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INNOVATIONS IN EARTHQUAKE AND NATURAL HAZARDS RESEARCH: THREE ADDITIONAL EXAMPLES

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To investigate the process by which earthquakes and other natural hazards innovations are utilized, this study examined three research projects that focused on design guidelines for flood damage reduction, seismic risk mapping, and long-term consequences of disasters. For each project, attention is focused on the factors that led to the initiation of the research project, the research that was conducted, the organization of the project, the research outcomes, and the utilization of research results. The research project for flood damage reduction resulted in a manual which synthesized knowledge compiled through state-of-the-art reviews and through interviews with architects, experts in flooding, and other professionals. The seismic risk map, developed primarily because of deficiencies in existing maps, succeeded not only in preserving the best features of those maps, but in paving the way for the development of subsequent seismic risk mapping activities. The study on long-term consequences of disasters observed no long-range effect from disasters in the communities studied, and concluded that no new Federal programs were needed.

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PREFACE

The present document is part of a study investigating the process by which earthquake and other natural hazards innovations are utilized. The goal of the project is to improve the usefulness of these innovations to policymakers, state and local officials, service providers, and citizens.

The study examined the background, conduct, and outcomes of nine research projects. Three of these projects are described here, in a "question-and-answer" format. The other six projects have been described in separate case studies.* The only difference in the six projects for which case studies were written, and the three which are presented here, is the form of the final document; the data collection and analysis of all nine research projects were the same.

The three research projects described here focused on:

- Design guidelines for flood damage reduction, under the direction of Donald E. Geis;
- Seismic risk mapping, under the direction of S. Theodore Algermissen; and
- Long-term consequences of disasters, under the direction of H. Paul Friesema.

We would like to thank the investigators of these three projects for their cooperation in conducting this study. We also appreciate the continuing assistance of William A. Anderson, our NSF project officer. This assistance notwithstanding, we alone are responsible for errors or omissions.

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*The six case studies, in the series entitled Innovations in Earthquake and Natural Hazards Research, are:

Synthetic Accelerograms, December 1984.

Determining Soil Liquefaction Potential, November 1984.

Hazards Insurance, April 1984.

The Social Consequences of Earthquake Predictions, November 1983.

Unreinforced Masonry Buildings, July 1983.

Local Government Liability, April 1983.

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I. DESIGN GUIDELINES FOR FLOOD DAMAGE REDUCTION

What led to the initiation of the project?

Two situations served as the impetus for the development, by the AIA Research Corporation, of a manual of design guidelines for flood damage reduction. The first was a series of congressional actions which established a new focus on hazard mitigation activities. The second was the recognition, by the design community, that design itself, along with other structural and non-structural aspects of floodplain management, were an important part of hazard mitigation. These two situations ultimately led to a request by the Federal Emergency Management Agency (FEMA), to the AIA Research Corporation, to develop a manual of flood-loss reduction strategies for architects.

Congressional Action

Since the mid-1960s, a number of federal policy initiatives have been established to reduce losses from flooding and other natural disasters. These include the National Flood Insurance Act of 1968, the Flood Disaster Protection Act of 1973, and the Disaster Relief Acts of 1970 and 1974. These legislative initiatives required the use of hazard mitigation activities to try to reduce economic losses from disasters. With this new focus on mitigation, several strategies for flood damage reduction were adopted. These included land-use planning and management, urban redevelopment and preservation, relocation, and floodproofing (e.g., see U.S. Water Resources Council, 1976; Waananen et al., 1977; and Platt, 1979).

Structural and Non-Structural Aspects

One outgrowth of these legislative actions was a program, established by the U.S. Water Resources Council, to examine the structural and non-structural aspects of floodplain management. This program reflected the importance of both the natural and the built environment in flood mitigation activities. It also highlighted the importance of architectural designs per se in the mitigation of flood losses. Historically, the construction of dams--a structural solution--was seen as the primary way to protect against flood damage. However, the new focus on mitigation, and the recognition that the encroachment of man in the natural environment served to increase the losses due to flooding, made it clear that flood damage reduction required more than just dams.

Architects were one professional group for whom this new focus was especially important. They had not previously believed that their activities were directly relevant to the mitigation of flood losses, because they had traditionally thought these issues to be "engineers' problems."[1] This situation began to change, however, as architects became more and more aware of the interactions between the natural and the built environment, and as it became clear that the way a structure was designed could directly reduce losses due to flooding. The need for more effective flood-loss mitigation strategies was also heightened by the dramatic increases in actual losses of property due to flooding (see Figure 1). This shift was summarized by the AIA Research Corporation (1981, pp. 4-5):

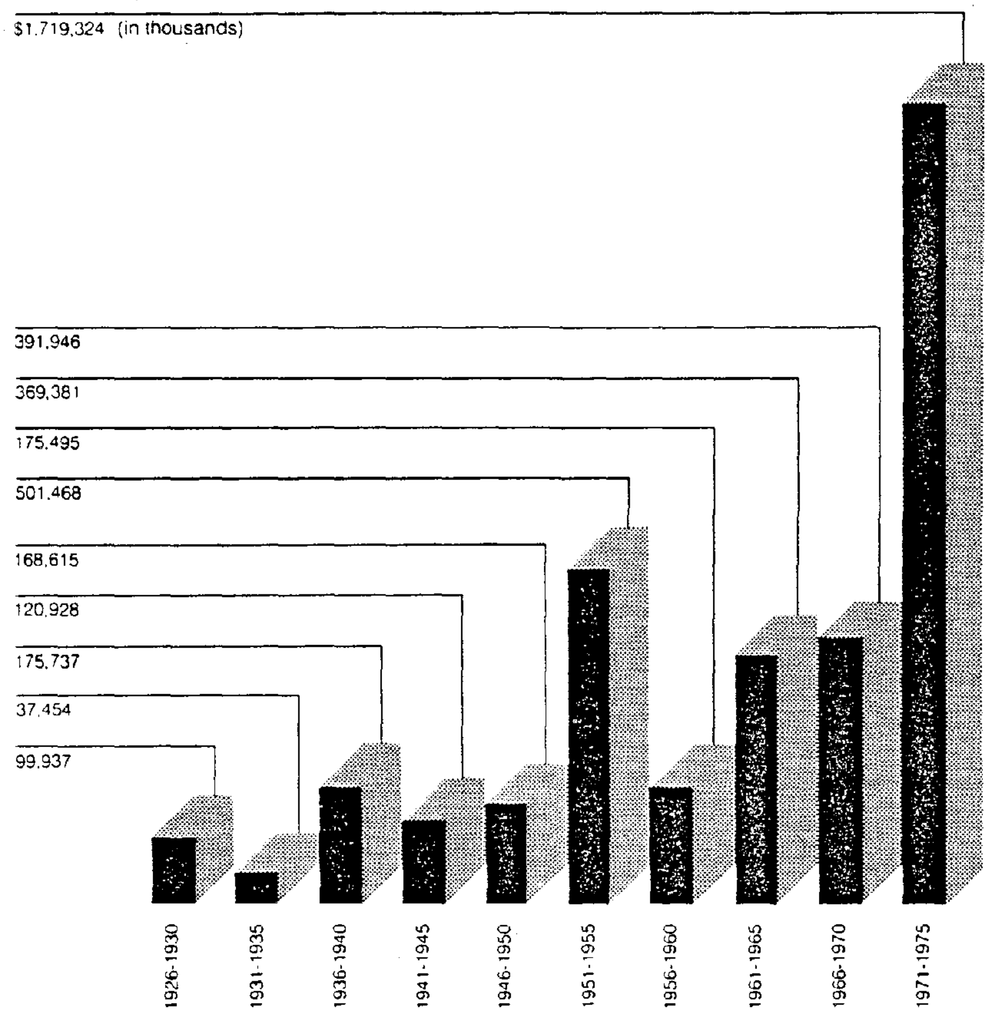
> There have been many attempts to moderate the impact of flooding, with modern efforts dominated by structural flood control measures devised to reduce or eliminate flooding itself or to protect areas from the effects of flooding. However, the continuing damage due to flooding and current awareness of the nature of flooding have led to a shift toward a more comprehensive range of flood damage reduction methods. Attention has turned from total reliance on dams, levees, etc., to include non-structural measures such as land and water resource management and **techniques for flood proofing individual buildings** (emphasis added).

Request for a Manual by FEMA

FEMA had been charged with implementing the National Flood Insurance Act of 1968. In doing so, FEMA sponsored a number of activities intended to reduce losses attributable to flooding, including

Figure 1

FLOOD LOSSES OF PROPERTY



Flood Losses. This table shows the average annual losses of property from flood in the United States, 1926-1975. The U.S. Water Resources Council, in preparing the data, concluded that the escalating flood damages resulted from continued development in floodplains and increases in the costs of making needed repairs.

SOURCE: AIA Research Corporation, 1981, p. 5.

encouraging appropriate design and construction practices in flood-prone areas (AIA Research Corporation, 1981). As part of their effort, FEMA asked the AIA Research Corporation to design a manual to address the need "for improved building and site design in flood-prone areas--not, however, in isolation from effective floodplain management, which must accompany improved design if flood losses are to be reduced significantly" (AIA Research Corporation, 1981, p. 1). The following section describes the work that was conducted to develop this manual.

What was the research and what were its activities?

The AIA Research Corporation began to develop a manual of design guidelines for flood damage reduction in early 1980. FEMA provided the research corporation with a contract for $187,000 to perform this work. The effort was directed by Donald E. Geis.

Objective

The objective of the manual was to provide architects with an "awareness document," which could be used to "get started" in developing flood-proof designs.[2] Specifically, the manual was intended "to give [designers] the basic information and the tools necessary to reduce the losses that continue to result from flooding" (AIA Research Corporation, 1981, p. 6). Thus, the manual was to serve as general guidance to architects, as they undertook flood damage reduction activities.

Activities

Three activities were undertaken to develop the manual: 1) a review of literature on flooding, flood damage reduction strategies, and flood-related programs; 2) interviews with experts in the field of flooding and flood-related research; and 3) interviews with architects and other design professionals, regardless of their prior work in the flooding field.

Literature Review. This effort, called the state-of-the-art review, was intended to provide the fundamental information upon which the entire project was to be based. Geis recalls that the key to this activity was understanding "the links between what architects do, their interests, and the subject."[3] Berry Steeves, a research associate on the project and the principal author of the final manual, collected information from numerous sources during this phase of the project. For example, he examined the library holdings of FEMA, the U.S. Army Corps of Engineers, the Department of Agriculture, and the Library of Congress. The results of this activity were contained in an interim project document, "Flood Design Guidelines for Architects: State-of-the-Art Review" (AIA Research Corporation, 1980).

Interviews with Experts. Nearly three dozen individuals who were considered to be experts in the field of flooding and flood research were contacted. These individuals were asked their views about the most appropriate approach to take in preparing the manual, and to recommend the topics that should be covered in it.

Interviews with Architects and Design Professionals. Approximately two dozen practitioners--including architects, planners, and engineers--were also interviewed. These individuals, who were chosen specifically because they did not have specialized knowledge about flooding, were contacted to identify the types of information they believed they would need to deal with flood-related issues. The interviews covered what people would do to understand flood problems, as well as their suggestions for what ought to be done by others, how information on flood issues was obtained, and the appropriate role of the architect in flood hazard mitigation. The results from these interviews helped to shape the final design and contents of the manual.

How was the project organized?

Project Staff and Consultants

The manual was developed under the direction of Donald E. Geis, at the AIA Research Corporation. The project staff also included: Barry Steeves, research associate and writer; David A. Robillard, research assistant and illustrator; Fred H. Greenberg, designer; and Paul K. McClure, editor. The staff was guided by an expert advisory panel. Additional advice was obtained from two consulting organizations which provided specific technical information. Also, a number of other individuals provided general guidance and comments.

Geis, an architect, joined the research corporation in 1979, one year before the project began. He was the director for the research corporation's community development and natural resources research activities. Geis had been previously involved in issues relating to research and community development.

The advisory panel included eight prominent individuals (see Table 1). The panel met one time as a group, and provided ongoing, informal advice to the project staff throughout the course of the project. The meeting of the panel occurred over a two-day period, in June 1980. The panel reviewed a draft of the proposed manual and developed a new outline. Geis estimated that one-half of the originally proposed outline was changed by the panel, thus indicating their substantial influence on the project's activities. The panel subsequently reviewed four drafts of the manual, providing their comments by mail and by phone.

The project staff also called upon two consulting firms for specific information on technical issues related to flooding and the environment. A number of other individuals were called upon to formally assist with the project, and they provided general comments to the project staff (see Table 2).

Organizational Context

The research was conducted within the AIA Research Corporation, which was founded in 1972 as a non-profit corporation. Its primary purpose was to advance the quality of architectural services by pursuing a comprehensive program of applied research. At the time the manual was being developed, the research corporation was legally independent from the American Institute of Architects (AIA), although there was some overlap between the Boards of Directors of the two organizations (a 1982 reorganization formalized the relationship

Table 1

EXPERT ADVISORY PANEL FOR PROJECT TO PREPARE MANUAL OF DESIGN GUIDELINES FOR FLOOD DAMAGE REDUCTION*

Armando C. Lardieri, Assistant Chief, Engineering Division, U.S. Army Corps of Engineers, Pittsburgh District

Larry A. Larson, Chief of Floodplain and Shoreline Management Section, Wisconsin Bureau of Water Regulation and Zoning, Madison

Luna B. Leopold, Professor, University of California, Berkeley

Rutherford Platt, Associate Professor, University of Massachusetts, Amherst

Gary Plosser, AIA, Kidd Wheeler and Plosser, Inc., Birmingham, Alabama

Mark Riebau, Assistant Chief of Floodplain and Shoreline Management, Wisconsin Bureau of Water Regulation and Zoning, Madison

Robert B. Riley, AIA, Professor, University of Illinois, Urbana

Conrad B. Wessell, AIA, Goldsboro, North Carolina

*Affiliations shown were those at the time the advisory panel was active in 1980-1981.

Table 2

CONSULTANTS AND INDIVIDUALS
WHO ADVISED IN THE DEVELOPMENT OF THE MANUAL*

Consultants:

EDAW, Inc.
Environmental Planning, Urban Design, and Landscape Architecture, San Francisco and Alexandria, Va.
Elliot Rhodeside, Principal
Sheila Brady, Project Manager

Sheaffer and Roland, Inc.
Environmental Planners and Engineers, Chicago and Washington, D.C.
H. Crane Miller, Vice President and General Counsel
James E. Goddard, Consulting Engineer

Individuals:

Christopher Arnold, Building Systems Development, Inc., San Francisco

Raymond R. Fox, Associate, Dames and Moore, Washington, D.C.

Narendra N. Gunaji, Director, Engineering Experiment Station, New Mexico State University, Las Cruces

George Phippen, Chief of Floodplain Management, Office of the Chief of Engineers, U.S. Army Corps of Engineers, Washington, D.C.

Gilbert F. White, Natural Hazards Research and Applications Information Center, University of Colorado, Boulder

John Ziegler, AIA, Regional Director, Federal Emergency Management Agency, New York

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*Affiliations shown were those at the time the AIA project was being conducted.

between the two organizations). Both shared the same facility in Washington, D.C., and the staffs of the two organizations informally discussed topics of mutual concern and interest. It was through this informal link that the research corporation had access to AIA's approximately 44,000 members.

The AIA Research Corporation had conducted other natural hazards projects before the manual was produced, and has published other related documents since then, including:

Architects and Earthquakes, 1975

Elevated Residential Structures: Reducing Flood Damage through Building Design, 1976

Seismic Design for Police and Fire Stations, 1977

Coastal Zone Management: Balancing Protection and Growth, 1978

Coastal Zone Management: A Strategy Guide for AIA Components, 1978

Designing for Earthquakes: Proceedings from the 1978 Summer Seismic Institute for Architectural Faculty, 1979

What were the research outcomes of the project?

The product of the research activity was a manual, Design Guidelines for Flood Damage Reduction, which was published by FEMA in December 1981. Many of the points covered in the manual had been summarized in an earlier article by two members of the project staff (Geis and Steeves, 1980). The manual was an up-to-date compilation of information about: 1) flooding and its effects on the built environment; 2) policies, programs, and strategies for flood damage reduction; 3) design analysis and design techniques; and 4) resources for obtaining further information on these three topics. Specifically, the manual addressed the following questions (AIA Research Corporation, 1981, pp. 6-7):

- What are flooding's inherent characteristics?
- How does flooding relate to the built environment?
- What steps have been taken to mitigate flood damage?
- What programs influence development in flood-prone areas?
- What essential information is needed to design in flood-prone areas?
- What design techniques are available to mitigate flood damage to the built environment?
- Where can the designer obtain additional information about flooding?

The manual represented a synthesis of knowledge compiled through the state-of-the-art review, and from the interviews with experts in the flood field, architects, and other design professionals.

The manual was unique in three ways. First, while geared to the architect, the manual represented a multidisciplinary approach to the mitigation of flood losses. It encompassed information that had bearing on the activities of designers, engineers, planners, and public officials. Likewise, the manual was drawn from the knowledge bases of each of these professional groups, so that it represented a comprehensive review of topics related to the mitigation of flood losses. This first feature emphasized the importance of the overall design process, rather than the designs of individual structures in isolation. A second way in which the manual was unique was that it synthesized all of this information into language that was understandable to architects. This was also a key characteristic of the manual. Finally, the manual was unique in its emphasis on the interrelationships between the natural and the built environments, and in emphasizing the importance of the natural environment in designing to reduce flood losses.

To illustrate the comprehensiveness of the topics covered by the manual, its table of contents is reproduced in Figure 2.

How were the project's results used?

The manual has served an enlightenment purpose within the architectural community. This section identifies the potential ways the manual might have been used, and describes its actual use.

Potential Uses and Users

The major potential use of the manual was for enlightenment purposes. For enlightenment, it could have served to give architects, planners, and others concerned with flood hazard mitigation a general sensitivity to the topics requiring attention. Two other potential uses of research results, for practice and for decisionmaking, were not relevant. The manual was not intended to be relevant for practice use, in that it was not sufficiently detailed to guide the design of any actual projects. (However, the manual did serve an awareness or educational function that is an important prelude to actual practice in architecture.) The manual was also not applicable to decision-making purposes. To be useful for decisionmaking, research results would help to shape legislative initiatives, codes or regulations, or program activities. The manual was, again, not sufficiently detailed to serve this purpose, in that it did not reflect the types of jurisdiction-specific information (e.g., floodplain regulations and building codes) that would be required for making decisions about programmatic or legislative initiatives.

Actual Uses of the Manual

Several illustrative uses of the manual for enlightenment purposes--the only potential use of the manual--were identified. For example, individuals contacted about potential uses of the manual were

Figure 2

TABLE OF CONTENTS FROM
DESIGN GUIDELINES FOR FLOOD DAMAGE REDUCTION

SOURCE: AIA Research Corporation, 1981.

able to cite specific concepts or principles contained in the manual about which they had been "enlightened" (e.g., the behavior of waves and storm surges, and the benefits of using stilts and other "pass-through" methods in design). In addition, other individuals noted that the manual had been useful because it had "pulled information together in one place, and it was put together well."[4] Further, the manual "brought the subject to national attention," according to one source.[5]

The conclusion that enlightenment use did occur was based on interviews with a limited number of individuals in the architectural community. A full determination of the overall extent of the enlightenment far exceeded the resources available for the present study. This is due in large part to the large size of the population of potential users (e.g., AIA alone has 44,000 member architects), and also in part to the extensive dissemination of the manual (20,000 copies were printed in the first printing). Thus, to confirm whether or not enlightenment had occurred, 14 individuals were contacted. These were selected randomly from lists of individuals who had requested copies of the manual from AIA, who had attended an AIA-sponsored workshop, or who had prior knowledge of the project (e.g., advisory panelists or individuals who had been contacted during the development of the manual).

In sum, even though a full-scale survey of the potential user group--i.e., architects and other design professionals involved in flood-related projects--was not feasible, clear evidence of enlightenment outcomes for the manual were found.

Why was the research utilized?

The utilization of the research findings embodied in the manual, Design Guidelines for Flood Damage Reduction, can be largely explained by matching the activities of the research project with the patterns of activities predicted by the problem-solver and social interaction models. The research, development, and diffusion model does not contribute to the understanding of this utilization experience (for a full description of these three models, see Yin and Moore, 1985).

Problem-Solver Model

Both of the patterns of events that are associated with the problem-solver model were evident in the research to develop the manual. As for the first pattern, the research was conducted in response to a problem that had been previously defined by FEMA. That problem was the need for improved building and site design in flood-prone areas. Further, this need had sprung from FEMA's activities in implementing the National Flood Insurance Act of 1968. Research addressing such pre-specified needs is consistent with the first pattern predicted by the problem-solver model.

There is also evidence of the second pattern of the problem-solver model: the involvement of potential users in defining the research. This pattern was evident in the research team's interviews, during early stages of the project, with nearly three dozen practicing architects and other design professionals. These individuals were seen as the audience for the manual (in contrast to the experts in the flood field who were also contacted). The views of these individuals helped to shape the overall contents of the manual, and hence, the second pattern of the problem-solver model was satisfied.

Social Interaction Model

Similarly, patterns of events associated with the social interaction model were also evident. Although the first pattern was only partially evident, the other two were apparent.

The first pattern--that producers and users belong to some overlapping network--was only partially evident, although on first examination it might appear to truly exist. The AIA Research Corporation--at the time the research was being conducted--was a separate, non-profit corporation, that was legally separate from AIA, the membership organization. There was some overlap between the Boards of Directors of the two organizations, and informal communication occurred between the staffs of the two organizations. To this extent, the research corporation (producer) was linked to a network of users--e.g., the AIA member architects. However, this linkage is not as strong as that envisioned by the social interaction model, in which knowledge producers and users are connected through a formal, continuously active network. Thus, the experience of the AIA Research Corporation only partially matches the first pattern of the social interaction model.

The second pattern associated with the social interaction model, that communication between producers and users will occur while the research is in progress, was evident in the research conducted to develop the manual. A panel of experts--which contained potential users--interacted on a regular basis with the research team during the development of the manual. This panel made significant and substantive changes to the initial draft of the manual, and also continued to comment on its subsequent drafts. As was previously noted, Geis estimated that one-half of the original outline of the manual was revised by the panel. The research staff also sought advice and assistance from a number of other individuals--including potential users (refer to Table 2)--during the conduct of their research. Because the panelists and others included potential users, the second pattern associated with the problem-solver model was evident in the development of the manual.

The third pattern of the social interaction model--that communication will continue, or occur, after the research is completed--was also apparent with the research to develop the manual. The research corporation had conducted prior work in the natural hazards field before the manual was prepared, and it's staff was in communication with many key individuals in the field. When the research was completed, the manual was actively disseminated, and copies were distributed at a number of conference and meetings. For example, in its first printing, 20,000 copies of the manual were produced. Of these, approximately 13,500 were distributed to AIA's "firm members" (as opposed to individual members).[6] The remainder were distributed by FEMA. In early summer 1984, FEMA reprinted another 10,000 copies of the manual. FEMA had no specific plans to actively disseminate these additional copies of the manual, although FEMA gets "a few requests each month" for the manual.[7] The workshops and meetings at which the manual has been distributed include:

- Meeting of state building association, Pensacola, Fla., March 1982;
- FEMA's National Emergency Training Center, Emmittsburg, Md., August 1982;
- AIA Committee on Codes and Regulations meeting, Las Vegas, Nev., September 1982;
- AIA/FEMA Workshop, Houston, Tex., March 1983;
- AIA/FEMA Workshop, Hilton Head, S.C., April 1983;
- FEMA/Floodplain Managers Association/American Builders Association meeting, Ocean City, Md., May 1983;
- AID workshop in Guatamala, 1984; and
- AID workshop in Peru, 1984.

In addition to these more formal meetings, other occasions where the manual was distributed were identified, including: a mailing to the members of the Association of Floodplain Managers,[8] at a city council meeting,[9] and at a local meeting of floodplain managers in Texas.[10] The manual is also included among the collection of the Natural Hazards Research and Applications Information Center, in Boulder, Colorado. The manual is cited in the Center's annual annotated bibliography, and it is also referenced frequently in responses to specific questions asked of the Center.[11]

Interactions with potential users have continued to present, and the manual has continued to be distributed at workshops on flood hazard mitigation, and Geis has continued to make presentations to groups of potential users of the research.

Research, Development, and Diffusion Model

No evidence was found to support any of the patterns of the RD&D model.

NOTES TO SECTION I

[1]Interview with Donald E. Geis, AIA Corporation, Washington, D.C., December 29, 1983.

[2]Interview with Donald E. Geis, AIA Corporation, Washington, D.C., December 29, 1983.

[3]Interview with Donald E. Geis, AIA Corporation, Washington, D.C., December 29, 1983.

[4]Telephone interview with Gary Plosser, AIA, Kidd, Wheeler & Plosser, Inc., Birmingham, Ala., May 11, 1984.

[5]Telephone interview with Armando C. Lardieri, Assistant Chief, Engineering Division, U.S. Army Corps of Engineers, Pittsburgh, Pa., May 11, 1984.

[6]Interview with Donald E. Geis, AIA Corporation, Washington, D.C., May 9, 1984.

[7]Telephone interview with John Gambel, FEMA, Washington, D.C., June 4, 1984.

[8]Telephone interview with Larry Larson, Executive Director, Association of Floodplain Managers, Madison, Wisc., May 17, 1984.

[9]Telephone interview with Conrad B. Wessell, AIA, Goldsboro, N.C., May 11, 1984.

[10]Telephone interview with Dell Grier, FEMA Region VI, Denton, Tx., May 11, 1984.

[11]Telephone interviews with David Morton and Susan Tubbesing, Natural Hazards Research and Applications Information Center, Boulder, Colo., May 10, 1984.

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Yin, Robert K., and Gwendolyn B. Moore, The Utilization of Research: Lessons from the Natural Hazards Field, COSMOS Corporation, Washington, D.C., 1985.

II. SEISMIC RISK MAP

What led to the development of the risk map?

Importance of Seismic Risk Maps

Effective urban and regional planning must take into account numerous factors--including the likelihood of earthquake activity within designated areas. The damage from earthquakes results from a number of causes, including the intensity of ground shaking, the effects of faulting, and other geologic effects such as landslides, soil liquefaction, and tsunamis (Karnik and Algermissen, 1978, p. 11). However, all of these conditions are either triggered or activated by a particular level of ground shaking. Thus, adequate seismic risk maps must display the expected maximum intensity of shaking (Algermissen, 1973).

To provide planners, engineers, and architects with information about the likely risk from earthquakes, seismic risk maps have been developed. Such maps are intended to inform some aspect of planning and design, with the ultimate objective being to safeguard the losses of human lives due to earthquakes.

Seismic risk mapping is the process whereby various seismic characteristics of a locale are depicted in map form. The development of seismic risk maps requires access to numerous data. These data might include an historical record of earthquake activity, movements of tectonic plates, and other information about geologic and ground conditions. Complete data are often not available for developing seismic risk maps of the United States, so that critical assumptions must be made and data must be assumed or reconstructed where missing.

Early Risk Maps

The first national seismic risk map was developed in 1948 by Frank P. Ulrich (see Roberts and Ulrich, 1950 and 1951) for the U.S. Coast and Geodetic Survey (C&GS). This "seismic probability map," although not based on probability, showed the distribution of expected damage from earthquakes. Ulrich primarily used historical data to distinguish regions of different levels of risk. The map displayed the epicenters of large earthquakes, and enclosed them in geometric zones that were numbered from zero to three according to the maximum intensity of the earthquake experienced in that zone (see Figure 3).

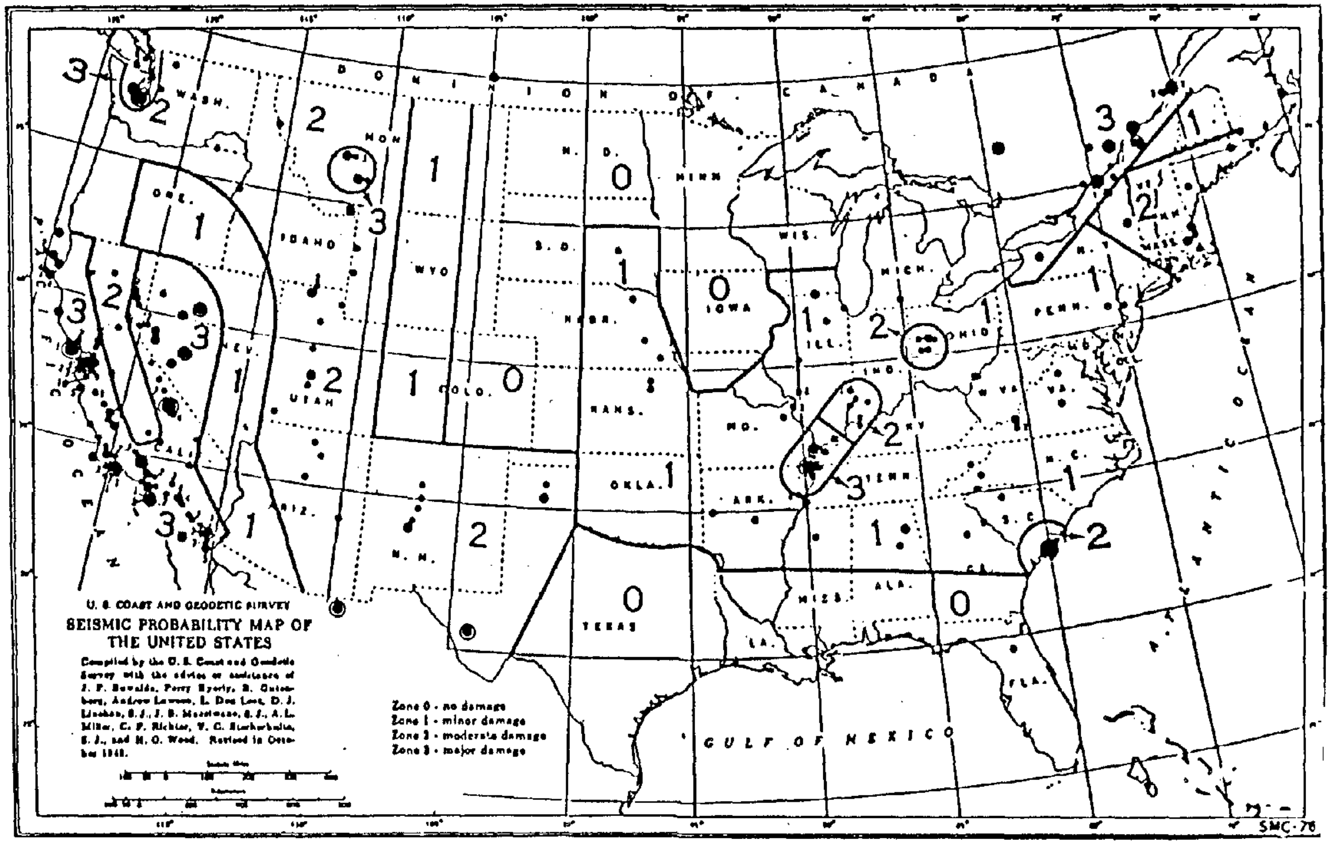
The principle underlying the Ulrich map was that major earthquakes will occur in the future where they have occurred in the past. The map, however, did not reflect known tectonic principles, and was criticized for "assigning probably too low a risk rating to areas with no known record of strong shock, but tectonically similar to others where such shocks were known (which received high risk ratings)" (Richter, 1959, p. 389). The map was also criticized for its lack of continuity between expected damage zones. The criticism was based on zone designations, such as where "no-damage" zones were contiguous to "moderate-damage" zones (see the northwestern portion of Texas on Figure 3), and where "minor-damage" zones were contiguous to "major-damage" zones (see the California-Nevada-Arizona area in Figure 3).

Despite the criticisms of the Ulrich map, it was incorporated into the 1952 edition of the Uniform Building Code (UBC). The map remained a part of the UBC until 1970, even though, also in 1952, it was withdrawn by the C&GS as being "subject to misinterpretation and too general to satisfy the requirements of many users" (Algermissen, 1972, p. 11). Nevertheless, the Ulrich map was seen as a pioneer seismic risk mapping effort in the United States.

A second national seismic risk map was developed in 1958 by Charles F. Richter (Richter, 1959). The Richter map (Figure 4) depicted the expected seismic intensity, or ground motion, in terms of maximum Modified Mercalli (M.M.) intensities. The map used the intensity scale, coupled with tectonic speculation and geology, for regional increases in intensity. However, the Richter map was quite conservative (i.e., the values shown were too high for purposes of planning), and it showed no areas of the country without some level of expected intensity. Richter himself noted deficiencies in the map, saying that "[maps such as this one] are open to every sort of

Figure 3

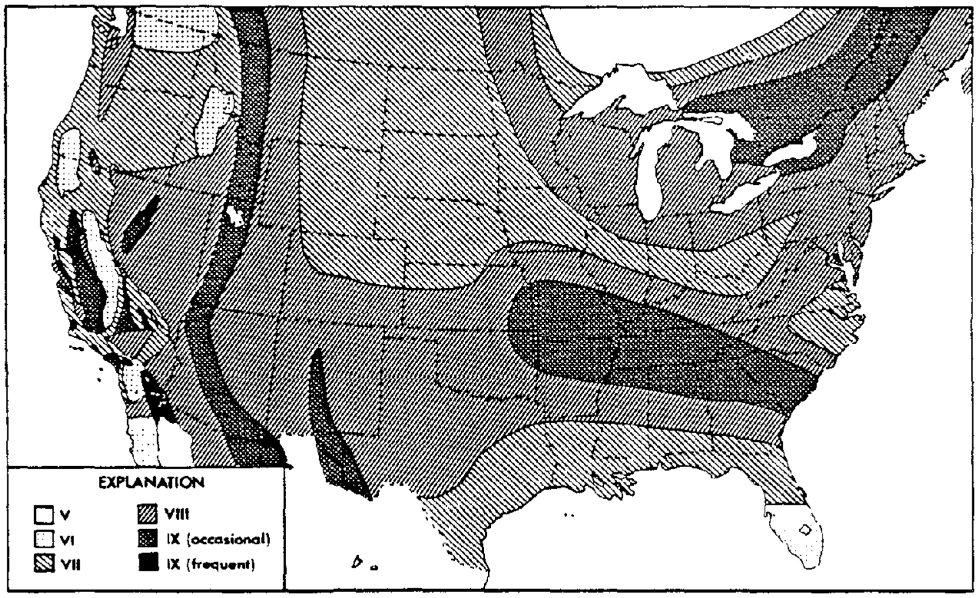
SEISMIC PROBABILITY OF THE UNITED STATES--ULRICH, 1948



SOURCE: Roberts and Ulrich, 1951.

Figure 4

SEISMIC RISK MAP--RICHTER, 1959



SOURCE: Perkins, 1974.

challenge and question" (Richter, 1959, p. 158).

The Impetus for a New Risk Map

Two circumstances converged which led to the development of a new seismic risk map by S. Theodore Algermissen at the C&GS in 1959. The first was the general recognition that both the early Ulrich and Richter maps contained a number of deficiencies, causing their utility to be limited. Specifically, the first two maps each represented "extremes of risk generalization" (Perkins, 1974), with the Ulrich map based primarily on past earthquake activity and the Richter map based primarily on the "hypothesized existance of wide-ranging tectonic processes" (Perkins, 1974, p. 12). Algermissen recognized that the deficiencies in both maps prevented their useful application for planning and other purposes. Thus, he believed that a new seismic risk map was needed that would reflect both of these elements--i.e., past earthquake activity and tectonic principles--in a more balanced manner.

The second circumstance was the opportunity for Algermissen to associate with and discuss the need for a new seismic risk map with "very experienced people,"[1] while he was working in Alaska with the C&GS during 1964 and 1965, just before and after the 1964 Alaska earthquake. These people included insurance and building code officials, structural engineers, and seismologists. During that time, he engaged in discussions with these senior people about the problems with the existing maps, which reinforced Algermissen's judgment about the need for a new seismic risk map.

After returning from Alaska, Algermissen sought and obtained approval from the C&GS to pursue the development of a new risk map. This activity, which took place between 1966 and 1969, is described in the following section.

What was the research and what were its activities?

Research Objective

The primary objective of the research undertaken by Algermissen was to develop a new seismic risk map that would overcome the deficiencies known to exist in previous maps. At the same time, Algermissen was keenly aware that any new map could not be radically different from the Ulrich map, which was still a part of the UBC. A substitute map could not require too great a change in the seismic provisions associated with the map, or too many areas of the country would appear to have been built to obsolete requirements.

The Research Effort

In developing the new risk map, Algermissen and a small team of geophysicists and statisticians began compiling data on the location and magnitude of past earthquakes in the conterminous United States. Such data were needed because Algermissen believed that seismic risk maps should generalize from the historical record, take tectonic principles into account, and display different earthquake-related variables (e.g., intensity, energy release, and recurrence).

The team compiled data from numerous sources, including such references as U.S. Earthquakes, 1928-35, C&GS catalogs of earthquakes, and other historical records. The task of compiling the data had two primary activities: 1) comparing and reconciling differences in data from the various sources, and 2) reassessing earthquake size estimates from the data. In total, data were obtained on approximately 28,000 shocks that had occurred in the conterminous United States (Algermissen, 1969, p. 1). The data were stored on punched cards and magnetic tape to facilitate analysis and subsequent development of the seismic risk map.

Although several different presentations of the earthquake data were possible, Algermissen chose the two he believed to be the most useful in estimating seismic risk: the distribution of maximum M.M. intensities and the strain release in the United States. Thus, as an interim step in the research, both intensity and strain release maps were developed. These maps further facilitated the development of a generalized seismic risk map of the United States.

The purpose of the intensity map was to guide the spatial extent of the strong ground shaking that is experienced at considerable distances from the earthquake source. This map (see Figure 5) depicted the maximum M.M. intensities reported throughout the United States from the first recorded earthquake in 1534 through 1965. The map was compiled by preparing and "enveloping" isoseismal maps of individual earthquakes (i.e., consolidating the specific characteristics of one or several actual earthquakes into a single map). This map showed the maximum intensities of reported earthquakes, but did not take into account the expected frequencies of recurrences.

The purpose of the strain release map was to help to estimate the possible future locations of earthquake epicenters and to guide the generalization of the historical intensity map. This map (see Figure 6), based on data from 1900 to 1965, showed the rate of earthquake energy release in various parts of the country. This map revealed, unlike the intensity map, areas of the country with continuing, but low-level seismic activity.

Finally, the intensity and strain release maps were analyzed, and a new, generalized seismic risk map (see Figure 7) was compiled. This new seismic risk map represented the completion of this phase of the research activity.

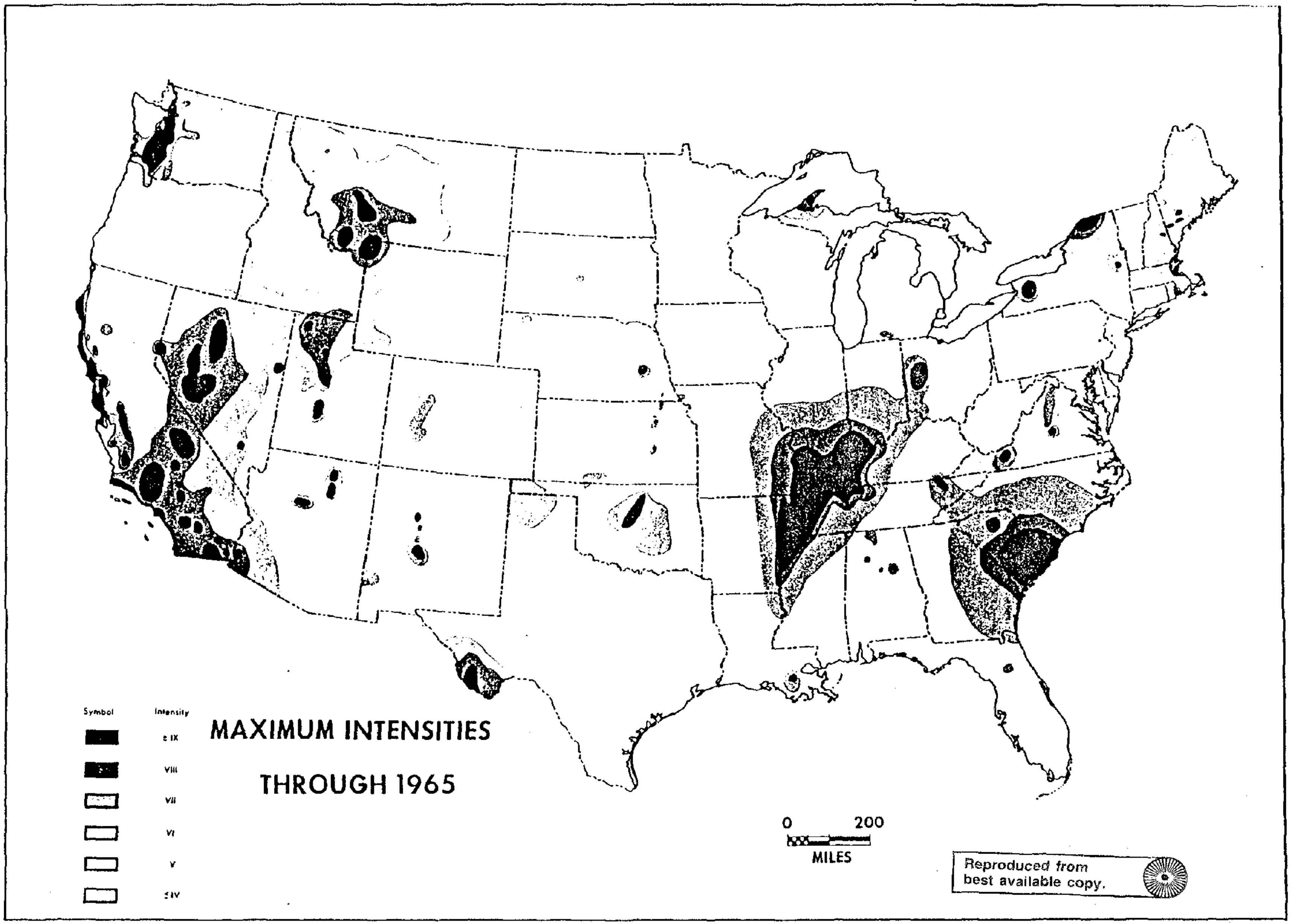
How was the project organized?

The development of the 1969 seismic risk map was organized and managed by Algermissen at the C&GS. Algermissen was assisted by J.C. Stepp and R.L. Rothman, whom he acknowledges for compiling and editing much of the data used (Algermissen, 1969, p. 9). These individuals began compiling earthquake statistics and other pertinent information in about 1965.

The research was undertaken as a part of other regular responsibilities at the C&GS, and was conducted at a low level of effort. Reliable records of the actual time committed to the development of the seismic risk map are not available, although Algermissen estimates that no more than one person-year was committed to the entire effort.

Figure 5

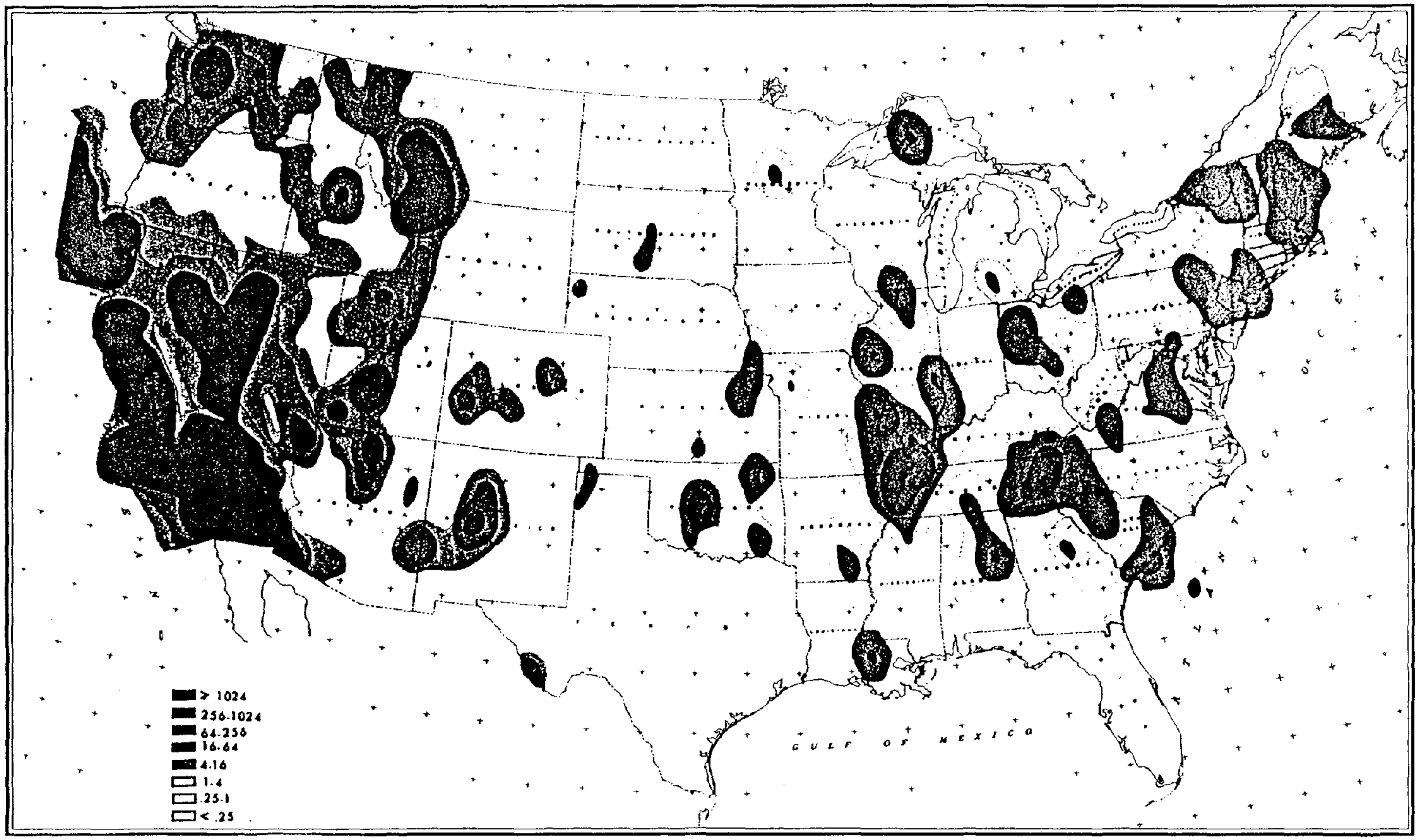
MODIFIED MERCALLI INTENSITIES MAP--ALGERMISSEN, 1969



SOURCE: Algermissen, 1969.

Figure 6

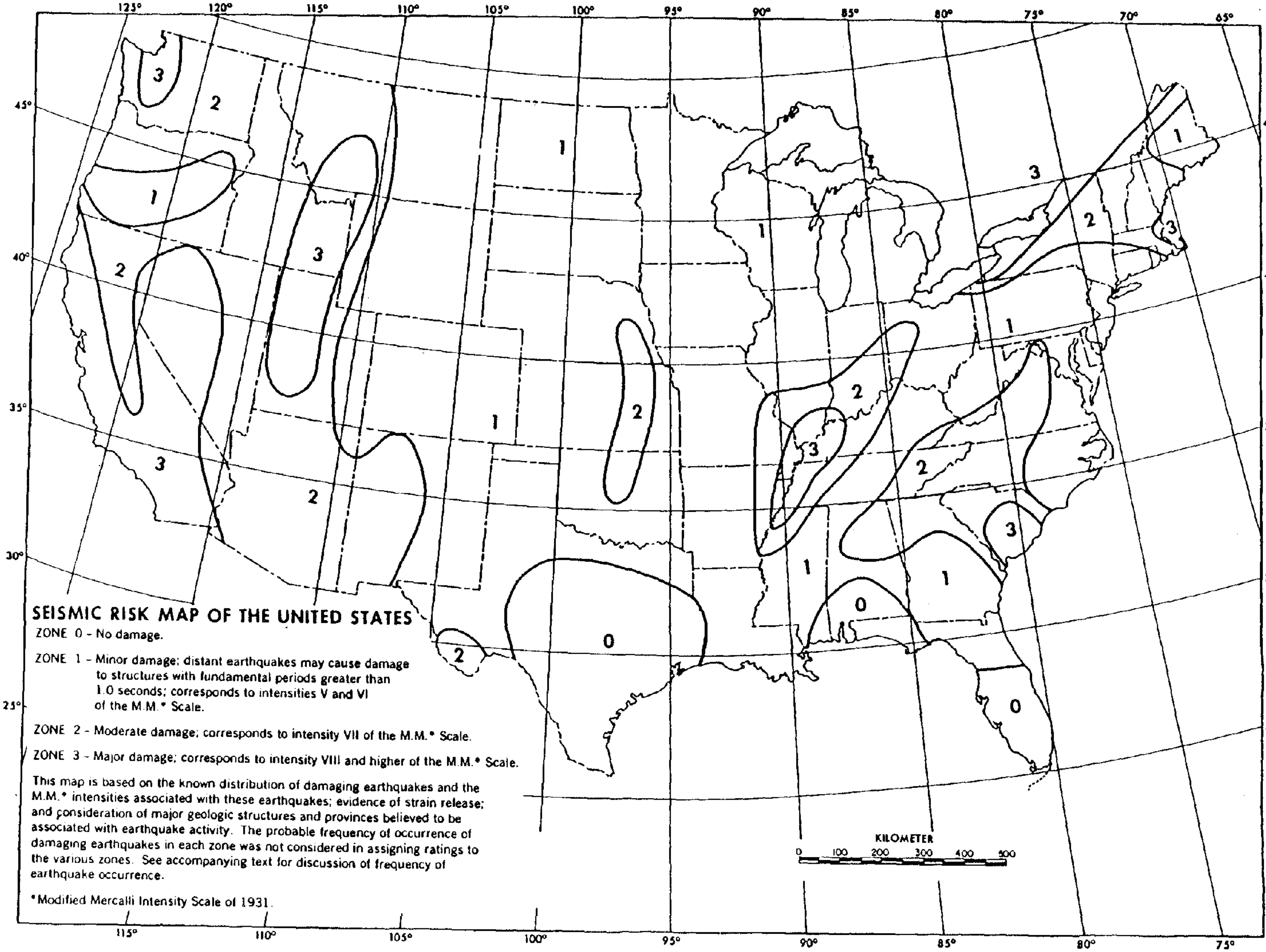
STRAIN RELEASE MAP--ALGERMISSEN, 1969



SOURCE: Algermissen, 1969.

Figure 7

SEISMIC RISK MAP OF THE UNITED STATES--ALGERMISSEN, 1969



SOURCE: Algermissen, 1969.

Algermissen's subsequent efforts to refine and develop specialized seismic risk maps have also been conducted within this same context.

Algermissen joined the C&GS in 1963, and served as the Chief of the Data Analysis Branch, where he was responsible for supervision and development of applied research in seismology. He was away from C&GS in 1965 when he served as a member of the Scientific and Engineering Task Force of the Federal Reconstruction and Development Commission for Alaska. After a 1965 C&GS reorganization, he became Chief of the Geophysics Research Group, and his responsibilities were expanded to include supervision of research in seismology and geomagnetism. It was during this period that the 1969 risk map was being developed. In 1971, the C&GS was renamed and merged into the National Oceanic and Atmospheric Administration (NOAA), where Algermissen directed the Seismological Research Group. Finally, in 1973, the NOAA research activities were transferred into the U.S. Geological Survey (USGS), and Algermissen began serving as Chief of the Branch of Seismicity and Risk Analysis. He is presently at the USGS, serving as a Supervisory Geophysicist.

What were the research outcomes of the project?

The initial outcome of the research activities was a new seismic risk map, which was introduced at the Fourth World Conference on Earthquake Engineering in 1969 (see Algermissen, 1969). Algermissen described the map as "only an interim one [that] does not represent the final form of a seismic risk map for the United States. It does not consider the frequency of occurrence of the seismic events in each zone" (Algermissen, 1969, p. 9). The seismic risk map was based primarily on an analysis of seismic intensities recorded during historical times, epicentral locations of damaging earthquakes, and their relationships to important fault systems and tectonic elements (Algermissen, 1972). More specifically, the basis of the 1969 seismic risk map was:

1. The distribution of M.M. intensities associated with the known seismic history of the United States;

2. Strain release in the United States since 1900; and

3. The association of strain release patterns with large scale geologic features believed to be related to recent seismic activity (Algermissen, 1969, p. 7).

Despite Algermissen's own qualifications of the map, it was an important contribution to the earthquake field. It represented the best features of both the Ulrich (i.e., historical record) and the Richter (i.e., ground shaking) maps, while at the same time endeavoring to minimize their shortcomings. The 1969 seismic risk map replaced the Ulrich one in the 1970 edition of the UBC, and it is also the 1969 seismic risk map that is the subject of the present investigation about its utilization.

However, the 1969 seismic risk map was not only an important contribution in and of itself, but it paved the way for the development of subsequent, seismic risk mapping activities. Algermissen and others have actively developed additional seismic risk maps for the United States and other countries, each of which further contributes to the overall science of seismic risk mapping. By expressing seismic hazards in terms of the level of ground motion and adding the particular probability of being exceeded in a given period of time, seismic risk maps now also reflect the role that earthquake recurrence plays in hazards. For examples of the subsequent seismic risk mapping efforts, refer to the following: Algermissen, Rinehart, and Stepp, 1972; Dewey, Dillinger, Taggart, and Algermissen, 1972; Dewey and Algermissen, 1974; Algermissen, 1975; Algermissen et al., 1975; Algermissen and Perkins, 1976; Algermissen and Perkins, 1977; Hays, Algermissen, Miller, and King, 1978; Perkins et al., 1980; and Algermissen et al., 1982.

How were the project's results used?

Algermissen's 1969 seismic risk map has been put to use in numerous ways--specifically through its inclusion in the UBC. This section discusses the potential uses of the map and provides information about the extent to which the research has actually been used. (The potential or actual use of other maps developed by Algermissen and his colleagues was not addressed by the present investigation.)

Potential Uses and Users

The primary potential uses of Algermissen's 1969 seismic risk map were for enlightenment and decision-making purposes. In enlightenment, the 1969 seismic risk map could have served to sensitize policymakers, officials, and citizens of the potential for earthquake risk in a given area. As the basis for decisionmaking, the 1969 map could have been used in at least three ways: 1) by developing building codes requiring structures in specified risk zones to be designed to withstand anticipated earthquake forces, 2) by adopting and enforcing building codes that included the map, and 3) by identifying and evaluating options for coping with potential earthquake risk. As for a third potential use, practice, the 1969 seismic risk map is not directly relevant for one principal reason: the information needed about the seismic characteristics of a particular site, by design and engineering professionals, far exceeds the information provided by the map. The map was not designed to meet these site-specific needs which might have led to practice use.

Actual Uses of the Map

Algermissen's 1969 seismic risk map has been used extensively for decisionmaking and enlightenment. One primary decision-making use--the adoption of the map by the International Conference of Building Officials for the 1970 and subsequent editions of the UBC--meant that the seismic risk map became a standard for professionals across the country. The design specifications in the UBC vary according to the different seismic risk zones included in the map (e.g., see Section 2314 of the 1970 edition of the UBC). The UBC is adopted by the majority of states and jurisdictions in the United States as the standard for building design. Many of these jurisdictions also adopt the seismic provisions of the UBC, which include the 1969 seismic risk map. Thus, the 1969 map has become a standard, available for use throughout the country. Further, the UBC's seismic provisions are required for all federal construction and federally insured or federally mortgaged properties.

Other decision-making uses, taken by three federal agencies, were also identified. First, the Office of Emergency Preparedness (whose functions were under the Executive Office of the President and are now under the Federal Emergency Management Agency) undertook, following the 1971 San Fernando earthquake, a program of earthquake preparedness and planning. The program used the 1969 seismic risk map to identify areas of the country with a significant risk of earthquakes, and focused their planning and preparedness activities in those areas.[2] Among the areas were upper New York State, Charleston, S.C., and the New Madrid area of the central United States. These high-risk areas had not previously been taken into account in federal emergency planning activities.

Second, the Nuclear Regulatory Commission also took the 1969 seismic risk map into consideration in its decisions about the siting of nuclear plants. The map was used to confirm the judgments of NRC officials, who "respected the zonation" included in the map.[3] This was especially true for sites in the eastern part of the United States, where little was known about the likelihood of seismic activity (as contrasted to the western United States which had been studied extensively). More recently, the USGS used the 1969 seismic risk map, along with another one Algermissen and Perkins had prepared (1976), to identify areas of high risk from earthquakes. These areas were to be the subjects of additional studies, including a synthesis of geological, geophysical, and engineering information; ground motion modeling; loss-estimation modeling; and the implementation of loss-reduction measures.

A final example of the decision-making use of the 1969 seismic risk map is by the reinsurance industry. This industry purchases policies from other insurance companies, and has used the risk map to study their probable loss from policies held in certain geographic areas.[5]

The 1969 seismic risk map has also been used for enlightenment. The risk map is routinely depicted in both professional and popular articles when issues of earthquake risk are discussed.

Why was the research utilized?

Much of the utilization of the 1969 seismic risk map can be explained by matching events that occurred while the map was being developed with events postulated by the problem-solver model. Some further understanding is derived from the social interaction model, but no additional insight is provided by the research, development, and diffusion model (for a full description of these three models, see Yin and Moore, 1985).

Problem-Solver Model

The risk map was designed to meet a need that had been acknowledged widely within the engineering community. Such notable individuals as Charles Richter had explicated the deficiencies in earlier seismic risk maps, and had clearly noted the need for a new seismic risk map. During 1964-65, while in Alaska, Algermissen had an opportunity to discuss the need for a new map with others, including Karl Steinbrugge, also a noted person in the fields of earthquake damage and earthquake insurance. Algermissen attributes his discussions with Steinbrugge with providing the incentive to develop the 1969 seismic risk map.[6]

Also in support of the problem-solver model, potential users were active in defining the research--in this case, the map itself. Algermissen reports that he talked frequently with Vincent Bush, of the International Conference of Building Officials, while the map was being developed. He reports that Bush was "very conscious of the format" the map would use.[7] The format was important, because it was deemed inadvisable to replace the map with one that was radically different. Bush believed, and Algermissen concurred, that a radically different map would be detrimental to the engineering community.

Social Interaction Model

Algermissen belonged to networks that also included potential users of the seismic risk map. First, the USGS is an organization that is frequently called upon by users for information. Algermissen reports that he frequently gets calls, that were made to USGS, on topics relating to earthquake risk. Second, Algermissen is a member of organizations which include both producers and users: the Seismological Society of America, the Earthquake Engineering Research Institute, the American Association for the Advancement of Science, and the American Geophysical Union. In addition, he was an active lecturer and was called upon frequently to talk about earthquake risk to groups of engineers.

In these ways, Algermissen communicated with potential users, both during the time the risk map was being developed and subsequently. Also, he continues to be called upon to deal with questions of seismic risk, either through inquiries made directly to him, or indirectly by people calling USGS.

Research, Development, and Diffusion Model

No evidence was found to support any of the patterns of the RD&D model.

NOTES TO SECTION II

[1]Interview with S. Theodore Algermissen, USGS, July 12, 1983.

[2]Interview with Ugo Morelli, FEMA, October 23, 1984.

[3]Interview with A. Thomas Cardone, NRC, October 24, 1984.

[4]Interview with Walter Hays, USGS, October 23, 1984.

[5]Interview with official of the Reinsurance Association of America, October 23, 1984.

[6]Interview with S. Theodore Algermissen, USGS, July 12, 1983.

[7]Interview with S. Theodore Algermissen, USGS, July 12, 1983.

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III. LONG-TERM EFFECTS OF DISASTERS

What led to the initiation of the project?

Three sets of prior conditions influenced the initiation of a Northwestern University project to investigate the long-range economic dislocation and other consequences of natural disasters. The first was a general priority, within the National Science Foundation's Research Applied to National Needs program (NSF-RANN), to support social science research in the hazards field.

The second was the participation of Prof. H. Paul Friesema--later to be the principal investigator of the Northwestern project--in a conference of natural hazards researchers in mid-1973. Friesema was asked to attend the "Estes Park conference" by Raymond W. Mack, who was then Director of the Center for Urban Affairs at Northwestern.[1] Mack had been asked by George Baker, who was a project officer in the NSF-RANN program, to identify someone to attend the conference. The purpose of the conference was to review a draft of an assessment of natural hazards research being conducted by Gilbert F. White and J. Eugene Haas, work that resulted in a book--Assessment of Research on Natural Hazards (White and Haas, 1975).[2] That conference, attended by some 200 researchers,[3] was the first contact Friesema had with researchers in the natural hazards fields.

The third was the passage of the Disaster Act of 1974. This Act, passed in the post-hurricane Agnes, post-Rapid City flood period, brought about two important shifts in federal policy:

> First, there...[was]...a clear intent to provide for more planning in the reconstruction of a community than was previously the case. Second, there seems to [have been]...a partial shift of responsibility to the states to carry out certain relief and rehabilitation activities" (Sorkin, 1982, p. 144).

In particular, Title V of the Act provided for the establishment of a long-range economic-recovery program (including the establishment of a recovery-planning council) to provide "relief and rehabilitation support to meet the long-term needs of disaster-stricken communities" (Rossi et al., 1981, p.13). (Formally, Title V amended the Economic Development Act.)

The passage of Title V rested on the "presumed congressional conviction that there are long-term negative economic effects in at least some communities" (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 175). However, Title V had not been immediately implemented (responsibility to implement it had not even been assigned to any executive agency). Also, there was apparently some conflict about the need to implement Title V in the first place. The Economic Development Administration (EDA) felt that it already had authority to provide appropriate economic development support to communities, whether they had suffered disasters or not, and thus felt that the legislation was redundant with its existing mandate. At the same time, the Federal Disaster Assistance Administration (FDAA)--the agency that was most likely to be given responsibility to implement Title V--did not want to become involved in the long-term economic issues implied by Title V.[4]

According to one later interpretation, it was in these circumstances that an examination of the actual long-term effects became a top priority of an informal interagency group, headed by NSF and FDAA officials. Such an inquiry could help to direct whatever implementation of Title V might be appropriate, and this objective became the basis for the new research project. An alternative interpretation is that no such priority had ever been set, but that NSF officials and Friesema both perceived the need to address the questions of the <u>actual</u> long-term consequences of disasters.

In any case, through a variety of discussions with officials at the NSF, FDAA, and other agencies concerned about natural disasters, Paul Friesema ultimately submitted a proposal to NSF to examine the long-term consequences of natural hazards. The research was funded in June 1975.

What was the research and what were its activities?

Research Objectives

The goals of the study were twofold:

- To identify and measure the economic and other disruptions that follow a disaster, and once the disaster and the short-range relief and rehabilitation activities have been completed; and
- To examine and explain the variance in long-run effects that occur from community to community.

Six principal research questions were associated with these goals (Center for Urban Affairs, 1975, p. 5):

1) How should such problems as "magnitude of disaster," "economic dislocation," and "relief effort" be defined and measured?

2) Given suitable measurement, what are the medium- and long-run effects and impacts of the disaster itself on economic dislocation and sociopolitical change in communities struck by disaster?

3) In what ways are the effects of disasters either mitigated or intensified by prevailing social, economic, and political conditions (including economic base, growth or stagnation, political system, social system, and other attributes of the community) prior to the disaster?

4) How does the existence of timely warning about a natural disaster affect the long-range recovery from the effect of a natural disaster?

5) What effect does variation in the immediate relief efforts have upon long-range economic dislocations and other social changes, following a natural disaster?

6) What are the elements of the community system most likely to be adversely affected over the medium- and long-run, and how can these be most effectively manipulated by present or possible public policies, to effectively speed economic recovery and ameliorate long-range social and economic dislocations?

The project was originally proposed in February 1975 in two phases, to be funded for nearly $330,000. During Phase I, the research team was to identify and refine measures and data (and research questions, as necessary) based in part on the conduct of pilot studies in four communities having recently suffered from tropical storm Agnes. During Phase II, 20 to 25 communities that had experienced wind- and water-related disasters, occurring between 1950 and 1970, were to be identified. Intensive data collection efforts were to be conducted within each of these communities. Also, Phase II called for the analysis of the factors hypothesized to be related to long-run recovery from disasters.

However, subsequent to discussions with NSF-RANN program officials, the scope of the project was revised, and an award was made to Northwestern, for the period June 1, 1975 to March 31, 1976, for $91,000. Under this award, the research team conducted intensive field work (similar to that envisioned for the pilot study in the original proposal), in four communities: two having suffered wind-related disasters and two having suffered water-related disasters. During this portion of the work, the Northwestern team gathered time-series and disaster-related data on the four communities, both from field work and from secondary sources. The time-series data were sought for periods ten years before and after the disaster event, at annual intervals.

Under a second award for an additional $50,000, covering the period April 1, 1976 to July 31, 1976, the project focused on the problems of further measuring the socio-economic magnitude of the disaster events in the four communities, and measuring the governmental and extra-governmental financial assistance and relief that had been provided to the communities. In addition, efforts were directed at identifying and measuring indirect and second-order economic and other consequences of natural disasters. The sites for this additional work were the original four communities. (It was at this time that the initial intention to study 20 to 25 communities was abandoned.)

Data Collection

The four communities selected for study were those that had experienced "disasters both severe enough in magnitude to constitute major shocks to the affected communities, and second, with events sufficiently removed in time that any long-run impacts can be ascertained, if they occur" (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 23). The communities selected had suffered from wind-related and water-related disasters between the period 1955 and 1965: Yuba City, Calif.; Galveston, Tex.; Conway, Ark.; and Topeka, Kans. (see Table 3).

Data collection in the four communities was done during site visits by at least one senior investigator and up to five graduate student researchers. In this effort, an average of 20 person-days per site was spent interviewing community officials and collecting data about the communities' economic and social activities from archival sources (e.g., newspaper morgues and city and county statistics). Data on sales tax receipts, unemployment claims, municipal expenditures, divorce decrees, and crime known to the police, were among those collected. In addition, information about each community and its disaster was obtained through state records and other sources (e.g., The New York Times).

Interrupted Time-Series Analysis

The application of interrupted time-series (ITS) analysis involved: 1) periodic observations of different dependent variables at equally spaced points in time, and 2) the identification of the disaster event somewhere in the series of points. The major question addressed by ITS was whether the disaster occurrence had an effect, or whether the behavior of the time-series after the event represented an undisturbed continuation of the series along its previous time path (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 44). Figure 8 includes two examples from the Northwestern project, and shows no effect from the disaster.

In using this method, the Northwestern team was applying a quasi-

Table 3

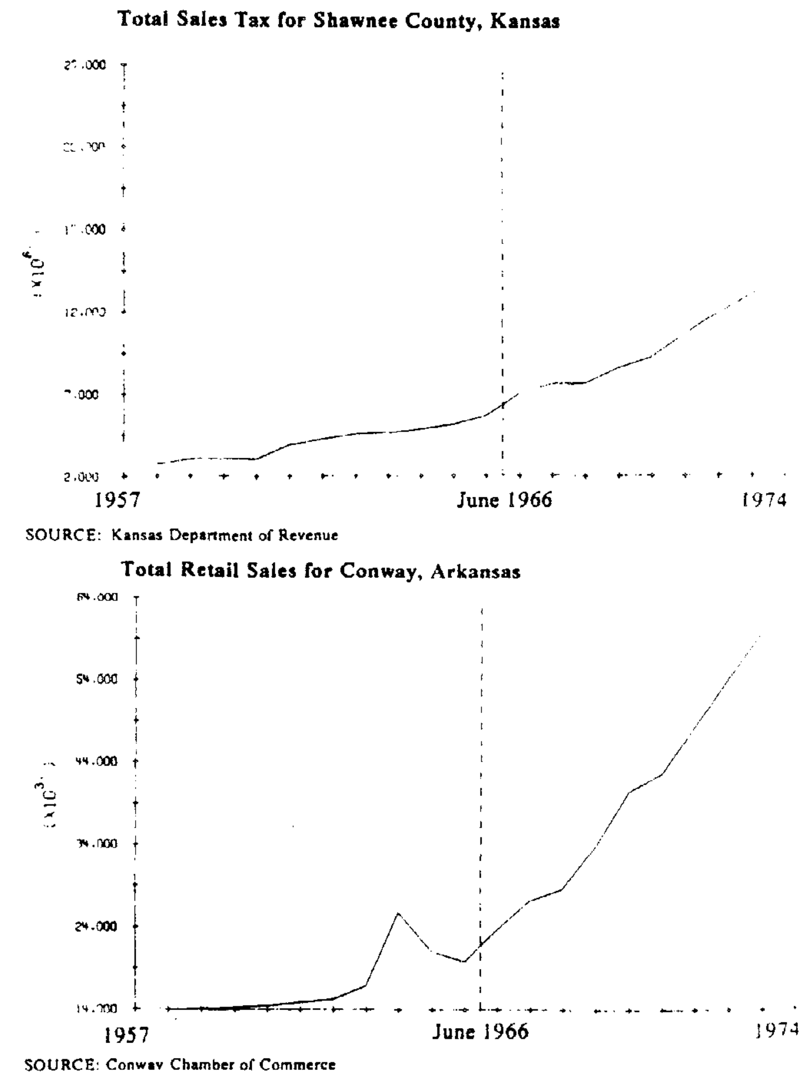
THE FOUR COMMUNITIES AND THEIR DISASTERS
STUDIED BY THE NORTHWESTERN PROJECT

COMMUNITY	COUNTY	DISASTER AND DATE	ECONOMIC CHARACTERISTICS	EST. POPULATION AT DISASTER	DEATHS
Yuba City, California	Sutter Co.	Floods, December 23, 1955	Agricultural center of northern Sacramento Valley	5,000	43
Galveston, Texas	Galveston Co.	Hurricane and related tornadoes, September 11, 1961	Port, medical center, tourism/resort	65,000	7
Conway, Arkansas	Faulkner Co.	Tornado, April 10, 1965	Colleges, commerce, industry	14,500	6
Topeka, Kansas	Shawnee Co.	Tornado, June 8, 1966	State capital, commerce, industry	120,000	17

SOURCE: Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 26.

Figure 8

TIME-SERIES DATA SHOWING NO IMPACT



SOURCE: Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 80.

experimental design to address disaster policy questions. Donald T. Campbell (Department of Psychology, Northwestern University) had pioneered the use of ITS design in psychological and social research, and he was a member of the project's advisory committee. This application thus represented an innovation in hazards research, that seemed entirely suitable to Campbell and the research team. This was because disasters were by definition exogenous and sharply delineated events, precisely the two conditions needed to justify the use of ITS. From the perspective of the NSF and FDAA officials, the application of the technique brought hope that rigorous social science methods could be used effectively to address a key policy question.

How was the project organized?

The project was directed by Prof. H. Paul Friesema, principal investigator, with participation by four other senior investigators: James Caporaso, Gerald Goldstein, Robert Lineberry, and Richard McCleary.

Friesema was a political scientist, with a joint appointment at the Center for Urban Affairs and the Department of Political Science at Northwestern. As principal investigator, he was responsible for the overall conduct of the project. He brought to the project his broad experience in the analysis of communities and their environments. He has since been actively involved in studies of land-use problems and in the implementation of public policy, especially related to environmental impact statements. At the time of the Northwestern project, Friesema had served on the NSF Advisory Panel on Energy Facility Siting, but had not been previously involved with natural hazards research.

Caporaso, also a political scientist, taught at Northwestern and had experience using time-series design (see, for example, Caporoso, 1971; and Caporoso and Roos, 1973). His specialties included the technical problems of social change and interrupted time-series analysis. His primary responsibility was project design and the writing of Chapter 3 of the final report, "Methodological Approaches to the Assessment of Long-Range Impact to Community Disasters" (i.e., in Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979). Caporaso is currently Professor and Mellon Chair at the School for International Affairs, Denver University.

Goldstein was an urban economist whose interests included economic analysis of labor markets and spatial mobility in urban regions. He held, at the time project was being conducted, a joint appointment in the Center and the Department of Economics at Northwestern. During Phase I, his primary responsibility was the identification of measures and indicators of long-term consequences, and in Phase II, his efforts were directed at data analysis, economic modeling, and analysis of long-term effects.

Lineberry held a joint appointment at the Center and as a Professor of Political Science. His professional interests were in urban politics, service delivery, and policy analysis. His project responsibilities were selecting communities, arranging for field work, gathering data, and training and supervising the field staff. Lineberry is currently Dean of the College of Arts and Sciences, Kansas University.

Finally, McCleary, who was a graduate student in sociology at the time the research was initiated, was primarily involved with analysis of the time-series data. McCleary is currently an Associate Professor of Criminal Justice at SUNY, Albany.

In addition to the senior investigators, ten social science graduate students were involved in the project, primarily for data collection and coding.[5] Finally, an advisory committee served the project, and the committee met twice during the course of the research. The first time was in September 24-25, 1975, when the project and its preliminary findings were presented and discussed (attendees at the meeting are listed in Table 4). The second meeting of advisory committee members occurred in June 1977, when draft chapters of the project report--the book entitled, Aftermath: Communities After Natural Disasters--were presented and discussed.

Table 4

ATTENDEES AT NATURAL DISASTERS WORKSHOP*
(September 24-25, 1975)

Sam Alexander
Greater Topeka Chamber
of Commerce

Peter Avioli
Center for Urban Development
Research

George Baker
NSF-RANN

Martyn Bowden
Department of Geography
Clark University

Donald Campbell
Department of Psychology
Northwestern University

James Caporaso
Department of Political Science
Northwestern University

Joe Daly
Conway, Ark.

Lloyd deRow
Greater Topeka Chamber
of Commerce

Thomas Drabek
Department of Sociology
Denver University

Douglas Drown
Galveston Chamber of Commerce

Paul Friesema
Center for Urban Affairs
Northwestern University

Gerald Goldstein
Department of Economics
Northwestern University

Robert Helmreich
Department of Psychology
University of Texas

Jim Kerr
Defense Civil Preparedness Agency

Brian Lambert
Department of Civil
Engineering
Texas Tech University

Ted Levin
Federal Insurance Administration
Department of Housing and Urban
Development

David Lines
Topeka Building Inspection
Department

Bob Lineberry
Department of Political Science
Northwestern University

Louis Masotti
Center for Urban Affairs
Northwestern University

Richard McCleary
Department of Sociology
Northwestern University

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Jack McGraw
Federal Disaster Assistance Administration
Department of Housing and Urban Development

Tim Monteen
U.S. Army Corps of Engineers

Ugo Morelli
Federal Disaster Assistance Administration
Department of Housing and Urban Development

Brian Moss
Foreign Disaster Relief Office
Agency for International Development

Greg Phifer
University of Central Arkansas

Dan Price
Department of Sociology
University of Texas

Roger Pulley
California Office of Emergency Services

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*Affiliations shown were those at the time the Northwestern project was being conducted.

What were the research outcomes of the project?

The principal conclusion of the project was that, for the communities studied, no long-range economic dislocations or other consequences resulting from natural disasters had been observed, and no new federal programs were needed. As summarized in the project's final report:

> The conclusions of this research are striking and straightforward. They can be summarized rather simply. So far as we can determine, none of these disasters led to major long-term economic losses to these communities. While more extensive and direct data could conceivably allow us to detect subtleties we could not find with what we had and resolve ambiguities in our analysis, whatever changes such analysis might reveal would seem to be relatively inconsequential in terms of the need for new federal programs (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, pp. 176-177).

The research team did observe short-term impacts "in every...time series we analyzed. That is important, because it defies common sense to believe that the disasters had no effect on these communities" (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, p. 136). The lack of subsequent, longer-term effects was explained as follows:

> By and large, it appears that the American society and polity has become so knit together and the economy so integrated by the mid-20th century that most of the economic costs of natural disasters are externalized to the larger, carrying society. To an important degree that shifting of the burden is not because of conscious disaster policy. Rather, it has occurred because local institutions have been economically, socially, and politically integrated into the national society. Because of the scale of this national society, events which might totally wipe out an isolated, unintegrated community, hardly cause a ripple on trend lines for the nation as a whole. ...There are already adjustment mechanisms at work, and they seem to work quite well (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979, pp. 177-178).

This conclusion later turned out to be consistent with that of another study endeavoring to estimate the long-term effects of natural disasters at the level of the household (i.e., Wright et al., 1979). The other study examined trends in the number and nature of households in every county and census tract that had suffered a natural disaster within the 1960 to 1970 decade.[6] Its conclusions were that "...there are no discernible net effects of natural disaster events on growth trends in housing or populations stocks for census tracts in the period 1960 to 1970" (Rossi et al., 1981, p. 17).

A book, Aftermath: Communities after Natural Disasters (Friesema, Caporaso, Goldstein, Lineberry, and McCleary, 1979), was the primary product of the Northwestern project, and was the final report of the project to NSF. The project, in a prior agreement with Sage Publications, purchased 300 copies of the book. These copies were distributed to federal officials and others who had been involved with the project, or who were otherwise interested in the long-term economic consequences of natural hazards. It is not known how many copies of the book were sold directly by Sage.

In addition to the book, a Graphical Appendix was compiled. It contained an extensive array of computer-graphed time-series sets for the communities studied. The appendix, available from Northwestern, was not disseminated, and only a few copies were ever distributed on request.

How were the project's results used?

Potential Uses and Users

The primary potential use of the results of the Northwestern project was for decisionmaking--i.e., in implementing the provisions of Title V. Because Title V of the Disaster Act of 1974 had called for the establishment of a long-range economic recovery program for communities that had suffered disasters, the results of the research could have helped the Congress and executive agencies to identify those economic areas in which communities were in most need of assistance. Thus, the research could have been used to structure the implementation of Title V.

An alternative "use" would be in asserting the absence of a need to implement Title V, by showing that communities did not, in fact, suffer long-term consequences from disasters. In this latter circumstance, the "use" is a nonevent--e.g., to "...make sense of what they have been doing ... justify actions, support positions..." (Weiss and Bucuvalas, 1980, p. 305), and thus may not be observable as would use in making decisions or developing new legislation. Because of the Northwestern project's negative findings, its only potential use was in facilitating this nonevent.

Actual Uses of the Research

To this day, although Title V still exists as a legislative mandate, no lead agency has ever been assigned, nor has, according to one knowledgeable official, federal aid ever been provided under this Title.[7] Therefore, the conclusions of the Northwestern project--i.e., that there appeared to be no long-term economic or social consequences of natural disasters in communities, and that federal initiatives to deal with the "problem" are not needed--are consistent with the inaction observed with Title V never having been implemented. (In fact, one informant[8] believes that there is current legislative interest in repealing Title V.)

However, there is no clear evidence that the Northwestern project's results were a factor leading to this inaction. First, there were the positions of EDA and FDAA, both, for different reasons, working against the implementation of Title V. Further, there was apparently a general belief that successive administrations have opposed implementation of Title V because it would: 1) be cumbersome to implement; and 2) not give the federal government control over the funds distributed.[9] In addition, other empirical evidence was being generated at essentially the same time as the Northwestern project (i.e., by Rossi and by Wright) that also failed to identify long-term consequences from natural disasters. In fact, one informant who had been involved with Title V had knowledge of the Rossi and the Wright work--but was not aware of the work that had been done at Northwestern.[10]

Within this entire context, therefore, there is no evidence to confirm that the Northwestern project was specifically taken into account in any action (or inaction) relating to Title V. Thus, although the findings of the Northwestern project support and are consistent with the inaction on Title V, we are unable to conclude that the results of the Northwestern project were utilized, even in facilitating this lack of action.

What explains the utilization experience of the project's results?

The apparent lack of utilization of the results of the Northwestern project can be largely explained by the absence of certain patterns associated with the three models of research utilization. Although both of the patterns associated with the problem-solver model were present, none of those predicted by the social interaction model was found, and only one of those related to the RD&D model was evident (see Yin and Moore, 1985, for a full description of these three models).

Problem-Solver Model

Both of the patterns of events associated with the problem-solver model were evident. First, the project was initiated to address a previously defined problem: do communities that suffer extensive damage from disasters also suffer long-term social or economic effects as well? Potential users of the results of the research--federal officials from FDAA--were involved in helping to define this research problem, and hence, the second condition of the problem-solver model was satisfied. In addition, NSF was involved in this problem-definition stage through their involvement, with FDAA, on an informal interagency committee. NSF ultimately funded the Northwestern project.

Social Interaction Model

None of the three patterns associated with this model was evident in the events surrounding the Northwestern research project. First, the principal investigator and his colleagues were not active in any organizations in which knowledge producers and knowledge users in the natural hazards field belonged. Nor was the Center for Urban Affairs at Northwestern University, where the research took place, an organization that had participated in other natural hazards research activities.

Second, there was little communication between the research staff and potential users during the course of the research. Although the project did have an advisory panel which included potential users, the panel did not meet until the preliminary findings of the research were presented. Thus, the panel did not have an opportunity to influence the direction of the research, which is implicit in the second pattern of the social interaction model. Further, the panel did not include one important potential user group: staff of the U.S. Congress, which had a major stake in the outcome of the project.

Third, communication between the project staff and potential users did not continue after the research was completed. The research team resumed their activities in fields other than natural hazards, and thus did not have a continuing opportunity for dialog with potential users of the research results.

Research, Development, and Diffusion Model

Of the four patterns associated with this model, one was somewhat satisfied by the Northwestern project. This pattern was that the research did contribute to further knowledge in its distinctive application of interrupted time-series designs, a specialty of a senior investigator at Northwestern (Donald T. Campbell) who consulted on the project.

NOTES TO SECTION III

[1]Mack was Director of the Center for Urban Affairs from 1968 to 1971. Since then, he has served as Northwestern's Provost.

[2]The National Science Foundation was supporting the White and Haas assessment. Baker has subsequently retired.

[3]Interview with Roy Popkin, American Red Cross, Washington, D.C., April 25, 1983.

[4]Interview with Clark Norton, May 18, 1983. Norton is currently with the Library of Congress, Government Division. He previously worked for the congressional committee that introduced the Disaster Act of 1974, and was a principal drafter of the Act.

[5]The graduate students assisting with the project were: Lowry Alexander, Clare Stapleton, Steve Craig, Dennis McFarland, Randall Eberts, Tim Gronberg, Stuart Russell, Mitzi White, Mike Stolarski, and Michael Maxfield. Also assisting at different stages were David McDowell, Leslie McCain, and Paul Culhane.

[6]Briefly, this study, conducted by Peter Rossi, James Wright, Sonia Wright, and Eleanor Weber-Burdin at the Social and Demographic Research Institute, University of Massachusetts, Amherst, intended to estimate the long-term effects of natural disasters by examining U.S. Bureau of the Census data. During the study, the investigators examined county and census tract data for areas that experienced disasters between 1960 and 1970, plus a control sample of metropolitan areas that had not experienced a disaster. A general linear model was applied. See James D. Wright et al., 1979.

[7]Interview with Ugo Morelli, FEMA, Washington, D.C., April 25, 1983. Morelli had been at FDAA during the conduct of the Northwestern project and had been a member of the project's advisory committee.

[8]Interview with Clark Norton, May 18, 1983.

[9]Interview with Ugo Morelli, April 25, 1983.

[10]Interview with Clark Norton, May 18, 1983.

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