If the damage is severe enough, it may be relatively easy to clear heavily damaged or destroyed areas and start anew.

4. If the damage is severe enough to warrant a federal disaster declaration, there may be several additional sources of money to buy or rebuild properties with flood protective design.

Accordingly, we modified the survey so it could be applied in a post-flood context. The key difference from the pre-flood survey is that the post-flood process is speeded up by utilizing the high water marks on the buildings rather than using a hand level and estimated ground elevations to determine the depth of the 100-year flood.

Even though we developed the post-flood survey technique and expected to use it more than the pre-flood one, we have yet to apply it. This has not been for lack of floods, however, for the post-flood survey to be used there are two prerequisites:

a. the community must already be interested in mitigation,

b. there must be someone familiar with the technique and able to apply it.

In most instances we had already helped those communities interested in mitigation. Other than in Thebes, Kampsville, and Peoria County, local leadership has not given flood hazard mitigation high priority. We have also found that local officials need help in understanding and beginning the survey. Therefore, for the post-flood survey to work, the

Division of Water Resources must go to the community, get the local officials' attention, and help run the survey.

We were unable to do this after the last flood. In February and March, 1985, flooding on the Illinois River Basin was so widespread that we had our hands full meeting groups of officials from the many affected communities. Since we felt a responsibility to ensure that local officials were properly enforcing reconstruction regulations, we could not devote the necessary time to run the post-flood mitigation survey. We followed the crest downstream and in four days met with representatives of 51 communities and 10 regional or disaster assistance agencies. At these meetings we discussed their obligation to regulate reconstruction, the disaster declaration process, flood insurance, and hazard mitigation. We advised them that if they were interested in mitigation, we could visit them later. A few communities did ask for a visit and some long range planning has begun.

We did conduct a "windshield survey" of buildings in the 33 hardest hit communities. We looked for easy-to-recognize signs of substantial damage: collapsed foundation walls. The problem of post-flood mitigation in Illinois is illustrated by our findings: in the 23 counties declared disaster areas by the President, we found only 28 buildings with obvious structural damage.

After completion of the windshield survey, we sent letters to the persons responsible for enforcing the local flood plain regulation ordinances, telling them the addresses of each building, restating the regulatory responsibilities under the National Flood Insurance Program, and offering to help work with the property owner to obtain funds for acquisition or reconstruction to regulatory requirements. Five months later we checked the status of the buildings and found:

6 rebuilt in accordance with flood protection requirements,

1 "red tagged" for attempting to rebuild without a permit,

8 not repaired or rebuilt,

6 not rebuilt/being reviewed for Section 1362 acquisition,

7 more detailed review had not found they were "substantially" damaged.

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It is interesting to note that in this post-flood survey of 23 counties, there were only 21 buildings that warranted enforcement of the substantial improvement regulations. In its pre-flood survey one town (Kampsville) identified appropriate mitigation measures for 100 buildings and expects to obtain financial assistance to acquire or elevate 53 of them. The remainder are on higher ground and property owners will be advised of self-help measures.

## CONCLUSIONS

Our experience leads to one obvious recommendation on post-flood surveys: Don't wait until after the flood to do your post-flood planning. A pre-flood survey and advance planning can accomplish the following post-flood mitigation objectives:

- it will build an interest in mitigation and help property owners become familiar with mitigation options,
- it will build good relations between local officials and flood plain residents,
- property owners at risk can be advised of the hazard they face and take protective action such as purchase flood insurance,
- surveyed building elevations will help in warning and evacuation which will minimize contents damage,
- flood fighting efforts can concentrate on areas not targeted for clearance,
- the flood plain regulation ordinance can be amended to set a more restrictive threshold for substantial improvements in areas targeted for clearance which would, in effect, prohibit reconstruction in those areas, and
- applications for funding assistance can be readied for submission with disaster assistance.

## RELATED LITERATURE

Copies of the following are available from the Illinois Division of Water Resources, 310 South Michigan Avenue, Room 1606, Chicago, IL 60604.

Surveying Buildings for Flood Hazard Mitigation, Local Assistance Series (LAS) 3A, 1984.

Protect your Home from Flood Damage, LAS 3B, 1984.

Elevating and Relocating a House to Reduce Flood Damages, LAS 3C, 1983.

Elevating Flood-Prone Buildings: A Contractor's Guide, LAS 3D, 1985.

# Reducing Future Flood Losses: Retrofitting Existing Construction

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## INTRODUCTION

This paper addresses four basis questions relative to the problem of reducing flood losses to existing floodplain construction. The paper reflects the policies and experiences of the National Flood Insurance Program (NFIP).

First: What is the NFIP's current program policy regarding existing construction? How effective has it been in reducing flood losses?

Second: How big a problem, in terms of loss experience and exposure, does "existing" construction pose? Does it warrant corrective regulatory or financial consideration?

Third: What practical measures are available i.e., actions which are both physically and economically feasible, which can be applied retroactively to existing construction?

Fourth: What options would appear to be available to encourage application of corrective, mitigating measures for existing construction?

## NFIP LOSS REDUCTION MEASURES FOR EXISTING CONSTRUCTION

From NFIP's inception, it was reasoned that adoption and enforcement of floodplain management measures would reduce future losses in three ways: (1) through preventive action for new construction, either by requiring that structures be elevated or floodproofed above the 100-year flood level and restricting construction within designated floodways; (2) through corrective action for existing construction, by requiring modification of structures whenever they were substantially improved (or repaired); and (3) under the Program's Section 1362 provision, by acquiring and removing severely or repetitively damaged properties from the floodplain. Substantial improvements in requirements for existing construction were historically viewed as a primary tool that would, within a reasonable period of time, lead either to removal of non-conforming structures and uses in flood hazard areas or require their modification so they would conform with the regulations applicable to new construction. Their long-term impact in terms of reduced exposure to flooding was thought to be significant.

For the purposes of this paper, the term "existing construction" refers to the broad class of buildings which have been constructed without regard to potential flood hazards, and which have been built prior to the adoption of floodplain management regulations required of communities which participate in the NFIP.

As has been suggested by a number of studies (1) and as evidenced by enforcement evaluations conducted in participating NFIP communities, it is probable that substantial improvement requirements have had little effect in reducing losses to existing construction. Two principle reasons for this include:

- Administrative difficulties at the local level in applying the provisions (including legal difficulties), rule interpretation problems, hardship considerations, and political pressures.

- A high percentage of non-coastal flood events which have occurred in this country in the last 15 years have not resulted in damages to buildings which have required application of the substantial improvement requirement. In fact, it appears that in large percentage of the non-coastal flood situations in the United States, the occurrence of even an extreme event, such as the 100-year flood, will not result in damage levels sufficient to trigger the substantial improvements requirement.

The second program provision which was intended to address the existing construction problem involves purchase of flood damaged property under Section 1362 of the National Flood Insurance Act. Under this program, structures may be acquired which have either incurred significant repetitive flood damage (3 losses in 5 years, where the average damage amount equals or exceeds 25 percent of the value of the structure), have been substantially damaged (50 percent or more) from single casualty event, or where a damaged structure is precluded from repair by a local regulation.

Since 1980 approximately 600 structures

have been purchased under this program at a total cost of $20 million. Through 1984 the predominant qualifying criterion involved structures which had been substantially damaged by a single flood event. Comparatively, 90 percent of the projects initiated in 1985 are qualifying under the repetitive loss criterion of 3 losses in 5 years. Although this trend suggests that the program will have an "immediate" impact on reducing future flood losses to some high risk (i.e., repetitive loss history) properties, the overall impact is probably not that significant given the limitations of funding and other requirements for qualifying for purchase under the program.

The conclusion which can be drawn from our short term observation of these two program components, is that although there is evidence that net positive gains have been achieved through application of the substantial improvement regulations and the Section 1362 program, these programs by themselves can not be expected to have a significant impact in reducing the sizeable inventory of existing at-risk floodplain development.

## EXISTING CONSTRUCTION LOSS EXPERIENCE

Almost 20 years ago, a report to Congress investigating the feasibility of the NFIP, estimated (without the advantage of credible loss experience data) that approximately 65 percent of the country's average annual flood losses occur to structures located within the 10-year floodplain — 95 percent within the 50-year floodplain (2). While these figures were always treated with some skepticism, information now available on repetitive losses to buildings insured under the NFIP suggest that the historical estimates are quite reasonable.

The NFIP's claim activity between 1978 and 1984, shows that out of a working base of 1.5 million insured buildings, there have been:

— 233,500 buildings which have suffered a flood loss (16 percent of the total policy base)

— Of that total, 200,000 buildings have suffered <u>one</u> insured loss, and 33,500 or 2 percent of the policy based have had more than 1 loss:

| | | |
|---|---|---|
| 2 losses | - | 23,000 buildings |
| 3 losses | - | 7,300 buildings |
| 4 or more | - | 3,200 buildings |
| | | 33,500 buildings |

— Since 1978 these 33,500 buildings have incurred a total of 80,000 separate claims (see Figure 1).

The actual <u>dollar claim</u> distribution for buildings insured under the program reveals that:

— During the period 1978-1984, $1.91 billion in claims were paid (actual damage amount to these structures was $200 million higher).

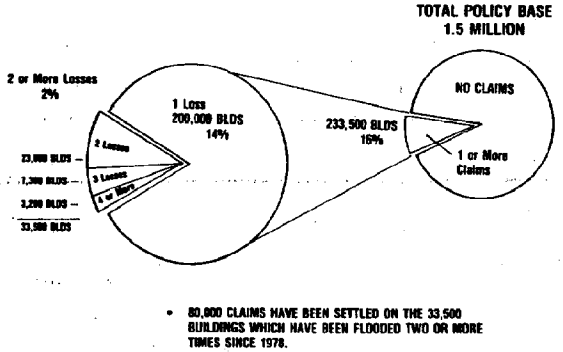
— Of that amount, 60 percent or $1.16 billion was paid on those structures which had incurred only 1 loss (200,000 buildings).

— Forty percent of the total amount of claims paid ($755 million) has involved buildings which have suffered 2 or more losses.

| | | |
|---|---|---|
| 2 losses | - | $409 million |
| 3 losses | - | 201 million |
| 4 or more | - | 145 million |
| | | $755 million |

— Two percent of Policy Base (or 14 percent of the buildings with a claim history), has incurred 2 or more losses accounting for 40 percent of the total amount of claims paid. (See Figure 2.)

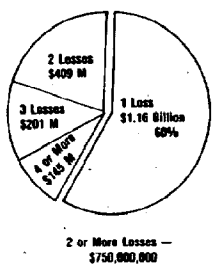
**Figure 1**
**CLAIMS ACTIVITY 1978 - 1984**




• 80,000 CLAIMS HAVE BEEN SETTLED ON THE 33,500 BUILDINGS WHICH HAVE BEEN FLOODED TWO OR MORE TIMES SINCE 1978.

**Figure 2**
**CLAIM OUTLAY BY REPETITIVE LOSS CATEGORY**

**1978 - 1984**




2 or More Losses — $750,000,000

2% OF THE POLICY BASE HAS INCURRED 2 OR MORE LOSSES ACCOUNTING FOR 40% OF THE TOTAL AMOUNT OF CLAIMS PAID

By statistical comparison, it seems probable that over half of the insured structures which have been repetitively flooded are situated within the 10-year frequency floodplain. This becomes an important factor when evaluating the economic feasibility of various corrective measures. On this basis, we can expect this small base of repetitively flooded structures to cause additional losses in the order of $75 - 100 million annually.

## FEASIBILITY OF RETROFITTING EXISTING CONSTRUCTION

Retrofitting or corrective actions for existing flood-prone property can take five principal forms. Each will be described and then analyzed in terms of physical feasibility, economic considerations, and primary advantages.

### Raising Existing Structure

A. Description. Existing buildings can often be raised in place to a higher elevation to reduce the susceptibility of foundation failure and inundation damages to the habitable portions of the structure. The steps generally involved in raising a structure include:

- -- disconnecting plumbing, wiring and utilities
- -- placing steel beams and hydraulic jacks beneath the structure
- -- either extending existing foundation walls and piers, or constructing a new foundation
- -- lowering and anchoring the structure onto the extended foundation, reconnecting service lines, and adjusting access points.

B. Physical Feasibility. Almost any type of construction - crawl space, slab-on-grade, masonry, brick veneer, etc. - can be elevated in place. The practical limitation of this method is governed primarily by cost. Wood frame residential structures constructed on crawl space foundations are particularly easy to raise. Almost any type of elevated foundation can be used with this retrofitting method. Its application is only slightly more limited by hazard type and elevation than for new construction.

C. Economic Considerations. The costs associated with retrofitting using elevated foundations have been found to vary widely according to factors such as structure type, size, shape, condition of house, type and height of elevated foundation, and local labor conditions.

A survey of some 40 elevation projects, placed most house raising costs in the $10,000 to $30,000 range. These projects typically involved raising structures 4 - 7 feet above grade. Most construction projects observed involved brick veneer and wood-frame construction on crawl space or slab foundations, with ground floor sizes ranging between 1200 and 1600 square feet.

From an economic feasibility standpoint, this method of retrofitting has been found to be almost always cost effective for structures located within the 10-year floodplain and under certain circumstances in the 10-15 year frequency range.

D. Primary Advantages

- -- Applicable to a wide range of structure types and flood situations.
- -- Involves permanent corrective action which does not require human intervention.
- -- Additional protection heights can generally be achieved for small additional cost per foot.
- -- Flood insurance premiums can be substantially reduced. (Example: Under the NFIP, a slab or grade structure, with $50,000 structural coverage, would have a premium of approximately $200 per year; elevating that structure 1 foot above BFE would reduce the premium by 60% to $80 per year).

### Small Floodwall/Levees

A. Description. Both levees and floodwalls are under some circumstances extremely effective in reducing losses to existing construction. Levees can be constructed using compacted soil with an impervious inner core to prevent seepage. Floodwalls are generally composed of brick, stone, or concrete. With either method, provisions must be made for handling water accumulations inside the protected area which result from seepage or internal runoff.

B. Physical Feasibility. Unlike other available retrofitting measures, the floodwall or levee option is not limited by the physical attributes of the structure and therefore is feasible for any type of existing construction. The question of physical feasibility centers more on site conditions - topography, available space, compatibility with existing use, soil and water conditions; and on the nature of flooding velocity, depth and warning time.

For most residential applications, protection heights of up to 5 feet are considered practical from a technical design standpoint. They should be avoided in areas which are subject to higher flooding levels, or where long duration or high velocity flow conditions are expected.

C. Economic Considerations. As with elevation-in-place, the costs for constructing levees and floodwalls tend to cost about a third more than a levee of similar height and length. Overall, levee and floodwall costs range from one-half to one-third less than the cost of elevating-in-place to the same height.

A sampling of project costs for levees and floodwalls suggests that for a protection level of 5 feet, levee costs range from $30 - $40 per linear foot. Concrete masonry walls range from $50 - $60 per linear foot.

D. Advantages/Limitations.

-- Prevents direct exposure of the structure to flooding including protection of areas outside the perimeter of the structure.

-- Not dependent on size, type or condition of the structure as in the case of elevation-in-place. It may be effective for many areas subject to repetitive flooding, where typical flooding characteristics involve low depths and velocities, and stage-frequency differences between the 10-year and 100-year event are small (i.e., low flood hazard factors).

-- Overtopping of design level may increase the level of structural damage.

-- Obstruction of flow or removal of floodwater storage can increase flooding on adjacent property.

-- Insurance rate reductions generally not applicable.

-- Use of shields requires human intervention.

Space/Use Adjustment - Raising Utilities

A. Description. To one degree or another it is feasible to either relocate damageable contents or utilities to a less damageable location, or to protect in-place. Some of the more obvious examples include:

-- protecting furnaces, water heaters, air conditioners, washers/dryers and other similar property by raising them off the flood, or by relocating to higher floors.

-- Eliminating or relocating habitable space, including finishings and contents subject to flooding.

B. Physical Feasibility. The degree to which property can be rearranged and protected is site-specific. It depends on the flood hazard (principally depth and frequency of flooding) upon the damageable contents or utilities, their type, value, location and movability, and upon the availability of adjacent, less floodprone locations within the structure. Every structure has some contents or utilities which can be either relocated or protected - the more there is, the more damage that can be reduced.

C. Cost Considerations. Costs to rearrange or protect damagable contents depends upon the specific actions taken. Some surveyed costs for utility equipment protection is as follows:

| | |
|---|---|
| small wall shielded furnace enclosure (6" high) | $250.00 |
| suspended utility system platform | $700.00-1000.00 |
| relocation of furnace and air conditioning to upper floor | $2000.00 |

Sealants/Closures

A. Description. Residential structures with exteriors generally impermeable to water can, in a limited number of situations, be made water tight by installing watertight closures to openings such as doorways and lower level windows. Seepage rates, while difficult to eliminate, can be reduced by applying waterproof sealants or wrap-around plastic membranes for all floodwater contact points. Closures may be temporary or permanent. Temporary closures are installed only during a flood threat and therefore need sufficient warning time for installation.

B. Physical Feasibility. Very little experience data is available on the reliability and effectiveness of sealants and closure systems for residential construction. This combined with the inherent limitations and drawbacks presented by these techniques do not make this a method of choice for most flooding situations. Because most residential structures are not designed to withstand hydrostatic pressure on exterior walls and floor systems, it is imperative where this method is being considered that a structural analysis of the building and analysis of soil and hydrologic conditions be performed.

These methods are generally appropriate only for structures with slab foundations and with exterior walls constructed of brick, brick veneer, concrete, concrete and masonry block. For most residential construction, design safe levels for water exclusion should not exceed two feet.

Relocation

A. Description. Relocation of an existing structure to a non-floodprone site is the most reliable of all "retrofitting" methods. It is also usually the most expensive. Steps in carrying out this option include purchase of

a new lot, preparation of the new site including services and new foundation, raising the structure off its existing foundation, transporting it to the new site, placing it on the new foundation, and finally, restoring the original building location.

B. Physical Feasibility. In general, just about any residential structure for which elevation in place is feasible can also be transported to a new site. One- and two-story wood frame construction built on raised foundations or basements are ususally easy to move because of the lower structure weight and access to the floor joists. Structures of brick, concrete or masonry can also be moved. However additional bracing requirements are usually necessary to prevent cracking.

C. Economic Considerations. Costs for relocating residences, exclusive of land cost at the new site, have been found to generally range between $20,000 - $40,000. Most studies have indicated that even with these higher costs, relocation is often economically feasible for structures located within the 20-year frequency floodplain.

## SUMMARY: STRATEGY FOR PROMOTING RETROFITTING APPLICATIONS

The preceding discussion has attempted to convey the following points:

1. First, that the NFIP's statutory and regulatory provisions (substantial iprovement and Section 1362) have had only a limited impact on reducing losses to existing construction.

2. Second, loss data suggest that a very small percentage of the NFIP's existing construction policy base (2 percent) or 14 percent of insured structures suffering a claim loss, are extremely flood-prone, accounting for 40 percent of the total claims payout under the program since 1978 -- and will continue to accumulate losses of between $75 -- $100 million per year.

3. Third, there are a wide number of mitigation strategies which can be physically and economically applied retroactively to these repetitively flooded properties.

In view of the above considerations, FIA has initiated a number of efforts which begin to focus on and address the tremendous "risk exposure" issue involving existing, non-protected floodplain construction.

This newly adopted strategy involves a two-phased approach. The first phase involves both basic research and information dissemination of the various methods and practices which can be used to reduce losses to existing construction. A research project, started in October, 1984, and to be completed by April, 1986, will result in publication of a technical guidance manual on retro-floodproofing techniques. This manual will differ from FIA's six existing or recently completed publication efforts, in that it will focus solely on mitigation techniques and methods which can be applied to existing, non-protected construction. This manual will report on the economic and physical feasibility of applying such retrofloodproofing techniques as elevation-in-place, use of small levees and floodwalls, watertight closures, and site relocation.

FIA plans to widely disseminate this manual, free of charge, as part of a general educational effort to promote the feasibility and practicability of applying applying retrofloodproofing measures. In addition to the manual, FIA will develop a "flyer" describing the various retrofloodproofing techniques and sources of additional information, which will be enclosed with claim payments issued to existing-construction insureds.

While the dissemination of State-of-the-Art informationon retrofloodproofing will be helpful in educating both homeowners and the building professions on application of such techniques, additional means to encourage the application of these methods will be necessary. Thus, the second phase of this strategy, will involve the identification, formulation, and as appropriate, adoption of policies or procedures to accomplish this objective. The first part of this effort to be performed during 1986 involves the following steps:

(1) Analyze current policy and claims data to identify the population of existing insured structures which are at risk and for which retrofloodproofing action may be feasible;

(2) Develop a series of case study analyses illustrating application of the various types of retrofloodproofing techniques,the resulting economic feasibility of each method, and the potential range in benefits accrued by the reduced potential for flood damage and claim payments; and

(3) Based in part on the findings from (1) and (2) above, identify and develop the range of program options which appear to be feasible given the statutory, administrative and regulatory limitations of the program.

The latter step will concentrate on identification of economic incentives, both positive and negative in effect, which rely on the insurance rating and coverage, or statutory provisions of the NFIP. Positive incentives to be considered include insurance premium reductions where corrective mitigation action has occurred, providing policy riders for covering part or all of the cost of retrofloodproofing, or providing loans for retro-elevating similar to the provision provided under Section 1362(c) of the National Flood Insurance Act. Other options to be considered will include use of

rating surcharges or co-payment clauses for repetitive loss cases where no action is taken by the property owner to reduce future flood damages.

## LITERATURE CITED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Committee on Banking and Currency, United States Senate. 1966. Insurance and Other Programs for Financial Assistance to Flood Victims. U.S. Government Printing Office, Washington, D.C.

# Modification of Homes and Buildings to Prevent Floodwater Damage

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## INTRODUCTION

For several years, the U.S. Army Corps of Engineers at its Waterways Experiment Station (WES) in Vicksburg, Mississippi has been researching to develop nonstructural methods for protecting buildings from floodwaters. We have been developing materials and systems which can be installed in existing buildings to reduce flood damages.

Each year a tremendous amount of damage is done to homes and other buildings by floodwaters. For example, Figure 1 shows flood-damaged homes in Atlanta, Georgia. Enormous damages have also occurred in New Orleans, Louisiana; Phoenix, Arizona; and other locales.

To reduce damages, a system is needed which a home or building owner can activate in approximately 30 minutes and which will prevent floodwaters from entering the house or other building. After the floodwaters recede, the owner should also be able to deactivate the system with no damage to the home or building.

## THE RESEARCH PROGRAM

We started our program at WES with both an analytical and an experimental study. The analytical study investigated the feasibility of using the finite element method to model and analyze walls or buildings and determine safe water loads. Such an analytical study could be done more quickly and at less expense than an experimental study; variables such as building strength and house modifications could also be analyzed. It was found in this study that deflections and stresses of a structure subjected to water loading could be determined; however, the analytical study was terminated when it was found that the experimental aspects of the problems were more complicated than had been expected and that more effort was needed to investigate practical designs which would help home and building owners protect their buildings from floodwaters.

### Testing of Designs

We have now performed tests on full scale brick veneer and block walls (Figure 2) to determine their structural integrity. We also have tested many systems and materials on walls and test cubes (Figure 3) for performance in retaining a head of water. Two tests on actual homes were performed. One was a typical block home just outside of Phoenix,Arizona (Figure 4) and the other was a brick veneer home in Tulsa, Oklahoma (Figure 5). We wanted to see how quickly floodproofing systems could be installed and how effective they would be when water rises outside of the house. Both tests were successful and suggested materials and systems which can be used to protect a house or building from floodwaters up to safe water loads.

In our investigation of the structural integrity of existing homes, we tested pertinent components (stud to base plate connection, roof rafter and ceiling joist connections to the top plate of the wall, wal tie strengths, etc.) so that a general understanding of the strength of each component could be obtained which would allow decisions about failure mechanisms or the weak links in wall construction. Entire walls were then tested, and it was found that a brick veneer or block wall can withstand about 3 feet of water loading before damage occurs.

We tested prototype test walls such as brick veneer wall (Figure 6), a typical construction of the end wall of a house; that is, it had no roof rafter or ceiling joist supports. An independent support system was constructed at the back of the wall for LVDT gauges which were used to measure the deflected shape of the wall. A trough was constructed in front of the wall to contain water, and computations indicated that a 4-ft head of water should be enough to fail the brick veneer wall. At 2.4 feet of head, the wall began to have large deflections with small increases in water depth (Figure 7) and failure occurred at a head of less than 4-feet.

Initially, about 1-1/2 feet of head was pooled against the wall to see how badly the brick veneer would leak, and it leaked very badly. The water was removed from the trough and a liner put in so that a static water pressure could be applied against the wall to determine the water level at which the wall would fail. Determining this failure point was critical because, if the wall was protected to a greater height it would collapse and be destroyed. In other words, it would be better to allow water to enter and damage a house than to waterproof it to a level which would collapse the walls.

Figure 1. Homes damaged by floodwaters, Atlanta, Georgia

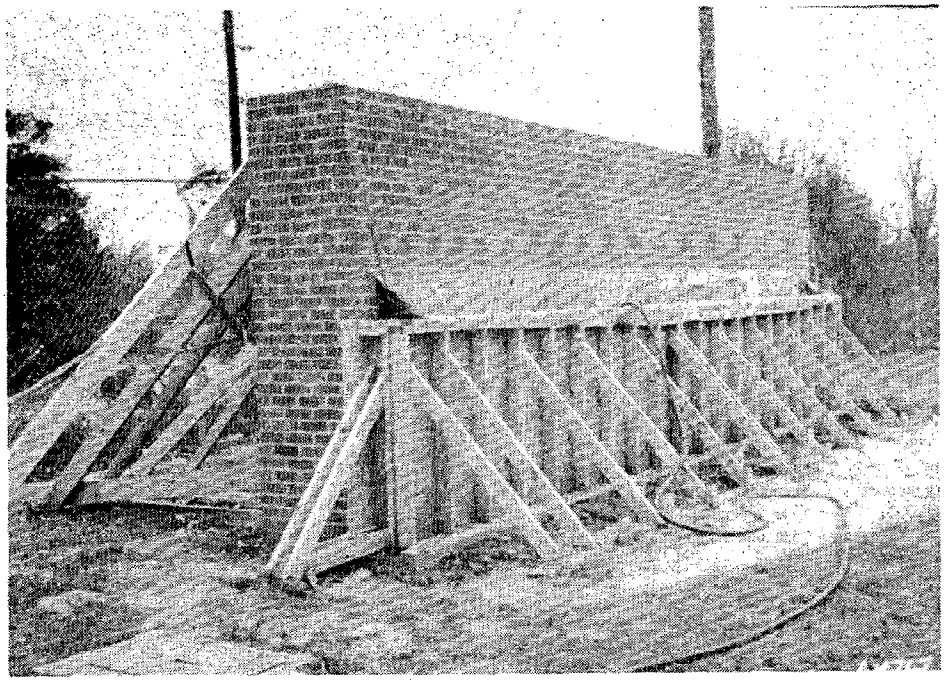

Figure 2. Brick-veneer test wall

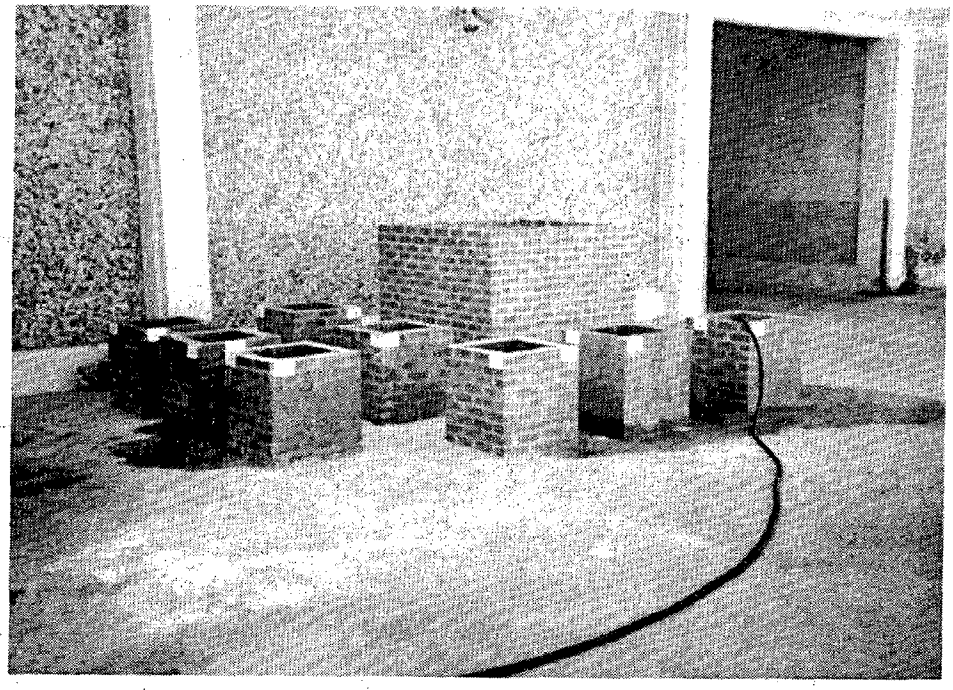

Figure 3. Cubes for testing flood-resistant materials and systems

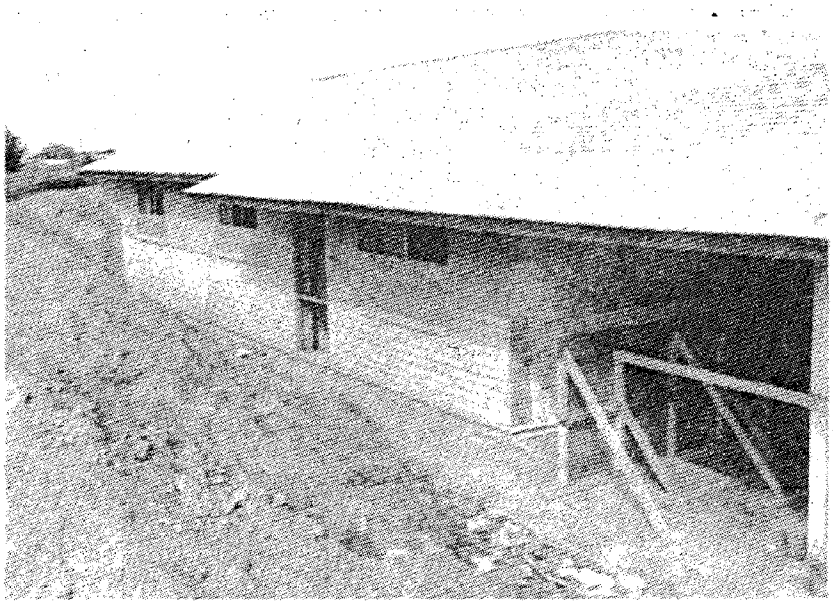

Figure 4. Front view of house to be made resistant to floodwaters, Phoenix, Arizona

Figure 5. House to be made resistant to floodwaters, Tulsa, Oklahoma

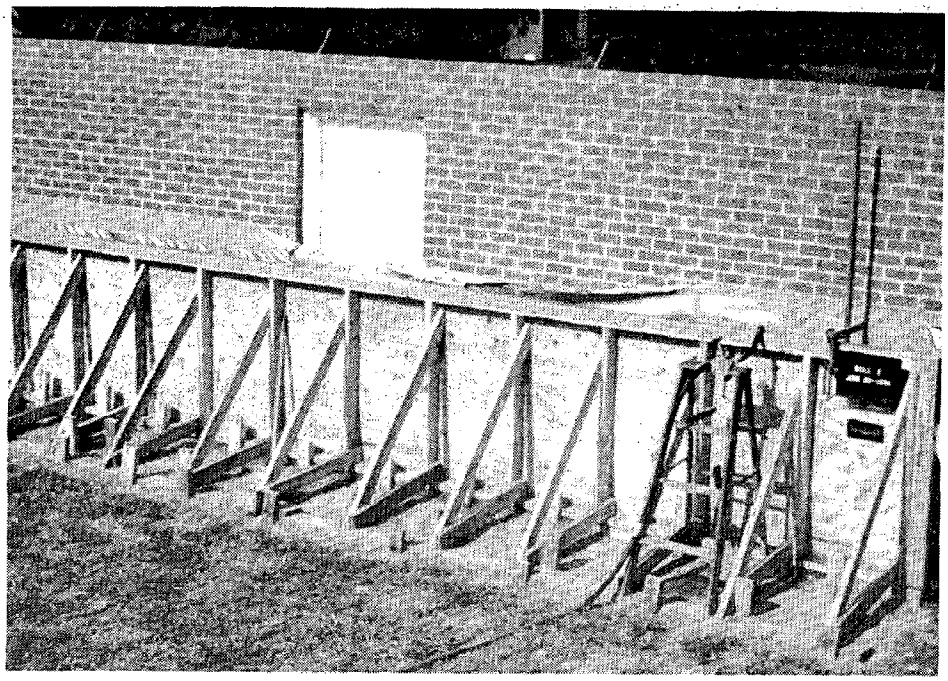

Figure 6. Test wall 1

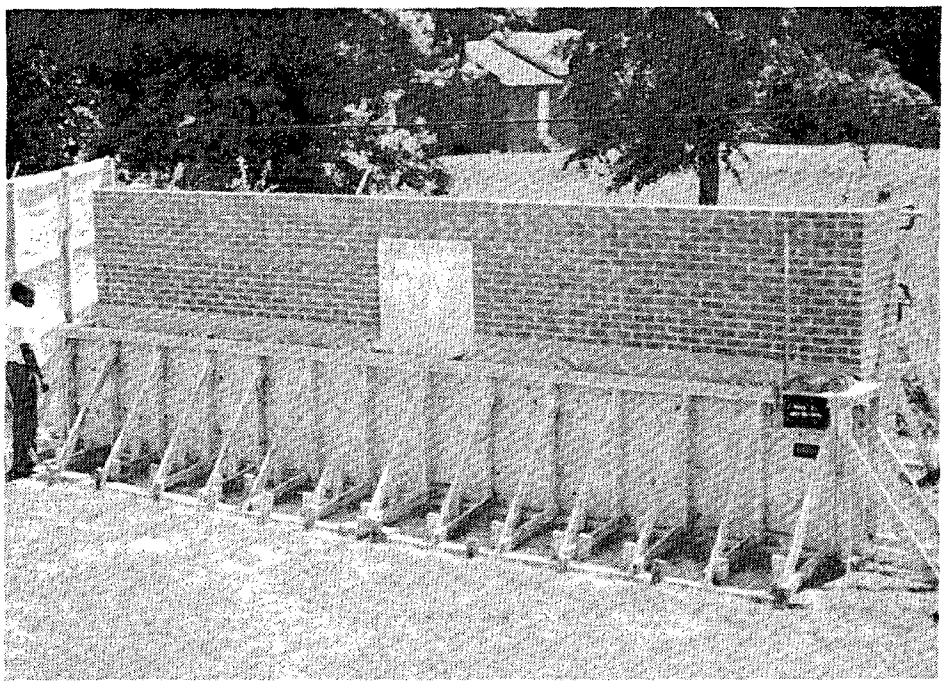

Figure 8. Brick-veneer wall 2

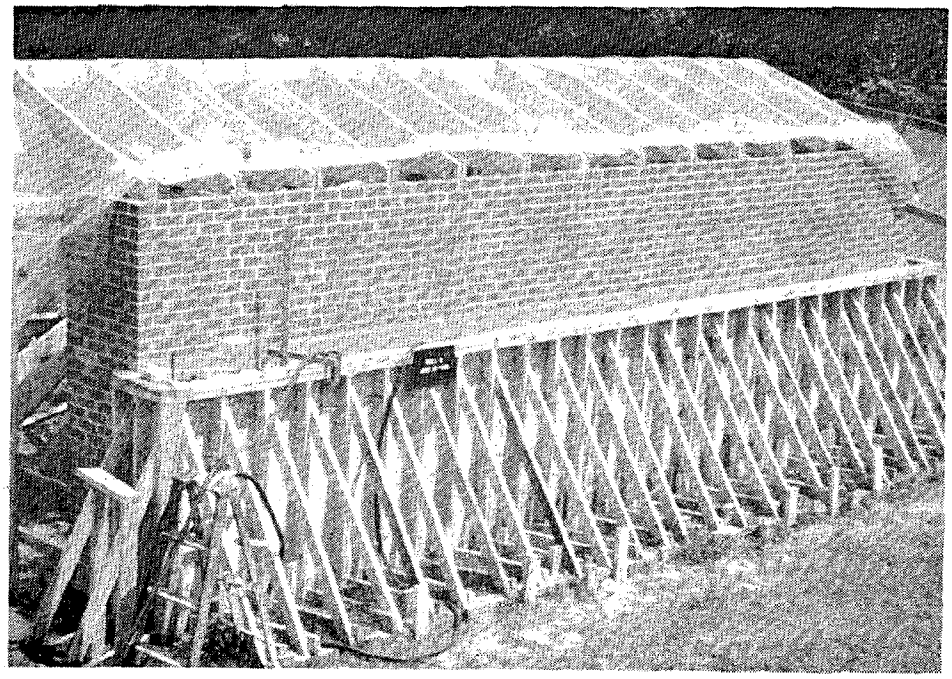

Figure 9. Brick-veneer wall 3

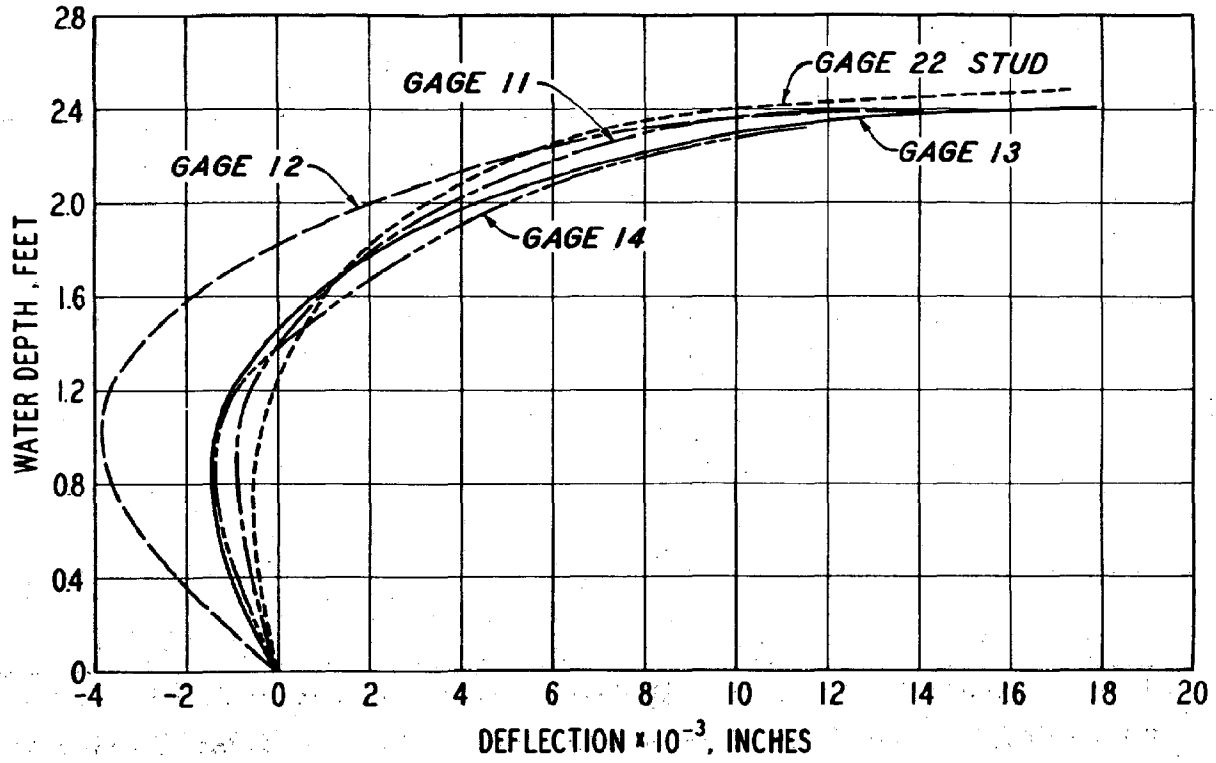


Figure 7. Wall 1 - brick-veneer wall and stud deflections, horizontal gage line

A second brick veneer wall (Figure 8) was constructed nearly identical with the first wall, except that a 3 foot by 6 foot, 8 inch door was constructed in its center. The test of this wall revealed that the metal lintel at the top of the door used to support the brick strengthened the wall to the extent that it was essentially the same strength as the wall without the door (wall 1).

Wall number three (Figure 9) was constructed identical with walls 1 and 2, except that it had roof rafter and ceiling joist supports. Earlier tests of a number of essential components and connections revealed that the motor joint at the base of the wall would not fail in shear. Consequently, we were somewhat concerned that the 6-foot high trough selected for holding water against this wall could not permit sufficient force to be applied to the wall to make it fail. However, at a 57-inch of static water head, there was a loud bang and the wall collapsed, with large pieces of brick veneer flying in various directions. The pieces of brick in front of the wall (Figure 10) flew over the trough and landed on the ground. The failure mechanism was a breaking of the studs, suddenly collapsing the wall.

These results are significant in several respects. Houses should not be floodproofed to heights which will permit structural damage due to water load. Owners and builders should be informed about water heights which can cause a house to collapse. Individuals attempting to remain inside their floodproofed homes during a flood reaching to these failure levels could easily be killed. The deflections which cause severe damage to the building are very small (approximately 0.001 inch).

A number of materials were tested to determine if they would make a brick or block wall impermeable to a head of water; several of them, which were claimed to waterproof walls, did not. for example, clear sealants that would bead rain water off of the wall would not retain a head of water. Other waterproofing materials worked temporarily but were not durable and would deteriorate in 6 months to 2 years. However two were satisfactory. One was a waterproofing material from a private corporation, and the other was a material developed at WES. The material developed at WES used an acrylic polymer to replace some of the water in the mixture.

We found that there are materials which will seal a wall from water penetration. But

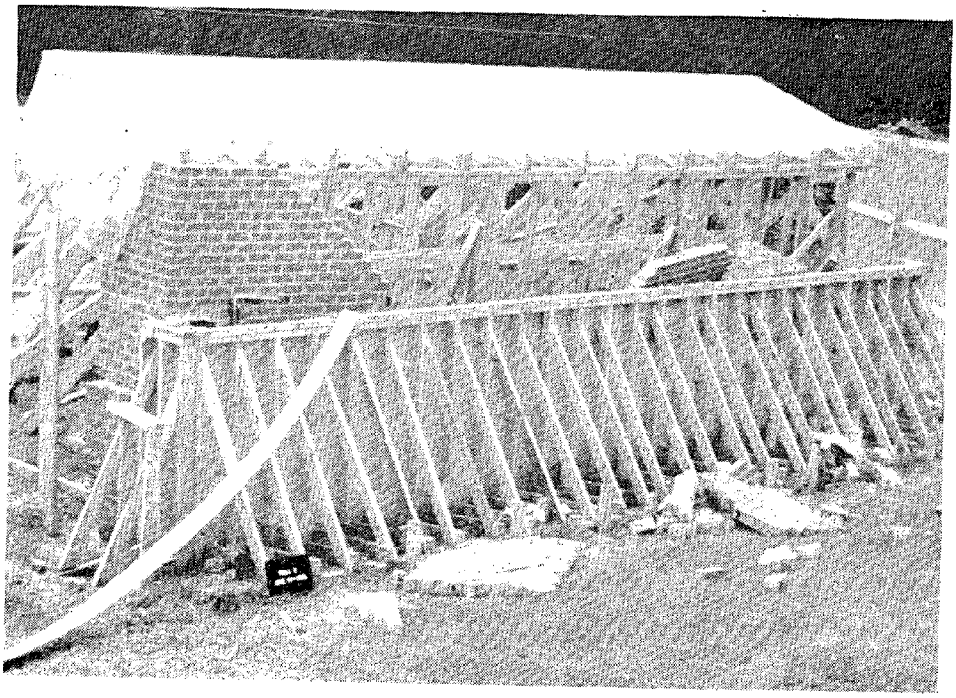

Figure 10. Failure of wall 3

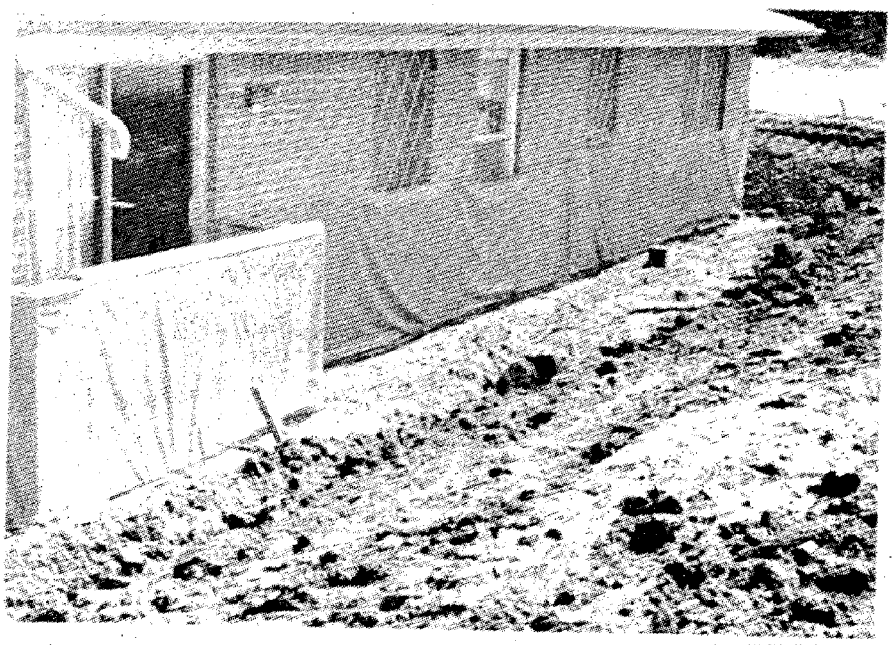

Figure 11. Vinyl-coated nylon fabric used in preparing house to resist floodwaters

the user must be careful in making a selection because there are many materials claimed by manufacturers to be effective which are not.

## CONCLUSIONS AND RECOMMENDATIONS

We recommend that the system used to protect the houses in Tulsa, Oklahoma (Figure 11) be applied elsewhere. This system consists of an impermeable membrane which is placed in the ground to prevent uplift and underseepage. The membrane extends from the ground up the wall of the house and is fastened to snap connections. A trough is located at the ground level and against the house for storage of the upper part of the membrane when not in use. A drainage, sump, and pump system is located behind the flood-resistant construction to collect and remove any underseepage. This system is workable and has performed well in tests. It can be activated very rapidly and has only a few sources of potential problems.

Contractors are now installing some of these systems in existing homes. It will be mutually beneficial for the Corps of Engineers and the private sector to work together in developing such materials and systems. The contractors who work daily in floodproofing buildings will undoubtedly encounter useful ideas, new techniques, owner concerns, etc., which will advance our general knowledge. In the same manner, the Corps is learning much through its testing and research program that can help both contractors and building owners. The Corps can address areas of special and unusual needs where the contractors may not have the time, money, or expertise to develop and research solutions. This information could then be provided not only to contractors but also to the broader private sector.

Based on our work, we recommend that tests of promising cementitious coatings be performed to determine their effectiveness in preventing water penetration when subjected to various environmental conditions. In addition, the penetration or flow of water over various periods of time through various foundation soils should be further investigated. Required depths for impermeable barriers to reduce underseepage and uplift for specific time intervals in various foundation soils should also be determined.

A loose-leaf homeowner's manual should be written presenting the pitfalls of flood-resistant construction, options for making buildings resistant to floodwaters, and other information which will be helpful to building owners and contractors. The manual should be organized so that it can be easily updated as pertinent information becomes available.

Cooperative efforts should be made with the public, contractors, material developers, and researchers to improve water-resistant construction as quickly and as efficiently as possible.

# Evaluating Hurricane Shelters and Other Flood Resistant Structures

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## INTRODUCTION

Whenever a hurricane threatens a coastal area there may be people who refuse to evacuate, who try to evacuate too late and cannot, or who must remain to provide emergency services. Local government can minimize the risk to these people by designating certain existing buildings as storm refuges or by designing and constructing new buildings as refuges.

Moreover, there may be vital supplies and equipment (food, water, medicine, generators, pumps, communications equipment, vehicles needed for post-storm operations, etc.) that must be sheltered from storms. These may be placed in buildings that will also protect people, or they may be placed in other storm-resistant structures.

This paper will provide basic guidelines for the evaluation of existing buildings or the design of new ones as refuges. These guidelines were developed and used during a recent study of hurricane shelters in the Florida Keys (Spangler and Jones, 1984).

## EVALUATION PROCEDURE

It is critical that the storm resistance of existing or proposed buildings be determined as accurately as possible. If the resistance is underestimated, use of the building may be lost. If the resistance is overestimated the results may be even more serious: the building may sustain structural damage or be destroyed resulting in destruction of needed supplies and equipment and injury or death of people.

It is important to realize, however, that the storm resistance of a building cannot be determined exactly. In the case of an existing building, it is rarely possible to obtain all pertinent plans, specifications, design calculations, construction records and other information needed to analyze the structure. In the case of a proposed or new building these items should be available, but there will still be some uncertainty. This is due to the fact that it is not possible to predict the exact wind, water and debris forces that will accompany a given storm.

Despite these limitations, uncertainties can be minimized by making a careful, detailed investigation of the structure, the site where the structure is (or is to be) located and by obtaining the best available estimates of wind forces and flood levels. A general procedure for evaluating existing buildings follows:

1. Identify Potential Shelters - this should be based on location, elevation, type of construction, etc.

2. Collect Information - obtain plans (as-builts, where possible), specifications, building modification and maintenance records; locate the designer and contractor; obtain flood hazard data.

3. Inspect the Building - check all structural elements and connections, where possible; note any deviations from the plans and any defects or problems; obtain samples of materials and perform tests on building components, as required; photograph and document the building and its condition.

4. Inspect the Building Site - check for exposure to wind and proximity to water; photograph and document adjacent structures or vegetation that may shield or damage the building.

5. Analyze all Information - the procedure and effort will depend upon the amount of information available and the complexity and condition of the building.

6. Rate the Building - determine the highest category storm that the building can withstand, taking into consideration the effects of wind, water, waves and debris; note any special precautions or repairs that must be made before the building can be used as a shelter.

Buildings proposed as refuges should be located away from shorelines and floodways, and should be designed to withstand all anticipated wind, hydrostatic, hydrodynamic, wave and debris forces. Guidance for estimating these forces can be found in numerous references (American National Standards Institute, 1982; Colorado Water Conservation Board, 1983; Culver, et al., 1975; Federal Emergency Management Agency, 1981; Kirkoz, 1982; Mehta,

et al., 1981; Texas Coastal and Marine Council, 1981; U.S. Army, Corps of Engineers, 1984).

Whether analyzing an existing building or designing a new building, there are many details that must be considered to ensure the protection of the people and equipment inside. Some of these are:

Exposure - buildings situated close to the shoreline are subject to the most severe wind and wave conditions.

Foundation - pile supported structures are susceptible to failure unless the pilings are adequately designed. Structures supported on spread footings cannot accommodate much scour without collapsing.

Exterior walls - have the exterior walls been designed to withstand the same design loads as the structural frame? Are the walls reinforced and/or properly tied to the frame? Will lower story walls break away under wave attack or will they transfer loads to the frame?

Openings - window and door glass are especially vulnerable to flying debris. Window and door frames should be in good condition and firmly attached to the walls.

Shutters - shutters are important, not only because they protect glass or other vulnerable areas, but also because they can prevent undesirable internal pressure increases in buildings. Shutters should be solid and should be attached to the main structure, not the window and door frames.

Connections - all structural elements should be tied together to resist positive and negative loads.

Roof - roofs are susceptible to uplift failures, especially near edges and corners and when large roof overhangs are present.

Roof drainage - check the capacity and condition of roof drains and scuppers. If these become clogged, can rainfall trapped on the roof lead to roof overload?

Maintenance - the resistance of buildings can be reduced considerably from original due to inadequate maintenance. Some of the older, monumental-type buildings can provide some of the best shelter, provided they are maintained.

Modifications - the installation of plumbing, air conditioning and other utilities, or the construction of additions to buildings can alter the resistance of shelters. Check for any modifications to the original building.

## RECOMMENDATIONS

1. Storm shelters and other vital structures should be located within the regions where they are needed, but away from sites exposed to wave attack, high velocity currents and, if possible, high winds.

2. Make sure that all parts of the structures are designed and constructed to withstand all anticipated storm forces.

3. Ensure that these structures are inspected periodically and that all necessary repairs are made before they are used for storm protection.

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# The Role of Vertical Refuge

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## INTRODUCTION

In the early 80's the SLOSH (Sea Lake and Overland Surges from Hurricanes) mathematical model for computing storm surge height and penetration for specific simulated hurricanes was used for hurricane evacuation planning. We now have a "fairly" accurate (plus or minus 20 percent of actual surge height) tool to indicate when evacuation routes could be blocked by storm surge from specific types of hurricanes. Not only does SLOSH indicate where storm surge blockage may occur, but also wind gusts which could tip vehicles.

Early evacuation studies, like those conducted in the Tampa Bay area of Florida and the Houston-Galveston area of Texas, calculated the evacuation route capacities and the number of vehicles that would be using these routes. For major hurricanes, the estimated evacuation time for Tampa Bay was 17 hours and for Houston-Galveston it was 26 hours. Vehicles would need to traverse these routes before they were blocked by flood waters or winds. Under certain extreme conditions, storm surge or wind gusting could block evacuation routes up to 20 or 30 hours before the time of landfall. Allowing 3 hours for the evacuation message to be disseminated (and for people to pack and begin evacuating), total evacuation lead times of 49 to 59 hours were needed before anticipated hurricane landfall. Unfortunately, accurate forecasts of landfall 49 to 59 hours in advance are not possible.

To further complicate the evacuation problem, there are barrier islands and coastal areas serviced by single evacuation routes. Should a catastrophic accident take place, or a loose barge damage the causeway, thousands of people could be trapped.

Because these are very real concerns, a solution was proposed. Why not use sturdy structures as sites of refuge during a hurricane as did people in Galveston who used the courthouse and the medical center during hurricane Carla. The possibility was suggested of not only using these buildings as a "refuge", but also in conjunction with horizontal evacuation where some residents would evacuate by vehicles. In contrast with horizontal evacuation from an area, the term "vertical evacuation" became associated with the idea of evacuating people (vertically) in buildings. Much confusion developed over the use of this term; many even thought it meant the use of helicopters.

Questions arose as the the feasibility of vertical evacuation. How safe are buildings? Would people use these buildings? Would politicians ever recommend the use of structures? What type of liabilities would be involved?

It was at this juncture that the National Science Foundation funded a study to investigate the feasibility of using "vertical" shelters. This study (still in progress) is to investigate the structural, the socioeconomic, the political, and the legal concerns of the potential use of vertical shelters.

To evaluate the feasibility of the concept of vertical evacuation, certain potential barriers to the acceptance of the general use of vertical shelters were to be studied. These barriers reside within four study areas: structural; socioeconomic; political and legal.

To evaluate the concerns in each of these areas, we found a common unifying thread of risk analysis and perception of risk throughout. In the area of structural concerns, building safety is rationally related to the risk of death to the occupants; building classification for vertical shelters is based on comparative risk levels; and finally upgrading of "non-acceptable" facilities to "acceptable" and the associated costs is again based on a target level of "acceptable" risk.

Under the socioeconomic concerns, public acceptance and use of vertical shelters are based on the public's perception of the level of risk. Sheltering groups also are interested in the risks involved in utilization of vertical shelters.

The political concerns also focus on risk. For example, politicians' acceptance of the vertical shelter strategy is dependent upon their perception of the risks involved; that leads to what is politically possible and to the identification of potential problems. Also, the legal issues revolve around a study of the liability risks involved in the use of facilities for vertical shelters. This concept of risk can be seen in the work flow diagram in Figure I.

The advisory committee for the study consists of:

Dr. Neil Frank (representing the National Hurricane Center)

Dr. Jay Baker (representing the Florida Perspective)

Roy Popkin (representing the American Red Cross Perspective)

Richard Krimm (representing the FEMA Perspective)

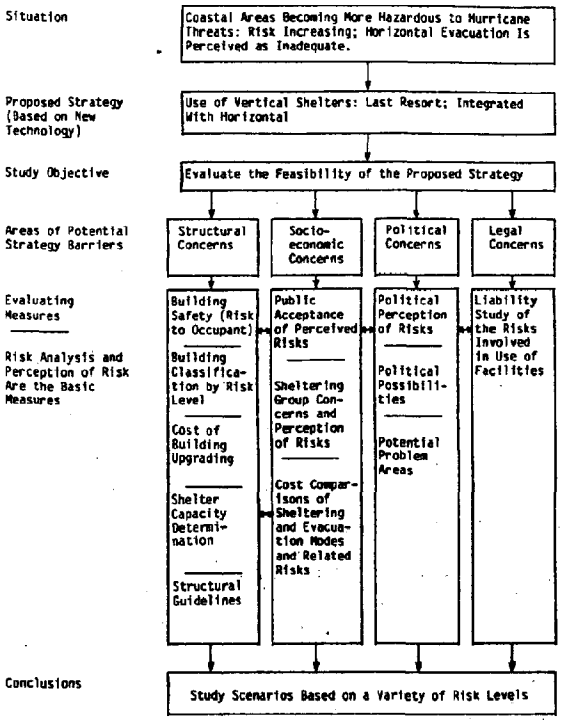


Figure 1: Work Flow Diagram

The project consultant is Dr. Robert Simpson, former Director of the National Hurricane Center.

## STRUCTURAL CONCERNS

In order to ascertain the feasibility of vertical shelters, it was decided to limit the structural investigation to engineered buildings over two stories, using only the non-glass interior portions of the first four or five floors as shelters.

Engineered buildings are those buildings which have received specific, individualized design attention from professional architects and engineers. The use of buildings over two stories insures a higher probability that it received design attention and that shelter space above potential storm surge depths is available. Using only interior portions of these buildings minimizes the risk to individuals of flying glass. Adverse psychological effects due to building sway can be reduced by using only the first four or five floors. Also the use of elevators would be restricted, limiting floor access to stairs, thus making higher levels functionally impractical.

Only structures in non-high velocity zones (located outside V Zones as defined by the Federal Insurance Administration on their Flood Insurance Maps) are being investigated. Areas outside V Zones are not subject to storm surge and fetch sufficient to generate breaking waves over three feet. Therefore, the major lateral force on these structures would be from wind.

Buildings in V Zones constructed to withstand the force of storm surge, waves, and battering may still be considered as potential shelters. However, at this stage of investigation our attention is focused on engineered structures in non-high velocity zones. If these structures prove to be feasible as vertical shelters, then the more controversial use of structures in high-velocity zones can be investigated.

Comparative risk of death is the primary criteria in evaluating the structural feasibility of vertical shelters. If the risk of death to an individual (under certain scenarios) in a vertical shelter is less than the risk in other options, such as remaining at home or going to a traditional shelter (such as a school gym), it would be structurally feasible. Using data as the performance of buildings in a wind hazard and an existing risk algorithm, Dr. Norris Stubbs, principal structural investigator, has shown that in the event horizontal evacuation is not possible, the use of a vertical shelter would result in the least risk.

Investigating the feasibility of using vertical shelters along with the horizontal evacuation introduces more complicated issues. Again, the risk to an individual is the key measurement. If there is a lower risk of death associated with vertical sheltering in connection with horizontal evacuation, as contrasted to horizontal evacuation only, then use of vertical shelters would be a safer option.

After an exhaustive review of the state-of-the-art, Stubbs suggests the use of fault-tree analysis to estimate the risk to an individual in a specific structure. This technique has been used to estimate risk by number of deaths in situations where there may be inadequate historical data, such as in the risk associated with meltdown in nuclear power plants. The fault-tree analysis process starts with a defined "undesired" event (i.e. the top event, in this case a fatality) then proceeds by deduction to develop a set of contributory events which can cause the top event. The process is continued for each of the contributory events until the resulting contributory events become basic events (i.e. events for which statistical information is readily available or can be developed by analysis). The method generates a diagram (called a

fault-tree) which is a model of the event relationships for the building system.

The basic events identified by the fault-tree analysis include: the occurrence of the hurricane, the probability of failure of the structural frame, the failure of the foundation, the failure of the roofing systems, the failure of the cladding systems, the chances that an occupant will be killed given that any one of the above failures occurred. These basic events are then combined to provide an estimate of the risk of a fatality in using a specific structure in a specific hurricane. Using these results, the structural safety of actual structures can be rationally compared.

## SOCIOECONOMIC CONCERNS

In the socioeconomic portion of the study, 1,000 questionnaire responses were received from coastal residents residing in Tampa Bay, Florida and Galveston, Texas. In response to the question, "Would you under any circumstances use a vertical shelter?" twenty-six percent in Galveston and 16 percent in Tampa Bay answered "No". However, for traditional shelters, 41 and 21 percent respectively, answered "No". Respondents further indicated that being surrounded by water would not strongly inhibit their use of vertical shelters. They also indicated there could be a significant delay in horizontal evacuation if vertical shelters were an option. Distance was also a concern. Fifty-seven percent from Tampa Bay and 47 percent from Galveston responded that if they had to travel as far as 10 to 20 miles to vertical shelters it would make a difference in their use of such shelters.

In addition to understanding the attitudes of potential users of vertical shelters, a study was conducted on the attitudes of personnel from the American Red Cross, the primary sheltering agency. Sixty-one persons from Texas and Florida and four from the Eastern Operation Headquarters in Alexandria, Virginia were interviewed. Red Cross personnel in larger urban areas with buildings suitable for vertical shelters were more favorable toward the use of vertical shelters than were personnel in less urbanized areas with few such structures or none at all. There was an overwhelming preference for the potential use of vertical shelters as a "last resort" or "refuge", rather than for their use in conjunction with horizontal evacuation. Problems identified with the potential use of vertical shelters included space allocation, supervision, care of elderly people, equipment protection, supply, toilets, food, fire protection, medical needs, ventilation, lighting, and use of elevators. The majority indicated these problems could be solved. Personnel in Texas were generally more favorable to the use of vertical shelters than were personnel in Florida.

In addition to the social aspects, an economic assessment of vertical shelters was conducted. The primary economic savings would results from fewer evacuations. By utilizing vertical shelters, evacuation times can be reduced. As a result, more time to make decisions would be available, possibly resulting in less evacuations having to be made. Over a 99-year period from 1886 through 1984 the following number of evacuations could have been avoided for a projected 1990 population on Galveston Island. The numbers are based on varying hypothetical percentages of people remaining in vertical shelters.

| Percentages of Population in Vertical Shelters | Cumulative Number of Fewer Evacuations |
|---|---|
| 10% | 3 |
| 20% | 5 |
| 30% | 8 |
| 40% | 10 |
| 50% | 13 |
| 60% | 18 |
| 70% | 20 |
| 80% | 22 |
| 90% | 24 |
| 99% | 26 |

Obviously, the larger percentages of the populations sheltered in vertical shelters result in fewer necessary evacuations. No substantial economic analysis has yet been done on potential costs.

## POLITICAL CONCERNS

While information from research on structural and socioeconomic aspects of this project is essential for solving vertical shelter problems, its effectiveness will be reduced or nullified, unless policy makers pay attention to the political barriers that can prevent use of such information. Dr. Philip Berke, principal investigator for political concerns indicates that both enactment and administration of a vertical shelter program is shaped by competing pressures from supporting and opposing interests. The effectiveness of such a program depends on implementation at the local level, involving decisions by local officials and private sector participants in the case of state or federal mandates, and by state or federal employees in the case of direct implementaton by state or federal agencies.

This study estimates the extent of support for a vertical shelter program and offers some suggestions concerning implementation if such a program proved feasible. The main variables that help explain patterns of support and opposition are also examined. Because the formulation and implementation of a vertical shelter program would require state and local government cooperation, the focus of attention is centered on state and local governments and their political environments.

Data were collected from 71 personal interviews of representatives of parties at the state and local levels (in Texas and Florida)

that have a stake in a vertical shelter program proposal. These parties include: elected officials, representatives of state and local agencies that are responsible for managing coastal development and hurricane emergency decision making, conservation groups, real estate interests, and homeowner association members. Pertinent statutes, legislative documents, research reports and emergency and land use plan documents were collected during the interviews. In addition, follow-up telephone interviews were conducted with interviews to further explain personal interview responses.

Figure 2 provides a diagramatic summary of the patterns of support and opposition to the proposed vertical shelter program. In Florida, there is moderate state and local support from politicians and regulatory agencies. Development interests in Florida are generally strongly in favor of the vertical shelter concept because it eliminates the "growth cap" argument in high risk areas which is aimed at minimizing horizontal evacuation times. Opposition to vertical shelters in Texas, on the other hand, is much stronger compared to Florida, and particularly at the state level.

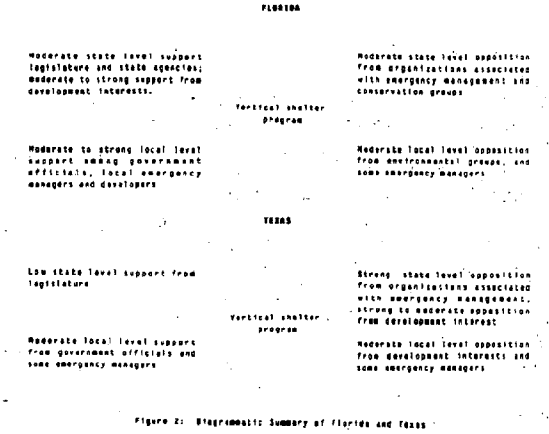


Figure 2: Diagrammatic Summary of Florida and Texas

Figure 3 summarizes the variables that are important in explaining the patterns of support and opposition that emerges from a vertical shelter's program proposal. Although perceived seriousness of the hazard is equal in both states, awareness of the vertical shelter concept and degree of statewide interest are much higher in Florida than in Texas. In Florida, parties and their positions of support and opposition are more clearly identified, points of conflict are apparent, and parties have aligned themselves firmly on one side or the other. In Texas, the political structure is less defined concerning the vertical shelter concept, and alignments are not as apparent because parties have not given as much attention to the concept. Compared to Florida, expressed values in the political environment of Texas tend to be more individualistic and less concerned about exploitation of natural resources, while commitment to carrying out federal programs tends to be lower.

| VARIABLES | TEXAS | FLORIDA |
|---|---|---|
| Awareness | State: High level of awareness in emergency management organizations; low level of awareness other state agencies | State: High level of awareness among all parties with a stake in vertical sheltering |
| | Local: Limited awareness in general; high level of awareness among emergency managers | Local: Limited awareness in general; high awareness among emergency managers |
| Perceived seriousness of the problem | State: Moderate to High<br>Local: High | State: Moderate to High<br>Local: High |
| Expressed values | Strong individualistic and procedevelopment | Moderately individualistic and procedevelopment, but opposed to exploitation of natural resources |
| Perceived security of federal consistency and commitment | Low | Moderate |
| Degree of statewide interest | Moderate | High |

Figure 3: Aspects of Political Environments in Florida and Texas

In addition to the findings discussed above, key legal and technical issues and points of conflict concerning vertical shelters will be identified. To achieve successful adoption and implementation of a vertical shelter program, should it prove feasible, strategies that could be used for manipulating the political environments will be offered. Such strategies will be based on structural risk assessment, legal and socioeconomic findings from other studies associated with the project.

## LEGAL CONCERNS

The final area of study involves legal concerns. Attention is being focused on the questions of liability associated with the potential use of both public and private facilities as vertical shelters. In the public area, studies are in progress by H. Crane Miller, a Washington, D.C. attorney. In the majority of states, absolute immunity of municipalities from liability has been abolished either by judicial decision or by act of the state legislature. Various degrees of limited liability now prevail. The positions of eight coastal states are being investigated. These states include Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina and Texas. In the area of private liability, a study is being conducted by the Office of the General Counsel of the Department of Commerce.

No recommendations concerning the potential use of vertical shelters will be made until all aspects of the various studies have been completed.

## FOOTNOTE

1 This material is based upon research supported by the National Science Foundation under Grant No. CEE 83-09511. Any opinions, findings, and conclusions or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CHAPTER TEN

# *WARNINGS AND EVACUATION PLANS*

Tropical storm Agnes in 1972 prompted the installation of an estimated 300 flood warning systems in the eastern United States. Flood warning systems and preparation of evacuation plans after a disaster are by no means new in the U.S. or elsewhere. But technology has improved greatly in the last decade including use of sophisticated automatic rainfall gauging and computerized analysis techniques combined with automated alarms.

The first paper in this chapter by Zhao Kejing observes that a flood warning system was first applied in China in 220 B.C. He emphasizes the cost-effectiveness of warning systems in developing nations and the need for increased international exchange of information on systems operating with simple and inexpensive technology.

A second paper by Stewart Wright examines flood warning systems in the Susquehanna River Basin in the U.S. and emphasizes the importance of local involvement and self-help in the design and operation of such systems. Without strong local involvement the data generated by warning systems is often not effectively utilized.

A third paper by David Griffith addresses evacuation planning techniques for hurricanes.

# Flood Forecasting and Warning Systems in Developing Nations

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## INTRODUCTION

China is a country which frequently suffers from floods. In their long-term struggle against floods, the Chinese people have taken flood forecasting and warnings as their "eyes and ears".

Flood warnings date back to the early times of the Qin Dynasty (221-207 B.C.). Delivery of flood information by the system of relaying information from one station to another was developed then, and has been applied for a long period in history. For instance, flood reports for the Yellow River during the Ming Dynasty (1368-1644 A.D.) were carried to downstream areas by establishing stations 15 km apart with shifts of horses. Men and horses were changed at every station, thus delivering flood information around the clock to the downstream reaches. However, owing to the feudal rule that hindered social progress, the delivery of flood information had long been at a stand-still.

After the founding of the New China, the Ministry of Water Conservancy (which has become the Ministry of Water Resources and Electric Power since 1958) was established. This ministry has the responsibility for flood control and water resources management. To meet the needs of flood control and preparation of river basin plans, the Bureau of Hydrology and local hydrological agencies at all levels were placed under the jurisdiction of the Ministry of Water Conservancy. They were given responsibility for the establishment and operation of the hydrological network, collection of hydrological data, and conduct of flood forecasting and warning. These hydrological agencies at all levels concurrently comprise the flood control offices.

In the early days after the founding of the People's Republic, severe flood disasters were encountered in successive years. In order to reduce the losses of lives and property and the expenditure for relief, the government made tremendous efforts to put into place flood disaster mitigation measures. Flood forecasting and warning systems at different levels were swiftly established. In accordance with the regulations adopted by the government, flood information reports have priority in the use of the channels in the telecommunication system. Also, unified codes and technical specifications were issued.

## EXPERIENCE WITH EXISTING SYSTEMS

Over the years, flood forecasting and warnings have played an important role in the fight against floods. Before liberation, a major flood occurred in 1931 along the Yangtze River, which inundated Wuhan City. The 1939 flood along the Haihe River inundated Tianjin City. After liberation, even though the 1954 flood along the Yangtze River was larger than that of 1931 and the 1963 flood along the Haihe River was larger than that of 1939, both Wuhan and Tianjin were safely protected. Flood forecasting and warning played important roles.

As a developing country, China's techniques for flood forecasting and warning systems are rather simple and not very efficient. The main problems are: 1) Delays. The time needed for the collection, transmission, and processing of data, and for the forecasting operation and issuing of warning is very long and usually takes several hours. 2) Poor reliability of communication. Communication is sometimes interrupted due to rainfall and typhoon. 3) Operation of the system. The system is manually manipulated, hence a lot of manpower is needed.

The floods of 1975 in Henan Province and of 1979 in Guangdong Province brought to our attention these problems with flood forecasting and warning. In recent years, with the favorable political and economic situations, radio transmission of flood information has developed remarkably. Several modernized real-time telemetering and forecasting systems have been established or under construction. Existing systems are being progressively improved.

I would like to suggest some conclusions with regard to flood hazard mitigation based upon the Chinese experience.

1. Putting a large amount of investment in the construction of flood control projects is not, in many cases, as economical, efficient, and readily implemented as establishment of flood forecasting and warning systems. Where a large, uncontrollable event is encountered, the structural measures may increase the damage from flood disaster. For example, the catastrophic flood of 1975 with a magnitude surpassing the design standard caused the dam of the Banqiao Reservoir, Henan Province, to break. The dam break outflow was several times greater than the natural flow and inundated the downstream valley. In addition, failure of communications during this flood increased human and property losses.

2. The functions and benefits of flood forecasting and warning systems have yet to be fully realized. Such systems, if expanded, could help forecasting for water supply, drought, and ice regime. If part of a broader, integrated system for data collection and processing, the system could be in operation at all times. This would facilitate management and maintenance.

3. Flood warning systems should be coordinated with meteorological services in order to make use of weather forecast data. The lead time of flood forecasting could thus be lengthened. Also, with such cooperation, a study of the feasibility of flood forecasting by using the QPF (quantity precipitation forecast) as input could be performed.

4. Users need forecasts not only of the water level (or discharge) of a certain cross-section in a river but also the probable areas, villages, roads, and buildings that are likely to be flooded.

5. Taking part in international cooperation activities and learning about foreign experience enables us to progressively improve the technical status of the existing systems. In this respect, we have acquired support and assistance from the relevant international organizations and friendly countries.

Apart from China, there are many other developing countries subject to flood disasters, and tropical cyclones which view flood forecasting and warning as an effective measure for mitigating losses. Examples of Asian countries include the Philippines, Malaysia, Indonesia, Thailand, Burma, Bangladesh, India, and Pakistan. Flood forecasting and warning systems were established in the past decade or are still under establishment in all of these countries. Warning systems have already borne beneficial results. International organizations have played a helpful role in establishing these systems by promoting the transfer of technology, technical cooperation, and training of personnel.

## CONCLUDING REMARKS AND RECOMMENDATIONS

Experience shows that forecasting and warning is of great importance in flood hazard mitigation. It is necessary to promote forecasting and warning systems in developing countries suffering from floods and tropical cyclones.

In many developing countries: (1) hydrological and hydrometeorological data are insufficient for appropriate flood forecasting; (2) the financial resources for establishing forecasting and warning systems are limited; (3) there is a great need for technology and knowledge for establishing and operating such systems; and (4) there is a lack of trained personnel. In light of these considerations I wish to recommend that: (1) concerned governments expand their hydrological networks; (2) hydrological services aim not only at the high level of sophisticated technology but also at the simple and cheap technology appropriate to their conditions; (3) in considering mitigation measures for reducing flood losses the appropriate authority should give investment priority to the funding of flood forecasting and warning systems; (4) in issuing forecastings and warnings to the public, maps should be produced showing areas susceptible to submersion. On such maps the probable flooded villages, roads, and important buildings should be identified; (5) concerned countries should make full use of appropriate channels for transferring technology from one country to another, or through international organizations, and for training personnel, in the field of flood forecasting.

# Flood Damage Mitigation Lessons Learned in the Susquehanna River Basin

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## INTRODUCTION

The Susquehanna River Basin has a history of frequent and severe flooding with eight major floods in 100 years. Two major floods in 1972 and 1975 created concern and stimulated actions at every level of government. Flood damages in 1972 were over $3 billion (U.S. Army Corps of Engineers, 1974); there were 125 lives lost and flood levels were 3 to 5 feet above the top of levees and into second stories of buildings in many communities. Federal and state funded Urban Renewal Projects costing $540 million were used to relocate 15,750 people, demolish over 8,000 and rehabilitate 24,000 buildings (Susquehanna River Basin Commission, 1975). Today, in spite of $460 million investment in structural flood damage reduction projects, average annual flood damages are estimated at $82.5 million (1984 dollars).

More than 1,300 municipalities are enrolled in the National Flood Insurance program in the Susquehanna Basin. There are 51,000 flood insurance policies in force with $1.8 billion in coverage (Susquehanna River Basin Commission, 1984). Only about 50 of these communities have 100-year flood protection by levees and dams.

Our studies show that the greatest damage and highest perceived potential for flood damage (as reflected in large numbers of flood insurance policies and greater amounts of insurance coverage) are in communities where previous floods over-topped levees and flood walls.

Many communities have attempted unsuccessfully to obtain structural protection during the past 60 years. There have been several large studies and many unfunded projects. Following the floods of 1972 and 1975, many communities drastically changed their approach to flood damage reduction. They decided that if they were going to reduce flood damages they must take action on their own. Non-structural flood damage reduction approaches became the most practical flood mitigation approach. This paper summarizes those activities that have resulted in a comprehensive self-help flood damage reduction program in the Susquehanna River Basin.

## MITIGATION EFFORTS IN THE SUSQUEHANNA RIVER BASIN

After the flooding of 1972, the Susquehanna River Basin Commission, a newly created organization, realized that different flood damage reduction approaches would be needed in the Susquehanna Basin. Some of the efforts supported by and stimulated by the Commission include:

Flood insurance studies. Over 245 flood insurance studies were completed that covered most lengthy stream reaches and many communities. These studies provided the technical data for other programs.

Flood warning systems. An Interagency Task Force studied the National Weather Service's (NWS) flood warning systems and recommended improvements for systems in the Basin (Susquehanna River Basin Commission, 1973, 1979). Improvements which ultimately were implemented included: installation of new equipment; increased communication between forecasters and users; and the development of over 50 self-help flood forecast and warning systems as a supplement to the NWS system. These currently provide flood forecasts to 745 municipalities (Susquehanna River Basin Commission, 1976 a and b).

Self-help flood warning systems, organized and operated by a combination of county staff and volunteers, have stimulated and become part of local community actions to reduce flood damages (Wright, 1980, 1983; Susquehanna River Basin Commission, 1985b). There are many benefits to these efforts which have been documented by case histories of community and area flood warning and damage reduction efforts (Flood Loss Reduction Associates, 1982; Susquehanna River Basin Commission, 1985c). These studies show that in moderate floods, adequate flood warning and well organized evacuation efforts can reduce damages to contents of buildings between 75% and 90%. Reducing damages to motor vehicles is another major benefit.

Data obtained in flood insurance studies has been used for the preparation of Flood Stage Forecast or Flood Inundation Maps. The maps are an information base for individuals, community leaders, and others to better understand the impact of flooding, and have been used in planning and carrying out phased evacuation efforts. They have stimulated community flood evacuation actions.

Mitigation of industry and public facility problems. Another program has been directed

toward the flooding problems of industry and public facilities. An Interagency Flood Damage Reduction Team carries out on-site surveys and prepares written recommendations for flood damage reduction planning by industries, other businesses, and public facilities (U.S. Army Corps of Engineers, 1983a). The efforts of this team reveal that there is a significant self-help effort under way to reduce industrial flood vulnerability through a combination of equipment modification, limited floodproofing and detailed evacuation planning.

A program funded by the Appalachian Regional Commission has also increased emergency communications capability for many counties and communities in Pennsylvania. Unified central county radio dispatch has resulted in improvements in emergency response capability.

## LESSONS LEARNED

Compared with pre-1972 conditions, the National Flood Insurance Program, with just under $2 billion in insurance coverage, is the most important incentive for flood damage mitigation in the Susquehanna River Basin. A decline in the number of policies - a decrease of over 20,000 policies between 1978 and 1983, or 28% - is of continuing concern (Susquehanna River Basin Commission, 1985d).

We have learned that flood plain management objectives should guide the use of disaster assistance funds. There were great differences in how disaster funds were used in the Susquehanna Basin following flooding in 1972. Some communities ignored flood plain management principles in use of funds, while others promoted long range goals that resulted in support for and stringent enforcement of measures to reduce flood vulnerability.

Development of capable and concerned local leadership is the key ingredient in local self-help flood damage reduction programs. Many communities have developed this leadership out of necessity. Leaders have emerged to fill the vacuum created by unfunded federal or state projects. Without this leadership, many local flood damage reduction programs would not have been implemented.

There is a short lead time between heavy rainfall and flooding in many areas of the Susquehanna Basin. Improvements in flood warning, primarily through self-help flood warning systems, have provided warnings to areas that did not have them before. These simple systems have proven their reliability and in turn have stimulated increased flood evacuation.

Industry and large commercial enterprises often have different flood situations and problems. Flood insurance does not meet their needs because of the $200,000 per policy limitation on contents and coverage. Some industries have multi-million dollar business-interruption policies, others have none.

For many industries and almost all wastewater treatment plants, the only practical flood damage reduction alternative is self-help. Well organized and implemented flood evacuation plans, and improved design or modifications to electrical and mechanical components (by elevating them or making them more easily and rapidly evacuated) are most commonly used (U.S. Army Corps of Engineers, 1983b; Susquehanna River Basin Commission, 1984a).

Wastewater treatment plants are a major remaining problem. About 50% of the plants in the Susquehanna Basin are located in the 100-year flood plain. Many are constructed so that evacuation of equipment is very difficult. This problem has been perpetuated in plant additions and some new plants. Many are designed so that it is almost impossible to evacuate large electric motors and pumps. On-site underground electric distribution systems contribute to increased plant vulnerability.

## RECOMMENDATIONS

Based upon our experience in the Susquehanna, I offer several recommendations:

1. Community compliance with the National Flood Insurance Program should be vigorously monitored and enforced. Reasons for declines in the number of policies should be studied. Are we trading reduced flood insurance subsidies for higher disaster assistance? Do we know who is not covered by flood insurance? It is recommended that reductions in flood insurance premium costs be used as an incentive and reward for municipalities or areas where there are well organized and operated flood warning evacuation response programs.

2. Major emphasis should be focused on immediate improvements to flood warning systems. Self-help flood warning systems provide a means of rapid improvement in flood warning while new methods are developed and equipment improvements are budgeted and implemented (Susquehanna River Basin Commission, 1985a).

3. A joint federal-state program should be developed for the support of training and education and for organizational assistance for community based flood damage reduction actions. There are thousands of communities in the United States that do not have, nor will they ever be eligible for, structural flood damage reduction projects. The only practical approach for flood damage mitigation for these communities is self-help. Little has been done in many of these communities to implement non-structural flood damage reduction programs. It is time to get on with the job. Progress has been slow because no program, other than the flood insurance program, has established a local government delivery system.

4. Use of technical data from partially completed flood damage reduction studies is an untapped resource that should be used to help communities and individuals better understand the impact of flooding and to prepare more

specific flood evacuation plans.

5. Differences between communities should be studied to determine the social, economic, and organizational factors influencing community response to flood hazards. Some communities have developed local leadership and taken effective steps toward self-help flood damage reduction. Others have taken little or no action.

6. The needs of industries and large commercial employers should be studied and technical assistance provided to encourage private investment in self-help decisions that will reduce the flood vulnerability of these facilities. Industry and large commercial employers often form the tax and employment base of a community.

7. The design of wastewater treatment plants should be reviewed to develop alternative designs that meet goals of rapid evacuation and restoration of service following flooding. The design process should evaluate the impacts of flooding above the 100-year level.

8. Practical short term approaches and long term solutions to stormwater management and the integration of stormwater management and flood plain management need to be identified.

9. Much more needs to be learned about practical solutions to ice jam problems. Ice jam flooding is also a problem for many areas. Little attention has been directed to this problem. Warning systems are inadequate, and structural solutions are at best trial and error approaches.

10. Developing nations should learn from the mistakes made in the U.S. and other countries. Such nations should make every effort to either keep development out of floodprone areas or to make it less vulnerable to flooding. Simple methods of estimating flood plain areas are needed. Flood proofing techniques used by U.S. industry to adapt to the flood problem might be transferable. Developing nations should find the inexpensive, simply organized and operated self-help flood warning systems attractive. They are very cost effective.

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# High and Low Cost Evacuation Planning Techniques

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## INTRODUCTION

Evacuation planning as a mitigation measure can greatly benefit from the knowledge gained in the post-disaster environment. Although the sophistication and viability of pre-event evacuation planning for certain hazards (e.g., hurricanes) has been advanced considerably over the past five to seven years, such planning without the benefit of observed data still requires many assumptions about the hazard as well as the way residents will respond.

The opportunities for pre-event evacuation planning vary greatly from hazard to hazard. For example, tornado and earthquake evacuation planning is only marginally feasible today because the state-of-the-art of the prediction technology is too slow in comparison with the speed of onset of the hazard.

This paper focuses on the major post-disaster evacuation planning opportunities for mitigating loss of life from hurricanes. It identifies low cost post-hurricane opportunities to improve the evacuation plans for which automated planning tools must be developed. The cost associated with developing these automated tools is ultimately justified by the ease and economy of post-disaster revisions or continuous updating of the evacuation plans. Finally, recommendations for the automation of key evacuation planning tools are made toward cost-effective post-disaster evacuation planning by government emergency managers.

## REVIEW OF HURRICANE EVACUATION PLANNING METHODOLOGY

A basic evacuation planning methodology employing several key computer modeling elements was developed by the Tampa Bay and Southwest Florida Regional Planning Councils and the U.S. Army Corps of Engineers, Jacksonville District in 1979-1980. This methodology, composed of a sound set of quantitative analyses, has been adopted by FEMA for use in all comprehensive hurricane evacuation studies along the U.S. Gulf and Atlantic coasts (Griffith, 1985). These analyses are listed and briefly described in Table 1.

The first analysis of the hurricane evacuation planning methodology is the hazard analysis, typically composed of multiple (200-300) simulation runs of NOAA's SLOSH (Sea, Lae, and Overland Surges from Hurricanes) numerical storm surge prediction model. After reading finer wave action phenomena and local astronomical tide to the SLOSH stillwater surge heights (referenced to MSL) are applied to the land of the study area. This vulnerability analysis is an intensive process including risk mapping of the area, formulation of geographic evacuation zones composing each level. Also included in this analysis is a comprehensive enumeration of population, dwelling units, and most importantly, vehicles within vulnerable areas. Finally, the vulnerability analysis includes site surge analyses for all public shelter structures, institutional, and medical facilities (hospitals and nursing homes).

The third major analysis is that of quantifying the anticipated behavior of residents as they receive warning information and evacuation orders/advisories. This behavioral analyis includes parameters such as evacuee shelter destinations, number of vehicles used for evacuation, and the timing of evacuation trips in relation to the "triggering" order and/or advisory.

TABLE 1

- Hazard Analysis - A comprehensive analysis of the potential hurricane hazards that could confront the region utilizing numerous simulations by the SLOSH model.
- Vulnerability Analysis - A detailed identification of the areas and population of the region vulnerable to specific hurricane hazards utilizing SLOSH geographic output.
- Population Data Analysis - A systematic enumeration of the dwelling units, population, and available vehicles within the identified vulnerable areas.
- Behavioral Analysis - A statistically significant survey and historical identification of the probable tendencies of potential future evacuees of the region.
- Shelter Resource Analysis - A regionwide inventory of existing public shelter characteristics and shelter capacity computation.

-- Shelter Surge Analysis - A quantitative analysis of the geographic storm surge vulnerability of existing as well as future potential public shelter structures.

-- Institutional Facility Surge Analysis - A quantitative analysis of the geographic storm surge vulnerability of all hospitals, nursing homes, prisons, and other residential facilities requiring special evacuation procedures.

-- Surge Roadway Inundation Analysis - An analysis of the estimated time of inundation of critical evacuation route points relative to hurricane landfall utilizing the SLOSH model time history output.

-- Gale Force Winds Arrival Analysis - An analysis of the estimated time of the arrival of gale force winds relative to hurricane landfall utilizing SLOSH model time history output.

-- Shelter Duration Analysis - An analysis of the estimated time of the arrival of gale force winds relative to hurricane landfall utilizing SLOSH model time history output.

-- Freshwater Roadway Inundation Analysis - A regionwide identification of historically inundated roadways from rainfall flooding.

-- Evacuation Zone Formulation - A regionwide delineation of SLOSH-defined vulnerable areas into evacuation zones based on common hazard vulnerability and common evacuation routes.

-- Evacuation Routes Assignment - The assignment of evacuation vehicle volumes from specific zones to specific routes to develop optimum intra- and inter-county routing strategies.

-- Shelter Assignment - The assignment of specific evacuation zones to specific shelters based on evacuation routing strategies and computed shelter capacities.

-- Clearance Time Quantification - The calculation of vehicle volume traveling times associated with the movement of the enumerated vulnerable population from SLOSH-defined vulnerable evacuation zones to specific evacuation destinations.

-- Evacuation Time Estimation - The estimation of total evacuation time needed for the timing of evacuation orders based on the addition of clearance time to pre-landfall hazards time (surge roadway inundation or gale force wind arrival).

The SLOSH model also enables the planner to estimate the timing of roadway inundation and arrival of gale force winds from model time-history output simulating the rise in surges and windspeed as the hurricane approaches. These timing factors compose the "pre-landfall hazards time" portion of the ultimate evacuation time estimate.

A criticaly analysis that requires and integrates results from the earlier analyses just described is the transportation analysis, consisting of numerically modelling evacuating vehicles traveling the evacuation route network to result in "clearance time" estimates. These modeling simulations for urban coastal regions require a sophisticated, dynamic evacuation transportation model. The resulting clearance times for each evacuation level are then added to the pre-landfall hazards times to produce a critical element of the evacuation plan -- the evacuation time estimate.

Finally, an on-going program of emergency management exercises are absolutely essential to maintain the viability and credibility of the evacuation plan.

All of the analyses of the hurricane evacuation planning process described above are relatively costly for an initial multi-county comprehensive study. Depending on several factors, the study process has required a funding level of between $200,000-$400,000 per coastal region. However, if the key quantitative analyses are performed utilizing the appropriate automated planning tools, cost effective post-disaster revision or on-going updates of the evacuation plan can be realized. These analyses and automated planning tools are described below.

## POST-DISASTER EVACUATION PLANNING

## THROUGH AUTOMATED TOOLS

The key to implementing low cost updates (e.g., in the post-disaster setting) of hurricane evacuation plans is utilization of automated planning tools in the plan's original formulation that are conducive to quick modifications of assumptions and input data. The three major areas of plan development and maintenance where such automated tools can be applied are (1) the hazard analysis, (2) the transportation analysis, and (3) the design of exercises to test the plan, train personnel, and demonstrate operational capabilities. Recommendations pertaining to these three topical areas include:

Hazard analysis. The automated tool used for hurricane evacuation hazard analysis since the first prototype studies in 1979-1980 has been NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) numerical storm surge prediction model (Jelesnianski, 1979). The SLOSH model has proven to be exceptionally accurate in matching observed surge heights for hurricanes since 1979. Thus, large scale recalibration efforts of coastal basins has not been necessary. So the original hazard analysis simulation effort described above, now costing about $50,000 per basin, can be considered a one-time cost as long as the model

continues to accurately predict surge heights for that coastal basin. The real advantage of the computerized SLOSH model for planning is the ability to build "one more" hypothetical hurricane to look at its potential effects on a coastal area. Similarly, running the model in real-time to simulate the storm that appears to be approaching on various hypothetical tracks can greatly enhance the local decision-making process.

Transportation analysis. The sensitivity of evacuation time estimated to transportation network loading rates and timing of evacuee response, demands a user-friendly model that is immediately accessible to the local and/or state emergency planner. The model should be one exclusively designed for evacuation planning and analysis and recognized as state-of-the-art in evacuation traffic simulation modeling. Such a model has recently been enhanced from its "point source" applicability for nuclear power plant evacuation analysis to also be applicable for the "regional" network analysis necessary for hurricane evacuation planning. This model, entitled the "DYNEV" or dynamic network evacuation model, has been developed by KLD Associates for FEMA. It is presently an on-line element of FEMA's IEMIS (Integrated Emergency Management Information System) computer network and intended for future access by state and local emergency management agencies. Unlike the models used in previous hurricane evacuation studies along the Gulf Coast, it is a non-proprietary computer model designed exclusively for evacuation planning by state and local emergency planners. Thus, it will be immediately accessible to users of FEMA's IEMIS system for the behavioral and time-sensitive variables of hurricane evacuation planning.

Design of exercises. Finally, one of the most important elements of the hurricane evacuation planning process that is moving very close to automated design is the emergency management exercise. A computer-aided exercise design capability can save valuable time and resources during routine plan testing as well as in the post-disaster setting. Specifically, the disaster event will clearly identify those aspects of a community's emergency capabilities that require the testing, training, and evaluation provided by exercises. The tailoring of exercises to specifically address those aspects is essential to maintaining a viable plan. An automated tool that quickly and efficiently implements this process is now available. Although not currently including a hurricane scenario, FEMA's Computer-Aided Exercise Design system, designed and developed by Research Alternatives, Inc., may become the exercise design tool that will make possible the conduct of much needed hurricane evacuation exercises all along the U.S. Gulf and Atlantic coasts. This will ensure that the regional hurricane evacuation plans become realistic and viable emergency guides for saving lives.

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# CHAPTER ELEVEN
# *ACQUISITION AND RELOCATION*

As with other post-disaster mitigation techniques, relocation can take many forms: small scale or large scale; voluntary or permissive; combined with public acquisition (compensation) or uncompensated; as part of a multiobjective planning or renewal program or on simple individual parcel basis.

This chapter examines relocation and acquisition from several perspectives.

The first paper by Russel Dyne raises questions concerning the wisdom of relocation schemes with regard to disaster victim needs and the ultimate success of relocation where there is little control over resettlement of the vacated area. International experience to date suggests that massive, compulsory relocation schemes which disrupt social and economic ties may cause severe emotional and economic suffering which outweight many of the benefits of the relocation.

More than 300 communities in the U.S. have acquired floodplain lands. Many of these efforts have involved at least partial relocation. This relocation has generally been small scale, voluntary, compensated, and pursuant to broader urban renewal or open space programs. The evacuated area has generally remained in public ownership for recreation and open space use. Many of these efforts have been popular at the local level and (apparently) with hazard area occupants.

The second paper in this chapter by John Handmer examines relocation in Australia. He suggests criteria for delineating relocation areas.

The third paper by Teddy Boen discusses a major relocation program being implemented in Indonesia.

The next three papers examine relocation in the U.S. Nona Thayer examines the use of moratoria and acquisition after the Big Thompson Canyon flood in 1976. Randall Strong examines relo- cation funded by Section 1362 of the National Flood Insurance Act in the Brownwood Subdivision at Baytown, Texas and suggests improvements for implementation of that program. John Seyffert concludes the chapter with a summary paper suggesting the "nuts and bolts" of a successful acquisition program.

# Strengthening Post-Disaster Mitigation: A Sociological Perspective

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## INTRODUCTION

Often a title of a paper is not a sufficient guide to its content. However, within the title there is some indication that there is some "sociological" perspective concerning post-disaster mitigation. In most interdisciplinary conferences, it is somehow assumed that a "sociologist" is a defender of people. And people are usually seen as being problematic to any cherished or planned post-disaster activity. Often the assumption is made that certain activities are appropriate and important for mitigation, but they fail because of the "people." Consequently, this problematic source--the people--are considered the province of sociologists with the implication that, if sociologists were able to "solve" the people problem, all else would be right with the world, especially since technological schemes could be implemented. Such schemes are assumed to be in the interests of the people, anyway. Thus, it is assumed that, if sociologists can solve the people problem, planning efforts would usher us into some new utopia. The role of sociologist is considered residual, rather than central, in the planning process.

While that is a common view, it is an incorrect one. It is much more appropriate to assume that, if you ignore "people" in your planning, your planning will be ignored. In fact, instead of assuming that people are incidental to mitigation-related activity, it is more appropriate to assume that disaster itself is essentially a sociological concept, rather than one which is based in the geological, atmospheric or toxological world. In effect, it will be argued here that "disaster" has to be seen in terms of social disruption. That disruption is only partially and incidentally related to physical damage.

Disaster, of course, is one of those words which has many meanings and which is used in many different ways. Disaster often is used to refer to the impact agent, such as a hurricane, a fire, etc. Disaster most often refers to the physical impact which the agent has, i.e., the physical damage and the personal injury. Other meanings are more psychological and sociological. Disaster can mean the evaluation of the physical impact. We see some physical damage and evaluate it as "disastrous." That evaluation is dependent not just on the extent of the physical damage but on our standard of evaluation. The final meaning refers to the social disruption which can occur as a result of the physical impact. Social organization of many different levels--family, neighborhood, organization, community, region and nation--can be disrupted.

In effect, I will argue here that the most appropriate sociological perspective is to view disaster as social disruption and, in turn, point out that such disruption is only partially and incidentally related to physical damage. Unfortunately, we have few measures of this type of disruption. On the other hand, we do have a number of measures concerning disaster agents. We can measure wind speed and direction. We can measure storm surges and flood stages. We have Richter and Mercalli Scales to measure earth movements. We have Geiger counters and gas detectors. Too, we have measures of physical damage. We can do body counts, and assessments of injuries. We can delineate "injuries" to building structures and to other environments. But when we do damage assessment, none of the measures we traditionally use touch on the most important impacts of social life. We have no good measures of broken social relationships, created by death or relocation. We have few clues as to the costs of fractured work patterns and other dimensions of disrupted lives. We keep no records on the segmentation and disorganization of community life nor do we have a clear idea of the social costs of delayed and destroyed futures.

It is also probable that what we call disaster assistance has only incidental and tangential effects on such problems. There is an emphasis on the immediate and the basic, often centered around food, shelter, and clothing. Such "needs" are seldom problematic, however. Especially in massive impacts, the response itself creates new needs for communication and coordination and sometimes can lead to making the response more traumatic than the initial impact. That possibility is symbolized in the grafitti painted on a wall in a recent disaster. It said: first, the earthquake, then the disaster.

If that is possible as a result of disaster assistance, let me also suggest the possibility that disaster mitigation measures aimed to reduce some future physical damage may also increase the risk of disaster in the sense of social disruption. Many disaster mitigation schemes involve, in one way or another, the relocation of populations at risk. Such

schemes are based on a logical assumption that, if people were not in the area of risk,"nothing would happen to them." Following that assumption, there have been efforts to relocate people from floodplains and from earthquake risk areas. Such actions are often defined by the relocating agencies as being successful and good. Such a definition is often recorded in the literature so that others are encouraged to develop similar policies for some future implementation. Such a definition of "success" is maintained by the absence of studies of the longer term consequences of such relocations. However, casual observations of so-called success raise a number of questions about such attempts. For example, Ian Davis has pointed out that the relocation of Gediz, a town in Turkey, after a 1970 earthquake, has lead to the development of a new town and the perpetuation of the old town as well as the uneasy symbiotic relationship between the two. We know, in India, Egypt, and the U.S., there have been massive relocations relating to dam projects. The point here is that relocation as a tool is frequently used but seldom studied, either in terms of its immediate or long range consequences. In the absence of such research, it is still possible to point out, using certain sociological concepts, some of the issues involved in relocation.

## ON RELOCATION AND ITS CONSEQUENCES

It is no accident that populations, families, groups, and communities are physically located in certain neighborhoods and places. Such physical placements are the result of very complex and historically rooted natural social forces. A village is located in a particular spatial location for many reasons --it just does not happen to be there by accident.

There are some very important implications of the general observation just made. Relocation could be working against natural social forces which have led that specific population or community to be located in that specific place. This is particularly true with respect to the short run. Thus, you might want to relocate a village which has been in a particular locality for hundreds of years because of the possibility of flooding in the next ten years. The time dimensions involved simply reflect the fact that in one case there has been a slow, natural social evolution, and that in the other case. there is a sudden, planned social intervention. The intervention act is often not consistent with the former process.

Furthermore, relocation involves not so much the moving of "people," but of families, villages, and communities. In fact, in a fundamental sense, you have to move a way of life. There has to be movement not only of where people live, but where they work, where they play, where they worship, an where they carry out the many integrated functions that constitute social life.

Put still another way, relocation involves moving a collectivity--the complex of the physical and social which is the neighborhood, the village, and the community. It is relatively easy to move physical entities per se. It is much harder to relocate the psychological webs, the social network, and social support systems which are the heart of social life. In some post disaster recovery efforts in the United States, individuals and families have been moved from their destroyed homes to distant trailer camps and parks. The results have often been a second disaster as victims have been uprooted from familiar settings, symbolically important things, crucial social ties, and interactions. Uprooting people from their way of life is bad enough in an evacuation from a disaster, but at least the evacuees can look forward in such situations to their returning to their old way of life. In a relocation situation, with the idea of permanency in the move, the negative consequences could even be worse.

In developing countries in particular, the web of social life at the village or community level is very complex and there are a number of highly interrelated physical and social elements. In many respects the whole is more than the sum of its parts. What has to be relocated is the whole--the collective way of life. It is in this sense that we suggest that relocation involves far more than moving individual persons or particular physical entities. They are part of what has to be moved, but only part, and they have to be relocated as a whole.

It is sometimes thought that force or at least involuntary means could be used to mandate relocation. There is an element of truth in that view. However, it is necessary to note that even very totalitarian societies during wartime have had extreme difficulty in trying to force semi-permanent evacuations on their own civilian populations. Studies of wartime evacuation in Germany and Japan during World War II found that there were definite limits to the population movements which could be forced even when drastic sanctions, such as taking away ration coupons, were used.

There is reason to believe forced disaster threat relocation as a whole would be even more difficult to implement than civilian wartime evacuation. In addition, such actions would run contrary to the actual or pseudo democratic values which prevail in most societies around the world today. Most governments are reluctant to be seen as forcing their own reluctant citizens to relocate, and as the current famine disasters in some African countries show, there is a desire to avoid being perceived on the international scene as engaging in such actions. All of this does not mean that forced relocation cannot be attempted, but that there are limits to what can be achieved operating that way, and also, that there are both internal and external political factors which will often discourage public use of force.

On the other hand, if relocation is left up to purely voluntary action or on grass-roots action, almost certainly nothing will happen.

To inform a population or community that they are at some indefinite risk at some indefinite time from some dangerous agent will not provoke a relocation effort. People and groups tend even not to evacuate in the face of specific warnings about specific dangers in specific places. If there is no evacuation in such situations, it is much less likely there will be relocation in even less clearly dangerous situations. Put another way, permanent relocation is very unlikely when temporary evacuation, as study after study has demonstrated, is not that common a response in the face of immediate danger.

Presumably, there are certain mixtures of direct and indirect means, and of rewards and punishments, which would be better than others. However, we feel that there are probably no universal sets applicable to all situations. Our view on this is influenced by the fact that there are different cultural values and beliefs in different societies around the world. Some cultures tend to emphasize rewards more than punishments, and vice versa. Some societies, such as some in Asia, value indirect rather than direct ways of talking about and doing things. Such cross-societal cultures differences would undoubtedly influence the use of different sets of means which could effectively be used to bring about relocation in different countries. To give another kind of example, populations differ widely in their expectations and reactions to different governmental levels --the national, regional or prefectural, the city, village or community level. What would be seen as the proper initiative at a particular governmental level in one society could be seen as completely inappropriate in another society.

There is an important implication in all this for anyone planning a relocation program. The implied suggestion is that one should first analyze the characteristics of the population targeted for relocation. From this analysis it ought to be then possible to estimate or project which mixtures of direct and indirect means might be most effectively used with that particular population. This approach is contrary to the view that certain means or techniques are universally and inherently better for bringing about relocation and that one should first select certain means and then apply them to those targeted for relocation. We suggest the reverse procedure would be a better starting point. This would prevent trying to use those direct and/or indirect means which are alien for that particuular socio-cultural setting. Developing countries, in particular, would escape trying to use social technologies created for Western-type societies but inappropriate for their own socio-cultural settings--a problem in technology transfer which has been increasingly recognized in many areas, and which should be kept in mind in the relocation area.

## OBSTACLES TO RELOCATION

Perhaps to be first recognized is that in some cases there are, for all practical purposes, insurmountable obstacles. For instance, in many developing countries there is simply no vacant or unused land to which a threatened group could be relocated. There is hardly need to document population pressure upon the land in many places. Or if there is land which is not populated, it is almost a certain sign that land cannot support for a variety of reasons a population, such as would be true of desserts or rocky mountain region.

To be certain, in some societies, there may be nominally usable land not given over to agricultural and/or residential purposes. Could not such empty space be used in relocation efforts? Probably not, for such cases probably reflect the natural social forces we mentioned earlier. They may be indicative of the land tenure pattern of that society, where perhaps a small elite of absentee owners for reasons that make sense to them, do not allow and cannot be made to allow more productive use of their land resources.

This last example, primarily of a political nature, indicates that there are a whole variety of social institutional factors--legal, economic, psychological, and cultural--which at worst are obstacles to relocation attempts, or at best make for inertia. Many social scientists have long recognized that the societies and their institutions tend to be weighted in favor of the status quo, the form of which can vary considerably in space and time. Revolutions in social structure can and do occur in the long run, but in the short run--which is the time frame for a relocation effort--the overall traditional pattern is not favorable to social change.

Legal systems vary considerably around the world. But such legal institutions and norms as do exist in many developing countries would not facilitate attempts at relocation. For instance, ownership of land and sometimes other resources is of a collective nature, in many nations around the world. In other places, title to resources is formally unclear. In either case, such kinds of socio-legal arrangements and understandings do not make change easy, do not facilitate relocating a neighborhood or village. If a specific group or village collectively owns the land, think of the difficulties involved in trying to relocate only part of that group or village.

Then, too, there are economic factors. It is often the poorest of a population which may live in a risk or vulnerable zone or area, such as a floodplain. Thus, those populations which should be relocated, are those with the least economic resources to do so. Furthermore, there is a parallel problem if the question of relocation is examined at a higher or more macro-level or social organization. Under almost all circumstances, there will be economic or financial costs for any relocation. But developing countries tend to have those populations most at risk from disasters. Therefore, such nations should be making the greatest efforts at relocating endangered communities. Of

course, such countries are least likely to have the economic resources to use for relocations. We leave aside here the fact that, when financial resources are scarce, national priorities have to be set for their use, and relocation of population from high risk but low probability events is not likely to rank high on the agenda.

In talking about the political, cultural, psychological, economic and legal institutions and factors, I have primarily stressed how they can act as obstacles, or at least inertial elements, in efforts to initiate and sustain relocation activities. Some of these factors, depending on their content in specific situations, could facilitate the relocation process. For example, there has recently been the relocation away from dangerous areas of three small communities within the United States. But in there situations the residents wanted to move, and all the factors we have discussed, for various reasons, were supportive of the efforts. However, these are the rarer situations, so we have emphasized that the content of the social structural aspects are usually not a supportive nature for relocation. Nonetheless, the examples are enough to indicate that relocations are more than hypothetical, never realized possibilities; they can and have happened.

## THE PURPOSE OF RELOCATION

That something can be done, even rarely, does not necessarily mean it should be done. Apart from the matters already discussed, there are other considerations that need to be taken into account. I shall discuss a few of the more significant ones and try to indicate that it is important in planning to specify clearly what is being attempted in a relocation attempt.

High risk areas are far from being all alike. Two areas which are equally at risk from a natural disaster agent are not necessarily equally vulnerable. One area may be able to undertake preventive or protective measures, such as building levees, which may not be possible in the other area. This is another way of saying that the possibility of relocation has to be evaluated against other actions which could be taken to neutralize or mitigate a disastrous impact. If it is easier and simpler to implement other hazard mitigation measures, that ought to clearly signal caution on insisting on relocation at the measure to implement. Put another way, relocation is almost always one of several options for dealing with the problem which will be available. Very seldom, perhaps never, is the situation one just of relocating or not doing anything else at all.

Also, it should not be automatically assumed that experts always know best. Experts tend to look at the world from the technical perspective of whatever are their specialties. Such a perspective, which usually is of very high quality from a technical point of view, is necessarily selective and uses only certain criteria. The average citizen or official is likely to use a more general perspective and to use different criteria in making judgments. While it does not follow that the latter view is, therefore, better than the view of the expert, the converse is not necessarily true either.

Apart from the matter just discussed, the average lay person may grant the greater knowledge of the experts, but still may not be moved to behaving differently, especially taking such a drastic action as is involved in relocation. People live in a risky world. They take chances everyday when they do such things as smoking, driving, or drinking. They "know" the negative consequences of the just indicated behaviors are more likely than whatever may happen in such low probability events as major disasters. To be certain, such views are "intuitive" and are not derived from statistical probability theories. Nonetheless, possible major disasters are only one of many risks for individuals, families, officials, and communities, and are less probable in negative consequences than a number of the other risks. Given this, it should not be surprising, and it certainly should not be seen as irrational, that even if people are convinced of a possible danger, that they will not undertake such a severe and life disrupting action such as would be involved in relocation.

If the objective in relocation is more than a simple movement, the kinds of questions and issues just discussed have to be put into the equation. There obviously should be far more pluses than minuses if relocation is to be attempted and implemented. If on balance there are more negatives than positives, as a result of the effort, the removal from a risk area would not seem totally warranted. At least a very systematic cost-benefits analysis including far more than economic factors ought to be undertaken.

## CONCLUSION

While the illustration used here has been focused on relocation and the discussion of that issue has been extensive, that example should not obscure the major point which the paper attempts to make. A disaster is best defined sociologically as social disruption. That social disruption is only tangentially related to physical damage. Therefore, actions taken during the emergency and recovery period which increase that disruption are "disastrous." The same assessment can be made for attempts at disaster mitigation. Such attempts often cast in terms of increasing physical safety may also have unintended consequences of increasing social disruption. The trade-offs between those competing values are obviously not easy to resolve, but issues are not resolved by "ignoring" the social consequences. A better solution is to try to fit planning to people rather than trying to fit people into plans.

# Acquisition and Relocation: The Australian Experience

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## INTRODUCTION

In the 1800's, during the early stages of European settlement, a few Australian towns were relocated after catastrophic flooding. However, floodplain acquisition and the relocation of existing urban development by governments following major flood disasters has been little used this century. After serious flooding in the 1950's, a number of local governments considered acquisition and the city of Maitland requested state government assistance to relocate. Instead, the state funded levees - the normal post-disaster response in Australia. One or two local governments pursued acquisition schemes on their own. One such scheme, at North Wagga, was examined for this study. Lack of state government action is probably due to the absence of large flood related death tolls, a general reluctance to adopt non-structural solutions, and the fact that local government has primary responsibility for land-use management.

More recently, acquisition has been used in small areas after repeated episodes of severe, but not catastrophic, flooding, where no other solution seemed feasible. Also, acquisition is being used to cope with isolated properties left unprotected by structural works and, occasionally, in conjunction with park creation programs. However, acquisition is frequently regarded as a last resort. Many officials see it as expensive and little more than a gift to relocatees. This attitude derives in part from a construction (i.e., flood control) mentality and from a failure to see flood damages as a loss to society. The attitude is less evident when the same public money is spent on levees.

This paper summarizes some of the results of a major study into acquisition reported in full in Handmer (1984). Additional details are also found in Handmer (1985) and Handmer (in press). After a brief description of the study sites, criteria for acquisition are presented with comments on appropriate post-acquisition use and on overcoming impediments to implementation. The criteria may also help delineate areas that should not be developed. For developed areas the suggested criteria may help establish acquisition priorities and identify potential acquisition sites during the preparation of contingency post-disaster mitigation plans. In the immediate post-disaster context, the criteria may help establish priorities for reconstruction moratoria and acquisition.

## THE STUDY

Three sites in southeast Australia were selected for study. All settlements function as service centres and are growing steadily. No site has a shortage of flood-free land. The acquisition areas are of low socioeconomic status with low property values. The business district and 1900 houses of the coastal city of Lismore, NSW (pop. 24,000) lie in the 1:100 (1%) floodplain. At study commencement in 1980 some 290 dwellings were found in zones of especially frequent and severe flooding and constitute the main focus of acquisition. In contrast, the inland cities of Echuca, Victoria (pop. 8,500) and Wagga Wagga, NSW (pop. 40,000) are largely protected from flooding by levees. In both cases, areas outside the levees have become the subject of acquisition. Acquisition of North Wagga, then a village of some 248 dwellings, commenced in 1956 following severe flooding. Echuca West contained 67 dwellings at scheme commencement in 1979. Many of the houses in the Echuca and Lismore acquisition areas lie below the one in five year flood level (1:5 or 20%), though the flooding in Lismore is much more severe with the added problem of only 6-12 hours warning. Dwellings in North Wagga lie at or above the 1:10 flood level, but the settlement is often isolated by flood waters.

The features of the acquisition schemes are important. They are entirely voluntary, with the authorities offering to buy property at its 'market value'. There are no clear post-acquisition plans. The Echuca scheme is well organized and funded, and includes regulations designed to prevent further development in the acquisition area. It has been the most successful scheme in terms of property purchased with 34% bought by the end of 1984. The Wagga scheme presents the opposite picture with nearly 30 years of indecision by the authorities. During that period only 16% of the dwellings have been removed, despite regulations discouraging the renovation or alteration of existing structures. Although state authorities have successfully resisted local attempts to have the "non-urban" zoning changed, lack of support by local officials and potential relocatees, and inadequate funds have led to scheme failure. Acquisition in Lismore has proceeded smoothly despite a fairly ad hoc program based on annual funding and the lack of zoning regulations. Success is due to the severity of the flood problem and determination of key state and local officials. Although only some 12% of the most

flood prone dwellings have been removed, the worst pockets have been largely cleared. The Lismore and Echuca councils have had to fund only 20% of scheme costs, the balance has been shared by state and federal governments.

Data were collected and analyzed using standard social science methods including interviews, questionnaire surveys, documentary data including census data, and property sales information. Innovative techniques were used for calculating flood damages; to assess the economic merits of acquisition; and for delineating areas on safety grounds.

## PUBLIC SAFETY

To develop safety criteria for acquisition, the physical elements of flooding must be combined with information on the tangible and intangible flood damage susceptibility of selected human activities, including the risk posed to life and the structural integrity of housing.

In general, at urban sites, flood velocity and depth, and warning time and isolation risk, are the critical physical factors for potential damage and risk to life. These factors should be estimated for the regulatory and maximum probable floods. Flood duration is generally not important for direct urban damages, and while debris and water-borne pollutants occasionally constitute a health risk they are of a highly unpredictable nature. Individual and community preparedness is a key human determinant of flood loss and degree of hazard. Preparedness, which itself appears to be largely a function of experience, leads to more appropriate warning response and evacuation behavior (SKP et al, 1982). Smith (1981) found that in Lismore an experienced and well prepared population, acting on a 6-12 hour warning, suffered actual losses equal to half the potential loss for the 1974 flood. Other social or cultural factors relate to the floodplain occupiers' socioeconomic status, for example certain groups such as the poor, aged, or infirm are less likely to respond effectively to warnings. Status in Lismore, in terms of a wide range of poverty criteria including housing, income, and health, declined with increasing flood frequency. The question of preparedness deserves a high research priority.

Water Depth and Velocity. A model devised by Sinclair Knight and Partners in conjunction with the NSW Public Works Department forms the basis of the recommended flood risk analysis procedure (Mathlin, 1983; Russell, 1982). The model is based on other studies and practice and experience in terms of flood damage to structures in NSW and elsewhere (Figure 1). All of these are modified in the light of expert opinion. Results are expressed as a number of flood hazard categories based on water depth and velocity.

An important data source for the model is a U.S. case study of structure damage following a severe flood (Sangrey et. al, 1975). An interesting aspect of their results is the unimportance of water velocity over the range examined (up to 3 m/second). Instead, depth appears to be the critical factor. When water exceeds two metres in depth unraised dwellings of average construction are likely to be destroyed or lifted off their foundations by hydraulic loading or buoyancy. Other studies indicate the limiting conditions in terms of water depth and velocity for vehicles (Bonham and Hattersley, 1967) and children (Foster and Cox, 1973), while a U.S. Army Corps of Engineers empirically derived criterion suggests a limit for light dwellings (see Figure 1). Thus where zones of high velocity can be identified, for example through local knowledge, they should also be considered for possible clearance and exclusionary zoning.

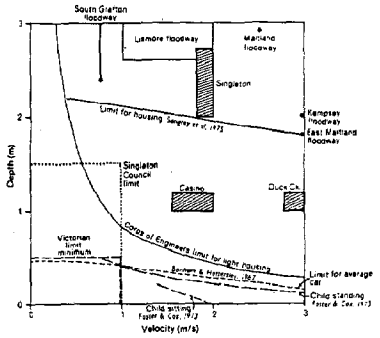


Figure 1(a): Main data sources for guideline construction. Shading indicates destruction of dwellings. Sources: Russell (1982), Mathlin (1983).

Isolation and Warning Time. The minimum desirable warning time is closely associated with the isolation factor: a short warning period requires substantially better flood-free access to maintain the same degree of safety as a site with a lengthy warning time. The reliable warning time available to NSW coastal settlements like Lismore is approximately six hours. This lead time is regarded by U.S. authorities as the limit of effective warning (U.S. NSF, 1980; Mileti, 1975).

The decision as to what constitutes dangerous isolation (lack of access during floods) should consider the safety of both the property occupiers and emergency service personnel, the provision of access at very short notice for emergency facilities such as ambulances and the fire brigade, and the ease of evacuation. To maintain access and evacuation routes, water depth and velocity should be within the zone marked "low hazard" in Figure 1(b). Particularly dangerous are areas that are flood free and isolated at low flood levels and thus appear to be safe islands, but which become completely inundated at higher flood levels.

Recommended Criteria. Priority acquisition areas are those where, for the regulatory flood, one or more of the following apply (see Figure 1): water depth more than two metres; velocity is high; warning time is short (<6 hours); isolation occurs rapidly; low preparedness or other human factors inhibiting effective warning response. Ideally this information should be mapped. Key research needs relate to preparedness and warning response.

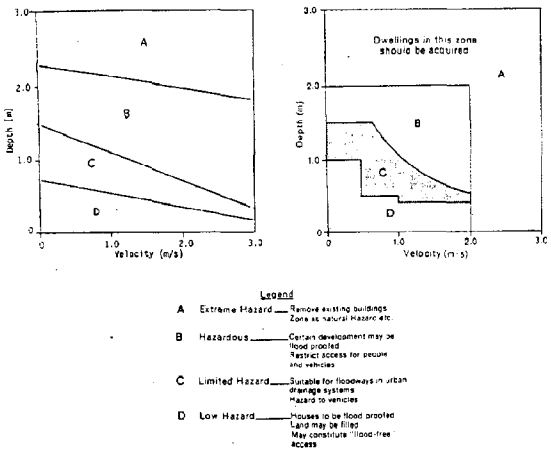


Figure 1(b): Alternative flood hazard diagrams. Right-hand diagram after Russell(1982) and Mathlin (1983).

## AN ECONOMIC BASIS FOR ACQUISITION

The monetary costs of the Lismore acquisition scheme were compared with the tangible benefits as part of the development of economic criteria for acquisition.

Costs are incurred in the actual purchase of property and in structure demolition or relocation; in abandoning public utilities with residual value; in maintaining the land in a flood compatible state and by the householder in having to seek a new residence, pack up, and move. Also, some householders may lose through leaving neighbourhoods they value. As many of these costs may also constitute benefits to certain sectors of the local community, the accounting procedures assume critical importance in determining strategy viability (Mallette, 1975).

Benefits are the flood damages avoided. In addition, special allowance can be made for the safety advantages of acquisition. For many householders relocation may have benefits other than flood damage reduction. Residents may dislike the rundown appearance of the area, the poor council services, or their neighbours, but may be unable to sell their property. Such people may see relocation as an opportunity to better themselves socially and economically. Other benefits of relocation as a strategy are more diffuse and include generally beneficial environmental impacts (U.S. NERBC, 1976), avoidance of an irreversible commitment of resources, and a reduction in the potential for catastrophic losses.

A synthetic approach based on the "ANUFLOOD" procedure was used for tangible flood damage assessment, rather than a structure by structure survey of historical flood damages (Smith et al, 1983; see also Penning-Rowsell and Chatterton, 1977). In the analysis used to arrive at the economic criterion, the estimated potential direct tangible damage was halved on the assumption that the community would be very experienced and well prepared for floods as was the case with the study sites.

The Procedure for Comparison. Substantial dollar losses are very often borne by relocatees when they are forced to upgrade their accommodation, or where living costs are greater in their new locations. Both intangible costs and benefits are incurred by relocatees, the net loss or gain depending on individual circumstances, while the community at large stands to gain substantial intangible advantages from acquisition.

It is important to appreciate the major assumptions underlying the comparison of costs and benefits. Economic efficiency is assessed without removing transfer payments such as taxes. The results therefore, may not reflect national economic losses though the difference should not be great. Other assumptions are: the preparedness factor mentioned above; the absence of intangible costs or benefits from the calculations; in the absence of any local data the use of a 15% (of direct damages) loading to estimate indirects; the use of a 10% discount rate following Australian practice; that the dwelling would be purchased and demolished rather than relocated, with no allowance for the salvage value of the property; and the residual value of services such as roads and water supply was excluded mainly because the standard of service in the Lismore and Echuca sites was low. For example part of Echuca West is without made roads and storm or septic drainage. It was felt that the intangible costs of moving could well have outweighed those associated with floods, at least in the short term. So intangibles were not included in the formal calculations. The situation would be quite different in an area with only limited flood experience.

Using actual tangible direct and indirect damages as set out in Table 1, and the average price of developed residential properties acquired in Lismore (1983 A$11,500), acquisition is economically viable for properties with floor levels lying below the 1:5 flood. This result is in good agreement with the results of U.S. acquisition studies employing similar methods (Mallette, 1975; Johnson, 1976; Johnson, 1978). Under the criterion the Lismore scheme is economic, the feasibility of acquisition in Echuca West is marginal, while the North Wagga scheme is not justified. The results of the analysis naturally vary according to the assumptions employed. For example, results are particularly sensitive to the discount rate, halving the rate from 10% to 5% doubles the present value of flood damages and makes acquisition viable to the 1:8 level.

Ideally governments should adopt the most cost-effective solution consistent with safety and other social and environmental goals. Once the political decision to reduce flood damages is made the authorities charged with implementation should establish the most cost-effective route (within the above constraints). It may be that acquisition is the cheapest and most appropriate solution even when it cannot be justified on cost-benefit grounds. Of course, following a disaster acquisition may be particularly cost-effective provided relocation starts before reconstruction.

The weakest area of economic analysis, and that where research is most urgent, is the measurement of intangible costs and benefits and their incorporation into the decision making process.

Table 1: Simplified Lismore Flood Damage Calculations. Tangible Damage for Indicated Flood Risk Increments. AAD = average annual damage.

| Flood Risk (Recurrence Interval in years) | Potential Direct AAD Per Dwelling | Actual[1] Direct & Indirect[2] AAD (0.5 Potential +15% of Actual) | Present Value of ADD (Per Dwelling) Discount Rate 10% |
|---|---|---|---|
| <2.5 | 4738 | 2724 | 27240 |
| >2.5-4 | 2948 | 1695 | 16950 |
| >4-5 | 1765 | 1015 | 10150 |
| >5-8 | 1096 | 630 | 6300 |
| >8-40 | 604 | 347 | 3470 |
| >40-100 | 249 | 144 | 1440 |

1 Contents: Structure = 79:21. Potential to actual damages = 0.5 of potential from empirical data. Theoretically 0.43 of contents, i.e., 55% of total damages (SKP et al, 1982). The empirical coefficient is preferred as it gives a slightly more conservative result.

2 Indirect losses = 15% of actual direct damages.

## LEGAL REQUIREMENTS

Regardless of other policy objectives, mandatory legal requirements must be satisfied. Although the law is not entirely clear, it appears that the only circumstance in Australia where a government authority would be unquestionably legally obliged to acquire land is where the land is reserved in a planning scheme, for example under the NSW Environmental Planning and Assessment Act 1979. Typically land is reserved for public purposes such as access, open space, recreation, cemeteries, and so on. Where the owner of reserved land so desires, public authorities must be prepared to acquire the property as compensation for the development restrictions.

## QUALITATIVE CRITERIA

Acquisition may be, and frequently is, undertaken for reasons of an explicitly political and social nature.

Acquisition programs may be instigated to satisfy a number of social welfare objectives. Apart from the safety criteria discussed above, there may be: a genuine desire to help people seen as trapped in high risk areas by low property values; a feeling that it is immoral to restrict land-use severely without some form of compensation, such as acquisition; and a need for acquisition as a complement to other government programs. Programs in this category include riverside park or public access creation, e.g., the original Lismore scheme and Toronto, Canada, slum clearance or redevelopment schemes, and environmentally based programs such as the preservation of natural floodplain storage or wetlands (U.S. NERBC, 1976), and structural flood protection. Institutional barriers to combining funds from diverse sources restrict the use of this objective.

The ultimate use of acquired land for parkland underlies the original Lismore program. Occasionally it is economically more efficient to use a severely flood-prone residential area as a park or for some other public purpose. A plan for post-acquisition land-use may help generate community support for the program.

The desire to eliminate repeated aid payouts and the disruption associated with frequent flooding were among the reasons advanced by the Victorian government for the Echuca West program. In fact the flood compensation paid to Echuca West residents has been very small, totalling only A$2330 (1974$) for all households after the severe 1974 flood (data from a survey by E. Bethune, Echuca West resident). As well, infrastructure damages would be very low due to the low standard of public utilities and services. In the U.S., government authorities have initiated acquisition in communities where flood insurance payouts have exceeded or approached the value of the insured property. Under the insurance scheme provisions the U.S. procedures are also satisfying an economic efficiency objective.

Concern over public safety and the political need for action underlie acquisition in the immediate post-disaster phase. The key to a successful program is public support for acquisition. Timing is critical to achieving and maintaining support: the program must be implemented before rebuilding commences. To assist rapid implementation consideration should be given to preparing contingency plans for the acquisition of potential disaster sites. Examples of successful post-disaster acquisition include Toronto (Handmer, 1981); Niigata, Japan (UNDRO, 1976); and cases in Southern Ontario (Mitchell, in press).

## OVERCOMING IMPEDIMENTS TO IMPLEMENTATION

Support for flood related land-use management programs by local and state government instrumentalities is dependent on local community support, or an otherwise attractive political and administrative environment. Despite recent improvements to this environment in terms of political commitment, funding and enabling legislation, some problems remain. There is considerable legal uncertainty; funding and planning could be more goal and policy oriented rather than project oriented; it is difficult to obtain funds from programs other than flood mitigation even when the goals of these other programs are being served; many of the relevant organizations have a strong "construction" mentality, though corporate management concepts are being introduced in some states; and lack of technical knowledge and expertise leading, for example, to an inability to produce local flood maps. The importance of institutional factors should not be underrated. Many flood mitigation organizations are staffed with construction personnel, have funding arrangements which largely exclude non-structural options, and even if the will is present may lack the necessary legal power.

Often working against the adoption of land-use measures, including acquisition, are those who perceive personal losses from the schemes. These individuals or groups oppose acquisition because of their land and business interests, because they are attached to the community and fear its destruction, or because they believe that they will be forced into accommodation they cannot afford. Because of their susceptibility to pressure from such groups local governments frequently find it expedient to be directed by state agencies on questions concerning the use of hazardous land. Councils are then implementing state policy, rather than manufacturing their own.

### Attitude to Acquisition by Potential Relocatees

The implementing authority can expect the support of the local community when residents believe they will personally benefit from acquisition. This was found to be the most important questionnaire factor in scheme support. Other significant factors were high perception of the local flood problem, and low attachment to the community or place (Table 2). A disappointing result of the study from a public policy perspective was that knowledge did not appear to affect attitudes to the acquisition schemes. Thus the impact of public education campaigns would be small. It is important to note that the simple provision of information is quite different from public involvement in planning.

Table 2: Significance and Strength of Selected Associations

| | ATTACHMENT TO COMMUNITY | | FLOOD PERCEPTION | BENEFITS OF ACQUISITION | |
|---|---|---|---|---|---|
| | Tenancy | Length of Stay | | | |
| ATTITUDE TO | .1 | | .01 | .0001 | Chi-square |
| ACQUISITION | .129 | N.S. | .205 | .31 | Contingency Coeff. |
| | 6.6% | | 17.6 | 17.6 | Asymmetric Lamda |

An association significant at (Chi-square) less than the .1 (90%) level is considered not significant. The contingency coefficient, a measure of association strength, has a maximum value of .707 for a 2 x 2 table. Asymmetric Lamda, here expressed as a percentage, measures the predictive power of the association. For a detailed explanation of the statistics see Nie et al, 1975.

Attachment may result from a wide range of factors including family and ancestral ties, length of residence, fear of new and unfamiliar places, and demographic variables such as age. Those most affected are the older long-term residents who own their properties. Public authorities may reduce the impact of acquisition on these people by relocating them within the same neighborhood. Alternatively some form of purchase and leaseback arrangement might be feasible.

A key issue in scheme acceptance, and in reducing the amount of stress and anxiety experienced by (potential) relocatees, is the property valuation procedure. In voluntary acquisition schemes in Australia property is purchased at its market value. This is usually well below the price of an equivalent flood-free dwelling. For older residents who bought or inherited their property before the property boom of the 1960's, the low values represent a major loss and an important reason why they still live in such dangerous areas. Ideally provision should be made to relocate especially needy cases by providing alternative equivalent accomodation and assistance with moving.

## POST ACQUISITION

The long term effectiveness of acquisition as a flood damage reduction strategy rests with appropriate post-acquisition land use. Selection of appropriate uses for high risk land should be guided by the following criteria:

- the safety of the public and emergency service personnel is paramount;
- nothing should be permitted that interferes with flood flow; and
- that strategy which maximizes the return on public investment should be used.

In general, only open space uses can be recommended, in particular those associated with recreation and farming. Such uses were also the dominant choice of interviewees.

The possibility of inappropriate development of acquired land always exists, especially when there are lengthy flood-free periods. To minimize this possibility the land should be rezoned as open space or to some non-urban use. Rezoning should occur at the start of the acquisition program to demonstrate and ensure commitment to the scheme objectives, and to prevent new development increasing the costs and difficulties of program implementation. The stability of the new zones is enhanced if they are part of an overall floodplain management plan specifying clear post-acquisition uses. In the absence of a properly enforced comprehensive plan, new development may occur in flood prone areas adjacent to those being acquired, reducing local confidence in the real aims of the scheme. Ideally, to insulate the land more effectively from local politics, title should be held by the Crown (State). In some circumstances sale or lease of the land for agricultural or recreational uses may serve the purposes of offsetting purchase and maintenance costs, and of maintaining a flood compatible use.

## CONCLUSIONS AND RECOMMENDATIONS

Acquisition is a most effective method of flood damage reduction because damages are completely eliminated within the acquired area, theoretically forever. This degree of damage reduction is attainable only if acquisition proceeds in concert with mitigation measures designed to prevent further development in the acquisition area during the scheme, to restrict the development of adjacent flood prone areas and prevent post-acquisition development.

Criteria, summarized in Figure 2, have been presented for delineating areas that should be acquired. But implementation of such land-use

measures is fraught with difficulty. In the Australian case study sites frequent severe flooding was the best motivator for sustaining commitment to acquisition. The North Wagga case study illustrates the importance of rapid action, political will and, in a voluntary scheme, support from potential relocatees. It also shows the limits of land-use regulations: after nearly 30 years of strict regulations designed to eradicate urban development the village shows little change.

The question of political will is especially important with land-use measures including acquisition - it is easy to roll back regulations or purchase schemes, but politically very difficult to abandon a major levee or dam halfway through construction. This relates to the question of maintaining local support for schemes which take many years to implement. One obvious option is to make schemes shorter, but this may not be possible with voluntary programs. There is no doubt however that reliable funding would

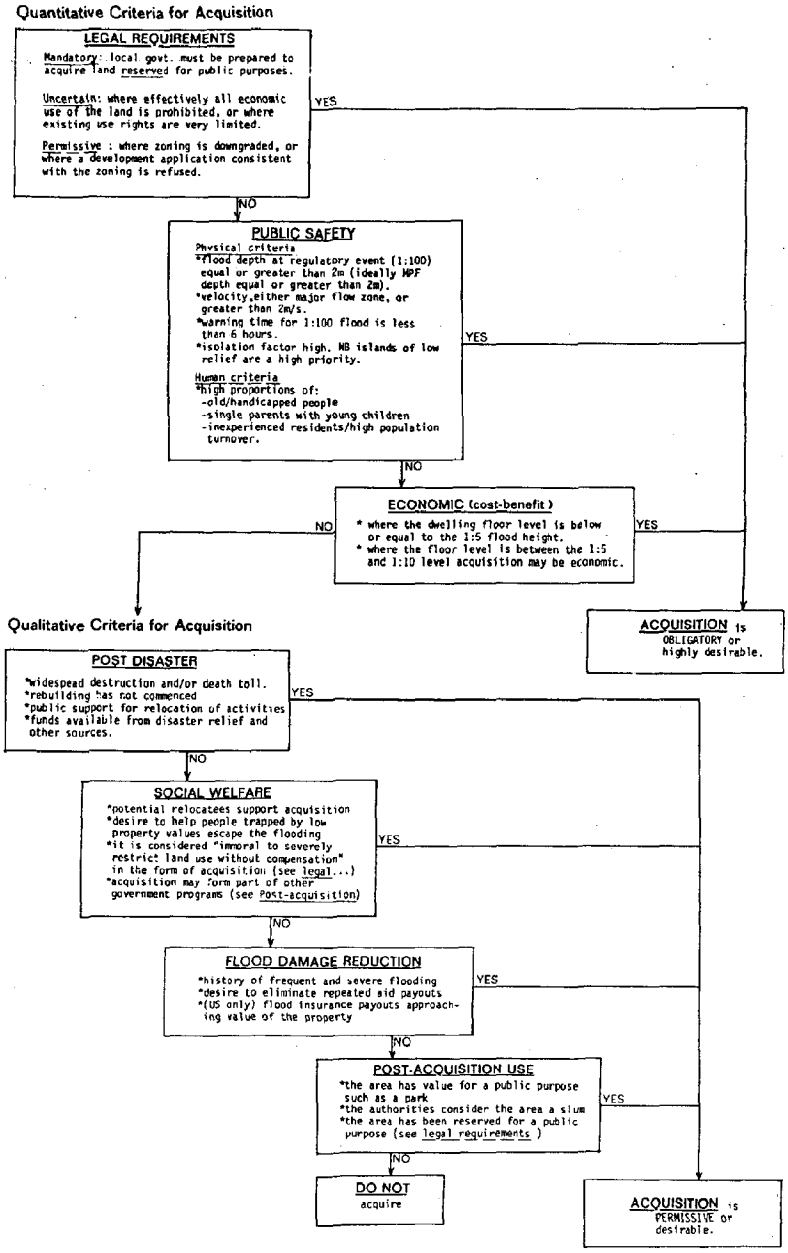


Figure 2 : Criteria for floodplain acquisition in Australia.
Source : Handmer (1984).

help. Erratic or uncertain finance based on annual budgets does little for local confidence in acquisition. Another aspect of funding concerns the combination of funds from diverse sources, some of which may be unrelated to flood damage reduction. For example an acquisition scheme may satisfy social welfare or urban revitalization objectives, in which case funds from these programs should be available.

Resolution of these issues requires research into the institutional environment including the internal organization and mandate of the responsible agencies. Research should not be confined to assessing how to make best use of the existing institutional context, it should also explore alternative organizational and legislative frameworks.

Finally, the focus on post-disaster mitigation should not obscure the fact that these disasters are often the results of planning errors, many of which were entirely predictable. The first priority therefore, must be to prevent the development of additional potential disaster sites.

## ACKNOWLEDGEMENTS

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## APPENDIX

## CURRENT ACQUISITION CRITERIA IN NSW AND VICTORIA

The report Flood Plain Management in Victoria (Victorian Water Resources Council, 1978:54) identified criteria for the conversion of flood prone land to public ownership:

"(a) the land should already be zoned for urban purposes or where no planning scheme exists, is already within an area of urban development and capable under all other regulations and requirements to be so developed but would not be permitted by the FPMA (Flood Plain Management Authority) to be so developed.

(b) the land should have no other reasonable use compatible with its location in the flood plain.

(c) the FPMA considers that no structural solutions to relevant flooding problems are, or will become, feasible.

(d) the FPMA determines that at some time in the future the land should be in the public ownership."

These criteria simply give full discretionary power to the FPMA.

Unlike Victoria, NSW has not set out any explicit criteria for floodplain acquisition. However, an implementation guide for the state's new policy defines high hazard areas. Some aspects of this are explored in the paper. In the absence of formal criteria, informal or unofficial reasons for the relocation of residential development were obtained from interviews with NSW government officials. Their responses fall into three main categories:

(i) When protection is desirable but is not feasible through structural measures,

(ii) Safety issues; situations where the safety of both the inhabitants and rescuers is endangered, especially where warning times are short and where the area becomes isolated at early stages of flooding,

(iii) Equity issues; in particular the case of areas left unprotected by major flood mitigation schemes. Here, acquisition is seen as a way of helping people get out of areas that should never have been developed.

In both states the formal or informal criteria do little more than acknowledge that acquisition is an appropriate strategy under some vaguely specified circumstances.

# Post-Disaster ReLocation: Indonesia's Experience

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## INTRODUCTION

The natural disasters that threaten Indonesia are varied and serious, having caused a great loss of human lives and property. The eruption of Mt. Krakatoa more than one hundred years ago spread ashes over the globe. This eruption reminds us of the geographical and geological setting of Indonesia, which is located on three earthquake belts. Hazards include earthquakes, in mild or severe form; landslides; floods caused by heavy rainfall; droughts which occur mostly in prolonged dry seasons; volcano eruptions - 90 volcanoes are categorized as living and may erupt any time and spread calamity among 70 percent of the population; lava floods, particularly secondary lava (from the eruption of volcanoes); and tidal waves, caused by earthquakes originating on the sea bottom. Tidal waves are a particularly severe threat to coastal village settlements as we observed in 1977, on Sumba island.

Estimated annual losses from these natural hazards in the last five years (1978/1979 - 1983/1984) include (from an annual average of 3.6 significant destructive events) 890 deaths, 3,000 injuries, 100,000 homeless, and 1,000,000 hectares of agricultural land destroyed. The total direct cost was approximately U.S. $135,000,000.

## THE NATURE OF DISASTERS AND THEIR MAGNITUDE

The magnitude of disasters, either geological or other, can be categorized as local/regional or national. Local or regional natural disasters are those of a limited magnitude, including disasters which do not affect too large an area or do not inflict severe damage. This kind of disaster is usually handled locally by the municipal or provincial government.

A disaster of national magnitude is of such an extraordinary magnitude or affects so large a territory that it inflicts huge damages on a large population.

All the disasters result in certain types of losses - (a) to the inhabitants in the form of loss of lives, property, etc., (b) to the physical infrastructure such as construction, office buildings, bridges, roads, dikes, and agricultural facilities, and (c) to the environment in the form of destruction of forests, deteriorating of rivers, destruction of marine life and so forth.

## CONTEMPORARY CONCEPTS

Knowing that disasters have multiple impacts on mankind and social and economical life, their prevention as well as their mitigation becomes a matter of everyone's response.

Traditionally, societies everywhere in the world have tried to alleviate their effects through post disaster relief and rehabilitation. But in recent years, advances in disaster preparedness and prevention offer better prospects. Such mitigation measures include cross-sectoral planning and organization, such as in public works, communications, monitoring and warning, public awareness, education and research.

## DISASTER MANAGEMENT

Disaster management in Indonesia is complicated not only by the frequency and diversity of natural phenomena, but by the country's large physical expanse and varied geographical character. It is also complicated by the diversity of the local sociocultural traditions and dialects, and last but not least, by the dense and unequal distribution of population.

To address our problems, we have to assess the state of knowledge in disaster prevention techniques and procedures for mitigation, especially with regard to future losses of urban development after disasters, and to understand thoroughly the physical as well as the sociocultural background. We have to develop a workable policy to enhance mitigation which is politically, socially, and legally appropriate.

Today in Indonesia many of the problems related to the various disasters are addressed sectorally, especially in their scientific and technological dimensions. The governmental agencies responsible for prevention, preparedness, or relief measures within their own areas of competence include the following:

- The Department of Social Affairs has responsibility for social sectors;

- The Department of Public Works conducts

programs for control of floods, volcanic lava, and debris floes;

- The Meteorological and Geophysical Centre (Dept. of Comm) addresses meteorological aspects and is also responsible for geophysical monitoring;

- The Department of Mine and Mineral Resources has two interested directorates: the Directorate of Environmental Geology for landslides and soil movement; and the Directorate of Volcanology for volcanic eruption and geologic research and a development centre interested in earthquakes;

- The Departments of Agriculture, Health, Defense and Security, Population and Environment, Tourism, Post and Telecommunications, Manpower, Transmigration, and others, have responsibility for the governmental administrative apparatus down to the sub-regency level and play a critical role in the conduct of all disaster-related activities.

Further, there are several technical departments with activities bearing on disaster management. For example the Palapa Domestic Satellite Communication System, and the LANDSAT Imagery Collection Station (LAPAN) together process data from the Japanese geostationary satellite GMS and U.S. NOAA Satellites.

Certain other technical institutions, such as universities (Institute of Technology, and University of Gajah Mada), play an important indirect role in disaster affairs. Such a role is also played by governmental organizations such as the Indonesia Red Cross.

In summary then, disaster management is not mono-sectoral, whether in prevention, preparedness, or relief. The socioeconomic and the spiritual welfare of the people, the protection of personal and public property, and the development programs require cross-sectoral efforts and resources at all administrative levels. Further, the character of disasters, especially in the post-disaster context, places a high premium on coordination and rapid exchange of information, horizontally between departments, and vertically within each department.

Organizational Structure and Activities

The importance of cross-sectoral coordination has been recognized by the Government. An important step was taken a few years ago with the issuance of the Presidential Decree No. 28 of 1979, which established non-sectoral Coordination Boards at three Chief administrative levels: the National, the Provincial, and the Regency levels. (We have 27 provinces and 295 regencies).

At the National level the organizational elements are:

- A national Coordination Board for National Disaster Relief (BAKORNAS PBA) under the General Chairmanship of the Minister Coordinator for People's Welfare, assisted by three chairman: the Ministers of Social Affairs, Home Affairs, and Public Works.

- A Technical Working Team bringing together, as needed, a predesigned group of middle-management officials under the chairmanship of the Secretary of BAKORNAS PBA.

- A Secretariat, supervised by the Secretary of BAKORNAS PBA, which supports the Board and Technical Working Team, and is the key structural element of the BAKORNAS PBA.

Since the 1979 Presidential Decree was issued, frequent and varied natural disasters have occurred, giving ample opportunity to asses the strength and weakness of the structure. These disasters have included:

- the floods/landslides and tsunamies on Flores Island in 1979,

- landslides and heavy rains in West Java and West Sumatra in 1980,

- the earthquake in Irian Jaya in 1981,

- serious drought in many parts of Indonesia in 1982/1983,

- volcanic eruptions of Mt. Galunggung (West Java) in 1982; of Mt. Colo (Central Sulawesi) and Mt. Gamalama (North Maluku) in 1983; of Mt. Soputan, Mt. Siau, and Mt. Karangetan (North Sulawesi) in 1984.

All of these engaged the emergency apparatus from local to national level, and provided useful evidence of areas needing strengthening.

Collective intra-institutional reviews of natural disaster management experience were made during two significant gatherings of officials with disaster related responsibilities at the three administrative levels: (1) the National Training Session for the Provincial Management of the National Coordinative Units for Emergency Relief of Natural Disasters, held in 1981, sponsored by the Indonesian Government, UNICEF, and U.S. AID, and (2) the "National Workshop on Galunggung Volcanic Risk Management" held in 1982, co-sponsored by the Indonesian Government, UNDP, UNDRO, UNICEF, and U.S. AID. Similar reviews are being conducted regularly in annual provincial level disaster management field training.

Post Disaster Relocation

As mentioned above, natural disasters in Indonesia are rather complicated because of their frequency and diversity and because of the diversity of the sociocultural traditions, different dialects, and unequal distribution of population. Such complexity makes the problems of post disaster relief and rehabilitation not only more difficult to solve but also requires different approaches.

Because physical rehabilitation takes time, our emphasis has been on relief programs in the form of workable relocation policy. Often the places where disasters occur are still dangerous to occupy after a disaster and many human beings desperately need help. Some of the places are in such terrible condition that is is unsafe to live there again.

Therefore, a fresh approach has to be taken, including a program that will relieve burdens and give disaster victims a better prospect for the future.

Most of the disaster-stricken areas are densely populated. Improving the standard of living there is very difficult. Most residents are rural peasants and landless agricultural workers whose traditional philosophy of life has been: "With or without food, the most important thing is for us to stick together." Facing the reality that they can no longer stay in their homes, they have to move to another place. For the government moving these people to other places within Indonesia is not only part of a mitigation policy but also a transmigration policy which attempts to solve the maldistribution of population problems.

Relocation of the people within Indonesia for one reason or another is not new. Relocation was practiced by the Dutch more than one hundred years ago. At that time, hundreds of thousands of people from Java were sent to Sumatra to work on plantations. Many others were sent to South Sumatra, where they were given land to support themselves.

Today's policy is very different, however, and so is its approach. It is based on elaborate planning and on a different philosophy. As it is stated in our transmigration policy, the aims and purposes of moving these people are: better distribution of population, regional development, beneficial use of natural and human resources, and national unity and security. However, the emphasis is on the increased food and agricultural production, and balanced development with the aim of an improved standard of living.

The program is not merely a relocation of people, but the setting up of a new organized community, and the achievement of a balanced spread of manpower, capital, and technology throughout the country. The direct recipients of benefits from this program are (among others) the victims of natural disasters and the rural poor consisting of peasants, landless agricultural workers, and other low income groups.

The settlers, especially those sponsored by the government, receive several types of assistance: terms of transportation from their place of origin to the settlement site; 2-5 hectares of land (per family), of which 1-1.25 hectare is cleared for cultivation; a house; food supplies for a period of 12 months; and agricultural inputs - including seed, fertilizer, pesticide, and extension services and a set of farm tools. In addition, facilities for education, health, religious worship, recreation, and other social activities are provided.

Implementation of the program requires site identification (aerial photography); land capability analysis and socioeconomic surveys; transmigrant recruitment and movement planning; physical and agricultural planning; land acquisition; land clearing; construction of roads, bridges, settlers's houses; establishment of schools, health clinics, community centres, and market places; the actual movement and placement of settlers; provision of food and agricultural inputs; and guidance and supervision during the initial years of settlement, to mention only a few of the elements.

The present average cost of the settling of a transmigrant family is about ten thousand dollars (U.S.$1 = Rp. 1,000). The budget allocation for the Transmigration Program accounts for about 12 percent of the total national budget. The annual budget for the program has increased from Rp. 2.3 billion in 1972/73 to Rp. 375 billion in 1981/82.

The Indonesian Government has set a target of settling five hundred thousand (500,000) families, or about two and a half million (2,500,000) persons during the Third Five Year Plan (1979-1984). To facilitate the accomplishment of this enormous task, the Government has developed a new mechanism through the Presidential Decree No. 26 of 1978, which requires the participation of all the concerned government departments. This integrated cross sectoral approach to the development of transmigration focuses on regional development.

A recent survey by the World Bank shows that the settlers are better off in the transmigration areas than they were in their area of origin. Our studies, including the investigation carried out by UNDP/FAO and other international agencies, indicate that low yield and low income are attributable to technical and institutional factors, such as lack of adequate farm inputs and other agricultural support services, adoption of inappropriate farming systems and technologies, and lack of suitable transportation, processing, and marketing facilities.

Foreign assistance extended to the Transmigration Program in Indonesia has come from international, multilateral, and bilateral sources such as UNDP, FAO, WFP, IBRAD, ADB, ISDB, EEC, U.S. AID, CRS, the Government of the U.K., France, the Netherlands, and FDR. Some of the assistance has been provided on a grant basis: the rest consists of low interest-bearing loans. The grant have been generally used for technical assistance and the loans for the development of specific projects.

Today, the transmigration program is being implemented with much improved organization and management, due to our experience in the last four years. It is a long term and integrated project with aims and goals much broader than just relief and mitigation from natural disasters.

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# Successes and Failures with Moratoria and Long-Term Mitigation After the Big Thompson Canyon Flood

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## INTRODUCTION

The Big Thompson Canyon flash flood struck the night of July 31, 1976. One hundred and thirty-nine people lost their lives. Private property damage was estimated at $16 million and public property damage at $27 million.

The catastrophe was caused by ten inches of rain falling in four hour on soils saturated from repetitive rains during the previous week. For many canyon residents there was no warning. An eighteen-foot-high wall of water caught some victims on the canyon highway. Cars and huge boulders were thrown like ping pong balls by the force of the water. The river bed was scoured. Debris accumulated behind bridges, giving a nearly inexplainable pattern to some of the destruction.

Prior to the disaster the canyon was dotted with retirement cabins and some weekend retreats. Fixed incomes placed an extra constraint on many of the retirement survivors whose homes were destroyed. Of those who lost year-round houses, 57 percent were over 50 years old.

## THE MORATORIUM

Very soon after the flood, the County Commissioners placed a six-month moratorium on rebuilding homes that were more than 50 percent destroyed. This was possible under state law which authorizes local governments to adopt a moratorium for up to six months in an emergency situation.

The Big Thompson Canyon had not been mapped for flood plain designation. This was begun with the assistance of the Colorado Water Conservation Board staff.

Larimer County had adopted Flood Plain Regulations in 1974, but these applied only to one stretch of the Cache La Poudre River which was under heavy development pressure. The County Commissioners had adopted regulations in order to qualify for the National Flood Insurance Program. The Commissioners in office in 1974 were largely laissez-faire in their attitude and inclined to think people ought not to build in flood hazard areas out of good judgment rather than be prohibited from doing so.

The Flood Review Board which had administrative authority for the Flood Plain Regulations consisted of three members appointed by the Board of County Commissioners. The County Engineer was Chairman of the Board. The other members were individuals with engineering training. This tended to put an emphasis on technical compliance with the regulations rather than political considerations.

However, in April, 1977, the Commissioners adopted an amendment permitting decisions of the Flood Plain Review Board to be appealed to Commissioners instead of directly to District Court. This amendment had the undesirable potential of making flood plain decisions more political and less technical.

During the six-month moratorium there were at least three building projects which proceeded without a building permit in violation of the moratorium. But, for one reason or another, the County Commissioners did not take action to enforce their regulations. With these exceptions, the moratorium was successful in providing time for completion of the flood plain study.

A public hearing to determine if the Big Thompson River flood plain maps were satisfactory to regulate the rest of the canyon was held on January 31, 1977. This was only three weeks after two new Commissioners were sworn into office following their successful election in November.

There was an emotional and hostile environment at the hearing with 250 people in attendance. About 15 or 20 individuals spoke passionately against adoption of the regulations. One person who had worked in the Canyon in the immediate aftermath spoke in support.

The three Commissioners unanimously added the Big Thompson maps to the flood plain regulations. They acted because they were convinced it was the only way to secure recovery assistance and not (all of them at least) with the conviction it was necessary to mitigate future risks of disasters.

Immediately following the flood it became apparent the County did not have the depth of personnel sufficient to handle the full range of problems facing them. Does a local government ever have the staff to undertake public works projects in the aftermath of a disaster that are four or five times larger in size or number than their annual expected projects? The County needed to immediately put destroyed county roads

back into service. They needed to make trade-offs between having roads rebuilt in the shortest possible time as opposed to careful engineering to mitigate future flood damage. For the most part, expediency won out. There were gargantuan problems in searching for victims; identification of the dead; concern about water contamination; assessment of property damage; identification of damaged homes to be destroyed because of public health considerations; immediate housing for the homeless; and short-term aid.

The post-flood recovery program was predicated upon the idea of redevelopment that would be safer. Where homes were more than 50 percent destroyed, landowners were prohibited by the flood plain regulations from rebuilding in the floodway. If these lands could be publicly acquired at pre-flood values, and if HUD relocation grants could be coupled with the acquisition, the 115 victims whose houses were more than 50 percent destroyed were to be given a substantial measure of relief.

## THE ACQUISITION PROGRAM

The acquisition program was launched in February, 1977 when the Commissioners committed $253,000 of County dollars to initiate a local, state, and federal program for acquiring floodway lands in the canyon for public open space. At that time it appeared that $2,530,000 would be needed to ensure enough dollars to negotiate with the owners of 364 floodway parcels which were either undeveloped or with improvements which had been more than 50 percent destroyed.

During 1977 applications were submitted for several sources of funding: monies were sought from the Colorado Land and Water Conservation Funds; a bill was put through the Colorado Legislature to obtain about $830,000 in state money; an application for $150,000 was submitted to the Four Corners Commission; and a request was sent to the Secretary of Interior for $1,000,000 from his Discretionary Fund.

To make the acquisition program work as a victim relief measure it was necessary to obtain a HUD Community Block Grant for relocation and rehabilitation grants. The joint concept of acquisition and relocation was jeopardized in June, 1977 when relocation dollars were deleted from the HUD approval of the rehabilitation award.

After considerable local effort and by the Colorado Congressional delegation, HUD did approve the relocation part of the application. This enabled some 32 families who were full-time residents in the canyon to qualify for relocation grants which averaged $11,500 per family. Added to the pre-flood purchase values of the land these grants created the possibility of buying a replacement home and putting their lives back together again.

It was not until December, 1977, when Secretary of the Interior Andrus announced that he had approved the Big Thompson application, that acquisitions actually began to take place. This was seventeen months after the flood. It is inhumane to have flood victims wait that long.

The final cost of the acquisition program was considerably less than originally estimated. It was possible to purchase 114 parcels from 94 property owners for $1,556,014. Parcels in the floodway not purchased by the County were sold to adjacent owners or were part of a larger holding; eight were kept by owners who planned to later develop them; and two owners received variances and did redevelop.

The purchased sites were cleaned up, grassed, and planted with trees and shrubs. Three sites were developed as picnic areas by the County with a 50 percent match from Colorado Land and Water Conservation funds. These picnic areas now act as tourist attractions to the canyon and as an entry to Rocky Mountain Park.

The chief problems in mitigation were the delays and uncertainties. If acquisition programs are to be successful, funds must be available that can be drawn upon for disaster recovery without delays of a year and a half. People suffer too much from the loss of loved ones and all their possessions to have added frustrations and uncertainties resulting from government inaction.

The State of Colorado had passed the Colorado Disaster Emergency Act of 1973 prior to the disaster, but had not appropriated money available for quick access. Having funding available at state of federal levels is essential so that it can be used effectively to leverage an integrated program to mitigate future disasters.

Another problem was that some owners were unwilling to sell their property to Larimer County. In time, the county political resolve may weaken and more development may occur in floodway areas. Some of the homes that were not 50 percent destroyed will be vulnerable if there is another destructive flood. The debris backup behind bridges gave protection to some buildings that were very exposed, if one looked just at the flood maps. There are variables in floods that hydrology cannot completely explain.

Another related problem was the assessment to determine if a building was more than 50 percent destroyed. The credentials of the team making that determination need to be defensible. The findings must be well-documented and complete. A hurried or less than fully competent assessment is unfair and adds to the suffering of people who have sustained great losses.

Public recovery programs must be conditioned on mitigation efforts. Incentives to implement mitigation regulations and to purchase flood plain lands are absolutely essential to overcome political pressure to rebuild in the floodway. Some survivors of the Big Thompson Flood were obsessed with the desire to rebuild destroyed homes. Politicians naturally felt compassion for them in their loss. But elected officials also wanted to help as many of the survivors as possible. Government programs should be structured with incentives for mitigation,

conditional assistance, and with strict accountability as to how recovery money is spent to ensure long term reduction in flood losses.

## SUMMARY

Based upon the experience of the Big Thompson, I believe local government officials should prevent development in floodways and regulate development in the flood fringe. But political obstacles to imposing restrictive flood plain regulations should not be underestimated. Those with affected properties are adamant in their objections. The public at large is disinterested and gives their public officials little overt support. There is little political gain from restrictive flood plain regulation.

Protecting flood plains from development is a long term policy. The benefits are not realized unless there are future severe floods. Probability dictates that such benefits are more likely in the long run than immediately. Today's political climate reflects society's short term concerns. In individual decision-making, instant gratification and buying with credit is more important than saving and planning for the future. Nationally, the benefits of consumption outweigh the effects of large deficits which threaten the next generation with a lower standard of living. With these political currents, it is not surprising that local elected officials do not implement mitigation measures more readily.

Much more attention and research needs to be directed towards the political problems of disaster mitigation. The speakers and panelists at disaster mitigation conferences are almost exclusively technical, legal, and academic professionals rather than legislators or local elected officials. Elected officials are not well represented as participants either at disaster conferences. Ways need to be found to place a stronger emphasis on the politics of successful mitigation.

# Acquisition: The Baytown Experience

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## BAYTOWN, TEXAS, AND THE BROWNWOOD SUBDIVISION

Baytown is located on the north end of Galveston Bay, adjacent to the mouth of the San Jacinto River. The Brownwood Subdivision is located on the east side of the city on a peninsula of land jutting into small bays off the San Jacinto River. It contains some 300 homes, all of which were built in the 1950's before the flood hazard was fully recognized. Recognition came with Hurricane Carla in 1961, during which water covered the entire peninsula and flooded every home with at least eight feet of water.

Since then, Brownwood and the rest of the Baytown/East Harris County area has suffered from subsidence. The Brownwood Subdivision has subsided approximately five feet since 1963, and an estimated nine feet since 1915. Although the subsidence has been halted by control of groundwater pumping, the effects are permanent. As a result of subsidence, the elevation of Brownwood is just above sea level and Brownwood is subject to periodic tidal flooding.

In the last six years the City has had to deal with many flood alerts due to high tides and has supervised evacuation of homes in Brownwood many times. In 1979, for instance, there were five flood alerts in Brownwood and four evacuations.

In response to this problem the Brownwood residences formed a civic association, the main function of which was to maintain the high tide alert system. When high tides threatened, the association notified all residents. The residents of the worst areas would evacuate; others would merely elevate their furniture, pull up their carpets, and ride out the flooding. The City installed several high speed pumps to help drain the lower interior bowl of Brownwood in an effort to minimize flooding.

Although many of the residents had experienced tidal flooding, twenty-three years without a hurricane had encouraged them to view hurricanes as a remote threat. The City continually warned its residents that the average occurrence frequency for the area was one hurricane every ten years, and that a hurricane was, therefore, thirteen years overdue.

A significant problem with the National Flood Insurance Program became apparent during this period. Many of the homes subject to frequent flooding were converted to rental units, and as such, were considered desirable property by the owners, not for their rental income, but for their flood insurance income. The owners would apparently submit a claim for several thousand dollars, spend a few hundred dollars on paint and superficial repairs, and pocket the difference. Some owners did this many times. One owner reportedly said that he looked forward to floods because they "helped his cash flow."

## HURRICANE ALICIA

With the arrival of Hurricane Alicia, Baytown was no longer overdue. Twelve to thirteen foot tides and 120 mph winds caused damage throughout the city. Over 600 housing units were destroyed and an even greater number damaged. Approximately 300 of the destroyed units were in Brownwood. Although the high tide from Alicia was lower than that from Carla, the subsidence in Brownwood during intervening years resulted in much higher water levels. Most homes had ten or more feet of water in them. The wave action, which had not been a factor in Carla, was severe. Many homes were completely swept away, leaving only concrete slabs. Most people were unprepared for this aspect of the hurricane. Residents who had been through Carla, or who stayed in their homes during many tidal floods, thought they could ride out Alicia, only to find their homes battered and destroyed around them. Rescue crews picked up people from the trees and the roofs of the remaining structures.

## FEMA AND SECTION 1362

FEMA responded quickly to the damage and made available many programs to help victims. Early in FEMA's response, staff discussed with the City the feasibility of an acquisition program under PL 90-488, Section 1362 for the Brownwood Subdivision. To qualify for acquisition, a structure in the subdivision needed to meet one of the tests set forth in Section 1362. Some homes had qualified for a 1362 purchase prior to Alicia under the first test, which required that a structure had to have been damaged by at least three previous floods over a five-year period, with an average damage of 25 percent or more of its value. An alternate criteria was that of a single flood which damaged a structure 50 percent or more of its value. The City and FEMA believed that all of the approximately 300 homes located in the worst area of Brownwood would qualify as damaged at least 50

percent by a single event (Hurricane Alicia). In addition, the City had passed an ordinance after Hurricane Alicia which prevented repairs and occupancy of structures within the Brownwood area. This qualified all the homes in Brownwood under a third test of Section 1362 related to the legal impossibility of rebuilding.

Initially most property owners in the Brownwood area were favorable to the 1362 program. They saw public acquisition as a way of finally getting rid of their property. Prior to this time, the area's reputation as a flood prone area prevented many owners from receiving what they considered to be reasonable purchase offers. For years, the only sales had been owner-financed.

The City of Baytown agreed to accept the property once it was purchased as required by FEMA, and implementation of the 1362 Acquisition Program for Brownwood began.

Was the program successful? The success of the program depends on one's expectations. Of the 265 homes eligible, 177 were eventually bought by FEMA. A 100% acceptance rate was desirable, but in light of some of the problems that occurred, the percentage that did agree to sell was high. An initial problem was the length of time it took to implement the program. Hurricane Alicia struck on August 18, 1983, and the City of Baytown signed the Agreement for Property Acquisition on October 11, 1983. But the first purchases did not occur until March, 1984; and the final purchase was not made until August, 1985. Many owners who initially wanted to sell changed their minds during the long wait. Others rejected the offers they received as too low. Some offers were for only $1,000 to $1,200, which was basically the value of the lot.

The program was also hurt by changing public sentiment. In addition to the displeasure with the long time period and the low values, many owners became suspicious and mistrustful of both FEMA and the City of Baytown. Rumors spread that the City was planning to sell the acquired property to industries for a large profit. Some owners complained that FEMA had told them that they had better take the FEMA offer and if they did not the City would come in and condemn the property. The owner would then get even less than what was offered by FEMA. One group of property owners sued the City in State Court and another group sued the City in Federal Court. Both groups claimed that the City's regulatory ordinance constituted a "taking". The publicity and ridiculously large claims in the lawsuits encouraged other owners to hold out to see if they could get more money at a later date. Despite all of these problems, 177 structures were acquired.

## SUGGESTED CHANGES IN THE 1362 ACQUISITION PROGRAM

Although the City of Baytown considers the acquisition program an overall success, a number of problems arose which if remedied could have resulted in more complete acquisition. Some of these problems do not lend themselves to easy remedies: they are a result of the size of the program and flaws in the National Flood Insurance Program itself. The Brownwood program was the largest acquisition even attempted -- most past 1362 acquisition efforts had involved 10 or 20 parcels.

Problems and/or suggested changes, based upon the Baytown experience include:

1. The acquisition process should be speeded up. The sooner after a flood event an offer is made, the more likely the property owner will accept. The passage of time allows the property owner to minimize, in his mind, the actual damage to his or her property. Delay in acquisition also provides extra time for rumors to spread as to the ulterior motives of FEMA and/or local government for acquiring the property, or as to possible future better offers.

2. FEMA should more carefully train or supervise the people who deal with the property owners. City of Baytown staff members were told by many Brownwood property owners that FEMA representatives coerced them into selling (or in some cases, the owner stated he or she might have sold if coercive statements had not been made). As long as 1362 is a voluntary program, it should be portrayed as such. Statements by FEMA representatives left a pool of ill will among the citizens and now that FEMA has gone, local government is left to deal with this resentment.

3. The National Flood Insurance Program and the Section 1362 acquisition program should be tied more closely together to prevent abuse of the flood insurance program and to encourage property owners to take advantage of Section 1362. For instance, insurance claims should be cumulative, so that if a property owner collects flood insurance more than once for the same property, the percent of damage should be noted and totalled. Once a property owner has collected claims totalling at least 50 percent of the value of his or her property, he or she would be eligible for the 1362 program. Furthermore, if claims exceeded some set percentage, say 70 percent, and the owner did not choose to accept the 1362 offer, the property would no longer be eligible for flood insurance. There is no reason for taxpayers to continue to pay the cost of people living in a flood prone area indefinitely (by means of subsidized flood insurance) when there is a mechanism to allow the property owner to dispose of flood prone property.

Possibly future flood insurance policies could be written to require a property owner to sell his property to FEMA when he has collected insurance settlements in excess of the value of the property. If a contractual arrangement was made part of the insurance policy, the issue of whether such action would be a "taking without compensation" could be avoided. A mechanism for enforcement would have to be developed, but such a provision could be developed and would prevent abuse of the flood insurance program.

4. Information regarding insurance

settlement payments, which are included as a part of the Section 1362 calculation, should be made public. FEMA and the City of Baytown received much bad publicity because of allegedly "low" offers being made through the 1362 program. In reality the total compensation, which included the insurance payment as well as the 1362 payment, was very generous in the Brownwood Subdivision. Had the City been able to use this insurance information it could have maintained much better public support. If the insurance program is to be subsidized by tax dollars, the insurance information should be available as public information.

5. FEMA should improve its communication with property owners. Many property owners are illogical and unreasonable in their questions, demands, desires, and positions. Knowing this, FEMA should be particularly clear and specific with regard to what is being offered. Owners need to be continually told that the purchase price is the total of the insurance payment and the 1362 payment. Many property owners apparently believed the 1362 payment should be the market value of their property.

FEMA should also have stressed that properties sold to FEMA could be only used in the future for open space purposes. Staff members with the City of Baytown continue to hear rumors that the City is going to sell the property it owns in Brownwood to industry for use in industrial development. In light of the fact that the City of Baytown has stressed open space use from the beginning, and these rumors continue, it may not be fair to criticize FEMA; people sometimes refuse to listen. But knowing this indicates the need to stress dissemination of constant, correct information.

## SUMMARY

The experience in Baytown has shown the 1362 program can be successfully used to acquire large numbers of properties. It also indicates that a number of changes should be made in order to increase the percentage of owners that will accept a 1362 offer. The process should be speeded up as much as possible, and FEMA representatives carefully trained and supervised in dealing with property owners. Furthermore, the 1362 program offers should be tied in some manner to the flood insurance program to prevent people from filing insurance claims again and again. Offers under 1362, including insurance payments, should be made public. Finally, FEMA should make sure that its policies are clear, correct, and constantly repeated in public information. Misinformation has probably been the single biggest limitation upon the program in Baytown.

# Acquisition and Relocation

*John D. Seyffert*
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## INTRODUCTION

I was originally asked to discuss the U.S. experience in acquisition/relocation of properties away from natural hazards. The dominant U.S. experience for acquisition and relocation has been in floodplain areas as opposed to areas of other natural hazards. The U.S. flood damages on an annual basis are now in excess of $4 billion per year. In discussing this topic with Jon Kusler, I felt that perhaps a nuts and bolts "how to" talk would be more effective than a verbal summary of successful projects or your typical "here's how we did one" talk. During your time here, there will be ample opportunity to speak with people about Rapid City, Prairie de Chien, Baltimore County, Mobile, Big Thompson Canyon, and other good projects. In this era of no or little federal funds, let's talk about how to put a project together.

I think the best way to discuss the nuts and bolts of assembling a successful acquisition program is to try to respond to and understand the standard 5 "W's" and 1 "H" of a good newspaper story - **WHO** - **WHAT** - **WHERE** - **WHY** - **HOW** - **WHEN**.

Let's use a basic riverine floodplain management situation. A small portion (100 properties) of a New England town is located within the 100-year floodplain, suffers damage twice a year from non-significant events, once a year from notable storms, and once every two years from our famed 100-year storms.

* 100 properties
* 35 flood occurrences last ten years ($1 million plus per event average)
* $40,000,000 total damage related (last ten years)
* $400,000 - average damage per property or dwelling unit

## WHO

There are several **WHOS** that should be identified and their causes understood. You can't lose sight of the audiences who must support your project if it is ever to be implemented.

**The victims** - these people are the ones who suffer the financial, physical, psychological losses from each disaster, as well as have the recurring fear of impending ones. These are also the same people who try to return to their homes as soon as possible after each disaster, driven psychologically by a desire to get their lives back to "normal" quickly, and often return to their flooded property without question.

**Taxpayers** - victims also, but in a different sense. Higher tax bills caused by disaster response requirements, emergency housing, utility repair, evacuation assistance, road repairs, etc. While these items are typically not included as line items in a municipal or state budget they have to be accommodated. In many communities these are recurring and constantly increasing expenses taxpayers have no choice but to pay - emergency response must be done, money must be found.

**Politicians** - a really different kind of victim. They typically are expected to have answers and solutions to all problems, but they usually only have to deal with them on a 4-year cycle. They must play to all audiences, not raise taxes, and solve all problems.

**Professionals** - we are also the victims because the politicians look to us for the answers. We must be innovative, unrestrained, limited only by imagination, but often without adequate funding, time, expertise, or community support.

The important aspect is that we must always identify the **WHO** and how they are impacted and what their interests and rights are. Knowing the various actors, their roles needs, and how the scenario fits together is essential in formulating any plan. What does the public need to know if it is to support your program?

## WHAT

The **WHAT** can either be a plan to clear the floodplain to minimize flood damages, a stream valley park, right-of-way for a sewer line, a conservation easement, or a watershed management plan. Give yourself the most options, with the broadest title.

The critical aspect in defining **WHAT** is to clearly define the problem: what is the cause of the flooding, where and why does the damage

occur, what are the total true costs of the flooding over a budget year? Account for non-disaster events and include utilities work, police, fire, costs assignable to highway crews, etc. for the insignificant events as well as the major ones. The **WHAT** also includes numbers of victims, market values of property, number of flood incidents during past 10 years, comparison between amount of total public costs vs. market value. Are there cheaper solutions to the flooding problem, cheaper than acquisition? Does the **WHAT** define a permanent solution and the values associated with that? The **WHAT** should be developed using the greatest, most expansive program available to us because this will in turn open up the funding options and reasons to vote in favor of the program.

The **WHAT** must compete with all other problems; solid waste, schools, crime, elections, and government employees salaries to get funding within the governmental structure.

Design your **WHAT** to reach as many audiences as possible. Be able to show it is cost effective. The **WHAT** can include a mix of solutions: acquisition and relocation, flood-proofing, storage/retention, building codes and zoning adjustments - don't forget long term maintenance required for any solution.

Find out, from a legal perspective, what public funds can be used for what purposes. If you can't buy private property for flood control, maybe you can remove obstructions in the floodplain.

| TOTAL DAMAGES & COSTS LAST 10 YEARS | | 100 PROPERTIES | | COST PROP. DAMAGE | = | RESULT NO FLOOD REDUCTION |
|---|---|---|---|---|---|---|
| $40,000,000 | v | 100 | | $400,000 | | |

| AVERAGE MARKET VALUE | | AVERAGE REDUCTION COST | | AVERAGE ACQUISITION RELOCATION | = | TOTAL FLOOD REDUCTION |
|---|---|---|---|---|---|---|
| $75,000 | + | $10,000 | = | $85,000 | | |

## WHERE

The natural boundaries of the **WHAT** need to be defined. All properties within the high hazard area, everything within the floodway, everything within the 100-year floodplain but not flood fringe or do we include all of the 100-year floodplain plus flood fringes? Priorities for acquisition need to be defined: residential only - residential first - flood fringe? Do we just want properties located behind the physical obstructions because it's cheaper than rebuilding the culvert, and by rebuilding the culvert, we increase flows downstream, causing greater damage? What is the impact on remaining properties? What about environmental enhancements: aquifer recharge; wildlife habitat; natural storage areas? What is to be the final disposition of land?

**WHERE** should try to respond to as many needs as possible - community, technical, political, economic.

## WHY

Explain the **WHY** requires us, as professionals, to begin to really earn our money. **Why** do we want to spend money to acquire and relocate properties? **Why** do we want to spend good taxpayer money to bail out someone silly enough to live in a floodplain? **Why** should we pay fair market value and pay relocation expenses? **Why** not put the stream in a pipe, **why** not build a dam?

The **WHY** is critical to this process because these answers are the ones required by the **WHOS** in order to make decisions. What are the reasons why we are doing this - all of them?

The victims have to understand why acquisition and relocation is the only practical and feasible option for them. The taxpayers have to be educated that proper use of taxpayer funds now can, in fact, save dollars in the long range. The politician needs to feel comfortable that the first two groups are happy, as well as understand the cost effectiveness of various proposals. The last group needs a clear understanding of who we are as professionals. We should feel confident that we have evaluated the options fairly and objectively and, in fact, have recommended the best overall option to achieve the most permanent solution to the flood problem.

## HOW

The **HOW** is something we "planners" typically don't spend as much time considering as we should. If the first attempt at acquisition ends up in court or with the community in an uproar, our program will die. We must take the time to think through all of the **HOW**. How will purchase value for houses be calculated: flood damaged or fair market value assuming no floods? Will we pay relocation expenses? How will we assign priorities as to which properties will be bought first? How will we handle hardships? How will we handle differences in opinion as to value? The key to the **HOW** is being open and available to the public for education and discussion. They must trust us. We must have answered the majority of questions out front.

The **HOW** also involves the funding which, as of late, is often the most difficult part. Funding can end up the most innovative task. Bring all the legal pieces together to achieve goals. We must have our lawyers tell us how we can do it; not that we can't.

Possible sources of funding you should think about include:

- Can sewer funds be used for purchasing the easement or partial right-of-way through the floodplain property?
- Can open-space funds be used for floodplain acquisition?
- Can recreation bond money be used to acquire floodplain properties as stream valley parks? Look at the wording of your bond bill.

- Can stormwater bond money be used to acquire properties for use as natural valley storage areas?

- In lieu of maintenance and repair or enlargement of channels, can you divert those finds to acquisition?

- Can you combine flood insurance proceeds plus Sec. 1362 funds, plus local funds for acquisition?

- Can you transfer development rights from flooded parcels to non-flooded property?

- Can educational funds be used to create an environmental education center?

- Can agricultural preservation funds be used?

- Can your government auction off acquired houses for removal to non-floodplain sites?

- Can your program be staged to offset impact on tax? What are historic spending patterns for storm drain work? How does your program impact tax rate?

- Can you use straight land swaps? Excess government property - trade for floodplain?

- Can you maximize disaster relief opportunities immediately after disaster? You may be able to fully utilize public and individual assistance opportunities -- flood-proof instead of just repair, remove in lieu of repair.

## WHEN

The **WHEN** ends up being the best guess and the magical piece of the puzzle. If you can't do it before the flood, then get all of the other pieces in place just prior to a disaster. Then, immediately after a disaster during the very brief "window of opportunity", you as a professional can whip out this plan for solving the community ills. This magical document is also referred to as a pre-disaster hazard mitigation plan.

Zoning and building ordinances can give direction to the **WHEN**. The period immediately after the disaster is clearly the best opportunity, when you have everyone's attention, memories are clear, and the political and popular support is there.

Memories fade incredibly fast and as soon as the flood debris is cleared away and as people move back in everyone moves on to different concerns and problems. Getting the time, the attention, the funds, and the votes together gets tougher the further away you are from a flood.

One thing is clear: that we should not have to be sitting here 10 years from now discussing how to acquire and relocate properties from a floodplain.

# CHAPTER TWELVE
# *STRUCTURAL MEASURES*

Despite costs and problems, nationally or internationally funded structural approaches to flood hazard reduction (dikes, dams, levees, sea walls) continue to be widely advocated and supported by hazard area occupants and government planners in both developed and developing nations. Structural approaches are attractive to those seeking "solutions" to hazard problems. Large scale reservoir projects are particularly attractive to international funding organizations because of their multiple benefits and because tangible and visible products can be derived from loans and grants (in contrast with broader planning schemes and non-structural hazard reduction approaches.) But, they are expensive and often only partially reduce threats. They may also be vulnerable to earthquakes and must be maintained. Hazard area occupants also have little incentive to undertake post-disaster mitigation basis if there is a plan or even a hope that structural hazard reduction approaches constructed at public expense will be applied to their area.

The two papers in this chapter examine structural measures in two developed nations. The first by Tom Goemans discusses the Netherlands experience in formulating and implementing a massive coastal storm protection program. The second by Dennis Parker examines the British structural flood mitigation experience.

# Use of Structural Hazard Reduction in a Post-Disaster Context: The Netherlands Experience with Flood Protection Measures

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## INTRODUCTION

Geographically the Netherlands belong to the alluvial coastal region of the North Sea. This means that the Western and Northwestern part of the country consists of alluvial deposits. The rivers Rhine, Meuse, and Schelde flow through the country and out into the North Sea. Together they have built and shaped the land through regular inundation. More than 50% of the country lies below storm surge level; about 7 million people live in that area (Fig. 1 and 2).

In the 9th century the first dikes were built. By the 13th century one can see a more organized way of dike building. At first the aim was defensive - people protected the land where they lived - but in a later phase dikes were used in a more offensive way to reclaim land from the sea. About 550,000 hectares of land has been reclaimed in the past seven centuries. Frequently however, the reclaimed land was lost again. But every time the people fought back. It is said that the Dutch have a constant dialogue with the sea.

The history of the Netherlands is marked with storm surge disasters.[1] The oldest known occurred in the year 1287 and affected the whole country; in the North 50,000 people drowned. During a storm surge in 1825 about 380,000 hectares of land was inundated, mainly around the (former) Zuyder Sea. Again in 1916 a major storm hit this area, triggering the plan for shortening the coastline (300 km of dikes) by constructing a 32 km long barrier dam which closed off the Zuyder Sea from the North Sea. Since the completion of the dam in 1932 (Fig. 3) it has become a fresh water lake.

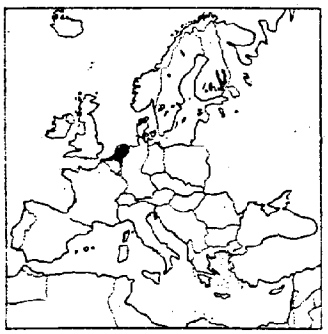

Fig. 1.
The Netherlands in Europe

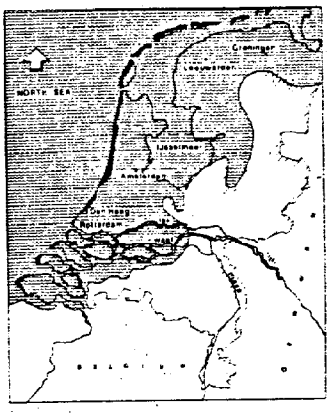

Fig. 2.
The Netherlands without sea defences

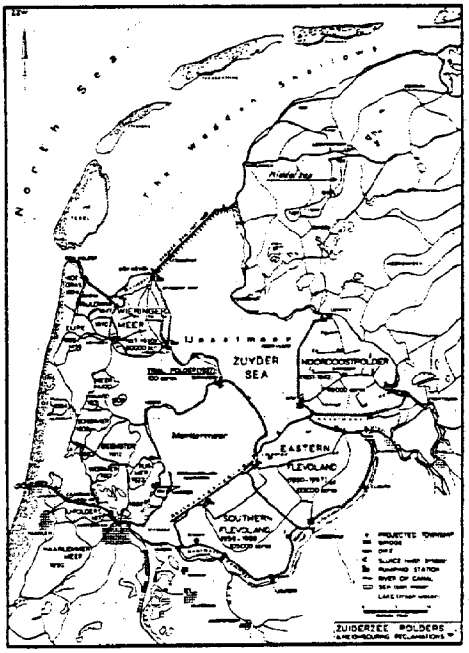


Fig.3.
The former Zuyder Sea turned into a lake

The Southwestern part of the country is called the Delta region and consists mostly of estuaries, peninsulas, and islands formed by the repeated shifting of the outlets of the Rhine, Meuse, and Schelde rivers. From North to South, five major stretches of water can be distinguished:

a. The New Waterway, connecting Rotterdam to the North Sea (constructed in 1872).

b. The Haringvliet estuary.

c. The Grevelingen estuary.

d. The Oosterschelde esturary.

e. The Westerschelde estuary, being the entrance to the port of Antwerp in Belgium.

The central Delta region is rural, completely unlike the highly developed areas around it. There is very little heavy industry and few of the picturesque towns have populations greater than 20,000. The most recent storm surge disaster took place during the night of February 1, 1953, when the dikes in the Delta region were seriously damaged over a total length of 190 km, with 89 breaches. One-hundred-fifty thousand hectares of polderland were inundated, causing the death of 1835 people, the loss of tens of thousands of cattle, and destruction or serious damage to thousands of buildings. Total losses were estimated at some 2 billion guilders. The area inundated is shown in Fig. 4.

## THE DELTA PLAN

In reaction to this disaster, the Dutch government embarked on a massive building program — the Delta Plan. By the end of 1953, the dikes had been provisionally repaired and the inundated area pumped dry. On February 18, 1953, the Minister of Transport and Public Works installed the Delta Committee, which was given the task of establishing a design philosophy for the sea defenses along the coast. Until then, the design was based on the highest observed storm surge level and an estimate of wave characteristics. Dike breaches in many cases were induced by wave overtopping, thus causing instability of the steep inner slopes.

In the work of the Delta Committee two central issues were addressed:[2] shortening the coastline by closing off the estuaries and choosing the design water level for the system of sea defenses. On the first issue the Committee advised the closure of three estuaries (Haringvliet, Grevelingen, and Oosterschelde) and the substantial heightening of the entrances to the ports of Rotterdam and Antwerp. The Committee argued as follows:

> Damming the estuaries would produce sea defenses consisting of a short closed coastline formed by dunes and dams, which could immediately and without special difficulties be given all the strength judged to be necessary in the near future. The maintenance of these defenses, whose level can be further raised at any time, would be simple and straightforward. Behind the new defense line would lie the old defenses, formed by the existing system of dikes, which, given the job it would then have to do, would still be capable of preventing disasters or minimizing its extent should unforeseen events occur. The fact that the new line of sea defenses would be much shorter and so much stronger, and the fact that it would be backed up by the second line of defense automatically created by the construction of the new dams, means that this system can offer safety levels of an entirely different and far higher order than those which could be obtained by raising the existing dikes. It would also keep open the possibility of responding quickly and easily to the problems which would follow from any adverse changes in the levels of sea and land. Only by closing off the estuaries we can obtain a system of sea defences which can be regarded as reliable well into the future.

With respect to the design water level, the Committee used a philosophy introduced by the Dutch hydraulic engineer Wemelsfelder, who published in 1939 an article about the probability of exceedance of storm surge levels along the coast of the Netherlands.[3] He presented probability exceedance lines, using a linear scale for the water levels and a logarithmic scale for frequencies of occurrence. Due to the tidal system of the North Sea the tidal difference increases as one goes from North to South along the coast and for each location a separate exceedance line can be drawn. By determining an acceptable probability of exceedance, it is then possible to establish a design water level.

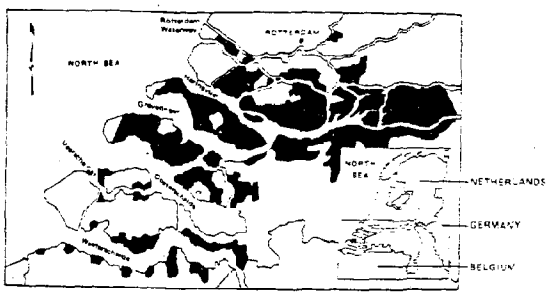


Fig.4.
Flooding from the February 1953 storm in the Delta region

The 1953 storm surge had a probability of 1/300 corresponding to a surge level of about 3 meters in the disaster area. The Delta Committee concluded that the entire coast of the country was inadequately protected and recommended strengthening the main sea defense structures. Considering the fact that the central part of the country has a very high economic value (major industrial and agricultural areas, large population in metropolitan areas) the probability of exceedance was set at 1/10,000. The corresponding water level was derived from an extrapolation of the exceedance lines (Fig. 5). For the coast North and South of central Holland reduced design water levels were advised, because the area protected has a system of secondary dikes which limit any flooding to smaller sections. For the Delta region this resulted in design water levels corresponding to a probability of 1/4000.

Up until now only the storm surge (still) water level had been considered. Other phenomena related to storm surge tides were taken into account separately, such as seiches and gust bumps. In addition wave action and wave runup have a significant influence on the design of hydraulic structures. The closure of the estuaries would also have some influence on the storm surge levels. Adding all these contributions together resulted in design criteria for all sea defenses. Since the publication of the Committee's final report, this has been called the Delta Level.

Apart from protection against flooding, the closure of the estuaries was projected to have some additional benefits:

- water management could be improved, especially with respect to salt water intrusion,
- infrastructural improvements on land and water, like connecting the islands with the mainland and better shipping routes,
- increased availability of fresh water for agricultural and industrial purposes,
- facilities for recreation could be developed,
- land reclamation would be easier, and
- increased potential for the development of central Holland, especially with respect to the port of Rotterdam.

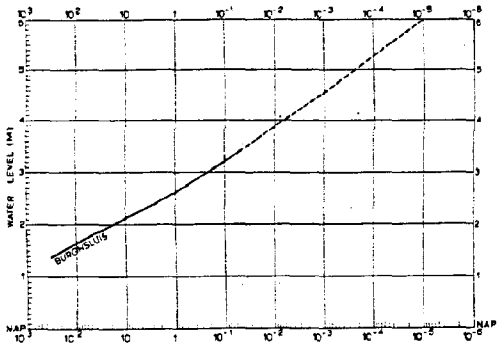


Fig.5.
Exess frequency curve for Burghsluis at the mouth of the Oosterschelde, based on a fifty year period of observations (1901-1950)

The work of the Delta Committee had a strong technical flavor as most of the members had a background in civil engineering. Only two sections of the final report dealt with economic aspects, the other twenty-two addressed technical matters such as hydraulic engineering, soil mechanics, and meteorology. Environmental or ecological factors were not considered. The fact that marine fisheries and shellfish cultures would be destroyed was considered a disadvantage of the plan, but compensation could be provided.

The whole plan was incorporated in the so-called Delta Act, which became effective as of 1958. This act provided the main framework for decisions at a later stage (like exact location of the structures, the method of constructions, and the closure dates). Construction costs of the plan would be paid by the central government. A separate Delta Compensation Act was adopted, which made it possible that any firm or individual suffering a lasting loss as a result of the project could claim compensation from the central government. For example, the government financed the modification of shipyards where the loss of tidal movements made modifications necessary.

Logically the execution of the Delta Plan (Fig. 6) started with the defense of the most vulnerable spots. Major works at the early stage included the construction of a movable flood barrier in the Hollandse Ijssel near Rotterdam (1958) to protect the low-lying part of Central Holland (at some places 6 meters below sea level), and the closure of the Veerse Meer with two dams (1960 and 1961). The Veerse Meer has since developed into a brackish water lake with an important recreational function. Having obtained experiences with small-scale closures, the larger and more difficult works were then constructed:

1965 Grevelingendam, separating the Grevelingen estuary from the Oosterschelde estuary with a shipping lock,

1969 Volkerakdam with shipping locks (serving the traffic between Rotterdam and Antwerp), thus separating the Southern Delta region from the Rhine and Meuse river water,

1970 Haringvlietdam with large discharge sluices which at the same time act as a barrier against storm surges,

1971 Brouwersdam, cutting off the Grevelingen estuary from the sea, thus forming lake Grevelingen, which is now a rare stagnant salt lake.

## THE OOSTERSCHELDE CONTROVERSY

The original time schedule of the Delta Plan called for the closure of the last and largest Oosterschelde estuary in 1978 by an impervious dam. This would be very difficult because of high tidal currents and deep gullies (down to 40 meters). Behind the dam a lake would be created

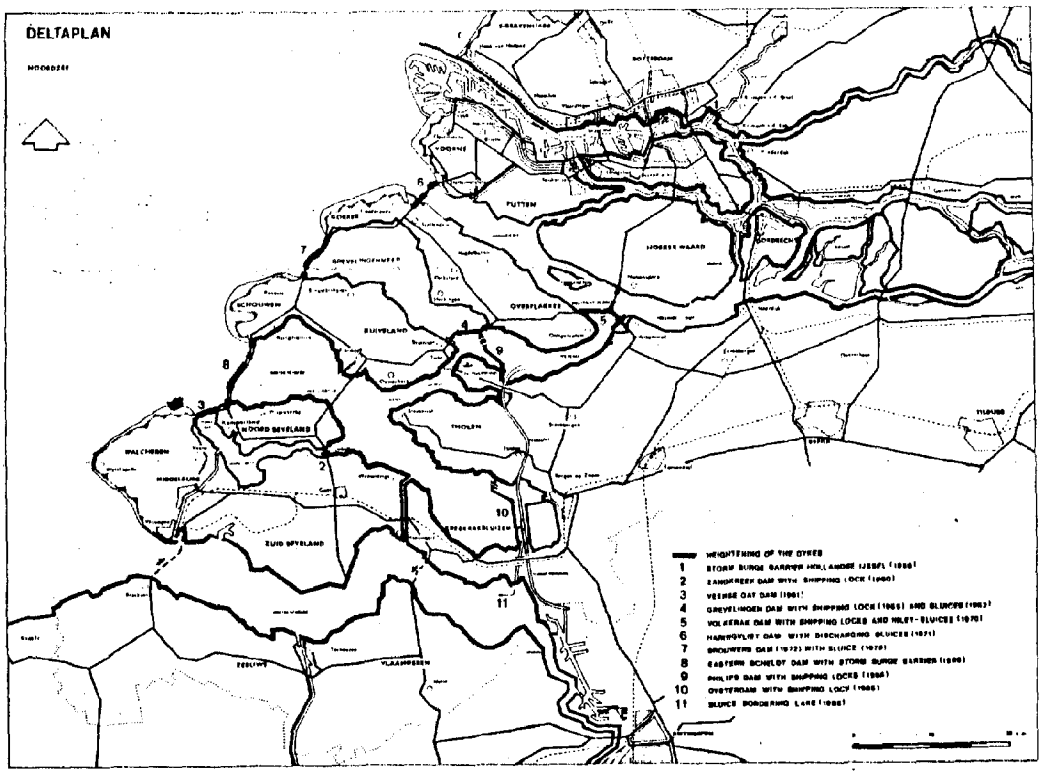


Fig.6.
The Delta plan

which - together with lake Grevelingen - could be converted into a fresh water lake using water from the Rhine let in through sluices in the Volkenrakdam. Work had already started in the Oosterschelde when opposition to the total closure grew in the early seventies.

The main reason for this opposition was a rising interest in the natural environment. Water in the Oosterschelde - especially after the separation in 1969 from the polluted Rhine and Meuse waters - had become relatively clean. The estuary had large tidal flats and shoals, great biomass production, and a rare ecology. In addition, the fishing industry saw an opportunity to continue business and added their voice to the growing number of people who doubted that the advantages of closure would outweigh the drawbacks. In the fifteen years since the Delta Committee's final report, ecological considerations had clearly gained a place in the decision-making process.

Although in the early seventies neither the Cabinet nor Parliament wished to heed the objections of those opposing complete closure of the Oosterschelde, a Cabinet change in 1973 brought the issue on the political agenda. Another Committee was formed, now with a more balanced membership. This Committee was directed to reevaluate the closure decision (officially stated, "to bring the required protection against storm flooding into harmony with preservation of the natural environment"). The Committee concluded, in 1974, that Oosterschelde should be closed off according to the Delta Act, but a solution would be preferred which would preserve tidal movements under normal (non-storm) conditions. The fact that an open Oosterschelde with higher dikes around it required an amendment of the Delta Act, which probably would not have carried a majority vote in Parliament, did much to prompt this conclusion.

A period of political maneuvering, action group demonstrations, and scientific confrontations occurred before the Cabinet ordered a feasibility study on a barrier type of dam with gates that would be closed in a severe storm, but would otherwise be open to allow the (somewhat reduced) tidal flow into the basin.[4] The feasibility study was performed by the government agency responsible for sea defenses (Rijkswaterstaat) and took about 400 man-years over an 18 month period. In parallel to this highly technical study, the POLANO (Policy Analysis of the Oosterschelde) project was executed in which three basic alternative means of protection against flooding were analyzed. The alternatives included building a storm surge barrier, a closed dam according to the original Delta Plan, or large new dikes around the estuary (Fig. 7). In this project the Dutch government contracted with the Rand Corporation (Santa Monica, CA) to help develop and apply a methodological framework for predicting and comparing the different consequences of these alternatives.[5] About 16 man-years were spent on this study.

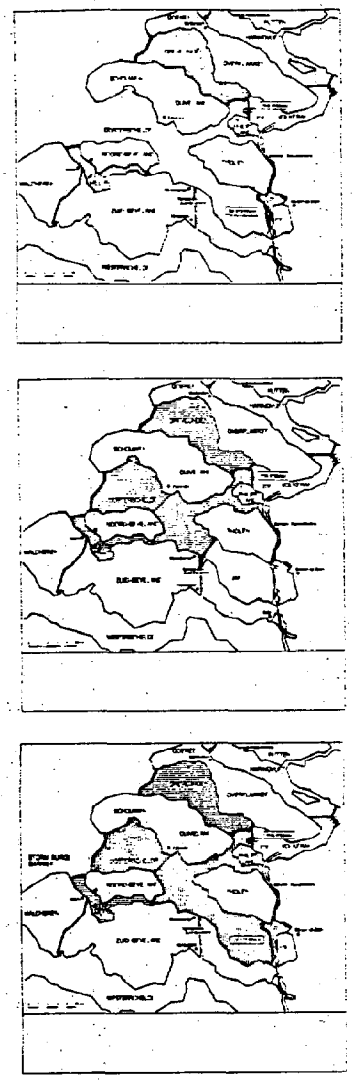

Fig.7.
The three alternatives analyzed in 1976; from top to bottom: open, closed, barrier

For the alternative options, the Rijkswaterstaat/Rand team analyzed and compared many different consequences, called impacts. In addition, a number of sensitivity analyses were performed to learn how the impacts would change with variations in the design of the alternatives and in the assumptions made for several uncertain factors. By intention, the study did not conclude by recommending a particular alternative. Rather, it attempted to clarify the issues by comparing, in a common framework, the many different impacts of the alternatives and left the choice among alternatives to the political process where the responsibility properly resides.

Significantly, there was no dominant alternative - one that was best for all the impacts. The impacts differed primarily in terms of costs of construction, security from flooding, and changes in ecology. Each option had a major disadvantage that might be considered sufficiently serious as to make it politically unacceptable: the storm surge barrier case was by far the worst due to cost, the closed case for ecology, and the open case for security. There were also different effects on the fishing industry, canal shipping, recreational opportunities, and the national economy.

The result of this policy analysis - together with the technical feasibility study - was submitted to the Cabinet in May, 1976. The Cabinet recommended the storm surge barrier plan to Parliament. The debate on June 23, 1976, during which Parliament accepted the Cabinet's recommendations, had a completely different atmosphere from the one that prevailed when the Delta Act was passed 18 years before. Then, there was remarkable unanimity; now, dissatisfaction was everywhere. It was a political compromise for which a high price had to be paid. Whereas the closure of the Oosterschelde according to the old plan would have cost 2.1 billion guilders, the barrier solution required 4.7 billion (guilders of 1976). In addition, the date at which the area would be fully protected was pushed from 1978 to 1985. But the unique ecology had been saved and the local fishing industry once again had a future.

## EXECUTION OF THE OOSTERSCHELDE PROJECT

Shortly after the decision, of June, 1976, work started on the newly defined project. Apart from the storm surge barrier in the mouth of the estuary (almost in open sea), this included dams of a more conventional type in the back of the Oosterschelde. This was necessary in order to keep the Rhine-Schelde canal - connecting Rotterdam and Antwerp - free of tidal movement -- a condition required by an international treaty with Belgium. An extensive matrix organization was set up within which various disciplines from government agencies worked closely together. It was clear from the beginning that designing and building a barrier with movable gates, founded on the loosely-packed sandy bottom and attacked by high waves, required a quantum increase in knowledge and experience.[6]

The barrier consists of 66 large concrete piers, varying in height between 30 and 40 m, which are positioned in the three tidal gullies at the mouth of the Oosterscheld (Fig. 8). Two artificial islands were built on existing sand banks. The total width of the estuary mouth is 9 km; the combined length of the barrier is almost 4 km. The concrete piers were prefabricated in a construction dock; once the piers were ready the dock was inundated and a specially built lifting vessel (lifting capacity 10,000 tons) transported the piers for placing in a partly submerged condition to their locations in the axis of the barrier.

The most difficult part of the design was the foundation for the piers. After compacting the sandy bottom by a special technique using vibrating needles 35 m long, two layers of prefabricated mattresses were deposited. The

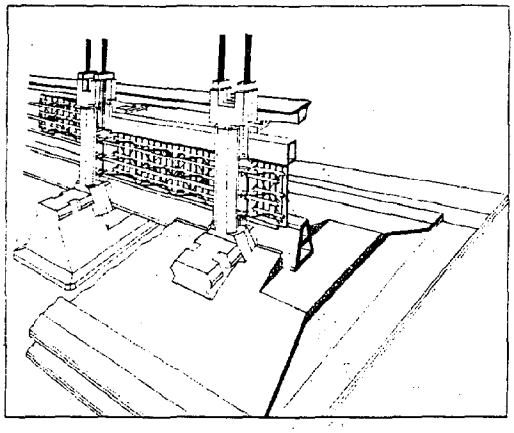

Fig. 8.
The barrier design

piers were eventually placed on these. In between the piers, prefabricated steel gates which can be moved hydraulically were installed. The barrier forms a contraction of the gully profiles under normal tidal conditions. After completion, the total wet profile at mean sea level will be reduced from 80,000 to 14,000 sq meters, which gives a 30% reduction in tidal range within the estuary.

It was clear that management of such a mega-project would not be easy. Problems never encountered before in hydraulic engineering had to be solved. Basic and applied research were carried out simultaneously, even after the design had been completed and construction started. It is well known from other mega-projects that cost control is extremely difficult when one cannot fall back on past experience and is forced to build a scale 1:1 prototype.

At this moment the Oosterschelde project is about 80% finished and the original time schedule has slipped one year. The current plan is to have the storm surge barrier operational by October, 1986. The total cost estimate as of July, 1985 comes to 8.0 billion guilders. Excluding cost increases due to inflation, this means an expected cost overrun of about 13%. Given the innovative character and long duration of the project, this can be considered quite a success.

After having completed the storm surge barrier, it can be used to prevent high Oosterschelde water levels during storms. Different strategies can be applied to close and open the barrier, each with differing specific effects on the Oosterschelde basin. These effects, relating to safety, ecology, water management, shipping, etc. have been analyzed in a policy analysis study called BARCON (short for Barrier Control). Like the POLANO study mentined previously, this was a joint effort of Rijkswaterstaat and the Rand Corporation.[8]

When choosing a "best" control strategy, the familiar problem of safety vs. ecology has to be resolved. From the safety perspective the barrier should be closed as long as necessary; from an ecological point of view it should be closed as short a time as possible. Different inside water levels can be effectuated by various control strategies. This has been studied by using storm scenarios and simulation models for water level response and the associated other effects. As an example, Fig. 9 shows the February, 1953 storm surge with and without the barrier. As in the POLANO study, it was not the purpose to recommend a particular alternative. Rather, the alternative control strategies were compared in terms of their different impacts, leaving the choice to those who are politically responsible. It may be mentioned that the barrier can also be closed in response to other contingencies such as off-shore oil pollution.

## LOOKING BACK

With completion of the Oosterschelde project in 1986, the Delta Plan will be completed 33 years after the 1953 flood disaster. The Delta region will then be protected to a level of 1/4000. The region will include a variety of landscapes - man-made but due to their dimension still important natural environments. Various functions are combined in a harmonious way. All this, however, cost a lost of money.

Projects like this influence the social system to such an extent that they generate major conflicts. Moreover, some parts of a mega-project run the risk of becoming less acceptable due to the long duration of the project. This can lead to a shift in functional demands, which clearly was the case with the closure of the Oosterschelde estuary. One way of handling the uncertainty of political boundary conditions is to have built-in flexibility. However, this always leads to extra costs which can be prohibitive in mega-projects. Another method is to phase the project; each phase ends in a milestone and a go/no-go decision. In mega-projects, however, go/no-go decisions are particularly difficult, because the changeover to

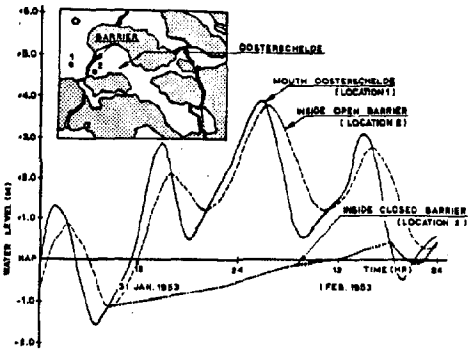


Fig. 9.
Water level as a function of time at the mouth of the Oosterschelde; simulation run for the Feb. 1953 storm

another alternative is time-consuming and results in political struggle. One should always keep in mind that there is no "best" solution for problems which involve safety, ecology, and economy.

Let us turn back now to the additional benefits of the Delta Plan, which have been mentioned by the Delta Committee in its final report:

- Improved water management: the construction of the Haringvliet sluices and the Volkerakdam made it possible to control the discharge from the Rhine through the Haringvliet, thereby facilitating the fight against salt intrusion.

- Infrastructural improvements: the islands of SW Netherlands have been connected to the mainland and every dam carries a road. This has been a substantial benefit for the Delta region as a whole. Through the construction of the Rhine-Schelde connection, shipping traffic between Rotterdam and Antwerp has increased dramatically; on other routes some locks have been added.

- Increased availability of fresh water: this benefit did not materialize because the Oosterschelde will stay an estuary and the Grevelingen is now a stagnant salt lake. It is even doubtful whether enough fresh water can be taken from the Northern region, through the Volkerak sluices, without seriously damaging the production functions up North. At this moment the agricultural areas can function with fresh water supply from other sources.

- Easier land reclamation: right now this is a non-issue; there are no plans for land reclamation, because the aquatic system is protected.

- Development of recreational facilities: Lake Grevelingen and most of the smaller lakes have developed into recreational attractions of international significance. For the Osterschelde, however, the main function is natural environment and any recreational developments are subordinate to that function. In this way the inner part of SW Netherlands is kept "quiet".

- Increased potential for economic development of Central Holland: industrial activities around the harbor of Rotterdam have grown substantially since the fifties; this was accompanied by a reconstruction of the area between the New Waterway and the Haringvliet. The most important function of the rest of SW Netherlands sill is, however, agricultural and recreational.

Last but not least, the Delta Plan has provided a unique opportunity for Dutch contractors, consultants, and research institutes to gain experience in innovative hydraulic engineering.[9] Skills and knowledge are applied all over the world and made the Dutch experts in handling "water".

NOTES

1. More historical information can be found in the Proceedings of the Delta Barrier Symposium (Rotterdam, 1982) and the Symposium on Integration of Ecological Aspects in Coastal Engineering Projects (Rotterdam, 1983).

2. Final Report of The Delta Committee. 1962. The Hague, Netherlands.

3. Wemelsfelder, P.J. 1939. The occurrence of storm surges. De Ingenieur. 9.

4. The closure of the Oosterschelde estuary. 1981. Report prepared for the cooperative action programme of the OECD on Joint Activity on Multipurpose Hydraulic Projects. Ministry of Traffic and Public Works. The Netherlands.

5. Goeller, B.F. et al, Rand Corporation. 1977. Protecting an Estuary from Floods - a Policy Analysis of the Oosterschelde. R-2121 (6 volumes).

6. Technical information can be found in the Proceedings of the Delta Barrier Symposium. 1982, and in: Hydraulic Aspects of Coastal Structures. 1980. Delft: Delft University Press.

7. Goemans, T. and H.N.J. Smits. 1985. Cost control in a mega-project: The Oosterschelde works. Proc. 8th INTERNET World Congress on Project Management. 1:3-12.

8. Catlett, L. et al, Rand Corporation. 1979. Controlling the Oosterschelde Storm Surge Barrier - A Policy Analysis of Alternative Strategies. R-2444 (4 volumes).

9. Some of this experience has been published in the book: The Closure of Tidal Basins. 1984. Delft: Delft University Press.

# British Structural Flood Mitigation Experience: A Critical Look at Response to Coastal Flood Disasters

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## INTRODUCTION

This paper evaluates recent British experience with structural flood mitigation and assesses the applicability of post-disaster mitigation, as currently experienced in the United States, to the British scene. A case study is provided of coastal flood mitigation successes, failures and deficiencies to help identify lessons from British experiences policy recommendations, and research priorities.

The post-disaster mitigation context is very different in Britain from the United States. Therefore, the transfer of experience should be highly selective. Areas where international comparisons may be profitable are identified at the end of the paper.

## THE POST-DISASTER MITIGATION CONTEXT

Until the mid-1970s reconstruction in situ without any form of flood protection was the most common response to flood disaster in the United States. Rebuilt structures were equally vulnerable to flood disasters although some were subsequently protected. From the mid-1970s United States flood mitigation policy pursued means of encouraging post-disaster response to avoid the cycle of destruction, reconstruction, and continued vulnerability. Major elements of this policy include the Flood Disaster Protection Act 1974 which made the adoption of local land use regulations a condition of federal disaster assistance and the purchase of flood insurance (Kusler, 1982). In 1979 the Federal Emergency Management Agency initiated a floodplain acquisition program to purchase selected heavily damaged properties (FEMA, 1981). Loans have also been denied for reconstruction and rapid post-disaster assessment by federal agencies has been required. The context of these policies is the need to find low budget nonstructural approaches to flood mitigation.

Within the British approach to flood mitigation (Parker, 1986) enhancing the post-disaster mitigation response is not currently a central problem. Rehabilitation of communities after flooding almost always receives positive government encouragement. The state provides strong financial incentives for structural protection and/or flood forecasting systems: the usual response to flood disasters is to improve flood protection and forecasting capability. In Britain the post-disaster mitigation problem therefore involves overcoming barriers to rapid provision of effective protection structures and/or forecasting and warning systems.

There are other important differences:

1. British floods rarely lead to the destruction of buildings. Reoccupation of the ground floor of buildings rather than their reconstruction is typical. Structural failure due to flooding is rare. Although timber-frame construction is becoming more common, the vast majority of British buildings are brick or stone and are not so vulnerable to flood damage as their North American counterparts. British rivers are also typically less powerful than those in North America.

2. The ratio of unprotected to protected buildings is more favourable in Britain than in the United States, especially along coasts. This reflects the long history of central government financial incentives for flood protection. It is therefore, more likely in Britain that serious flooding will be followed by protection to relatively high standards.

The distinctive characteristics of the British flood scene which underlie these important differences in the post-disaster mitigation context are further explained below.

## THE BRITISH FLOOD SCENE

The flood risk in Britain is smaller than in the United States. About 4.79 percent of Britain's population is estimated to live in flood hazard zones (Table 1) compared with about

Table 1. Estimates[1] of Properties and Population Located in Flood Risk Areas of Britain[2]

| Flood Type/ Protected Category | Properties | Population | Percentage of Total Population |
|---|---|---|---|
| Riverine flood plains: | | | |
| Unprotected | 101,600 | 274,200 | 0.54 |
| Protected | 231,700 | 625,590 | 1.25 |
| Coastal flood zones: | | | |
| Unprotected | 56,000 | 150,000 | 0.30 |
| Protected | 500,000 | 1,350,000 | 2.70 |
| Totals: | 889,300 | 2,399,790 | 4.79 |

1. Derived from figures and estimates researched by Handmer (1986).
2. Excluding Scotland and excluding urban storm drainage surcharge risk.

8.9 percent in the United States (Handmer, 1986). A larger proportion of the flood prone population is protected in Britain: less than 1 percent of the total population is unprotected.

Sea flooding is the major risk. The largest proportion of properties at risk with the greatest potential for disaster are located along the south and east coasts. Sea flooding disasters dominate British flooding history (Steers, 1953).

Inland riverine flooding is a widespread but comparatively less serious risk. Most major and minor urban developments contain some flood plain (Parker & Harding, 1974). However, only small sections of most urban centres are flood prone. Moreover, the flood behaviour of British rivers is much less aggressive than their North American counterparts and British rivers are comparatively easy to contain within embankments (Handmer, 1986). The ratio of normal river channel capacity to the discharge of large floods is generally much greater in the United States than in Britain (Porter, 1970).

However, surcharging of storm drainage systems is an escalating problem due to urbanization and years of insufficient re-investment. In most urban areas localized foulwater flooding is a widespread problem (Parker & Penning-Rowsell, 1983).

Flood mitigation in Britain relies upon a mix of structural and nonstructural measures, notably levees; flood forecasting; and flood warning systems (Penning-Rowsell, 1981; Parker, 1981). There is no national flood insurance program. Private industry has offered flood insurance since 1961 to prevent the nationalization of the insurance industry (Arnell, 1986). Flood insurance has been purchased by most householders and businesses: household policies automatically cover flood loss at no additional premium. There has been no attempt, as in the United States, to make the sale of flood insurance conditional upon the adoption of land use regulations.

Because of land shortage and related urban and countryside planning problems, there has been a national system for controlling urban development since 1947 (Penning-Rowsell, 1981). This system also applies to flood plains. In such areas Water Authorities advise local planning authorities about developments likely to worsen the flood hazard. Although there is growing evidence that the development control system has failings, the need to encourage communities to adopt land use management has not been present (Whittle, 1986). Nor has there been as much concern in Britain as in the United States about rising flood losses (Parker & Penning-Rowsell, 1983). Institutional arrangements favour structural remedies. Incentives for structural flood mitigation have come through a central government grant system which removes much of the cost of protection from the direct beneficiaries (Penning-Rowsell, Parker, & Harding, 1986).

Generally, in a riverine context, structural adjustments have been successful in Britain. The comparatively docile nature of riverine flooding means that it is often economically feasible to embank rivers to provide high standards of protection. For reasons explained below, sea flooding is more difficult to control and, arguably, structural flood loss mitigation has been less successful and a little more prone to failure.

Apart from flood forecasting and certain warning systems, central government grants have not been available for non-structural measures. High population densities (325 people/km$^2$ in Britain compared to 24 people/km$^2$ in the U.S.) mean that there is a comparative land shortage leading to a need, perceived by town planners, to utilize even flood prone land. While there has been flood plain encroachment, post-war population growth in Britain (12.7 percent for Britain compared to 50.3 percent in the U.S.) means that encroachment has probably not proceeded at a pace comparable to that in the United States (Parker & Penning-Rowsell, 1983).

The established state-led approach to flood mitigation in Britain is now being undermined by the Thatcherite political doctrine (Penning-Rowsell, Parker, & Harding, 1986). Unfortunately this doctrine of reducing the role of the state in some areas is likely to lessen the potential for both effective structural and nonstructural measures. Central government financial incentives for structural measures have been reduced: both grant aid rates and local and central government budgets have been substantially reduced. Planning controls are being dismantled and it is unlikely that regulatory measures such as building regulations will be strengthened. Public acquisition of flood plains is less likely than ever since central government is discouraging local authority property holdings and is pressuring the local governments to sell real estate assets to the private sector. Government plans to "privatise" the Water Authorities threaten to seriously weaken their regulatory power and are bound to place more emphasis on the self-financing of flood mitigation without also providing the necessary controls and incentives to make this approach effective.

## MTTIGATION RESPONSES FOLLOWING COASTAL FLOOD DISASTERS

Three examples of coastal flood mitigation illustrate the British experience. London's Thames barrier is the most recent major addition to Britain's east coast flood defences and exemplifies par excellence the British structural approach. Coastal levees in Whitstable and Swalecliffe in the county of Kent, and Chesil in the county of Dorset, demonstrate deficiencies in the structural approach.

### The Thames Barrier and East Coast Flood Defences

The Thames tidal surge barrier became operational in 1983 (Horner, 1978). The project was implemented following the 1953 east coast

floods; the ensuing government appointed Waverley Commission report (Home Office, 1954); and the subsequent increase in London's flood risk.

Britain's east coast is defended against erosion and flooding for approximately 2000 kilometres. Large areas of reclaimed prime agricultural and urban development, much of which is below sea level, lie behind this protected coastline. The flood defences include earthen embankments, some armoured; flood walls; beach and groyne systems; and a series of moveable tidal exclusion barriers. The Thames barrier is the largest of seven barriers constructed in the Thames estuary since 1974.

East coast protection policy is primarily structural and is directed at land and property protection. However, this policy is also heavily dependent upon the East Coast Storm Tide Warning Service, established on Waverley Commission recommendations. This service triggers barrier closures and local public warning systems, and is directed principally at protecting life.

East coast protection and the defence of London against floods is of national strategic importance. The reliance upon structural protection is due to the severe coastal erosion problems and threat of land loss faced by a nation with a comparative land shortage. Protection policy clearly favours defence against abandonment to the sea and no other approach could achieve this. In addition sea levels are rising relative to land because of polar ice cap melting, and the slow tilting of Britain toward the southeast, and because London is sinking on its clay foundations. Tides are rising by about 0.76 metres per century at London bridge.

Some 115 kilometres of central London are now below highest recorded flood levels. This area contains London's commercial core, the seat of government, homes for 750,000 people, 70 'tube' stations, and countless public service buildings. One hundred deaths occured in the Thames estuary following the 1953 tidal surge which caused $250-410 million damage (at 1985 prices) and over 300 deaths along the east coast.

The Thames barrier cost 435.6 Million (at 1982 prices). To prevent navigational obstacles the barrier is only closed following a tidal surge warning. Closures are expected 2 or 3 times per year in the 1980s, rising to 10 closures per year after 2000. The barrier has a protection standard of 1:1000 years - much higher that is the usual practice in Britain. Construction of the barrier has reduced the need to heighten floodwalls in central London which would have a major negative impact.

Completion of the barrier has necessitated an additional 62.5 Million expenditure (at 1982 prices) for increasing the height of downstream estuary defences. About 75 percent of the cost of the barrier was funded by central government as part of a grant aid policy for flood defence and coastal protection works. The remainder was raised on local rates.

The Waverley Commission inquiry into the causes of the 1953 flood recommended protection standards (Home Office, 1954) which have been adopted and remain important 30 years later. Broadly 'Waverley standards' relate to the value of property at risk. A protection standard to prevent the recurrence of the 1953 flood (a 200 year event) was recommended and subsequently adopted for urban areas and valuable agricultural land. Elsewhere protection standards may be lower or, in a few circumstances, higher. Somewhat prophetically the 'Waverley standards' were criticized at the time for being too low (Davey, 1954) and, sure enough, these standards have since been revised upwards.

The 1978 tidal surge presented the most severe test of the east coast defences since 1953. Although surge levels were higher than 1953 levels in the north, they were somewhat lower in the south. Compared with the 1953 event, flood losses were limited but nevertheless sea defences were breached or overtopped in several locations. Consequently, over 3100 properties and over 2500 hectares of agricultural land were flooded (Wakelin, 1978; Briant, 1978). In London the 1975 and 1978 surges almost overtopped flood defences.

Over 30 years elapsed after the inception of the barrier project before its completion. Design problems, negotiations over navigational needs, funding, and the need to promote a special Act of Parliament together with labour union tactics during the latter construction phases combined to delay implementation. In the interim, and because of the progressive worsening of the flood risk, a major effort was made to establish an effective public flood warning system for London. However, the extensive and unprecedented advertising and public education efforts failed to adequately raise public awareness of the flood warning system and appropriate responses (Barrett, 1980).

## Protection for Whitstable and Swalecliffe

Whitstable and Swalecliffe are adjacent coastal towns on Britain's east coast, approximately 80 kilometres from London. The towns' combined population is approximately 20,000, 25 percent of which is located in flood prone areas mainly in Whitstable. Whitstable's commercial centre, with many buildings of historic value, is flood prone as is a recently constructed old people's home and century-old housing which are located on the lowest land (Parker & Penning-Rowsell, 1981). In Swalecliffe post-1945 single-story 'retirement' housing has been seriously flooded together with seafront caravan and chalet parks (Parker, Penning-Rowsell, & Green). New retirement and mobile home developments are particularly common in flood prone coastal communities in Britain.

Owing to falling land levels there is a documented 900 year long history of coastal erosion, sea flooding, and sea defence on this coast. Despite this, low-lying land in Whitstable has been reclaimed in recent centuries. Development has advanced in a seaward direction - sometimes forward of sea defences -

taking advantage of storm generated beach shingle accumulation.

Whitstable was last seriously flooded in 1953 when the present sea walls were being constructed. However, the 1978 floods which seriously affected unprotected Swalecliffe, brought Whitstable close to disaster. Now both Swalecliffe and Whitstable have new sea wall and coast protection proposals which are about to be implemented. Whitstable's 30 year old sea wall is now structurally unsound and too low to protect against the severe events now envisaged.

There is no evidence of any measures other than structural ones combined with a public flood warning system being considered for Whitstable or Swalecliffe. Each flood disaster has led to progressive strengthening of defences and new developments have been permitted into flood prone areas making the control system fail when single-story housing was permitted in an unprotected flood risk area.

Both Whitstable and Swalecliffe have encountered severe difficulties and delays in gaining local support and central government funding to improve sea defences. Political opposition and successive proposals have split the communities. While nearly all favor a structural remedy, some have argued effectively on cost and amenity grounds against successive proposals. The saga developed into a protracted struggle during the 1970s and 1980s when 3 public inquiries were necessary to examine proposals and counter-proposals.

## THE CHESIL PROBLEM

Chesil beach is a 28 kilometre long natural shingle bar some 200 kilometres southwest of London which connects the Isle of Portland to Britain's southern mainland. Because of its environmental and amenity significance, Chesil beach is a Site of Special Scientific Interest. Chiswell, a community of 130 people protected by the natural shingle bar, is part of a NATO naval base and the only main road linking the Isle community of 16,000 people to the mainland. The Isle has other important defence establishments. Historically Chiswell buildings were constructed to withstand severe sea flooding. These ingenious flood proofing features in evidence in old buildings have been ignored in new building design.

Chesil beach is today subject to a variety of natural and man-made pressures which combine to weaken its protective qualities. Commercial shingle extraction is just one factor thought to be leading to the gradual inland movement of the shingle bar and to the fall in the bar's crest level. Prior to 1970, Chiswell experienced flooding on at least 10 occasions but in the 1970s at least 7 floods occurred. Shallow "nuisance flooding" occurs most years because of seawater seepage through Chesil beach. Storm surge floods, as in 1978, threaten to breach the beach and swamp Chiswell: these event have a return period of about 5 years. Ocean swell floods, as in 1979, originate far out in the Atlantic and arrive almost announced. These 50 year events seriously erode the beach and inundate Chiswell with both shingle and floodwater.

Severe structural damage was caused by the 1978 and 1979 floods: some buildings were destroyed. The mainroad was closed for up to four days causing major economic disruption to the surrounding region. The floods occurred without warning; residents and drivers were rescued in sometimes desperate circumstances. In the aftermath many houses, shops and public houses were temporarily abandoned and boarded up. Some remained abandoned for several years. Fearful for their lives and suffering from extreme anxiety, some residents were rehoused elsewhere at their own request; others remained to form a resident's action group to fight for a structural mitigation "solution". Many Portlanders are proud of their island traditions and are totally opposed to the deterioration and abandonment of the historic site of Chiswell.

Despite the misgivings of some local politicians, the mitigation approach adopted for Chiswell has been one of reconstruction, rehabilitation, and structural defence against further sea flooding. Buildings have been reconstructed, repaired, and refurbished. With local government funding, infrastructure improvements have followed. With a central government grant, a 4.5 Million sea defence project was implemented within 4 years of the last flood. It consists of beach gabions, a new sea wall and a 'monsoon' ditch behind the beach.

Providing that the sea defence project could be demonstrated to be economically efficient the authorities were predisposed towards a structural solution even though such a solution is widely acknowledged to be technically problematic at Chiswell. The performance of the gabions on a possibly unstable shingle beach is untested and the design life of the gabions is no more than about 15 years.

Chesil is perhaps one of the few cases in Britain where a floodplain acquisition policy linked to community relocation might have been a logical option. Although considered by local officials, this option was never seriously entertained because of the strong local opposition, community heritage factors and institutional barriers to acquisition and relocation.

## LESSONS AND RECOMMENDATIONS

Nine lessons and recommendations follow from these three examples and the previous analysis. These lessons apply equally to coastal and riverine settings in Britain:

1. Structural approaches are particularly appropriate under the following circumstances: where there is land shortage; where communities are long-established; where there are urban heritage values to protect (as in Whitstable and Chesil); and where very high standards of

protection are justifiable (as in London).

2. Structural mitigation measures must be combined with effective flood warning systems to guard against structural failure (as on the east coast).

3. Britain is locked into a long term cycle of protection; development intensification in protected areas; and subsequent increased protection needs (as in Whitstable and London). The problem is worsened on the east coast by falling land levels and everywhere by wealth accumulation.

This cyclical process is reminiscent of the United States prior to its shift toward a regulatory policy. In the case of Britain, continued development in coastal and other flood risk zones is inevitable with current social and economic trends. However, development controls must be strengthened to "weed out" proposed development which could be located elsewhere and to enforce more restrictive elevation and other flood proofing measures in protected zones.

4. More specifically, development control procedures must be strengthened to avoid the location of non flood-proofed old people's homes, retirement dwellings (particularly single story), and caravan and chalet parks (as Swalecliffe and Whitstable) in protected and unprotected zones.

5. Further attention must be given to financial incentives for non-structural mitigation measures employed as "back up" to protection measures. Financial incentives could ensure that new homes, local government property and other buildings incorporate flood proofing measures in order to reduce the growth in flood damage potential and to break out of the cyclical process described in 3 above. Further attention should also be given to providing technical and financial assistance to local authorities and to the police to improve the dissemination of public flood warnings.

6. The existing development control system should be modified to give strengthened powers to Water Authorities to control flood plain development. Local planning authorities currently have too little regard for the flood risk (e.g., Swalecliffe).

7. Consideration should be given to those exceptional cases where floodplain acquisition and property relocation may be feasible (as in Chiswell).

8. Further experimentation is required regarding public education to improve public awareness of flood warning procedures and actions (following London's experience), especially in protected areas.

9. Present Thatcherite policies undermine various components of British flood mitigation policy. What is required is a continuation of the state-led structural approach more strongly combined with wider regulatory powers and mitigation measures for protected zones (see 5 above).

## RESEARCH PRIORITIES

1. Evaluation of development trends and increasing damage potential in different types of flood risk areas: riverine/coastal; protected/unprotected.

2. Evaluation of the effectiveness of the current development control system for flood risk areas including identification of deficiencies and improvement needs.

3. Evaluation of the performance of selected flood protection works including a comparison of achievements against original expectations.

4. Evaluation of the pattern of financial incentives of various kinds (e.g., mortgages, loans, government subsidies, etc.) for development in flood risk zones.

5. Evaluation of flood proofing costs and benefits specifically linked to British construction methods.

## LESSONS FOR THE UNITED STATES

What can the United States learn from British experience and vice versa, and in what areas may cooperative international research be profitable? We must proceed with caution here in Britain in applying U.S. techniques. The post-disaster mitigation context in Britain is very different from that in the United States. Thus, the transfer of experience must proceed only in carefully selected areas.

1. Britain has been comparatively successful in avoiding catastrophic flood losses by combining structural flood protection measures with flood forecasting and public warning systems. While differences in success rates between the United States and Britain may be due partly to "local factors", the reasons for the British experience might be profitably explored. Similarly, in evaluating the performance of structural measures, United States experience is likely to be valuable to Britain.

2. British buildings are comparatively resistant to flood damage: structural failure is rare. Again, accepting the differences in the hydraulic characteristics of British and North American rivers, further examination of

construction methods and materials used in Britain might be fruitful. There is also experience in Britain of building elevation and structural flood proofing and comparative studies of building designs, costs, and benefits may be worthwile. Again United States experience in this area is also likely to be useful to Britain.

3. The British development control system is largely alien to the United States but there may be some advantage in investigating the 38 year British experience with land use regulations and, particularly, changing attitudes toward regulations over time. This may provide a useful context in which to plot the path and direction of United States regulatory policies and to evaluate their successes.

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# CHAPTER THIRTEEN
# *LEGAL ISSUES*

Legal issues in post-disaster mitigation may be grouped in three general categories:

1. Issues pertaining to the scope and interpretation of legislation, rules, regulations, and government plans and policies establishing the framework for post-disaster mitigation including goals, techniques, lines of authority, and funding. This legal framework may be incorporated in constitutions, statutes, local ordinances, executive orders, and other policy documents. The lack of legal framework authorizing, requiring and providing incentives for post-disaster mitigation is a serious problem in both developed and developing nations. Suggestions for elements in legislation establishing a more satisfactory framework are contained in the appendix of this report.

2. Issues pertaining to the constitutionality of government regulations and actions in post-disaster mitigation such as moratoria on rebuilding, building codes, use of eminent domain to acquire lands for flood control structures, and compulsory relocation. Most governments (in the U.S. and abroad) have adopted constitutions protecting the rights of individuals against the taking of private property without compensation and due process of law, discrimination, and arbitrary government action. Courts determine whether various government actions violate these rights.

3. Private tort actions by thosed damaged by natural hazards against governments or private individuals for negligence, breach of contract, trespass or other actions which result in or exacerbate hazard losses (e.g., construction of an emergency levee which blocks flood flows). Liability is an increasing concern worldwide on the part of architects and engineers who design buildings in hazard zones and of national, state, and local governments which construct and maintain dams, levees, warning systems and other mitigation measures.

This chapter examines some of the major legal issues in both developing and developed nations.

It begins with a paper by Franklin McDonald examining legal issues in disaster mitigation in developing countries.

This is followed by a paper by Errol Chase examining legislation as it affects disaster preparedness in Barbados.

James Huffman next examines government liability for harm resulting from disaster loss mitigation.

James Slossen considers the role of the forensic geologist/expert witness in encouraging government mitigation.

Jon Kusler provides an overview paper in a question and answer format addressing major legal questions in a post disaster context in the U.S.

Richard Hamman concludes with a discussion of the constitutionality of land use restrictions in post-hurricane reconstruction planning in the U.S.

# Some Legal Issues in Disaster Mitigation in Developing Countries

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"The law can, in various ways, direct new human settlements away from hazard prone areas and also assist in mitigating the risk of disasters in presently occupied areas. In the absence of coherent legal policies for disaster prevention, the law might have the effect of actually facilitating disasters, indeed to some extent guaranteeing them." (UNDRO 1980; Disaster Prevention and Mitigation: A Compendium of Current Knowledge, Vol 9: Legal Aspects)

## INTRODUCTION

The impact of floods and other disasters on the countries of the Third World is now recognized as a major developmental issue. Disasters have profound physical, social, economic, and even political impacts whenever they occur. In the case of developing countries, disasters impact states which have significant problems in implementing preparedness, prevention, and mitigation measures.

This paper attempts an overview of some of the important issues and seeks to identify some areas for possible action or further research.

## MITIGATION MEASURES

### Land Use and Building Regulations

The overall purpose of mitigation is usually the reduction of the effects of a disaster. Mitigation therefore must include actions that will reduce the human suffering, social or economic disruption, or physical damage. Widely accepted mitigation measures include land use control measures (subdivision, planning, and zoning regulations) and building regulations to ensure hurricane or earthquake resistance design or flood proofing. In many developing countries these measures exist and are based on conventional systems for monitoring and enforcing the laws of the land.

In developing countries, according to studies done by the U.N., the existence of such laws has not guaranteed adequate hazard mitigation programs. For instance, the implementation of zoning regulations assumes the existence of historic, technical, and scientific data on the potential effects of hazards (e.g., floods) at particular locations. In many countries, the collection and dissemination of such information is less than optimally organized. Where settlements are being established for the first time, such data may in fact be non-existent or very hard to obtain.

A second problem associated with traditional land use or building control/mitigation measures in developing states is the need for strong administrative infrastructure - preferably at the local or municipal level - to monitor, enforce, and continuously update the mitigation measures. The lack of enforcement of planning regulations and building standards is one of the weakest aspects of hazard mitigation. The UNDRO report on Legal Aspects elaborates effectively on this point, and concludes that in many countries "zoning and subdivision regulations are hardly enforced at all."

In a similar fashion, though building regulations may exist, they may cover only geographically restricted areas or prove impotent due to the lack of adequate building inspectors.

### Public Acquisition of High Risk Lands

The acquisition by government of high risk floodways is an established mitigation technique in the United States. In many countries, the state has the right to acquire land for the benefit of the community at large and to compensate the former owners appropriately. Hindrances to this mitigation technique include the availability of adequate technical data, the financial cost of acquisition and the problem of preventing illegal occupation (squatting) on the land once it is in government hands.

### Role of Land Tax Legislation

Taxation policies inevitably influence land use. The potential therefore exists for governments to use tax incentives and penalties as a part of a national strategy for flood damage mitigation. Developing countries can only make use of this tool if, in addition to having the appropriate legally based tax regime, there exists adequate infrastructure in the form of a land title registry, cadastral maps, valuation system, and an effective system for land tax collection. In addition, of course, adequate knowledge of the spatial distribution of flood (or other) risk is required in order to implement an effective Land Tax based mitigation regime.

Liability of Public Agencies (for "Acts of God" or Neglect of Man)

Where local or municipal agencies can be sued for the consequences of their decisions in flood or other natural hazard related matters, the quality of their decisions and sensitivity to public safety concerns improve. The exposure of developing societies to societies such as the U.S. where there is a high propensity for such legal action is likely to lead to the expansion of such suits (providing the legal regime allows for such action). If public agencies can be legally challenged, this may increase the pace of implementation of effective mitigation measures. Grounds for such suits can include issuance of planning permits in hazardous areas, government development activities which increases natural or technological hazard vulnerability, or the failure to adequately design (and maintain) public infrastructure such as flood control works.

Legislation in the U.S. which forces disclosure of information on hazards to affected interests may also prove influential. The U.N. in its review of legal issues suggests that public participation in the land use planning process is desirable and should facilitate mitigation measures at the local government and municipal levels.

## CONTROL OF POST DISASTER RECONSTRUCTION

The period immediately after a disaster is one of great opportunity for instituting effective mitigation measures for the next event. Taking advantage of this opportunity requires that a coherent strategy be evolved and held in readiness for just that eventuality. Ideally such post disaster reconstruction action should be guided by legislation ensuring that repairs, reconstruction, and longer term development incorporate relevant mitigation measures.

Disaster management legislation, which defines the roles and functions of emergency services, is often silent on the matter of the mitigation standards to be followed by the lead agency (often an emergency response office) responsible for decisions in the post emergency phase.

## DISASTERS AND DEVELOPMENT

Perhaps the most crucial legal issue in Disaster Management is this: Can sound economic development be legally influenced? One of the greatest potential areas of leverage presently available to citizens of developed "donor" countries is to influence their agencies in the underwriting of projects in the developing world to insure mitigation is included in economic development projects.

This very superficial overview has, I am afraid, not done justice to the complex subject. A careful review of the UNDRO report on Legal Aspects of Disaster Prevention and Mitigation is recommended for persons wishing to examine the subject in greater depth. I will conclude with a second verbatim quotation from that report: "The dearth of legal studies on almost all aspects of disaster prevention and mitigation clearly supports the conclusion that comparative research into these areas of law is urgently required."

# Legislation Affecting Disaster Preparedness As It Relates to Barbados

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## INTRODUCTION

When I began preparing my material for this morning's presentation, I examined some of the literature on the subject of disaster preparedness, and I was immediately struck by two statements which I would like to share with you.

The first appears in the 1984 United Nations Compendium of Current Knowledge Vol. 11 of the series entitled "Disaster Prevention and Mitigation" at p.1, and is as follows:

> Preparedness is not limited only to the short-term measures which are taken during a warning period before the impact of a disaster event: it must be supported by legislation and be concerned with operational planning, education and training of the population at large, and the technical training of those who will be required to help in a relief operation, stockpiling of supplies, and emergency funding arrangements. The more effectively these tasks are carried out in advance, the more readily will it be possible to take also the action necessary during the emergency phase itself and in later phases of relief, rehabilitation, and reconstruction.

The other appears at p.7 of the same volume under the caption "Legislation" and states as follows:

> It will be essential for the effective operation of the plans that sufficient legal powers exist for their execution. The conferment of responsibility without power is, in terms of disaster preparedness and relief, worse than its opposite.

With these statements in mind, I propose giving you a brief overview of two legislative models which seem to have incorporated some of the guidelines contained in the foregoing statements, and thereafter I will examine the Barbados legislation. The two models are the Tasmania Emergency Services Act, 1976, and the Commonwealth of Virginia Emergency Services and Disaster Law, 1973.

## TASMANIA MODEL

The Tasmania model provides for the establishment of a number of state agencies with varying functions. There is, for example, the State Disaster Committee. This Committee consists of senior government officials, such as the Director of Emergency Services, Director-General of Health Services, Director of Public Works, the State Fire Control Officer, Deputy Commissioner of Police, etc.

The Committee's function is to advise and assist the Minister and the Director of Emergency Services in the planning and implementation of all measures considered necessary or desirable to plan for and to counter the effects of disasters (section 7).

Another agency, known as the State Disaster Executive consists of the Commissioner of Police, Director of Emergency Services who is the executive director of the agency, and one other officer (section 9). The functions of the Executive Director include:

(a) assisting and advising the Minister on matters relating to counter-disaster measures; and

(b) translating into action the instructions of the State Disaster Executive; and ensuring that those instructions are conveyed to and carried out by the persons to whom they are directed whether prior to, during, or subsequent to the occurrence of a disaster or emergency (section 12).

There is also The State Emergency Service, and the functions of this body include the following:

(i) the education and training of government departments and other bodies, members of the public, volunteers, and volunteer groups for counter-disaster purposes;

(ii) the evaluation of emergency equipment and facilities and the dissemination of the results of such evaluation;

(iii) the coordination, direction, and control of members of the public, volunteers and volunteer groups, materials, and resources for counter-disaster purposes.

The cumulative effect of all these provisions is to ensure that measures are in place to minimize or prevent the effects of a disaster. Quite apart from providing for

measures aimed at prevention and disaster preparedness, the Tasmania model also empowers the Governor, on the recommendation of the Minister responsible, to declare that a state of disaster exists in respect to any region or to the whole State if at any time it is made to appear to the Governor that the extent or severity of a disaster or impending disaster is or is likely to be so great that the counter-disaster measures necessary or desirable with respect to the disaster are beyond the resources of the Statutory Services.

Statutory Services refers to bodies whose roles include counter-disaster operation. The term "counter-disaster" is defined as meaning:

> The planning, organization, coordination, and implementation of measures that are necessary or desirable to prevent, minimize, or overcome the effects of a disaster upon members of the public or any property in the State and includes the conduct of or participation in training for those purposes..

When a declaration of a state of disaster is made, it continues in force for 14 days, and may be extended for such periods not exceeding 14 days as the Governor thinks fit.

It is during this period that those measures which comply with the directions and orders of the State Disaster Executive and with disaster contingency plans are instituted for the protection of the community.

Brief as this overview may be, it nonetheless indicates that legislation can be designed not only to deal with the post-disaster situations of relief and reconstruction, but also with the phases of prevention and preparedness which are an integral part of the "disaster continuum" which is described as the phases of disaster prevention, preparedness, emergency relief, rehabilitation, and reconstruction.

## The Commonwealth of Virginia Model

The other model to which I have already referred is that of the Commonwealth of Virginia Emergency Services and Disaster Law, 1973. One of the declared purposes of this legislation is:

> That all emergency service functions of the state [are to] be coordinated to the maximum extent possible with the comparable functions of the Federal Government, other states, and private agencies of every type, and that the Governor shall be empowered to provide for enforcement by the State of national emergency services programs, to the end that the most effective preparation and use may be made of the nation's resources and facilities for dealing with any disaster that may occur (section 3).

Apart from conferring powers on, and assigning duties to the Governor to deal with disasters, this legislation also provides for the establishment of an Emergency Services Agency with responsibility for administering the disaster preparedness programs which include the promulgation of plans and programs that are conducive to adequate disaster preparedness.

Here again we see an attempt being made to provide for the early phases of the "disaster continuum".

## The Barbados Model

In Barbados the position is quite different. The legislative provisions are embodied principally in an enabling Act. That is an Act which established broad provisions, the details of which are left to be provided for in orders made by the Cabinet after a state of public emergency has been declared by the Governor-General.

The Barbados Act is entitled the Emergency Powers Act, and contemplates a post-disaster situation, i.e., the emergency relief and rehabilitation and reconstruction phases. The Act provides in part that:

> Where the Governor-General is satisfied:
>
> (a) that a public emergency has arisen...as a result of the occurrence of any earthquake, hurricane, flood, fire, outbreak of pestilence, outbreak of infectious disease or other calamity, whether similar to the foregoing or not,
>
> . . .
>
> the Governor-General may, by proclamation declare that a state of public emergency exists (section 2(1)).

It is to be noted that although the words "Where the Governor-General is satisfied" would import an element of subjectivity, thereby giving the Governor-General a wide discretion in the exercise of his power to declare a state of emergency, nonetheless the exercise of that power is circumscribed by reference to the objective criteria embodied in the words "that a public emergency has arisen as a result of the occurrence of an earthquake, hurricane, flood, etc.".

These latter words reflect what I term the jurisdictional facts or grounds upon which the Governor-General may rely for the exercise of his power to declare a state of emergency after a hurricane, earthquake, flood, or fire, etc. has occurred.

It is clear, therefore, that under the terms of the Barbados Emergency Powers legislation the Governor-General has no legal power to authorize the execution of emergency measures until after a disaster has occurred. This post-disaster requirement at once distinguishes the Barbados position from that of the two models examined earlier.

Procedural Requirements

In terms of procedure, the Barbados legislation requires that both Houses of Parliament be informed of the state of emergency immediately after the Proclamation has been made. If at the date of the Proclamation, Parliament is prorogued or either House is adjourned to a day beyond 5 days from that date, then the Governor-General is required to summon both Houses, or the House that is adjourned, to meet within 5 days.

When this procedural requirement has been fulfilled, and during the period that the proclamation is in force, the legislation empowers the Cabinet to make any orders that it considers desirable in the public interest, notwithstanding the provisions of any other law (section 3(1)).

Before focusing on the kinds of orders that Cabinet may contemplate making under these provisions, it may, perhaps, be more than of a little interest to consider the effects of these enabling provisions on the Bill of Rights provisions enshrined in the Constitution of Barbados.

As you are no doubt aware, subject to certain conditions, those provisions guarantee certain fundamental rights and freedoms to the individual; that is to say, the right to:

(i) life, liberty, and security of the person;

(ii) protection for the privacy of his or her home and other property, and from deprivation of property without compensation;

(iii) protection of the law; and

(iv) freedom of conscience, of expression, and of assembly and association.

However, the Constitution acknowledges that the enjoyment of those rights and freedoms must in certain given cases be limited so as to ensure that such enjoyment does not prejudice the rights and freedoms of others or the public interest.

The Constitution therefore permits the taking of certain measures under the authority of legislation (and only under the authority of legislation) which would in the ordinary case, be in conflict with the Bill of Rights provisions.

To illustrate this Constitutional license, I would refer you to the following provisions as they relate to certain fundamental rights and freedoms.

With respect to the provisions protecting the right to personal liberty, the Constitution provides that:

> Nothing contained in or done under the authority of any law shall be held to be inconsistent with or in contravention of the foregoing provisions of this section to the extent that the law in question authorizes the taking during a period of public emergency of measures that are reasonably justifiable for the purpose of dealing with the situation that exists during that period of public emergency (section 13(5)).

In this context, it should be noted that one of the meanings assigned by the Constitution to the phrase "period of public emergency" is a period during which "there is in force a proclamation by the Governor-General declaring that a state of public emergency exists (section 25(1)(b)).

As regards protection from forced labor, it is provided that:

> No person shall be required to perform forced labour (section 14(2)).

The Constitution further provides, however, that the expression "forced labour" does not include:

> (d) any labour required during any period when Barbados is at war, or in the event of any hurricane, earthquake, flood, fire or other like calamity that threatens the life or well-being of the community, to the extent that the requiring of such labour is reasonably justifiable, in the circumstances of any situation arising or existing during that period or as a result of that calamity, for the purpose of dealing with that situation (section 14(3)).

Similar provisions allowing measures to be taken as reasonably justifiable in the interests of public safety are reflected in the Constitution in relation to deprivation of property, and to entry on, and search of property.

The presence of these provisions, therefore, in the Constitution would seem to support the view that orders made during a period of public emergency which reasonably and justifiably deprive an individual of his or her property or of his or her liberty to move freely or requires him or her to undertake unusual work, would be valid within the constitutional framework of Barbados.

I turn now to the kinds of orders that Cabinet may reasonably and justifiably make to deal with a post-disaster situation, that is to say, after a state of public emergency has been declared by the Governor-General. In this regard, section 3(2) of the Emergency Powers Act sets out the areas in respect to which orders may be made. Included in that section are the following:

(a) the supply and distribution of food, water, fuel, light, and other necessities;

(b) maintaining the means of transportation by land, air, or water, and the control of the transport of persons and things;

(c) (i) the taking of possession or control of any property or undertaking;
(ii) the acquisition of any property other than land;

(d) the entering and search of any premises;

(e) . . .

(f) the payment of compensation and remuneration to persons affected by any order.

On the basis of the legislative power conferred on Cabinet by the enabling Act, orders can be drafted and made generally for the purpose of:

(i) requisitioning any form of transport from the owner, e.g., a motor car, motor lorry, mini-bus, etc., tractor or motor van;

(ii) requisitioning supplies, such as food, articles, and property other than lands and buildings;

(iii) requisitioning lands and buildings;

(iv) imposing additional duties on public officers, and on statutory employees, or requiring the performance of additional work by these persons;

(v) the control of traffic, both vehicular and pedestrian;

(vi) reserving areas, and prohibiting access to those areas, e.g., the Garrison area, Deep Water Harbour area, Cable and Wireless stations, Utility Companies, privately owned warehouses, etc.;

(vii) providing for shelter, refuge control, e.g., to ensure good discipline and behavior in an emergency shelter;

(viii) controlling the level of rents which a landlord may fix during a state of public emergency;

(ix) requiring the owner or occupier of a house, shop, store, or warehouse to sweep and clear the road area adjoining his or her premises, etc.;

(x) prohibiting persons in essential occupations from being dismissed or leaving their employment without the consent of the Chief Labour Officer, e.g., persons employed by the Barbados Water Authority, Light and Power Company, Telephone Company, Barbados External Telecommunications Company Linited, or by a bakery, food distribution company, or dairy; and

(xi) imposing penalties for contraventions or failures to comply with the orders so made.

This list is not exhaustive, but is illustrative of the points raised in connection with the effect which an order made under a state of public emergency may have on the rights and freedoms of the individual.

### Tabling of Orders in Parliament

Where any such orders are made by Cabinet, they must be tabled in Parliament as soon as possible after being made. When tabled, these orders remain in force for 7 days from the date of tabling, unless both Houses resolve that they should continue in force for a further period.

It should also be recognized that the enabling Act prohibits the bringing of any action in a court of law against a person for anything done in good faith in exercise of any power conferred by an order made under the Act.

## CONCLUSION

From our examination of the Barbados legislation within the context of a post-disaster situation, there appears to be adequate machinery for dealing with that part of the "disaster continuum" that relates to the relief, rehabilitation, and reconstruction phases. Even within this context, however, one can only contemplate and prepare in draft legislative form the kinds of emergency orders that would be reasonable and justifiable to deal with the situation. Consequently, any such orders can only be effectively made after a state of public emergency has been declared by the Governor-General.

In terms of the pre-disaster situation or the taking of counter-disaster measures, however, it is patently clear that in Barbados there is no juridical base to support the putting in place of any legally enforceable measures that would reasonably ensure a degree of disaster preparedness to the extent that is compatible with the developmental objectives and independent status of Barbados.

Whether or not this lacuna in our law should be rectified is a matter for the policy makers; but in my view, rectification is indeed desirable in the interests of the life and well-being of our community.

## FOOTNOTE

This paper was prepared for a seminar on Emergency Planning for Senior Administrators co-sponsored in Barbaros in May, 1985 by the Central Emergency Relief Organization (CERO) and PanCaribbean Disaster Preparedness and Prevention Project (PCDPPP).

# Government Liability for Harm Resulting from Disaster Loss Mitigation

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## INTRODUCTION

One hundred years ago people in most parts of the world accepted the devastating consequences of natural disasters as the inevitable result of forces beyond human control. The only role for government, if government was thought to have any role at all, was to provide post-disaster relief.

Twenty years ago people in many parts of the world began to believe that they could mitigate future disaster losses. The role of government was expanded to include pre-disaster activities designed to avoid or limit future losses. Building codes were adopted. Land use regulations were increasingly proposed and enacted. Disaster relief planning was improved. Governments began to contemplate disaster prediction as a mitigation tool.

Today, disaster loss mitigation is an agenda item for most governments in the world although the specifics of these programs differ greatly. The recent earthquakes in Mexico and Tadzhikistan remind us of the importance of these governmental efforts to mitigate disaster losses.

The task of mitigating disaster losses is formidable, but it is not the only problem faced by governments in the context of natural disasters. Governments throughout the world are being challenged on the adequacy of their mitigation efforts. Governments are being sued in courts of law by complainants who seek to recover damages for losses allegedly sustained because of inadequate or improper governmental response to the threat or reality of hazard losses. Ironically, governments which have most aggressively pursued disaster loss mitigation may be the ones most likely to be subject to claims of liability.

People not familiar with recent trends in the law of government liability will no doubt be surprised to learn that governments may be liable for damages to the parties they are trying to protect. This surprise may become disbelief when it is suggested that government may be liable to individuals to whom the government offers assistance during or after a natural disaster. During a 1982 interview with officials of the Disaster Prevention Section of the Hokkaido Prefectural Government of northern Japan, I was told that it was unimaginable that they would be sued for failing to adequately mitigate disaster. After all, they said, they were doing their best to protect people from disaster. However, Japanese government has frequently been sued by unhappy victims of disaster, and in several instances has been required to pay damages.

From 1981 through 1985 the Government Liability Project at Lewis and Clark Law School was involved in a comparative study of government liability law in the context of disaster loss mitigation. We studied the laws of six countries: China, Japan, New Zealand, Peru, the Soviet Union, and the United States. I will draw upon that study in the remainder of my comments.

## THE PROSPECTS FOR GOVERNMENT LIABILITY

First, it is important to recognize that the prospect of liability is not limited to reputedly litigious countries like the United States. Indeed, significant government liability in the United States is a relatively recent development due to the persistence of the doctrine of sovereign immunity. Countries whose legal systems are rooted in the civil law of western Europe have a much longer history of government liability. Even the culturally non-litigious countries have provided legal mechanisms for seeking compensation from an allegedly negligent or careless government.

The prospects for government liability are as much a function of the nature and extent of government activity as they are a function of the nature of the legal system. In Peru, for example, where the civil law provides few doctrinal obstacles to suits against the government, such suits are, nevertheless, unusual. The Peruvian government is relatively small in scale, a fact reflected in the country's modest and feldgling disaster mitigation program. The government has limited resources, and popular expectations of government assistance are not high. In the United States, on the other hand, where the common law erected numerous obstacles to suits against the government, such suits are commonplace.

Governments in the United States have greatly expanded their functions in recent decades, an expansion evidenced in the area of disaster mitigation. United States citizens tend to rely heavily on governmental assistance, particularly in times of natural disas-

ter. I would, therefore, suggest that countries which, like Peru, have only recently undertaken significant programs of social assistance, are likely to experience increasing numbers of suits against government as they expand their disaster loss mitigation activities.

The government liability laws in the six very diverse countries we have studied are illustrated in Table 1, which is taken from our final report. I include this table only to underscore the pervasive nature of the problem, not to explore the intricacies of the law. Of more importance to our purposes here, are the contexts in which liability may be an issue for disaster officials. Figure 1, also from our final report, identifies four types of disaster loss mitigation within the broad categories of direct government action and government regulation of private action. Each of these types is broken into sequential stages from data collection to implementation. The prospects for liability vary with both the types of mitigation activity and the particular stage of that activity. For example, an allegedly negligent disaster prediction is less likely to be the basis for government liability than the allegedly negligent operation of a rescue vehicle. A negligent decision to undertake a rescue is less likely to be the basis for governmental liability than the negligent operation of the rescue vehicle.

The reasons for these variations in the prospect of liability are illustrated in Figure 2. Governmental decision making is a multistep process influenced by empirical and normative factors at each step. As a general matter, governments are more likely to be liable for empirical errors than they are for normative errors. The basic reason is reflected in the distinction between empirical and normative factors. It is difficult for courts to articu-

GOVERNMENT TORT LIABILITY

| COUNTRY | SOVEREIGN IMMUNITY | GENERAL LIABILITY | STATUTORY LIABILITY | BASIS OF LIABILITY | AFFIRMATIVE DUTIES | COMPENSABLE LOSSES | LIABILITY OF OFFICIALS |
|---|---|---|---|---|---|---|---|
| CHINA | Total immunity in Imperial China.<br><br>De facto immunity since revolution.<br><br>1982 Code of Procedure may indicate waiver. | No indication that general rules of liability apply to government, but forthcoming civil code may clarify issue. | No pre-1986 civil code provision on government liability. | Liability for intentional acts, but not for accidents. Some sufficient degree of negligence (fault) may be interpreted as intent. | Constitution (Art. 26) imposes duty to prevent hazards, but probably does not imply private right of action. Historical remedies have been political. | No specific limits, but potential economic losses are limited by relative lack of private property. | Officials are criminally liable and may be required to indemnify government. |
| JAPAN | Since German Law reception immunity limited to acts of state.<br><br>Practical immunity resulting from general nature of much national legislation. | General law of obligations applies where government is not immune unless provided for by statute. | Article 17 of Constitution mandates liability for unlawful acts of state.<br><br>Implemented by State Redress Law of 1947. | Liability for intentional acts and where state or official is at fault.<br><br>Trend is to raise normal standard of negligence where government is defendant. | Developing theory of liability for failure to act under State Redress Law, but 1984 Supreme Court decision may halt trend. | Disaster Basic Law limits compensation to direct losses. Same limit may apply to damages under State Redress Law. | Under one theory state is vicariously liable for actions of officials. Officials may be personally liable and may be required to indemnify government. |
| NEW ZEALAND | Traditional adherence to British immunity doctrine with significant limits since 1900.<br><br>Crown Proceedings Act 1950 granted major waiver of immunity. | Principles of general tort law apply where government is not immune. | Liability of the Crown and its agents under Crown Proceedings Act of 1950. | General rule is common law negligence as modified by policy concern.<br><br>Accident Compensation Act abandons fault for no-fault liability. | Some liability for failure to act in land and building regulation. Must be a duty owed to particular individuals. | Personal injury compensation severely restricted under Accident Compensation Act. | Officials may be personally liable and may be required to indemnify government. |
| PERU | No formal immunity under civil law, but de facto immunity for political and economic reasons. | If government is found not immune, private law of obligations in civil code will apply. | No provision for liability under Civil Code.<br><br>Some actions may be brought under administrative code. | Administrative acts must be non-arbitrary. | No indication of any liability for failure to act. | No express limits under Civil Code. Administrative Procedure Act prohibits recovery for consequential damages. | Officials may be liable under Civil Code law of obligations. |
| SOVIET UNION | Russian law granted immunity for governmental actions.<br><br>Immunity persisted in Soviet law until 1961, and many specific immunities still exist. | Where government is not immune, general rules of Civil Code (1969) will apply. | 1961 Civil Code (1989) makes state liable, unless otherwise provided, for acts of public administration. | 1922 Code rejected fault in favor of causation as basis of liability.<br><br>1961 Code (1988) reinstates fault as basis of liability. | No private right of action for government inaction except where mandatory administrative acts are not performed. | No specific limits, but potential economic losses are limited by relative lack of private property. | Officials may be personally liable and may be required to indemnify government. |
| UNITED STATES | Rigid adherence to English immunity doctrine as underlying principle.<br><br>Significant waiver of immunity in 1946 Federal Tort Claims Act. | Where government is not immune, general principles of tort law apply. | Federal Tort Claims Act of 1946 is a general waiver of immunity with broad exceptions. | General rule is common law negligence. Increasing concern for plaintiff's need for compensation. Other policy concerns also relevant. | May be liability for failure to act where particular private parties have reasonably relied. No general duty owed to public at large. | Except where limited by statute, compensation may be required for economic and non-pecuniary losses. Potential compensable losses are very large. | History of circumvention of sovereign immunity by official liability with indemnification by government. |

* From J. Huffman, Government Liability and Disaster Mitigation: A Comparative Study at p. 743 (1985).

## FIGURE 1*

### THE CONTEXT OF GOVERNMENT LIABILITY FOR DISASTER MITIGATION

| I. Government action to mitigate and compensate for natural disaster losses. | II. Government regulation of private mitigation and compensation actions. |
|---|---|
| **A. Prediction and Forecasting** | |
| 1. Data collection<br>2. Data analysis<br>3. Decision to predict<br>4. Prediction communication | 1. Evaluation of prediction<br>2. Regulation of prediction content and communication<br>3. Implementation and enforcement |
| **B. Advising and Mandating Action** | |
| 1. Data collection<br>2. Data analysis<br>3. Decision to warn or issue order<br>4. Content of warning or order<br>5. Communication of warning or order<br>6. Enforcement | 1. Evaluation of warning<br>2. Regulation of content and communication<br>3. Implementation and enforcement |
| **C. Mitigation Action** | |
| 1. Data collection<br>2. Data analysis<br>3. Decision to act or not act<br>4. Implementation of action | 1. Evaluation of warning<br>2. Regulation content<br>3. Implementation and enforcement |
| **D. Compensation for Loss** | |
| 1. Data collection<br>2. Data Analysis<br>3. Decision to compensate<br>4. Implementation | 1. Evaluation of private action<br>2. Regulation content<br>3. Implementation and enforcement |

* From J. Huffman, Government Liability and Disaster Mitigation: A Comparative Study at p. 708 (1985).

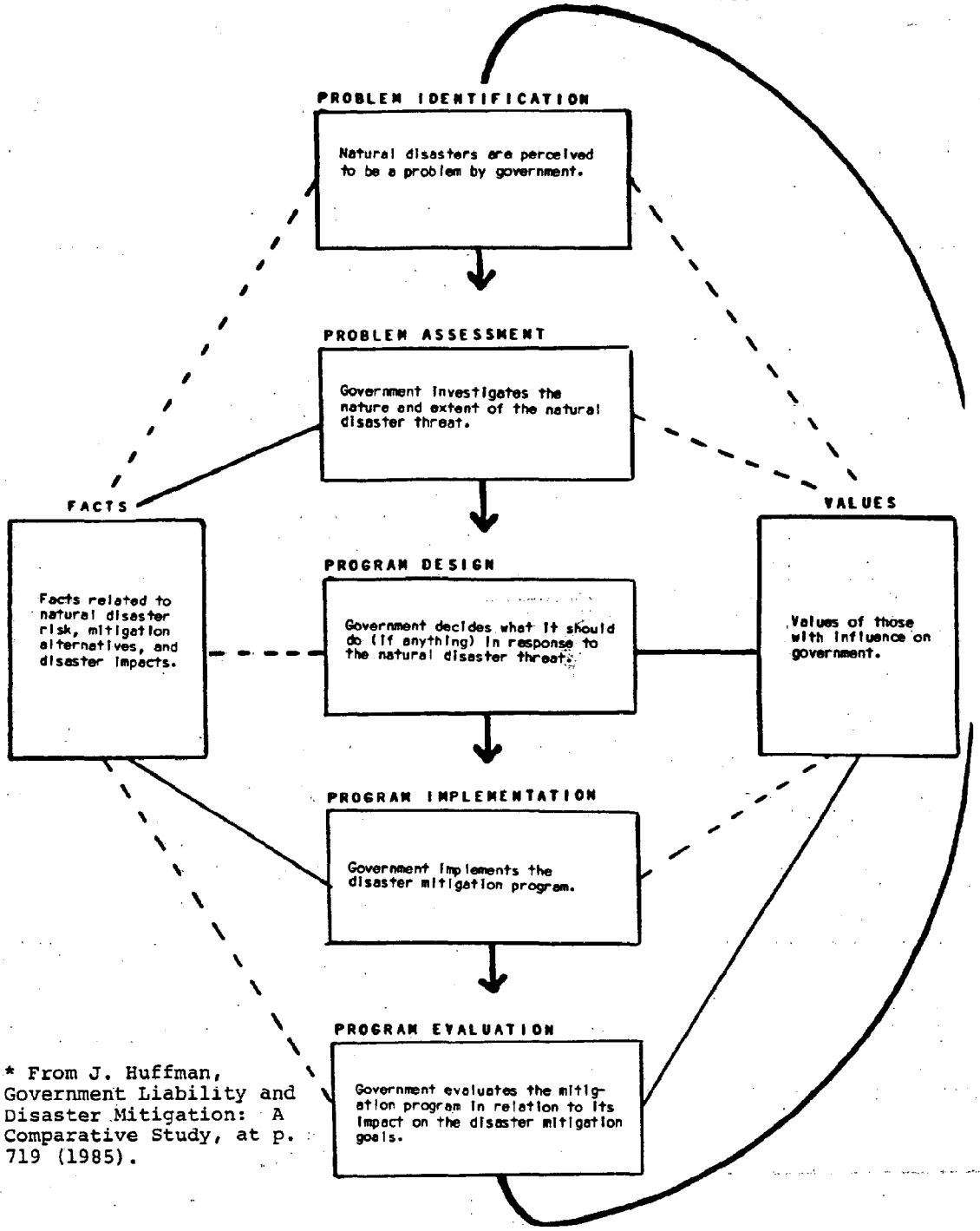
late standards of normative behavior against which liability can be tested. Indeed, in most governmental systems the determination of norms is committed to the political, not the judicial, institutions.

In the six countries we have studied, it is not unusual for the government to be held liable for harm which results from functions described as problem assessment and program implementation in Figure 2. These are functions, like the gathering of streamflow or weather information and the operation of flood control facilities, for which standards of reasonable care can be judicially determined. It is unusual, however, for governments to be liable for harm which results from functions described as problem identification, program design, and program evaluation in Figure 2. These are functions, like deciding whether or not to undertake flood control and deciding where and how to accomplish flood control, which involve the making of political choices for which the standard of performance is set by the political process itself.

It is interesting, but not surprising, that one can generalize in these terms about the six very diverse countries we have studied. Each legal system has its own doctrinal approach to accomplishing these similar results, and the practical consequences of liability vary in response to several factors independent from the basic issue of

**FIGURE 2***

**THE PROCESS OF GOVERNMENTAL DISASTER MITIGATION**




* From J. Huffman, Government Liability and Disaster Mitigation: A Comparative Study, at p. 719 (1985).

liability. The most important independent variable is recoverable damages which are dependent upon legal limitations, other government entitlements, and existing circumstances of parties who might suffer harm at the hands of government.

## A POLICY PERSPECTIVE ON GOVERNMENT LIABILITY

Disaster officials can approach the problem of government liability from one of at least two perspectives. They can view liability as a result to be avoided, and adjust their mitigation efforts on the basis of their understanding of the controlling law. Alternatively, they can view liability as one of several ways in which the costs of disasters are distributed. This latter perspective, which I urge as the better one, means that government liability is a factor to be considered in the formulation of disaster mitigation policy. It may be in the society's interests for the government to undertake activities which may lead to future government liability for damages.

I will illustrate my argument with a hypothetical example. Assume that a government is debating the implementation of a flood warning system. Streamflow data is to be collected through remote electronic measuring devices with the data sent by telemetry to a central station for processing and analysis. If the analysis indicates a flood is imminent, a warning is to be communicated by special telephone and radio facilities to emergency officials and the broadcast media. Government decision makers know that occasionally a mechanical failure attributable to human negligence will occur. If, under the applicable law, the government would be liable for resultant harm — say a dairy farmer has relied upon the warning system to advise him of the need to move his cows from the river bottom lands, a decision he would have made on his own information prior to the implementation of the warning system — should the government choose not to implement the system? Should the government resist the farmer's claim for compensation if they do implement the system and the hypothetical harm results?

The answer to both questions should be maybe, and maybe not. Both are policy questions which should be resolved in terms of the underlying goals of the disaster loss mitigation program. If mitigated flood losses exceed the costs of mitigation, including the anticipated costs of prospective liability, then the flood warning system should be implemented. If the dairy farmer can demonstrate that he would not have lost his cows had he not been induced to rely on the government's warning system, there is no more reason for him to bear that indirect cost of mitigation than for him to be taxed for the entire cost of the telemetry system. A central purpose of governmental disaster loss mitigation is cost spreading, an objective which can be achieved as well through the collection of taxes or the payment of damages.

It might be suggested that the diary farmer will be hard pressed to prove that he would not have lost his cows anyway, in other words that his loss is the result of the flood, not the government's negligence. But that does not change the underlying principle if he can prove that his loss was a result of the government's error. Surely, we would not say that the innocent person, hit by a negligently driven rescue vehicle. is not entitled to recover for his losses. Where the government acts to benefit the many, as it does in disaster loss mitigation, the costs should be borne by the society as a whole, not by individuals who suffer unintended but inevitable costs of government action.

## THE VALUE AND LIMITS OF COMPARATIVE STUDY

This policy focus on government liability can benefit from comparative study and the interchange of ideas. Although the laws of all countries vary in often significant ways and, more importantly, the cultural and historical roots of legal systems are diverse, all legal systems exist for the purpose of resolving the common problems of social existence. It would be a drastic mistake to believe that the rules of legal systems, institutions, or individual rules can be transplanted from one country to another with clearly predictable results. However, I am convinced that there is much to be gained by comparative legal study in the context of disaster law mitigation. Every country is dealing with the same consequences of disaster: destroyed housing, economic disruption, human suffering, and disrupted urban services like water, sewage, and electricity. We should not assume that our own legal system is the only one to have responded to these problems. We have much to learn from each other.

## RECOMMENDATIONS

1. Governments at all levels should recognize that under particular circumstances their laws will require payment of compensation to individuals injured by governmental disaster loss mitigation activities. Although the circumstances and extent of liability vary among countries, they are important issues in most countries. Where there is no history of cases in which liability has been found, there may nevertheless be existing laws upon which findings of liability can be based in the future.

2. The prospect of liability should be viewed as a question of loss mitigation policy, rather than as an evil to be avoided. Like disaster loss mitigation, liability law has as central purposes the avoidance of losses and the redistribution of losses which have occurred. In terms of the goals of disaster loss mitigation, it will sometimes be appropriate and desirable for government to compensate individuals who are injured by government activity. Policy makers should endeavor to understand the impact of liability law on the goal of disaster loss mitigation.

3. Governments should look to the laws and experience of other countries in seeking to understand their own situation. Although the laws of all countries vary in important ways, there are many similarities which allow one country to benefit from the experience of another. The basic problems of disaster loss mitigation are similar in all countries, amking a comparative approach particularly useful. Where laws differ, a comparative approach will often suggest new approaches to solving common problems.

# Encouraging Government Mitigation: The Forensic Geologist/Expert Witness Perspective

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## INTRODUCTION

One of the great frustrations in working as a forensic geologist or expert witness for government is the realization that the majority of disaster losses could have been avoided if government had done a responsible and prudent job in regulating land uses. As my good friend, Michael F. Richman, Esq. (Salt Lake City, Utah) has often stated: "Governments have a monopoly on the issuance of land use, grading, and construction permits. They are the responsible bodies in the creation and promulgation of codes, regulations, and ordinances. They have authority to assure compliance. Government also has an obligation to do a reasonably good job."

Why then do we have losses such as those caused by the 1985 Mexico City earthquake (approximately $4 billion and 8 to 10 thousand lives); the 1971 San Fernando earthquake ($500 million and 64 lives); the high intensity rains, floods, landslides, etc., that plagued San Francisco in 1982 and caused hundreds of millions of dollars damage and loss of approximately a dozen lives; and the Malibu landslide which is now in litigation with an estimated $500 million to $1 billion in claims and cross-complaints (Daily Journal, 1985)?

Some, because of ignorance, ambivalence, or vested interest, will argue that more research is necessary to determine the cause and effects of disasters and how best to reduce losses. Some will foolishly argue that "every man has the right to use his land as he wishes without interference from government." Others may argue that "it was caused by an Act of God." Still others will suggest that government and its representatives have immunity for their actions. These arguments are responsible for the lack of concern by government when people want to build on an active landslide, floodplain, active surf zone, or any other hazardous site. All of these arguments or excuses are without justification and only exacerbate an already cavalier attitude.

The monetary losses resulting from the loss of structures, roads, dams, reservoirs, etc., and the accompanying injuries and deaths could be readily and significantly reduced if government would only accept the leadership role that it seems to want to avoid. The cost to government for its errors is skyrocketing. Losses can only increase, considering the population trends, unless government exercises its responsibility and society recognizes that the type of losses that we have witnessed over the past few decades can be reduced by 90% to almost 100% through adequate land use control measures.

Cost/benefit studies performed by Dr. William J. Petak (University of Southern California), the U.S. Geological Survey, California Division of Mines and Geology, this author, and others have shown that the development of effective codes/ordinances/regulations coupled with appropriate quality control can result in savings of tens to hundreds of dollars (loss avoidance) for every one dollar spent on mitigation. An outstanding example of this is the current litigation involving a landslide in Malibu in which there are claims and cross-complaints estimated at $500 million to $1 billion. In the first, or test case, of a series of 200+ cases, the judge found the County of Los Angeles responsible for the loss. The court assessed a value of $2.1 million to this loss. The County's legal defense via outside legal counsel cost the County an estimated $3.2 million, including an estimated cost for engineering and geologic experts of $960,000. Additionally, the County will be required to pay for the fees of the plaintiff's attorney and expert witness - to date, the expert witness costs are $800,000 and legal fees may exceed $1.5 million. It is interesting to note that due to the lack of a $300,000-$400,000 investment by the developer, not the government, in sewage facilities and storm drains during the development stage in 1963, the County is now facing losses of $500 million to $1 billion in damage claims plus additional legal costs (L.A. Times, 1985).

Without mitigation, escalation of population and inflation will cause:

- greater losses of structures, facilities, etc.;
- greater total dollar losses in value of these structures and facilities;
- greater number of people killed or injured; and
- greater costs (or losses) to society.

## EXAMPLES OF MITIGATION

The engineering and science communities have

the capability, knowledge, and technology to mitigate, through design and/or land-use planning, most of the losses from natural hazards. For example:

- The City of Los Angeles, through the development of realistic codes and prudent enforcement, has reduced losses from landslides by an estimated 97%.

- Depending on the degree of quality control, some Southern California jurisdictions have reduced the losses from expansive soils by 90% to 99+% (state regulations require soil engineering analyses of the expansive factor; loss reduction is keyed to this regulation, plus the efficiency of local government's report reviews and enforcement).

- Many jurisdictions have dramatically reduced flood losses by strictly adhering to prudent floodplain management procedures related to location of structures and the design construction of flood control facilities. The City of Los Angeles requires all new subdivisions to design their flood control facilities for a 1000-year flood; the County of Los Angeles requires design for a 100-year flood. In contrast, Louisiana only requires design for the 10-year flood.

- Although not completely realistic and effective, coastal zone management procedures adopted by the California Coastal Commission have had some effect on reducing coastal erosion losses. The limited nature of mitigation achieved is related to the California Coastal Commission's failure to hire and utilize talented/knowledgeable staff personnel. For the entire coastal area of California, only one engineer and one engineering geologist comprise their staff expertise. Conversely, there are ample attorneys available for litigation and prosecution.

- Hawaii has taken effective action in design, land use, and emergency procedures to reduce losses from tsunamis (tidal waves).

- Many other examples are available.

All of these examples highlight the benefits of mitigation in the loss prevention process. Reference can also be made to U.S. Geological Survey Circular 832 entitled "Estimating the Costs of Landslide Damage in the United States", which again addresses the question of reduction or mitigation of losses from landslides.

## REASONS FOR INADEQUATE MITIGATION

Why aren't we mitigating these costly losses if we already have the ability, knowledge, and technology? Some factors include:

- Many local governments will not, for a variety of reasons, hire the experts needed to prevent known problems, even though such experts are readily available. Some local governments plagued with landslides and even litigation related to landslides doggedly refuse to hire even one engineering geologist and one civil engineer experienced in soil engineering although they may have dozens of civil engineers on their staff.

- In many cases, government employees lack the desire and/or incentive to do a professional job.

- Many government employees lack administrative support, and complain that their supervisors are reluctant to support staff personnel or even oppose their own staff.

- Often the elected officials will, because of the cherished position of contributors, make life miserable for efficient and effective civil servants over whom they have direct control and whose job security rests in their hands.

- Some civil servants are simply waiting for retirement and therefore have no desire to do anything - some even refuse to visit the construction site in question or the site of the hazardous condition.

- The built-in efficiency depressor called "immunity to error and/or negligence" which creates a mental attitude of "why do anything that will cause someone or anyone to give you a bad time" syndrome.

- Inadequate budget is allotted to quality control.

- Governmental tort immunity statutes which offer government employees immunity for their actions or inactions can encourage professional negligence.

Additional problems which contribute to a lack of consistent professional performance include actual retirement, anticipated retirement, promotions, changes in elected officials, and general lack of motivation ("institutional inertia") and lack of interest. When these conditions prevail, many attorneys for plaintiffs suffering losses learn about the situation and become very aggressive, thus perpetuating the cycle of disinterest and inefficiency. Additionally, the lack of cost/benefit analysis prevails, giving a false sense of low potential losses.

## REDUCING POTENTIAL LIABILITY

What can be done in the post-disaster situation to reduce government's legal exposure? The obvious is to learn from each disaster and

then take action to reduce or hopefully avoid losses from similar hazards in the future. Experience gained from research and from forensic analysis of floods, landslides, earthquakes, subsidence, and other similar hazards has greatly enhanced our understanding of the causes and effects of the various natural hazards. This, coupled with a knowledge of engineering design and construction and their relationship to codes/ordinances/regulations, has allowed a giant step forward in geographic areas where progress is preferred rather than repetition of the same problems and losses.

To reduce potential liability and losses, it is imperative that the best expertise possible be assigned to the collection, collation, and analysis of all of the data available. From this can evolve new technology and improved codes/ordinances/regulations as well as better educated engineers and scientists. This sequential method of analysis resulted in promulgation of Chapter 70 of the Uniform Building Code (the hillside grading chapter) following the rainfall/landslide disasters of Southern California in 1952, 1958, and 1962. The 1925 Santa Barbara and the 1933 Long Beach earthquakes stimulated the first earthquake-resistant construction (seismic safety codes) which went into effect immediately following the 1933 earthquake. After the 1971 San Fernando earthquake, there was also quick reaction by local and state government agencies which initiated new seismic safety codes based on data from studies by their own staffs as well as by professional organizations such as the Earthquake Engineering Research Institute and the Structural Engineers Association of California. Other similar disasters and subsequent studies have brought knowledge and technological development related to all natural disasters. Unfortunately, mitigation of natural hazard disasters usually lags far behind the capability to mitigate.

To assure a closer relationship of knowledge/technology and mitigation, all available recoverable information has to be recorded by knowledgeable engineers and scientists who are allowed to collect, collate, and make these data available to all involved in recovery, analysis, mitigation, and the development of codes/ordinances/regulations. One of the best examples is the data collection program utilized by the Structural Engineers Association of California following the 1971 San Fernando earthquake. This volunteer program made available to local and state government some of the finest structural engineers in the United States. In addition to collecting valuable seismic and structural engineering data, they also provided an all-star team of structural engineers to assist local governments to quickly evaluate the safety of buildings affected by the earthquake. From this effort evolved the modern seismic safety design criteria and seismic codes. Similar efforts are being achieved by this same organization in the post-disaster analysis of the 1985 Mexico City earthquake. The author has been involved with similar volunteer efforts (or assistance) by this and other professional societies - all with beneficial results to government and the mitigation of future losses.

Cooperative action is needed of experts with expertise in various disciplines. For example, the collective efforts of the Association of Engineering Geologists and the American Society of Civil Engineers during the early 1960's in studying the cause and effects of landslides triggered by the high intensity rainfall of 1958 and 1962 assisted local government in preparing guidelines for professional reports and recommended code amendments for the mitigation of slope failures. Following the actions of these professional societies, the International Conference of Building Officials generated grading codes and land use concepts. From these efforts came Chapter 70 of the Uniform Building Code. The effective utilization by government of Chapter 70 has had a dramatic effect on the reduction of losses from landslides.

Currently, the American Society of Civil Engineers in California has developed a program and cadre of top flight experts (civil engineers and engineering geologists) to assist local government in the post-earthquake evaluation of the damage to lifelines and to suggest methods of mitigating damage in the future. This will include recommendation to government for the modernization of codes.

Government at all levels should draw upon the examples and make greater use of the expertise offered by the professional societies to assist in collecting data, evaluating the data, and modernizing codes/ordinances/regulations. This upgrading should be put into effect before any rehabilitation, reconstruction, or additional new construction is allowed. Failure of government to act responsibly and in a prudent manner may cause the courts to place the blame for losses squarely on governments with subsequent expansion of the California "deep pockets" concept to other jurisdictions.

## SUMMARY

In summary, it is unfortunate, but litigation has already become an important factor in encouraging governments to mitigate losses from natural hazards. Litigation will likely become an even more important factor as sovereign immunity is further reduced throughout the nation permitting land landowners to win additional massive awards as in the recent Malibu cases. Government can no longer be complacent with the other defenses of the past decades such as the "Act of God", lack of knowledge of past episodes or the potential of future activity, or other excuses based on ignorance of existing conditions or lack of review.

## FOOTNOTE

The author wishes to express his appreciation to the following for their review and comments: Michael F. Richman, Esq., Arthur Keene, Jon Kusler, Esq., Bill Brown, Arnold Graham, Esq., Gerard Shuirman, and William Kockelman.

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# Legal Questions in a Post Disaster Context

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The following legal questions are commonly raised in the U.S. after a natural disaster. The first set of questions are raised by those suffering damage (referred to here as disaster victims). The second set are raised by governmental entities. The two sets overlap since many law suits after a disaster are between victims and government entities.

The discussion broadly reflects the law of the U.S. and not that of a particular jurisdiction. Constitutional and statutory provisions as well as case law, of course, differ in other countries. For case cites see J. Kusler and R. Platt, The Law of Wetlands and Floodplains, The American Bar Association; J. Kusler and R. Platt, Common Legal Questions Pertaining to the Use of Floodplain and Wetlands, the Association of State Floodplain Managers; and, J. Kusler, Natural Hazards and the Courts (unpublished report) prepared for the Federal Emergency Management Agency.

## QUESTIONS OF DISASTER VICTIMS

1. Do I have a right to federal, state, or local loans, grants, free food, debris removal or other disaster assistance? In general, no. You have no legal right to disaster assistance unless a statute or regulations explicitly create such a right. In general, disaster statutes create no rights.

Although disaster victims have few "rights" to assistance, you might compel government action if you can show that government is authorized to provide assistance and is doing so in situations like your own and government is flagrantly discriminating against you.

2. Do I have a right to national flood insurance payments or to purchase national flood insurance? You have a right to flood insurance payments if you suffer a loss and have a flood insurance policy in effect and you qualify under the terms of the insurance contract. However, certain types of losses are not covered under your contract such as those from wind, cyclic erosion, etc. A considerable amount of litigation has already occurred concerning the interpretation of specific contract language with landowners prevailing in some cases and FEMA in others.

You have no right to purchase flood insurance if your community is not participating in the flood insurance program. A court has held that eligibility for National flood Insurance is a priviledge rather than a right and landowners can claim no taking of their property if they are denied such insurance because their community failed to qualify for the flood insurance program or was suspended from the program. However, if your community is validly participating in the program and you meet all legal requirements for insurance, you are entitled to such insurance.

3. Do I have a claim against the federal government, state, or local government for failing to construct flood control, landslide protection, mudflood control, erosion control or other hazard reduction measures? In general, no. Ordinarily government has no duty to remedy natural hazards occurring on public or private lands. However, government may have a duty to remedy natural hazards if the governmental unit has aggravated such hazards in the first place. For example, it may have a duty to reduce flooding at least to natural levels if it constructed a drainage ditch which increased flooding.

Government may also be responsible for damages for naturally occurring hazards where there is a special relationship between government and the injured individual. For example, a local government might be liable if it constructs an industrial park in the floodplain and rents or sells space in the park.

Several recent cases from California suggest broader concepts of public liability in that state for failure to remedy known natural hazards on lands that damage adjacent lands. Citing earlier decisions holding governments liable for damage caused by trees on public lands which fell into private lands, the California court held that a landowner who failed to remedy a drainage condition which resulted in mudslide damage on adjacent land could be liable for failing to act "unreasonably". The extent to which governments will be held liable for inaction in other states or even California remains to be seen, but a rapid expansion of this doctrine seems unlikely.

4. Can I sue an adjacent private landowner for failing to correct a natural hazard on his or her land such as erosion or flooding which damages my land? Probably not. But see discussion of question 3 above.

5. Do I have a claim against an adjacent landowner or governmental body for aggravating damages caused by a natural hazard? In general, yes, although there are exceptions. A landowner must not, through his or her action, substantially increase flooding, drainage, erosion or other hazards on adjacent lands. But liability depends upon the type of hazard, the nature of the activity aggravating the hazard, and the overall circumstances:

> Type of hazard. At common law, landowners could not block the flow of a stream with resulting damage to other landowners. However, landowners could, in some jurisdictions, alter the flow of diffused surface waters without liability because of a "common enemy" theory applied to flood waters not in water courses. Over the last two decades, courts have, in most jurisdictions, shifted from a common enemy theory to one of "reasonable" use so that landowners now alter surface drainage at their peril. This is not to say that they cannot somewhat increase runoff; but they must act reasonably. A similar "reasonable use" concept has been applied to erosion, mudslide, landslide, and other hazards in most jurisdictions.
>
> Nature of the activity. What is reasonable depends in part on the nature of the activity. Courts have been willing to allow some grading, leveling, channel modification or other hazard-reduction measures which increase damage to other lands if economic use of the land is impossible without such improvements, the measures are designed to reduce offsite impact, and the offsite damages are not great.
>
> Overall circumstances. Liability depends upon the reasonableness of a landowner's actions. This is determined by the overall circumstances including the magnitude of the threatened harm. The greater the threatened harm, the greater the care that must be exercised. For example, courts in a fair number of jurisdictions have imposed strict liability on the owners of dams because they pose great risks in the event of a failure.

6. Do I have a claim against government for inadequate flood or other hazard warnings? In general, no. Absent a statute mandating warnings, governmental agencies have no duty to provide flood or other warnings. However, if government bodies do warn, they may be held to a standard of "reasonableness".

Several courts have held federal agencies free of liability for inadequate flood warnings because such warnings were, in the courts view, "flood control measures" under a federal flood control exemption on liability discussed below. Nevertheless a lower federal district court in New Bedford, Massachusetts held the U.S.Weather Service liable for an inadequate storm warning. Due to an inoperative weather buoy, the Weather Service broadcast an inaccurate boating report. A boat was lost due to hurricane force winds and the relatives of the fishermen sued NOAA. The problem here was inoperative equipment, not the failure to exercise judgement in forecasting -- an important distinction since most governmental entities are liable for negligence in ministerial actions but not those discretionary in nature (policy-making, interpretive). This judgment was reversed on appeal.

7. Do I have a claim against government for inadequate hazard maps? Probably not, but this depends upon the level of government and the circumstances. Several courts have dismissed claims against federal agencies for flood damages when areas were excluded on inaccurately drawn federal flood maps. The courts in these cases held that federal flood maps were, in fact, "flood control measures" and therefore subject to Section 702(c) of the Flood Control Act of 1936 (discussed below) which exempts the federal government from damages for flood control measures. Arguably, state and local governments, which are required to rely on federal maps by the National Flood Insurance Program, could also claim immunity under this broad statute. But they might be held liable for gross disregard of errors or for dissemination of information they knew to be inaccurate.

Whether a state or local government could be held liable for inaccurate flood maps prepared at state or local levels is a different matter since there is no comparable statute limiting state or local liability for flood control. A California court held that the state might be held liable, under a theory of negligence, for disseminating erroneous information concerning potential flood elevations to a marina. But liability would depend on the circumstances, the law of the state, and the nature of the inaccuracy. In many states, state agencies and local governments are not liable for governmental actions of a "discretionary" nature. It could be argued that errors in drawing maps are ministerial while judgemental errors in analysis of flood hazards are discretionary.

8. Do I have a claim against government for negligently maintaining or operating a dam, levee, debris basin, drainage ditch, or other hazard reduction measure? Maybe, depending upon the unit of government. In a long line of consistent cases, courts have held that the federal government is not liable for negligent operation of a dam, dike, levee or other flood control measures due to the federal limitation on liability under section 702(c) of the Flood Control Act of 1936 which provides in part:

> No liability of any kind shall attach to or rest upon the United States for any damage from or by floods or floodwaters at any place...

Traditionally courts have also held that states and local governments participating in such projects are not liable although courts in several recent decisions disagree.

Liability for a state or local project is another matter. Liability depends on the law of the jurisdiction and the specific circumstances. Under most state "tort claim acts", states and localities can be sued for certain types of negligence. For example, courts have often held that municipalities can be sued for inadequately maintaining a storm drain (ministerial function) or failing to maintain a dam (ministerial function). But it is unlikely a court would hold a municipality liable for deciding to release water from a municipally owned dam when, after careful evaluation of all factors, city fathers decided that less damage would be done through the release than if all the water were retained (a judgemental and discretionary decision).

9. Do I have a claim against my architect or engineer for failing to provide protection from earthquake, flood, or other hazards in designing my house or business structure? You might, depending upon your contract with the architect or engineer, the building code and other codes in effect at the time of construction, and the prevailing architectural or engineering practices. If your architect or engineer agreed in writing (as part of your design contract) that the structure was to be "hazard-resistant" or would withstand a particular magnitude of hazard and it did not, the architect or engineer would be liable.

If natural hazards were not mentioned in the contract, the architect or engineer should, at a minimum, have met requirements of building codes and zoning regulations. Failure to follow minimum regulatory requirements has, in general, been considered negligence or breach of professional contract and the basis for liability.

Courts have also held that architects and engineers must, in order to provide adequate services, perform as a "reasonable" or "prudent" architect or engineer in the profession would perform in the circumstances considering standard professional practices and all factors including the intended use for the structure and known or reasonably foreseeable hazards. Particular care must be exercised when a high risk structure such as a dam or levee is involved or where a building is to be used for refuge during a disaster and loss of life may occur if the building fails. Although the design professional is usually not responsible for conducting independent flood or other surveys, he or she should be aware of published maps. As a result of widespread design guidelines for flood and earthquake resistant structures now available, design professionals are being held to an increasingly high standard of care.

10. Do I have a claim against the individual who sold me the property for natural hazard damage? Perhaps. Again, this depends on what you bought, the circumstances, and the law of the jurisdiction. If you bought raw land and the seller had no reason to believe that the land was subject to natural hazards, the seller would probably not be liable. If he or she knew the land was subject to hazards and either lied to you about it or concealed information, he or she would be liable (fraud). If he or she knew the land might be subject to hazards and represented the land as suitable for "residences" or other purposes, he or she could be liable under a theory of "constructive fraud", or perhaps "implied warranty."

If you purchased a property with a finished house or other structure, seller liability would depend upon the age of the structure, its type, and the law of the jurisdiction. If it was an old structure constructed before flood maps or other evidence of hazards were available, the seller would not be liable unless he or she lied or concealed facts. On the other hand, if it was a new residential structure constructed by the seller after hazard information became available, he or she could be liable in an increasing number of jurisdictions under various theories of "implied warranty" or "implied habitablity". Your chances of recinding the sales contract or collecting damages would be even greater if the structure did not conform with floodplain zoning, earthquake resistance or other design standards in force at the time of construction.

11. Could I recover against my bank for failing to inform me of floodplain zoning restrictions or other hazards at the time they provided my mortgage? Unlikely. In general, banks are not responsible for assessing the condition of lands prior to a sale and sharing this information with purchasers. Federal appellate courts have held that the so-called Jones amendment to the National Flood Insurance Act which requires that federal and federally insured banks notify buyers if a property is in a FEMA designated and regulated floodplain does not create a private cause of action by mortgagees who are later flooded. But failure to notify could still be evidence in a private fraud action if the bank were financially involved with the developer or concealed information.

12. Do I have a claim against my city, town, village, county for failing to qualify for flood insurance program and, as a result, I cannot-purchase flood insurance? Probably not. However, a few states such as Minnesota have adopted statutes requiring communities to adopt regulations meeting the minimum standards of the flood insurance program. A community failing to adopt such standards would not meet statutory duties. Failure to comply with an express statutory duty could subject the community to liability. Even without such a statute, a court and/or jury might give weight to the community's failure to qualify for flood insurance in a suit against a municipality for negligence in operation of flood control works, etc.

13. Can I bring suit against my local government for approving a subdivision which increases flooding or other hazards on my lands? Perhaps. Courts in several jurisdic-

tions have allowed claims against governmental units for issuing permits or approving subdivisions plats with inadequate drainage. However, courts in other jurisdictions have held that approval of plans and plats is a discretionary function and does not subject a municipality to liability.

14. Can I recover damages from my municipality for having approved a variance for my property and this property later suffers natural hazard damages? Probably not. You are in a poor position to claim damages due to flooding or other natural hazards if they are caused wholly or in part by the variance you requested. On the other hand, if a prior owner requested this variance and it was illegally issued (did not conform to regulatory standards for a variance) you may have a claim. Similarly, if the community planning department negligently approved building plans or issued an occupancy permit for a structure not in conformance with floodplain regulations or other hazard reduction regulations you may have a cause of action.

## QUESTIONS OF GOVERNMENTAL ENTITIES

Many of the liability questions raised by disaster victims are also raised by governmental entities — the targets of many suits. Conversely, many of the constitutional questions raised by governmental entities are also of interest to landowners who wish to rebuild after a disaster.

1. Can our government unit enter private lands to carry out rescue and relief operations? Usually yes. Entry onto private land in emergencies has been sustained as a valid exercise of the police power.

However, such entry may not be valid if landowners specifically prohibit such entry (unusual) and public health or safety are not threatened. Government cannot permanently occupy private land after the disaster and is limited in its reconstruction activities without landowner permission. For example, a New Jersey court held that a government agency could not rebuild a dune on private land without landowner permission.

2. If our local government suffers flood damage, may it sue private landowners or other governmental entities which have aggravated such damages through grading, flood control measures, etc.? Probably yes. As public landowners, you are usually in the same position as private owners to sue other landowners or governments which may aggravate your damages. However, in some states, local governments, such as counties have no standing to sue the state since the local government is considered a part of the state.

3. Are we liable if private landowners are injured in evacuation, rescue or relief operations? You may be if such injuries are caused by municipal negligence. However, the injured party must show you acted negligently (i.e. unreasonably). What is reasonable in a time of great stress might be unreasonable at another time.

4. Are we, as a local government, liable to FEMA if we fail to enforce our floodplain regulations consistent with minimum standards of the flood insurance program and this failure results in increased flood insurance claims? Possibly. FEMA is now suing more than forty local governments based on various theories to recover for increased flood damages due to failure to administer or enforce flood plain regulations.

5. Can we adopt a moratoria to prevent rebuilding or reconstruction after a disaster? Yes, but there are limitations. Moratoria for relatively short periods of time have been adopted by many local governments pursuant to statutes specifically authorizing such moratoria or more general home rule or statutory zoning, subdivision control or building code powers. Courts have upheld moratoria for periods of six months to three years. Extensions have also been allowed in some instances. However, the moratoria must be of reasonable length for a valid purpose such as permitting your municipality to undertake more intensive data gathering and planning and to prepare more permanent regulations before rebuilding begins.

6. Can we upgrade zoning and other regulations after a disaster? Yes. But statutory procedures pertaining to regulatory amendments must be followed. In some instances, this requires written notification of affected landowners.

7. Can we require that unsafe buildings be razed after a disaster or ourselves raze such buildings in the event a landowner fails to do so? In general, yes. Courts have often held that governments can require abatement of nuisances or unsafe structures. However, structures must be nuisances in fact — not simply damaged. Although courts have sustained summary abatement procedures, they also examine them with care.

8. Can we prevent rebuilding in high risk areas without "taking" property? Perhaps. The answer to this depends upon the circumstances. Courts, in general, have held that regulations are a taking if they prevent all economic use of entire properties. An exception is where all economic uses are hazardous or cause nuisances. Courts have sustained very restrictive regulations where such restrictions are needed to protect public safety or prevent nuisances. A California court upheld open space zoning adopted for a portion of Klamath, California where buildings were destroyed by severe flooding. Similarly, a New Jersey court upheld a beach setback line for an area occupied by apartment buildings destroyed by a "Northeaster."

9. Can we require disclosure of hazards in the deeds of damaged properties? Maybe, depending on the circumstances and the law of the

jurisdiction. A local government can require that hazard areas be indicated on plats for new subdivisions and that these plats be recorded prior to sale. Whether the recording of hazard information could be required prior to the sale of individual lots without a subdivision or could be required as a condition to issuance of building permits is not so clear. State real estate laws often preempt local ordinances regulating real estate transactions. However a court might find ways to sustain a local recording requirement if it could be shown that such a requirement was necessary to prevent fraud or protect public safety.

10. Can we prohibit subdivision of high risk areas or require that prior to subdivision risks be reduced through levees, fill, retaining walls, etc.? In general, yes. Courts have uniformly upheld regulations prohibiting the subdivision of properties unsuitable for their intended purposes or posing threats to public safety. They have also uniformly upheld requirements that subdividers install drainage facilities or provide "fees in lieu" of such facilities if the requirements are reasonable and related to the needs of the subdivision.

11. Can we require that landowners tear down, repair or rebuild damaged or unsafe dams or levees after a disaster? Probably, yes. Such a requirement could be adopted pursuant to home rule or broad statutory powers of most cities and villages. However, at least one court has held that state laws pertaining to licensing and repair of dams preempted local regulations.

12. Should we regulate development in hazard prone areas now with possible resulting suits by unhappy developers or wait to regulate with possible claims by landowners when new construction is damaged by a later hazard event? In general, regulate now. Based upon existing trends in the law, there is a very low porbability of a successful claim of taking by a developer against your community now if you reasonably regulate. But there is quite high probability of a successful damage suit based upon negligence if no regulation occurs and hazard losses follow. Hazard-related regulations, particularly those of a performance-standard nature, have invariably been upheld. On the other hand, successful liability suits against municipalities by landowners damaged by inadequate drainage systems, inadequate warnings, etc. are increasing.

13. Can we reduce successful challenges to regulations? Yes. Measures to reduce the successful constitutional challenges to regulations include:

(1) Follow statutory procedures carefully in adopting, amending, and administering regulations. Provide ample notice and hearing. Careful involvement of affected property owners will help reduce future challenges to regulations on "due process" grounds.

(2) Document disaster losses through air photos, maps, etc. Such evidence is particularly persuasive before a court determining the reasonableness of regulations applied to an area.

(3) Prepare accurate hazard maps and keep the field notes and other background information in a form suitable for introduction in court. A solid data base can held support regulations against claims of unreasonableness or "taking".

(4) Apply a "performance standard" approach to rebuilding or new development where few economic uses remain for the land. Such an approach has been broadly upheld.

(5) Coordinate community regulatory, infrastructure, and real property tax policies. For example, if rebuilding is to be prohibited in an area, sewer and water assessments and tax policies need to be modified to reflect such restrictions.

14. Can we reduce potential municipal liability if a natural disaster again occurs? Yes. Your best way of reducing liability is by reducing future private damages. You will not be sued if individuals are not damaged. You can reduce liability in a number of ways:

(1) Map hazard areas to help guide future private development and public infrastructure repair, rebuilding, and new services.

(2) Require retrofitting and other damage-reduction measures in building repair.

(3) Prohibit rebuilding and new development in the highest risk areas.

(4) Adopt performance standards for rebuilding and new buildings in lower risk areas.

(5) Submit to your governing body important decisions with regard to mitigation measures such as the capacity of a storm sewer system (e.g., sufficient to accommodate a 5-year storm? 10-year storm? etc.). Once approved by the municipal body, such decisions are likely to be characterized by a court as "discretionary" and not subject to a liability.

(6) Qualify the community for national flood insurance (if this has not already been done). Also, encourage purchase of private insurance. Landowners damaged by a flood, earthquake, etc. are less likely to sue if their losses have already been compensated.

# Land Use Restrictions in Post-Hurricane Reconstruction Planning: Weathering the Storms of Constitutional Challenges

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## INTRODUCTION

The disastrous aftermath of a coastal storm offers a significant challenge to state and local officials charged with land use responsibilities. They can use the momentum of the experience to avoid recreation of the problems -- by control of the reconstruction process -- but they must do so in a manner which will withstand legal challenges. Proper advance planning and utilization of scientific and technological expertise can result in effective post-disaster reconstruction regulations which can remain in effect despite constitutional challenge.

## WHAT ARE SOME OF THE TOOLS FOR POST-DISASTER RECONSTRUCTION REGULATION?

A variety of regulatory measures can be used. Building codes can be upgraded to require deeper foundations, stronger bracing and tiedowns or higher construction elevations. Requiring the relocation of buildings further inland from the shore through increased oceanfront setbacks, can allow for dissipation of storm forces and for movement of the dune/beach system. If experience has proven there were too many people to evacuate safely, then an effort can be made to reduce the number of allowable dwelling units in rebuilding. The reuse of certain parcels for construction purposes might be deemed so unsafe or so consumptive of public resources (for infrastructure) that rebuilding of structures would not be allowed. To use an extreme example, the rebuilding of a house on a parcel permanently submerged offshore of a beach by an avulsive shoreline change can be prohibited.

Government might also choose to reduce its own exposure to future loss. Publicly owned structures and facilities can be redesigned, relocated or abandoned to reduce the costs of repair and avoid probable future losses. If, for example, the expense of rebuilding a destroyed bridge is excessive, considering use levels, available funds and the probability of recurring damage, it might be replaced by a ferry.

The scope of permissible objectives for regulation is very broad. The commonly accepted goals of coastal development regulation have been uniformly upheld by the courts. Protecting the safety of those who might occupy coastal structures or be struck by their debris or who would be endangered in rescue missions are well recognized, legitimate police power objectives.[1] Protecting the public health against the discharge of inadequately treated sewage is recognized as valid.[2] Aesthetics,[3] recreational access,[4] water quality,[5] fish and wildlife habitat[6] and the integrity of the beach/dune system[7] have all been treated as legitimate objectives in recent cases. Unitl the last decade, many of these objectives were not considered valid. The growth of scientific and technical data and its translation into popular understanding has led to he expansion of regulatory goals as legitimate and necessary.

States or communities that adopt post-hurricane regulations enjoy tremendous advantages in a court setting. The problem addressed by the regulations is not speculative or abstract: it has happened. The causes and results are clearly evident. If buildings failed because of inadequate foundations, the reasonableness of strengthened building codes is not likely to be even seriously questioned. The courts will not seek to second guess an expert determination that new setbacks should be 300 feet from the water rather than 100 feet.

Nevertheless, severe restrictions on future land use, and particularly prohibitions on rebuilding, may be carefully scrutinized, particularly if they have severe impact on landowners. The probability of a successful defense can be enhanced if constitutional considerations are taken into account in drafting and implementing post-hurricane reconstruction plans. The planning process should anticipate and prepare to counter legal challenges.

## BASIC CONSTITUTIONAL ISSUES

State and local authority over post-disaster reconstruction is based on the police power -- the inherent, sovereign authority, reserved to the states by the Constitution, to promote the public health, safety and welfare through regulation or other means. Balanced against this reservation of public power are various individual rights and liberties guaranteed by amendments to the Constitution. Of primary relevance are the rights of due process

and equal protection and the prohibition against "taking" private property.

Due process and equal protection are guaranteed by the Fourteenth Amendment. Due process requires that an exercise of the police power be properly authorized by enabling statutes and procedurally fair. Of more substantive importance, due process requires that the exercise of power bear a reasonable relationship to the attainment of valid governmental objectives.[8] Equal protection analysis is similar, requiring that all classifications of persons be rationally based.[9]

The Fifth Amendment provides "nor shall private property be taken for public use, without just compensation." Although intended to prevent uncompensated seizures of title or of physical possession, the Supreme Court has interpreted the clause to prohibit police power actions that have an equivalent effect.[10]

Basic tests for due process in land use cases require that the means chosen for implementation be reasonably necessary to accomplishment of the purpose.[11] They must bear "a real and substantial relation to the object sought to be attained."[12]

Because the reasonableness of an ordinance can only be evaluated after considering a broad range of factors, the courts have not developed and probably cannot articulate specific criteria for defining the limits of substantive due process. Determination is made on a case-by-case basis by reference to the facts and circumstances of the situation. What is reasonable for one situation may well be unreasonable in another.

## Meeting the "Reasonableness" and "Rational Relationship" Tests

Regulations based on well accepted technical principles are most likely to be accepted by the courts. Courts are not likely to second-guess expert opinion, but without it, they will more closely scrutinize regulations. The following three cases illustrate this.

In Indialantic v. McNulty,[13] the property in question was located between a road and the Atlantic Ocean. The town had established a regulatory dune line running approximately 20 feet seaward of the road and required residences to be set back 25 feet landward of the line. Building was thus effectively prohibited. The owner sought a variance to construct a house on stilts over the dune which was denied.

The opinion of Florida's Fifth District is exceptionally well reasoned. In utilizing the applicable legal principles, the court considered the important natural resources functions of the dune system: stabilizing the beach and protecting life and property from erosion and storm surge. In addition, the dune system is a hazardous location for building. As the court stated:[14]

> There can no longer be any question that the "police power" may be exercised to protect and preserve the environment .... The wetlands and coastal areas are places of critical concern because of their important role in protecting the inland regions against flooding and storm danger. The ordinance in this case passes constitutional muster because it was not shown to be in any way arbitrary or discriminatory, or more severe or strict than necessary to achieve a valid police power purpose.

Where the reasonableness of an approach is not well documented, however, particularly where substantial interference with use of property results, the courts have been willing to invalidate regulation.

In City of Boca Raton v. Boca Villas Corp.,[15] the citizenry established by initiative and referendum a 40,000 unit cap for the entire city. A property owner sued, claiming there was no rational relationship between the density cap and a permissible municipal purpose.

The court agreed, noting that the city planning department had never been consulted on the need for the cap. The court also found it significant that the director of the planning department testified that other than "community choice" he knew of no compelling reason for imposing a permanent fixed limitation on population or dwelling units.[16] Finally, the court considered the relationship of the cap to such aspects of community welfare as utility services, schools, fiscal soundness, water resources, air quality, noise levels and comprehensive planning. In each case, the court found the evidence inadequate to show that the cap promoted that aspect of community welfare.[17]

In a more recent case, however, another coastal community was able to prove a rational relationship between a density cap and the health, safety, and welfare of the people. In City of Hollywood v. Hollywood, Inc.,[18] Florida's Fourth District Court of Appeal again decided the validity of a cap. In that case, the City of Hollywood placed a 3,000 unit cap on an area adjacent to the Atlantic Ocean, which was held reasonable because it was based on rational consideration and study:[19]

> A multitude of factors was taken into consideration over and above traffic. Water and sewer capacities were measured as was the provision of services such as fire and police protection. The questions of how to evacuate the residents in a hurricane with only two possible escape routes to the mainland, one at each end, was also considered concomitantly with maintenance of the dune line to protect against storm ravage. The fact that this, as the developer admitted, "is the last undeveloped beach area on the Gold Coast," is filled with desirable rare flora, is ecologically sensitive and crying out for environmental

> protection, is in desperate need of open space and easy public access to the ocean, were all addressed and considered in agonizing detail .... The question of shadow on the public beach from these proposed monolithic structures was also addressed .... Last but not least, the record shows that much thought was given to aesthetics ... The record is replete with comprehensive plans, studies, reports, public meetings and actual discussions with the developer over a period of years. Unlike the Boca Raton case, the City of Hollywood did not present its community purpose in the abstract, but presented a more than adequate case for the proposition that the proposed cap would contribute substantially to the public health, morals, safety and welfare of its citizens.

The quality of study and of documentation was an important factor distinguishing the two cases. There is little doubt that police power action to prevent recurrence of a disaster will receive sympathetic judicial review. But significant levels of interference with future use receive stricter scrutiny in the balancing process and their reasonableness should be supported by thorough, detailed study.

Considerations of public policy are important. The courts are, in essence, balancing two conflicting interests: the right of the public to protect social and environmental interests and the needs of landowners. To determine whether an ordinance is reasonable, the courts must weigh the strength of public interest factors supporting the regulation. A court's perception of the public interest will depend on its understanding of the facts of the case and of how the development at issue fits into larger patterns of land and water use.

## Avoiding Conflict with the Fifth Amendment:

## Restrictions That Are Takings

The taking of private property is obviously to be avoided; it will result in invalidation of the regulation or the requirement of compensation to the landowner, which may be prohibitory. As with the determination of reasonableness, however, no clear test has emerged from hundreds of taking cases as to when regulation or other police power action takes private property. Determination depends upon the specific facts and circumstances of each particular case. Most opinions reflect a balancing of the factors and the use of several tests.

The taking clause was enacted to prevent government from acquiring unjustified benefits. Many cases have held that it does not prohibit the government from preventing harm.[20] The distinction between prevention of harm and acquisition of benefits is important in taking cases. There is a long tradition of using the police power to prevent nuisance-like or otherwise harmful effects. The abatement of hazards to life and property, unsanitary conditions, beach erosion or impediments to the public use of public beaches would arguably fall within the scope of permissible regulation despite the loss of expected profits by an affected landowner.

The effect of regulation on the monetary value of property is a major factor in takings analysis. Decisions invalidating land use regulations as taking have done so primarily because property values were too severely affected. The law is clear, however, that diminution in the value of regulated property does not, in and of itself, establish a taking.[21] It is only one factor to be considered by the courts. Numerous decisions have sustained stringent regulations against taking challenges even though property values were very substantially reduced. [22]

From another perspective, the courts look to whether any value or practical use remains for the parcel. A taking occurs only when there has been a virtual destruction of the property interest. If the potential exists for the owner to make some reasonable use of the regulated property, then no taking will be found.[23] Recent versions of this test require consideration of whether the government action results in a loss of economically viable use of the property[24] or whether it forecloses all reasonable investment backed expectations. [25]

The courts have incorporated several important qualifications in takings theory. An entire parcel is examined, not just the portion subject to the greatest restrictions. [26] In examining land subject to oceanfront setbacks, for example, the remaining value and usefulness of the entire lot is considered. Assuming valuable economic uses are left to the remainder, a taking is unlikely to be found.

But what about the situation where application of the necessary setbacks results in a lot with no remaining buildable portions? The owner is likely to argue loss of reasonable use or of all reasonable investment backed expectations. An appropriate response is that it is not reasonable to build in a dangerous location. [27] Further, one has no legitimate expectation of being able to rebuild or otherwise use property if to do so would threaten harm to the property of others or to public resources.[28] Denial of an unreasonable use is not a taking.

In Spiegle v. Borough of Beach Haven,[29] the application of a dune protection setback to several lots was challenged as a taking. There was a prohibition against building residences seaward of the setback line. The court looked at the circumstances of each lot individually. On one lot, the court found that it was feasible to build a residence and held it was a taking to deny that use. As to the other lots, there was no taking: [30]

> Our review of the evidence as to the physical characteristics of this tract and the hazardous conditions to which it might

> be subjected because of its location satisfied us that although it may be possible from a strictly engineering standpoint to erect a residential structure on the site with supporting utilities, it would not be safe ot economically feasible to do so from a common sense standpoint. As with any health or safety regulation, the interest of one property owner must be subjected to some degree to the welfare of the general public. Weighing the interest of the property owner against that of the public, we are satisfied that this tract has no present beneficial use for residential construction, absent an outlay of money out of all reasonable proportion to the use to be derived from it and the imposition of an unreasonable hazard on the public. We conclude that plaintiffs are entitled to no compensation as to this property.

A similar type of restriction, prohibiting building in the floodway of the Klamath River, was upheld in Turner v. County of Del Norte.[31] There was evidence of previous flooding and that if buildings were constructed they would likely be destroyed, endangering their occupants and owners of other property. Rejecting a claim of taking, the court noted the ordinance "imposes no restrictions more stringent than the existing danger damands." [32]

## APPLICATION OF LEGAL PRINCIPLES TO PRACTICAL PLANNING OBJECTIVES

The balancing of public and private interests inherent in constitutional analysis of police power action is somewhat subjective. The results of litigation are therefore difficult to predict. The following suggestions result from an analysis of the current legal standards and basic constitutional issues as applied to planning goals:

1. Leave open the possibility of development. Rather than prohibit reconstruction, impose performance standards and restrictive criteria that are sufficient to protect the public interests. The denial of an application for one proposal does not foreclose the possibility of a future approval made possible through changes in design or improvements in technology.

2. Attempt to accommodate development on at least portions of each parcel. Although it may not always be possible to allow reconstruction and attain planning objectives, owner's needs should be carefully considered.

3. Offer the owner incentives for compliance with the plan. An opportunity to transfer or sell density credits may be an appropriate incentive or may serve as mitigation of financial impacts for the owner. If purchase is considered, be aware that saying or writing anything that can be construed as an underlying intent to reduce the costs of acquiring the property for use as a public park, can be used as evidence against the regulation.

4. Base the plan on the best available technical information. Plan comprehensively, relating individual cases to larger issues and objectives. Here, the role of the scientist or planner is most critical. Not only should the best possible plan be developed, but it must be well substantiated.

The magnitude of problems addressed by the plan should be well documented. Preparations should be made in advance to gather information on the effects of the storm that triggers implementation of a reconstruction plan. The consideration of less restrictive alternatives should also be documented. Remember that someday these documents may need to be introduced as evidence in court in support of the plan.

5. Summarize the data and conclusions in clear, concise language that any lay person can understand. Use photographs, drawings, maps and other illustrations. The plan should be popularized and communicated to the general public to the greatest extent possible. A plan that is widely understood and supported is likely to be upheld. Good facts make good law.

## FOOTNOTES

1. Turnpike Realty Company v. Town of Dedham, 284 N.E.2d 891 (Mass. 1972).

2. Milardo v. Coastal Resources Management Council of Rhode Island, 434 A.2d 266 (R.I. 1981).

3. City of Hollywood v. Hollywood, Inc., 432 So.2d 1332 (Fla. 4th DCA, 1983).

4. Sea Ranch Ass'n v. California Coastal Commission, 527 F. Supp. 390, 395 (N.D. Cal. 1981).

5. City of Annapolis v. Annapolis Waterfront Co., 396 A.2d 1080 (Md. App. 1979).

6. Potomac Sand and Gravel Co. v. Governor of Maryland, 266 Md. 358, 293 A.2d 241 (1972).

7. Indialantic v. McNulty, 400 So.2d 1227 (Fla. 5th DCA, 1981).

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

9. See, J.M. Mills, Inc. v. Murphy, 352 A.2d 661, 668 (R.I. 1976); Sands Point Harbor, Inc. v. Sullivan, 136 N.J. Super 436, 346 A.2d 612 (1975); Responsible Citizens v. City of Asheville, 302 S.E.2d 204 (N.C. 1983).

10. Pennsylvania Coal Co. v. Mahon, 260 U.S. 393, (1922).

11. Goldblatt v. Town of Hempstead, 369 U.S. 590, 594 (1962).

12. Nebbia v. New York, 291 U.S. 502, 524 (1934).

13. 400 So.2d 1227 (Fla. 5th DCA, 1981).

14. Id. at 1232.

15. 371 So.2d 154 (Fla. 4th DCA, 1979).

16. Id. at 155.

17. Id. at 156-157.

18. 432 So.2d 1332 9 Fla. 4th DCA, 1983).

19. Id. at 1334-1336.

20. Graham v. Estuary Properties, Inc., 399 So.2d 1374 (Fla. 1981).

21. Penn Central Transportation Co. v. New York City, 438 U.S. 104, 131 (1978).

22. In Euclid v. Ambler Realty Co., 272 U.S. 365 (1926), zoning was upheld despite a 75 percent diminution of value. The owner of the regulated brickworks in Hadacheck v. Sebastian, 239 U.S. 394 (1915), sustained a 93 percent loss in the value of his property (from $800,000 to $60,000), yet the regulation was sustained. The practical effect of Goldblatt v. Town of Hampstead, 369 U.S. 590 (1962), was to prohibit further operation of a rock and gravel mine. Finally, in Miller v. Schoene, 276 U.S. 272 (1928), the regulated property, cedar trees, was completely destroyed.

23. See, Moskow v. Commissioner of the Dept. of Environmental Management, 427 N.E.2d 750 (Mass. 1981); Loveladies Harbor, Inc. v. Dept. of Environmental Protection, 176 N.J. Super. 69, 422 A.2d 107 (N.J. Super. Ct. App. Div. 1980).

24. Agins v. City of Tiburon, 447 U.S. 255 (1980).

25. Penn Central Transportation Co. v. New York City, 438 U.S. 104 (1978).

26. Graham v. Estuary Properties, Inc., 399 So.2d 1374 (Fla. 1981).

27. See, Spiegle v. Borough of Beach Haven, 281 A.2d 377 (N.J. App. 1971); Turner v. County of Del Norte, 24 Cal. App.2d 311, 101 Cal. Rptr. 93 (Cal. App. 1972).

28. Just v. Marinette County, 56 Wis.2d 7, 201, N.Q.2d 761 (1972).

29. 281 A.2d 377 (N.J. App. 1971).

30. Id. at 387.

31. 24 Cal. App. 2d 311, 101 Cal. Rptr. 93 (Cal. App. 1972).

32. Id.

# CHAPTER FOURTEEN
# *TRAINING AND EDUCATION*

Inadequate training and dissemination of information is not confined to developing nations or rural areas of the U.S. with small numbers of experts. In a developed nation such as the U.S., the extent and seriousness of hazard events are often discounted or forgotten by area occupants in both large city and rural settings and may be unknown to new landowners or residents. Manuals, guidebooks and other sources of information concerning hazard mitigation options which are available after a disaster are often lost or misplaced as the memory of the disaster wanes.

Dissemination of hazard information on a long term basis is not easy. Decision-makers come from many sectors both within and outside of the hazard area: landowners, bankers, local government officials, architects, engineers, etc. Many have little interest as well as expertise in mitigation.

Various post-disaster and pre-disaster training and education approaches have been applied in developed and developing nations. The most common include dissemination of written materials; one-on-one discussions with landowners and contractors; workshops; and demonstration of projects.

This chapter examines post-disaster education. The first paper by Donald Schramm, discusses "distant learning" approaches.

Next, Mary Ellen Williams discusses the U.S. Geological Survey's international training program for geologic and hydrologic hazards.

The chapter concludes with a paper by Donald Geis describing the American Institute of Architects Latin American workshops on natural hazard protection design.

# The U.S. Geological Survey's Training Program in Geologic and Hydrologic Hazards for International Participants

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## INTRODUCTION

The U.S. Geological Survey (USGS) has been involved with the transfer of geoscience expertise to the foreign community for more than 40 years. Through a variety of programs sponsored by the Department of State, foreign governments, and international organizations, scientists have provided training in-country and at facilities in the U.S. either in workshops or seminars, or on-the-job. In keeping with this tradition, the Geological Survey developed a scheduled training course in Geologic and Hydrologic Hazards. The purpose of this training program was to develop hazard-abatement expertise in order to save lives and reduce economic losses in countries where geologic and hydrologic hazards are prevalent.

## DEVELOPMENT OF COURSE

With the concurrence of the Agency for International Development's Office of Foreign Disaster Assistance (AID/OFDA), a cable was sent to diplomatic posts announcing the proposed course and requesting indications of interest. An interest questionnaire was also circulated overseas by the Office of International Geology, USGS. Responses were included in a proposal presented to AID/OFDA in December 1982. The proposal was favorably received and an agreement signed by AID/OFDA and the USGS in February 1983.

Between January 1 and March 1, 1983, two drafts of a course syllabus were prepared and circulated for comments in the various USGS Divisions as well as among Regional Coordinators in the Office of International Geology. Three scientific teams were organized who would travel to specified regions of the world. Specialists on each team included the following disciplines: seismology, volcanology, engineering geology, and hydrology.

Countries were selected for team visits in each of three regions: Europe/Near East, Eastern Asia, and Latin America. Cables were sent to each Embassy to arrange for briefings. These prearranged briefings were to include high level officials as well as scientists at the technical level. It would be an opportunity to explain the program, to make contacts with those working in the hazard-abatement efforts, and to identify potential candidates for the course.

The first of the three teams left in August for the Philippines, Thailand, Burma, Nepal, and Bangladesh. The second team visited Algeria, Portugal, Spain, Italy, Greece, Yugoslavia, and Turkey in September and October. The third team left late in September for Latin American giving briefings in Costa Rica, Ecuador, Chile, Peru, Argentina, Paraguay, Uruguay, and Bolivia.

The Embassies cabled assessments of the briefings. In msot cases the meetings were well-attended, very well-received, and generated considerable interest in the hazards training program.

Upon return of the teams, an evaluation meeting was held in Reston in October 1983. During that meeting, team leaders presented overall team assessments and participant slots were allocated to countries. A number of suggestions for improvement and expansion of the program were discussed.

During November and December 1983, the course participant selection was underway and the lecturers identified. By early February 1984 participant acceptances had, for the most part, been confirmed by the Embassies and the lecture schedule circulated. Lecturers received a letter outlining requirements for preparing course notes and the format for the open file report. Bibliographies and USGS publications were assembled for distribution at the course.

## THE GEOLOGIC AND HYDROLOGIC TRAINING COURSE

### DENVER, CO MARCH 5-30, 1984

### Participants and Observers

All 42 invited candidates accepted the invitation and attended for the entire training session. Thirty-one were funded by OFDA; eleven were funded from other sources including UNESCO. The participants represented 28 countries from the three regions of the world visited by the scientific teams.

The participants were a carefully selected group. Team members and leaders established a pool of potential candidates based on their being at a high enough technical level to be able to interact and be a part of hazard program development in their country. Also

required would be sufficient knowledge of English to enable them to comprehend and interact. Team leaders submitted these names to the Project Chief who established a balance by region and discipline. OFDA also suggested candidates. The participants were from diverse backgrounds (seismology, engineering, volcanology, hydrology, emergency management), but at a high enough technical level to profit from the multidisciplinary approach and comprehend wider hazard problems. The participants worked very diligently as individuals and over the month developed cohesiveness as a group.

## Lecturers

The course syllabus was organized through the efforts of four discipline coordinators. Discipline coordinators were charged with determining the content of their portion and obtaining a commitment from would-be lecturers. If a particular subject was not within the area of expertise of the USGS, outside experts were invited to participate in order to complete the coverage. All lectures were to be incorporated in a USGS Open-File Report and available in the fall of 1984.

Over half of the 50 lecturers were U.S. Geological Survey employees from the three regions in the U.S. FEMA provided eight lecturers to cover the hazard-response portion. There were five international speakers invited with hazard expertise from various regions of the world. There were also five speakers from NOAA, and the USDA Forest Service and four consultants from the private sector.

Participants wanted more time to visit with lecturers in their offices or in small conferences elsewhere. One group of four lecturers was particularly effective at presenting a three-day module of lectures and discussions. They solicited lectures from four participants prior to their arrival in Denver. They held conferences on breaks and after class at their Denver offices. They worked on problems of mutual interest as a cohesive group. This was followed up by a field trip.

## Field Trips

The four field trips that were to follow the month-long course were announced the first week of the course. These trips, which would vary in length, were offered to Mt. St. Helens, the landslides areas south of San Francisco, the Albuquerque Seismological Laboratory, and agencies in the Washington, D.C. area that are concerned with emergency management. Thirty-three participated in the field trips; seven at Mt. St. Helens, six in Albuquerque, nine in San Francisco, and eleven in the Washington, D.C. area. All field trips were completed by April 5, the Washington, D.C. trip being of longest duration.

The seven who went to Mt. St. Helens had good weather and were able to have an overflight of the volcano as well as a field trip to surrounding areas. The weather held for the landslide trip south of San Francisco where nine participants observed a half-a-dozen landslides in the fault area. The Albuquerque Seismological Laboratory was visited by six with seismology interests. The eleven who went to Washington, D.C. spent four days visiting seven agencies (USGS, OAS, NOAA, FEMA and its associated Federal Emergency Management Agency, AID/OFDA, and the American Institute of Architects Foundation).

## SUMMARY

Several evaluations of the course were made, one by Susan Tubbesing (Natural Hazards Research and Applications Information Center, University of Colorado, Boulder), Training Section, Office of International Geology, USGS, and Stephen Bender, who attended as an observer from the Organization of American States. The evaluations support the concept of formalized, scheduled training either in the U.S. or overseas. The caliber of information provided at the course was generally considered to be excellent; some participants felt it was perhaps too technical. The overall concept of studying several interrelated hazards in one course was considered to be of value. Attendees felt they had gained a greater knowledge of these disciplines, how they may be integrated on a regional or global basis, and how they could be utilized in hazard mitigation techniques in their particular countries.

# Post-Disaster Education and Training: Innovations in Distance Learning

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## INTRODUCTION

Building on a history of work in distance teaching, the University of Wisconsin-Extension (UWEX), in 1982, created the Disaster Management Center as part of its Department of Engineering and Applied Science. With initial development funding from the Office of Foreign Disaster Assistance (OFDA) of the U.S. Agency for International Development (USAID), a group of world experts in disaster management met in Madison, Wisconsin in November 1982. This International Advisory Board was given the task of defining the education problems in disaster management, identifying course topics and suggesting textual materials and individuals who could address those topics. Fifty-five courses were identified and preliminary course outlines were prepared by the Board.

The Board's mandate to the Disaster Management Center (DMC) was to develop courses in a distance education format. The courses were to focus on the technical information needed for the complex situation that exists at the time of a disaster and during the recovery period. Education to mitigate against future disasters was a parallel focus. All courses were to be oriented toward a Third World situation (UWEX, 1982, p.2).

Disaster Management has a variety of meanings. Disaster management includes the relief that follows the occurrence of an earthquake, hurricane or flood and the longer term reconstruction that rebuilds community systems and individual lives in the months following a natural disaster. Comprehensive disaster management includes activities in preparedness, predisaster strategies to mitigate against a disaster's impacts in hazard prone areas and to lessen the casualties to life and property. Comprehensive disaster management also includes activities in risk reduction--the longer term, larger scale policy decisions that can prevent or diminish the disaster's impact. Education and training in all phases of disaster management are the key to successful mitigation of impact and effectiveness of response.

Information comes from various sources on all phases of disaster management activities. International and local disaster relief organizations have documented past work. University research centers have studied many aspects of disaster impact. Journals disseminate disaster facts and experienced disaster professionals share individual and collective insights about disaster response. As in many fields, there is a wealth of disaster management information but few effective ways to get that information to people in the field who need it. That is a role for distance education.

To understand the evolution of distance teaching into this new multinational role in continuing professional education, it is useful to look at some definitions of "distance education" and a few historical precedents.

## A LOOK AT DISTANCE EDUCATION

Distance education is a generic term that includes a range of teaching and learning strategies variously referred to as correspondence education or correspondence study in both developed and developing countries. Examples include: home study or independent study in the U.S.; external studies in Australia; teleenseignment in France; Fernstudium or Fernunterricht in Germany; educacion a distancia or ensenanza a distancia in Spanish-speaking countries; and teleducacao in parts of the world where Portuguese is spoken. Distance education can be contrasted with traditional forms of education where teacher and students are in a classroom lecture or laboratory situation (Keegan and Rumble, 1982, p.11-12).

The basic distinction between traditional and distance education is a teacher/student separation. That separation can be in time or in space; it can be physical or psychological. Other elements of a distance education program are: 1) the use of educational planning principles through some organized educational institution; 2) the use of technical media, usually print, to transmit the educational content of a course; and, 3) the provision of two-way communication and dialogue between teacher and learner (Keegan and Rumble, 1982, p.33). There will always be an element of communication, a dialogue at some point, between teacher and learner in the distance education process. Distance education, or independent learning, is studying on your own within an established context. It is not the complete independence of teach-yourself-books or educational broadcasting, where the element of two-way communication is absent.

## International Distance Education

Throughout the world, distance education methods have been used at technical and vocational levels for more than 130 years and in higher education for more than 100 years.

Examples of current distance education institutions abound. In the United Kingdom there is the British Open University, begun in 1970 and the University of London with its external degree students. University level distance education is available in Australia from five universities and in New Zealand from two institutions. In the USSR, there are 11 distance teaching universities which enrolled 2.2 million people in non-resident university courses in 1979 (Keegan and Rumble, 1982, p.20).

Other examples exist throughout the world. Canadian distance education at the University level was initiated at Queens University in Kingston, Ontario in 1889. Today, 20 Canadian universities have distance education departments. In France, 18 French universities have centres de tele-enseignment universitaire (CTU), whose enrollment in 1980 was 15,000. In India, correspondence directorates exist in 23 universities and other institutions if higher education. In Columbia, the University of Antioquia and the Javeriana University both provide educacion a distancia (Keegan and Rumble, 1982, p.23).

## Distance Learning in the U.S.

Correspondence education in the U.S. began at Illinois Wesleyan University in 1874. In 1883, the Correspondence University was formed in Ithaca, New York, based principally on the Chautaqua movement (an educational idea started as a summer camp for Sunday School teachers) and the experience at Illinois Wesleyan.

The "Father" of American correspondence teaching and the person most responsible for its acceptance as a learning method was William Rainey Harper. In 1890, Harper organized and became the first President of the University of Chicago. He incorporated a Correspondence Study department as part of University Extension (DeCrow, 1971, p.2).

From 1891, correspondence courses were offered at the University of Wisconsin. However, they were not formally organized until W. H. Lighty was named head of the Home Study Department in 1906. For Lighty, the University had a dual role of helping the individual to adjust to change and fostering change itself. This idea also led to his experiments with the use of radio and the idea of organizing classes in factories.

During the first quarter of this century in the United States, approximately 39 universities organized correspondence study programs. Following Wisconsin were the University of Oregon (1907), University of Kansas (1909), University of Nebraska (1909), University of Texas (1909), University of Missouri (1910) and University of North Dakota (1910). Three more universities started programs in 1912 and 16 followed in 1919. (DeCrow, 1972, p.4).

## Delivery Media for Distance Learning

There is a variety of learning media available for distance education. In any distance learning situation, the selection of media to deliver instructional materials will be based on low cost, simplicity, accessibility and availability to produce the desired learning results.

The range of educational media include television (in its various forms including video-tape and video-disk), computer-aided instruction, telephone, radio, and satellite-delivered educational programs. However, given the situation most likely to be encountered in the developing world, two traditional means for distance education are probably the most effective: audio formats and the printed word. (Feasly, 1983, p.22).

## THE WISCONSIN DISASTER MANAGEMENT CENTER

Over the past five decades, the University of Wisconsin-Extension (UWEX) has worked in continuing professional education in engineering, health sciences and business, in addition to its traditional role in agriculture. The Department of Engineering and Applied Science annually conducts hundreds of seminars and short courses for engineers, scientists, architects, and industrial managers. The Management Institute offers an equivalent number of workshops, seminars and conferences for professional managers at all levels, from first line supervisors to top executives in government and business. In Health Services, additional hundreds of continuing professional education programs are offered in Medical Education, Nursing, Pharmacy, plus Health and Human Service Administration.

## A New Idea

The Disaster Management Center (DMC) began in November 1982 with the convening of an International Advisory Board of disaster experts. Membership on the Board includes representatives of disaster-related groups from Australia, Belgium, China, Colombia, Ethiopia, Great Britain, India, Jamaica, Philippines, Switzerland and the United States. The Board guides course development and advises on the establishment of professional standards for a Disaster Management Diploma (which can also be the foundation for a Professional Development Degree in Engineering).

The Disaster Management Center, with the assistance of individuals and agencies experienced in disaster management, is developing a series of self-study courses in the areas of

disaster preparedness, mitigation, and response. More than 55 new courses were identified and outlined by the Advisory Board. This series of courses has two basic directions: individual courses for developing expertise in specific areas and a Diploma Program in Disaster Management, for a broader knowledge base.

## Course Development

Courses are developed as a joint effort between technical experts with field experience and disaster management and educators with experience in continuing professional education and distance teaching. Preliminary course outlines prepared by the Advisory Board are first expanded at the University by educational editors using materials suggested by the Board. These more detailed outlines are then reviewed by a small group (2-4) of disaster technical experts. Based on this expert review process, a final outline is prepared by a technical editor, who may be one of the expert reviewers.

With this outline in hand, course text materials are either selected from existing publications or prepared by the technical editor. At the materials are collected or prepared, learning objectives are determined for the entire course. Key questions suitable for testing a student's progress are also noted.

Once the materials are complete, they are reviewed again by the original expert panel. Wherever outside agencies have funded course development, materials are also reviewed by them at this point. Following the incorporation of comments from all reviewers, the course materials are sent to the University for development of the Course Study Guide.

The Study Guide is used to take a student through the course text and other technical materials. Learning objectives are refined and the materials are broken into suitable individual lessons, designed to take 1-2 hours reading time. Self-Assessment Tests are prepared from the list of key questions for each lesson. In addition, a Pre-Test is designed to test the student's level of knowledge before starting the self-study program. All these materials are designed for student self-evaluation of progress without instructor-student contact.

Finally, to measure the student's learning on completion of self-study, a Final Examination Package is prepared. The student requests this package on completion of self-study. This is an open-book examination and combines objective questions with a subjective, Disaster Development Problem, which asks the student to apply knowledge to a situation and select from alternative courses of action.

These Study Guide and Final Examination materials are reviewed technically and academically before being published. Technical reviewers include a representative from the DMC Advisory Board and academic reviewers include UWEX-Independent Study Program representatives. Wherever possible, courses are also evaluated by potential students for content and ease of use.

## An Audience

People who have worked in disaster preparedness, mitigation or response understand the unique context of disasters. Individuals or agencies coming into disaster management for the first time need to develop that understanding.

The disaster management audience includes any development agency personnel assigned responsibility for hazard-prone areas. International, national and regional organizations (public and private) involved in health, engineering, and public administration are members of that audience. Members of voluntary agencies, local and international, are another key group.

## An Educational Process

The primary emphasis of the Disaster Management program is on worker training to increase the professional standards in the field, at all levels. The Diploma will be offered as an incentive for those students who desire some recognized certification for job purposes and/or for their personal professional development.

At the simplest level, a student will complete a course, take the exam, and if successfully passed, receive a certificate of completion.

At the next level, a student will complete a grouping of courses in a particular area (e.g., health and nutrition) and receive a letter of commendation indicating the specialized series of courses completed.

The final level is the Disaster Management Diploma. A student's program will consist of courses in one of two options: Natural Disasters or Refugee and Displaced Persons. To obtain the Disaster Management Diploma, students will be required to complete required core courses in Management, the required core courses in the option selected, and a number of electives in their area of interest. Students must pass examinations in all courses taken and prepare an Independent Study Project.

## FINANCES AND THE FUTURE

In 1985, the first self-study modules are available. Course development was funded by organizations interested in disaster management. In addition to direct funding from the University of Wisconsin, financial assistance from three organizations has been vital to early program development: Office of Foreign Disaster Assistance, U.S. Agency for Interna-

tional Development; the Office of Emergency Preparedness and Disaster Relief, Pan American Health Organization; and the Bureau of Refugee Programs, U.S. Department of State.

Course development will continue to be externally funded with UWEX picking up costs for course administration. The Disaster Management Center program in distance education is planned to be self-supporting from student fees after it has been established several years.

Experience has shown that in this type of continuing professional education effort a collaboration of university faculty and those with technical field experience is critical. Those involved in a technical field (like disaster management) on a routine basis understand the needs and limitations of technical information based on their experience. Those involved in education on a daily basis can establish the frameworks within which material prepared by technical experts can be transferred to distance learners.

There is a final important lesson to remember in international distance education. Educational tools developed in one country or culture may not always be completely applicable to another country or culture. Distance learning strategies provide an educational tool with the greatest latitude for modification on a country-by-country or culture-by-culture basis.

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# The American Institute of Architects Latin American Workshops on Natural Hazard Protection Design: Accomplishments and Recommendations

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## INTRODUCTION

Damage caused by natural disasters in the Americas continues to increase at an alarming rate. Most of this damage occurs to elements of the built environment, notably buildings.

Each disaster, whether caused by an earthquake, flooding, or other natural hazard, brings stark evidence that the way in which a building is designed determines in large part how it performs under the forces imposed by natural hazards. It is therefore essential that building designs incorporate features to resist these forces.

In the building design process the architect is usually the team leader, both organizationally and contractually. As such, the architect plays the major role in determining a building's site plan, shape, form, configuration, interior layout, basic structural system, materials, nonstructural systems and components, and basic mechanical and electrical systems. These decisions directly determine whether the building will perform successfully when a hazard strikes.

For architects to be able to maximize their efforts in this regard, they must first be made aware of their responsibility for incorporating hazards resistance into their building designs. Second, they must have knowledge of the specific design technologies and techniques required to do so. The challenge posed by needed improvements in hazards-resistant design is thus two-fold: to raise architects' awareness and to transfer needed technology.

While individual architects are ultimately responsible for the design of a nation's buildings, a nation's architectural association provides the communication and support network for the profession as a whole. Individual architects rely on their professional associations to provide needed information on new design techniques and authoritative policy direction concerning architects' responsibilities in the design process. For these reasons architectural associations can be extremely effective mechanisms for improving hazard-resistant design. For example, virtually all architectural associations in the United States, Latin America, and the Caribbean emphasize design workshops and seminars as forms of continuing education to keep their members abreast of new idea or to expose them to areas of knowledge not included in architectural school curricula. Architectural associations also support strongly the use of licensing requirements to ensure that their members are professionally competent. In Latin America and the Caribbean, moreover, most architectural associations are affiliated with universities and can directly influence the content of architectural school curricula. These long-standing architectural association roles offer established mechanisms for increasing the use of effective hazards-resistant design techniques among both currently practicing architects and future architects now in school.

In 1982 The American Institute of Architects (AIA), through its nonprofit research arm, the AIA Foundation, initiated a program with support from the Office of U.S. Foreign Disaster Assistance to raise awareness of the importance of hazards-resistant design among architectural associations in the Americas and to begin the process of transferring knowledge of hazards-resistant design techniques. The primary components of this effort thus far have been two workshops - in Lima in February 1983 and in Antigua, Guatemala, in February 1984 - held to achieve a consensus on how the program can best proceed. The workshops were attended by the presidents of the architectural associations in the following countries:

| | |
|---|---|
| Argentina** | Honduras** |
| Bahamas** | Jamaica** |
| Barbados** | Mexico* |
| Bolivia** | Nicaragua* |
| Brazil** | Panama* |
| Chile* | Paraguay** |
| Colombia* | Peru* |
| Dominican Republic** | Trinidad & Tobago** |
| Ecuador* | United States*,** |
| El Salvador* | Uruguay** |
| Guatemala* | Venezuela* |

* Lima, February, 1983
** Antigua, Guatemala, February, 1984

In addition, each workshop was attended by Arq. Juan Jose Casal Rocco, president of the Panamerican Federation of Architects' Associations (FPAA) and vice president of the International Union of Architects.

Although all buildings should be designed

to withstand natural hazards, the inherent limitations on what the workshops could effectively accomplish led to an emphasis on major public and private buildings -- those primarily designed by architects. There were two important reasons for concentrating on this building type, which includes hospitals, schools, public safety, and community buildings as well as churches and larger private buildings such as office, retail, industrial and apartment buildings. First, a disproportionate amount of damage and loss of life can occur in these buildings. In the 1967 Caracas, Venezuela, earthquake, for example, 20 small residential buildings and five major, multistory buildings collapsed. Of the 266 deaths occurring in this earthquake, however, approximately 75 percent occurred in the larger buildings. The size, weight, and multistories of larger buildings, and the relatively large numbers of people in them at given times, increase the damage and loss of life they can cause if not designed effectively. Second, these buildings -- especially those housing public-sector functions -- make up a community's infrastructure, providing public services, health care, and fire protection. These functions must continue during and after a disaster. A community's large buildings also usually provide jobs and goods essential to post-disaster recovery.

Although each association's president was accompanied at the workshops by a technical associate from his country, the workshops concentrated less on specific hazards-resistant design techniques than on the policies and programs that architectural societies can use both to increase their members' awareness of the importance of architectural design decisions for hazards protection and to improve their members' ability to design for hazards effectively. The workshops were meant to lay the groundwork for subsequent efforts to put such policies and programs into effect.

An important feature of the workshops was the request that each association prepare a report on its country's current use of hazards-resistant design, including architects' responsibilities, the hazards-resistant design measures commonly used, most significant hazards, relevant building regulations, and related matters. These reports proved extremely beneficial to the workshop because they led the associations to examine in depth their capabilities and needs in this area. (The report outline suggested to the associations appears later in this report. The individual associations' reports are separately bound in the appendices.)

The results of the first workshop have been reported separately. The results of the second workshop were so similar to the first that no separate report has been written on it. Rather, this overall report makes note of differences between the two workshops where relevant.

An additional element of the program thus far has been the development of a Spanish-language design manual on how to protect buildings from the forces of earthquakes, floods, and hurricanes. Presented in draft form at a special session of the quadrennial congress of the FPAA in February 1984, the final version of this manual will be made available in reproducible form to each of the associations for distribution to their memberships and use in technical design workshops and university courses.

## PROGRAM ACCOMPLISHMENTS

The accomplishments of this program to date have far exceeded expectations. The program has been highly visible among Latin American and Caribbean architects with concrete steps toward improving hazards-resistant design taken on a variety of fronts:

- The Guatemalan association has created a natural hazards commission to further Guatemalan architects' involvement in this area. The association is also working with community groups and public officials to develop widespread awareness of the problem and the need for improved design practices. There have been a number of national and regional design workshops involving Guatemalan architects, universities, and experts from other countries.

- The associations in Peru, Colombia, Mexico, Paraguay, Bolivia, El Salvador, and Brazil have implemented or are developing hazards programs. The Peruvian association has had a number of workshops and has developed a formal policy of encouraging better design practices in this area. The association in Brazil will soon hold a major workshop on flooding, and the Association of Commonwealth Societies of Architects in the Caribbean (ACSAC) will host a natural hazards workshop in Barbados in March 1986.

- The FPAA has formed a natural hazards committee and has incorporated the recommendations developed by the workshops into FPAA policies and goals. The new FPAA president, Juan Torres Higneras, was the Latin American coordinator of the Lima workshop and will be a strong supporter of the program over his four-year term.

- The AIA Foundation has just received a grant from the National Science Foundation to develop a state-of-the-art workshop curriculum and instructional materials on earthquake-resistant design for U.S. architects. This will be made available to Latin American and Caribbean associations as well. The National Science Foundation has also encouraged the AIA Foundation to submit a proposal

to establish a natural hazards building design clearing-house that would directly benefit this program.

- The individual country reports prepared for the workshops provide the first comprehensive picture of the status and needs of hazards-resistant design in Latin America and the Caribbean. They provide an informed basis for planning needed next steps.

- The workshop attendees have been identified as the key individuals for promoting hazards-resistant design in Latin America and the Caribbean.

- The central role of the associations in improving hazards-resistant design practices has been established throughout Latin America and the Caribbean, giving the program a firm institutional basis.

- The various associations have come to see that they share many common problems and needs concerning hazards-resistant design and that their resources can be pooled in a number of ways to increase the program's effectiveness. Agency for International Development administrator Peter McPherson has stated (Washington Times, 6/14/83), "As the president says, let's not give people fish, let's teach them how to fish." This program has not only created a commitment to the use of hazards-resistant design among the associations, it has also shown that much of the needed work can be accomplished through our own institutions with our own resources.

- The recommendations in this report represent a consensus of the various associations concerning needed efforts by both the United States and the associations themselves. This provides a firm foundation for program and policy planning.

## RECOMMENDATIONS

The consensus recommendations of the two workshops involve overall needs that can be best met on a hemispheric basis and needs that should be addressed by the individual associations.

### Overall Needs

This program has been designed so that individual associations will be able on their own to pursue needed efforts to improve hazards-resistant design practices among their members. There are nonetheless a number of support functions that should be provided for the Americas as a whole to ensure that each association's effort can be effective. These primarily concern technology transfer and utilization. It was the consensus of the workshops that the exchange of information is the single highest priority. While the associations in several of the more developed countries can develop the needed information without assistance, most cannot.

### Technology Transfer and Utilization Service

A centrally located technology transfer and utilization service is needed to provide individual associations a source of up-to-date information on available educational resources and ongoing activities and a focus for multilateral efforts in this area. This service should have the following components:

- Data Bank and Clearinghouse. The collection, evaluation, and dissemination of information on hazards-resistant design for the Americas is a critical need. The few existing clearinghouses (e.g., the University of Colorado's Natural Hazard Research and Applications Information Center) do not have a design focus and have proved inadequate for U.S. designers, much less those in Latin America and the Caribbean. The AIA Foundation has begun to serve this role informally, but its resources cannot keep up with the growing demands for assistance. An AIA Foundation proposal is being submitted to the National Science Foundation for support to create a formal clearinghouse for U.S. designers. If funded, there will remain a need of Spanish-language services for this program.

- Newsletter. A newsletter is needed to communicate data, ideas, news of innovations, etc., among the various FPAA member associations. This newsletter would keep each association aware of what the others are doing. Of perhaps equal importance, the existence of the newsletter will itself be a concrete encouragement to an increase in such communication. (This newsletter could be published perhaps three times a year, with articles, data, etc., solicited from the FPAA members. The AIA Foundation should publish the first issues of the newsletter while it is being established; subsequently responsibility for publication could rotate among FPAA members.)

- Advice on Association Efforts. The technology transfer and utilization service would be in an excellent position to advise on educational materials, workshop curricula, and other materials developed by the associations for their members. This function would arise directly from the service's clearinghouse role and would help ensure that after the

technology is transferred it is effectively utilized.

-- Development of Needed Educational Materials. Much existing useful information in this area is not available in formats and language that designers can use effectively in the design process. The general Spanish-language hazards-resistant design manual recently developed under this program provides an excellent technical foundation document but must be supplemented by other material that provides a greater level of detail and that takes into account variations among different countries and regions in geography, climate, and construction practices. The technology transfer and utilization service provides a convenient central fiduciary vehicle for support of such work and an effective mechanism for coordinating multinational collaboration in it.

### Technical Advisory Teams

Another priority in international exchange identified by the workshop participants is the need for multidisciplinary teams of hazards specialists to visit certain countries to help the associations develop their programs in hazards protection. It was determined that the various associations differ in their needs and other characteristics sufficiently that generalized advice is inadequate to the task of helping all countries improve their hazards protection.

An added benefit would be that the teams would increase the associations' credibility in dealings with their governments and general publics, facilitating the introduction of building codes and other innovations that may be needed to improve hazards protection.

Conversations since the workshops indicate that with adequate pre-visit preparation these teams probably need to spend less than a week in any given country and, further, that the teams should be multidisciplinary (i.e., architects, engineers, planners, builders, bankers, etc.) and multi-national.

### International and Regional Workshops

The long-term success of this program, like the success of its work thus far, will depend in large part on periodic face-to-face meetings of those involved throughout the Americas in promoting hazards-resistant design practices. This will require meetings every two or three years like the Lima and Antigua workshops, probably best held in conjunction with major FPAA meetings.

## ASSOCIATION NEEDS

The role of the associations in this program cannot be overemphasized. Their organizational stability, ties to their members, and the long-term commitment they have made in this program to improving their members' hazards-resistant design practices will be essential to ensuring that hazards protection does not become simply last year's design fad. The success of this program will to a large extent depend on implementation of the foregoing recommendations to provide the associations the technical material, advice, and continuing attention to hazards-resistant design they need to maintain vigorous effort in this area. At the same time, the associations must be more than passive recipients of such assistance. They must work actively with their members, their governments, and their publics to ensure that hazards-resistance technology is utilized after it is transferred. The following recommendations are the consensus of the two workshops concerning the associations' role internally in relation to their members and externally in relation to their governments and publics.

### Internal Association Recommendations

### Hazards Instruction in Architectural Schools

Although a few Latin American and U.S. architectural schools offer courses in seismic design, most do not. There is also virtually no material available to students on other hazards. The associations should work with their countries' architectural schools to introduce hazards-resistant design techniques into their curricula and into architectural license requirements. The U.S. National Council of Architectural Registration Boards has in recent years improved to an extent its registration requirements for seismic design, but other hazards should be covered as well.

### Continuing Education for Practicing Architects

Architects practicing today need to receive education on hazards-resistant design techniques. First, design workshops or other continuing education formats (e.g., self-help study guides, slide shows) must be available for various skill levels. The AIA Foundation has recently developed a flood-resistance design workshop and is currently developing an earthquake-resistance design workshop. These efforts should be expanded and used as the basis for similar work elsewhere. Second, practicing architects must be made aware of the importance of hazards-resistant design and must be motivated to take advantage of available continuing education offerings. The associations should do this through their policies, articles in association periodicals, exhibits and hazards seminars at association meetings, and other means to reach the widest possible number of their members. Recently, for

example, the AIA Board of Directors approved the policy that "seismic design is as much the architect's responsibility as the structural engineer's." As this policy is disseminated to AIA members their motivation to learn more about seismic design will increase accordingly.

### Multihazard Design

The associations should increase their efforts in "multihazard" design, which involves balancing and integrating the sometimes conflicting, sometimes mutually supportive, design strategies needed to resist different kinds of hazards simultaneously. Multihazard design is only beginning to be explored in some of the more developed countries. More is needed.

### Architectural Collaboration with Other Professionals

The associations should work to increase interactions early in the design process between architects, engineers, and other involved design professionals. Early design decisions by the architect (e.g., building orientation, configuration) can greatly hinder the structural engineer's ability to provide seismic resistance in later design stages, for example.

### Research on Hazards-Resistant Design

The associations should strengthen their involvement in research on improved hazards-resistant design techniques. The research programs that do exist are usually isolated from both the practicing professionals who will use the research results nd other research efforts. More cooperative efforts could increase the cost effectiveness of the generally limited support available for research in this area. The associations should also promote the training of more disaster researchers among their members as well as engineers, geographers, and geologists, with provision for exchange of interdisciplinary data among them.

## External Association Recommendations

Hazards-resistant design does not occur in a vacuum. The associations have a responsibility to advise the external groups that can affect whether hazards protection can be incorporated into a building's design and how well. Without adequate site-specific information on the expected reach of floodwaters, for example, a designer may not know whether flood protection is needed or to what extent. Without client awareness of the need for disaster damage prevention, designers will be discouraged or prohibited from using protection techniques that may increase a building's cost.

The workshop participants, particularly those at he Antigua workshop, stressed the critical need for active efforts by the associations to place hazards-resistant design high on their communities' agendas in order to facilitate needed changes. To this end, the associations should become more fully involved in their communities' political processes, taking full advantage of news media exposure, formal and informal contacts with community leaders, and other community relations techniques.

### Inventories of Vulnerable Buildings

The Antigua workshop also identified the need for the associations to develop comprehensive inventories of the vulnerabilities to hazards of critical community buildings and other elements of community infrastructure. Such inventories would not only alert owners and government officials to the need for specific remedial measures, but also increase general community awareness of the importance of hazards-resistant design.

### Indigenous Housing

Also emphasized at the Antigua workshop was the need to involve the associations in public-service programs to improve the hazards resistance of their countries' indigenous housing stock. As noted in this report's Introduction, this program's focus has been on larger buildings. Nonetheless, increased attention to indigenous housing would again serve the dual purpose of improving a community's hazards resistance and increasing general community awareness of these issues.

### Land-Use Regulations and Building Codes

The associations should actively promote the development of local and regional land-use regulations and building codes that address hazards protection needs and ensure that building design and construction are under the supervision of qualified personnel. Building permit systems should incorporate provisions to permit the creation of a unified data base on construction systems used in new buildings and other relevant information.

### Governmental Functions

The associations should actively seek to persuade their governments of the importance of publicly supported hazards bibliographic centers, distribution of regional and community maps of foundation soil conditions and flood-prone areas, etc., and the development of temporary housing for emergencies. The associations should attempt to become represented in or affiliated with governmental units and other official organizations involved in these and other hazards-related activities. The associations should also monitor the support made available for these activities, actively promoting the levels of support needed for effective work.

Funding from Outside Organizations

The associations should actively pursue funding for needed hazards-related workshops, exhibits, and other activities from the various organizations created to further relevant national and international goals. The Inter-American Development Bank and the World Bank, for example, work with a nation's central government to support important projects within their mandates. In the United States, the National Science Foundation, the Federal Emergency Management Agency, and other public and private institutions support work to improve hazards-resistant design. Organizations like these, as well as business groups with an interest in improving the hazards resistance of buildings, should be considered when an association's own resources are inadequate to support needed activities.

ISSUES ADDRESSED

1. Natural hazards that architects must design for in your country
   a. characteristics of hazards
   b. user needs in hazards
2. The present state-of-the-art of natural hazard damage mitigationn for architects in your country (flooding, hurricanes and earthquakes)
   a. available technical data in your country; how effectively is it used?
   b. concepts and techniques being used; how they are used; effectiveness of use; recommended improvements needed.

      Examples:

      -- building design and construction techniques
      -- land management, use and planning--zoning, duvdivision, etc.
      -- building codes
      -- general policies and programs
   c. expertise and experience available in your country
   d. public and private support available
   e. present problems architects face when designing for flooding, hurricanes and earthquakes
3. Recommendations for improving natural hazard protection design in your country
   a. the architectural profession's needs
   b. available opportunities
   c. what technical information is needed?
   d. recommended innovative concepts and techniques
4. Role of the architect in hazard protection design in your country
   a. relationship with other professionals (planners, engineers, developers, building officials, etc.)
   b. the architect's responsibility
   c. improvements needed to maximize results
5. Role of the association in hazard protection
   a. natural hazards damage reduction design programs and policies that your association has been involved in (training, data development and dissemination, awareness building, etc.
   b. recommended programs your association might adopt to assist your membership to become more aware and knowledgeable in hazard protective design.
6. Methods and strategies for exchanging information and experiences between countries and associations
   a. have you exchanged technical data and experiences with other associations and countries; what type of data was exchanged; what methods were used for the exchanges
   b. what methods and strategies do you recommend for exchanging natural hazard protection design data and experiences between countries and associations, in such a manner than can maximize the benefits for all involved
   c. identification of transfer mechanisms for example: clearinghouse, newsletters, conferences, etc.
7. Research and information sources available in your country; what are your needs in this area
   a. types of research being done and by whom
   b. hazard programs available in universities--schools of architecture
   c. key people involved in natural hazard work in your country
   d. important publications
   e. public and private agencies involved in hazard work
   f. public and private programs available in hazards areas -- a summary of their workings

8. Case studies and examples of natural hazards protection design development

9. Multihazard design approaches being used in your country

10. Natural hazards protection design considerations in the licensing process

FOOTNOTES

1 American Institute of Architects Foundation, International Workshop on Natural Hazards Protection Design: Lima, February 2-4, 1983: Report to the Office of U.S. Foreign Disaster Assistance, Agency for International Development (Washington, D.C.: AIA Foundation, 1983).

2 The Antigua workshop did differ from the first in one important way: because the Guatemalan association has been represented at the 1983 Lima workshop, the Guatemalans were already committed to the goals of the program before the Antigua workshop. Because a number of hazards experts would be in Antigua for the workshop, the Guatemalans asked them to speak at a seminar on hazard-resistant design the day after the workshop. This six-hour seminar attracted over 100 local students, designers, and community officials.

# CHAPTER FIFTEEN
# *MITIGATION AND BROADER PLANNING*

There was agreement by symposium participants that long term mitigation works best within a broader, multi-objective planning context. Rarely are natural hazards sufficient in themselves to motivate long-term and aggressive land management including retrofitting of structures, urban renewal, and major water projects. But hazards may be an important consideration and add weight to multi-objective land use and resource management. For example, many U.S. communities have rehabilitated urban waterfronts to reduce flood losses, increase open space, provide recreational opportunities, upgrade substandard housing, and provide economic revitalization for downtown areas.

Post-disaster mitigation also works best when the basis for such mitigation has been provided prior to a disaster through hazard area mapping and planning for development and redevelopment. Particularly successful mitigation programs in the U.S. such as Soldier's Grove, Wisconsin, Baltimore, Maryland and Rapid City, South Dakota were implemented through multi-objective planning initiated prior to a serious flood.

In developing nations, most of the large-scale government and private commercial, industrial, housing and other projects are designed to promote the economy and are at least partially financed by multinational corporations, international banks, or other countries. The incorporation of hazard loss reduction including post-disaster mitigation into such projects may be the only way to insure a long-term perspective on mitigation.

This chapter considers mitigation and broad economic and development planning from several perspectives. First, Stephen Bender discusses the need for hazard assessment and mitigation planning in integrated regional development and offers suggestions for implementation.

Ovsei Gelman also makes strong arguments that mitigation be placed in a broader planning context and makes additional suggestions for mitigation planning.

John Clark urges that hazards reduction efforts join forces with natural resources management interests in managing the coastal zones of the world since protection of natural features such as dunes, beaches and wetlands, can reduce disaster losses while achieving broader environmental and economic development objectives.

Ian Davis, one of our keynote speakers, concludes the chapter with suggestions for a model national program for economic vulnerability reduction and recovery.

# Natural Hazard Assessment in Integrated Regional Development

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In developing countries, disaster mitigation programs which are part of an integrated development planning process stand the best chance of implementation. Economically sustainable development is the basic activity of both the public and private sectors. Prevention of death and destruction will be enhanced to the degree that planning decisions and the execution of investment projects incorporate disaster mitigation measures.

In the past, disaster management in lesser developed countries (LDCs) has concentrated on reacting to the damage caused by natural phenomena. The reduction of the vulnerability levels of production facilities, infrastructure, and human settlements to natural hazard risks was frequently not explored. As a consequence, the need for massive local and foreign assistance for post-disaster relief and reconstruction has increased as ever larger segments of LDC's population - particularly the poor - and ever greater portions of their productive capacity are affected each year by disasters. While disaster prevention is widely recognized as the most efficient and effective means of reducing damage and loss of life, mitigation measures have been difficult to implement. Mitigation implementation ought to be part of development activities and the development planning process must include natural hazard risk assessment and mitigation measure identification if significant reductions in the damaged caused by natural phenomena are to be achieved..

## PROJECT DESCRIPTION

The Organization of American States through its Department of Regional Development has undertaken an initiative to incorporate natural hazard risk assessment and mitigation measure identification into the integrated regional development planning process through the "Natural Hazards Risk Assessment and Disaster Mitigation Pilot Project in Latin America and the Caribbean Basin" (NHP). This project is supported by the United States Agency for International Development and its Office of Foreign Disaster Assistance.

With the intention of modifying development activities so that potential disasters can be avoided, the NHP seeks to:

1. Assess natural hazard risk as part of natural resource evaluation and development strategy formulation;

2. Identify and formulate mitigation measures for development investment projects;

3. Improve information interchange, and;

4. Inform planning technicians and decision makers about risk assessment and disaster mitigation techniques.

The NHP is bringing to the disaster management area a decidedly focused approach. It is an effort in researching, field testing and implementing disaster mitigation measures by means of integrating appropriate technical information into real technical assistance activities. The NHP, recognizing the special role that integrated regional development planning plays in LDCs, is attempting to expand that role in the short term using the resources at hand while collaborating in drawing up an agenda for intermediate and long term mitigation research and implementation.

This approach is particularly relevant in post-disaster situations where tremendous pressures are brought to bear on local, national and international agencies to replace, preferably on the same site, destroyed facilities. All too quickly the need for natural hazard and risk assessment information and its incorporation into the development planning process become evident. In some instances, the disaster and the resulting reconstruction program dictates a reassessment of national or regional physical and economic plans and programs as, for example, in Nicaragua. In other situations, regional and local plans and programs have to be reformulated to reflect newly recognized disaster vulnerability, as in Guatemala, Honduras, Peru, the Paraguay River Basin and several Caribbean Islands. In still other situations, the disaster, as devastating as it might be, is still overshadowed by pre-existing development problems, as in Mexico City.

## INFORMATION NEEDS

To address the disaster mitigation issue,

specific information must be incorporated into the various stages of the integrated development planning study, including studies carried out in a reconstruction context. Needed data can be grouped in four categories:

1. Natural Events: As part of the natural resource investigation, the presence and effect of natural phenomena on the goods and services that natural resources provide must be determined.

2. Natural Hazard Assessment: As part of natural resource evaluation, hazard and risk assessment information qualifies the impact natural events can have on possible development activities.

3. Post Disaster Investigations: Following the occurrence of natural events which result in disasters, be they major or not, post-disaster investigations further describe the qualitative and quantitative aspects of natural hazards, often supplanting historical observations and scientific research.

4. Lifeline Network Identification and Vulnerability Analysis: Lifeline networks for production facilities, infrastructure networks and support systems to settlements define those critical segments or components which should have the lowest damage vulnerability or which should be recognized as priority elements for rehabilitation following a disaster.

In accordance with these groupings, the NHP has identified key information pieces that are required for effective mitigation to take place through the planning process:

a. In the Preliminary Mission, information concerning natural phenomena, the presence or absence of hazards, and post-disaster damage evaluation of the study area should be collected. The presence of hazards will indicate the need for further qualitative assessment as it affects natural resource management and economic development potential.

b. In Phase I an assessment of the risks that natural hazards present to the study area should be prepared. Existing critical segments or portions of production facilities, infrastructure and settlements in high risk areas should be identified through examining risk and lifeline network maps. The vulnerability of those segments or portions should also be determined. The development strategy is affected by the presence of hazards, and hazard mitigation is a consideration in the identification of sectoral development projects.

c. In Phase II specific mitigation measures for selected investment projects should be determined as well as vulnerable lifeline network elements for disaster preparedness activities. The presence of hazards should affect specific site selection, project engineering design and economic feasibility of development investment projects.

d. In the Implementation Phase, the monitoring of mitigation implementation and disaster preparedness activities provides information for evaluation of development studies in execution and the formulation of new development studies and disaster management activities.

The information pertaining to these four stages is presently generated by three principal networks: international and national phenomena research and monitoring centers and universities, disaster mangement entities, and multisectoral and sectoral planning agencies and operational secretaries and ministries. The source of financial support, staff training, subject areas of responsibility, and the role in mitigation program implementation of these networks varies greatly from country to country, as does their interrelationship. The national situation can be generally characterized, however, as having an emerging disaster management program, resource constraints in the area of natural phenomena research and monitoring, and a planning process that is under tremendous pressure to design and implement economic development programs in the absence of natural hazard information.

## RECOMMENDATIONS

Based on the experiences to date of the NHP, particularly those where field testing of natural hazard and risk assessment, mapping, and project formulation methods have taken place, the following recommendations can be made. They are divided into two categories: those with an institutional focus and those with a technical focus.

A. Institutional Focus:

1. Give preference to existing planning and executing agencies for post-disaster damage evaluation, risk assessment, and reconstruction project formulation and implementation rather than establishing new agencies. Define the roles and tasks of these agencies as to who coordinates, who executes and who enforces.

2. Insist on participation from all affected sectors in the above mentioned activities.

3. Define realistic budgets and ensure that approved reconstruction projects complement one another.

4. Insist that natural hazard risk assessment and mitigation measure selection are part of the planning process at the policy, program and project levels.

5. When necessary, insist that adequate risk assessment and mitigation selection technical assistance, including personnel training, is made available through reconstruction activities.

6. Ensure that disaster preparedness officials are made aware of the vulnerability levels of existing and proposed economic production, support infrastructure and human settlement projects.

The formulation of reconstruction programs following major disasters has had the greatest impact on national, regional and local development planning processes. The degree to which these programs have been integrated into existing planning processes varies considerably from country to country and occurrence to occurrence. The most typical response has been the creation of a reconstruction planning process in parallel with existing planning processes. Reconstruction programs are often supported by major international technical assistance and funding programs, and the preference has been to implement reconstruction programs outside of the mainstream of development activities in the hopes of expediting execution and avoiding existing bureaucratic delays.

The result of this dual development planning approach has often led to sectoral reconstruction efforts taking place without an assessment of the overall post-disaster situation of the particular affected area. The natural event may have altered substantially the conformation of the natural resource potential, sometimes by making clearly evident the natural hazard risk and the vulnerability of pre-disaster development activities. Damage resulting from the event has almost always necessitated a re-evaluation of existing development policies and sectoral projects. In many cases, such policies and projects are no longer appropriate to the needs of the area, nor coincide with the best use of its natural resources. Reconstructing damaged production facilities, infrastructure and settlements without formulating a comprehensive development strategy based on the post-disaster situation has often led to missed opportunities for incorporating disaster mitigation measures and recognizing the influence natural hazard risks have on development planning decisions.

In preparing policies and programs, realistic budgets should be drawn up which will permit execution of an integrated package of reconstruction projects. This necessitates appropriating scarce funds among sectors and programming sectoral activities to complement one another, a difficult task even in non-post-disaster circumstances.

At a policy level, reconstruction programs should strengthen efforts to include disaster prevention as a development policy issue. This is in recognition of the vulnerability of existing development activities, development capital needs, dependency on international investments and disaster relief assistance, and anticipated increased risk assessment requirements from international lending and insurance institutions. At the development program level, sectoral agencies should examine the impact of disaster-related damage and repair costs on yearly operating budgets and specific development programs. Besides identifying contingency funds for disaster relief and rehabilitation needs, the identification of prevention criteria and their cost, and the form of implementation should also be discussed.

At the project level, the appropriate institutions should be encouraged to include mitigation measures as part of project design and to identify those segments or portions of their development activities which are most vulnerable to natural hazards so that disaster preparedness actions may anticipate the location, type, and magnitude of possible damage.

The role individual specialists from national technical agencies will play is also important. Additional orientation and training in using existing risk assessment methodologies and proposing new areas for investigation are critical to reconstruction development programs. Thus, international technical cooperation should include a personnel training component so that their approach is pragmatic and firmly rooted in incorporating natural hazard and risk assessment information into the natural resource evaluation and project formulation stages.

Finally, the information contained in lifeline maps identifying the critical components of infrastructural and production networks should be shared with sectoral and disaster preparedness agencies to ensure that those responsible for responding to an emergency situation are aware of the relative vulnerability of each of the networks' components.

B. Technical Focus:

1. Immediately prepare multisectoral damage assessment and reconstruction needs inventories and syntheses of same.

2. Define the precise geographical area for reconstruction activities and assign priorities.

3. Collect all available natural resource and natural hazard analytical information and assess the impact of the disaster on national, regional and local development policies, pro-

grams and projects.

4. Include natural hazard risk assessment and mitigation measure information in all sectoral reconstruction project formulation.

5. Insist that subsequent scientific research and disaster preparedness activities are focused on the geographical areas encompassing priority public and private sector investments.

Development planning processes, in general, are more highly evolved and have more influence than disaster management processes at the present time in Latin America and the Caribbean. Notwithstanding the risks posed by natural hazards, national governments continue to make decisions concerning major investment projects with or without appropriate hazard assessment and mitigation measure information. Thus, post-disaster studies should recognize this situation and attempt to make disaster mitigation part of policy, program and project issues during reconstruction.

Following a catastrophic event, disaster management programs usually take the lead in generating damage assessments and relief need analysis, supported by sectoral studies for funding rehabilitation activities. These individual investigations can be quite detailed. But often their usefulness in formulating reconstruction programs in the context of integrated development planning can be limited if comprehensive conclusions are not drawn. Development planning studies must contain a comprehensive view of the impact of the disaster drawn from sectoral reports in order to define a precise geographical area for reconstruction activities and assign priorities based on modified predisaster needs.

Post-disaster studies should include timely multisectoral damage assessments and an inventory of reconstruction needs. They should identify areas where no or extremely limited development activities should take place regardless of the natural resource potential. Previously available general natural phenomena and hazard studies may identify potentially hazardous areas, but often lack adequate definition to evaluate existing or proposed development activities. Further study is then needed of these areas promising in terms of natural resource potential and location yet potentially disasterous in terms of the threats posed by natural hazards.

In preparing reconstruction projects, planning studies should use available non-structural and structural mitigation techniques including land use zoning, performance criteria, building codes, material specifications, and taxation and insurance programs. When absent or inappropriate, the planning team should collaborate in their creation as modification to fit national, regional and local needs. The cost of mitigation measures should also be included in the economic analysis of the projects at the prefeasibility stage.

In considering rural areas, such studies may lead to increased investigation of alternative cropping and irrigation patterns, soil conservation and reforestation techniques, farm to market road patterns, and new settlement location and existing settlement expansion programs. These programs may have been identified previously as possible development activities given the natural resource potential and proposed public and private sector programs. Thus, sectoral development planners such as water resource, agricultural, transportation and agricultural economic specialists must become aware in the resource evaluation stage that natural hazards may pose constraints to certain development activities and that mitigation measures will have to be part of overall development project design.

## CONCLUSIONS

To the extent possible scientific investigation, disaster management, and reconstruction planning activities in integrated regional development should be focused on the following areas:

1. Natural event occurrence and the review and synthesis of existing natural resource and natural hazard information;

2. Increased earthquake, volcano, floodplain, landslide, and incipient desertification hazard assessment;

3. Lifeline network mapping on a sector-by-sector basis;

4. Review and synthesis of existing post-disaster damage assessment, including local interviews and oral histories;

5. Initial lifeline network vulnerability mapping;

6. Review and synthesis of existing structural and non-structural mitigation programs, and;

7. Modification of land capability mapping methodologies to more clearly manifest natural hazard information.

In carrying out these activities, an agenda for further investigation and evaluation should be created without altering the existing organizational structure for natural science investigation and disaster preparedness. By creating the need and opportunity to generate this information, these activities forge concrete, operational linkages which will produce results while strengthening the national institutional structures of all involved agencies.

FIGURE 1

OAS/DRD NATURAL HAZARDS PROJECT
SYNTHESIS OF THE DRD DEVELOPMENT PLANNING PROCESS

| COMPONENTS | STUDY DESIGN | STUDY EXECUTION | | IMPLEMENTATION OF RECOMMENDATIONS |
|---|---|---|---|---|
| | | PHASE I<br>DEVELOPMENT DIAGNOSIS | PHASE II<br>PROJECT FORMULATION AND PREPARATION OF ACTION PLAN | |
| Activities: | Receipt and analysis of request for cooperation<br>Preliminary Mission<br>- pre-diagnosis<br>- preparation of cooperation agreement | Diagnosis of region<br>- sectoral analysis<br>- spatial analysis<br>- institutional analysis<br>- environmental analysis<br>- synthesis: needs, problems, potentials, constraints<br>Relation to national plans, strategies, priorities<br>Development strategies<br>- formulation and analysis of alternatives<br>- identification of project ideas | Project formulation (profile or prefeasibility) and evaluation<br>- production sectors (agriculture, forestry, agroindustry, industry, fishing, mining)<br>- support services (marketing, credit, extension)<br>- social development (housing, education, labor training, health)<br>- infrastructure (energy, transportation, communications)<br>- urban services<br>- natural resources management<br>Action plan preparation<br>- formulation of packages of projects<br>- policies for priority areas and sectors<br>- enabling and incentive actions<br>- investment timetable<br>- evaluation of funding sources<br>- institutional development and training<br>- promotion | Assistance for specific programs and projects<br>Assistance in incorporating proposed investments into national budget<br>Advisory services for private sector actions<br>Support to executing agencies<br>Support in inter-institutional coordination |
| Products: | Signed cooperation agreement<br>- definition of products of study<br>- financial commitments of participants<br>- preliminary workplan | Interim Report (Phase I Report)<br>- diagnosis of region<br>- preliminary development strategy<br>- identified projects | Final Report<br>- development strategy<br>- action plan<br>- formulated projects<br>- supporting actions | Government execution of<br>- feasibility and final design studies<br>- implementation of projects<br>- changes in legislation and regulations<br>Improved operational capability of institutions |
| Time Frame: | 3 to 6 months | 9 to 12 months | 12 to 18 months | Variable |

FIGURE 2

OAS/DRD NATURAL HAZARDS PROJECT

GENERAL COMMENTS ON THE RELATIONSHIP OF NATURAL HAZARDS EVENTS AND DEVELOPMENT PLANNING PROCESS COMPONENTS

| | | EARTHQUAKE | VOLCANO | MAJOR FLOOD EVENT | HURRICANE | DROUGHT |
|---|---|---|---|---|---|---|
| Preliminary Mission | Objective: | Collection of information to establish the presence of hazards in the integrated regional development study area and the limits of risks posed. | | | | |
| | Affect on development patterns: | Presence of hazards indicates the need for further qualitative and quantitative assessment as they affect natural resource and economic development potential. | | | | |
| Development Diagnosis, Strategy Formulation, and Project Identification | Objective: | For those hazards present in the study area, assessment of the risk (risk hazard map) and identification of existing criterial segments or elements of production facilities, infrastructure and settlements (lifetime network map).<br>Inclusion of risk and vulnerability aspects in defining development potential and strategy (for example, flood plain, landslide area, incipient desertification identification, and land capability maps).<br>Identification of alternative non-structural and structural mitigation measures in initial development project identification. | | | | |
| | Affect on development patterns: | Presence of hazard will affect the formulation of the development strategy and the type and location of investment projects and suggest modification of the lifeline network. | | Presence of hazard will affect overall strategy formulation and hazard mitigation should dominate identification of production sector projects, particularly agriculture. | | |
| Action Plan Preparation and Project Formulation | Objective: | Determination of specific mitigation measures for selected investment projects and determination of critical lifeline network elements for disaster preparedness activities. | | | | |
| | Affect on development patterns: | Presence of hazard will affect the action plan for project implementation and the specific site selection of investment projects at the local level, project engineering design and economic feasibility. | | | | |
| Implementation | Objective: | Follow-through on implementation of mitigation measures and disaster preparedness. | | | | |
| | Affect on development patterns: | Monitoring of natural phenomena for early warning against possible damage, and formulation of future risk assessment and disaster preparedness activities. | | | | |

# Toward an Integration of Post-Disaster Planning into a Broader Planning Context

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## INTRODUCTION

A disaster presents a challenge to any country and a very special one to a developing one, since it disrupts the normal development process and demands, very abruptly, a tremendous effort from the suffering nation.

Quite early after a disaster, even during the initial stage of response devoted basically to rescue and life saving operations, the responsible authorities must cope with a wide spectrum of serious and crucial tasks. In the midst of the immediate urgencies such as the organization of medical attention to injured or the supply of water and food to survivors (just to mention a few), they must begin to rehabilitate basic services as well as establish a huge enterprise for future restoration.

Thus any government and particularly the unprepared one finds itself very soon in the recuperation stage, trying feverishly to improvise its main objectives, to invent its basic policies, and to implement any immediate actions that are occurring to desperate minds.

Due to the lack of a previously prepared plan as well as to the shortage of time and insufficient experience in the post-disaster situation that is aggravated by the need to take decisions under very strong and deep psychological, socioeconomical, and political pressures, it is not surprising that the best intentions soon fail. The whole recuperation process is practically aborted and frequently reduced to the short scope of damage reconstruction merely restricted to corrective actions oriented basically to fulfill just first and immediate needs.

The world experience and particularly that of Latin America consists of a multitude of isolated and fragmentary actions directed primarily to reconstruct the damaged sectors and systems without taking into account their interrelations as well as their roles in and contributions to global development. As a result of this widespread and, in a certain sense, usual practice, the disastrous effects are amplified and grow deeper in such a way that they have certain socioeconomic effects and may contribute to the political instability of the affected region.

To prove the validity of this thesis, it may be useful to examine some of the main consequences of several recent disasters in our Continent, namely in Nicaragua, Guatemala, and Mexico.

## THE CONSEQUENCES OF INADEQUATE PLANS

Our recent analysis (Gelman, 1984a) has shown that the rather inefficient recuperation process that lacked any plan after the Managua Earthquake of 1972 resulted in:

- Delay in restoration of productive activities due to the priority of building and infrastructure reconstruction (i.e., slow maturity investments).
- Shrinkage of private investment due to social commotion and disputes between the different groups of entrepreneurs.
- Incongruity of the imported equipment with the reconstruction goals and the development programs.
- Inefficient use of reconstruction funds aggravated by consequent corruption and speculation due to an intermediarism system that lacked adequate control and supervision.
- Increase of foreign debt with a very unfavorable structure due to the commercial conditions attached to the engaged loans.
- Loss of confidence with the government and the indignation of a wide and diverse strata of the population.

The Guatemala recuperation after its earthquake of 1976 also lacked necessary planning. This was despite a completely different pattern that gave total liberty to the foreign support agencies which were trying to avoid the corruption typical of the centralized control of Somoza. The role of the government was restricted to infrastructure and building stock reconstruction. As a result there were many alterations in the social, economic, and political life with special impacts on the agriculture, tourist, and construction sectors -- the pillars of the national economy. Moreover, the divergence between the recuperation goals as well as the failure to take into account the long and medium range needs of national development produced serious consequences such as:

- Increase in the foreign technological and economic dependency,

- Disequilibrium of the human settlements through the growth of their heterogeneity due to the intensification of the socioeconomic differences,

- Transformation of the social and cultural patterns in Guatemala due to the diversity and incompatibility of the recuperation criteria and,

- Alteration of the national production and consumption patterns due to the intervention of the foreign technical and economic aid.

A recuperation process had been established in Mexico immediately after the disaster caused by the eruptions of the volcano Chichonal in 1982. A special Program of Reconstruction was established ad-hoc which was headed by the Federal Government. Unfortunately it was suspended at the end of the year when the Mexican President finished his six-year term.

Meanwhile, pursuing its main goal of relocation of the surviving population, the Program had not taken into account the social and anthropologic peculiarities of the affected nucleus of Zoque "costumbrero". As a consequence, the recuperation provoked a process of disintegration and acculturation of the mentioned ethnic group due to:

- The aggression it suffered from the alien culture,

- The imposition of behavior patterns alien to its customs, and

- The physical change in its habitat.

Moreover, in spite of its great cost, the recuperation was not linked with state plans and missed a unique opportunity to impel integral regional development (Gelman, 1983b).

One may conclude, based upon these three Latin American disasters, with their sorrowful and dramatic experiences, that a Preliminary Elaborated Recuperation Plan (PERP) is needed.

The rest of this article will present some basic characteristics of the PERP (Gelman, 1984b) prepared for Mexico City's Protection and Reestablishment System (SIPROR) in case of Disasters (Gelman, 1978; Gelman, 1979; Gelman, 1983).

## RECUPERATION PLANS

The development of a PERP employing the conceptual framework of Interdisciplinary Disaster Research (Gelman, 1982; Gelman, 1984c) has to consider three main priorities related to the periods before, during, and after a disaster:

- Preparedness that is devoted to the elaboration of the PERP general outline such as its fundamental goals, objectives, strategies, policies, and main programs of action as well as to the preparation of the indispensable conditional organization, capacitation, instrumentation, etc., that would be necessary for its fruitful realization.

- Concretization, i.e., the specification and tailoring of the PERP programmed activities in accordance with the conditions of the disaster and consistent with the nature and magnitude of the damages.

- Adjustment, that seeks to incorporate into the plan the necessary changes and adjustments that would emerge during its execution.

Taking into account that the purpose of any plan is to support and help implement a general management process (Gelman, 1981), a PERP has the goal of providing and sustaining the activities and programs for reconstructing the affected zone and to better the well-being of its population. To reach its goal, a PERP has to help fulfill the next three objectives:

- To substantiate, design, and organize the reconstruction process.

- To improve the safety of the affected zone.

- To firm up the bases for future normal and harmonic development of the whole region.

A rational and efficient use of the available resources could be achieved by pursuing the four main strategies of a PERP:

- Rehabilitation of the basic life-support services in order to maintain the minimum levels necessary for survival.

- Consolidation of the life-support services to reach the minimum level of well-being with reasonable and optimal expenses.

- Restoration of the normal functioning of the region subsistence systems, taking advantage of the opportunities and cojunctures due to the relaxation of the restrictions in effect prior to the disaster as well as to the availability of the new and plentiful financial resources.

- Revision of the long range regional plans in order to incorporate a PERP and to mesh it with normal development.

As with any plan, a PERP has to establish certain policies, criteria, and restrictions crucial to selection and adoption of the recovery

actions. Several of these policies include:

- Maintenance of national sovereignty, especially political, social, and economic aspects.
- Consideration of the socioeconomic and political contexts of the region as well as its development goals.
- Active participation of government, the private sector, and the population in the recuperation process.
- Guarantees for individual liberties and social stability.
- Assurance of adequate legal foundation for the recuperation process: this requires the existence of the pertinent legislation as well as implementation mechanisms.
- Special attention to the areas and population with scarce resources.
- Improvement of the population well-being through the recuperation process.
- Diminution of the consequences and adverse effects that could be produced, in the long and medium range, by foreign aid.
- Honest and efficient use of resources with priority given to the recuperation of jobs, dwellings, services, and immediate productive works.
- Access to soft loans for small and medium enterprises as well as the establishment of economic incentives for quick recuperation.
- Conservation and respect for the cultural, social, technological, etc. patterns of the population.
- Linkage and integration of the PERP with other plans such as the Plan of Prevention, the Mitigation Plan (Gelman, 1984), as well as the Plan of Emergency Attention (Gelman, 1983a).

The above described general goals, objectives, strategies, and policies constitute the basic level of a PERP. At this level it is important to identify, organize, and coordinate all the participants of the recuperation process as well as to make it compatible and coherent with the General Plan of Regional Development.

Moreover, any PERP has to have another level in order to foresee and to plan the activities of subsistence systems, life-support services, and the different participating agencies, i.e., a PERP has to contain their partial recuperation plans.

To conclude, the methodology for the PERP at both of its levels has been briefly described here. This paper has elucidated its main features as well as the reasons why PERPs are needed.

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# Collaboration for Mitigation: Combining Hazards Mitigation and Resources Management Through Coastal Area Planning

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## INTRODUCTION

A simple and effective way to strengthen hazards prevention and mitigation in the coastal zone is to join forces with natural resources management interests. Taking as an example the United States coastal zone, hazards loss reduction begins with preservation of coastal landforms that provide natural resistance to wave attack, flooding, and erosion from hurricanes and storms. These landforms differ significantly on our various coasts. On parts of the Atlantic and Gulf coasts, for example, there are barrier islands with special features - dunes, beaches, wetlands - that protect coastal inhabitants and property against moderate storms and absorb some of the more violent energy of major storms. Human activities that remove or degrade protective landforms - for instance, by removing beach sand, weakening coral reefs, bulldozing dunes, or destroying mangrove swamps - diminish the degree of natural protection the coast affords (Clark et al, 1980).

As experienced planners and managers already know, the measures best suited to conserving ecological resources are often the same as those needed to preserve the natural landforms that serve as barriers to storms and flooding. Accordingly, many communities have found that a combined approach to hazards and resource management simplifies the process of zoning and permit reviews and leads to more predictable decisions on what constitutes acceptable development. For example, the same setback requirement that protects beachfront homes from erosion and storm waves can also preserve turtle nesting sites on the backbeach. Similarly, a zoning restriction on development of mangrove swamps can not only conserve an economically valuable resource, but maintain a physical defense against storm waves (Clark et al, 1980). In a final example, a seashore or coral reef park can protect these natural landforms from both hazards and natural resource perspectives (Salm and Clark, 1984).

The administrative approach to combining coastal hazards prevention and resource management is an integrated, multi-sectoral initiative called Coastal Area Management and Planning (CAMP) or Coastal Zone Management (CZM). There is a well-developed CAMP program in most U.S. coastal states through the Coastal Zone Management Act of 1972 - P.L. 92-583. There is also progress in many other countries toward truly integrated CZM programs (Sorensen et al, 1984).

## HAZARDS AND NATURAL DEFENSES

Disasters are inevitable in coastal nations. They result from cyclonic storm attack, tsunamis, shore erosion, coastal river flooding, land and mudslides, and soil liquefaction. It is neither economically feasible to eliminate the hazards (e.g., seawalls), nor in the humanitarian and economic interests of these countries to keep all individuals out of the hazard zones. Most societies have developed social mechanisms to cope with extreme natural events. However, modern development processes increase the level of coastal hazards (Hausner and Sorensen, 1984).

Recent tabulations show the tropical cyclone to be equal to earthquakes in its annual death toll (34,360 persons/year in the 1970's according to the Swedish Red Cross). Populations continue to grow rapidly in countries affected by cyclones, increasing the risk of community disturbance and the annual death toll. The Philippines, Bangladesh, St. Lucia, and dozens of other countries are affected. This risk, and that from other hazards could be lessened through controls on type, density, and location of settlement through initiation of effective CAMP programs. Of particular importance in such programs is the maintenance of natural landforms that take the brunt of storms and therefore protect lives and community structures.

The short-lived but intensive winds of hurricanes and cyclones exert enormous forces on both natural and built systems. They drive before them rising water, known as storm surge, which in rare and very intense storms can elevate normal water levels over 20 feet. A less intense storm (such as Hurricane Alicia which struck Galveston, Texas in 1983 with maximum winds about 110 mph) may raise water levels 6 to 12 feet.

The winds build waves on top of the storm surge which, as they strike the coastline, can increase flood elevations by as much as 55 percent over the storm surge. In an open ocean setting, wave heights of 40 to 60 feet and higher have been observed by seamen and operators of offshore oil rigs; but these wave heights are achieved because of the great depths of water beneath them (a 3-foot wave needs at least 4 feet of water depth beneath it to be sustained; a 6-foot wave needs 8 or 9 feet, and so on). As the waves enter shallow water the sea bottom both slows the submerged portion of the waves and decreases the wave height that can be sustained, resulting in a "breaking" of the wave (Miller, 1985).

While the wave energy can be quickly dissipated if waves strike the coastline, beaches, dunes, or vegetation, structures built in the wave zone are subjected to extreme forces. At the boundary of land and sea, beaches and low-lying dunes may be scoured to sea level, and, depending on the profile of the beach, scoured sand may be washed overland hundreds of feet, or the sand may be deposited seaward, where by decreasing the water depth it acts to "trip" waves farther from the shoreline. Moreover, sand may be liquefied to a depth of an additional 3 or 4 feet during the scouring process, eliminating or greatly reducing the ability of the sand at those depths to bear the weight of structures or provide friction against uplifting or overturning forces.

Reefs, beaches and dunes, and mangroves are among the most important natural defenses against wave action. Reefs act to "trip" waves which cannot be sustained over their shallow depths. And, the reach between the reef and the shore is frequently too short to permit waves to build to previous heights. Beaches are also efficient dissipators of wave energy: if the sand is deposited seaward, water depth is decreased and storm waves break farther from shore; if the sand is deposited landward the beach is increased, further reducing the danger of destructive waves.

In this context, dunes are important sand suppliers. If removed by sand mining or because of obstruction to ocean views, the risk to coastal development behind the former dunes is greatly increased. Similarly, mangroves serve to dissipate wave energy and to stabilize the land areas behind them from the erosive forces of storms.

## DEVELOPMENT MANAGEMENT

International and domestic disaster efforts have quite appropriately been reserved for those who are already the victims of natural disaster. However, from a resource management perspective there must be a concern for potential victims of future disasters, a matter which has received relatively little attention. In addition to local effects, disasters are costly to the entire nation, to its region, and to the donor nations which sponsor relief and recovery programs (many seem to be reaching the limits of their generosity). Any approach, such as CAMP, that can reduce the effects of future disasters will be beneficial to the larger community (Hausner and Sorensen, 1984).

Virtually any development project in a coastal area is affected by and can have an effect on hazards and risks. There are many examples of poorly controlled development that has increased potential hazard losses as well as had a serious negative effect on the value of our coastal resources. Demands for retirement and vacation housing and other investments in waterfront land have been intense. Developers have encouraged and satisfied these demands and, in so doing, have frequently imposed high capital and servicing costs on coastal communities. These costs are felt by the public in higher taxes. Another pronounced effect is that coastal development attracts additional population to and around the project site, increasing the number of lives and the amount of personal property in jeopardy. For a variety of reasons, the principal city in most tropical nations is a port. People migrate to these cities for the jobs which cannot be found inland. For example, development in coastal areas surrounding the Bay of Bengal has attracted an enormous additional population despite the fact that cataclysmic cyclones and floods have often occurred.

Dual goals of conserving coastal resources and maintaining nature's hazard protection systems can save taxpayers money. Because of the link between development and disasters, an important aim of CAMP is to integrate the knowledge of coastal hazards and risks into planning for on-going and future development programs and projects. Specific guidelines for estimating how a project or program affects risk and coastal hazards should be applied to every development proposal to insure that each project does not increase risk and, further, that the project can be implemented in a way that reduces existing hazards. Development proposals should be evaluated for their "cost-effectiveness". Hazard assessment should be accomplished through the mechanisms for project review and environmental impact assessment under CAMP (Hausner and Sorensen, 1984).

## USING CAMP

Fully comprehensive CAMP programs target natural hazards prevention and mitigation as well as coastal resources conservation (Sorensen, McCreary, and Hershman, 1984). Some of the common elements of resource conservation and hazard mitigation include:

1. They both require integrated approaches to influence where development is located and what type of structures are built at what density.

2. They both require involvement of many levels of government from national to local, as well as international cooperation in some instances.

3. They both require preservation of the natural elements that protect coastal populations from cyclonic winds and storm surges, e.g., mangrove forests, dunefields, and coral reefs.

4. They both require management of coastal watersheds and river basins in order to reduce flooding.

This mutuality suggests that agencies responsible for prevention and mitigation of natural hazards should perhaps be as interested in advancing CAMP programs as agencies responsible for resource conservation and environmental protection.

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# A Model Program for Economic Vulnerability Reduction and Recovery

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## INTRODUCTION

Disasters represent more than the loss of lives and property; they also represent economic hardship on people, on societies, and on governments. There are measures, however, that governments can take to reduce vulnerability and ensure that post-disaster programs contribute to economic recovery as well as physical rehabilitation.

This paper describes such steps to reduce economic vulnerability to major natural hazard events such as hurricanes, earthquakes, major flooding, or volcanic eruptions. The steps are presented as a model, step-by-step program that could be modified and adopted by national planners consistent with their own needs and preferences.

## WHY ADOPT A PROGRAM?

Reducing a country's economic vulnerability to disasters should be a high priority for all governments in areas where disasters frequently occur. There are several reasons:

1. Economic impact of a disaster on a nation's economy: Disasters can severely affect the total economic output of a country and in some cases have caused a decline in the total GNP. In countries that are highly dependent on one or two crops or economic enterprises, disasters pose a particularly serious threat to the overall economy.

2. Impact on the balance of trade: A widespread disaster can have an immediate impact on a country's balance of trade, especially if a substantial number of housing units are destroyed. Unless a country has the ability to replace losses from materials within the country, large quantities of materials and supplies will have to be imported.

3. Impact on the balance of payments: Widespread disasters often immediately impact a country's balance of payments. Normally the country will experience a decline in earnings from foreign investments and must increase its volume of borrowing.

4. Possibility of increased dependence on foreign aid: If a country cannot internally cope with a disaster, it must seek international aid. While foreign assistance can be helpful, it does place additional constraints on the government and may slow efforts to develop self-sufficiency.

5. Competition for development funds: Disaster relief and reconstruction compete with development projects for available funds. Often a country must postpone major development schemes in order to divert funds to disaster recovery. If major disasters occur frequently, the overall pace of development may be severely impaired.

The economic impact of disasters may be illustrated by the case of Fiji. In the last decade, five hurricanes or floods have struck the island group. A sizable portion of the national budget has been reallocated after each disaster, and expenditures for reconstruction have increased dramatically during this period. There has been a corresponding increase in foreign aid, but only a slight total increase in the amount of money available for both development and reconstruction (in terms of real dollars). The funds available for development have decreased because of the amount needed for reconstruction.

Relief operations have also contributed to raised expectations regarding the standard of housing, not only of inhabitants of the disaster-affected areas, but also of inhabitants of the outer islands and the rural areas of the larger islands. This has required the government to expand housing services offered to people throughout the country to ensure equity for all. While this might have occurred even without the disasters, the disasters have increased expectations and the government's burdens.

## OBJECTIVES OF A VULNERABILITY REDUCTION PROGRAM

The objectives of an economic vulnerability reduction program should be:

1. To develop methods to reduce losses.

2. To develop methods to reduce the economic impact of disasters on:

   a. individuals and families;
   b. small businesses;
   c. principal economic sectors;
   d. a country's overall economy.

3. To determine the most appropriate uses and types of foreign aid.

4. To determine viable alternative economic activities that could reduce losses.

5. To identify opportunities created by disasters for redirecting economic activities (e.g., heavy losses to coconut plantations may provide the impetus to change crops or to select other uses for the land).

6. To identify opportunities created by disasters for expanding development program activities.

## STEPS IN PLANNING AN ECONOMIC VULNERABILITY REDUCTION PROGRAM

The following are a suggested list of activities or steps for developing an economic vulnerability reduction program. They are presented in the sequence in which they should occur with each step building upon the previous one.

A. Develop an economic loss profile. This profile can help officials at all levels of government determine what the potential losses from a disaster will be and provides the background information needed for vulnerability reduction priorities in each government sector.

There are five steps in developing an economic loss profile. They are:

1. Conduct a hazard and risk analysis: There are three activities involved. The first is to identify the threats. Potential for damage from hurricanes, earthquakes and floods is fairly easy to recognize and historic information, as well as data from international scientific organizations, is usually available. For hazards that occur less frequently (such as volcanic eruptions, tsunamis, and the various man-made threats such as oil spills, fires, etc.), more detailed research may be required.

   Next, determine the degree of probability that any one of the hazards might affect a particular community. Historic records as well as scientific information about patterns and recurrence intervals can be used to determine the probabilities.

   Comparing probabilities, location, and the geographic areas where disasters are likely to occur forms the basis for a "risk map". A risk map is usually prepared for each hazard or threat. Risk areas are usually fairly broad and may encompass whole communities or even regions.

   Within each of the areas at risk, planners should then more specifically identify communities or portions of communities that are threatened, their economies and principal economic activities. This is known as "vulnerability analysis". A community that is vulnerable to one type of disaster may not be vulnerable to others. Furthermore, not all sectors (e.g., housing, agriculture) may be equally at risk. For example, mountains may protect an area from high winds, but not flooding. Certain types of agriculture (e.g., palm trees) may be vulnerable to high winds but not to flooding.

2. Estimate the Gross Economic Loss (GEL). The Gross Economic Loss is the total cost of losses in each economic sector, plus the losses in investments made by both the public and private sector (for example, loss of capital investments, damages to infrastruture, and loss of raw materials).

3. Estimate the potential Net Economic Loss (NEL). Net Economic Loss is determined by calculating the total cost of replacing or rehabilitating damages and losses from the disaster, less the percentage of the GEL that was insured, plus the percentage of the GEL that is non-recoverable, plus the increased costs of borrowing for reconstruction.

4. Determine the overall impact of the NEL. It is necessary to determine the impact of the NEL in order to determine which sectors should receive priority. The impact is determined by:

   a. Estimating the percentage of loss that the NEL represents as a percentage of the total output in each sector and as a total of the Gross National Product (GNP);

   b. Estimating the country's ability to absorb the losses in each sector and in the overall economy;

   c. Determining the impact on economic development. The costs to economic development are determined by calculating the cost of diverting development funds to relief, rehabilitation and reconstruction, the costs that accrue from delays to normal development activities, and the additional costs that result from "accelerated modernization" (e.g., the replacement of traditional housing with more modern and more costly buildings).

   The impact on economic development may not always be negative, for disasters often hasten the demise of a weak or declining sector. This permits the government to focus reconstruction resources where they

can help strengthen or start new activities that can advance overall development plans.

5. Determine the social costs of economic losses. The social costs can be determined by:

   a. The impact of economic losses on employment: Sectors of concern are normally agriculture, fishing, forestry, small-scale enterprise, and large industries that provide a substantial percentage of the jobs in a community. The economic consequences may not all be completely negative. In urban areas, a "boom economy" may develop in the aftermath of a disaster, especially in the construction industry. The boom may provide a substantial number of jobs for those who have lost other sources of income.

   b. The impact of relief and reconstruction on the society: There are numerous concerns of which planners should be aware. Among them are:

      1) Rising expectations: Relief operations often foster the idea that the standard of living will improve in the aftermath of a disaster through the provision of better housing and substantial economic assistance. For example, countries that have attempted to replace damaged traditional houses with modern and more costly prefabricated units have often set in motion a nationwide expectation and demand for improved housing for all the people. Planners must ensure that relief operations do not encourage unrealistic expectations that cannot be met.

      2) Disincentive effects of relief on recovery: Often relief operations foster a belief that government and relief agencies will assume responsibility for the total economic welfare of the disaster victims for an indefinite period of time. Victims often are led to believe that if they try to help themselves, it may jeopardize the amount or type of assistance they will receive. This serves as a disincentive and slows the recovery process, which in turn further increases the total costs of recovery.

6. Determine the impact of reconstruction on the private sector. Relief and reconstruction efforts often focus on providing individuals and families with aid. Planners should remember that the private economic sector is also affected by a disaster and by relief operations. It is important that, to the greatest extent possible, relief operations should be designed to encourage the economic recovery of local producers, markets, etc. Methods for stimulating recovery may include providing "script" to disaster victims to enable them to purchase materials through local stores, providing temporary jobs for people to enable them to purchase goods through local markets, and restricting the distribution of free relief materials that compete unreasonably with goods available in local markets and that could be purchased in stores and markets in the affected area.

B. Establish priorities for vulnerability reduction. By reviewing the economic loss profile, planners should be able to establish priorities for vulnerability reduction. Priorities should be established in each sector (industry, agriculture, small business, etc.).

   The establishing of priorities requires consultation with a wide range of groups. It is important that community leaders in each sector be consulted and that ministers, directors, and supervisors of the government organizations responsible for both mitigation and response have ample opportunity to review and comment on the priorities.

C. Prepare an economic mitigation plan. Economic mitigation involves examining existing development plans and either reordering priorities or initiating activities in sectors that require special attention due to disaster threats. Most activities can be carried out as part of normal development programs. The steps of economic mitigation planning are:

   1. Identify and study alternatives. The various strategies for mitigating the economic impact of disasters are:

      a. Adjusting normal development programs to reduce losses. For example, certain varieties of crops that are more wind or flood resistant and that produce higher yields can often be introduced in hurricane- or flood-prone areas. Not only will normal crops be improved, but disaster losses can be reduced.

      b. Strengthening the capacities of the private sector to absorb losses. This is normally accomplished by encouraging the private sector to acquire disaster insurance or by developing stockpiles or reserves of important commodities. Both approaches will enable the private sector to continue at least limited operations in the aftermath of a disaster, as well as stimulate local markets.

      c. Diversifying the economy. In communities where the principal or sole source of income is threatened by disaster, governments should attempt to diversify the economy and introduce economic activities that

are less vulnerable or not as vulnerable to the same types of disaster. Diversification is extremely important where economies are based on a single cash crop. It will help protect the economy not only from natural disasters but from dramatic price fluctuations on the international market.

d. Investing strategically. Government is often able to encourage development away from hazardous areas by investing or creating a favorable environment for investment in less vulnerable regions or communities.

e. Developing "disaster resistant" economic activities. For example, handicraft production is relatively unaffected by disaster. Efforts should be made to identify enterpises that are less vulnerable and to encourage their development.

f. Expanding economic opportunities to help mitigate losses. Studies have shown that savings-and-loan associations, cooperatives, credit unions and other mutual economic institutions play a key role in helping people obtain funds in the aftermath of a disaster. Governments should encourage the growth and development of these institutions in vulnerable areas. Both savings and credit are invaluable assets in reconstruction and will reduce the burden on government.

2. Select mitigation strategies and begin implementation. After reviewing the various altenatives and strategies, a formal mitigation plan should be developed. Government and private sector leaders should review the options in a series of meetings and determine the approaches to be used. Once these choices have been made, they should be incorporated into the normal operating and development plans. To ensure that progress has been made, responsibility for overseeing and coordinating implementation should be assigned to an appropriate authority within the government.

D. Develop an economic preparedness plan. Economic preparedness refers to the development of plans and programs to stimulate economic recovery in the immediate aftermath of a disaster. The actions attempt to reduce immediate economic hardship on families and institutions within the stricken community, as well as to provide methods for shaping economic recovery.

Several approaches can be used to expand economic preparedness, including:

1. Expansion of a government's ability to assist in salvage and recovery. In the immediate aftermath of a disaster, a government should assist in salvaging and/or recovering supplies, materials, crops, etc., to reduce the total percentage of loss. For example, some crops may be partially salvageable. The usual problem is finding transport to move the recovered crops so that they can be processed or sold. Government transport networks can be extremely useful for this purpose.

2. Improvement of infrastructure that can help reduce losses. Certain essential services or physical infrastructure can be extremely useful in salvage and recovery operations. Efforts should be made to develop or expand the necessary infrastructure or services so that they can be used in the aftermath of a disaster.

3. Development of stand-by programs for economic assistance. Four types of stand-by programs can be developed, including:

   a. Economic relief programs for families, e.g.,

      -- loans;
      -- grants;
      -- subsidies;
      -- material assistance;
      -- temporary (or alternative) employment;
      -- loan guarantees.

      In many cases, emergency economic programs for families can be based on existing programs and require only a change in eligibility criteria and the terms or conditions of existing contracts. When reviewing various alternatives, planners should be careful to select programs and structure them so that they will not raise unrealistic expectations, increase economic dependency, or create disincentives to recovery in other sectors.

   b. Economic relief programs for farmers. Farmers require specialized economic assistance in the aftermath of disasters. Programs may include:

      -- loans;
      -- grants;
      -- subsidies;
      -- material assistance (replacing or repairing damaged structures);
      -- loans of equipment;
      -- temporary (alternative) employment;
      -- provision of seeds, fertilizers, pesticides, or chemicals/additives to treat or protect soils.

      (For further discussion of aid to farmers, see the paper, "A Model Program to Reduce Agricultural Vulnerability".)

c. Economic relief programs for small businesses. Small businesses require two types of assistance -- assistance to reduce or recover losses, and programs to stimulate recovery from lost business.

1) Programs to reduce/recover losses: Economic assistance to help businessmen replace damaged merchandise and repair facilities include:

-- loans;
-- grants;
-- subsidies;
-- loan guarantees;
-- material aid (for reconstruction of buildings or facilities).

2) Programs to stimulate recovery from lost business include:

-- issuing coupons to disaster victims that can be redeemed through local stores. Coupons can be of two types: script redeemable in merchandise or coupons that can be used for partial payment of the normal price of specific goods.

-- guaranteed credit. In the immediate aftermath of a disaster, survivors may have difficulty obtaining funds for purchasing materials through local stores. A government may wish to encourage store owners to extend credit so survivors can buy needed materials. To facilitate this process, a government can guarantee survivors credit for the store owners.

-- licensing distributors of relief aid. As a means of both stimulating recovery and controlling prices, the government may wish to consider licensing certain stores to sell disaster relief materials and reconstruction supplies. The government could provide the supplies to the stores or markets at a greatly reduced price and allow them to sell the materials at a small profit. This would enable materials to be distributed at relatively low cost while at the same time allowing the small business to obtain funds for recovery.

4. Establishment of programs for encouraging institutional development. Participation in economic recovery activities can be a strong stimulus to small-scale lending institutions and other economic organizations, such as cooperatives. Governments should develop plans to utilize existing organizations for economic recovery. For example, by providing loan funds to co-ops, the cooperative movement can be expanded.

Once various alternatives have been explored, government and private leaders should meet to select approaches for implementation. When a concensus has been reached, a formal economic preparedness plan should be adopted. The plan should become a part of the overall national disaster preparedness plan and should be periodically reviewed and updated. Participating financial organizations should be kept informed of any revisions and encouraged to develop, on an ongoing basis, ways in which they can participate in the program.

E. Determine aid requirements. In reviewing the mitigation and preparedness programs, planners should determine if foreign assistance could be helpful in pre-disaster or post-disaster phases. Direct assistance to support specific projects or schemes might be obtainable. Furthermore, foreign governments or other institutions might be prepared to enter into standing agreements for support of specific projects as part of their overall commitment to disaster preparedness or response. Mechanisms for activating the programs and integrating foreign aid on a stand-by basis should be established.

F. Reprogram foreign aid. Some international aid organizations permit governments to reprogram normal economic development assistance to help meet disaster needs. The requirements of each of the donors should be determined, and plans for reprogramming should be developed as a preparedness measure.

G. Restructure national debts. In the aftermath of a disaster, many international lending institutions will allow a government to restructure its national debt to permit greater flexibility in reconstruction. Each government should determine what the requirements are and what additional constraints or costs may be imposed by restructuring. If restructuring is desirable, stand-by plans for initiating a request to restructure should be developed and the data needed to analyze and process such a request should be collected on a routine basis.

SUMMARY

For governments in disaster-prone areas, reducing a country's economic vulnerability should be a high priority. Emphasis should be upon integrating vulnerability reduction measures with normal development programs. Mitigation efforts should become part of the planning process, and government officials in all sectors should include disaster preparedness and mitigation measures in their day to day activities.

# CHAPTER SIXTEEN
# CONCLUSIONS, RECOMMENDATIONS, RESEARCH NEEDS

# Conclusions, Recommendations, and Research Needs

What conclusions and recommendations for strengthening future post-disaster mitigation can be gleaned from these many excellent papers and discussion? What are the research needs? To what extent do the mitigation needs of developing and developed nations differ?

## OPPORTUNITIES FOR POST-DISASTER MITIGATION

Not all future hazard losses can, of course, be predicted or prevented. The costs of preparedness and mitigation must be compared with the benefits. As emphasized by speakers throughout the symposium (e.g., Speck), strong political and social pressures to return to the status quo as quickly as possible will undoubtedly continue. Mitigation must compete, in both pre- and post- disaster contexts, for scarce funds and will often lose to higher priority needs. Lack of expertise and limited dissemination of hazard information to decision-makers will be a problem for the foreseeable future. The tendency of both private and public decision-makers to quickly forget or minimize hazards and to focus upon the immediate, rather than the possible or inevitable return of a statistically low probability event, will no doubt remain.

Despite these problems, the opportunities for cost-effective and "do-able" mitigation in both developed and developing nations are increasing as the result of several factors:

-- improved hazard data base and hazard evaluation techniques (e.g., Hay, Whetmore)

-- increased "how to do it" information on a broad range of mitigation techniques including design of new buildings, retrofitting of existing buildings (Lash), warning systems (Wright), marking of areas, relocation (Seyffert), use of insurance as an incentive (Thomas), and conditioning of grants (Cole),

-- increased awareness of the problems which have hindered or prevented mitigation in the past and approaches for overcoming those problems,

-- increased motivation of governments and financial institutions (public and private) to encourage and require mitigation in both pre- and post-disaster contexts (e.g., Speck, Platt, Gelman, Cole),

-- improved exchange of information between government agencies, researchers, educators, consultants, architects engineers, legislators and others concerning workable (and unworkable) mitigation approaches (e.g., Geis, Schram.)

## KEYS TO SUCCESSFUL MITIGATION

Successful mitigation has two major requirements:

-- timely knowledge on the part of those who make rebuilding and repair decisions (hazard area occupants, banks, relief organizations, builders, government agencies) about <u>what to do</u>, and

-- sufficient short-term and long-term <u>motivation and funding</u> to carry out mitigation activities.

More specific suggestions for strengthening post-disaster mitigation offered by speakers and panelists include the following:

1. <u>Establish clear goals and commitments to long-term mitigation</u>. Long-term commitments to mitigation are needed since the tendency is to quickly rebuild and return to the status quo. (Davis, Thomas, Gelman, Hirsch, Seyffert, Popkin) Such goals should be established by legislatures, agencies and relief organizations and incorporated into legislation, regulations, executive orders, plans, deeds, plats and other legal instruments pertaining to disaster assistance grants, loans, public reconstruction activities, building permits, and long-term economic development and redevelopment programs.

Equally important, those providing leadership in a post-disaster context must be familiar with and have an incentive to follow such goals since most of the political pressures favor return to the status quo. Appointment of post disaster mitigation teams with members having sufficient power and responsibility to formulate mitigation options and to act on behalf of relief and response agencies can help counter the tendency of public and

private agencies to stress short-term relief (Eisel, Bond, Zensinger).

2. Initiate mitigation "early on". It is necessary to act quickly after a disaster to assess damages, formulate mitigation options, educate decision-makers with regard to those actions, and carry out certain implementation activities (Zensinger, Thayer). However, not all actions must be undertaken with equal speed. For example, less urgency exists for permanent relocation of structures than for repair of partially damaged structures.

3. Adopt temporary moratoria on rebuilding and repair for certain areas or structures. Often repair and reconstruction must be temporarily halted until mitigation plans are complete and necessary resources are located for implementation. Government regulations prohibiting repair, rebuilding, and reoccupation are often politically unpopular (Thayer) but necessary. Relatively detailed analyses of hazards and damaged buildings and infrastructure can permit the imposition of highly selective moratoria for specific areas or buildings which should not be rebuilt or repaired rather than a large area (Brower).

4. Map hazard zones at scales and degrees of accuracy consistent with implementation needs. Broadscale analysis of hazard zones may be sufficient in a predisaster context to guide evacuation and disaster assistance activities, especially where such broadscale delineations are used only as a presumption of future hazards. More detailed delineation of hazards is necessary for formulating mitigation options and applying particular design standards to specific structures and infrastructure. (Hay, Whetmore, Seffert, Thayer, Lash). For example, flood velocities, duration, and erosion as well as flood heights must be known if structures are to be adequately retrofitted or rebuilt with hazard protection.

Hazard information must usually must be developed quickly if it is to guide repair decisions. It is particularly important to quickly collect perishable data (Mitchell).

Various approaches are available for defining hazard zones and risks within those zones including onsite surveys of damage by postdisaster teams (Zensinger, Wright, Bond), engineering studies by consultants or agencies (Hay, Kochleman), and the use of damage questionnaires (Alexander).

5. Survey damage to structures, facilities, activities. Assessment of the nature and degree of damage to structures and infrastructure is needed to guide the adoption of building moratoria and form the basis for reoccupation and repair decisions including more detailed mitigation planning for redevelopment, relocation, etc. (Brower).

In some instances such assessments must be carried out within days of the disaster since it is often unrealistic or impossible to keep occupants of hazards areas from returning to their homes and beginning repairs within a few days of a minor hazard event and a week or two of a major disaster except for severely damaged areas.

A "triage" classification of damaged structures to guide decision-making may be helpful (Brower).

Evaluation of damage and mitigation potential often requires engineering and architectural expertise not available at the local level. In the U.S., the federal post flood disaster teams have proven particularly useful in providing such expertise and formulating mitigation options (15 days). (Zensinger, Bond, Eisel).

6. Propose and evaluate specific mitigation options. Successful mitigation requires the formulation of timely, practical and attractive mitigation options. What can be done with a specific structure to reduce vulnerability? Who will pay? how much? with what time frame? Post flood disaster mitigation teams in the U.S. have proven highly useful in suggesting options. Engineering consultants and agency staff trained in retrofitting and other mitigation approaches have played similar roles in other contexts.

Detailed analysis of not only damaged buildings but those suffering little or no damage can help guide mitigation planning for future disasters including the identification of buildings which may be used for shelter in future disasters (Lash, Pace, Ruche, et. al.)

7. Support local government initiatives in mitigation. Federal agencies, states, and private relief organizations play major roles in relief and the immediate post disaster context. But local governments are often principally responsible for long-term land use decision-making and rebuilding. State, national, and international relief efforts are often poorly coordinated with local government mitigation initiatives (Rubin, Hirsch, Popkin) and may, in fact, undermine their efforts. For example, relief efforts which facilitate immediate repair of buildings in high risk areas may undermine long-term relocation goals for a redevelopment area. The promise of long-term flood control or other subsidies by a federal government agency may undermine local government efforts to encourage or require retrofitting or relocation.

Support for local short and long-term mitigation efforts may take many forms: involvement of locals in post-disaster teams (Bond); putting locals in charge of relief and recovery (Alexander); working closely with locals to discover "what they want" (Hirsch, Seyffert); training and education (Schramm, Torrellva); financial assistance for acquisition (Strong, Thayer); demonstration projects (Godshalk); mapping hazard zones (Hay, Thayer); subsidized insurance and disaster assistance conditioned upon mitigation (Thomas, Simeon, Cook); and technical assistance (e.g., Lash, Pace, Wright).

Encouragement and support for local government initiatives will do little good, however, unless the local governments themselves have some interest in mitigation and are willing to "help themselves" (Rubin). Local government initiatives to "help themselves" may include the formation of local post-disaster assessment teams (Bond), adoption of moratoria (Thayer), future planning for disasters (Berke, Seyffert, Whetmore), formation of one or more recovery teams (Brower), marking of hazard areas (Thayer), acquisition (Hirsch, Seffert, Strong), evacuation planning (Griffiths), and building surveys (Whetmore).

8. Encourage private retrofitting of partially damaged structures. Most structures in a disaster area are partially damaged, not destroyed (Whetmore, Lash, Alexander). These are often quickly repaired with little thought of future damage.

Building surveys should be conducted quickly after a disaster to classify structures according to degree of damage and mitigation possibilities. (Whetmore, Brower, Pace, Lash). Guidebooks and training should be provided to hazard area occupants, engineers, architects, and other builders and contractors to encourage retrofitting (Lash). Financial incentives are also needed such as preferential insurance rating and disaster assistance specifically earmarked for mitigation.

9. Define disaster victim and local area needs and preferences. Earthquakes, floods, tornados, etc. cause physical damage but the extent of the "disaster" depends upon the impact of the event on people (Dyne) and their responses. The true nature of this impact and disaster victim needs and preferences in responding to various sorts of damage are unfortunately poorly understood in many disaster relief and recovery contexts. Plans are fitted to people and not vice versa. This undermines long-term mitigation efforts since long-term mitigation depends (to a considerable extent) upon the motivation of victims, not simply the desires of agencies.

More attention needs to be placed upon the "politics" of mitigation (Thayer). To insure their support for long-term mitigation, victims must be treated equitably. Government programs need to be carefully explained and reexplained (Strong). Victims should not be given false expectations with regard to disaster assistance or long-term mitigation (e.g., a dam) (Lydstadt).

They must be carefully educated and worked with in formulating mitigation strategies and options (Seyffert, Hirsch).

10. More fully involve the private sector in formulating and helping to implement long-term options. The help of private relief organiza tions, bankers, developers, hazard area occupants and other "private" sector groups and individuals is needed in promoting and implementing longterm mitigation. In general, private relief organizations such as the churches and the Red Cross now focus almost exclusively upon immediate relief (Popkin). Training and education of these groups with the aim of having them shift some of their emphasis and resources to long-term mitigation could help bring the message to local governments and disaster victims as well as encourage better coordination of relief and long-term recovery.

Bankers, contractors, developers and hazard area occupants are also inadequately involved in post-disaster mitigation planning (Popkin, Godschalk) although they make most of the long-term land use decisions. Options for strengthening their roles in mitigation include their involvement on post-disaster assessment teams, the formation of redevelopment committees (Brower, Godschalk), training and education (Popkin), incorporation of mitigation conditions in grants and loans, and negotiated development (Godschalk).

11. Strengthen training and education for those making rebuilding and repair decisions. Training and education of hazard area decision-makers such as bankers, contractors, local governmental officials and hazard area occupants with regard to the nature of risks and what can be done about them are key to long-term mitigation (Schramm, Popkin, Godschalk, Geis). But such training and education is not easy since decision-makers are located throughout a region, not simply in hazard areas; turnover is large (particularly among local government officials); and decision-makers may have a low level of interest except immediately after the disaster.

Suggestions for training and education include the development and widespread dissemination of "how to do it" manuals and guidebooks on retrofitting and other mitigation technique (Lash), the use of demonstration projects (Godschalk), and marking hazard areas (Thayer).

Workshops, short courses, and special semi nars also have considerable potential, particu larly for members of professional organizations such as architects and engineers and bankers who deal, over a period of years, with individual projects in hazard areas (Geis), post disaster team members (Eisel), and state agency personnel who deal on a continuing basis with many local governments and hazard area occupants (Bond).

12. Formulate "visionary" mitigation plans. Visionary, multi-objective mitigation plans based upon a "future image" for a community sometimes succeed where small plans do not (Zinsinger, Hirsch, Rubin). Some of the major success stories in mitigation such as Soldier's Grove, Wisconsin; Baltimore County, Maryland; and Denver, Colorado have involved considerable "vision" and imagination. A well-conceived development and redevelopment plan for a community as a whole may tap a wide variety of funding sources (Hirsch, Seyffert), and may draw support from groups within the community.

This is not to suggest that large scale plans are always necessary or successful or that plans drafted without careful attention to specifics, funding potential, and client groups will succeed.

13. Formulate "factually sensitive" mitigation plans. Successful mitigation efforts have, with little exception, been "opportunistic" with regard to the specific factual situations. They have rarely been imposed solutions, but rather ones which arose when practical and do-able alternatives were identified for specific structures or activities (Seyffert, Hirsch, Rubin). In other words, the design and deployment of successful mitigation requires a high degree of sensitivity to specifics and often must be built upon the desire of hazard occupants to improve their own situations.

14. Attachment mitigation conditions to insurance payments, grants, loans and other forms of disaster assistance. The attachment of mitigation conditions to various forms of assistance (Gelman, Davis, Bender) is politically difficult but may be essential for long-term implementation of mitigation strategies. The conditioning of flood insurance upon adoption of local floodplain regulations in the United States has been very successful in encouraging communities to adopt floodplain regulations (Thomas, Platt). Progress had also been made in the U.S. in conditioning both flood and nonflood disaster assistance upon the preparation of disaster mitigation plans (Zensinger) and in conditioning federal activities and financial assistance for activities in the floodplain with compliance with the Floodplain Management Executive Order (Thomas). On the international scene, some grants and loans have been conditioned upon mitigation (Cook, Cole).

However, the use of conditions has not always worked, particularly where the agency attaching the conditions is not in a position to compel long-term compliance (Cook). To be successful, conditions must be carefully tailored to the mitigation objectives, the actual financial situation, the time frame, and the sponsorship. (Cook)

15. Provide financial incentives for long-term mitigation or remove disincentives. The success of the National Flood Insurance program in the U.S. promoting in 17,000 communities to adopt regulations for future development is quite phenomenal (Platt, Thomas). However, this program has been largely unsuccessful in encouraging retrofitting for partially damaged structures and has been largely unsuccessful in reducing the number of existing structures at risk (Thomas, Lash) due (at least in part) to lack of incentives in the insurance rate structure. Some landowners have apparently come to look forward to "flood insurance income" from repetitively damaged structures (Strong).

Additional financial incentives or disincentives are needed in this and other insurance programs (Simeon) to encourage mitigation such as a surcharge on repetitively damaged properties. This surcharge might be waived or reduced if mitigation measures were installed.

Other financial incentives for mitigation could include allocation of a portion of disaster relief funds to mitigation (e.g. 20%), additional long-term loans and grants specifically earmarked for mitigation, favorable cost-sharing for projects involving mitigation, and favorable mortgage financing for retrofitted structures.

On the other side of the coin, financial disincentives to mitigation should also be removed or modified such as flood insurance policies which continue to pay whether or not mitigation occurs, federal "bail out" programs for flood control, and subsidies for redevelopment of floodways as well as barrier islands (Godschalk, Whilden).

16. Implement comprehensive pre-disaster preparedness and prevention measures. "An ounce of prevention is..." (Alexander, Luther, Speck, Whetmore, Seffert, etc.). Advance mapping of hazard areas, adoption of design guidelines for structures in hazard areas, deployment of warning systems and other measures to reduce loss of life and property are most effective when implemented as part of the original construction.

It is, of course, moot to argue after a disaster that a prevention program should have been in place. But the awareness and political support generated by one disaster may permit establishment of a broader mitigation program to control new development, retrofit and reduce vulnerability to buildings and infrastructures over time as well as repair and rebuild consistent with mitigation guidelines. A disaster prevention program also can establish many of the policies, data base and organizational responsibilities which facilitate mitigation after a disaster.

17. Prepare a post-disaster redevelopment plan prior to a disaster, ready for implementation when and if a disaster occurs. "Ad hoc" attempts to mitigate future losses after a disaster have been much less successful than situations in which redevelopment plans were already in place (Rubin). The experiences of Rapid City and Soldiers Grove and other areas with prior redevelopment plans indicate their value (Hirsch, Whetmore, Seyffert). Having a plan and policies for redevelopment, deployment of warning systems, acquisition or other mitigation matters prior to a disaster can guide immediate repairs, the adoption of moratoria, and long-term rebuilding. Preparation of such a plan in the pre-disaster period is complicated by lack of staff and resources, chaos, and the inability of local officials to make complicated decisions during the stress period.

As desirable as a "pre-post disaster" development plan may be, it is difficult to gain the political support to prepare a

detailed redevelopment plan based solely upon the contingency of a future disaster. But long range, multi-objective land and water resource planning with hazard mitigation as a major component and scheduled for long-term implementation whether or not a disaster occurs can be politically acceptable (e.g., Soldiers Grove, Wisconsin).

18. Implement measures to provide long-term landowner and institutional awareness of hazards. Landowners and other decision-makers often quickly forget or ignore hazards (Thayer) unless reminded on a continuing basis. Possibilities for improving long-term awareness include putting signs in hazard areas; construction of monuments; indicating high water marks (for flooding) on trees, public buildings and telephone poles; including descriptions of hazards in deed restrictions and notations, and plat restrictions and notations; incorporation of hazard maps into zoning maps; and the conditioning of mortgates and other forms of long-term financial assistance upon the purchase of hazard insurance or other mitigation measures.

19. Incorporate hazard mitigation into long-term comprehensive and multisectoral planning. Hazard mitigation should be incorporated in long-term economic development, housing, infrastructure and other types of planning. (Luther, Berke, Brower, Bender, Gelman, Davis). In developing nations much of the development is planned and financed through such programs. Considerable engineering, architectural and other forms of expertise of the sort not typically available on an individual small project basis can be brought to bear in such planning efforts. Large scale development programs for infrastructure, economic development and housing often offer opportunities for mitigation also not available on a building by building basis.

## DEVELOPED AND DEVELOPING NATION NEEDS

To what extent do these suggestions for strengthening post disaster mitigation differ for developed and developing nations? Speakers repeatedly emphasized that mitigation policies and techniques must be modified to reflect actual conditions whether in developed or developing nations (e.g., Seyffert, Whetmore). See Appendix B of this report. Careful tailoring is needed of techniques and approaches to the cultural context (Dyne), available funding, local materials, expertise and other factors. Nevertheless the overall framework needed for mitigation -- clear policies, hazard maps and data, post-disaster surveys, guidelines for reconstruction, incentives, education -- appears much the same.

### Differences

Some differences between developing and developed nations include:

Design standards. In developed nations, hazard mitigation design standards for new construction in areas subject to earthquake, wind, and flood hazards are now quite widely available. Few standards have been developed for privately constructed adobe or other non-engineered structures in developing nations.

Building codes and building permit systems. Developed nations have, in general, adopted planning, zoning and building codes which can be used to control (at least to some extent) the location of structures and their design. Developing nations have rarely adopted such codes except for larger cities.

Construction materials. Steel and concrete are widely used in developed nations. Adobe, wood, and other local materials are more common in developing nations.

Engineered versus nonengineered structures. Larger commercial, industrial and residential structures in developed nations are constructed with plans prepared by architects and engineers. Single family residences and smaller commercial structures in developing nations are often built by landowners or local artisans without the benefit of engineering or architectural help.

Landowner and builder literacy. In developed nations, most landowners, craftsmen, and builders can read hazard warnings, construction standards, etc. Literacy is less common in developing nations and poses special problems for the use of maps, codes, etc.

Hazard maps. Most developed nations have, to some extent, mapped hazard areas. In some instances this mapping has involved a statistical analysis of the hazard probability (e.g., the 100 year flood). Few systematic hazard maps are available for developing nations although general records of flooding, earthquakes and other disasters may be available.

Land ownership. Statutory survey and land title systems have been adopted in developed nations. Ownership and boundaries are often less clear in developing nations, complicating the application of building codes and relocation schemes and the construction of hazard reduction measures such as dams.

Communication. In developed nations, hazard warnings and information concerning post-disaster mitigation measures may be communicated to threatened areas and indiviuals through television, radio, and telephone. Communication systems are less effective in developing nations although widespread electrification and broadened radio and television networks have improved the situation.

Available disaster funds. Larger sums are available for disaster prevention and response including the repair of buildings in developed nations. This facilitates the construction of "structural" hazard reduction measures such as dikes and dams in a post-disaster context. Less

expensive approaches and more care in setting priorities is needed in developing nations.

Foreign aid. Large amounts of foreign aid are rarely needed or sought by developed nations. In contrast, developing nations often seek or are offered large amounts of technical assistance, food, blankets, and temporary housing, grants, etc. This aid may or may not be linked to the actual needs of the disaster victims.

Insurance. Disaster victims in developed nations are often partially or wholly insured. Insurance is less common in developing nations.

Local coping mechanisms. In developing nations, disaster victims rely more upon family, neighborhood, friends, and other local coping mechanisms. In developed nations the national government, other governments, insurance, and other mechanisms play larger roles.

Available expertise. In developed nations, large numbers of architects, engineers, planners and other experts are often available for hazard mitigation planning or rebuilding. Much smaller numbers are available in developing nations.

Liability. In developed nations the threat of law suits by disaster victims claiming that government failed to provide adequate warnings, construct adequate hazard mitigation measures, or otherwise prevent or mitigate hazards is a major stimulus (and/or) limitation upon government action. Government liability is a less serious problem in developing nations.

Accountability for funds. Charges that disaster relief funds find their way into private pockets is more common for developing nations although misallocation of funds is sometimes a complaint elsewhere.

Impact of the disaster and disaster aid on the local economy. Disasters such as floods or volcanoes which destroy crops may cause famine in developing nations highly dependent upon local food sources. In contrast, famine is rarely a problem in developed nations. The impact of disaster aid also differs. Disaster aid such as food in developing nations may suppress local agricultural activities while such aid rarely has much impact on food production in a developed nation where food is marketed nationally.

## Similarities

Despite the differences, and they are significant, there are also many similarities in hazard mitigation needs between developed and developing nations:

Victims needs. In some respects, disaster victim needs are similar world-wide. Is the pain and suffering caused by loss or injury of a loved one or friend any different in a developed or a developing nation? Economic losses may be more easily absorbed by victims in developed nations but such victims also have more to lose. It is not clear that the loss suffered by a homeowner of an adobe structure worth $800 (a year's income) is more serious than that of a homeowner in a developed nation with a structure worth $40,000 (a year's income) although the developed nation homeowner may find financing more easily.

Victim needs in both developed and developing nations include the following:

(a) Need for food and water. Obtaining basic sustenance both immediately after and the longer term is more of a problem in developing nations.

(b) Need for immediate shelter, clothing, blankets. Again, meeting this need may be a more serious problem in a developing nation.

(c) Desire to rebuild or reestablish a "home" as soon as possible. This seems universal.

(d) Concern for well-being of family and friends. This is universal.

(e) Desire to be in familiar surroundings and with friends and neighbors as soon as possible. This is universal.

(f) Desire for a job or income as soon as possible to provide funds for day-to-day requirements to replace lost personal items, and to permit repair and rebuilding. This may be a higher priority in a developing nation without a long-term welfare or relief system.

(g) Desire for fair and even-handed treatment by governmental officials and relief organizations so that one group does not disproportionately benefit from relief and rebuilding. This is universal.

Hazard Characteristics. Despite differences based upon climate, topography and other factors, a flood is a flood. The overall characteristics of the physical phenomenon and sorts of damages caused to similar structures, infrastructure, crops, etc. are pretty much the same world-wide. Because the physical phenomenon are the same, the prediction techniques, mapping techniques, and mitigation needs and options are also pretty much the same, although materials costs, levels of expertise and available finances differ.

Options for Mitigating Losses. Overall options to reduce hazard losses are much the same although specific designs, building materials, available expertise, and methods for construction differ. For example, several major options are available to reduce flood damages world-wide: mapping and warnings; relocation outside of the floodplain; elevation on fill, pilings, etc.; structural floodproofing; or hazard reduction (e.g., dams). The engineering and architectural design formulas

for stress and loading are universally applicable although materials differ.

Structural (engineering) measures to reduce hazards are similar world-wide. Flood hazards can be reduced through dams, dikes, levees, sea walls, channelization. The options are limited. Earthquakes cannot be reduced, although damage from them can be. Landslides, mudflows and mudslides can be reduced through debris basins and dewatering of formations. The technical design requirements are pretty much the same country to country although materials and construction practices again differ.

Problems With Post-Disaster Mitigation. Problems with or impediments to post disaster mitigation noted in Chapter 1 above are also quite similar. Some progress has been made in both developed and developing nations in reducing vulnerability in reconstruction after disaster through relocation, upgraded building standards or other techniques. But effective post-disaster mitigation is still uncommon in both developed and developing nations.

In summary, then, the overall policy, legal and economic framework and approach for hazard mitigation in similar in developed and developing nations. The required technical analyses are also quite similar. The specifics of implementation with regard to funding levels, training and education and dissemination of information differ.

## RESEARCH NEEDS

Most post-disaster research to date has focused on response, not the effectiveness of various mitigation measures including those for only partially damaged structures. Priority research needs include

1. Goal-oriented and specific post-disaster assessments. More careful, goal-oriented post-disaster assessments are needed to better determine the effectiveness of various mitigation approaches, the nature of damages, victim needs, accuracy of maps and hazard prediction models, and the effectiveness of public education and information transfer approaches. Much of this research should be carried out quickly after a disaster but follow-up studies 3, 5, 10 years afterwards are also needed. Research should be goal and hypothesis-oriented, and must be carried out by experts (Mitchell, et. al.).

2. Guidelines for retrofitting damaged buildings. Additional research is needed to develop building and retrofitting guidelines. (Lash, Pace, et. al.) These guidelines should apply to partially damaged structures and for retrofitting in advance of disasters in earthquake, flood, mudslide and other natural hazard areas. Guidelines should be prepared for both engineered and nonengineered structures. After preparation, guidelines should be disseminated in simple "how to do" manuals as well as incorporated into more formal regulations and design manuals.

3. Damages and mitigation measures for multiple loss structures. Further study is needed of mitigation needs for multiple loss structures, investigation of types of damage and magnitude of damage suffered by such structures over time, and the preparation of retrofitting and relocation criteria (Lash, et al.). What sorts of damages do multiple loss structures typically suffer? What mitigation measures might be practical for such structures and in what circumstances?

4. The evaluation of U.S. post-disaster mitigation teams and their possible applicability to other nations. The U.S. Federal post flood disaster teams should be studied to determine how they can be made more effective with regard to the formulation and implementation of mitigation options (Platt, Eisel, Bond). Are state and local interests adequately represented? The possible applicability of the U.S. experience to other types of disasters and to other nations should also be examined.

5. Guidelines for mitigating losses to internationally financed projects. Studies should be carried out to determine the rate of actual losses for major development projects financed by international loans and grants and to establish improved guidelines for reducing losses to projects (Bender, Davis, Cole).

6. Impact of relief, insurance and other assistance and subsidies on local leadership, coping mechanisms, retrofitting, and long-term mitigation. Research should be carried out on the impact of various types of relief efforts on local leadership, local support mechanisms, retrofitting and long-term recovery (Rubin, Berke, et. al.). It should examine and suggest alternative approaches for national and international relief agencies to help support rather than undermine local leadership and to encourage long-term mitigation.

7. Mitigation guidelines for long-term, multi-objective, economic planning. Research should be carried out to help establish guidelines for incorporating hazard mitigation measures into long-term economic planning for agriculture, forestry, recreation, industry, and other activities (Bender, Gelman, Davis, Brower). Cost-benefit studies with regard to mitigation techniques should be one component.

8. Techniques for promoting long-term awareness of hazards. Research should be conducted into the effectiveness of various techniques for promoting long-term awareness of hazards by the occupants of hazard areas, planners, government officials, etc. What techniques such as marking areas, zoning, deed restrictions, workshops work best to establish long-term awareness? At what cost?

9. Calibration of hazard prediction models. Post-disaster studies should be carried out to help calibrate various models

and mapping approaches for floods, mudflows, landslides, avalanches, and earthquakes. Actual hazard events should be compared with predictions to suggest weaknesses in existing approaches and help refine them for application in various conditions.

10. Improved mitigation planning. The various phases and types of mitigation planning now underway should be examined and compared to suggest a satisfactory sequence of planning prior to and after disasters and an adequate hierarchy of planning involving the private sector, local governments, the states or provinces and national governments (Zensinger, Gelman, Davis, Berke, et. al.). Such a study should consider the interrelationships between the following:

- predisaster planning of both a general nature and specifically for rebuilding after the next disaster,
- formulation of post-disaster mitigation options by post-disaster mitigation teams,
- post-disaster mitigation planning by states and communities after a disaster, pursuant to section 404 (the U.S.), and
- longer term infrastructure, economic development, housing and other planning.

11. Establishing priorities for mitigation activities. Given limited funds and manpower, what approaches should be taken by developing nations, local governments, private industries, etc. to mitigate future losses including selection of priority communities and areas, selection among various mitigation techniques, etc.?

12. Quantification of costs and benefits. Further study is needed to quantify the costs and benefits of mitigation measures. What losses will likely result to particular activities conducted in areas with particular levels of risk? What are the costs, benefits (loss- reduction attributes) of various mitigation techniques for these areas? A careful analysis of disaster losses in various identified (quantified) hazard zones is needed to provide this information.

13. Low cost methods for risk assessment. The effectiveness of alternative approaches for predicting and mapping hazards (e.g. use of satellite imagery) in various management contexts should be investigated. Are low cost methods for mapping risk areas including mudslide, earthquake, flood, or other hazards of any value in regulation, acquisition, warning? What degrees of accuracy are needed for what techniques? How can inaccuracies be best dealt with through data gathering on a case-by-case basis as development proposals are submitted? other approaches?

14. Legal/institutional mechanisms for financing and promoting self-help. Legal research and institutional studies should be carried out to analyze alternatives and suggest specific legislative options for self-help by hazard area occupants or communities in financing recovery and long-term mitigation through bonding mechanisms, creation of special taxing districts (e.g. levee districts) or creating rehabilitation districts.

15. Identification of areas or activities in developing and developed nations needing similar mitigation strategies. Further efforts should be made to identify similarities and differences in developing and developed nation hazard mitigation efforts and to suggest mechanisms for improved coordination and cooperation where there are similarities. For example:

- Developing nations and rural states may share similar mitigation needs due to limited resources, limited financial expertise and an agrarian economy. Could guidebooks be prepared which would be of use to both groups? How could they better share information?
- Large cities in developing and developed nations have much in common including high land values, building code systems and considerable engineering and architectural expertise. How could information on hazard mitigation approaches including their effectiveness (e.g., performance of earthquake resistant design in the Mexican earthquake) be better shared?
- Island nations and larger coastal islands in developed countries may have much in common including evacuation problems during a meteorologic disaster, large scale flood problems, water supply problems after a disaster, and tourism as a principal industry. Could special guidebooks serve both types of areas?
- Arid and semiarid regions in developed and developing nations share similar problems and needs including flash flooding due to the lack of vegetation, mudslide and mudflow problems, desertification, etc. What sorts of common research and information transfer might be appropriate here?

# *Appendix*

# *Appendix A*

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# Appendix B

## Elements of a Post-Disaster Mitigation Statute or Policy

*Jon Kusler, Esq.*

What provisions should be contained in a statute or regulation designed to provide a satisfactory administrative framework for post-disaster mitigation? The following recommendations are distilled from speaker presentations and discussion in the symposium. An overall statutory framework is first presented and then more detail is suggested for individual elements. However, there is no attempt to provide actual statutory language. These elements could be incorporated into local ordinances, administrative regulations, or agency policies as well as a statute. The elements are grouped into major and somewhat overlapping categories.

### THE FRAMEWORK

A statute establishing a post-disaster mitigation program for either a developed or developing nation should

- Establish clear statutory goals for short-term and long-term post-disaster mitigation for all agencies and organizations involved with predisaster preparedness and post-disaster relief, repair and long-term recovery;
- Authorize an agency or agncies to coordinate relief and post-disaster mitigation;
- Authorize an agency or agencies to adopt moratoria on rebuilding and repairs.
- Authorize an agency or agencies to conduct immediate post-disaster assessment of hazard zones, damages and mitigation options;
- Authorize an agency or agencies to establish guidelines for redevelopment, retrofitting, relocation;
- Authorize an agency or agencies to assist landowners and others in short-term mitigation;
- Promote long-term rebuilding and economic development consistent with mitigation goals.

Major differences between developing and developed nations will occur in the implementation, but not necessarily in the statutory framework. For example, in a developing nation with limited resources, more emphasis might be placed upon

- prioritizing hazard areas for mapping, adoption of codes, etc. It may be unrealistic to embark on a nationwide program;
- identifying and supporting local (neighborhood) and family "coping" mechanisms;
- coordinating international disaster relief (e.g. food supplies) with the needs of the local economy;
- developing codes and educational materials for nonengineered structures and the onsite training of craftsmen and local builders;
- implementing "nonstructural approaches" for loss reduction such as building standards rather than expensive hazard reduction measures such as dikes, dams, debris basins, etc.;
- creating demonstration projects.

A statute can, at best, establish a commitment to and framework for strengthening post-disaster mitigation. The success of mitigation will depend upon appropriation of necessary financial resources, the commitment and expertise of the administering agency, and the cooperation of disaster victims who ultimately determine the content of most post-disaster reconstruction decisions.

### STATUTORY ELEMENTS

Individual elements may include the following:

#### Statutory Goals

A statute for either a developed or developing nation should establish clear goals to guide agencies, local governments, and relief organizations, in pre-disaster planning

and post-disaster response and counter some of the pressure to quickly return to the status quo. These goals should:

- promote and (in some instances) require mitigation measures in short-term and long-term rebuilding, repair, recovery and economic development to reduce future losses including loss of life, economic losses, disruption of the economy;
- establish clear lines of responsibility for pre-disaster mitigation and post-disaster response including designation of a lead agency with sufficient power and expertise to insure that a mitigation perspective will in fact be incorporated in the actions of all relief and recovery agencies;
- coordinate disaster relief and recovery with local economic needs to create jobs for victims as soon as possible and encourage maximum use of local materials in the recovery process;
- encourage and support local "coping mechanisms" and local leadership in predisaster planning and post-disaster response.

## Coordination of Relief and Post-Disaster Mitigation

The statute should direct the agency or agencies responsible for immediate relief activities to consider long-term mitigation in their activities. This will encourage a long-term perspective. One approach is to require the agency or agencies responsible for relief civil defense, emergency preparedness) to formulate long-term mitigation plans with other agencies (planning, natural resource, etc.) More specifically, a lead agency should

- identify organizations (both prior to and after a disaster)which may assist with repair and long-term rebuilding;
- form one or more short and long-term post-disaster recovery and mitigation coordinating committees consisting of representatives of principal organizations and agencies with potential long-term mitigation goals;
- provide emergency shelter, food and temporary housing consistent with possible long-term mitigation options (e.g., possible relocation for some areas);
- establish expert interagency mitigation teams with the help of the coordinating committee to be sent immediately after the disaster into the field to delineate hazard areas, assess the severity of hazards within the areas; assess damages to structure and infrastructure; and identify mitigation options (see discussion below);
- coordinate and condition immediate government loans and grants to encourage short-term and long-term post-disaster mitigation.

## Adopt Moratoria on Rebuilding and Repairs

The lead agency responsible for post-disaster mitigation (civil defense, natural resource, planning, finance, etc.) or another cooperating agency should be authorized to

- adopt a moratorium or moratoria on repair and rebuilding until the primary assessment of hazards and mitigation options is complete. Such moratoria may be of varying length, depending upon the severity of the damage to structures, the preliminary assessment of mitigation options and other factors.

## Conduct Immediate Post-Disaster Assessment of Hazard Zones, Damages, Mitigation Options

To reduce victim uncertainties and provide the basis for long-term mitigation, a lead agency should quickly identify mitigation options in the post-disaster context. This lead agency should, in cooperation with other agencies and organizations, be authorized to form one or more interagency mitigation teams (as suggested above) which would be sent into the disaster area within a designated time period to.

- conduct an assessment of the extent of the damaged area (e.g., boundaries of a slide area, flooded area, etc.) and the seriousness of the hazard (velocities, depths, etc.) within the area;
- map or otherwise document hazard areas at sufficient scale to guide repair and rebuilding;
- inventory structures and infrastructure in the disaster area to determine which are safe for immediate reoccupation, which will require short-term or long-term repair, and which should be relocated or razed;
- formulate standards for retrofitting and repair of structures (if they have not already been developed);

— make recommendations for emergency housing consistent with long-term mitigation;

— suggest broader mitigation options such as levees, debris basins, warning systems, or relocation to prevent the reoccurrence of future disasters;

— suggest how disaster relief and recovery can be used to encourage mitigation of future losses, including conditions which should be attached to loans, grants, other forms of disaster relief;

— assess the impact of the disaster and possible relief on jobs and the economy and make suggestions for quickly reestablishing jobs;

— identify local "coping mechanisms" and suggest ways to support these mechanisms.

Establish Guidelines for Redevelopment, Retrofitting, Relocation

The statute should authorize the lead agency responsible for mitigation or other agency to

— establish guidelines for construction, repair and rebuilding of public infrastructure (roads, sewers, water supply) in risk areas (e.g., the Floodplain Management Executive Order in the U.S.);

— develop, in cooperation with engineering and architectural organizations, design standards for retrofitting or rebuilding various types of private structures including single family "nonengineered" structures;

— develop guidelines for condemming severely damaged structures and preventing reoccupation;

— develop broader guidelines for state and local planning and regulation of land use in hazard areas, including not only building standards (see above), but also location of industries and commercial uses, to reduce disruption of jobs during a disaster; standards for hazard reduction measures such as dikes, dams, debris basins; establishment of warning systems; multiple use of hazard areas for recreation, etc; and

— prepare, in cooperation with local governments, states, and private organizations, plans for post-disaster relocation plans for high risk areas (where appropriate).

Assist Landowners and Others in Short-Term Mitigation

The lead agency should assist landowners and others in carrying out short-term mitigation. It should

— restore, on an emergency or more permanent basis, roads, electrical power, sewers, and water supply, or provide technical assistance, materials, or loans to facilitate such restoration;

— undertake or assist with the removal of debris and structures damaged beyond repair;

— provide disaster assistance funds (loans, grants) with a specific portion of such funds earmarked for mitigation and with legally enforcable conditions attached to such funds.

— provide architectural and engineering advice to local governments, architects, engineers and disaster victims to encourage short and long-term mitigation;

— house victims as close to repairable structures as possible to facilitate self-help;

Promote Long-Term Rebuilding, Recovery, Economic Development Consistent With Mitigation Goals

The lead mitigation agency should establish policies for long-term rebuilding and recovery and the integration of short-term and long-term disaster response. However, the operational responsibilities for much of the rebuilding and recovery may be placed in another planning or development agency. The agency should

— specify what will not as well as what will be done in long-term rebuilding and recovery so that local governments and landowners do not develop false expectations concerning government hazard reduction efforts (e.g. construction of dams and levees to remedy all flood hazards);

— establish hazard mitigation as an element in all economic development planning, infrastructure improvements, and low income housing construction and reconstruction;

-- have authority to undertake or fund public acquisition of selected high risk areas and relocate residents;

-- undertake additional mapping, vulnerability analysis, guidance of new construction; predisaster planning; and disaster preparedness planning of the sort outlined below;

-- where necessary, research and promulgate building standards for both new structures and the retrofitting or repair of existing structures which address the full range of hazards and elements of risk;

-- provide grants or low interest loans to assist private and local government repair consistent with mitigation guidelines;

-- utilize (to the extent practical), disaster victims in repair to provide jobs, stimulate the local economy, and provide education and training in mitigation approaches;

-- utilize local materials, local suppliers (particularly those damaged by the disaster) to stimulate self-help, recovery;

-- construct "demonstration buildings" to illustrate design guidelines and recommended building materials and practices. Government buildings (e.g., post offices, administrative offices) under construction for other purposes may be used for such demonstration. Publicly financed low income housing is another possibility.

## Promote Comprehensive Disaster Prevention, Preparedness and Response

Post-disaster mitigation works best as a part of broader disaster prevention, preparedness and response. A legislature could best reduce future disasters by establishing a comprehensive program incorporating not only the elements suggested above but the following broader measures. A lead agency for post-disaster mitigation or another agency could best be given broad powers including the following:

### 1. Mapping and Marking Areas

Broader mapping and marking of hazard areas could be authorized for both pre- and post-disaster contexts. Particularly detailed maps are needed to guide recovery and post-disaster efforts. The statute should authorize an agency to

-- establish priorities for pre-disaster mapping and marking based upon a preliminary assessment of risks in the country, degree of hazard, population at risk and other factors (see vulnerability analysis below);

-- map and mark hazard areas through signs, high water marks, etc. both after disasters, when the physical evidence of hazards is available, and in pre-disaster contexts as part of pre-disaster mitigation efforts;

-- reflect relative risk in such mapping (to the extent practical) to indicate areas where no reconstruction after a disaster or new development should be permitted (e.g., the immediate fault in an earthquake zone; the moving portion of a landslide; a floodway) and areas of lesser risk where buildings may be reconstructed after a disaster or new buildings may be constructed consistent with damade reduction guidelines;

-- publish and disseminate hazard maps to emergency management personnel, local governments, developers, private landowners, etc.

### 2. Vulnerability Analysis

The statute should authorize the lead agency to prepare "vulnerability analyses" for various communities, transportation corridors, key industries, electrical power supplies, etc. based upon areas of risk, magnitudes of risk, population levels, probable impacts of disaster events on key sectors in the national economy, food supply, etc.

### 3. Preparedness

The statute should authorize the lead agency to (the list is not exhaustive):

-- prepare evacuation plans or, if evacuation is not possible, a plan for refuge during the disaster (e.g. vertical refuge in public building during a hurricane);

-- certify public and private buildings as "refuges" during disasters and able to withstand expected winds, flooding, etc.;

-- design and operate prediction and warning systems;

-- prepare emergency access plans for rescue and relief for areas where normal access will be cut off due to flooding, destruction of bridges, etc.;

-- acquire and maintain emergency vehicles and equipment;.

-- stockpile or identify sources of food, blankets, medical supplies, emergency water supply which will be used during or immediately after the disaster event;

-- stockpile and identify sources of materials needed for emergency hazard reduction such as sandbags for levees;

-- stockpile or identify sources of temporary shelter or housing such as existing "safe structures," tents, mobile homes, etc.;

-- identify sources of expertise and manpower for emergency rescue and relief;

-- identify personnel for policing of the disaster scene to prevent looting, maintain order;

-- prepare contingency plans for secondary hazards such as fires or dam breaks resulting from an earthquake;

-- establish emergency communication facilities for use during and after a disaster;

-- establish lines of organization and authority for coordinating agencies during and after a disaster.

4. Incentives for Mitigation

The statute could also authorize the agency to administer a variety of programs to encourage pre- and post-disaster mitigation such as

-- federally or state subsidized insurance for communities or individuals undertaking construction consistent with minimum hazard reduction guidelines (e.g., the U.S. National Flood Insurance Program),

-- withholding of government subsidies for insurance, infrastructure, disaster assistance and other aids or incentives for certain high risk areas (e.g., the U.S. Barrier Resources Act) for redevelopment or new development.

-- income tax write-offs for the incorporation of hazard mitigation measures in new construction or retrofitting of existing construction;

-- grants-in-aid to local governments or hazard area occupants for hazards identification, mitigation planning, adoption and implementation of building permit systems;

-- grants-in-aid , on a cost-share basis, for various hazard reduction measures such as dikes and levees; and

-- initiation of long term research and training programs in universities and technical schools concerning design standards and techniques for loss reduction.

# *Appendix C*

## Resolution
## Considerations Regarding Natural Hazard Mitigation in Developing Countries

Drafted by Scott Luther and others and
Presented to Symposium Participants

Natural hazards are not, in and of themselves, disasters but rather agents that transform a vulnerable condition into a disaster.

In developing countries the condition of vulnerability that produces so many disasters is a result of the poverty that exists in these places. This situation of mass poverty is actually on the increase because of the following reasons, some of which vary in intensity from country to country. These are:

-- population growth (uncontrollable)
-- political instability and paternalism
-- urbanization (mass)
-- debt crisis

When the majority of the population of the Developing Countries (which are a majority in the world) are barely living at subsistence levels, to talk about natural hazard mitigation is almost a waste of time. In the Dominican Republic, for example, 85% of the housing construction occurs in the informal sector. This sector is that which is outside of the legal and banking system and is therefore unregulated and uncontrollable. They build inadequate houses, on potentially dangerous sites (which are usually illegal) in high density urban areas of sizes that that are almost uninhabitable.

Taking into account these and other factors so common throughout the Third World we feel that it is necessary to consider the following:

(1) If natural hazard mitigation measures are to have any success, they must be integrated into the ongoing development process.

(2) These programs should have an integral focus taking into account not only hazard mitigation but also education, food, employment, housing, and other basic needs.

(3) The natural hazard mitigation programs must be in accord with the social, cultural and economic context if they are to be successful.

(4) Within the informal sector, these programs must emphasize the capacity of the people to act themselves in making their own decisions, for self-help and self-development.

(5) The programs, as much as it is feasible, should use local financial resources to fund the activities.

(6) Safe housing construction affordable for the poor must be developed and the option of subsidizing additional costs to make housing safe must be studied.

(7) In urban areas, techniques for upgrading squatter settlements to incorporate effective mitigation measures should be studied.

(8) Alternative land-use planning must be studied as a means of protecting vulnerable communities taking into account social, economic and political implications.

(9) Natural hazard mitigation programs must be understandable and easily comprehended by communities. They must also be easily replicable.

In summary, in developing countries the "best" solution if often not possible. This must be foremost in the mind of anyone attempting natural hazard mitigation.

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# Appendix D

## A Selected Bibliography with Annotations
## Post Disaster Response and Mitigation of Future Losses

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A Bibliography on Disaster Mitigation Techniques for Housing and Urban Redevelopment - Selected and Annotated.

Entries focus primarily on the legal and related institutional aspects of disaster mitigation. For easy location and comparison of particular experiences or techniques the entries are arranged as follows:

GENERAL REFERENCES contains items that compare different types of hazards or provide an overview of housing issues or legal perspectives. Periodicals likely to contain pertinent articles from time to time are listed here.

FLOODS - CASE STUDIES/TECHNIQUES/BIBLIOGRAPHIES contains descriptions, analyses, and sources of information on earthquakes, volcanoes and other ground failures.

OTHER HAZARDS - CASE STUDIES/TECHNIQUES/BIBLIOGRAPHIES contains descriptions, analyses, and sources of information on disasters ranging from hurricanes and tornadoes to drought to avalanches.

### General References

Butler, J.R.G. and D.P. Doessel. 1983. Natural disaster relief and horizontal equalization in Australia. The Journal of Federalism, 13 (Winter):55-72.

Describes the Commonwealth's disaster relief financing program including the impact of various federal policies on local government mitigation efforts.

Cuny, F.C. 1983. Disasters and Development. Oxford University Press, New York.

Examines mitigation measures and disaster response program planning and management in the international aid context. Includes case study of an innovative housing program.

Cuny, F.C. 1978. Disasters and the Small Dwelling. INTERTECT, Dallas, Texas.

Reviews common problems, identifies knowledge gaps and recommends actions, including research to improve the quality of disaster aid.

Cuny, F.C. and P. Thompson. 1981. Economic Issues in Housing Reconstruction. INTERTECT, Dallas, Texas.

Presents the basics of the economic issues involved in housing reconstruction.

Cuny, F.C. and A.J. Taylor, 1979. Evaluation of Humanitarian Assistance. INTERTECT, Dallas, Texas.

Assesses the need for program evaluation, type of information that should be sought and evaluation procedures to obtain it.

Cuny, F.C. and P. Thompson. 1981. Formulating Policies for disaster Management. INTERTECT, Dallas, Texas.

Manual presenting a step-by-step plan for developing a policy framework to guide relief/reconstruction programs. The manual is designed for use by government officials in emergency preparedness.

Cuny, F., I. Davis, and F. Kringold. 1978. Issues and Problems in the Provision of Shelter and Housing: A Review of Experience and Lessons from Recent Disasters. INTERTECT, Dallas, Texas.

Identifies issues and lessons learned in provision of emergency shelter and housing including responsibility for actions, resources available and recommendations for improvement; the analysis is based on an intensive review of international relief operations over the past 15 years.

Cuny, F.C. 1978. Scenario for a Housing Improvement Program in Disaster Prone Areas. INTERTECT, Dallas, Texas.

Step-by-step discussion of the considerations involved in development of a housing improvement program in a disaster prone developing country; available in English or Spanish.

Cuny, F.C. 1977. Strategies and Approaches Which Can Be Used by Voluntary Agencies to Provide Post-Disaster Shelter and Housing. INTERTECT, Dallas, Texas.

A review of approaches used in providing post-disaster shelter and in reconstruction programs, including common problems and recommended solutions.

Davis, I. (Ed.). 1981. Disasters and the Small Dwelling. Pergamon Press, New York.

A collection of papers on social and economic problems with disaster relief, including the long-term impact of aid on housing patterns and types.

Davis, I. 1978. Shelter After Disaster. Oxford Polytechnic Press, Oxford, U.K.

An overview of relief and housing reconstruction.

Hubert, D.T. and R.L. Johnston (Eds.). 1982. Geography and the Urban Environment: Progress in Research Applications - Volume 5. John Wiley and Sons, New York.

Three essays in the volume address urban disaster issues: "Natural Hazards and Urban Planning" by Graphan A. Tobin; "Flood Risk in the Urban Environment" by D. Parker and E. Penning-Rowsell and "Earthquake Hazard Information: The Experience of Mandated Disclosure" by Rise Palm.

International Disaster Institute Periodical. Disasters - The International Journal of Disaster Studies and Practice.

Focuses on socioeconomic aspects of hazards and disasters.

International Sociological Association Periodical. Mass Emergencies.

In addition to material on social and behavioral aspects of natural disasters, the journal features contributions dealing with technical hazards, resource shortages and human conflicts.

INTERTECT. 1981. Coordination: Issues and Problems in Coordinating Post-Disaster Programs. INTERTECT, Dallas, Texas.

Discusses the process of coordinating relief activities and means of improving cooperation between agencies in post-disaster programs.

INTERTECT. 1981. Establishing Needs After a Disaster: Assessment. INTERTECT, Dallas, Texas.

A description of the role of disaster assessment and methods for more effective assessment.

INTERTECT. 1981. Land Acquisition Strategies for Post-Disaster Housing Programs. INTERTECT, Dallas, Texas.

In addition to describing strategies in general, the effects of a disaster on land prices and innovative methods for obtaining use of land before actual transfer of title are presented.

INTERTECT. 1981. Land Issues in Reconstruction. INTERTECT, Dallas, Texas.

A briefing paper describing what happens to land and land costs and other land issues following natural disasters; land issues and land tenure are major problems confronted by reconstruction agencies.

INTERTECT. 1981. Post-Disaster Housing: A Conceptual Framework for Program Planning. INTERTECT, Dallas, Texas.

Jones, B.G. and M. Tomazevic, (Eds.). 1982. Social and Economic Impacts of Earthquakes and planning to Mitigate their Impacts. Cornell University Urban and Regional Studies Program, Ithaca, New York.

"Government Roles in Reducing Vulnerability", "Planning as a Tool", "Emergency Management as Mitigation", "Financing Reconstruction", and "Reconstruction Policy" were among the headings for papers at this U.S. - Yugoslav conference.

Mader, G. et al. 1980. Land Use Planning After Earthquakes. William Spangle & Associates, Portola Valley, California.

Focuses on actions taken and decisions made after an earthquake that led to permanent reconstruction; identified situations where land use change was more appropriate than structural response.

Margerum, T. 1979. Will Local Government be Liable for Earthquake Losses? Association of Bay Area Governments, San Francisco, California.

Presents survey results on local officials' perception of liability; describes liability issues and how local governments can minimize them in California.

_____. 1979. Earthquake Hazards and Local Governments' Liability. Association of Bay Area Governments, San Francisco, California.

An overview of four documents prepared for local government liability study, including legal reference review, survey of local officials and administrative/legislative recommendations.

Mintier, J.L. and P.A. Stromberg. 1983. Seismic safety at the local level: does planning make a difference?. California Geology 36(7):148-154.

Studies seven California jurisdictions to determine the effectiveness of the state requirement for a seismic safety element in local plans.

Moore, G.B. and R.K. Yin. 1983. Innovations in Earthquakes and Natural Hazards Research: Local Government Liability. Cosmos Corporation.

Analyzed the Association of Bay Area Governments' local government liability project to gauge its use.

Nakano, T. and I. Matsuda. 1980. Earthquake damage, damage prediction, and countermeasures in Tokyo, in Essays in Geography of Tokyo: Geographical Reports of Tokyo Metropolitan University, No. 14/15:141-153.

Describes the compulsory regional survey and mitigation methods mandated by the Tokyo Earthquake and Fire Protection Ordinance adopted in 1971.

National Academy of Sciences. 1984. Debris Flows, Landslides and Floods in the San Francisco Bay Region, January 1982. National Academy Press, Washington, DC.

Summary of a conference that produced many recommendations for reducing future damages.

Office of Earthquake Resistance. 1982. P.R.C. - U.S. Joint Workshop on Earthquake Disaster Mitigation through Architecture Urban Planning and Engineering. State Capital Construction Commission, P.R.C.

An exchange of information and experiences on urban earthquake mitigation, one part of which focused on planning and land use in reconstruction.

Schwartz, G.T. 1978. Legal References on Earthquake Hazards and Local Government Liability. Association of Bay Area Governments, San Francisco, California.

History, summaries of cases and statutes dealing with tort liability of local governments in the event of an earthquake.

Scott, S. (Ed.). 1979. What Decision Makers Need to Know: Policy and Social Science Research on Seismic Safety. Institute of Governmental Studies, University of California, Berkeley, California.

Based on a workshop, the report identifies seismic safety issues in need of policy and social science research.

Southern California Earthquake Preparedness Project (SCEPP). 1982. Japanese Earthquake Prediction/Preparedness Program. Seismic Safety Commission, Van Nuys, California.

The Japanese program integrates policy, educational, and technical aspects of mitigation; the SCEPP team recommended elements for transfer, including legal and institutional elements.

**Geologic Hazards — Bibliographies**

Jones, B. and E. Weeks. 1983. The Social and Economic Aspects of Earthquakes and Other Natural Disasters: Risk Assessment, Hazard Mitigation, and Emergency Management, Reconstruction and Recovery. Vance Bibliographies, Monticello, Illinois.

One of the few earthquake bibliographies that gives major attention to non-engineering solutions.

**Other Disasters — Mitigation Techniques**

McElyea, W.D., D.J. Brower and D.R. Godschalk. 1982. Before the Storm: Managing Development to Reduce Hurricane Damages. Office of Coastal management, Raleigh, North Carolina.

Identifies tools available to local governments and outlines a planning process as well as many specific aspects (assessment, enforcement, legislation).

Minor, J.E. 1981. Hurricanes and Houses: Hazard and Solutions. Texas Tech University Institute for Disaster Research, Lubbock, Texas.

The effects of wind and engineering techniques are well known; the author examines factors that determine whether or not they are adopted.

Niemczyk, K.L. 1982. Inventory and Evaluation of Land Use controls Addressing Snow Avalanches. Kenneth L. Niemczyk, South Royalton, Vermont.

Establishes a reference base of land use management techniques addressing snow avalanche hazards to human settlements.

Sutter, J.H. and M.L. Hecht. 1974. Landslide and Subsidence Liability. California Continuing Education of the Bar, Berkeley, California.

Gives lawyers useful discussion of legal issues as well as a basic appreciation of engineering and geologic problems.

Walker, G.R. 1981. Mitigation of the Effects of Hurricanes on Human Settlements: An Australian Perspective. Texas Tech University Institute for Disaster Research, Lubbock, Texas.

An overview of the hurricane threat to Australia's developing coast with comments on the variety of mitigation mechanisms taken up by all levels of government.

**Other Disasters — Case Studies**

Apeldoorn, G.J. 1981. Perspectives on Drought and Famine in Nigeria. George Allen and Univin, Inc., Boston, Massachusetts.

This study proposes a policy alternative that increases self-reliance throughout society in order to prepare for future disasters.

Britton, N.R. 1981. Darwin's Cyclone "Max": An Exploratory Investigation of a Natural Hazard Sequence on the Development of a Disaster Subculture. James Cook University of North Queensland Centre for Disaster Studies, Queensland, Australia.

A unique opportunity to observe and compare disaster precautions between "Max" and cyclone "Tracy" seven years earlier.

Chin, A.N. et al. 1983. Hurricane Iwa, Hawaii - November 23, 1982, Prepared for the Committee on Natural Disasters, National Academy Press, Washington, DC.

An overview of Hawaii's disaster preparedness measures and response to the most costly - but not the strongest - hurricane to hit the islands.

Francaviglia, R.V. 1978. Xenia rebuilds: The effect of predisaster conditions on postdisaster redevelopment. American Institute of Planners Journal 44(January):14/15.

Comprehensive case study exploring reasons for Xenia's inability to mitigate even when the opportunity was realized.

Palacio, J.O. 1982. Posthurricane resettlement in Belize, in Involuntary Migration and Resettlement - The Problems and Responses of Dislocated People.

Describes three resettlement projects undertaken by the Belize government following Hurricane Hattie (1961); factors in success or failure are distilled from the comparison.

Windsor, Connecticut. 1980. The Phoenix Study: A Community Response to Disasters, Windsor, Connecticut.

Study of the long-term response to a tornado includes financial assessment and citizen surveys.

Bennett, G. 1979. Reports from China - mass campaigns and earthquakes: Hai Cheng, 1975. China Quarterly, 77:94-112.

Contains the findings of a group of American seismologists studying the political, social, and economic infrastructure of Chinese disaster mitigation in the aftermath of a successfully predicted earthquake.

Blair, M.L. and W.E. Spangle. 1979. Seismic Safety and Land Use Planning: Selected Examples from the San Francisco Bay Region. U.S. Geological Survey, Department of the Interior, Washington, DC.

Shows typical planning responses and federal, state, regional, and local roles in mitigation.

California Seismic Safety Commission. 1983. Preliminary Reports Submitted to the Seismic Safety Commission on the May 2, 1983 Coalinga Earthquake (proceedings of the June 9, 1983 Seismic Safety Commission meeting). California Seismic Safety Commission, Sacramento, California.

Reports from public agency and professional groups on-site indicate major areas of concern including performance of hazard reduction programs and long-term reconstruction.

Cuny, F.C. (Ed.). 1977. The OXFAM/World Neighbors Housing Reconstruction Program: Guatemala 1976-77. INTERTECT, Dallas, Texas.

A detailed report on Programa Kuchuba'l documenting objectives, goals, and priorities of the program.

Davis, I.R. 1975. Emergency Shelter and Natural Disasters. INTERTECT, Dallas, Texas.

Summary comparison of post-disaster reconstruction following earthquakes in Skopje and Managua.

Drabek, T., A. Mushkatel, and T. Kilijanek. 1983. Earthquake Mitigation Policy: The Experience of Two States. Institute of Behavioral Science, University of Colorado, Boulder.

Examines policies in Washington State and Missouri, including various types of implementation barriers.

Earthquake Engineering Research Institute. 1980. The 1976 Tangshan Earthquake. Earthquake Engineering Research Institute, Berkeley, California.

A collection of papers written by delegates from the People's Republic of China discussing lessons learned from the event and mitigation measures being taken.

Ellingwood, B.R. 1980. An Investigation of the Miyagi-Ken-ogi, Japan Earthquake of June 12, 1978. Prepared for the Center for Building Technology, National Bureau of Standards. U.S. Government Printing Office, Washington, DC.

Contains a concise, informative section on government response to the disaster under Japan's Disaster Countermeasures Act of 1977.

Geipel, R. 1982. Disaster and Reconstruction. George Allen and Union, Inc., Boston, Massachusetts.

An analysis of the response to earthquakes that struck the Friuli region of Italy in 1976.

Hirotada, H. 1982. Community Reconstruction and Functional Change Following a Disaster in Japan. Ohio State University Disaster Research Center, Columbus, Ohio.

The study provides a theoretical framework for disaster recovery based on the rapid response and long-term renewal following a volcanic eruption.

Jackson, E.L. 1982. The Laki eruption of 1783: impacts on population and settlement in Iceland. Geography, 67(294):42-50.

This rural example is included because it is one of the few historic examples where settlement patterns were studied. Study of historic disaster provides a long-term perspective unavailable through much current disaster research.

Kartez, J.D. 1982. Emergency Planning Implications of Local Governments' Responses to Mount St. Helens. Institute of Behavioral Science, University of Colorado, Boulder, Colorado.

One of the study objectives was to identify the institutional constraints faced by local officials.

Keller, S.A.C. (Ed.). 1982. Mount St. Helens: One Year Later. Eastern Washington University Press, Cheney, Washington.

One third of the papers in this set of proceedings explores the human consequences of the eruption, including housing damage and planning for low probability events.

Kockelman, W.J. 1983. Examples of the Use of Geologic and Seismologic Information for Earthquake Hazard Reduction in Southern California. U.S. Geological Survey, Denver, Colorado.

Five examples contain a problem summary, the earth science information used and the mitigation actions taken.

Lazario, H.J. and G. Mader. 1981. Earthquake in Campania-Basilicata, Italy, November 23, 1980: Architectural Planning Aspects. Earthquake Engineering Research Institute, Berkeley, California.

The report discusses a reconstruction law adopted six months after the tragedy (late 1980). Guidelines for organizing the executing post-earthquake planning studies.

Leeds, A. (Ed.). 1983. Al-Asnam Algeria Earthquake of October 10, 1980. National Academy of Sciences/Earthquake Engineering Research Center, Washington, DC.

Oliver-Smith, A. 1982. "Here there is life: the social and cultural dynamics of successful resistance to resettlement in post-disaster Peru", in A. Hansen and A. A. Oliver-Smith (Eds.), Involuntary Migration and Resettlement - The Problems and Responses of Dislocated People, Westview Press, Boulder, Colorado.

Examines resistance to resettlement in a highly vulnerable, densely populated region.

Scholl, R.E. 1982. EERI delegation to the People's Republic of China: An Information Exchange in Earthquake Engineering and Practice. Earthquake Engineering Research Institute, Berkeley, California.

The delegation was given a description of the 1976 Jangshan earthquake including the master plan for rebuilding and the actual reconstruction. Earthquake hazard mitigation in the PRC is discussed.

Stratta, J.L. et al. 1981. Earthquake in Campania - Basilicata, Italy - November 23, 1980: A Reconnaissance Report. National Academy Press, Washington, DC.

The findings of a team of observers who analyzed the reasons for extensive damage resulting from a relatively mild quake.

Tarry, W.I. 1980. Urban earthquake hazard in developing countries: squatter settlements and the outlook for Turkey. Urban Ecology 4(4):317-327.

Documents some of the difficulties and makes recommendations for reconstruction and delivery of relief in poor urban areas where suitable political structures do not exist.

Thompson, C. and P. Thompson. 1977. Post-Disaster Reconstruction of Housing in Latin America. INTERTECT, Dallas, Texas.

Analysis of post-disaster housing programs based on case studies in Chile, Peru, Nicaragua, Honduras, and Guatemala; background research included examination of 70 post-disaster housing programs for both short- and long-term impacts.

Urban Regional Research. 1982. Land Management Guidelines in Tsunami Hazard Zones. Urban Regional Research, Seattle, Washington.

Three regional cases are studied to identify the framework for implementing mitigation procedures: Kodiak, Alaska; Hilo, Hawaii, and Kauai, Hawaii, north shore.

**Geologic and Earthquake Disasters — Mitigation Techniques**

Arnold, C. 1982. Earthquake Disaster Prevention Planning in Japan. Building Systems Development, Inc., San Mateo, California.

Part of a multidisciplinary study attempting to identify the information necessary for earthquake mitigation in urban areas; Japan's countermeasure laws are studied in communities including Tokyo, Yokohama, and Osaka.

Evans, J.C. 1979. Attorney's Guide to Earthquake Liability. Association of Bay Area Governments, Berkeley, California.

In response to local officials' concerns, the study examined whether liability was a disincentive to earthquake mitigation.

Gari, P.L. and W.W. Hays (Eds.). 1983. A Workshop on "continuing Actions to Reduce Losses from Earthquakes in the Mississippi Valley Area. U.S. Geological Survey, Reston, Virginia.

Topics discussed included the politics of earthquake policy and the forms and functions of seismic safety organizations.

Heikkala, S.F. (Ed.). 1982. Urban Scale Vulnerability. Proceedings of the U.S. - Italy Colloquium on Urban Design and Earthquake Hazard Mitigation. Universities of Rome and Washington, Rome/Seattle.

Urban vulnerability issues and a research agenda are identified; paper topics include Italian earthquake legislation and urban development regulation and planning.

Critiques Ontario's floodplain management program including financial incentives and institutional framework, among other factors.

Higgins, R.J. and D.J. Robinson. 1981. An Economic Comparison of Different Flood Mitigation Strategies in Australia: A Case Study. Australian Government Publishing Service, Canberra.

A comprehensive evaluation of methods to distribute relief and mitigation resources in flood-prone areas.

Minnesota Department of Natural Resources - Division of Waters. 1980. Reducing Flood Damages by Acquisition and Relocation: The Experiences of Four Minnesota Communities. Department of Natural Resources, St. Paul.

Specific problem solving methods used in relocating the four communities are described.

Parker, D.J. and E.C. Penning-Rowsell. 1981. Whitstable Central Area Coast Protection Scheme: Benefit Assessment. Flood Hazard Research Centre, Middlesex Polytechnic, Middlesex, U.K.

The analysis identifies the real resource gains resulting from avoiding future flood damage.

Platt, R. and G. McMullen. 1980. Post Flood Recovery and Hazard Mitigation: Lessons from the Massachusetts Coast, February, 1978. Water Resources Research Center, University of Massachusetts, Amherst.

An overview of federal flood policy, 1978 storm impacts, and post-disaster reconstruction after the storm.

Rubin, C.B. 1981. Long Term Recovery from Natural Disasters: A Comparative Analysis of Six Local Experiences. Academy for Contemporary Problems, Washington, DC.

A literature review and case studies; recommendations for federal interaction with local disaster managers.

U.S. Federal Emergency Management Agency. 1982. Harlan County Kentucky: Flood Hazard Mitigation Plan, Volume I - Final Report. Federal Emergency Management Agency, Washington, DC.

This comprehensive plan includes many elements addressing regulation, institutions, and financing.

**Floods - Mitigation Techniques**

Burby, R. and S.P. French. 1981. Coping with floods: the land use management paradox. Journal of the American Planning Association, July 1981:289-300.

This study determined that mitigation involving land use management stimulated encroachment into hazard zones. Policy elements to remedy this paradox are discussed.

Clay, G. (Ed.). 1979. Water and the Landscape. McGraw-Hill, New York.

Five articles in this anthology from Landscape Architecture magazine deal with planning around natural hazards, including some innovative financing and regulatory schemes.

Committee on Natural Disasters, National Academy of Science and Environmental Quality Laboratory, California Institute of Technology. 1982. Storms, Floods, and Debris Flows in Southern California and Arizona, 1978 and 1980. National Technical Information Service. Springfield, Virginia.

Flood control and disaster mitigation policies are one of the major headings for contributions to this symposium proceedings.

Federal Insurance Administration. 1981. Evaluation of the Economic, Social, and Environmental Effects of Floodplain Regulations. U.S. Federal Emergency Management Agency, Washington, DC.

Describes results of modeling of losses under several regulatory regimes. Includes an appendix of court decisions recognizing the effects of floodplain regulations.

Kusler, J. 1982. Floodplain Regulation and the Courts. Institute of Behavioral Sciences, University of Colorado, Boulder.

Highlights judicial approaches of the 1970's and considers important issues such as taking and discrimination in depth. Includes recommendations for avoiding legal entanglements.

Kusler, J. 1970, 1972, 1984. Regulation of Flood Hazard Areas to Reduce Flood Losses - Vol I, II, III. U.S. Water Resources Council. U.S. Government Printing Office, Washington, DC.

Comprehensively examines floodplain regulations to reduce flood losses. Suggests strategies for improving the quality of regulations including upgrading of interim regulations and developing post disaster plans.

Office of Mitigation and Research, U.S. Federal Emergency Management Agency. 1981. Evaluation of Alternative Means of Implementing Section 1362 of the National Flood Insurance Act of 1968. Federal Emergency Management Agency, Washington, DC.

Identifies economic, social, legal, and environmental considerations inherent in acquisition of flooded property.

Olson, J.M. 1983. Observations on community based flood hazard mitigation in the United States. Disasters, 7(2):83-85.

A descriptive report by a participant in disaster response. Includes observed limitations on flood insurance ability to change settlement patterns.

Parker, D.J. and E.C. Penning-Roswell. 1983. Flood hazard research in Britain. Progress in Human Geography, 7(2):182-202.

Examines and compares a broad range of research needs including assessment methods for complex urban areas.

Platt, R. and W. Rechamen. 1983. Flood Loss Reduction through Interstate Compacts: An Underutilized Method. Water Resources Research Center, University of Massachusetts, Amherst.

Effectiveness and potential of interstate compacts are assessed. Legal and political issues are examined.

Platt, R.H. et al. 1980. Intergovernmental Management of Floodplains. Institute of Behavioral Sciences, University of Colorado, Boulder.

Investigates factors determining intergovernmental coordination among jurisdictions with conflicting interests through case studies.

Rossi, P.H., J.D. Wright, and E. Weber-Burden. 1982. Natural Hazards and Public Choice: The State and Local Politics of Hazard Mitigation. Academic Press, New York.

Presents findings of a survey of state and local officials on a variety of mitigation issues, including patterns of local political power.

Smith, M.T. 1979. Litigation on the national flood insurance program. Insurance Law Journal, September(680):524-533.

Documents legislative, administrative, and judicial history of the NFIP, including examination of its constitutionality.

U.S. Army Corps of Engineers Institute for Water Resources. 1981. Implementation Aspects of Flood Warning and Preparedness Planning. U.S. Department of Defense, Fort Belvoir, Virginia.

An extensive chapter on legal considerations emphasizes liability factors including many recommendations.

**Floods - Bibliography**

Brown, R.J. 1980. Flood Control, August 1977-80 (citations from the National Technical Information Service), U.S. Department of Commerce, Washington, DC.

223 entries including research on urbanization and urban planning zoning and land use management.

National Technical Information Service. 1982. Flood History and Floodplain Management: 1977-May 1982 (citations from Selected Water Resources Abstracts). U.S. Department of Commerce, Washington, DC.

306 citations including historic floods as well as management techniques including the National Flood Insurance Program.

National Technical Information Service. 1982. Floods: Insurance 1977 to June 1982 (citations from the Selected Water Resources Abstracts). U.S. Department of Commerce, Washington, DC.

Federal, state, and local regulations as well as floodplain zoning issues are including in the 118 citations.

Vance, M. 1982. Floods, Flood Control, and Flood Damage Prevention: A Bibliography. Vance Bibliography, Monticello, Illinois.

A wide sampling of materials dealing with technical solutions to flood problems.

**Geologic and Earthquake Disasters - Case Studies**

Alexander, D. 1981. Disaster in Southern Italy: November 1980. Geographical Magazine, 53(9):553-561.

Overviews the damage and reconstruction following the severe earthquake; the province of Naples, the most densely populated area in Europe, was significantly damaged.

Bates, F.L. 1982. Recovery Change and Development: A Longitudinal Study of the 1976 Guatemalan Earthquake (three volumes), University of Georgia, Athens.

Provides a step-by-step procedure for selecting an appropriate housing reconstruction program following a natural disaster.

INTERTECT. 1981. Program Evaluation: Suggested Criteria for Addressing Post-Disaster Programs. INTERTECT, Dallas, Texas.

Describes methods and suggested evaluation criteria, including vulnerability analysis.

INTERTECT. 1981. Program Planning Options for the Reconstruction of Disaster Resistant Housing. INTERTECT, Dallas, Texas.

Discussion of the various approaches used by agencies rebuilding housing after a national disaster.

Joint Assistance Centre Periodical. Disaster Management. Joint Assistance Centre, Delhi, India.

Provides a forum for the disaster relief and mitigation field on the Indian subcontinent and in Asia.

Krimer, A. 1979. Emergency, temporary, and permanent housing after disasters in developing countries. Ekistics, 46(279):361-365.

Examines the impact of current housing trends, including urbanization, on the three shelter classifications.

Kunreuther, H. et al. 1978. An interactive modeling system for disaster policy analysis. Institute of Behavioral Science, University of Colorado, Boulder.

Describes and analyzes an interactive modeling system.

Lewis, J. 1982. Natural disaster mitigation: environmental approaches in Tonga and Algeria. The Environmentalist, 2(3):233-246.

Points up social and institutional mitigation opportunities in two areas very highly vulnerable to different natural disasters.

Morentz, J.W., H.C. Russell, and J.A. Kelly. 1982. Practical Mitigation: Strategies for Managing Disaster Prevention and Reduction. Research Alternatives, Inc., Rockville, Maryland.

This manual examines mitigation elements including agency regulations and economics on the basis of 81 detailed case studies of all types of hazards.

Morton, D.R. 1981. A Selected Bibliography on Disaster Planning and Simulation. University of Colorado, Boulder.

Housing and urban development are among the problems to which the selected planning techniques and simulations apply.

National Academy of Sciences. 1983. Multiple Hazard Mitigation: Report of a Workshop on Mitigation Strategies for Communities Prone to Multiple Hazards. National Academy Press, Washington, DC.

Participants suggested methods of mitigating economic loss, including budgeting tools and other administrative techniques.

Pryor, L.D. 1982. Ecological mismanagement in national disasters. The Environmentalist, 2, Supplement 2.

The author identifies ecological management practices including extension of infrastructure and certain land uses that aggravate natural disaster.

Quarantelli, E.L. 1982. Development of Collaborative Japan-United States Socio-Behavioral Disaster Research. Disaster Research Center, Columbus, Ohio.

In addition to an inventory of Japanese Research, the author comments on future research directions and on the importance of cultural differences.

Quarantelli, E.L. 1982. Sheltering and Housing After Major Community Disasters: Case Studies and General Observations. Ohio State University Research Foundation, Columbus, Ohio.

An intensive literature review that identifies problems specific to housing provision, including three major case studies.

Ressler, E.M. 1978. Accountability as a Program Philosophy. INTERTECT, Dallas, Texas

Discusses accountability to disaster victims as both an operational method and a program philosophy and recommends ways to use the principle in positive relief/reconstruction programs.

Ressler, E.M. 1978. Post-Disaster Technical Information Flow for the Reconstruction of Housing. INTERTECT, Dallas, Texas.

Analyzes, through interviews with relief agency personnel in Guatemala, post-disaster availability of technical information, information needs and ways of meeting needs.

Taylor, A.J. 1978. Coordination for Disasters. INTERTECT, Dallas, Texas.

Discussion of the necessity for coordination in general and factors that inhibit it.

Taylor, A.J. 1977. Disaster Housing Aid: A Program Planning Model from Guatemala. INTERTECT, Dallas, Texas.

Reviews agency response to emergency housing needs and available alternatives for content, style, and timing based on the approaches taken in Guatemala.

United Nations Children's Fund. 1981. Disasters: Devastation and Opportunity. United Nations, New York.

Thirteen articles examine disaster relief experiences for lessons learned with major findings in the housing field.

United Nations Disaster Relief Coordinator Periodical UNDRO NEWS.

This bimonthly newsletter reviews current disaster relief efforts by the U.N.

United Nations Disaster Relief Coordinator. 1980. Disaster Prevention and Mitigation: A Compendium of Current Knowledge - Volume 9. Legal Aspects. United Nations, New York.

As the name implies this volume is a broad overview of legislation, constitutional, and administrative issues.

United Nations Disaster Relief Coordinator. 1982. Shelter after Disaster: Guidelines for Assistance. United Nations, New York.

A major review of conventional emergency shelter concepts, including mitigation and financing aspects.

U.S. General Accounting Office. 1979. Report by the Comptroller General: The Federal Drive to Acquire Private Lands Should be Reassessed. GAO Document Handling and Information Center, Washington, DC.

A policy study with implications for acquisition of floodplains, dam sites, coastal zones; includes examination of selected land protection techniques.

U.S. Congress Office of Technology Assessment. 1980. U.S. Disaster Assistance to Developing Countries: Lessons Applicable to U.S. Domestic Disaster Programs. Government Printing Office, Washington, DC.

Compares objectives and draws administrative conclusions applicable to U.S. aid programs.

U.S. Department of Commerce. 1982. Disasters: Effects, Preparedness, Assessment, and Recovery - 1976-1982. National Technical Information Service, Washington, DC.

A bibliography of agency publications on disaster relief, including organizational performance.

U.S. Federal Emergency Management Agency periodical Emergency Management. Federal Emergency Management Agency, Washington, DC.

A quarterly publication for the information of government and private sector emergency management personnel.

U.S. State Department. 1981. Housing Survey for Disaster Relief and Preparedness - Latin America. Prepared for the Office of Foreign Disaster Relief Agency for International Development. U.S. State Department, Washington, DC.

Focuses on low income housing types and patterns along with financing and building institutions.

U.S. State Department. 1981. Transition Housing for Victims of Disaster - Disaster Assistance Manual - Volume I. Prepared for Office of Foreign Disaster Assistance, Agency for International Development. U.S. State Department, Washington, DC.

Vance, M. 1982. Disaster Preparedness and Disaster Relief: A Bibliography. Vance Bibliographies, Monticello, IL.

This bibliography attempts to cover the entire spectrum of disaster management.

**Floods - Case Studies**

Beyers, W.B. et al. 1980. Nonstructural Approaches to the Management of the Snohomish River Basin Flood Hazard. Geography Department, University of Washington, Seattle.

Describes elements of laws that enable the nonstructural approach as well as the institutional framework to flood hazard mitigation.

Committee on Natural Disasters, National Academy of Sciences. 1982. The Austin, Texas Flood of May 24-25, 1981. National Academy Press, Washington, DC.

Presents information on local government policies and the response to government agencies to a specific disaster.

Gardner, J. and B. Mitchell. 1980. Floodplain regulation in Ontario: an analysis of existing and proposed policy in the Grand and Credit River watersheds. Journal of Environmental Management, 11(2):119-131.

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