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Papers delivered at an international conference on earthquakes are presented. The papers are divided into twelve categories, including: socio-economic aspects of hazards, risks, and vulnerability; attitudes toward risk; governmental roles in reducing vulnerability; planning as a tool for vulnerability reduction; emergency management to mitigate impact; post-disaster response; impact of disasters on socio-economic systems; and reconstruction following earthquakes. A conference program is provided and participants are listed.

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SOCIAL AND ECONOMIC ASPECTS OF EARTHQUAKES

edited by
Barclay G. Jones
and
Miha Tomaževič

PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE:
THE SOCIAL AND ECONOMIC ASPECTS OF EARTHQUAKES
AND PLANNING TO MITIGATE THEIR IMPACTS

held at
Bled, Yugoslavia
June 29 - July 2, 1981

Sponsored by The National Science Foundation and the Council of Yugoslav Association of Self-Managed Communities of Interest for Scientific Research
Under the auspices of the US-Yugoslav Joint Board on Scientific and Technological Cooperation

Institute for Testing and Research in Materials and Structures,
Ljubljana, and
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Dedicated to the

Memory of

Professor Viktor Turnšek, dipl. ing. gradb.

November 28, 1911 - August 19, 1981

PREFACE

Four years ago the US-Yugoslav Joint Board on Scientific and Technological Cooperation agreed to undertake a series of three international invitational conferences to report significant advances achieved over the past decade on various aspects of earthquakes through research by scholars in a number of countries and to identify gaps still remaining to be studied. The first of these conferences was held at Ohrid, Yugoslavia, in September 1979. Organized by Dr. Jakim Petrovski and Prof. Clarence R. Allen this Research Conference on Intra-continental Earthquakes dealt with geological and seismological aspects of earthquakes emphasizing prediction. The second event, the International Research Conference on Earthquake Engineering, was organized by Dr. Jakim Petrovski and Prof. Jack G. Bouwkamp and concerned the analysis, design and construction of earthquake resistant structures. It took place in Skopje, Yugoslavia, in June and July 1980. The third and final conference in the series, the Social and Economic Aspects of Earthquakes and Planning to Mitigate Their Impacts, was held in Bled, Yugoslavia, in June and July 1981. The host organization was the Institute for Testing and Research in Materials and Structures of Ljubljana. The papers in this volume were prepared for this third conference. All three meetings were sponsored by the National Science Foundation and the Council of Yugoslav Association of Self-Managed Communities of Interest for Scientific Research under the auspices of the US-Yugoslav Joint Board on Scientific and Technological Cooperation.

The concept behind the third conference was to assemble a broad spectrum of social scientists--economists, sociologists, geographers, political scientists-public administrators, and city and regional planners, together with earthquake engineers--from various parts of the world who were all engaged in research on earthquakes and other natural disasters to share their results, exchange their findings, and display areas in which further study is needed. The invitational conference was attended by 57 scholars and officials from 12 countries including: Belgium, Canada, France, Indonesia, Italy, Japan, Sweden, Switzerland, United Kingdom, United States, West Germany, and Yugoslavia. A wide range of disciplines was represented by the authors of the 43 papers which were presented and 2 others which were submitted by persons unable at the last moment to attend.

The fact that the Institute for Testing and Research in Materials and Structures was designated the host organization constituted recognition of the contribution of its founder and former director, Prof. Viktor Turnšek. The conference was in a sense a celebration of the contributions to the field of this very productive and distinguished engineer who was among the founders of earthquake engineering research in Yugoslavia. The paper he presented at this meeting was the last of a very long series of reports of research results because he died the following month in August 1981. It is to his memory that this volume is dedicated.

Many individuals contributed to the organization of the conference, the intellectual stimulation and smooth conduct of the meeting, and the preparation of the proceedings. The authors of the papers and the participants at the conference, who are listed in appendices, established the content which was the essence of the meeting. The U.S. and Yugoslav Committees helped shape the program and conduct it. The U.S. Committee consisted of Dr. William A. Anderson, Prof. Jerome W. Milliman, Mr. Stanley Scott, Prof. Ralph H. Turner, and Dean Myer R. Wolfe. The Yugoslav Committee consisted of Prof. Sergej Bubnov, Dean Vladimir Frankovič, Mr. Vladimir Braco Mušič, Dr. Jakim Petrovski, and Dr. Stane Saksida. The Chairman of the US-Yugoslav Joint Board on Scientific and Technological Cooperation, Dr. Muris Osmanagić, took a personal interest in the conference. Various officials of the National Science Foundation played critical roles. Dr. Charles Zalar, Program Manager, Division of International Programs and a member of the Joint Board was directly responsible that the conference took place. Dr. William A. Anderson provided counsel, advice, and necessary additional financial support. Dr. Michael P. Gaus, who has spent a decade developing US-Yugoslav cooperative research on earthquakes, developed the idea for the conference.

Many of the staff of the Institute for Testing and Research in Materials and Structures assisted in various ways. They include: Miha Tomaževič, Ludvik Bonač, Darija Podbevšek, Janez Kutnar, and Martin Ozimek. The conference was arranged by the staff of the Congress and Cultural Center: Maya Bajželj, Darija Tomanič, Marko Miklič, and Jože Odar. At Cornell University Ellen Weeks did the bibliographic research for the proceedings, Beverly Buckley handled correspondence and administrative matters, and Jen Gage prepared the manuscript.

We are very grateful to all who contributed in any way.

Jože Vižintin
Barclay G. Jones

Co-Chairmen

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FOREWORD

Almost any attempt to organize so voluminous and heterogeneous a set of papers as that which follows is bound to be arbitrary. Arraying the papers or placing them in some order implies a categorization, and such classifications are rarely satisfactory. In the first place, most of the papers will span several of the categories that have been devised. The question then arises whether a paper deals chiefly with one category or another. In the second place, many different dimensions emerge. These include the nationality of the author and the organizations, institutions, and research traditions in that country; the scientific discipline of the author and the perspectives this may give to the approach to the subject; the particular phase or phases of a disaster situation the author treats; case studies or specific disasters from which the research has been drawn; and a number of others. Again, the papers are likely to transcend those particular bounds and exhibit commonalities across nationalities, disciplines, cases, etc. Were it possible to organize the papers in n dimensional space such as can occur in various multivariate techniques like factor analysis, one might be able to juxtapose papers appropriately to each other. However, language is linear and unidimensional. Spoken language presents material in an immutable temporal sequence. Written or printed language necessitates the same constraint but with the important exception that it can be violated. The reader is free to reorder the material to suit various interests and purposes. The reader can begin in the middle of the manuscript, move backwards or forwards, select and omit at will. Editors do not have this privilege and must impose an order of some kind.

The system of organization that has been chosen is a traditional one in the field relating roughly to the temporal sequence of a disaster. Concerns with the predisaster situation are dealt with first, followed by the event itself and the emergency situation attending it, and finally the post-disaster period is treated. Thus a form of symmetry between the organization of the material and the nature of the event is imposed. Since most events are recurring ones, the post-disaster period becomes by necessity a predisaster situation. Many of the papers that follow will span a number of these phases of the event. It was necessary to select that point in the continuum that seemed to constitute the most pertinent contribution of the paper. Many of the authors may be disconcerted at the ways their papers have been classified and placed. Readers, too, may not agree with the choices that have been made. The editors can only hope that the order may provide the reader with some direction in selecting the material of greatest interest and that some of the juxtapositions that have been made will provide new insights.

The first section contains three of the presentations that were made at the opening session of the conference. Mrs. Zupančič Vičar speaking on behalf of the host country gives a lucid description of the organization that has evolved in Yugoslavia to deal with earthquakes and other disasters. It is interesting to compare her statement with papers by Mušič, Bubnov, Zelenkov, Orožen Adamič, Štukelj, Ladava, Kirijas and Turnšek which together provide one of the most complete discussions of disaster organization in Yugoslavia that is available in the literature.

Dr. Zalar sets the context for the conference in terms of the long tradition of US-Yugoslav cooperative research on earthquakes and relates the subject matter of the conference to the full range of research efforts that have been carried out. Dr. Anderson describes briefly social science research on earthquakes in the United States, the necessary international dimension of it, and the necessity for the international exchange of research findings.

Hazard, risk and vulnerability to earthquakes and other natural disasters are characteristics of human populations in space and time and of the social systems they comprise. They relate, therefore, to the pre-event situation. The second section deals with these in particular ways. Hazard has usually been considered an attribute of the physical environment at a point in space. However, Hewitt and Baker raise questions about whether or not changes induced in physical environments by their social occupancy may not change their hazard characteristics. While Baker does not deal with earthquakes there are interesting parallels with the type of disaster he treats. Risk and vulnerability are high correlates of other attributes of social systems. Pelanda deals with this relationship specifically and other papers expand on it in different ways, particularly Ribarič, Quarantelli, Geipel, Cattarinussi, Cavazzani, and others.

The third section contains papers which deal specifically with hazard assessment, risk analysis, and vulnerability determination. The perspective is primarily in terms of the man-made environment of structures and buildings in a locale. Karnik defines the terms and displays the relationships. Lapajne generalizes on these concepts in developing a procedure for the assessment of acceptable seismic risk and in devising a scheme for managing risk. Fournier d'Albe discusses the difficulty of assessing the seismic risk of existing buildings. Wangsadinata suggests the use of the intended structural lifetime of buildings and relating this to the seismic hazard of their locations in determining structural design. Turňsek addresses the problem of increasing the seismic resistance of existing building stocks which will comprise the majority of the structures in any impacted area. The importance of this problem is referred to later by Bubnov and other writers dealing with specific cases such as Geipel and Orožen Adamič. Jones proposes a method for estimating the building stock in a region and determining the structures at risk. Such estimates relate to needs implicit in Karnik, Milliman and Schulze. The usefulness of such estimates in post-event situations is noted by Orožen Adamič and others.

Anticipating the economic effect of an earthquake and determining whether the costs of preventive measures are justified is the subject of the papers in the fourth section. Milliman proposes changing current models of regional economic analysis to make them useful for estimating impact. Schulze devises analytical procedures to assess the costs of imposing seismic building codes and establishing whether the benefits to be obtained from them are greater or less. The necessity of having advance estimates of the economic impact of an earthquake is dealt with explicitly or touched upon by Parr, Zelenkov, Bubnov and others.

The actual attitudes towards risk held by individuals inhabiting areas subject to hazard may or may not resemble assumptions of rational models that have been devised. Consequently behavior may not conform to expectations. Various analyses of attitudes towards risk are the subjects of the papers in the fifth section. Turner and Palm survey populations in hazardous locations which have not been subject to recent disasters. They explore their awareness and perception of the hazard and the ways in which this influences their behavior. Akimoto and Chandessais deal with actual situations. Akimoto studies the effects of predictions of aftershocks following an actual earthquake. Chandessais studies the effects of a false alarm of an earthquake due to a mechanical malfunction of the alarm system. Saarinen studies the behavior of people in response to warnings about an impending volcanic eruption.

Reducing the vulnerability of social and economic systems is the subject of the next two sections. Governmental responsibility for vulnerability reduction is the subject of the papers in section six. Given the evidence presented previously that individuals subject to hazards that recur sporadically at long intervals tend to discount risk unduly in their behavior, the necessity for responsible leadership is more apparent. Scott discusses the necessity for this leadership and the difficulty in developing it at the regional and local level drawing specifically on experiences in California. He points out the difficulties in absorbing technical information into public policy. Olson describes the leadership that has been provided by the State of California and generalizes from it. He notes that disasters are useful in developing policy response. Wyner surveys officials and reports the variability in willingness on the part of local leaders to assume responsibilities. Earthquakes are not issues that generate sustained political support: dedicated officials and professionals are necessary. Governmental roles in other countries are dealt with in papers in other sections by Alrasjid, Štukelj, Bubnov, Akimoto, Geipel, Cattarinussi, Cavazzani, and others.

Urban and regional planning, covered in section seven, is an instrument for reducing vulnerability. It has not been extensively used for various reasons. Mušič discusses this in general and gives examples of post-earthquake reconstruction planning that has had as one of its objectives the reduction of vulnerability citing cases in Yugoslavia. Two of these cases are covered by Zelenkov. Wolfe outlines the ways in which planning can be used to reduce the vulnerability of urban systems. He uses examples of pre-event planning from California. Germen indicates the potential role of planning is not being realized in reducing vulnerability and suggests a failure of interdisciplinary communication is a major cause. Compare Scott. Kirijas outlines the information that planners must take into consideration in planning if they are to make urban areas less vulnerable.

Education and information are instruments for both reducing vulnerability of social systems and managing emergencies when disasters occur. The eighth section contains two papers that deal with this. Battisti describes a post-event situation and a decision to develop an educational program that will lead to vulnerability reduction and make emergency behavior more appropriate in subsequent events. The situation he describes deals with a population similar to that studied by Chandessais and comparisons are interesting. In another section, Ladava and Štukelj describe response situations in which some education had taken place before the event, and it is useful to compare their reports with Battisti. Scanlon develops a model of the predicted response of the media in an emergency situation. It is interesting to compare Akimoto and Saarinen who report actual emergency behavior of reporters. Dynes refers to the social function of information.

The management of emergencies is the subject of papers in the ninth section. Dynes discusses alternative models of planning for managing emergencies. Comparison of his preferred emergent human resources model with the operation of various systems in emergencies as reported by Ladava, Štulkelj, Cavazzani and others is illuminating. He also covers the function of information in emergencies: see Akimoto and Scanlon. Bighinatti makes a plea for non-proliferation of international disaster relief mechanisms and indicates that a system which responds to specific requests from the impacted region will result in more appropriate response. Lechat deals with managing the very serious health problems that can arise in an emergency and also points out the dangers of well intentioned but entirely inappropriate response.

Post-disaster response is the subject of four papers in section ten. Alrasjid describes the earthquake disaster mitigation program in Indonesia with greatest emphasis on the post-disaster response phase. Štukelj describes the contrasting system that exists in Yugoslavia: compare Lechat and Battisti. Ladava displays the organization outlined by Štukelj more directly in the context of its actual operation after an earthquake. Cavazzani reports some of the problems in the Italian response mechanism which were revealed in the earthquake in Southern Italy in 1980. It is interesting to compare this account with Battisti and the Northern Italian situation described by Cattarinussi and Geipel.

Measuring the impact of an earthquake or other disaster on a social and economic system is difficult and complex. This is the topic of a number of quite different types of papers in section eleven. Ribarič suggests that the impact of an earthquake is an attribute of the resources available to it to assist in its recovery. He develops a scale for making international comparisons of the specific destruction of earthquakes. Compare Hewitt. Quarantelli explores what constitutes a disaster and in doing so details the various kinds of impacts not only of earthquakes but of a variety of disasters. Compare Baker. Bates develops a level of living scale for making cross-cultural comparisons of the relative effects of earthquakes and other disasters. Although Bates uses data from a specific event, the 1976 Guatemalan earthquake, the first three papers in this section deal with the subject in general. The last three papers deal with specific cases and arrive at generalizations from them. All three draw their material from the 1976 earthquake which struck Northeastern Italy and Northwestern Yugoslavia. Geipel details the impact of the earthquake by describing its effect on the culture of a social and economic system in space. Cattarinussi surveys the social and psychological impact. It is interesting to compare some of his survey results with those of Chandessais. Orožen Adamič looks at the social and economic impact of the physical destruction in various communities in Yugoslavia and develops a composite scale as a measure. He discusses the use of the damage rating scale mentioned by Bubnov, Turnšek and others.

The final stage of the disaster sequence is that of reconstruction. Finding ways of financing reconstruction is a critical problem and is the subject of the papers in section twelve. Decisions on how to finance reconstruction are an aspect of emergency planning and, therefore, could be considered as an element of the pre-event phase. However, the event itself is the ultimate test of the adequacy of the plan and it is natural to make re-evaluations in the post-event phase. Bubnov describes the model currently in use in Yugoslavia. It has already been pointed out that it is useful to compare his statement with Zupančič Vičar, Turnšek and others. Zelenkov reviews the Yugoslav financing system and suggests what amounts to an insurance trust fund financed by individual tax levies prior to the event rather than the post-event financing which occurs now. Parr develops a strong argument for earthquake insurance drawing on the New Zealand experience.

Experience in the recovery and reconstruction phase is dealt with in the last three papers that constitute section thirteen. Mader investigates land use planning after earthquakes using three case studies from California. The purpose of such planning is vulnerability reduction, and there are, of course, direct relationships with the papers by Mušič, Wolfe, Germen and Kirijas. Since the cases describe governmental behavior, there are interesting comparisons with Scott, Olson and Wyner and as a concrete reflection of attitudes with Turner and Palm. While Kreimer treats housing reconstruction, the concern is in relationship to vulnerability reduction planning and planning to achieve other social goals particularly in regard to the mangement of patterns of urban growth in developing countries. Hultåker studies the impact on families made homeless by a landslide through the reconstruction process. The process was so lengthy that this becomes a study of long-term impact, and it is interesting to compare it to the long-term results obtained by Cattarinussi. Recovery processes were described in many other papers including Geipel, Alrasjid, Ladava and others.

These brief descriptions establish that the papers that follow are rich and varied. Any attempt to do justice to them by summarizing their content would result in an excessively long introductory essay. Hopefully, this short exposition of the way in which the papers have been organized and the actual juxtaposition of the papers themselves will serve the purpose better than a lengthy review. The papers will speak for themselves. In editing the papers, a major attempt has been made to clarify the meaning in many instances by changing the phrasing and the structure of sentences. Uniform use of footnotes and references has been imposed and much time has been spent checking citations. In all instances every effort has been made to be faithful to the original content of the paper. The views expressed represent those of the authors and not necessarily those of any sponsoring organization. Errors of content or fact are the responsibilities of the authors. In any editorial process, additional errors are inevitably introduced. The editors sincerely regret any instances of this kind.

SECTION I

INTRODUCTION

WELCOMING REMARKS

Marija Župančič Vičar

Allow me to greet you most cordially on behalf of the Executive Council of the Assembly of the Socialist Republic of Slovenia and to wish you great success in the work you are undertaking. Your previous meetings have brought a range of fruitful results that have been incorporated in organizations and laws for preventing and mitigating the impacts of natural disasters such as earthquakes.

Major catastrophic earthquakes that have struck Yugoslavia and Slovenia have encouraged the working people and citizens of our socialist self-management society to pay more attention to the problems of preventing and eliminating the impacts of natural disasters. Various kinds of natural disasters continually endanger the safety of people and damage resources in citizens' ownership and social property. Among the natural disasters in the region of SR Slovenia that have caused high material losses, and in some cases claimed victims, earthquakes are the most frequent. Two catastrophic earthquakes occurred in the 16th century, and in 1895 a particularly serious one nearly razed Ljubljana to the ground. In recent years earthquakes inflicted heavy damage in the region of Kozjansko in 1974 and the Soča Valley in 1976.

The working people and citizens, associated into basic and other organizations of associated labour, in self-managing organizations and communities, local communities, communes, and republic, have the right and responsibility to develop systems to reduce vulnerability to natural disasters and assure that the impact of such disasters should affect as small a number of the population and as few of their possessions, as well as social property, as possible. For that purpose organizing and activities have been undertaken in order, first, to mitigate disasters, in the event of disasters to rescue lives and property efficiently, and after disasters have occurred to eliminate their impacts through organization and solidarity.

Experiences to date, as demonstrated by the reconstruction of Kozjansko and the Soča Valley, prove the power and ability of our socialist self-management society in such extraordinary conditions as major disasters to enable and assure, through self-management, self-organizing, and socialist solidarity, the mobilization of the initiative and actions of all affected and all working people and citizens and the organization of their material, technical, professional, personnel, organizational, and other forces for mitigating disasters, recovering from their impacts, and restoring normal living and working conditions in impacted areas.

The solidarity actions in the cases of Kozjansko and the Soča Valley produced important material, financial, and socio-political results, since the action was organized in such a way that every working person or citizen could participate. The solidarity action was quick and effective in meeting basic needs for living and working, and at the same time a larger solidarity action for eliminating the impacts of the disasters was carried out.

At present the most important role in activities of defense and rescuing people and property when earthquakes have occurred has been undertaken by working people and citizens through their self-protection activity, headquarters for civil defense and organization of associated labor, social and other organizations which are directly incorporated into civil defense.

We must emphasize especially the connection and solidarity between the citizens and our army, as well as the large contributions and participation of Yugoslav youth in working on the reconstruction of affected areas after an earthquake. In such actions thousands of working people, members of the Yugoslav National Army, youths, and citizens cooperated through their voluntary work.

An important consideration in the efficiency of actions is that they quickly attend first of all to restore the basic means for living and conducting social activities of the economy in eliminating impacts of natural disasters.

The public media significantly contribute with objective and engaged reporting in providing information about the catastrophe, conditions, and requirements in impacted areas, measures that have been taken and their effectiveness. In these ways they promote the success of solidarity actions for eliminating the impacts of natural disasters.

In the Federated Socialist Republic of Yugoslavia, as well as in Slovenia, we have since 1963 normatively stipulated principles of counter-earthquake construction as preventive measures to protect ourselves from the impacts of earthquakes. Civil engineering and urban legislation provide the basis for earthquake resistant construction, taking into consideration all points of view for life safety, rescue procedures, and measures taken when natural disasters occur (adequate distance between buildings with respect to height, possibilities of access of emergency vehicles, etc.). Special attention is paid to training and equipment of civil defense units and citizens in general.

A uniform methodology for evaluation of primary losses from disasters has been developed and adopted to establish the principles of republic or federal solidarity participation. This provides a standard procedure for ascertaining impartial evaluation of items. Competent bodies in the socio-political community decide in which cases in the commune or republic the evaluation of loss should be carried out.

The responsibilities and liabilities for preventive and defensive measures against natural and other disasters are being stipulated in their middle-term and annual plans by socio-political communities, local communities, and other organizations of associated labor, as well as self-managing communities of interest and other self-managing organizations and communities.

Everyone within the limits of his abilities is liable for financing preventive measures against disasters in his area, as well as for ensuring funds for implementing relief when disaster occurs and for restoration after the disaster. In the case of major natural disasters, at the republic and federation level, a system of solidarity is formed, based on social compacts and legal regulations.

The law on forming solidarity funds for eliminating impacts of natural disasters of 1975 defines the level of the amounts to be paid by respectively employees, retired people, farmers, and other citizens. Also, by this law, solidarity week is introduced in which in various ways solidarity funds are collected (e.g., one-day's earnings of all employees employed by the organizations of associated labor, etc.). The 1975 social compact on the manners for usage and management of solidarity funds for eliminating natural disasters was concluded in order that such funds are used for the intentions for which they are collected. The social compact regulates that solidarity funds can be used in a commune only when the loss, ascertained by the uniform methodology for evaulation of primary losses from disasters, exceeds 3% of social production of the previous year. In less developed communes, as defined by the law, the criterion is 1.5%. On the proposal of the committee of signers of the social compact, the signers define to what extent and in what regions the solidarity funds should be used for eliminating impacts of natural disasters. In the case of major disasters, where elimination exceeds the possibilities of the republic, pursuant to the criteria of the social compact, concluded by the republics and autonomous provinces in 1974, the solidarity funds of nations and nationalities of Yugoslavia, can be used.

We have introduced an extensive system for ensuring funds for implementation in cases of natural disasters. But even then we can see that the funds, collected as stipulated by the law, are not sufficient to meet the needs of major natural disasters. That is why in such examples agreements are being concluded for additional pooling of funds in communes, local communities, basic organizations of associated labor, and self-managing communities of interest.

Post-earthquake reconstruction requires a large and complex step. It is not enough that the previous situation before the earthquake be restored. Something more must be provided to impacted areas through the solidarity funds and complete engagement of all working people and citizens. Steps must be taken to ensure the development of the economy, social activity, infrastructure, and housing. The evaluation of post-earthquake reconstruction in the areas of Kozjansko and the Soča Valley shows that in that respect we have completely succeeded.

In short, I have described the operation of the unique system which was adopted in our Socialist Republic of Slovenia, assigning responsibilities and liabilities for eliminating the effects of natural disasters, among which earthquakes are the most frequent.

The Third International Conference--Social and Economic Aspects of Earthquakes and Planning to Eliminate Their Impacts shall undoubtedly result in many exchanges of points of view and experiences with new solutions which should contribute to better organization for eliminating the impacts of natural disasters of which earthquakes cause heavy material losses and claim many victims. Once again, I wish you much success in your work and a pleasant stay in this beautiful part of our country.

OPENING REMARKS

Charles Zalar

Permit me to say a few words on the present and past cooperation between the United States of America and Yugoslavia in the field of the earthquake sciences.

In 1963, an earthquake destroyed the capital of the Republic of Macedonia, Skopje. The city of Skopje was soon rebuilt through the tenacity of Yugoslav engineers and with the assistance of engineers from countries all over the world.

This international cooperation marked the beginning of the establishment of a new institute in Skopje, the Institute for Earthquake Engineering and Engineering Seismology, which, in only 16 years, has developed, under the sagacious leadership of Professors Tiberije Kirijas and Jakim Petrovski, into a world-class scientific institution.

In October 1969, another earthquake severely damaged the Yugoslav city of Banja Luka. In response to a Yugoslav request for U.S. participation in a multi-disciplinary research project, a 14-man research team, representing U.S. government science agencies and universities and coordinated by Dr. Michael Gaus of the National Science Foundation, visited Banja Luka, Skopje, and other Yugoslav cities, in February 1971. A few months later, Dr. Gaus initiated a series of joint U.S.-Yugoslav research projects in seismology and geophysics, earthquake engineering, Karst hydrology, and urban planning.

These studies have been conducted by well-known Yugoslav experts, such as Professors Kirijas, Petrovski, Hahamović, Trumić, Žeželj, Aničić, Somborski, and Turnšek, in cooperation with American Professors Bouwkamp and Wilson of Berkeley, Hudson of Caltech, Yevjevich of Colorado State, and Jones of Cornell University.[1]

Some three or four years ago, the National Science Foundation of the United States of America took the initiative to bring together scientists and engineers from all over the world for discussion and extensive study of earthquake phenomena. It was only natural that Yugoslavia was selected as the gathering place for these scientists.

In 1979, the First International Conference on "Intra-Continental Earthquakes" was held in Ohrid, Macedonia, and in 1980, the Second International Conference on "Earthquake Engineering" took place in Skopje. Both conferences were very successful and resulted in a great number of studies which have been or are about to be published. For the excellent organization of the first two conferences we have primarily to thank Director Jakim Petrovski and his associates.

The Third International Conference on "Social and Economic Aspects of Earthquakes and Planning to Mitigate Their Impacts" is being held--as were the first two conferences--under the auspices of the U.S.-Yugoslav Joint Board on Scientific and Technological Cooperation, sponsored by the National Science Foundation of the United States of America and the Yugoslav Association of Self-Managed Communities of Interest for Scientific Research. The conference has been organized under dual chairmanship: the indefatigable American Co-Chairman, Professor Barclay Jones, Director of the Program in Urban and Regional Studies of Cornell University, and the Yugoslav Co-Chairman and your host, Dr. Jože Vižintin, Director of another fine institutc, the Institute for Research and Testing Materials and Structures in Ljubljana.

I have the pleasure to greet on behalf cf the National Science Foundation the representatives of the Yugoslav government authorities and of Yugoslav scientific institutions Engineer Marija Zupančič-Vičar, Prof. Dr. Muris Osmanagić, Prof. Dr. Sergej Bubnov, and finally, an internationally known expert in the field of the mitigation of natural catastrophes, the former Rector of the University of Ljubljana and present President of the Slovenian Academy of Scienres and Arts, my dear friend Prof. Janez Milčinski.

And now, I am pleased to extend on behalf of the National Science Foundation warm greetings to all the participants of this conference, and wishes not only for fruitful professional discussions but also for a pleasant sojourn in this beautiful country.

FOOTNOTES

1. The following series of studies resulted from this initiative:

   Prof. V. Yevjevich of the Colorado State University and Prof. A. Trumić of the University of Sarajevo conducted "Analytical and Field Studies of the Hydrology, Water Resources, Pollution, and Economic Development of Karst Regions."

   Prof. J. Bouwkamp and E. Wilson of the University of California at Berkeley and Prof. J. Hahamović of the University of Sarajevo in conjunction with other experts from Belgrade (B. Žeželj), Zagreb (D. Aničić), and Skopje (J. Petrovski) conducted "Analytical and Full-Scale Studies on the Earthquake Design of Buildings Constructed by Industrialized Methods and of Four Different Dams."

   Prof. D. Hudson of California Institute of Technology and Prof. T. Kirijas of the Skopje University supervised "The Establishment of a Basic Instrument Network for Recording Strong Earthquake Motions in the Six Republics of Yugoslavia."

Prof. B. Jones of Cornell University and Prof. M. Somborski of the University of Sarajevo cooperated in a project of "Large-Scale Integration in Urban Planning with Trial Application to the Banja Luka Region."

At this time, Prof. Bouwkamp is cooperating with Engineer D. Aničić of the Institute of Civil Engineering of Croatia, and Engineer V. Turnšek of the Institute for Research and Testing Materials and Structures of Slovenia, in studies on "Earthquake Resistant Design of Buildings."

OPENING REMARKS

William A. Anderson

As one of the representatives from the National Science Foundation's Earthquake Hazard Mitigation Program, let me say that we are delighted to be in Yugoslavia and to participate in this Third International Conference. The Earthquake Hazard Mitigation Program includes engineering and architectural components, as well as a social science element called Societal Response Research. Societal Response is the principal program in the United States supporting research on the social and economic aspects of earthquakes. Researchers from such disciplines as economics, sociology, political science, geography, law, and anthropology are supported through the program.

Societal Response was established as a program in the mid-1970s. It is designed to complement the engineering and related mitigation research funded by NSF. For example, while engineers are developing knowledge for designing safer structures, social scientists supported under NSF's Societal Response program are conducting investigations which will help put more of that knowledge into practice. Social scientists are informing us how earthquake hazards are viewed by vulnerable populations, what the barriers to the adoption of building codes and land use planning measures are, and how these barriers might be overcome through regulations, incentives, and education. In a similar way, this Third International Conference, with its emphasis upon socioeconomic factors, should complement the first two conferences which dealt with geophysics and earthquake engineering.

Many of the U.S. social scientists participating in this conference are receiving, or have received, support from the Societal Response program. Their work reflects the emphasis placed by Societal Response on developing knowledge on the social and economic aspects of mitigation and preparedness, on disaster impacts and responses, and on hazard and disaster information dissemination.

While the focus of the work supported by Societal Response has been on problems in the United States, we are also interested in experiences of other societies. We have even supported researchers to conduct studies in other countries. For example, Dr. Frederick Bates will be presenting some of the findings of his NSF funded study on the 1976 Guatemala earthquake. We have also supported and participated in international workshops and conferences. For example, Dr. E. L. Quarantelli, another participant at this conference, was awarded a grant by NSF to organize a U.S.-Japan Conference on social science disaster research in the two countries. At this conference, then, as in our previous international activities, we look forward to both learning from and sharing our experiences with our colleagues from Yugoslavia and around the world.

SECTION II

SOCIO-ECONOMIC ASPECTS OF HAZARDS, RISKS AND VULNERABILITY

SETTLEMENT AND CHANGE IN 'BASAL ZONE ECOTONES':

AN INTERPRETATION OF THE GEOGRAPHY OF EARTHQUAKE RISK[1]

Kenneth Hewitt

Introductory Remarks: Disaster Geography

The geography of disaster presents severe problems of interpretation as of practical response. Not least is the complex way both discontinuities and continuities of material life are involved. There is not only the disarray, uncertainty and destablisation that the disaster event itself is most widely typified by. Also there is always a carry-over of some stable features, or definite expectations; behaviors, struggles to restore an implied 'norm', that link disaster strongly to the rest of life, and the on-going patterns of its spatial organization.

In the present discussion I shall be concerned primarily with aspects of human geography that do express spatial continuities, asking how they may exercise an influence upon the location, form and recurrence of earthquake disaster. This seems to be the function of a human ecology of risk. That is to say, we shall look at the incidence and features of disasters as they relate to the habitats where they occur, the human occupancy of those habitats, and larger spatial continuities of socio-economic organization. Little will be said about the seismic issues or crisis behavior. If so much had not already been written about them this would lead to an unbalanced approach. But here we shall look essentially at earth surface features rather than seismicity; at the phenomena of human settlement and on-going relations to habitat rather than of crisis.

This is a frankly academic piece of work exploring such data and ideas as are available, rather than an attempt to guide policy or management. It will differ too in the balance of abstraction and concreteness from so much of the specialized work on seismic risk [UNESCO, 1978]. I would argue, however, that the matters discussed are essential parts of the realities of place and people into which earthquake-triggered disaster intrudes; with which relief efforts must cope, and with whose features any successful aseismic planning must ultimately deal.

First, we shall examine some of the geographical relations of the global distribution of damaging earthquakes in recent decades. This will be based upon an inventory of some 154 of the largest disasters for the last thirty years (Figure 1). It has rarely been possible to get sufficient evidence to place all examples in terms of the aspects discussed [Hewitt, 1978]. We shall then turn to more detailed locational, site and internal patterns of individual disasters.

The Global Distribution of Earthquake Disaster

Among the geoecological conditions that seem as significant as seismicity itself, and important determinants of the variation of risk within seismic zones, are terrain and climate.

The great majority of destructive earthquakes involve damage zones partly or wholly within mountainous terrain. In our inventory at least 90 per cent included areas of highly accidented topography, where available relief exceeds 1000m. In most instances for which we have relevant data, the damage zones also stretch over a range of those marked altitudinal and aspectual differences in climate and vegetation cover, typical of mountain ecosystems [Hewitt, 1972].

The role of mountain terrain in disaster cannot be reduced simply to the geophysical coincidence between mountain building and seismicity. Descriptions of the disasters show clearly how the form and degree of damages reflect the environmental peculiarities of mountain habitats. The significance of surface geology, topography and plant cover is demonstrated by the growing body of work on seismic microzoning [Brabb, 1979]. The 1974 Himalayan disaster described elsewhere [Hewitt, 1976] is a fairly extreme reflection of the significance of mountain conditions, but the large role of landslides, of adverse weather and difficulties of relief and communication in steep-slope terrain are repeated in many examples. I have discussed elsewhere the detailed ways mountain conditions shape the spatial patterns within disaster zones, so that the same problems for survivors, relief efforts and rehabilitation constantly recur [Hewitt, 1978].

The relations of globally common earthquake damage to mountain conditions will hardly surprise anyone familiar with mountain ecosystems, and the kinds of impacts earthquakes can have. However, there is an apparent global relationship to climate that is more paradoxical.

About three-quarters of the disasters in our thirty-year inventory occurred where regional climates are semi-arid or seasonally dry (Table 1, Figure 2, Appendix A). The main exceptions lie in the humid, mountainous islands of Southeast Asia. Even here, we are dealing mainly with climates that are "transitional," usually monsoonal with a marked seasonality, and with a variability shown by two or more "year-climates," to use Mizukoshi's terminology [1971].

The Budyko-Lettau Dryness Ratio, said to be a more sensitive indicator of biophysical conditions, [Lettau, 1969] was estimated for

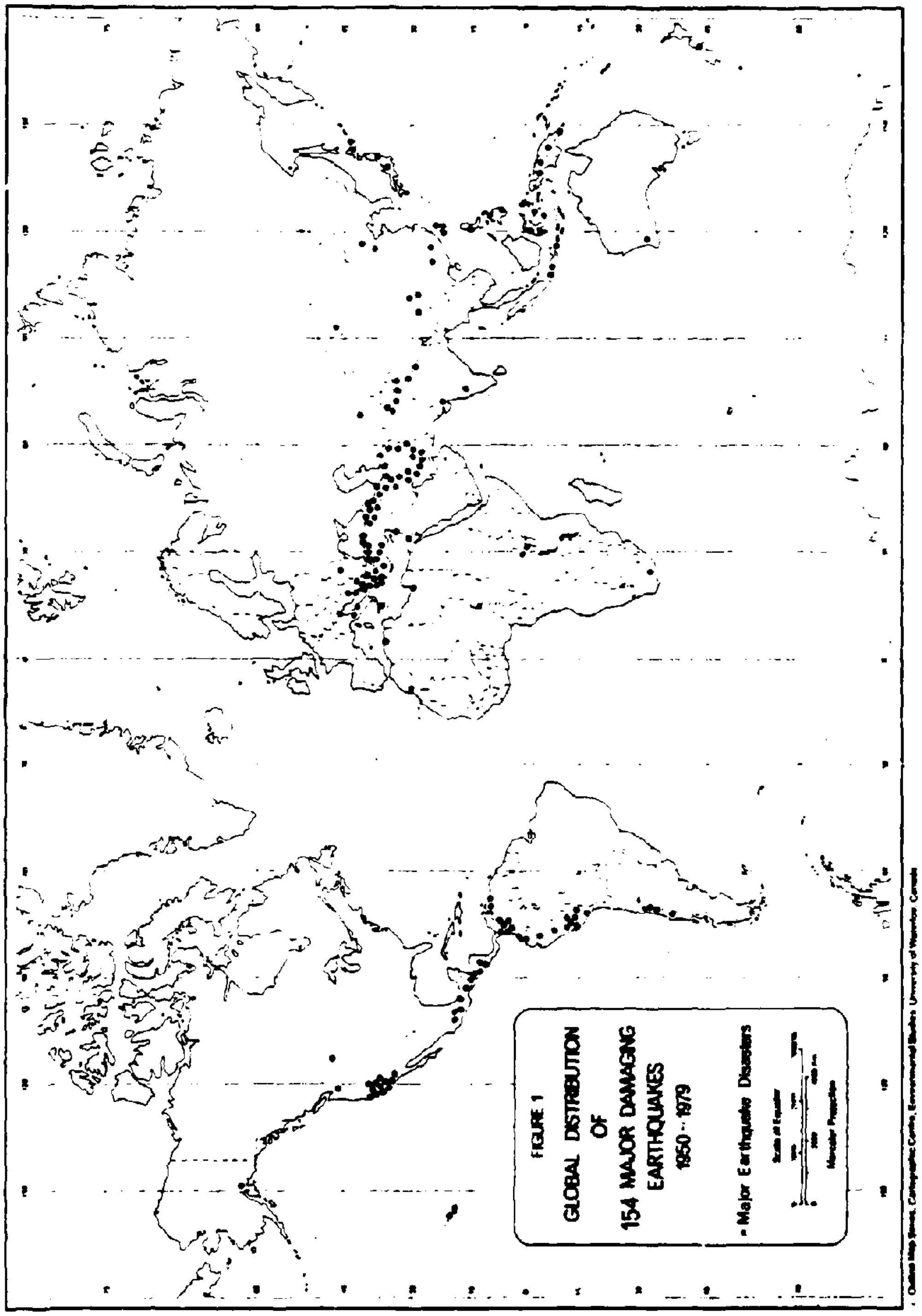


FIGURE 1
GLOBAL DISTRIBUTION
OF
154 MAJOR DAMAGNG
EARTHQUAKES
1950 - 1979
• Major Earthquake Disasters

the disaster areas too (Table 1). Mountain influences and remoteness from weather observations limit the accuracy of these estimates, but they do provide a striking indication of the regional association of most damaging earthquakes with zones of moisture stress.

More specifically, the disasters seem to be associated with zones of transition in moisture supply; that is, not simply in semi-arid or sub-humid areas, but where there are relatively marked gradients between drier and wetter zones. The seasonal precipitation is associated with seasonal shifting of storm belts. The important fraction of disasters occurring on or close to sea coasts involves strong gradients of moisture supply from the coast, inland. The orographic effect upon precipitation and rain shadows further create sharp moisture gradients across these areas.

There is an anomalously high concentration of disasters in "humid mesothermal" climates with a marked summer dry season. Nearly thirty per cent occurred in Koppen's class Csa, the 'mediterranean' and 'sub-mediterranean' climates [Aschmann, 1973a].

Now, the geography of seismicity itself shows no relationship to climate, and no known causal connection exists between the two. Therefore, if the evidence of recent disasters does show a higher concentration in particular climates, this must have to do with influences of surface conditions upon the impact of seismic shocks. That may be in direct physical ways such as the effects of geoecological conditions upon, say, slope stability. Or they may depend upon the nature of human settlement, or more likely, the interaction of the two to produce a greater vulnerability in these habitats.

Evidence of Human Ingredients of the Global Distribution

Wherever one can obtain local details of damage and of pre-disaster conditions for the earthquake areas, invariably they record more or less drastic, recent and accelerating processes of environmental and social change. The details are not simple or uniform. I have found no attempts to systematically record these features of earthquake disaster zones.

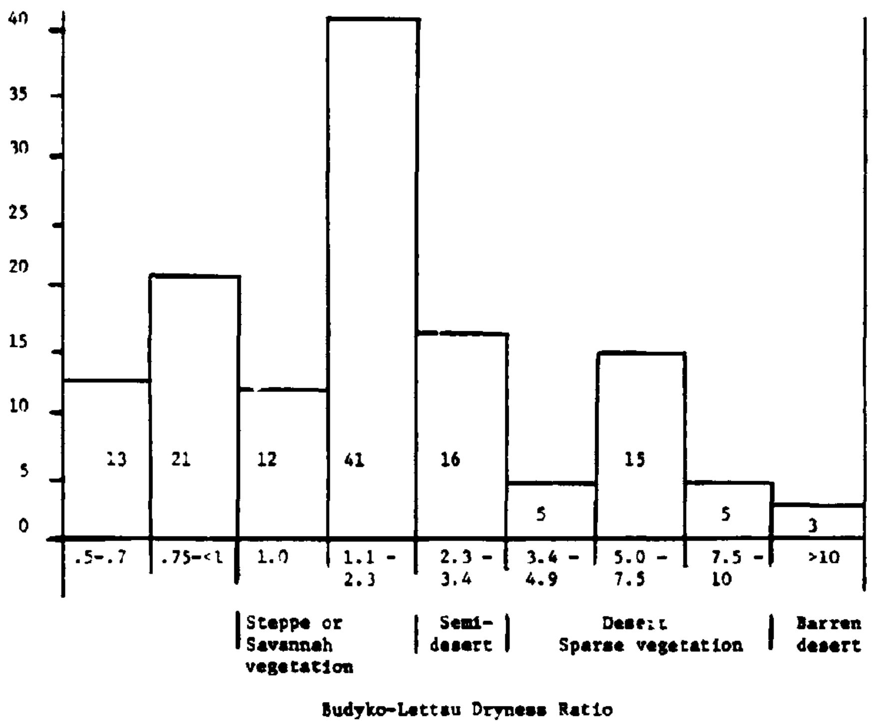
The most common of all observations relate to "poor construction" that includes new and old buildings; "traditional" and modern styles, poor design, poor maintenance, poor siting. What concerns the social scientist, however, is not just classifying what is damaged and what survives. We need to identify the processes, or indicators of processes, governing say, the proliferation of some types of structures when others might serve.

In the Himalayan disaster described elsewhere [Hewitt, 1976] much loss of life was due to the collapse of "traditional" buildings. But the few modern structures rarely stood up any better. Meanwhile, there were styles of "traditional" house or facility that resisted damage best of all (c.f. photos in Ambraseys, et al.,[1975]). More to the point, so many of the traditional buildings that failed were of relatively recent construction and in a style distinguished by lack of timber supports in the walls. There is reason to think this reflects a timber shortage. That style of building in the past was restricted to

Table 1

Regional Climatic Relations of Major Earthquake Disasters
(Jan. 1, 1950 - Dec. 31, 1979)
Provisional Site Classifications Using the Köppen System

Groups of Climate	Types of Climate		No. of Disasters
A. Tropical rainy	Af,	tropical wet	9
	Am,	tropical wet, monsoonal	9
	Aw,	tropical wet and dry	11
			29
B. Dry	BS, semi-arid (steppe)		
	BSh	tropical - subtropical, short moist season	12
	BSk	middle latitude meager rainfall, most in summer	9
	BW, arid (desert - constantly dry)		
	BWh	tropical and subtropical	6
	BWk	middle latitude	4
			31
C. Humid mesothermal	Dry summer, winter rain		
	Csa	Subtropical, hot summer ("Mediterranean")	33
	Csb	warm summer	9
	Dry winter		
	Cw		14
	Cwa	moist, warm summer	3
	Cwb	(Cooler than Cwa)	3
	No marked dry season		
	Cfa	humid subtropical	4
	Cfb	(cooler than Cfa)	9
			74
D. Humid microthermal	Dry winter		
	Dwb		1
	No marked dry season		
	Dfb	humid continental, cool summer	6
	Dfc	cold winter	2
			9
		Total	143



Notes: i) The Ratio (D) is: D = R/LP
where R = mean annual net radiation
P = mean annual precipitation
L = latent heat of vaporization of water
i.e. D >1 indicates an increasingly large moisture deficit.

ii) Of the sites having D.I <1.0, there are 23 with a marked dry season, and probably a net moisture deficit in some or most years. The majority are in monsoonal regimes of a transitional type (ed. Yoshino,)

iii) "Desertification" has been most commonly recognised in areas with D between 2 and 7 (see Hare, 1976).

iv) Values for our sites were interpolated from maps kindly supplied by Prof. Dieter Henning of the Meteorological Institute in Bonn.

Figure 2

Distribution of Budyko-Lettau Dryness Radio for Major Earthquake Disaster Sites 1950-1979 temporary summer settlements at higher altitudes, animal shelters and poorer landless folk. Traditional designs that did have timber supports survived largely intact. The exceptions that I saw were cases where rotten beams failed, suggesting that the timber shortage had prevented renovations. Then again, the bulk of the losses and damage were due to slope failure and landslides. In most cases these occurred on recently deforested slopes. The remaining forested areas showed no evidence of the many rockfalls and soil slips on bare slopes. It seems fair to say that not only most of the damage, but the occurrence of a disaster at all was largely an artifact of recent land-use and socio-economic changes. The main ingredient of risk turned out to be man-induced destabilization of slopes fatally connected with impoverishment of traditional building supplies, when there has been little penetration of new techniques of sound construction. The single greatest source of damaging response to earthquake appears, therefore, as deforestation. In turn, this has surely been associated with progressively larger influences by outside social changes. They range from the role of medicine in increased populations or pressures to extend cultivated land, to economic incentives to expand the size of goat and cattle herds, and export lumber or firewood to the cities of the plains. One might just as well classify this as a 'development' or 'deforestation' disaster!

If Indus Kohistan has unique environmental and social conditions, similar transformations recur as background in the reports from most of the mountain area disasters. The literature is full of comments that suggest enhanced risk, --less often, decreased risk,-- as a result variously of development or "underdevelopment." In the latter there is often a greater transformation of land and people. In one area, rapid intensification of land use may be the issue; in another decline, impoverishment, or abandonment and increased out-migration.

Urbanization is a widely reported aspect of damages that reflect recent land use changes. Some of the more spectacular losses have been in new multi-story construction. Examples have been described in the disasters at:

Agadir, Morocco	1960
Niigata, Japan	1964
Alaska, U.S.A.	1964
Caracas, Venezuela	1967
Bucharest, Rumania	1977
Al Asnam, Algeria	1980

Elsewhere, and more extensive in numbers of structures involved, we find new wealth put into renovating older buildings, but in cosmetic ways that do not help, and may decrease structural safety [Ambraseys, 1976]. This has been remarked upon in several eastern Mediterranean disaster areas:

Fruili, Italy	1976
Thessaloniki, Greece	1978
Montenegro, Yugoslavia	1979
Al Asnam, Algeria	1980

But perhaps the most extensive problems and human misery relate to concentrated destruction in sprawling areas of new, poor housing and squattments. So often, they are on the poorest sites, whether steep hillsides, low-lying alluvial land, ravines and bluffs:

San Salvador, El Salvador	1965
Lima, Peru	1966, 1974
Luzon I, Philippines	1968
Managua, Nicaragua	1972
Guatemala City, Guatemala	1976

But an equal or perhaps larger aspect of this problem, is where older sections of cities are run-down, often they have become slums that modernization passes by. Here, even once solid buildings are weakened by neglect and decay to become death traps in relatively moderate earthquakes. In so many of the high risk areas of the eastern Mediterranean lands, for example, one can literally smell the dampness that betokens decaying masonry, stone, plaster, wooden beams. The results were seen recently in Kotor, Yugoslavia (1979) and in Naples, Salerno and the Campagnan mountain towns (1980). Similar problems were present in:

Cuzco, Peru	1950
Ionian Islands towns, Greece	1953
Arequipa, Peru	1960
Skopje, Yugoslavia	1963
Peloponnese, Greece	1965, 1966
Peru, Ecuador	1970
Fruili, Italy	1974

It may be noted, too,that if a high proportion of the worst events in recent years in terms of fatalities and property loss have been centered on, if not exclusively in, a large city, they do not necessarily involve the larger earthquakes (Table 2). How far that is a matter of the location of epicenters, or the kinds of sites the cities include and how far a problem of the urbanization itself, is not readily determined from the evidence available, but is a significant question given the pace of the process.

However, there is a much higher spatial probability that disaster will occur in the rural and small settlements that cover so much more of the habitable earth surface. And it is change, development and devolution beyond the urbanized areas that is the most widely reported transformation of all.

Rural "decline" or impoverishment, even in the presence of rapidly expanding populations and total productivity, recur in the landscapes of the many disasters in the interior of Turkey and Iran, as in Peru, Ecuador, Colombia and Mexico. It was equally apparent in:

Table 2

Features of Selected Damage to Urban Centers in Mountain Regions, from Earthquakes of Moderate Strength (c.f. Appendix A)

Place	Date	Richter	Casualties	Dollar loss estimates
Amato (Ecuador)	1949	6.8	6,000	66 million
El Asnam (Algeria)	1954	6.8	1,250	-
Agadir (Morocco)	1960	5.6	12,000	500 million
Skopje (Jugoslavia)	1963	5.8	1,200	1500 million
Caracas (Venezuela)	1967	6.5	277	150 million
San Fernando (California)	1971	6.6	64	750 million
Managua (Nicaragua)	1972	6.2	5,000	1000 million
Gemona de Friuli (Italy)	1976	6.5	965	2500 million

Assam, India-Tibet	1950
Ionian Islands, Greece	1953
Pindhos Mountains, Greece	1954, 1960, 1967
Chouf, Lebanon	1956
Barce, Libya	1965
Kashmir, N.W. India	1963, 1975
Peloponnese, Greece	1965, 1966
Western Nepal	1966
W. Sicily, Italy	1968
Celebes, Indonesia	1969
Pattan, Pakistan	1974
Fruili, Italy	1976
Irian Ja Ja, Indonesia	1976
Campagna, Italy	1980

In terms of our earlier points about mountain habitats, a further growing form of economic loss involves damaged installations related to recent accelerating development of resources and facilities in mountain areas. The Karakoram Highway, still under construction when the 1974 Himalayan disaster occurred, surely absorbed the bulk of the relief manpower in efforts to restore it for communication to and beyond the disaster zone. Elsewhere, damages to rail and highway links are widespread. To them are added destruction of tunnels, water conduits, dams, power lines, mining and forest operations. Common, but often given little attention is the fate of steep slope and terraced agriculture [Hewitt, 1976], sometimes in the process of abandonment but for the most part extending onto less stable areas. Examples of such damages related to economic and technological developments of mountain lands were found in:

Assam, India-Tibet	1950
Potesi, Nicaragua	1951
Kern Co., California	1952
Chile	1958, 1960, 1965, 1971
Mindanao, Philippines	1955
Elburz Mountains, Iran	1957
Hegben Lake, Montana, U.S.A.	1959
Alaska, U.S.A.	1964
Celebes, Indonesia	1965
Tashkent, U.S.S.R.	1966
Keyna, India	1967
N. Honshu, Japan	1968
Inangahua, New Zealand	1968
Peru	1970
San Fernando Valley, California, U.S.A.	1971
Hokkaido, Japan	1973
Khulm, Afghanistan	1976
Friuli, Italy	1976
San Juan, Argentina	1977
Montenegro, Yugoslavia	1979
Jiangsu Prov., China	1979

Of particular note, in relation to dryness of the regional environments are the many occasions when water resource facilities suffer destruction. Examples range from conduits in Maipo Valley, Chile (1958) and dams in the San Fernando Valley (1971), or Valparaiso Province, Chile, (1965); to irrigation ditches widely damaged in the Indus Kohistan disaster (1974) and Qanats in Iranian examples such as Turud, (1953) and Tabas e Golshan, (1978).

One final particular of damages relates to the great number of disaster zones that include sea coasts. Tsunamis are a notorious side-effect of seismicity that damage shoreline installations and fisheries. But of note lately are the number of occasions when port and harbour installations have suffered directly from shaking. And so often they prove to have been built upon alluvial deposits or artificial fill, flat land being so scarce along mountainous coastlines:

Long Beach, California	1951, 1955
Aegean Islands, Greece	1956
Chile	1960
Alaska, U.S.A.	1964
Niigata, Japan	1964
Lima-Callao, Peru	1966, 1974
Venezuela	1967
N. Honshu, Japan	1968
Manila, Philippines	1968
New Guinea	1970
Hilo, Hawaii	1973
Esmeraldas, Ecuador	1976
Montenegro, Yugoslavia	1979
Tumaco, Colombia	1979

A much-needed survey is that of the social circumstances of victims and survivors of these disasters. It is a vexed problem. Clearly, in most instances it is the relatively poorer, less vocal, powerless elements of society who suffer the greater casualties. It is equally obvious that they are most often the occupants of the least safe sites, of the least cared-for, most cheaply built or dilapidated structures, and therefore most adversely associated with the kinds of physical circumstances described above.

Disaster as a Symptom of Environmental Deterioration

It is hard to generalize about the socio-economic details of earthquake damage. It is not hard to draw a parallel with the evidence of environmental change in these habitats, world-wide. And it is important not to ignore the way in which all social and economic development that affects risk is becoming tied into and increasingly shaped by a single international system that produces convergent problems [Hewitt, 1982].

We have identified earthquake disaster especially with mountain regions. There is overwhelming evidence of man-induced change in these habitats. Most is of kinds that increase the impact of earthquake. It does so directly by affecting such things as slope stability. Indirectly, the scope of risk is expanded by the rapid pace of intensified resource use, construction and extension of communications, and of political and military activity into them [UNESCO, 1974] [Eckholm, 1975].

At the same time, the processes of environmental deterioration summed up in "desertification" are most evident in semi-arid, sub-humid and seasonally dry lands, rather than the fully arid lands [U.N., 1977]. Hare [1976] has identified the most serious zones of desertification as having Dryness Indices in the range 2-7, which would embrace the regional climates of a good half of our disasters (Figure 2). Degraded vegetation cover, accelerated erosion, increased run-off and floods are also processes we could expect to adversely affect earthquake risk.

With the earthquake problem, however, we are not dealing in general with either semi-arid areas or mountain areas. Most damage zones involve both. The concentrated areas of earthquake disaster in the world lie at the intersection, as it were, of somewhat dry lowlands or coasts and mountain belts, which in most cases are much wetter. Such is broadly the case for the greatest concentration between the Eastern Mediterranean and Indus Valley (Figure 1). The concentration of disasters in Latin America and California exhibit similar gross relations to habitat. They are less obvious in S.E. Asia where humidity is generally higher. But it is worth noting that, in addition to the prevalence of mountainous terrain, and seasonal climate, the extensive processes of deforestation and other harm to vegetation cover are producing conditions in the landscape there that are analogous in effect to "desertification" [Ranjitsinh, 1979] [Panabooke, 1977].

It is, however, the convergence of the distribution of earthquake disasters upon areas where drier regional climates, and mountain zones meet, that leads us to our next step in their geographical interpretation.

Disaster Sites: Location and Patterns of Damage

It is essential now to move from gross geographical patterns, to the detailed distribution of sites and damage in earthquake disasters. If surface conditions and human activities play any role in seismic risk, it is here that we see it most clearly realized, including the importance of climatic relations.

The first thing to note is that detailed field surveys reveal a more complex and variable picture of earthquake impacts than the idealized image of isoseismal lines whose intensity falls off radially from the epicentral area. The worst damages may be well removed from both the epicenter and reactivated faults. There are commonly multiple centers or patches of damage of given severity. Within a zone that contains damages of the highest intensity, we find structures and people that go unscathed. Not uncommonly there are also isolated patches of the most severe damage in areas far removed from the main damage zones. Rarely is there a spatial coincidence between the different forms of damage used to define earthquake intensity, be it building performance, slope failure, surface rupture, or perceived events. In sum, just as there is a rather poor correlation between earthquake magnitude and scales of disaster [Hewitt, 1978, Table 4], so the geophysical "footprint" itself is only a very gross indicator of the spatial arrangement of damages.

Is it therefore impossible to make any generalizations about damage patterns, in particular as they might point up relations to human and geoecological conditions?

Looking first at an obvious dimension, topography, there is a broadly repetitive type of morphology of damages in most of the disasters. The "typical" event has the main, concentrated pockets of greatest destruction and loss of life in mountain foot or foothill areas, with a "scatter-gun" effect of highly variable damages over a mountainous hinterland. Sometimes as at Skopje in 1963 or Guatemala City in 1976, destruction is largely confined to piedmont or intermontane basin areas. Conversely, in a case like the 1974 Himalayan disaster, the negligible area of mountain foot features made the influence of mountainous topography overwhelming in the destruction of small settlements in crestlines and in narrow defiles. This disaster was, nevertheless, identified with the largest settlement affected, Pattan, which lies on the floor, river terraces and alluvial fans of the Indus Gorge. And as in many other cases, processes initiated at higher altitudes and on very steep slopes wrought the main destruction of life and property at the mountain foot. More commonly, however, we encounter situations intermediate between these two examples. The 1979 Montenegran Coast, the 1976 Friuli, the 1968 Dasht-y-Bayaz or 1964 Niigata disasters were more typical. Most damage was in foothill, piedmont or intermontane basin areas, but with scattered destruction to villages, farms, communications and other installations in surrounding mountain areas.

In itself, the identification of highest damages with piedmont areas is not profound. However, it becomes profoundly important in relation to human settlement, environmental impacts and the climageomorphic relations of earthquake disaster.

The mountain foot environments, the areas where steep slopes give way to gentler ones; where mountain ranges soften into foothills or plunge to the sea coast, were discussed by the ecologist Schimper 1903, p. 702 under the term "Basal Zones". Except locally or incidentally little further work has been done on them.

In terms of seismic risk, the outstanding features of the Basal Zone are those of its heterogeneity, as much as the sharply transitional or "ecotonal" aspect. Seismic shaking is particularly influenced by slope, by the mechanical properties of rock and regolith, by vegetation cover, and moisture conditions. These largely govern the stability of slopes and foundations, and the likelihood of surface rupturing. Variations in them modify the amplitude and form of seismic motion at the surface, or involve very different responses to it. As a landscape, the Basal Zone is characterized almost everywhere by complicated interfingering of erosional and depositional environment. That reflects sharp transitions in the surface geologic or geomorphic processes. The result is a complex mosaic of seismic conditions. The most favorable and least favorable are closely juxtaposed. Steep slopes with little or no superficial deposits pass suddenly onto the thick aprons or fans of colluvial and alluvial sediments. Steep slopes are particularly susceptible to landsliding in earthquakes. Alluvium can mean unstable foundations and, where finer material is in abundance, the problems of soil liquification. Similarly, soil moisture and moisture in rock fissures or the water table greatly affect slope and soil stability.

Basal Zones have complicated patterns of well-drained, modestly drained and poorly drained sites. Spring lines are common. So are areas of coarser deposit or steeper slopes that drain and dry out quickly. The torrential behavior of streams debouching from mountain valleys has a complicating effect, and one that may vary greatly with season and weather conditions. Again, the amplitude of seismic shaking tends to be increased both by steepening slopes and certain types of salient and cliffs; but also in the passage from a solid rock medium to deep alluvium.

It is here that an explanation of much of the complexitiy of damage patterns in the disascers lies. Otherwise identical structures fail at one point and go unscathed or at least much less damaged at a nearby one. Poorly designed structures will survive while nearby, relatively well-designed ones collapse, presumably because of differences in foundation materials or the amplitude of shaking. This was apparent, for instance at Bar and Zelinika in the 1979 Yugoslav disaster. There was massive destruction of modern reinforced concrete port facilities on the coast, while nearby, many seemingly poorer, dressed-stone and masonry buildings survived with often only superficial damage. But the former were on alluvium and fill at the sea's edge, the latter on solid limestone or well-drained regolith back from the coast. Similar situations have been described for many parts of the world. We may just cite reports on the Niigata, 1964; Varto, 1966; Skopje, 1963; and Chile, 1960 earthquakes; [Kawasumi, 1968] [Ambraseys and Zapotek, 1968] [UNESCO, 1963] [Weischet, 1963a and b].

The influence of settlement sites in relation to adjacent mountain slopes or foothills is illustrated again and again in the amount of damage done by landslides at the mountain foot. This is not confined to extreme mountain topography as in Assam (1950), in the avalanche at Yungay, Peru (1970) or the 1974 and 1975 Himalayan disasters and Hindu Kush disaster (1976). In total, destruction by steep slope processes when they reach the mountain foot is probably always much greater. Moreover, the danger of failure of steep slopes is not confined to rock walls. Basal Zones commonly include erosional and tectonic breaks of slope in young sediments. The collapse of poorly consolidated materials where settlements are sited near the crest or at the base of such slopes, has made up much of the damage in some of the worst disasters. Examples include:

Cuzco, Peru	1950
Turud, Iran	1953
Valdivia, Peru	1960
Alaska, U.S.A.	1964
San Salvador	1965
Guatemala City	1976

The geological, topographical and hydrological complexity of the Basal Zone tends to be reflected in vegetation cover, too. Hardly anywhere in the regions we are considering, however, is there much remaining of natural cover. But the transformation of vegetation cover is likely to exaggerate the relative differences in terrain and surface materials as they respond to earthquake shaking. It represents one of the most profound human effects upon these environments.

Human Settlements of Basal Zone Ecotones

Looking again for a moment at the global distribution of earthquake disaster, one simple relation to human populations can be stated: throughout nearly all the areas of concentrated disaster occurrence, mountain fringe settlement is the pre-eminent form. More clearly than anything else it links even the humid areas of S.E. Asia to the rest; their populations being mostly in dense settlements near the coasts of mountainous islands. In the zone of greatest numbers of disasters from the eastern Mediterranean to the Indus Valley, Basal Zone settlement is clearly the case. Here, most of the population is typically distributed in "islands" and more or less continuous ribbons or series of settlements wedged between the mountains and the sea; in the broader intermontane valleys; or between the mountains and arid basins of interior drainage. In the cases of Italy, Greece, Turkey, Iran and Afghanistan this describes the location of not only the bulk of the national populations, but of most towns and cities. In other words, it is not only that earthquake damage is concentrated in the Basal Zone; so is the bulk of human population and wealth at risk [Clarke & Fisher, 1972].

A similar situation applies throughout much of the zones of concentrated disaster incidence in the American cordilleras, and the mountainous islands of S.E. Asia.

It is in this feature of mountain fringe settlement that the significance of climate emerges. In dry or seasonally dry lands mountains are generally favored with higher precipitation and perennial streams or springs. For sedentary agrarian societies or urban development, however, the Basal Zone is where runoff and underground waters can most effectively be taken advantage of--before they are lost to the sea, in coastal marshes and swamps, or the saline plains--and where slope, soil, drainage and climate provide the more congenial conditions for settlement. Often we are looking at an accommodation to environment reflecting prevailing economies and technologies going back some millenia. And if moisture supply is of outstanding importance, other advantages of piedmont locations are significant, too, such as exploitation of the mountain pastures and forests, but also of desert pastoralism, or maritime resources and trade.

In fact, the preconditions for the areas of highest disaster incidence are the result of certain major patterns of what has been called "universal history", patterns as significant in their way as that of the far denser riverine civilizations nearby, where the waters of the mountains cross the dry plains in major streams.

Few of the areas we are discussing are, in fact, without a long history of human change as culture after culture found the gentler, well-watered and wooded slopes of these mountains ideal places for settlement. But in recent years we have seen a new, accelerating wave of changes. It is tempting to attribute much of the recent damage to that.

The details of site and process associated with damages in the earthquakes, repeatedly relate to the particular geoecological and settlement conditions of the piedmont. The major settlements damaged tend to be largely or partly on alluvial fans, or the terraces left by their dissection. Many lap up against or onto the relatively young, contorted, shattered and friable rocks that so often form the outer zone of active mountain ranges. Settlement nuclei may be on outliers and spurs of the foothills, along valleys and bluffs whose existence records the surface outcrop of an active fault. This particular sort of siting that defines the Basal Zone recurs in accounts of damage from Morocco to Baluchistan:

Turud, Iran	1953
Ionian Islands, Greece	1953
Orleansville (El Asnam), Algeria	1954
Agadir, Morocco	1960
Lars, Iran	1960, 1961
Danesfahan, Iran	1962
Barce (Al Marj), Libya	1963
Skopje, Yugoslavia	1963
Varto, Turkey	1966
Trikalla, Greece	1967
Erzincan, Turkey	1967
Dasht-e-Bayaz, Iran	1968
Gediz, Turkey	1970
Bingol, Turkey	1971
Qir, Iran	1972
Lice, Turkey	1975
Friuli, Italy	1976
Bandar Abas, Iran	1977
Tabas-e-Golshan, Iran	1978
Montenegran Coast, Yugoslavia	1979

Most of these events, as noted earlier, also had severe pockets of damage in truly mountainous terrain, where farms and villages, highways and other installations were damaged by the shaking or landslides. But it is the Basal Zone areas that dominate the reports of damage.

However, that is only one perspective on the story, and certainly the pessimistic one. It must be balanced by noting, of course, the great attractions and benefits of these areas and this kind of settlement. And the record of earthquakes is also one of substantial survivals, too. Damage tends to be highly localized in form and extent as we have noted. Specific structures, sitings, land uses and often enough, socio-economic circumstances are involved. But if there are many "unpredictable" or unmeasureable things here, if there is large uncertainty or "chance" in earthquake damage and survival, the literature tends to exaggerate the inevitability of certain damages and the mere good fortune of survivals.

Here, I think, we must beware of using a geophysical "surrogate" for risk. In flood hazard work, for example, it is common to treat the flood plain, and flood height and frequency over it, as an exact analogue of risk. I am skeptical of that approach to floods. But such a simplification is quite unacceptable in earthquake risk. Mapping that strives to reduce damage zone surveys to an epicentral area and isoseismal lines often seems largely artifice.

The essential point turns upon human use of and adaptation to Basal Zone ecotones and, to lesser extent mountainous hinterlands. These are characterized by singularly heterogeneous conditions. But if the complex map of damages indicates the scope of the hazard, what of the equally complex map of survivals, or modest damages?

One could cite the larger municipal area of Kotor in the (1979) Montenegran Coast disaster, or greater Skopje in 1963. While part of these cities was the focus of the worst damages and losses--in the Skopje case almost the only damage--nearby structures and persons suffered little. The total destruction at Skopje was an extraodinary example of concentrated damage to a particularly vulnerable urban neighborhood, sited upon deep, seismically sensitive river alluvium [Poceski, 1969]. Again, the old masonry buildings within the walled city of Kotor were badly damaged. So was a new glass and concrete hotel on the torrential stream delta beside it. But extensive new high rise development, north and south of this, and many smaller homes, survived with little damage. So did most of the old walls.

Obviously, what concerns us most is the plight of victims and vulnerable property. But should we not look much more closely at what survives in disaster zones? May that not record effective, safe siting? well-designed and maintained structures? sensible and informed local behavior? Such investigations seem an integral requirement of social and economic understanding of the sources of earthquake risk. Given the local complexities and enormous geographical and socio-cultural scope of earthquake-prone settlement, the hope of determining general rules about safety in constructions, zoning or emergency measures seems utopian without it. And one might even suspect that, overall, risk reduction is most likely to take place if built upon the existing, successful adjustments of peoples and activities in the disaster-prone areas, rather than upon first principles developed by infant sciences like seismic engineering.

Concluding Remarks

If this exploration has any worth, it must be in the formulation of the problem of earthquake risk. It situates the problem within the complex adaptive and adjustment problems of, especially, people occupying Basal Zone areas. Internally, that involves the safety of sites, or of particular activities at particular sites, in what is a singularly heterogeneous, ecotonal habitat. That must reflect economies that are primarily oriented to the exploitation of this ecotonal setting. They may equally depend upon its locational advantages within surrounding different ecosystems of mountain, lowland or sea.

Seismic risk cannot be expressed in, nor reduced to any <u>one</u> or <u>two</u> variables out of:

i) The location and recurrence of larger magnitude earthquakes.

ii) General seismicity and geotectonic conditions.

iii) "Official" aseismic engineering concepts and codings.

iv) Terrain.

v) Climate.

vi) Population and settlement patterns.

vii) Land use.

viii) Environmental degradation.

ix) Internal man-habitat relations of disaster zones.

x) External relations of high risk areas to the larger space economies of nations and the world.

xi) Wealth, development and relative access to the most "advanced" notions of seismotectonics, engineering, or emergency planning.

xii) Crisis behavior and emergency measures.

The problem lies at the interface of these, and is a complicated "space" variously modeled by them all. That does not prevent it being a characteristic problem of certain distinctive forms of human occupancy of seismic areas.

Since we cannot deal with everything, the strategy my work suggests is essentially an extension and rethinking of the microzoning approach. This is already bringing about important modifications in the sense of seismic risk [USGS, 1979]--although one could see the implications already in, say, the studies following the 1906 California disaster [Carnegie Institute, 1908]. But microzoning is still far too much the creature of seismology and engineering geology. Slope, active fault-traces, surface and subsurface materials and other physical factors are important. But their meaning is quite abstract in the absence of a sense of the land uses, social conditions, development pressures, experience and expectation within the communities involved. We can only hope to ground our work here by studying areas with a history of recent, damaging earthquakes. And it is essential to do so by mapping, evaluating and interpreting the socio-economic and ecological background to what survives as well as what is damaged.

This is the objective of my current research examining the sites and surroundings of past disasters in the Eastern Mediterranean and South West Asia. More generally, if this preliminary sketch of the geography of earthquake disaster has any validity it suggests we are dealing with much more than seismic hazard per se. The problem needs to be carefully situated with the complex of conditions involved in the human ecology of settlement, land use and their transformations.

FOOTNOTE

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Appendix A

Dryness Correlates* of 145 Sites of Major Damaging Earthquakes - 1950-1979: By Region and Country

		Date	Location (province, city region)	Dryness Index	Koppen Classification
(1)	Mediterranean (20)				
	Italy	Jan.15, 1968	W. Sicily	1.5 - 2.0+	Csa
		Feb. 7, 1971	Tuscania (Apennines)	1.0	Csa, Csb
		June 15, 1972	Ancona (Adriatic	1.0	Cfb
		May 7, 1976	N.E. Italy (Yugoslav.)	1.0+	Cfb-Cfa
	Jugoslavia				
		July 27, 1963	Skopje	2.0+	Csa
		Oct. 26, 1969	Banja Luka	.75	Csa(Cfb)
		Apr. 15, 1979	Dalmatia, Montenegro	.5 - .7	Csa
	Greece	Aug. 11, 1953	Ionian Islands, western	1.0	Csa
		Apr. 30, 1954	Pindhos Mts. central	2.0	Csa
		Apr. 20, 1955	Thessaly (Volvos)	2.0	Csa
		July 9, 1956	Aegean Islands(Thera)	3.0	Csa
		Mar. 8, 1957	Thessaly (Volvos region)	2.0	Csa
		May 26, 1960	Pindhos Mts. Albanian border - Ioannina	2.0	Cfb, Cfa
		Sept. 1, 1966	S. Peloponnese (Megalapolis)	1.0-2.0	Csa
		June 20, 1978	Thessaloniki	2.0	Csa
	North Africa				
	Algeria	Sept. 9, 1954	Orleansville, Algeria	2.0-3.0	Csa
	Lebanon	Mar. 17, 1956	Beirut, Lebanon	1.5	Csa
	Morocco	Feb. 29, 1960	Agadir, Morocco	5.0	BSh
	Libya	Feb. 21, 1963	Barce, Libya	4.0-7.0	BWL
	Israel	Mar. 31, 1969	Israel, Sinai Peninsula	2.0+	Csa
(2)	Southwest Asia (42)				
	Turkey	Aug. 13, 1951	(N) Cankiri, Changra	2.0	Csa
		Jan. 3, 1952	(E) Erzurum (Hasankale)	2.0	Cfb, Dfc
		Mar. 18, 1953	(NW) Istanbul (Canakkale)	1.5	Csa
	May 26,	May 26, 1957	(N-C) Bolurov.	1.5	Csa
		Aug. 19, 1966	(E) Varto prov.	1.5	Dfc, Cfb

* Note: I am indebted to Professor Dieter Henning of Bonn for the maps of the Dryness Index from which our values are derived and to Ms Katherine Miller, graduate student at Wilfrid Laurier University who did the detailed preparation of this table.

(Turkey)	July 22, 1967	(NW Anatolia) Adapazari	1.5	Csa
	July 26, 1967	Erzincan and Tunceli provs.	2.0	Cfb
	Mar. 28, 1969	(W) Alasehir	1.0	Csa
	Mar. 28, 1970	(W) Kutahya prov. (Gediz)	1.5	Csa
	May 12, 1971	(S.W) Burdur-Taurus Mts.	1.5	Csa
	May 22, 1971	(E) Bingol prov.	2.0	Cfb
	Sept. 6, 1975	(E) Lice	< 1.0 - 2.0	Dfb - BSk
	Nov. 24, 1976	(E) Van prov.	1.5 - 2.0	Dfb - BSk
Iran	Feb. 12, 1953	Turud, Elburz Mts.	10.0	BSk
	Oct. 31, 1956	(S.W) Bostak, Lanstan	7.0	BSh
	July 2, 1957	(N) Caspian Coast	2.0	Csb, Dfb
	Dec. 13, 1957	(W) Central Zagros Mts.	1.0 - 5.0	Csb, BSh
	Aug. 16, 1958	Kermanshah, Zagros Mts.	5.0	Csb, BSh
	Apr. 25, 1960	(S) Laristan, Lar	7.0	BSh
	June 11, 1961	(S) Lar (Deh Kuyeh)	7.0	BSh
	Sept. 1, 1962	(N.W) Danesfahan	5.0 - 7.0	Csb (Dfb)
	May 1, 1968	(W) near Turkish border	2.0 - 3.0	Dfb, Dfc
	Aug. 31, 1968	(N.E) Khurasan prov.	2.0 - 3.0	BSk (Csb)
	Jan. 3, 1969	U.S.S.R. border, Khurasan	3.0 - 4.0	BSk (Csb)
	July 30, 1970	(N.E) Khurasan prov.	4.0 - 10.0	BSh (Csb)
	Apr. 10, 1972	(S) Fars prov. (Ghir)	5.0 - 7.0	BSh (Csb)
	Mar. 21, 1977	(S) Bandar Abbas	7.0 - 10.0	BSh
	Apr. 6, 1977	(C and S.W) Shakr Kord	2.0 - 3.0	BSh (Csb)
	Dec. 20, 1977	Kerman prov. (Zarand)	5.0	BSh (BWh)
	Sept. 16, 1978	(E) Tabas (Khorasan)	10.0	BWk
	Jan. 17, 1979	(E) Qaen (Khurasan)	4.0	BSk (Csb)
	Nov. 14, 1979	(N.E) Qaen, Bohnabad	5.0	BSk
Afghanistan				
	June 8, 1956	Kabul	5.0	BSk
Pakistan				
	Dec. 28, 1974	Pattan (Karakoram)	< 1.0 - 3.0	Csb
India	Aug. 14, 1950	Assam prov/Burma	.5	Cw
	July 21, 1956	Bombay to Pakistan border	3.0	BSh
	Sept. 2, 1963	Kashmir, W. Himalaya	2.0 - 3.0	Cw (H)
	Dec. 11, 1967	Western Coast (Koyna)	1.0	Am
	Sept 2, 1972	N.W Kashmir - Karakoram	.5 - 2.0	BWk
	Jan. 19, 1975	Kashmir - Tibet border	3.0	BSk
Nepal	June 29, 1966	Western Nepal (Rajhang)	.5 - 1.0	Cw (H)
S. U.S.S.R.				
	Apr. 25 - July 19 1966	Tashkent (n. Uzbekistan)	4.0	BSk

(3) South and Central America (32)

Mexico	July 28, 1957	Guerrero state (Mex. City)	2.0	Cw - BSk
	July 4, 1964	Guerrero	2.0	Cw - BSk
	Sept. 25, 1968	Chiapas state (Guat.border)	1.0 - 1.5	Aw, Cwb
	Jan. 30, 1973	Colima, Jalisco states	1.5	Cw - Aw
	Aug. 28, 1973	Puebla, Veracruz and Oaxaca states	1.0 - 2.0+	Cw, Aw
Guatemala	Feb. 4, 1976	Guatemala City	1.5+	Cwb, Cfb
El Salvador	May 6, 1951	(SE) Tucuapa, Chinameca	.75 - 1.0	Aw
	May 3, 1965	San Salvador and environs	1.0	Aw, Cwb
Nicaragua	Aug. 3, 1951	Potosi (NW)	1.5	Aw
	Dec. 24, 1972	Managua	1.5+	Aw, Cwb
Venezuela	Aug. 4, 1950	Lara state (Tocuyo)	1.0	BWh
	July 30, 1967	Caracas (wide area)	2.0	BWh
Colombia	July 10, 1950	(NW) Bogota, Santander	.75	Cw
	May 24, 1957	Buenaventura	.5	Cw
	July 30, 1962	W. Colombia	.5	Af
	Feb. 9, 1967	Huila Dept (Guacamaya)	1.0	Cw
	Nov. 24, 1979	(N) Pereira	.5	Aw (Af, Cw)
	Dec. 13, 1979	(W) Tumaco, coast	.5	Af (Aw)
Ecuador	Apr. 9, 1976	(N) Esmeraldas (mtns)	.5 - 1.5	Af, Aw
Peru	May 22, 1950	Cuzco	3.0	Cw
	Jan. 19, 1958	Arequipa	7.0	BWh
	Jan. 14, 1960	Arequipa	7.0	BWh
	Oct. 17, 1966	Caltao, coast	50.0	BWh
	Oct. 1, 1969	Lampa, Chilifruca	20.0	Cw
	May 31, 1970	Yunkay, Caras	3.0	Cw, BWh
	Dec. 9, 1970	Peru/Ecuador border	2.0 - 3.0	Cw
	Apr. 25, 1974	Arequipa	7.0	BWh
	Oct. 3, 1974	Lima, Canete	50.0	BWh
Argentina	Nov. 23, 1977	San Juan prov.	7.0 - 10.0	BSh (ET)
Chile	May 21, 1960	Concepcion Valdivia	.5 - 1.0	Csb
	Mar. 28, 1965	Central Chile (Valparaiso)	3.0	Csb
	July 8, 1971	near Valparaiso Santiago	3.0 - 4.0	Csb, BWh

(4) E. and Southeast Asia (28)

Mongolia	Dec. 4, 1957	E. Altai Mts.	5.0 -> 10	BWk
Japan	Mar. 4, 1952	Hokkaido, N.E. Honshu	.75 - 1.0	Dfb
	June 16, 1964	(N) Niigata, Akita	.5	Cfa
	May 16, 1968	N. Honshu (Tokachi-Oki)	.5 - 1.0	Dfb (Cfa)
	June 17, 1973	Hokkaido	.75 - 1.0+	Dfb
China	Dec. 21, 1951	Yunnan prov	n.a.	Cwb
	July 25, 1969	Swatow area	1.0	Dwb, BSk
	May 11, 1974	Szechwan-Yunnan	n.a.	Cwb, Cwa
	July 28, 1976	Tangshan	1.5	Cfa
	July 9, 1979	Chiangsu prov. (Shanghai)	1.5	Cfa
Taiwan	Oct. 22, 1951	Hualien, Taitung	.75	Cwa
	Nov. 25, 1951	Hualien (e. coast)	.75	Cwa
	Jan. 18, 1964	(S) Paiho, Tungshan	.75	Cwa
Philippines				
	Mar. 31, 1955	Mindanao	.5 - 1.5	Am
	Aug. 1, 1968	Luzon (Manila)	< 1.0	Am
	Aug. 16, 1976	Mindanao	.5 - 1.5	Am
Indonesia				
	Oct. 20, 1958	Java (Blitar)	< 1.0	Aw
	Mar. 15, 1965	Sanana Is. Ceram sea	< 1.0	Am
	Feb. 20, 1967	Java (Malang)	< 1.0	Aw
	Aug. 14, 1968	Celebes, Tuguan Is	1.0 +	Am
	Feb. 24, 1969	Celebes (Madjene)	< 1.0	Am
	Jan. 9, 1976	huge area	n.a.	Af
	June 26, 1976	West Irian Jaya	n.a.	Af
	July 14, 1976	Bali (Seririt)	< 1.0	Am
	Oct. 29, 1976	Irian Jaya	n.a.	Af
	Aug. 19, 1977	S. of Sumbawa Is.	< 1.0	Am
New Guinea				
	Jan. 18, 1951	Papua (Mt. Lamington)	n.a.	Af
	Oct. 31, 1970	Port Moresby, Madang	< 1.0	Aw

(5) Africa (3)

Uganda	Mar. 20, 1966	Ruwenzori foothills	1.0+	Aw
Zaire	May 18, 1966	north Kivu prov.	1.0+	Aw
South Africa	Sept. 29, 1969	Cape, Natal prov.	1.5 - 2.0	BSh, BWh

(6) Non-Medit. Europe (1)

Romania	Mar. 4, 1977	Bucharest	1.0	Cfb, Cfa

(7) North America (15)

California U.S.A.			
Aug. 15, 1951	Long Beach	n.a.	Csb
July 21, 1952	Kern County	n.a.	CSa
Aug. 22, 1952	Bakersfield	n.a.	CSa
Dec. 21, 1954	Eureka	.5	H/BWk
Jan. 25, 1955	Long Beach	4.0	CSa, CSb
Oct. 25, 1955	San Francisco	1.5	CSa, CSb
Mar. 23, 1957	San Francisco	1.5	CSa, CSb
Apr. 4, 1961	Los Angeles	3.0	CSa, CSb
Oct. 2, 1969	Santa Rosa	.75	CSa, CSb
Feb. 9, 1971	San Fernando	3.0	CSa, CSb
Feb. 21, 1973	Oxnard	2.0	CSa, CSb
Aug. 17, 1978	Santa Barbara	2.0	CSa
Montana Aug. 17, 1959	Hebgen Lake	n.a.	BSk
Alaska Mar. 28, 1964	Anchorage	.5	Dfc
Washington			
Apr. 30, 1965	Seattle, Tacoma	.5	Cfb

(8) Australia, Oceania (4)

New Zealand			
May 23, 1968	South Island	n.a.	Cfa
Australia			
Oct. 14, 1968	(SW) Perth	n.a.	Csa
Hawaii			
Apr. 26, 1973	Hawaii Is.	n.a.	Af
Nov. 29, 1975	Kilauea Rift	n.a.	Af

Total - 145

LAND DEGRADATION IN KENYA:

ECONOMIC OR SOCIAL CRISIS?

Randall Baker

Introduction

This paper examines, through the medium of one project, the nature of a serious paradox. Why is it that despite a rapid growth in research, institution building, training and investment--the "development" packages--we are able to witness an acceleration of environmental degradation in fields such as irrigation, soil erosion, catchment destruction and so forth? This study concentrates on one particular paradox, that of the so-called "desertification process". The research dimension of this paradox has been studied elsewhere by the author [UNESCO, 1979] but in this case a wider perspective is taken. By using the vehicle of a fairly typical multilateral project in the area of "desertification" it is possible to reveal the weaknesses of searching for a solution within an approach which excludes the political economy, or the system within which problems are defined and decisions taken. The conventional approach is to treat the environmental issue as the problem and to seek a technical solution. The repeated failure of these technical solutions is then usually attributed to some form of aberrant behavior such as economic perversity, ignorance, tradition or lack of "environmental awareness". If we step back one pace and pull the policy- and decision-making system itself into the array of variables, then the environmental "problem" fairly rapidly demotes itself into a set of symptoms of a malaise within the broader issue of the political economy. This, at least, is the conclusion drawn from the various studies of "desertification" in the semi-arid areas of the Third World examined by the author. There is no suggestion that the case presented in this paper, that of Kenya, provides a universal mode explaining the desertification process: that would be naive in the extreme. However, it shows conclusively that the technical perspective and the technological approach are totally inadequate in this case. Those who would refute the need for a broader approach must take upon themselves the responsibility of offering an alternative explanation for the paradox outlined above and the deepening crisis. The old portmanteau of "social factors" usually offered - tradition as an indepedent variable,

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resistance to change, ignorance and so forth - posits a degree of irrationality which is unacceptable, flies in the face of historical evidence of change and, in short, tells us more about the people who offer these explanations than the behavior they are trying to explain. Geographers have long stressed the essential strength they derive from bringing physical and human factors together in their frame of analysis and the case that follows illustrates an urgent need for this synthesis for, all too often, what is found in reality is a contempt for politics on the part of the technical specialists and a tendency by the politicians to look to the technical people to provide both the palliatives and an aura of legitimate effort directed at solving an "environmental crisis".

The Origins of the Project

In 1977 the United Nations convened a global conference to consider the growing problem of desertification. This tended to give desertification an identity apart though, in effect, it is only another form of environmental degradation like soil erosion distinguished only by the fact that the end state tends toward desert-like conditions because it occurs in marginal and semi-arid regions. The conference agreed that there was insufficient evidence to attribute desertification to climate change [UNCOD, 1977] and, instead, identified "mismanagement" as the main cause of the problem. Mismanagement is a loose term for anything that leads to a localized, or more general, energy imbalance and a reduction in the productive capacity of the land. As an explanatory term it is extremely limited insofar as it explains only why a physical process has taken place. What is really needed for any remedial approach is to ask what brought about the human behavior which, in turn, initiated or accentuated the physical process. This may well have far wider implications than the simple assemblage of human and physical phenomena _in situ_ where the manifestations of desertification are seen. However, the conference went no further than the basic mismanagement thesis, incorporating such terms as overgrazing, overpopulation, overcultivation, and so forth. In consequence the conference produced the customary "Plan of Action" which, inevitably, was couched in management terms: institutions, laws, land use practices and the like. This would then pave the way for a better system of land management through technology and control, education and awareness. Since it is a principal thesis of this paper that mismanagement is the manifestation, very often, of a wider and more fundamental malaise within national political economy, then a management approach is merely tackling symptoms. However, from the management perspective arose two fairly standard recommendations in the Plan of Action (Nos. 21 and 22) to "create, where it does not already exist, a national mechanism to combat desertification and drought" and "Programmes to combat desertification must be formulated, as far as possible, to fit with a land use plan established at the national level".

Thus a project of a fairly typical "institution building and strengthening" type emerged in Kenya as part of a national effort to apply the Plan of Action. This project forms a useful vehicle for illustrating how the technocratic approach functions, in this case seeking to make the official response more "effective" or "efficient". In a later section of the paper the perspective is widened beyond the narrow "management of the environment" view to one in which one asks why people behave the way they do and how environmental "management" behavior arises.

The technocratic approach is a very pervasive one and may be described as identifying secondary and dependent phenomena as basic or fundamental problems. By so doing those charged with the responsibility of decision making avoid, sometimes deliberately, and consequently fail to deal with, the elements giving rise to the manifestations of environmental crisis. This is not really surprising when one accepts that the primary causation often derives from political, social and economic inequalities. As a result of this failure to tackle real causes, the only possible consequences are: a worsening of the environmental crisis; control through increasingly oppressive legislation or a revolution in the countryside.

Although this critical, and sometimes deliberate, misperception of the problem operates principally at the national level it tends to be reinforced at two other levels. On the one hand global conferences, such as UNCOD, stress the technical or "mismanagement" aspects of the situation because to do otherwise would be to enter the realms of politics and be seen by many member countries to be touching matters of internal policy and sovereignty. Furthermore, the position papers and country studies presented at these gatherings are prepared by national governments or experts they commission so that the policy and political realities are built in implicitly and not considered as something to be examined as a possible contributory factor to environmental decline in their own right.

The second reinforcing agent is that of aid. Much criticism is levelled at the "inappropriateness" of aid [Sitwell, 1980] as a contributory element in environmental degradation. It is essential to remember that most aid is requested rather than offered. Consequently aid responds to problems already defined by the authorities in the recipient countries so that once more, the social and economic status quo becomes implicit. On the donor side there has been a long tradition of regarding technology, within a framework of technical assistance, as being somehow "neutral", or value-free so that if it fails to match the results achieved in the donor country that is "someone else's fault".

The purpose of this paper is to examine the framework within which the question of environmental degradation is identified and responded to. In the first instance the orthodox response is analyzed to reveal the consequences of internalizing and accepting as immutable the social, economic and political status quo and ignoring the historical processes by which these were created. The study will consider the consequences of working within such an approach from the point of view of the objectives which such an approach will naturally produce. In the second instance the decision-making structure and its social, economic and political norms become the central focus of the analysis so that many of the elements of the "problem" identified in the first level of analysis are reduced to dependent variables. Once more, the consequences of change at this more fundamental level will be considered and the issue of environmental destruction will be seen as part of an evolving historical process which expands the boundaries of the problem far beyond the national frontiers of Kenya.

Although Kenya is being used as a case study in this instance the comparison between the two approaches is one which will be recognizable

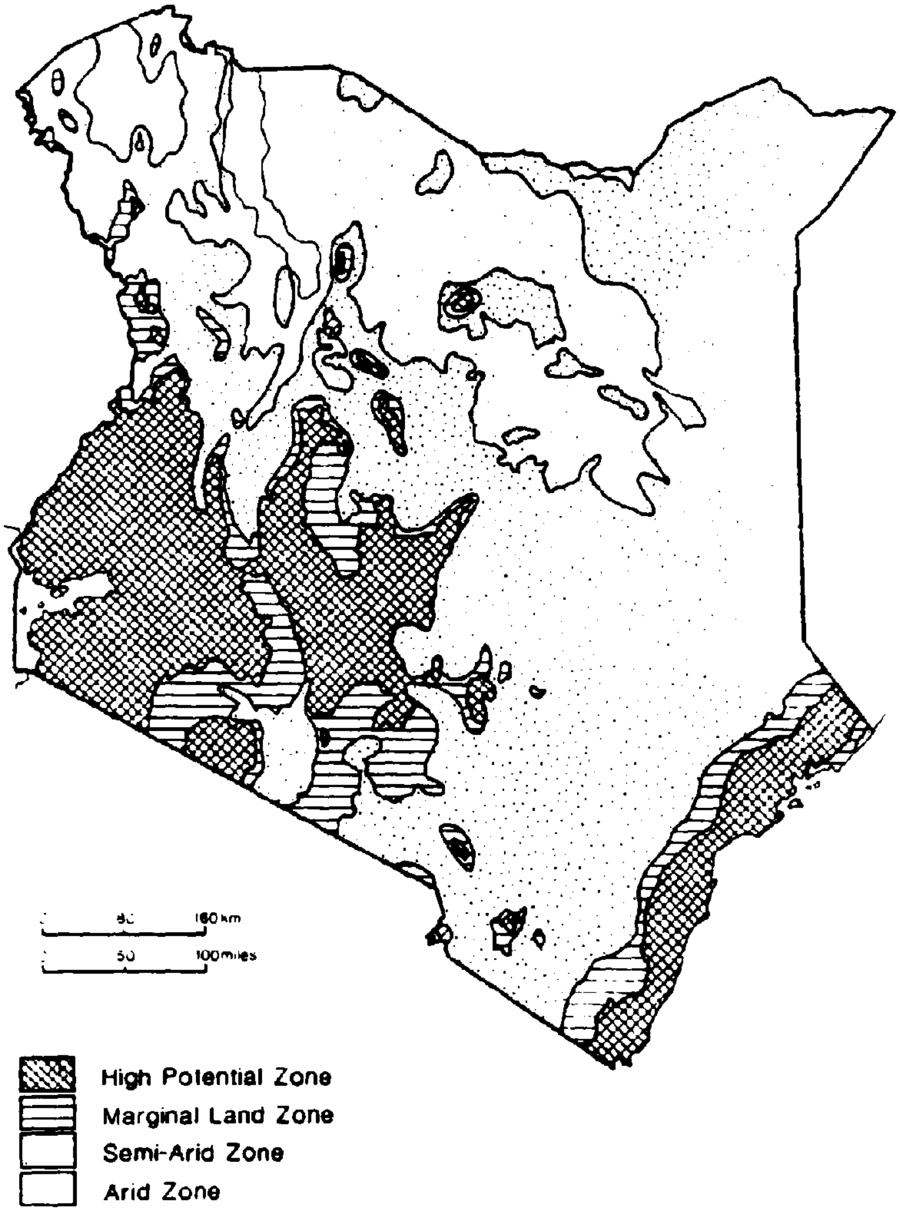

Figure 1

Ecological Potential of Kenya

to researchers in many countries. The fairly general nature of this conflict of approaches raises serious questions for those in the environmental sciences who, frequently, see the political economy of the situation in which they work as something divorced from their technical expertise (a soil is a soil is a soil, etc.) as well as being something slightly disreputable which interferes with the "scientific objectivity of their effort". It is critical that all such people realize and accept the fact that their efforts cannot be divorced from the political economy within which they work. Treating soil erosion as a purely physical problem may well deflect attention away from the real causal processes within the political economy which will, in turn, perpetuate those causes, e.g., short term profit-taking in the charcoal industry or the marginalization of the peasantry onto poor or steep lands by the inequity of the land holding system in a situation of virtually no subsistence alternatives (Honduras, for example). There is nothing to prevent anyone working in such a situation, but intellectual honesty should, at the very least, require that the realities are recognized and thought through. Not only is it foolish to hide behind such expressions as "I'm only doing a job" or "It's not my place to involve myself in other people's political situations," it is frankly quite untrue. Every aid worker is involved simply by being there and interfering in however small a way. Neutralism, or the technocratic approach, is inherently conservative stressing the status quo simply by excluding the political economy as a causal element.

The Environment and the Loss of Resources

Kenya is sharply divided into two contrasting physical zones. On the one hand four fifths of the country is classified as marginal, semi-arid or arid (Figure 1 ecological zones IV, V, and VI). In this region about one fifth of the country's inhabitants reside. The remaining four fifths of the total population of fifteen million are compressed into the high-potential areas (ecological zones II and III of the Central, Rift Valley and Lake provinces (Figure 2). There is a tendency to extend this physical division into a typology of environmental degradation so that losses in productivity and the natural resource base in ecological zones IV, V, and VI are attributed to "desertification". In the remaining areas the more traditional categories of "soil erosion" and "deforestation" are usually identified separately. Although it is true to say that the end state of degradation in these two physical regions may appear different, to assume that the causal process is different is quite wrong. Consequently the various projects initiated by Kenya under the U.N.E.P. aegis to "combat desertification" by institution building are in danger of dividing the effort by concentrating on one manifestation of a wider process. The newly-created Presidential Commission on Soil Erosion is a further example of this false division, this time in the high potential areas. So the physical preoccupation is confounded by an artificial spatial division of process.

The evidence of environmental degradation is widespread and often alarming in Kenya and is usually classified according to the following categories, although even at the purely physical level they are intimately linked:

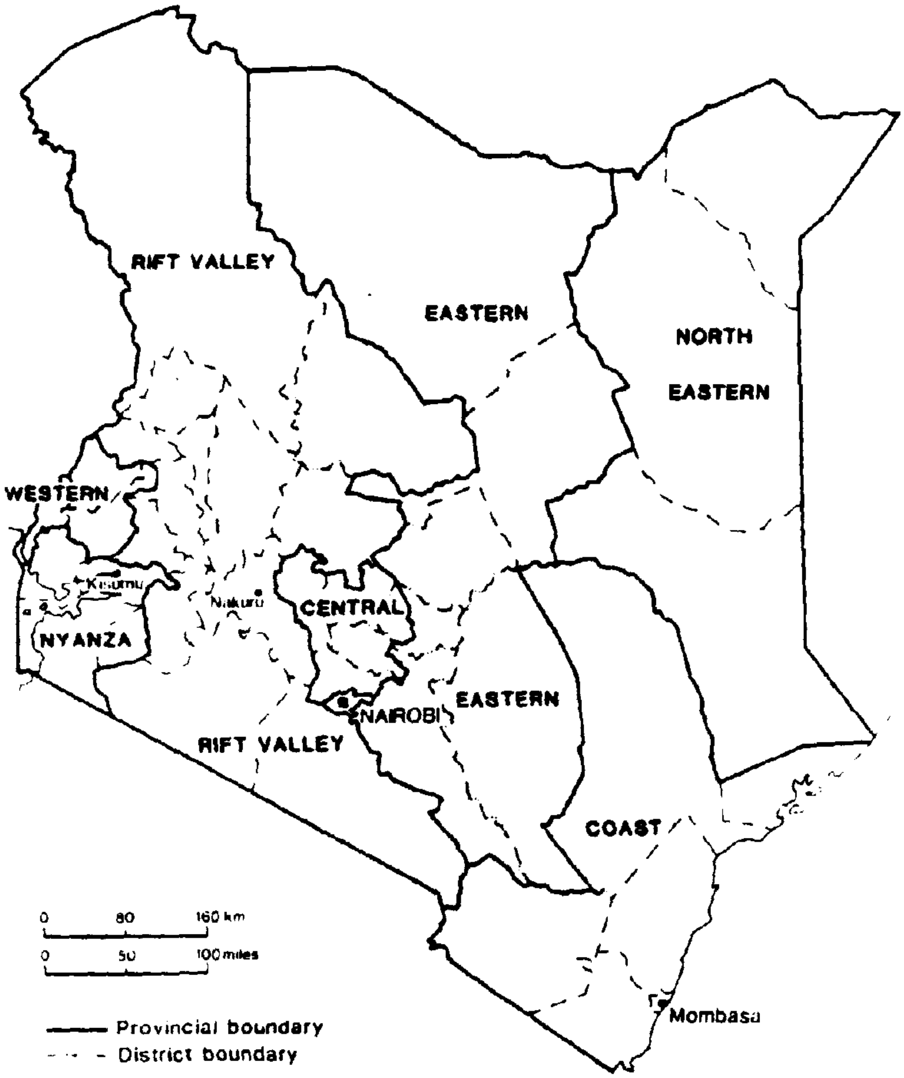

Figure 2

Administrative Boundaries of Kenya

Soil Erosion. This is very much in evidence on slopes over fifteen percent, near river banks (despite laws preventing the cultivation of both these land units) and in the marginal land (Ecological zone IV of Figure 1) where cropping practices, usually involving maize, have been taken by recent migrants. Most of this erosion is water induced but in the semi-arid, pastoral zone it is effected by wind after the soil has been exposed by overgrazing. The scars of soil erosion are widespread and the results may be seen in the declining per capita yields of subsistence food crops returned since 1970. The soil which has been stripped by water is now threatening one of Kenya's major development initiatives, the Tana River Irrigation Scheme where accumulations of silt are reducing the expected life of the dams to a fraction of that planned in the original cost-benefit analyses. As estimated three million tons of silt per annum is collecting behind the Gitaru dam whilst the heavy silt load has been responsible for the closure of hydro-power facilities as a result of damage to the turbine blades. Some rivers, such as the Perkera, have ceased to be perennial and are being turned into swampy terrain.

Deforestation. The gazetted forest reserves of Kenya are estimated by the Forest Department to cover 3.5 per cent of the national territory. However, since 1970 some 6,000 hectares have been legally excised from this reserve. There is no figure for illegal encroachments but an analysis of Landsat imagery in 1980 revealed that the actual area remaining under forest is now down to 2.5 per cent. Much of this land serves as catchment protection as it is to be found in the hilly headwaters of Kenya's main rivers. It is deforestation in the upper reaches of the Tana which is largely responsible for the downstream siltation of the dams. At present the gazetted areas provide only 200,000 cubic meters of wood against the country's estimated demand for 30 million cubic meters. There is no control over the taking of wood from ungazetted woodlands but large-scale stripping from hils and around settlements in ecological zones IV, V, and VI is clearly evident from air photo and satellite imagery. The Integrated Project on Arid Lands based at Mt. Kulal in northern Kenya noted: "a decline in indigenous wood cover, a lowering of the water table and the spread of sand. The clearing of forests on the mountains of north Kenya has destroyed river regimes and threatened the livelihood of the people."

Overgrazing. The impact of overgrazing in the drier areas is at such a scale that it shows up clearly on Landsat images, being most concentrated around watering points and settlements, which are grazed bare. Possibly the most dramatic consequences are to be found in the Baringo area where animals are funneled into a narrow zone in passage to the markets of the south. This, plus the introduction of wholly inappropriate cultivation has ravaged the land and led to recent, horrifying gully erosion. In the 1975/76 drought 25 per cent of the livestock, worth 20 million shillings, died in the Eastern Province.

In Kenya's famous wildlife parks and reserves the battle against poachers has reached the level of a minor military campaign as animals are hunted for their meat. Throughout the country the uncontrolled (until October 1980) chopping of trees for charcoal production and export to Arabia is laying waste to marginal lands.

In making these observations one is continually aware of the qualitative nature of the comments which leaves one open to criticisms of scare-mongering, exaggeration, and a lack of real evidence. The situation, however, is recognized in the studies of all interested ministries, is evident to even the untrained observer and is imprinted on the time series of Landsat images and written large in the declining food-crop yield figures for the subsistence sector. That environmental degradation is clearly recognized as present, serious and accelerating by the authorities is evidenced by the establishment of new ministries, departments and commissions, drafting of new legislation and the initiation of internationally-funded studies to tackle it.

The Conventional or Technocratic Approach

The main elements of this approach are presented in Figure 3 in a sequential form. A summary of the main characteristics of this approach would be as follows:

a) It is ahistorical.
b) It deals only with symptoms of much worse fundamental causal processes.
c) It places environment above people.
d) It leads to increasing polarization in the economy and the society penalizing people for actions resulting from their own poverty.
e) It maintains a facade of technical objectivity and an appearance of concern.
f) Those perpetuating the approach have a vested interest in its use though it is quite possible that they genuinely believe that they are acting in the "best interests" of the country as a result of the model of development to which they adhere.
g) In the context of the political economy it presupposes no change.

In this approach the "environmental crisis" is the baseline problem as defined, and from this perspective all other components of the analysis derive. Fundamentally it is the environment which is sick and must be cured. The evidence, or symptoms of this malaise are recognized as widespread and alarming even though the components are not systematically monitored or the losses regularly quantified. If we start from this standpoint it is possible not only to trace a sequence of predictable responses but to predict the likely consequences of proceeding within this approach which puts the socio-economic system under the heading of *ceteris paribus*.

The various physical parameters outlined above, soil erosion, deforestation, etc., are seen as the evidence of a widespread physical problem. "Success" or "failure" in dealing with the problem will tend, naturally, to be measured in terms of how far these components of environmental destruction are brought under control. This is precisely the environmental-management approach outlined earlier in which the focus is upon control over the use of the natural resource base. Control, however, may be effected without consideration of the real reasons why mismanagement resulted in the first place and so the relief of pressure on the environment may well be at the cost of increasing pressure on a particular part of society, usually the weakest. Those in authority may

PROBLEM	SYMPTOMS	CAUSES	SOLUTIONS	CONSEQUENCES
Kenya has an Environmental Crisis →	Desertification →	Overpopulation →	Family Planning →	Lack of response
	Deforestation	{ overgrazing, overcultivation		
	Soil Erosion	Ignorance →	Education →	Inappropriate knowledge
	Catchment loss	{ tradition, culture, inapp. practices	Change atitudes	= frustration
	Silting		Demonstrate new ideas →	Short-term palliatives
	Decline of Rivers	Lack of Environmental Awareness →	Environmental Education and E.I.A. →	Rationalising oppression
	Decline of food production			
		Inadequate Legislation →	Tougher legislation →	Oppression and polarisation Protect environment against people
		Institutional weaknesses →	Integration Min. of the Environment →	New and more efficient ways of avoiding problem

Figure 3

The Technocratic Perception: "Environmental Protection" justify their approach by resorting to the argument that they must act as trustee of the natural resources for generations yet to come and that the authorities have a duty to protect the environment against what is generally termed "abuse" or "mismanagement".

In short, the social, economic and technical factors will "explain" the environmental dilemma rather than the environmental situation being evidence of a social, economic or political dilemma.

At the center of this framework of explanation in Kenya, as in many other countries such as Nepal and Guatemala, is placed the issue of population. This is manifested throughout the press and in government statements, of which the following are typical:

> Kenya will enter the 21st century with about 34 million people.... Most of the problems that will continue to face this country well into the next century are closely related to the present high population growth rate of about four per cent per year - a situation that is referred to in some circles as the 'Rabbit Syndrome'...such a population growth rate, doubling after only 17 years, would continue to complicate planning efforts, quicken the depletion of scarce resources and undermine economic prospects. It is undesirable.... Today the average land holding in the high and medium agricultural potential areas of Central, Rift Valley, Nyanza, Western and Coast provinces is about 0.55 hectares per person. This is likely to drop to about a quarter of a hectare by the turn of the century. [Daily Nation, November 19, 1980]

A conference on desertification in Kenya held in 1977 was told by a representative of the Ministry of Agriculture that four districts in the Nyanza area would run out of additional land for subsistence between 1983 and 1995. The Ministry of Lands and Settlements (as it then was) stated in 1977 that by the year 2000 the "surplus" rural population, based on an estimate of available land for subsistence, would be six million: an almost unimaginable figure. In the marginal lands the growth rate is estimated, through in-migration at ten times the national figure.

Overpopulation is, of course, a relative term and in this case is a measure of access to land for subsistence and the provision of alternative employment opportunities and not just a simple matter of dividing the total stock of land by the number of rural families. This is an area to be explored in the second part of this paper but here it will be sufficient to say that the term "available" land assumes the present distribution pattern of the land, the present unequal access and the present mix of cash versus subsistence crops.

The second major "cause" emerging from this approach may be subsumed under the heading of Ignorance, Tradition and Attitudes. This has close associations with the official thinking about the "population problem" revealed in the use of the term "Rabbit Syndrome," i.e., mindlessness and unthinking behavior with no regard for the wider or longer-term consequences. This is best revealed in terms of the pastoralists who are blamed for accentuating or even causing desertification, attributed to a set of cultural attitudes stressing the benefits of accumulation of stock numbers for reasons of "pride, prestige and wealth". These criteria are seen as deriving from traditional forces so that "tradition" alone is the explanation of behavior, i.e., it is an independent variable. Superimpose on this rigid cultural framework rapid technological changes resulting from veterinary and water development, as well as the impact of human health care, and one has a formula for mindless accumulation and rangeland destruction. Similarly much destruction in the high potential and marginal zones is attributed to "inappropriate practices" (growing maize in dry areas, vertical strip farming on slopes, etc.), ignorance, the "short term mentality of the peasant farmer" and "low levels of environmental awareness". Thus the dead hand of the past is, in conjunction with uncontrolled exogenous technical change, creating a situation of catastrophe in which elements of the population seem embarked on a course set towards their own destruction and that of much of Kenya in the process.

The next causal variable is that of legislation. There are fourteen acts relating to the environment but in general they are criticized because they are rarely implemented; they overlap; they contradict one another; the fine levels were set over twenty years ago and are basically "colonial" statues. In other words they provide inadequate protection for the natural resource base at the present time. As the principal means of effecting control over the environment the legislation is clearly inadequate at the present time since the situation is so clearly out of control. Part of the reason for this inadequacy is attributed to the "low level of environmental cc sciousness" of many politicians (who make the law and who recently threw out the revised Forest Act), the judiciary and those charged with implementing the law in the field.

Within the decision-making structure itself certain weaknesses are recognized but, not unnaturally, these are measured against such parameters as effectiveness and efficiency rather than general relevance or appropriateness. Thus emerge such elements as lack of coordination and integration, the sectoral system versus regional or horizontal linkages, over-bureaucratization, slowness, etc. The principal dysfunction is seen as being that between the comprehensive nature of ecological systems and the divided systems of decision making.

Finally there are comments about the inadequacy of research: the lack of social research, the lack of coordination between researchers and decision makers and the export of many research findings.

Given this assemblage of "causes" it is now possible to derive the package of "solutions" offered, and see them in a clearly-defined context. They will be familiar to most environmental scientists and social scientists with aid experience.

The "Rabbit Syndrome" naturally leads to a program of intensified family planning aimed at counteracting ignorance and offering a way out to families caught in a population trap. For the government fewer people added to the population each year is, to a great extent, its own way out of the situation of environmental destruction as it will reduce future potential increases in the pressures on available land for subsistence. It is a solution which enables other solutions to be avoided and maintains the status quo. It is, superficially, an attractive approach, despite the various ethical dilemmas, for undeniably fewer people must mean less pressure on the land. However, fewer children can mean more pressure on the poor for reasons outlined in the second part. The family planning approach is the keystone and thus a central element of a perspective in which the environment assumes the central position rather than the disadvantaged people trying to live on and from it, even though the program appears to focus on the well-being of people.

To tackle Ignorance, Tradition, and Cultural Attitudes the natural solution appears to lie with education. This last term is rarely clarified in terms of what values the education seeks to inculcate. The best one can detect is something entitled environmental education which seeks to disseminate concepts and practices appropriate to putting the use of natural resources onto a sustainable basis. This involves sweeping away old and outmoded attitudes leading to destructive behavior so that people (since one is countering "ignorance") become aware of the consequences of their actions. If they are educated in this regard, then the legislation (toughened and smartened up) will have every exuse to deal firmly with them if they carry on in the old manner. The old ways must go, whether they be manifested in tribal institutions (banned in Kenya in the summer of 1980) or the "cattle complex". In their place will come new concepts of resource management and a stronger national consciousness and national economy. The lack of environmental awareness will be offset by an Environment Enhancement and Protection Bill due to be presented to the Kenya Assembly this (1980/81) session. This will set basic standards and establish a legal framework to give the government authority to act as trustee of the environment through the enactment of Environmental Impact Assessment procedures. Films, television, radio and other media presentations will instill the message of environmental awareness at a basic level throughout the country.

Inadequate legislation is overcome by drafting new laws and creating strengthened bodies to see that these laws are enforced. Recently there has been a spate of attempted new legislation and more is in the pipeline (a new Water Act for example). These revised, toughened and coordinated acts will provide a legislative basis to ensure adequate protection for the environment against the people who are currently abusing it. Significantly these new acts are meeting considerable opposition in the National Assembly and the Forest Act, as revised, was rejected totally. Such behavior is explained by a need to "educate the politicians in the context of conservation", i.e., ignorance again.

The institutional reforms, wherein the author's project was born, seek, like their legislative counterparts, to give the authorities a more effective vehicle for "environmental management" through improved bureaucratic efficiency, innovative and integrative marginal adjustments such as commissions, regional initiatives, interministerial programs (the Arid and Semi-Arid Land Program) and so forth. This is almost entirely an efficiency exercise to avoid duplication, sharpen the spatial variable in planning or, at best, to allow a level of integration reflecting the way factors interrelate in an ecological system. The project with which the author was concerned identified, therefore:

i) desertification as a separate process; and
ii) desertification as a process amenable to an institutional solution or, at least, requiring a specific institutional response.

It is true that much can be done to make present decision making and implementation structures more effective or integrative but their effectiveness can only be relative to the way the problem they are handling has been defined. It is rather like building a car which can only be driven in reverse. Everything functions, it looks right but when driven it injures people and increases the distance to one's destination as it is being used incorrectly. The pedestrians get hurt but there are various remedies to patch up the broken pieces. Soon, however, it will cease to function as the strain is too great.

An Alternative Approach

Here the political economy becomes a variable alongside all the technical and institutional elements outlined in the previous approach. In the case of Kenya this allows us a new level of explanation which will render most of the causal elements of Approach I to become dependent variables, i.e., the "problem" is not a physical one, only the symptoms are physical. It must be stressed that the development of this level of explanation offered below is specific to Kenya, though the seeking of solutions and explanations at this level is more universal. So, even if no universal model of explanation emerges, the case for a wider basis of explanation for environmental degradation is convincing.

The explanation of what is occurring in the Kenyan environment now derives from an historical process which has passed through several phases to produce the economy and society of Kenya today. It is this political economy which offers us the causes for the environmental malaise.

Kenya has gone through not only the colonial experience involving the sudden intrusion of imperialism and a colonial administration and an attendant set of social, political, and cultural values of a pervasive nature, but also has experienced a particular form of settler colonialism setting a precedent for dividing the country into the camps: the commercial crop, large farm areas and the over-crowded native reserves with their subsistence crops. This peculiar form of political economy associated with a system quite incontestably based on a notion of inequality made the transition to independence with little structural modification except that the large landowning class was, to some extent, indigenised. This gives us the root of the problem as we are now able to redefine it: grossly unequal access to land in a situation of almost no alternative forms of security and in an economy geared to a model of development based on modernization, fueled by foreign exchange, blocked off in the towns and paid for by cash crops grown by a rising capitalist class.

During colonial times Kenya was clearly divided into the "Scheduled Areas" and the "native reserves": in the former, only Europeans were permitted to hold land and gain title on either freehold or 999-year leases. The reserves, into which the bulk of the rural population were confined by legislation, were rapidly overcrowded and the land, perforce, was allocated almost exclusively to subsistence crops. The overcrowded reserves were, in turn, a convenient source of cheap labor to subsidize the cash crop sector in what came to be called the "White Highlands".

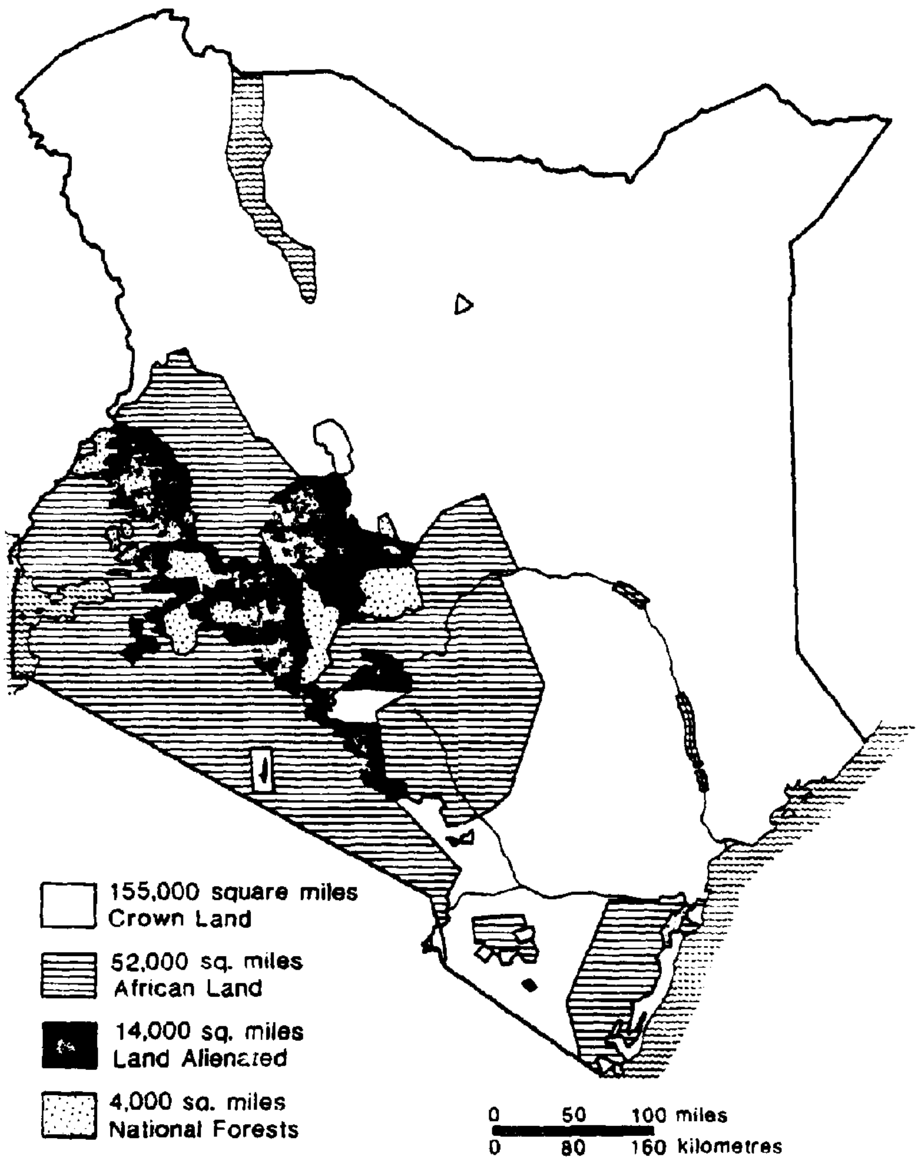

Figure 4

Colonial Land Classification in Kenya

The initial apportionment of land along these lines was itself based on a particular coming together of events which needs to be understood if the contemporary "environmental problem" is to be comprehended.

The colonial government arrived in Kenya in the wake of two devastating events resulting from the European intrusion: the Masai herds were almost wiped out by the virus of Rinderpest entering from German East Africa whilst the Kikuyu were struck down by an epidemic of smallpox. This left a large amount of good land apparently unused. By alienating this land, first to a variety of remittance men and fading artistocrats still wedded to the concept that the only respectable source of income was from land, and later to demobilized soldiers, a pattern of differentiation along class, spatial, and initially, racial lines was clearly drawn. This exclusive zone of white privileges was delimited in 1906 and extended until the Carter Commission boundaries were fixed by law in 1938/39 [van Zwanenberg, 1972, p. 7] creating the dichotomy of two Kenyas which was to prove very pervasive. At its peak the colonial government had allocated land along the following lines: 14,000 square miles for European settlement, 52,000 square miles for African farming, 10,000 square miles for forest and lakes and 149,000 square miles of "Crown Land" which included virtually all the communal grazing of the pastoral nomads (though vast tracts of Masai dry-season range was sold off in the Laikipia area for European ranching).

By allocating 14,000 square miles, virtually all of it in the highest potential category, to 3,500 European farmers and planters and only 52,000 square miles of land to 4 million Africans (1948) the safety value for expansion was screwed down. The options were: labor for the European farms in the White Highlands; seek employment outside the farming sector or try and locate new land within the reserves or squat on European land. Not surprisingly pressure in the reserves grew rapidly and, to the colonial authorities the situation appeared in the following terms: "The humane impulses of the colonial government put an end to those harsh Malthusian factors; tribal wars, disease and famine which, hithertofore, had maintained a population balance. In due course, population increase <u>brought about pressure on the land, overcropping and, in consequence, soil erosion</u>" [Clayton, 1964, p. 143 my italics]. Thus, soil erosion was seen as a natural phenomenon arising from the good intentions of colonialism which had led to overpopulation. The fact that the people had no good land onto which to expand, in itself directly the result of colonialism also, is conveniently overlooked, even though over one million acres of the land taken up by Europeans remained totally underdeveloped as late as 1942 [van Zwanenberg, 1972, p. 9].

The "causes" of soil erosion were identified by the Agriculture Department [Clayton, 1964, p. 11] as "population growth, the breakdown of shifting cultivation, the inheritance system, primitive farming methods and the absence of rotation of manuring." So it was largely a technical problem arising from a basic human process (uncontrolled breeding) to which was added a cultural dimension necessary to explain what, to European eyes, appeared perverse and irrational behavior:

> Farmers are well known for their conservatism. The African agriculturalist is no exception and is very tenacious of the customs and methods practiced by the forefathers...the poor farming methods and soil-depleting practices prevalent among peasant cultivators stem from

> ignorance, custom, and lethargy...the main obstacle to be overcome is the native's lack of understanding of the need for the prevention of soil erosion [Clayton, quoting Agriculture Department, Nairobi].

Somehow the African had failed, because of the dead hand of his own tradition and culture acting as independent variables, to respond in other than a purely mechanical way to the benefits of colonialism. The agriculturalists were now seen as agents of salvation able to rescue the African from himself, with a package of technical remedies. The authorities, meaning the colonial government, were, interestingly, seen by the agriculturalists as a reactionary element because, it was stated: "...in relation to the development of (African) agriculture, the administration have, on the whole, been conservative, seeking to maintain the <u>status quo</u> with regard to the social framework" [Clayton, 1964, p. 41]. In retrospect this seems an astonishing stance when one considers the wholesale intervention which had been carried out by the authorities in order to become an "authority" in the first place: "pacification", new rulers, appointment of chiefs, taxes, apportionment of land, missionary activity, etc.... Leys described this stance as follows:

> On the other hand there was another sense in which the 'peasant' mode of production would continue indefinitely, so long as the capitalist mode of production remained dominant. They would be required to absorb an <u>increasing</u> proportion of the adult population, and to continue to make available cheap labor and cheap produce. For this reason it seems useful to continue to keep them in view as modes of production still distinct from capitalism [Leys, c. 1976, p. 175].

What the authorities were anxious to maintain was the <u>status quo post bellum</u>: white supremacy, a cheap labor pool, the export crop economy. Africans were discouraged from, and in some areas forbidden, the cultivation of perennial cash crops because of their "lack of knowledge and the threat of disease to the European crop". Annual cash crops, particularly maize, were also discouraged on African farms as they did "nothing to solve the serious problem of depletion of soil fertility which is facing the native reserves. On the contrary (this) aggravates it by increasing the produce surplus to family needs which is sold out of the reserves. Nothing is returned to the soil to make up for this annual drain of plant foods." Before the last war the thrust by the agricultural officers was to introduce mixed farming and soil-conserving practices and the fact that very little response was elicited from the African farmers was attributable to "the native's lack of understanding of the need for the prevention of soil erosion". Indeed, attempts to introduce some "conservation" measures met with widespread civil disobedience, passive resistance and, occasionally, hostility. The Wakamba, for instance, marched on Government House in 1938 as a protest against compulsory destocking "which was being attempted as a means of combating severe soil erosion conditions". In 1946 they threw themselves in front of tractors terracing their land. The reaction of the Agriculture Department was predictable when one bears in mind their conceptualization of the "problem": "...unless some pressure is applied to urge improved methods and practices, and unless such pressure is continuously applied...it will not be possible to save the fertile areas of Kenya from deterioration...without the application of compulsion under legislation to enforce improved agricultural practices" [Clayton, citing Agriculture Department 1940's]. The education role was yielding to the policing function.

Thus the position was polarizing rapidly and the gulf was indicated by a remark made by the Agriculture Department some years later when the back of the resistance had been broken by force. They wrote: "Things have improved greatly...the agricultural officer is no longer regarded as a person deputed by government to spy out good land". That the people should suspect this after the alienation of over 8.5 million acres was not too surprising. They felt that the trickery of a concept of land ownership had been foisted on them by a government which indulged in several punitive military missions at a disastrous time in their history.

The conflict developed inexorably towards violence and frustration which erupted in the so-called "Mau-Mau" disturbances between 1952 and 1955. The authorities had noted before the uprising that: "Many (agricultural) leaders are reluctant to initiate changes which may lead they know not where and, quite possibly, cause political trouble at the same time. More specifically they shrink from the heavy responsibility of encouraging the growth of a landless class." Yet when trouble came the authorities managed to perceive the event as, somehow, unconnected with anger, frustration and lack of access to resources. Clayton (p. 43) notes that the conservation work had to be suspended during the "civil war" as though the events of the early 1950's had little direct connection with the action of the authorities in creating and perpetuating the gross inequalities over access to land. After all the Agriculture Department was an arm of that same government which had taken the land in the first place.

The superior military power of the colonial authorities, in conjunction with those Africans who openly supported the colonial status quo or what it might yield them eventually, broke the organized resistance of the "Mau-Mau". After that it was easier to impose the technical changes as the political, or wider, battle had been won and the colonial system had prevailed. Not surprisingly the agricultural authorities saw the events of Mau-Mau from their own perspective as "a 'blessing in disguise' for, without it, large-scale financial help from the British government and whole-hearted support from the Administration would have been unlikely". Thus developed the Swynnerton Plan which, through consolidation, mixed farming, cash cropping and farm planning was to produce freeholders and yoeman farmers with established minimum cash incomes and good farming practices. This, however, would take care only of a proportion of the farmers as the planned farms were considerably larger than many of the holdings in existence. However, this emerging propertied group would have a vested interest in stability and continuity. No provision, however, was made for the millions to come, but the land had now been protected against the people: that was the shape of things to come. There was no way the consolidated holdings could absorb even the existing landless.

As the country moved towards independence in 1963 a powerful landowning African community began to emerge clearly as the inheritors of colonial rule. Those without land, but with adequate cash resources, could acquire land from the newly-created freehold market. At independence aid funds were made available to buy out those Whites who wished to leave and the way in which these funds were disbursed set the pattern for a continuing marginalization of a large proportion of the rural population. In essense the transition to independence was made with the minimum of structural change so that, to a considerable extent, the inequalities of the colonial land holding pattern were transferred into African hands. As Leys has observed: "...the policies pursued in the 1960's ensured that...there would be a structure of agrarian interests and an institutional apparatus strong enough to resist pressures for radical change" [Leys, c. 1975, p. 65]. Although various settlement schemes eventually absorbed around 400,000 Africans on small and medium-sized plots around the periphery of the former European areas, a growing proportion of land was passing into the hands of the "credit-worthy", an emerging powerful class with an interest in perpetuating the colonial divisions. In 1965 the distribution was 28 per cent capital outlay for farm purchase by cooperatives, 33 per cent by partnerships, 24 per cent by companies and 14 per cent by individuals. After this date the emphasis was placed increasingly on the more "credit-worthy" as small-scale settlers and cooperatives defaulted heavily on their loans and shifted from cash to food crops. So by 1978 the large farms in African and European hands now occupied 266 million hectares, and the small farms, with a population of 10.3 million persons (0.25 ha/head) 3.45 million hectares. (About 7% of the holdings occupy 35% of the land.) The average size of the large holdings is 700 hectares and 30 per cent of the small farms are below 1 hectare. The large farms produce approximately 55 per cent of value of Kenya's gross marketed farm output. Although no figure exists for landless people outside alternative employment 99,000 holdings are classified as having no cash income whatsoever. The number of large holdings, especially below 400 hectares, is growing. Over the period 1961-5 to 1976 there has been a steady decline in the index of food production per head: 1961-5 = 100; 1972 = 92; 1973 = 88; 1974 = 86; 1975 = 86; 1977 = 85 [FAO, 1977, p. A-11].

It is now possible to reconstruct the diagram illustrated above as Figure 3, so that we redefine the "problem" in the context of the political economy (Figure 5). The central issues now emerge as: unequal access to land resources; the 'foreign-exchange/import based model of development'; a lack of alternative forms of security other than land, and; no real alternatives to land-degrading activities for a growing number of rural poor. In other words the problem is the model of development which rewards private accumulation and allows a proportion of the population to fall out of the bottom end of the system.

The "environmental crisis" thus can be recognized as a symptom of this deeper malaise and people replace objects as the focus of concern. The export cash crop sector continues as the mainstay of development along with tourism (though it has been suggested by the tourist authorities at a recent conference in Mombasa that Kenya actually loses money in this sector). The earnings from cash crop exports provide the foreign exchange to maintain the urban economy with its high propensity to import: between 1970 and 1978 Kenya's bill for imported fuel rose from 15 million K pounds to 118 million K pounds and the cost of imported foodstuffs rose from 9 million K pounds in 1970 to 21 million K pounds in 1978. At a time when the country's visible balance of trade deficit has grown from 64 million K pounds (1970) to 304 million K pounds (1978) the response of those promoting this model of development is to retrench (grow sugar for fuel alcohol, grow more and different industrial crops), thus resisting pressures to put more land under subsistence crops. At

PROBLEM	SYMPTOMS	ENVIRONMENTAL CONSEQUENCES	SOLUTIONS	CONSEQUENCES
The Political Economy of Kenya →	Unequal access to land →	Environmental degradation →	Radical change →	Greater self reliance and security
			New forms of security	
	Marginalisation of poor →	Hopelessness		Diminished need for children
		Frustration	Land redistribution	
	Lack of alternatives for those short of land		New priorities in use of land	Greater spread of cash economy through greater participation
	The export/crop, urban based, foreign exchange model of development			Diminished resources for urban sector
	Institutional oppression of poor			A stake in the future for rural poor
	Environment over people			
	No security other than land or children			

Figure 5

An Alternative Perception

the same time statutory marketing boards for staples keep the price down to the urban population and tax the rural poor even more.

In this context access to land is the only form of security open to the growing community of the rural poor for there are no pensions, no social security and a diminishing ratio of jobs to people. As settlement is now over as a policy (indeed the department has been abolished with the changes of January 1980) and few peasants have the capital or security to purchase land, they have little option other than to move onto hillslopes, into forests and out into the dry zones. What is seen even by those involved in it as collective madness and desperation is still individually rational and unavoidable. Similarly livestock keepers see no other security than accumulation of herds, a practice encouraged by urban investors who now run investment stock in the care of pastoralists. Ranching may solve the problem for a few but that, along with encroachments by cultivators (Baringo) and large-scale wheat farmers (Narok), merely compounds the problem for those who remain.

In these circumstances it is not surprising that many flout the law; they have no realistic alternative. Similarly it is not surprising that most of the laws are never enacted; it is quite unrealistic to use coercion against people who have no viable alternatives open to them. These same people, perforce, look upon children as their only security in old age and the more one has, the better eventual prospect whatever the immediate cost. As women cannot inherit land and are less likely to secure paying jobs, the need is for male offspring so this, too, accentuates the pressures for large families. This process of breeding security may now be observed operating in the context of a desperate gamble whereby parents are realizing capital by selling land, cattle, etc., in order to pay school fees to broaden their options. Since the wealth is blocked off in the cities, education is seen as the key with which to enter this privileged realm. Seen in this context the family planning approach is an irrelevance; worse, it is a threat as has been seen in the resistance shown under similar circumstances in India. Its value can only be to the successful who may secure their future in other ways.

"Tougher and more comprehensive" legislation favored by several ministries becomes an instrument of oppression in these circumstances. Legislation exists, or should exist, to protect the environment from willful abuse by those fully aware of their actions when acceptable alternatives are open to them. Otherwise it adds to the burdens and hopelessness of the rural poor who may not be expected to tolerate it in docility for long.

So as matters stand good land is sold in a last-ditch stand to break out of the rural poverty trap. Those who sell move to the margins and fuel the destruction; those who buy consolidate their hold on the resources for production, or simply realize the wish of many of the "successful" in Kenya for a place in the country or even somewhere to be buried. Thus the two Kenyas drift apart. Clearly no amount of institutional tinkering through commissions, integrated programs, Ministries of the Environment and the like can do anything to change the basic cause of the problem, although a little time may be purchased by demonstrating conservationist ways of actually using hillslopes, riverbanks, and so forth without damage, as is said to be done in China. Only a radical reappraisal of basic policy: the model of development;

offers any hope at all. There must be real alternatives for those degrading the environment.

There are several potential alternatives which merit consideration. One is to permit a considerably larger proportion of the rural population than hitherto to participate directly in the cash crop economy using cooperative production methods and by reallocating land from the larger holdings. There is reluctance on the part of the authorities to accept this as the record of cooperatives has been bad in Kenya. But if the real rewards for labor were forthcoming and if more of the budget could be redirected to production at this level rather than in subsidizing the urban economy and encouraging the accumulation of capital at a higher level, then some alternative form of security for the poorest element may emerge based on cash. Naturally those who have cornered the market will be less than happy with an arrangement which must incorporate some form of land redistribution. However, the option on their property may have a very limited life anyway if action is not taken. The fact that the ostrich is a Kenyan bird should not influence policy making.

During the 1960's and early 1970's those in a position of privilege were able to avoid direct confrontation with those being locked into the lower end of an unequal relationship by offering some land on the settlement schemes, through the development of irrigation schemes and by the various Tripartite Agreements which required employers to increase their labor force by 10% regardless of need. Now things are different for there are no more settlement schemes, employers cannot go on absorbing staff indefinitely, the government is reluctant to tax its allies (40% of those assessed for income tax do not pay) in order to expand the bureaucracy and there is a limit to the amount of irrigable land. Education is, as often as not, a path to frustration. One remaining potential safety value is the Asian holding in the wholesale and retail sectors which is a steady target for sniping with regard to "Africanization".

The incorporation of a greater proportion of agriculturalists into the cash crop economy is not, of course, without difficulties. It might tend to weaken the capacity of the poorer sections of the rural population to withstand seasons of poor harvest, due to the historically well-established tendency for cash crop production to occupy higher quality soils. Then there are the familiar international market disadvantages of reliance on export crops; for example widely fluctuating prices, instability of incomes at the producer level, and tendency for prices in real terms to decline in the long term. This first alternative would only indeed make sense within the continued thrust of the present development model.

A second alternative would be to abandon the export-crop/foreign exchange model of development favoring plantations, perennial crops and luxury products. Thus priority would be given to the basic subsistence security of the mass of the population. This would, of course, bring the cities to their knees immediately and render most non-farm employment redundant as the means to pay salaries would disappear. Only a Chinese "back to the land" approach could deal such a transformation.

Ideally some combination is required which allows for either an industrial crop based smallholding providing a sufficient income to allow farm families to buy food crops from the surpluses of other farmers concentrating on the production of basic staples, or mixed holdings. Perhaps then an alternative form of security will exist which will eliminate the need for large families. All this would require considerable planning and control but at least it would be working towards a more positive future for all, especially as virtually all Kenyans equate land with security. To some this may appear like the Swynnerton Plan all over again, but it must be remembered that that plan was conceived within a framework of accepted gross inequality and even recognized that many would be left "outside". Any future change would have to be enacted within the context of greater equity, a focus on the really poor and a new sense of opportunity for the hopeless.

As Leys pointed out in the conclusion to his study, Underdevelopment in Kenya, such a reformist approach, like that being propounded by the I.L.O. with regard to unemployment [I.L.O., 1972] may be naive and totally unrealistic. Is it remotely conceivable that a power structure will set about dismantling, through land reform and a greater emphasis on self-reliant models of development, the very system which gives it its power, privilege and status? Like the I.L.O. study, this broad evaluation can draw attention to the seemingly inevitable conflict inherent in the present contradictions but then a profound process of cognitive dissonance somehow always allows those in power to retreat into an alternative explanation of evidence and avoid the unthinkable.

And so we return to where we started, comparing the technocratic and the broader approaches. Clearly, even by its own measures the technocratic approach is failing as the "environmental crisis" deepens and even global conferences fail to make any real impact. By its own measures also the political economy of Kenya serves its masters well as the gulf between rich and poor widens even though the national economic weakenesses of the large-farm/export crop sector are even more glaring than they were in colonial times, for the cost is carried by others. At present the approach of the authorities represents an elaborate mechanism for rearranging the ways of avoiding the real issues under the guise of environmental protection and its attendant allies. But this will have to face far greater presures as the range of palliative measures diminishes.

Frequently those in the technical fields actually resent or resist more profound explanations of the causation of physical phenomena with derisory accusations of "politics" or simply that they cannot be held responsible for what non-scientists do to abuse their skills and advice. Worst of all is the statement that they are "simply doing a job and doing it well." Indeed the technocratic approach, rather like neo-classical economics, is often seen by its practitioners as being apolitical. In fact, it operates on the premise that the political economy as a variable is held constant. There can be no hope of real improvement until it is clearly recognized that there is a political economy of soil erosion.

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DISASTER AND SOCIOSYSTEMIC VULNERABILITY[1]

Carlo Pelanda

The aims of this paper are to suggest a preliminary sociological definition of vulnerability to disasters, to discuss this notion in relation to different levels of sociosystemic complexity, and, only for heuristic purposes, to present a tentative and synthetic conceptual scheme for the assessment of the overall vulnerability of a social (sub)system.

If one seeks an understanding of what happens at the interface between extreme physical phenomena and social systems, it is necessary to look at the relationship between the context of "normality" and the processes of disaster. From the point of view of disaster research, the pre-impact type of social organization could be considered in terms of its degree of vulnerability, in relation to different types and intensities of potentially destructive events. In conceptual terms, it would be relatively simple to assume a direct linkage between the pre-and post-disaster structural state, and the behavior of a social (sub)system. But very little is known about the quality, the quantity and the type of this relationship. In other words, we could state that pre-disaster social vulnerability plays a crucial role in determining the range of destruction and the aftermath of social dynamics, but we do not know, or we know only roughly, what type of vulnerability plays what role.

Current social science does not have manageable models of societal dynamics. In particular, there is a lack of knowledge about the critical thresholds which determine the loss of the system's structural stability. Even though we must accept temporarily the general state of the art, in disaster research, we cannot maintain too high an indeterminacy in understanding and defining what is the sociosystemic vulnerability to disaster. This is particularly crucial when we advance the hypothesis that the post-disaster society is an extension of the pre-disaster one.

In the following sections of this paper we will try to give some starting points for the matter under discussion. In Section 1 we will present a new synthetic definition of both disaster and sociosystemic vulnerability. In Sections 2, 3, and 4 we will identify three levels--the typological, specific, and general--of social vulnerability to disasters. In Section 5 we will propose a hypothetical and tentative scheme in which the degree of structural indeterminacy predicts the overall degree of vulnerability to disasters of a social (sub)system.

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The discussion will be at a relatively abstract level. But we believe that our point of view can be a heuristic and preliminary tool for finding the most powerful and simplest indicator of social vulnerability, for later application in disaster minimization strategies.

1. Definitions of Disaster and Vulnerability from a Sociological Point of View

The conceptual need to define vulnerability depends on whether or not one believes in the utility of a synthetic concept for assessing the probability of a social (sub)system losing viability under given conditions, and/or the probability of generating these conditions. For the purposes of this paper we need to consider the definition of disaster before dealing with the conceptual and terminological identification of the notion of social vulnerability.

In the literature, definitions of disaster of a "social nature have clearly and fortunately replaced the very early referents in almost solely physical terms" [Quarantelli and Dynes, 1977, p. 24]. Nevertheless, the major part of the sociological definitions of disaster focus only on the description of social and environmental effects of an impact, i.e., when disaster strikes. In these definitions, disaster is viewed as an event concentrated in time and space in which the normal structural arrangements of a social (sub)system are suddenly destroyed, and the fulfillment of all or some of the essential social functions are prevented [see: Endelmann, 1952] [Form and Nosow, 1958] [Fritz, 1961] [Cisin and Clark, 1962] [Skeet, 1977]. Other authors define disasters as collective stress situations which render expected conditions and goals unattainable to the degree customarily considered essential by the social units [see: Killian, 1954] [Loomis, 1962] [Gillin, 1962] [Barton, 1970]. Only a few definitions try to relate the notion of disaster to the collapse of the already existent capacity of the routine social structures. In other words, a disaster is defined as a situation in which the social demands exceed the organizational capabilities and precautions which had hitherto been culturally accepted as adequate [see: Dynes, Quarantelli and Kreps, 1972] [Turner, 1978]; [see also Sjoberg, 1962] [Western, 1972].

In spite of many variations in existing sociological definitions of disaster, the causes which generate disasters, i.e., the reasons why disaster occurs, are commonly left undetermined. In other words, the disaster social situation is arbitrarily separated from, or not explicitly connected to, the pre-disaster one. This could mean that a certain degree of "neutrality" of the pre-disaster type of normality is assumed.

In the last two decades researchers have produced many findings stressing the relevance of pre-disaster social conditions on post-disaster effects. On the other hand, the causes of a disaster have been considered partially external to the "normal" structural state of a social (sub)system. This view could be summarized as the "principle of limited responsibility" of the social structure in generating disaster situations. On the contrary we believe in the principle of the "total responsibility" of the sociostructural organization in generating the pre-conditions of every type of disaster, even when a natural agent is involved. In human systems there is always a social or a sociotechnological cause for every sort of destruction and the effectiveness of the response to it [see Battisti, 1980] [DiSopra, 1980]. When, for example, a large scale earthquake occurs, the level of destruction depends on the capacity of the physical structures to absorb the massive release of energy. But this capacity is totally predetermined socially, economically, and technologically.

In the case of technological disaster-agents, it has been shown that "the community preparedness necessitates social change, not mere technological upgrading" [Quarantelli and Tierney, 1979, p. 10]. We could generalize this to all types of disaster, that is, a "technical investigation alone is insufficient to provide a full understanding of the origins of disasters and that a socio-technical approach must be employed" [Turner, 1979, p. 57]. Similarly, in the case of natural disasters we could also apply the principle that disasters always arise from an absence of some kind of knowledge at some point Turner, 1978 . From this perspective we could interpret all disasters as acts of ignorance or situations which depend on a lack of rationality. On the other hand this lack of rationality is a constant in social systems. It is well described in Simon's principle of "bounded rationality" which asserts that there is always a state of potential ignorance that prevents the maximization of any human goal [Simon, 1957].

We must temporarily accept as a constant the incapability to control and understand perfectly the dynamics which lead to a disaster situation. But we cannot tolerate a conceptual ambiguity about the context in which a disaster arises. Any sort of disaster, natural or man-made, dissensus or consensus type, etc., totally depends on social causes. If we accept this principle of "total responsibility", then the simplest and most general definition would state that <u>disaster is the actualization of social vulnerability</u>.

In the disaster literature there is a lack of clarity about the interpretation of the term "vulnerability". In many studies, the notion of vulnerability is implicitly defined as proneness, risk hazard; or lack of preparedness, readiness, organization, experience, viability, or low capability for absorption, normalization; or low elasticity, flexibility, stability; or high susceptibility, fragility, penetrability, exposure, etc. Only a few authors try to define explicitly the notion of social vulnerability. Here we can mention a representative sample of their writings.

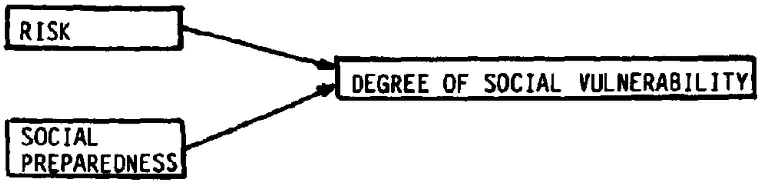
"In some sense vulnerability is a concept which stands in a reciprocal relation to viability. Studies of social vulnerability should identify those key structures and processes which, when broken under assumed or actual stress will decrease the general and specific viability of society and its institutions" [Vestermark, 1968, p. 14]. The following definition is relatively similar: "vulnerability defines the susceptibility of population-at-risk to loss when an event of given intensity occurs" [Friedman, 1975, p. 2].

Disagreement is explicitly present in the distinctions among "vulnerability", "proneness" and "risk". Lewis, for example, trying to distinguish between proneness and vulnerability states that "the former concept refers to the frequency and magnitude of the physical events; the latter describes and measures the impact of disasters by means of statistical and other methods" [Lewis, 1979, p. 104]. For other authors the term "proneness" describes the degree of social capacity to absorb or minimize disasters, while "vulnerability" refers to the degree in which a social (sub)system is at risk to extreme phenomena see for example: [Burton, Kates and White, 1977]. Westgate and O'Keefe, criticizing the above point of view, assert that the notion of social vulnerability is a combination of both of the concepts of proneness and risk, as follows: "vulnerability is the degree to which a community is at risk from the occurrence of extreme physical or natural phenomena where risk refers to the pejorative probability of occurrence, and the degree to which socio-economic and socio-political factors affect the community's capacity to absorb and recover from extreme phenomena" [1976, p. 65]. A recent work in the area of chemical disasters amplifies the latter approach, asserting that vulnerability is a characteristic of a community as a totality and that it is a complex function of both risk and preparedness [Gabor and Griffith, 1979].

Even though many of these definitions stress the socio-ecological quality of the term vulnerability, they assume a relative independence between the probability of occurrence of a destructive event and the sociological context. From this point of view one could derive by logical implication that a low or high probability of occurrence of an extreme phenomenon reduces or increases the level of social vulnerability. This, in operational terms, could be expressed, for example, with the formula: VULNERABILITY (disaster risk) = NATURAL HAZARD RISK x DAMAGE PROBABILITY [U.N.D.R.O., 1977]. In spite of the conceptual evidence that the degree of risk cannot be viewed as a factor which is independent from the sociostructural context, a distinction is made "as it serves to illustrate the different strategies community planners can pursue according to the relative importance of the two sets of factors in a given situation" [Gabor and Griffith, 1979, p. 325; Gabor and Pelanda, 1981]. In fact there is a level of applied knowledge in which, for practical purposes of contingent assessment, the separation of the notions of risk and the structural state of a social (sub)system could be justified in building both a working definition and combined indicators of social vulnerability.

Here, for our purposes, the problem is that this latter approach stays at the level of "functional rationality". That is, it is a series of actions organized in such a way that they lead to a previously defined goal with every element in these series of actions receiving a functional position and role [Mannheim, 1940]. But for a better understanding of what social vulnerability and disaster are, we need to operate at a level of "substantial rationality" i.e., acts of thought from which arises an intelligent insight into the interrelations of events in a given situation [Mannheim, 1940].

In other words, even though at a practical level we could separate the notions of risk and the social structural state, this point of view, assuming the relative independence between the pejorative probability of occurrence of an extreme phenomenon and the sociological context, is ambiguous for purposes of a substantial understanding of the concept of social vulnerability against disasters. As previously stated, we believe in the principle of "total responsibility" of the social organization in creating the pre-conditions of all the types of social destruction. This means that the approach in which risk and type of sociological context are both separate and independent factors (predictors) of the dependent variable "social vulnerability", i.e.:



does not satisfy our principle. On the contrary, we interpret the notion of social vulnerability as an independent factor (predictor) of risk, i.e.:

where risk is defined as the probability of an event occurring multiplied by the magnitude of the loss.

The latter causal relation satisfies the principle that the type of organizational state of a social (sub)system generates the pre-conditions for any sort of destruction, natural or man-made. It also impies that the sociological notion of vulnerability refers to the structural situation of a social system. The common sense preliminary assumption is that the notion of the probability of occurrence of an extreme environmental event is relevant from the sociological point of view only when it is an extreme social phenomenon, i.e., when a "barrier of indifference" does not exist. This means that risk depends on a factor of sociotechnological capacity which is a subcomponent of the degree of social vulnerability inside a given societal and/or community system.

From this perspective we need a "pure" sociological concept for defining the term "social vulnerability". The simplest notion could be the quantity of sociostructural "domain" (e.g., control) that a social system (or subsystem or component) has over its internal and external processes. At an abstract level, the condition of perfect domain is constituted by the fulfillment of two prerequisities: a) substantial knowledge of all the events which are possible given the structural state of the system of interest and b) related successful construction of sociotechnological barriers of indifference in opposition to the subset of possible events whose actualization would directly or indirectly lead the system below the threshold of minimum viability. At this level of generality we could assert that the degree of social vulnerability of a (sub)system is the quantity of sociostructural "non-domain" (e.g., non-control) over its internal and external processes. The notion of vulnerability is a relativistic concept based on the interests of an observer. This definition could be applied to the point of view of all the components placed along the continuum of sociosystemic complexity.

The actualization of any event socially defined as disaster is a specific property of the sociosystemic non-domain [Pelanda, 1981a]. This approach implies that both man-made and natural disasters simply assume the same quality of outcomes of "sociotechnological options", which are not sufficient to dominate the environmental variability. Furthermore, one of the implications related to the above definition of social vulnerability is that no extreme physical phenomenon, relevant from the point of view of human systems, can be considered independent from the involved sociological context. Or, better stated, any physical event characterized by a social impact is directly "generated" by causes inside the structural organization of a social (sub)system. Sudden, rare, random, unexpected, destructive events are only synonyms of what we do not know, or of what we are not able or do not want to organize.

In the last section of this paper we will tentatively identify the main structural determinant of the q antity of social vulnerability as defined above. In the following pages we will discuss the problem of how many types of social vulnerability play what role in localized disasters.

2. Preliminary Identification of Three Levels of Social Vulnerability

To observe whether or not localized disasters have relevant long-term socio-economic and psychological effects, could be a preliminary way of finding some empirical evidence about what and how many types of social vulnerability play a role in disaster situations. In the social science disaster literature, at the socioeconomic level, American studies have produced two recurrent findings.

(1) The first finding is that localized natural disasters do not generate significant long-term changes in the demographic, economic and urban dynamics of impacted communities when compared with the pre-disaster ones [Wright et.al, 1979]; [Friesma et.al, 1979]; [Aguirre, 1981]. If small changes occur, they tend to be positive in economic terms and more relevant at a regional level rather than for single communities inside the geographical area of the disaster [see: Dacy and Kunreuther, 1969].

(2) The second finding is that localized natural disasters tend to produce an acceleration of the already pre-existing developed and underdeveloped trends [Bates et al. , 1963]; [Haas et al., 1977].

At the psycho-social and epidemiological levels, there is a basic conflict between two subsets of survey findings relating to the long-term individual effects of natural disasters for a general discussion see: [Mileti et al., 1975] [Perry and Lindell, 1978]. The first set asserts that a natural disaster might produce short-term psychological disturbances, but does not generate significant long-term individual consequences [see Drayer, 1957] [Dohrenwend, 1973] [Hall and Landreth, 1975] [Taylor et.al, 1976] [Omaha Tornado Project, 1976] [Western and Milne, 1976] [Sterling et al., 1977] [Melick, 1978]. Moreover, disasters do not necessarily produce negative individual effects, but they can have many positive effects on some characteristics of the invol social units [see Barton, 1970] [Turner, 1966] [Drabek, 1976]. In contrast, the second set suggests that relevant psychological consequences can appear after a considerable period subsequent to the impact [see Killian, 1954] [Demerath and Wallace, 1957] [Form and Nosow, 1958] and can persist in the long-run among significant numbers of the disaster victims [see Wilson, 1962] [Erikson, 1976] [Titchener and Knapp, 1976] [Logue et al., 1978] [see also Ahearn, 1979]. A variation of this latter finding, based on community studies focused on the long-term social consequences of the 1976 Friuli (Italy) earthquake, proposes that both the destruction and the type of reconstruction tend to produce significant negative effects only, or mainly, on those victims already characterized by high pre-disaster psychological and/or socioeconomic vulnerability [Tessarin, 1980]; [Pelanda, 1981]; [Pascolini, 1981].

From a societal point of view, and on the basis of the literature we reviewed, we could hypothesize that in developed western societies, local natural disasters do not produce any long-term relevant structural effects. In other words, these types of social systems maintain their structural stability under localized destruction.

If one is interested in a more formal description of this observation we could use (only as a parenthetical note in the context of this paper) the mathematical concept of topological isomorphism related to the preservation of a system's structure over time [see Gottinger, 1975]; [Willigan, n.d.]. If we identify (S,X) as a differential dynamic system, where S is the system's phase space, with some assumed appropriate topological structure, and X is a vector field made up of a set of differential equations specified in S, we could define the system (S,X) to be structurally stable if for some perturbation dX on X the system (S, X + dX) is topologically isomorphic to (S,X). This is simply a description of a system which maintains its qualitative dynamics under perturbation.

From a macroscopic point of view this should be the situation of the developed western societies in relation to localized disasters. On the other hand we do not know anything, or little, about the threshold of intensity beyond which a local crisis becomes a societal disaster, and about the permanent effects of localized disasters in both non-western and non-developed societies. Therefore, we can only assume that in western developed societies there is a general factor of sufficiently low social vulnerability, which maintains the structural stability of the system when the typological vulnerability, (i.e., the quantity of "non-control" over a particular sort of environmental variation) of a subsystem actualizes into a local disaster.

Further problems arise when we have to assess the disaster effects at the involved subsystem (regional area or community) level. In spite of many systematic observations which suggest that local natural disasters do not produce permanent changes on the characteristics of both the structural dynamics and the social units of the involved subsystem, we have good reasons to believe that this finding is more appropriate for low-range disasters, which are easily counterbalanced by the average capacity of institutional rehabilitation existent in developed western societies.

On the basis of the above reductively summarized findings, and assuming a relevant level of destruction, we could hypothesize that there are differential disaster effects among communitites inside the same societal system, and among social units inside the same community. These differential effects are mainly based upon the subsystem's social units level of pre-disaster specific vulnerability, i.e., a pre-disaster capacity factor related to the involved social unit's probability of maximizing adaptive behavior under stress. This means that the differential distribution of the specific pre-disaster social, economic, cultural, organizational, vulnerabilities in the components inside the sociosystemic level of interest, creates the pre-conditions of differential adaptive or maladaptive post-disaster social dynamics.

But neither these factors of specific vulnerability nor those of typological vulnerability, which determines the post-impact degree of environmental alteration, are sufficient for exhaustively predicting/explaining the type of disaster response of the involved social units. In fact, in modern societies, no social subsystem is left alone to cope with mass emergencies [Quarantelli and Tierney, 1979;] [Strassoldo and Pelanda, 1981]. Further, the degree of institutional rehabilitation (i.e., the level of actualization of a societal factor of general vulnerability), can totally modify the only apparent linear relationship between the particular vulnerabilities inside the involved subsystem and its overall degree of adaptive response to the disaster.

A unifying general notion for understanding this complex matter is the principle of continuity [Quarantelli and Dynes, 1977] which asserts that the pre-disaster behavior (or state) is the best predictor of the post-disaster dynamics. This principle fits our point of view. But for our purposes, which are focused on how the social vulnerability at different levels of the sociosystemic continuum plays its role in disaster situations, we have to elaborate this point. Until now we have identified the notion of total sociosystemic vulnerability (i.e., the quantity of "non-domain" of a social system over its internal and external processes) as a conceptual leitmotif. This implies at least three sublevels of social vulnerability: general, at a societal level, and specific and typological, at the involved subsystem level. The hypothesis is that if we know only one of these levels, or we assess them separately, we cannot measure the overall vulnerability of a social subsystem of interest nor predict/explain its post-disaster behavior. We need a simultaneous assessment of at least all these three types of social vulnerability. In other words, the fact of knowing each type of vulnerability alone does not allow us to predict/explain the subsystem's post-disaster social dynamics. Only a threefold simultaneous assessment could have this property at an acceptable level of reliability.

Before trying to define better these three levels of social vulnerability and their interrelationship, it will be useful to give a brief concrete empirical example of the matter under discussion.

3. An Example: The Friuli Earthquake Case

We undertook a questionnaire survey focused on the 1976 Friuli earthquake[2] and obtained a sample of 896 dwellers from 16 damaged and destroyed communities. We gathered data organized in a (recursive) causal scheme (see Figure 1) in which the rough determinants of the long-term individual (mal)adaptivity to the disaster are represented and measured [see Pelanda and Cattarinussi, 1981] [Cattarinussi, Moretti and Pelanda, 1980] [Strassoldo and Pelanda, 1981]. Here, because of space limitation, we can only briefly mention those findings most directly relevant to the topic of this paper.

In this research, we used reliable indexes of the disaster-victim's pre-impact socioeconomic (X_1) and psychological (X_{11}) vulnerabilities. In the causal scheme (Figure 1) the degree of pre-disaster psychological (in)stability is the best direct linear predictor of the long-term psychological state of the disaster involved subjects (X_2). The degree of pre-impact socioeconomic vulnerability (X_1) is not directly related to the latter index (X_2). But, the socioeconomic vulnerability strongly influences other direct predictors of the dependent index (X_2), that is, the degree of loss of cultural identification (X_7), the degree of post-disaster family economic change (X_5) and the degree of "individual disaster frustration" (based on a measure of self-esteem change) (X_8).

Therefore, this type of vulnerability is one of the most crucial determinants of the long-term level of individual (mal)adaptivity to the disaster (X_2).

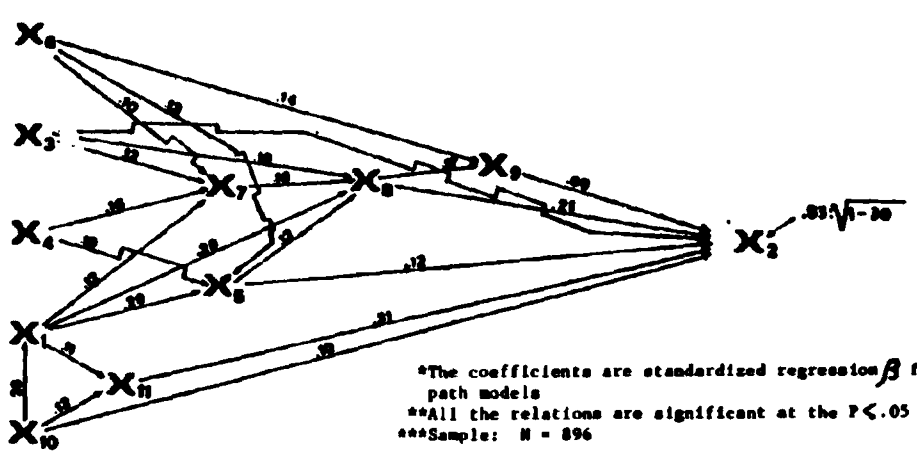
Compared with the pre-disaster overall personal state, the relative majority of the sample does not show changes four years after the impact. But relevant numbers of individuals, about 20%, show significant symptoms of maladaptivity. A similar number of disaster victims as well exhibit a general improvement in their socioeconomic and psychological conditions when compared with their pre-disaster state. Both changes tend to be linearly predicted by the degree of pre-disaster socioeconomic and psychological vulnerability.

In some of the findings derived from the causal schema (Figure 1) we can see that the levels of pre-disaster economic and psychological vulnerability are the best linear predictors of the long-term degree of individual (mal)adaptivity to the disaster. Even though this relationship is true in the statistical model we built, it does not imply, on the other hand, that we can exhaustively predict/explain the individuals' post-disaster situation only knowing their pre-disaster degrees of specific vulnerability. The statistical significance only means that there is a particular tendency in the data. Many exceptions suggest that the continuity between the overall pre- and post-disaster personal state of individuals is obviously affected by many other factors.

Before exploring these factors, we need a synthetic and manageable concept to identify the key dimension of the social units' capability for absorbing environmental crises. This crucial notion is the individual capability to maintain a sense of predictability and cultural coherence in spite of both the "disorder" produced by the destruction and the uncertainly related to the reconstruction process (this general factor is roughly captured and measured by the variables X_7 and X_8 in Figure 1). While this crucial notion is suggested in the model presented in Figure 1, it is clearly evident in the context of other parallel qualitative analyses of the sociological dynamics related to the Friuli earthquake. The degree of this cultural mediation capability weakens, for example, the linear relationship between the material objective disaster-situation (see the weak relation between X_6 and X_2 in Figure 1) and the psychological state of the disaster victim.

In synthesis, the general pre-disaster social state of individuals is not alone sufficient to explain exhaustively the probability of maintaining predictability under perturbation, and adaptivity to the disaster situation. Hundreds of intervening variables are relevant for the remaining quantity of this type of prediction/explanation. But we could state that all of them depend on the degree of actualization of both the typological (i.e., all the factors which determine the degree of environmental alteration) and the general (i.e., all the factors which determine the level of institutional rehabilitation) vulnerability.

In the Friuli earthquake case, the actualization of the typological vulnerability (1000 casualties, 2800 injured, 70,000 homeless) was bounded inside the housing system, leaving whole the productive structure. Moreover, the presence in Friuli of 2/3 of the Italian Army substituted and counter-balanced the total lack of community preparedness for emergency management. The general vulnerability, at a societal



*The coefficients are standardized regression β for path models
**All the relations are significant at the $P \leq .05$ level
***Sample: N = 896

X_1 Degree of pre-disaster socioeconomic vulnerability (min - max: high)
X_2 Degree of long-term individual maladaptivity (min - max: high)
X_3 Degree of perceived social climate change as compared with the pre-disaster one (min - max: deterioration)
X_4 Degree of "kin embedness" (min - max: low)
X_5 Degree of family economic change as compared with the pre-disaster one (min - max: pejorative change)
X_6 Degree of damage and its persistence over time (min - max: still living in a barracks)
X_7 Degree of loss of cultural identification (min - max: high)
X_8 Degree of disaster frustration (min - max: high)
X_9 Degree of change in the family climate as compared with the pre-disaster one (min - max: deterioration)
X_{10} Sex (max: female)
X_{11} Degree of pre-disaster psychological unstability (min - max: high)

Figure 1

Causal Schema of the Determinants of the Long-Term Individual (Mal)Adaptivity to the 1976 Friuli Earthquake level, actualized mostly in some intervention delays, but not in the amount and quality of the financial and organizational resources which converged onto the disaster area. The bounded actualization of both the typological and general vulnerability, generated a similarly bounded actualization of the specific vulnerability of the social units inside the involved subsystem.

From a general point of view, this means that the overall post-disaster organizational environment remained below the threshold, beyond which the average capability of the disaster-area social units for maintaining a sense of cultural coherence and predictability collapses. On the other hand, and at another level of observation, the partial actualization of these vulnerabilities was high enough to create a relevant quantity of randomness in the individual adaptive success. The quantity of post-disaster environmental indeterminancy was, and is, high enough to make unpredictable the degree of adaptation of many social units if we know only their own degree of pre-disaster social vulnerability. For our immediate purposes, this set of necessarily reductive considerations, is sufficient to make reasonable the hypothesis that the simultaneous assessment of at least three levels of vulnerability along the continuum of sociosystemic complexity, is the minimum pre-condition for getting an acceptable prediction/explanation of the social dynamics inside a post-disaster subsystem.

Now let us go back again to the general discussion we interrupted to present some rough empirically-based illustrations.

4. Role and Interaction of Three Levels of Sociosystemic Vulnerability in Determining the Overall Subsystem's Vulnerability and Disaster Response

When disaster strikes modern societies, the involved social subsystem is not left alone, but is "rehabilitated" by some larger system. When we have to deal with the problem of the assessment of disaster minimization in communities or regional areas, we cannot simply use measures of local exposure or of social vulnerability inside the area of interest. We have to identify as many levels of vulnerability as there are functional connections among components, subsystems and systems. For minimum acceptable predictions/explanations at least a simultaneous assessment of three levels of social vulnerability, defined as follows, is required.

A. Subsystem of Interest Level.

(1) Typological Vulnerability: refers to all the local sociotechnological pre-conditions whose resultant defines the degree of the social subsystem's indifference to a given intensity of a possible type of environmental perturbation. In other words, this term includes both the technological and social factors which directly define the probability of avoiding or minimizing a specific type, or a set, of potentially destructive events. The level of emergency planning preparedness, the degree of resilience of the physical structures, the technological capability to assess locally the degree of exposure, the sociopolitical awareness of risk, etc., are examples of some of the

required indicators for assessing the typological vulnerability. Its degree of actualization directly determines the subsystem's post-impact degree of environmental alteration.

(2) Specific Vulnerability: is the combined resultant of the distribution of the cultural, organizational, technological and economic resources of the subsystem's social units (individuals, families and organizations). In other words, this is a complex measure of the local levels of both socioeconomic development and cultural stability. The degree of specific vulnerability directly influences both the degree of pre-disaster typological vulnerability and the social units' type of response when the typological vulnerability actualizes.

B. Society System Level.

(1) General Vulnerability: is the societal degree of socioeconomic, organizational and technological development. The national society vulnerability indicators refer to: 1) the quantitative and qualitative availability of economic, organizational, cultural, normative and technological resources; 2) the degree of functional connection between the societal system and its subsystems; 3) the degree of functional linkage with the international oversystem [see DelliZotti, 1981]; [Strassoldo, 1979]. The degree of general vulnerability directly influences both the pre-disaster levels of typological and specific vulnerability and the degree of after-impact institutional rehabilitation.

As shown in Figure 2, these types of preliminary analyses imply both a causal relationship among the three levels of social vulnerability and their different direct roles after the impact of a localized disaster. In the disaster situation, the degree of societal general vulnerability directly influences the subsystem's vulnerabilities. The degree of specific vulnerability amplifies or reduces that quantity of typological vulnerability which directly depends on the general state of the societal system. After impact, the three types of vulnerability play a combined but differential role in determining the subsystem's overall social response. Its level of success directly depends on the degrees of: a) environmental alteration (the actualization of the typological vulnerability), b) pre-disaster specific vulnerability of the involved social units and c) institutional rehabilitation (the actualization of the general vulnerability).

The representation in Figure 2 is made from the point of view of the involved social subsystem. This approach means that for assessing its overall vulnerability against possible disasters, we have simultaneously to use reliable indicators related to at least all three levels of the social vulnerability identified above. If we know only one or two levels or if we are not able to combine all of them, the failure to predict/explain the involved subsystem's disaster related dynamics is more likely to occur.

The required social science assessment, as shown in Figure 3, could be described as a three-step process: 1) reduction of the complexity of the reality by the identification and measurement of a satisfying number of indicators related to all three levels of sociosystemic vulnerability; 2) employment of multivariate techniques (e.g., factor analysis) for reducing the complexity of the indicators and finding the latent

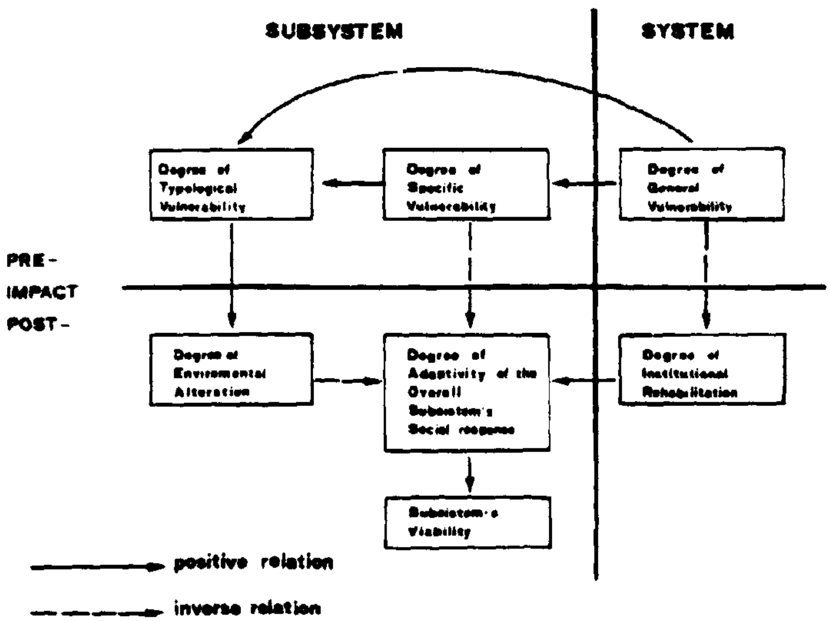
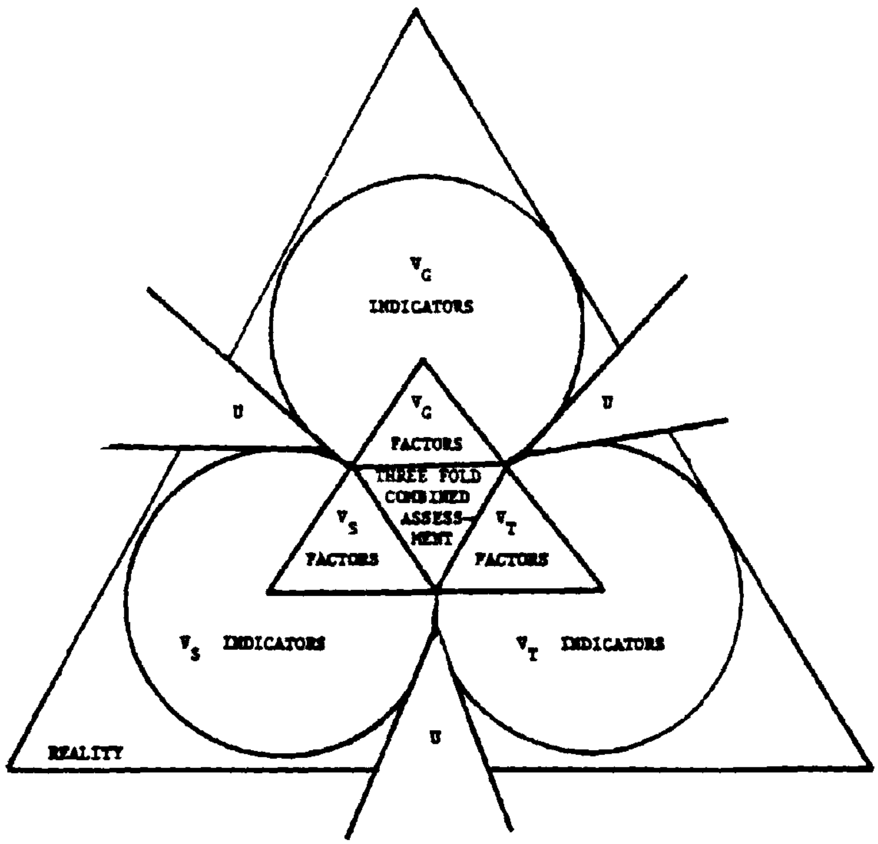


Figure 2

Role and Interaction of Three Levels of Sociosystemic Vulnerability in Determining the Overall Subsystem's Vulnerability and Disaster Response



V_G : General Vulnerability
V_S : Specific Vulnerability
V_T : Typological Vulnerability
U : Unknown Processes and Relations

Figure 3

Representation of a Three-Step Measurement Process for the Assessment of the Overall Subsystem's Sociosystemic Vulnerability dimensions which synthesize them; 3) combined assessment of the factor analysis derived indexes, and their causal relationship, to obtain the degree of overall social vulnerability of a societal subsystem for any chosen set of unwanted possible events.

This is the minimum we believe that is required. But obviously, after accepting the idea of the simultaneous employment of indicators related to all the relevant levels of sociosystemic functional interconnections, we could use many other techniques. For example, to perform risk analysis, we could employ the Monte Carlo Method and the related Network Analysis, or the Delphi procedure, or the Event Tree Analysis, and so forth. We think that the problem of choosing the technique which better fits the researcher's goal follows, and does not precede, the problem of being able to pursue a holistic approach.

The point of view expressed here might satisfy a preliminary introduction to the problem of assessing the degree of the social subsystem's vulnerability for every given set of perturbing events, but it is only a rough idea of what is necessary. Among the many difficulties, one is particularly crucial. In fact, if we could operationalize our approach, we would find not only difficulties in dealing with the large number of required indicators, but, above all, the crucial problem of having to use different criteria of vulnerability per any chosen level of socio-systemic complexity.

Employing only one common criterion for assessing the vulnerability related-state of all the sociosystemic components of interest would be a better strategy. But we have to find something which could fit this goal. In this perspective, our preliminary working hypothesis is that the degree of (in)determinacy of the structural state of a social (sub)system could be functionally related to its overall degree of social vulnerability [Pelanda, 1980].

In the following and final section, we will try to suggest some tentative considerations about the hypothetical possibility of employing an indicator of the degree of sociostructural (in)determinacy, for assessing the overall level of vulnerability of a social (sub)system. The discussion will be necessarily short and incomplete because of the tentative and preliminary nature of our untested hypothesis.

5. Sociosystemic Vulnerability and Bounded Indeterminacy: A Tentative and Preliminary Approach

The problem is to find only one indicator of vulnerability which can be compatible with any structurally relevant component and/or level, placed along the continuum of sociosystemic complexity. If one believes in the possible existence of such an indicator, then the preliminary methodological step is to identify the simplest, theoretically acceptable dimension which could fit any element of the system(s) under analysis. Our point of view is that the degree of (in)determinacy in the structural relations among social system, subsystems and components could be functionally related to their degree of sociologically relevant vulnerability. A necessarily short general discussion justifying this tentative approach is required.

We define a social system as a particular type of cybernetic system in which all the components are interconnected and have a certain degree of autonomy (for a general discussion see Buckley, [1968] Katz, [1981]). By logic, the behavior of any component could be viewed as totally determined, relatively undetermined, or totally undetermined.

If the behavior of all or many of these components is highly undetermined, we could say that the structural state of the system is characterized by high levels of disorder and unpredictability in its functional connections. The opposite situation could be viewed as a state in which the behavior of any component is highly determined and therefore the structure is extremely rigid. A great amount of structural rigidity implies that there is not sufficient elasticity for absorbing some possible unexpected event.

Let us assume two systems whose structure is characterized by, in the first, extreme indeterminacy, and, in the second, extreme determinacy. In both cases we could predict that, for different reasons, there is a similar high level of vulnerability. In the first case this is because there is a lack of structural control over those social and environmental processes which potentially can lead the system to a disaster situation. In the second case, it is because the structural organization has not sufficient variety (e.g., alternatives) for adaptively reacting to an unpredicted event.

This abstract consideration implies that there is an optimal level of indeterminacy in the structure of a system, where a sufficient degree of variety combined with a high but not extreme level of order (determinacy), maximizes the probability of reacting to the actualization of an unpredicted event, by adopting the required inelasticity. We define this optimal level of indeterminacy as "bounded indeterminacy" [see: Katz, 1974] [Pelanda, 1980]. We can measure the degree of indeterminacy of the structure of a given system along a continuum of indeterminacy-determinacy (i.e., 0 = max. indeterminacy; 1 = max. determinacy). We assume that there exists an interval along this continuum called "bounded indeterminacy", in which the system's structure maximizes the required levels of both variety and organization for minimizing or avoiding all types of potentially destructive events. If the system's structural state goes beyond the limits of bounded indeterminacy towards the extremes of both determinacy (rigidity) or indeterminacy (disorder) then its degree of vulnerability rises.

Let us give some conceptual examples for clarifying the latter statement. One of the smallest units of social structure are roles. They could be viewed as packages of expected and socially enforceable behavior. Their interaction makes up role systems [Katz, 1974]. If we observe some individuals who are playing social roles, we could find that the interaction is functional or possible as long as the role-playing remains within the socially defined limits. If the role-playing goes beyond these limits in the direction of both extreme indeterminacy and determinacy, a dysfunction in the involved social interaction is more likely to occur.

Let us change the level of observation and let us assume, from a macroscopic point of view, that a social system reproduces its structure over time. If there is a rigid (i.e., highly determined) reproduction of the original matrix we could say that such a social system is at a steady state, and it does not increase its levels of variety, organization, development. If the process of reproduction generates a new structure which is highly different from the former one we could say, roughly speaking, that the social system has lost its structural stability at a certain point over time. In both cases, we could predict an extremely high level of social vulnerability. In the first case, this could be because of the rigidity in the structural dynamics. In the second case, this would be because of too high an uncertainty in the social processes. Only a bounded change from the former structural state makes a social system able to increase its levels of organization and variety, maintaining at the same time its already established structural stability. In other words if a structural change occurs within the limits of bounded indeterminacy we assume that it maximizes the organizational resources for coping with all the events which could lead the system below the threshold of minimum viability.

In general terms, if we observe the behavior of an organization we could find that both extreme determinacy (e.g., centralization, rigid hierarchy) and indeterminacy in the structural connections among components produce some dysfunction. The situation in which any component has a relatively high but structurally bounded degree of freedom maximizes the probability of avoiding or minimizing the organizational collapse under unexpected tasks.

The function of a limited degree of indeterminacy in the structure of systems is well known in both the daily experiences of engineers and planners and in the scientific work undertaken with systems. In the latter sector, particularly, the recent evolution of all the scientific disciplines shows a great interest about the role of indeterminacy in the life of both man-made and natural systems. We can only mention some examples incidentally in the context of this paper.

How a system maintains or increases order in its interaction with environmental variations is an important question in many disciplines. Von Foerster [1960], criticizing Schrodinger's [1945] principle of the "order based on order" observed that a self-organizing system does not feed only upon order and formulated the principle of "order based on disorder" (i.e., noise, indeterminacy). One of the basic findings in the first developments in the science of cybernetics was an assertion that as an automaton increases its complexity, a certain quantity of indeterminacy (e.g., redundance and delocalization of both the functions and the components) is required for maximizing its probability of adaptation to a perturbation [see: Von Neumann, 1956] [Winograd, 1963] [Cowan, 1965]. This latter consideration is at a certain degree related to the Ashby [1958] law of "requisite variety". Atlan [1972], generalizing a finding which Eigen [1972] obtained in biochemistry, formulates the principle of "noise (i.e., indeterminacy) as a principle of self-organization". It states that a certain degree of indeterminacy in the structural processes of a self-organizing system is a required pre-condition for transforming a perturbing event by generating an increasing level of organization, complexity and variety. Closer to our purposes, a sociological hypothesis suggests that

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there exists indeterminacy, can be specified precisely while at the same time, accepting the unspecificability of what lies within these limits" [Katz, 1979, p. 394].

Going back to the specific topic of this paper, from our point of view the probability that a perturbing event (i.e., disaster, threat) will activate a process of increasing organization in the involved social (sub)system is the key dimension which defines its overall degree of social vulnerability. Our hypothesis is that a social (sub)system's state in which all the structurally relevant components are operating within the limits of bounded indeterminacy maximizes this probability.

The main assumption of this approach is that such a structural state is the optimal pre-condition for having the maximum availability of the required organizational resources for coping with <u>all potentially destructive events</u>.

To synthesize we believe that:

A) There is a theoretically justifiable possibility for measuring the degree of (in)determinacy of all the chosen structurally relevant components of a social (sub)system.

B) The probability of both maintaining order and increasing organization inside a social (sub)system under perturbation, could be seen as a function of the degree of (in)determinacy in which it and its components operate during the "normality" phase.

If we assume a continuum 0 - 1 along which we can measure the degrees of both social vulnerability and structural (in)determinacy, then our hypothesis could be represented as shown in Figure 4. According to our preliminary and rough conceptualization, we assume that the overall vulnerability of a social (sub)system and its components is at a relative minimum when their structural dynamics operate within the limits of bounded (in)determinacy (see Figure 4). Such a structural state maximizes the (sub)system's and components' probability of absorbing a perturbation (or threat) by generating positive social change and increasing organization variety. The related statement we propose to subject to falsification asserts that: <u>if the dynamics of all the structurally relevant sociosystemic components operate within the limits of "bounded indeterminacy", then the overall degree of social vulnerability is at a relative minimum</u>.

Going back to the starting point of this section, we believe that the degree of sociosystemic (in)determinacy could be the best single dimension or indicator of upper level, for assessing the overall structural vulnerability of a social (sub)system, for any type of possible disaster. This is a tentative and only a conceptually based approach. In future work we will try to falsify this preliminary hypothesis. Meanwhile, we believe that it might serve as a heuristic tool for developing holistic and concretely manageable methodologies of sociostructural vulnerability analysis. To find the most powerful and simplest indicator of social vulnerability is one of the main preliminary goals for applying disaster minimization strategies.

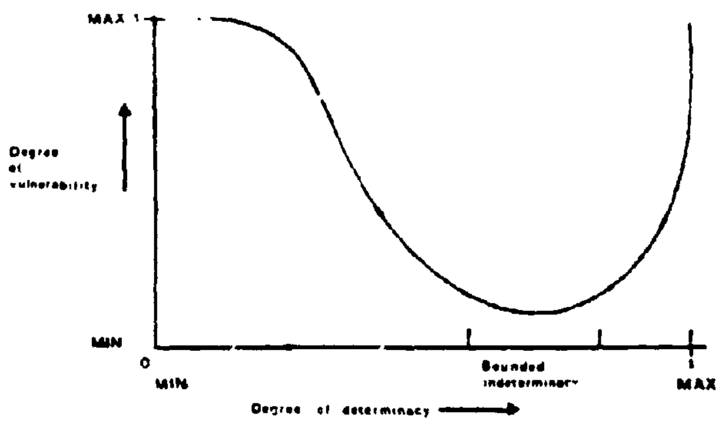

Figure 4

Hypothetical Relationship Between
Vulnerability and Indeterminacy

FOOTNOTES

1. Funds for this work were provided partly by the Italian National Research Council, and its assistance is appreciated, but responsibility for the content is solely that of the author. This paper was written while the author was a visiting professor at the Disaster Research Center, The Ohio State University. Professor E.L. Quarantelli, the Center's Director, is thanked for his help and for the advice he offered on preliminary drafts of the paper. The author is also very appreciative of the fine work by Ruth Orr in typing the draft and the final version of the paper.

2. Four years after the impact, less than 50% of the houses have been rebuilt, while about 40,000 disaster victims still live in a temporary housing system. The disaster area communities show differential trends. Those already developing in the pre-impact period have had an acceleration of their economic and urban improvement dynamics, while those already marginalized (e.g., mountain communities) have tended to increase their degeneration or to maintain a steady under-developed state. For the sociologically relevant history of the Friuli earthquake, see Geipel [1977], Strassoldo and Cattarinussi [1978], M. Strassoldo, [1979], Tellia [1979].

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SECTION III

HAZARD ASSESSMENT, RISK ANALYSIS AND VULNERABILITY DETERMINATION

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PROBLEMS OF EARTHQUAKE HAZARD ASSESSMENT

AND VULNERABILITY ANALYSIS

Vit Karnik

Introduction

According to recently adopted definitions, "seismic hazard" means the probability that a certain ground motion parameter will not be exceeded at a site within a specific period of time. "Vulnerability" is the degree of loss to a given element at risk, resulting from the occurence of a natural phenomenon, and is expressed on a scale from 0 to 1. The word "risk" is then used to denote the expected, probable loss in terms of number of lives lost, damage to property or disruption of economic activity. Thus, risk depends on hazard, vulnerability and elements at risk. The definitions were formulated by a group of experts convened in Geneva by UNDRO in July 1979 [UNDRO , 1980].

The knowledge of seismic risk is a determining factor in preventing or mitigating the disastrous effects of earthquakes. Equally determining is the awareness of risk, that is the perception by the public and the authorities of its social and economic implications. Such awareness will ease the problem of defining locally acceptable levels of risk, which are in themselves determining factors for the successful application of detailed land-use measures and site planning as well as the formulation and implementation of appropriate building codes. Hazard and vulnerability analyses comprise the key inputs to risk assessment. The purpose of the present paper is therefore to review the methodology of hazard and vulnerability assessments and the accuracy of the information provided.

Methods of Seismic Hazard Assessment

The present methods of seismic hazard assessment are based on the following operations:

1. Definition of potential earthquake source regions in terms of their boundaries and of the average earthquake activity which is defined by the magnitude (or intensity)-frequency relationship

$$N(M) = \alpha e^{-\beta M}$$

and by the upper threshold magnitude (or intensity) M_{max} truncating the N (M) distribution.

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2. Determination of the attenuation function for the selected ground motion parameter X, that is

$$f\ (X) = X_o a D^n e^{-bD}$$

where D is epicentral distance and a, n and b are coefficients.

3. Formulation of a statistical model defining the probability of occurrence of a certain ground motion parameter at a site during a period of interest. The calculation of the probability function is based on the cumulative distribution of ground motion parameters resulting from the earthquake activity in all surrounding source regions.

The mathematical formulae describing different statistical approaches can be found in the literature. Most methods consider earthquake occurrence as a random Poisson process with a constant annual rate. A detailed scheme of individual steps is reproduced in Figure 1. The described procedure has several weak points. It is first of all very difficult to estimate the earthquake potential of a certain volume of the Earth's crust or upper mantle.

The source regions are delineated by using mainly evidence from past earthquakes and assuming simple correlations between tectonic features and the origin of earthquakes. The N (M) distribution always represents an averaged observation without taking into account fluctuations in seismicity.

Most estimates of M_{max} are still based more on personal judgment than on a defined algorithm. The assumption of a random character of earthquake occurrence greatly simplifies the whole earthquake-generating process; however, it seems to be valid, at least for large events.

The attenuation functions are again taken in an averaged form, disregarding the azimuthal or regional variations observed in the change of the parameter with distance and magnitude of the event.

All these simplifications, reflecting the level of knowledge, result in substantial inaccuracy of the calculated probabilities or other parameters. There are ways to improve accuracy, e.g. by installing temporary networks of stations monitoring various geodynamic phenomena, by detailed geological mapping, by field and laboratory experiments, etc.; however, such detailed investigations are made only when seismic hazard is being estimated for critical structures or installations (large dams, power plants). Standard seismic hazard maps on the scale 1:1 million or 1:500,000 are always based on simplified models of earthquake occurrence and earthquake effects and provide average data which may be modified by corrections for local conditions. These corrections can be quite significant, e.g. in terms of macroseismic intensity, the range may be ± 2 degrees of the scale, or factor four for accelerations, etc. Such variations must be taken into account when review hazard maps are used for economic considerations.

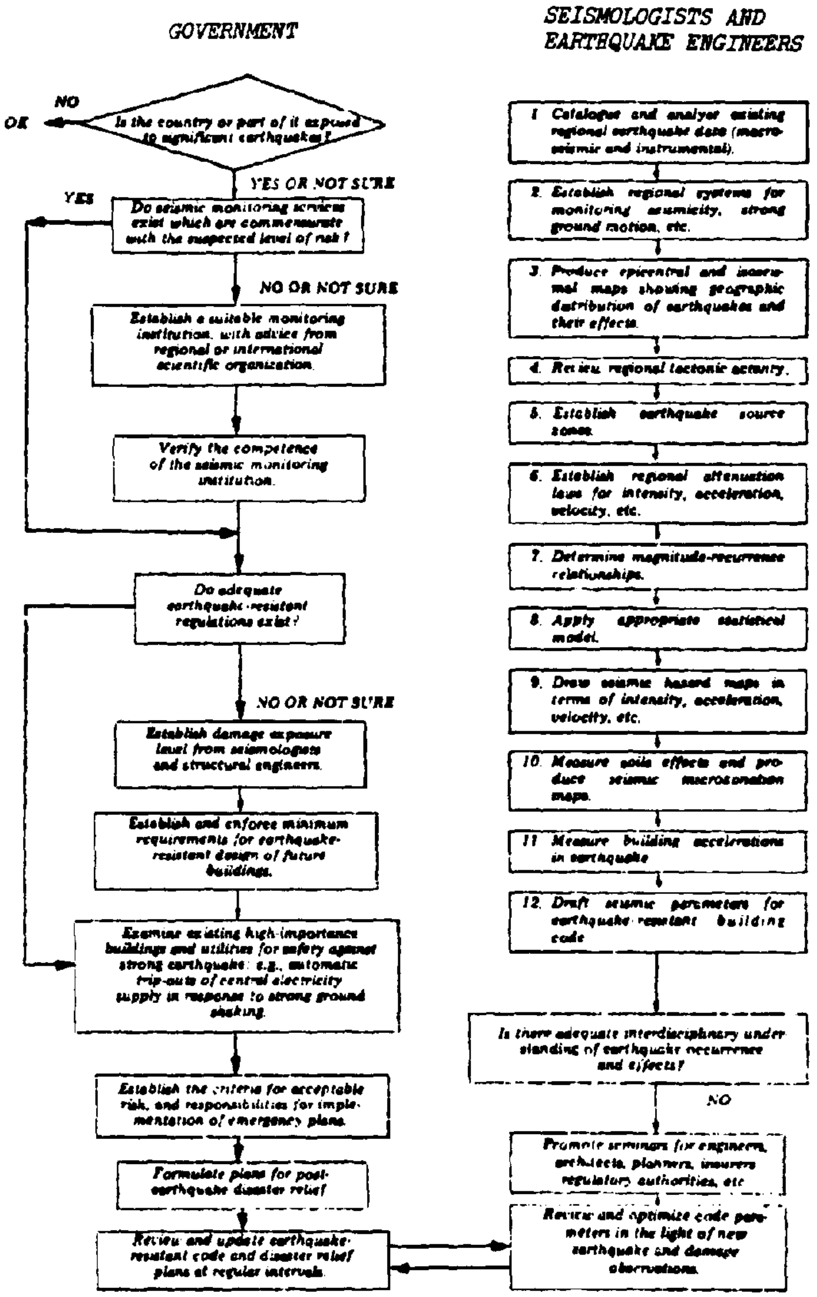

Figure 1

Detailed Steps in Seismic Hazard Assessment

Vulnerability

As mentioned above, vulnerability means the degree of loss to a given element at risk, such as buildings, population, public utilities, industry, etc. As a result of strong ground motion generated by an earthquake, buildings are damaged to various extents, people are injured or killed, bridges may collapse, pipelines may be interrupted, etc. Every element is vulnerable to a different extent according to its sensitivity to vibrations or secondary effects. The vulnerability of an element can be expressed by the percentage by which its function would decrease due to a certain level of hazard.

Information on vulnerability is relatively rare and less clearly defined than information on seismic hazard. We can use some observations on vulnerability contained in the description of macroseismic scales. First of all, each scale introduces several basic types of structures, and degrees of intensity are assessed according to the extent of damage on individual structural types. For instance, the MSK-64 scale [Willmore and Karnik, 1970] uses three categories of structures:

A. Buildings of fieldstone, rural structures, adobe (clay) houses

B. Brick buildings, large block constructions, half-timbered structures, structures of hewn blocks of stone

C. Precast concrete skeleton constructions, precast large panel constructions, well-built wooden structures

The classification of damage in the scale is as follows:

Classification of Damage

0: no damage

1: slight damage (fine cracks in plaster, fall of small pieces of plaster)

2: moderate damage (small cracks in walls, fall of fairly large pieces of plaster, particles slip off, cracks in chimneys, parts of chimneys fall down)

3: heavy damage (large and deep cracks in walls, fall of chimneys)

4: destruction (gaps in walls, parts of buildings may collapse, separate parts of buildings become disconnected, inner walls and filled-in walls collapse)

5: total collapse of buildings

Table 1 gives a rough estimate of loss in value due to various degrees of damage. Values above 30% can be considered as too high for economic repair and can therefore be classified as a 100% loss. The relationship between the degree of damage to a basic type of structure and the grade of intensity is shown in Table 2, which completes the information in the scale.

Table 1

Loss of Value Due to Degree of Damage

Damage category, MSK-64 scale	1	2	3	4	5
% Loss in value of buildings	2	10	30	80	100

Table 2

Grade of Intensity, Type of Structure, and Degree of Damage

MSK-64 Intensity	Type of Structure A	B	C
V	95-0 5-1	100-0	100-0
VI	45-0 50-1 5-2	95-0 5-1	100-0
VII	10-1 35-2 50-3 5-4	15-0 35-1 50-2	50-0 50-1
VIII	10-2 35-3 50-4 5-5	10-1 35-2 50-3 5-4	10-0 35-1 50-2 5-3
IX	15-3 35-4 50-5	10-2 35-3 50-4 5-5	10-1 35-2 50-3 5-4
X	25-4 75-5	15-3 35-4 50-5	10-2 35-3 50-4 5-5
XI	100-5	25-4 75-5	50-4 50-5

There have been proposals for further subdivision of structural types to accommodate, e.g., the tall buildings now very common in new settlements, pipelines, earthquake-resistant constructions, etc. Other proposals have been made to introduce five classes of quantity of damaged structures instead of the three now in use (few = 5%, many = 50%, most = 75%). So far, these proposals have not been accepted.

By combining the above information, we can draw simple vulnerability functions for the three categories of buildings. They may be used in risk estimates when the rough subdivision of buildings is sufficient. For more detailed studies, vulnerability functions for individual elements must still be elaborated.

Simple vulnerability functions can be calculated by using the description of a category of damage if we estimate the probable loss in value (in %) of a structure, e.g. damage category 3 means an approximate 30% loss in value of the building and category 5 means total destruction (i.e. 100%). Each intensity grade on the macroseismic scale is defined by describing how many buildings of, say, category A were damaged to the extent corresponding to damage category 1, 2, 3.... In the description of the scale, percentages corresponding to the expressions "few," "many," and "most" are specified; however, it is necessary to complete the figures for each intensity grade and type of structure to get a 100% total. Such an attempt is presented in Table 2. Now, by combining the loss in value (Table 1) with the above percentages, one can obtain the estimated degree of loss (damage) inflicted on buildings in categories A, B and C (Table 3). If we consider a 100% loss in value already for damage category 4, which is quite justified, the figures in Table 3 will be higher for $I \geq VIII$.

Table 3

Loss in Value by Buiding Category for Various Intensities

Category of Building	Macroseismic Intensity						
	V	VI	VII	VIII	IX	X	XI
A	0.001	0.015	0.227	0.565	0.825	(0.950)	(1.000)
B	0	0.001	0.057	0.227	0.565	(0.825)	(0.950)
C	0	0	0.010	0.072	0.227	(0.565)	(0.900)

This exercise can be repeated under different criteria of damage, loss in value and type of building. However, the resulting vulnerability values could be used in some preliminary econrmic analyses, particularly if the hazard assessment has been made in terms of macroseismic intensity.

Conclusions

Hazard and vulnerability values are needed for social and economic analyses within development programs. The present state of the art permits only preliminary estimates of the social and ecoromic impact of earthquake disasters. An improvement could be made by expanding data on the vulnerability of different elements at risk and by developing standard methodologies of hazard, vulnerability and risk assessment.

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SOCIAL AND ECONOMIC ASPECTS OF SEISMIC RISK

Janez Lapajne

ABSTRACT

An attempt has been made to outline some general procedures for risk management and for the assessment of an acceptable risk level, taking into account scientific, engineering, economic, social and political aspects. The proposed method relies on accepted definitions of seismic hazard, vulnerability and risk. The procedure is first of all meant for the earthquake resistant design of capital engineering structures, like dams and nuclear power plants, but can be adapted also for physical planning and other purposes.

Introduction

Increasing technological complexity of engineering structures incorporated in a sensitive socioeconomic environment calls for rational evaluation of earthquake or seismic risk. The most important and most crucial result of seismic risk analysis is the determination of the acceptable risk for the purpose of earthquake resistant design.

There is no unique procedure for the estimation of seismic risk. In the narrower sense, the object of seismic risk analysis is to describe the nature of possible future ground shaking, that is to assess the seismic hazard. This is actually only the first stage of seismic risk assessment, nevertheless, it is often the only one.

In order to assess the seismic risk, in addition to the information on seismic hazard, data on elements at risk and their vulnerability are required. Once all this information has been prepared, the determination of the acceptable risk is chiefly an economic, social, and political subject. Concerning the economic part of the problem, an appropriate optimization technique would be highly desirable.

Seismic Hazard, Vulnerability and Risk

In engineering seismology and earthquake engineering literature, there is, or at least has been in general, ambiguity regarding the use of some terms. In order to avoid misunderstanding, definitions of terms proposed by UNDRO have been used in this paper. These terms are seismic hazard, seismic risk and specific seismic risk, vulnerability, and elements at risk.

The distribution of the hazard is given by its probability of exceedance $P(X \geq x)$ or the probability density function $p(x) = -(dP/dx)$, where X is a random variable or a set of random variables defining some earthquake parameter or ground motion parameter, and x its value.

Methods for the evaluation of seismic hazard seem to be reasonably adequate in spite of some deficiencies of basic data both in quantity and quality. The general form of $(P(X \geq x)$ for different time periods is given in Figure 1.

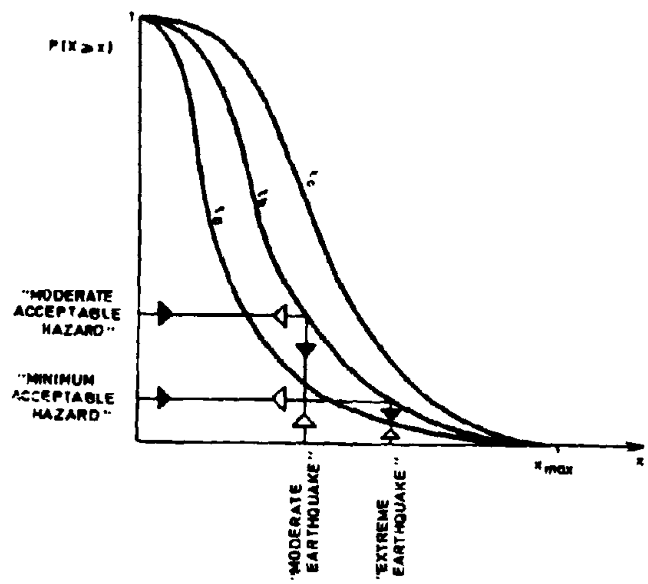

Figure 1

Seismic Hazard Functions

t = Design Period

x_{max} = Maximum Possible Value of X

Direction of Engineering Judgment

Direction of Investor's Policy

As mentioned above, usually seismic risk analysis stops at the assessment of seismic hazard. In this simplified procedure, the problem of the determination of the acceptable seismic risk is transferred to the problem of the determination of the "moderate earthquake" or the "operating basis earthquake" (high probability of occurrence) and the "extreme earthquake" or the "safe shutdown earthquake" (low probability of occurrence). With regard to some more or less (un)justified engineering judgment of "acceptable hazard" in the economic lifetime period the design (ground motion) parameters are determined.

Often some subjective reasons (investment policy, unfavourable financial situation, investors' goals, local motives) create policy formulation of "acceptable costs" and "acceptable design parameters." The usual final decision lies somewhere between the above mentioned engineering judgment and investors' policy.

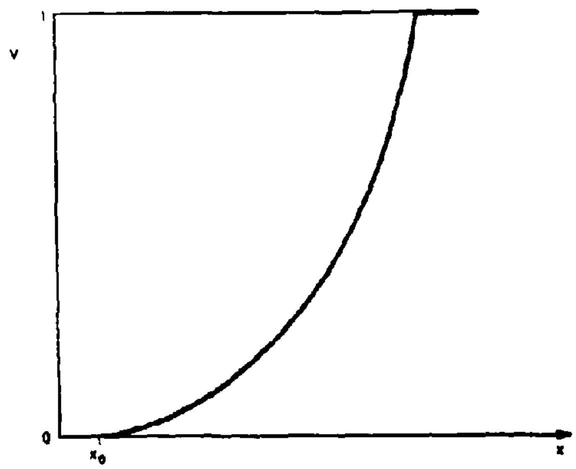

Figure 2

Vulnerability Function

To assess the possible degree of loss (that is the specific risk) and its absolute value (the risk) of an element at risk, the vulnerability of this element has to be taken into account. Neglecting the randomness of the properties of elements at risk and vagueness in vulnerability estimation, a simplified profile of a vulnerability function V(x) is rather similar to the one represented in Figure 2.

Specific risk R/E is determined by convolution of hazard and vulnerability:

$$(1) \qquad \frac{R}{E} = \int_{x_0}^{x_{max}} V(x)p(x)dx$$

where E represents element at risk (some property of that element, e.g. its monetary equivalent or number) and R means corresponding risk. Expected losses are given by the risk:

$$(2) \qquad R = E\int_{x_0}^{x_{max}} V(x)p(x)dx$$

Taking into account all important elements at risk, the first approximation of the total expected losses will be:

$$(3) \qquad \sum_{i=1}^{n} R_i = \sum_{i=1}^{n} E_i \int_{x_0}^{x_{max}} V_i(x)p(x)dx$$

A more complete solution should involve mutual dependence of individual elements at risk. Total risk of a group of interrelated elements at risk will be generally higher than a simple sum of partial risks:

$$(4) \qquad R\left(\sum_{i=1}^{n} E_i\right) \geq \sum_{i=1}^{n} R(E_i)$$

Elements at risk are, in the case of an adverse seismic event, interconnected by some positive feedback loops.

Acceptable Seismic Risk

Let us define economically acceptable seismic risk of an engineering structure (dam, nuclear power plant, etc.) on the basis of the minimum of a sum of earthquake resistant construction costs and expected losses during earthquakes.

Expected losses include direct structural damage and production losses (standstill losses) on the one hand and indirect damage and losses in the natural, economic, social, cultural, and political environment (local, regional, interregional, . . .) on the other, caused by the above direct damage and losses.

Considering in (4) only those elements at risk, which could be inflicted by the damage of the structure under consideration and taking into account only those interrelated effects which are caused by mentioned structural damage and production losses, the total economic risk could be written as:

$$(5) \qquad R_{TE} = R_{SD} + R_{PL} + \left[R(\Sigma_j \; E_j) - \Sigma_j \; R(E_j) \right]$$

Writing the term in the square brackets as ΔR_E, we obtain:

$$(6) \qquad R_{TE} = R_{SD} + R_{PL} + \Delta R_E$$

where

R_{TE} means total expected economic losses = total economic risk,

R_{SD} means expected structural damage = structural risk,

R_{PL} means expected production losses = production risk,

ΔR_E means expected damage and losses related to R_{SD} and R_{PL} = indirect environmental risk.

It is useful to separate some subgroups of ΔR_E. A reasonable procedure is to distinguish expected damage and losses at the local scale from the expected losses at the regional (interregional, national) scale. In this sense we can write the expression (6) as:

$$(7) \qquad R_{TE} = R_{SD} + R_{PL} + \Delta R_{EL} + \Delta R_{ER}$$

where:

ΔR_{EL} means expected damage and losses in the local environment = indirect local environmental risk,

ΔR_{ER} means expected damage and losses in the regional (interregional, national) environment = indirect regional environmental risk.

In (5), (6) and (7) only those elements at risk have to be taken into account which are economically evaluable. The vulnerability of any element at risk in (5), (6) or (7) depends on the vulnerability of the abovementioned structure. From (2) and (3) we can see that the risk is a function of x_o, the maximum value of parameter X at which an element at risk is still completely safe. For our structure this value is practically equal to the corresponding earthquake resistant design parameter. It is evident that:

$$(8) \qquad x_{oj} \geq x_{oS}$$

where:

x_{oj} means x_o of an arbitrary element at risk,

x_{oS} means design parameter or x_o of the structure.

Let the design parameter take all values of the variable X. Next suppose we know risk functions $R_{SD}(x)$, $R_{PL}(x)$, $\Delta R_{EL}(x)$, and $\Delta R_{ER}(x)$, x meaning all possible values of the design parameter. The general profiles of $R_1(x) = R_{SD}(x)$, $R_2(x) = R_{SD}(x) + R_{PL}(x)$, $R_3(x) = R_{SD}(x) + R_{PL}(x) + \Delta R_{EL}(x)$, and $R_4 = R_{SD}(x) + R_{PL}(x) + \Delta R_{EL}(x) + \Delta R_{ER}(x)$ are represented by curves in Figure 3.

Let the earthquake resistant construction costs be represented as a function of design parameter values x in a general and simplified form in Figure 4. An eventual change in type of construction at some x would very likely alter the course of the curve in Figure 4 abruptly. For the sake of simplicity a smoothed curve is presented.

Summing risk and cost functions from Figure 3 and Figure 4, we get cost-risk functions or cost-loss functions represented graphically in Figure 5.

Economically acceptable seismic risk can be defined as:

(9) $$R_{AE} = R(x_{min(C+R)})$$

Taking into account more elements at risk, min(C+R) moves to the right. An economically acceptable risk depends upon the decision maker. An investor's acceptable risk might be related to $min(C+R_1)$ or to $min(C+R_2)$. Local society might accept $min(C+R_3)$, while regional or national policy should be based on $min(C+R_4)$.

In the above procedure only the economic component at risk has been treated. How can one deal with elements at risk which are not economically assessable or have an economically questionable equivalent, the most important and most typical among them being population?

Expected life losses and injuries can be assessed using equations (1) and (2), with E expressing the number of inhabitants in a potentially affected area. In the same manner as for other elements at risk a population function can be found. Since the risk level is given in number of expected victims and not in a monetary equivalent, population risk function cannot be directly used in calculation of cost-loss function. It would be ethically unacceptable to make a transformation of a population risk function to some monetary equivalent risk function for the sake of simplicity of acceptable risk level assessment.

It is natural to treat the population at risk (and maybe some other elements at risk with an inestimable value, e.g. cultural and historical monuments) apart from economically evaluable elements. As with the risks associated with other activities of every-day life, people have to live with certain seismic risk. Therefore, the decision about the acceptable public or social seismic risk level is the right and obligation of the population at risk. Some minimum requirements on social seismic risk level should be at least regulated at the national level and given in earthquake resistant design and safety codes.

No matter how the population at risk is included in the procedure, the care for public safety will very likely push min(C+R) and the corresponding design parameter to higher values. Taking into account the requirements for public safety and care for some other unevaluable elements at risk, the total acceptable seismic risk will be:

(10) $$R_A \leq R_{AE}$$

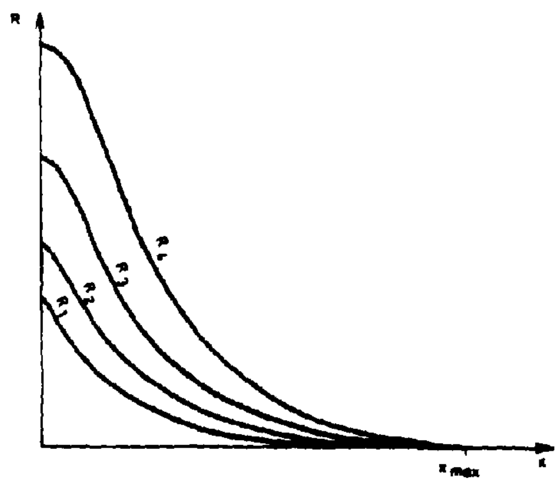

Figure 3

Risk Functions for a Given Design Period

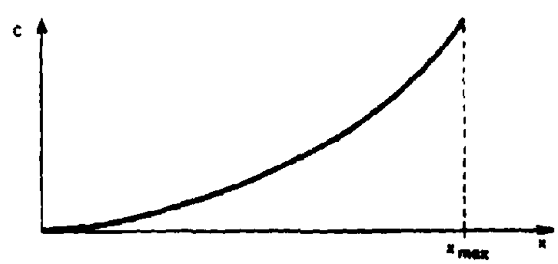

Figure 4

Cost Function

Figure 6 represents general outlines of the proposed risk management procedure. Only from the assessed acceptable risk can we get an idea about what an acceptable hazard might be, and not a priori, as it is often done.

Up to now, the structure has been taken as a whole. Since a capital engineering structure is a system of substructures, different earthquake resistant design criteria can be used for different components. In this sense the concepts of "moderate" and "extreme" earthquakes could be applied. However, a design parameter level approach might be preferable. It has to be emphasized that various design parameter levels do not necessarily result in different risk levels (but there are of course different hazard levels), and eventual dissimilar risk levels do not generally have the same succession of values as the corresponding design parameters (as it is in the case of hazard).

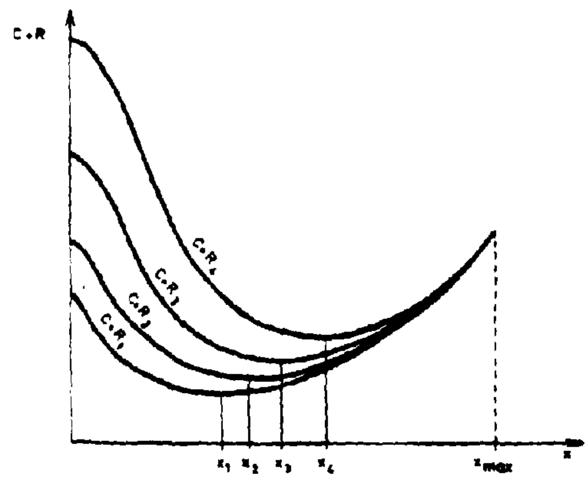

Figure 5

Cost-Loss Functions for a Given Design Period

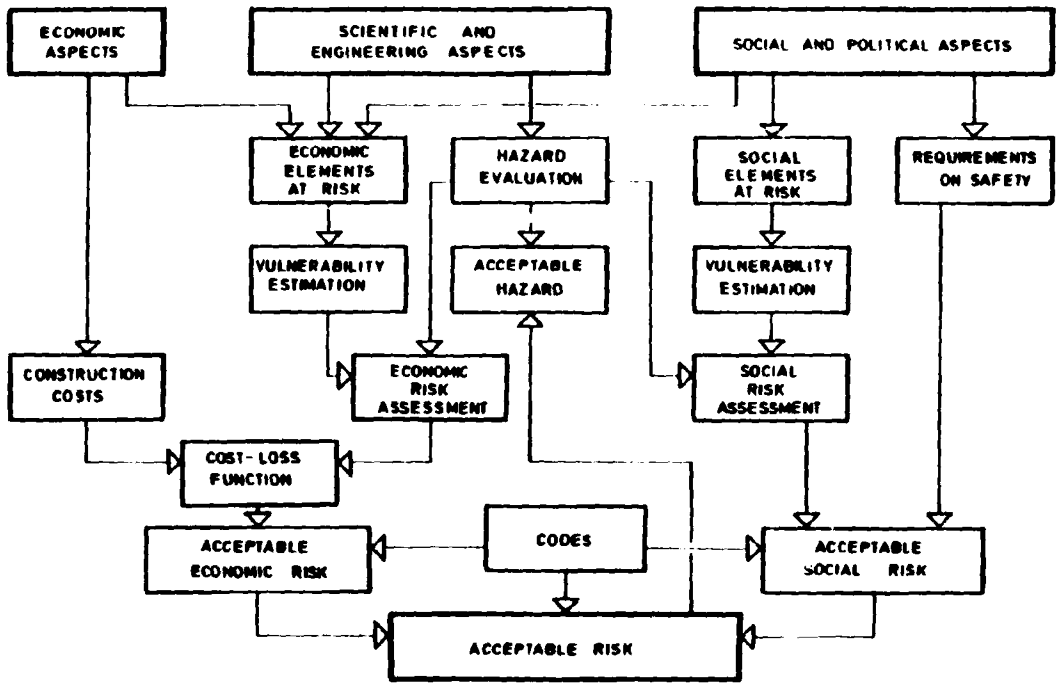

Figure 6

General Scheme for Managing Seismic Risk

Conclusions

In the procedure for the assessment of acceptable seismic risk just described, some questionable suppositions, approximations and simplifications have been made, some of them are already present in the accepted concepts of hazard, vulnerability and risk.

It has not been mentioned that the basic information on vulnerability, on mutual dependence of individual elements at risk, and on cost functions is rather poor and unreliable. Even the definitions of those quantities are not entirely clear. Also the concept of expected losses over a given lifetime period may not be entirely satisfactory.

Nevertheless, once the concepts and definitions of basic quantities and their interrelationships have been clarified and more reliable and more plentiful information has been accumulated, the proposed method might find a practical use in seismic risk management.

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THE PROBLEM OF ASSESSING SEISMIC RISK TO EXISTING BUILDINGS

E.M. Fournier d'Albe

The new UNDP/UNESCO project entitled "Earthquake Risk Reduction in the Balkan Region," in which Bulgaria, Greece, Romania, Turkey and Yugoslavia are taking part, has first of all to develop methods for evaluating the risk to buildings and structures. This is not easy to do for existing buildings, particularly the older ones.

The proportion of its value lost by any building on the occurrence of earthquake ground motion of intensity I is, by definition, equal to its vulnerability V_I to ground motion of that intensity (using here the definitions adopted by UNDRO and UNESCO). The risk to the building over a given period of time is given by the equation

$$R = E \times \int_{0}^{I_{max}} V_I . p_I . dI$$

where p_I is the probability of earthquake ground motion of intensity I occurring at the site of the building during the given period of time, and E is the value of the building. The specific risk to the building is simply the value of the integral.

The use of the above equation to assess risk presents very different problems, depending on whether one is concerned with new buildings or with old ones.

By new buildings, I mean those for which one has detailed structural plans and for which it is possible to calculate the vulnerability, using the results of laboratory tests and the accumulated knowledge of the relations between the dynamical properties of structures and their vulnerability to ground motion. Then, if information is available on the seismic hazard in terms of the relevant parameters of ground motion (i.e., peak acceleration, peak particle velocity, power spectrum, etc.), one may use the above equation to calculate the specific risk and, if desired, the absolute risk in terms of value.

On the other hand, it is impossible to apply this equation to the many old buildings whose dynamical properties can neither be measured nor inferred with accuracy and whose vulnerability therefore remains unknown. Furthermore, unless an earthquake has occurred in the area very recently, no information is likely to be available on seismic hazard expressed in terms of the physical parameters of ground motion.

The situation is, however, not quite so desperate as it may appear at first sight. Records of earthquake damage have been kept for many centuries throughout the Balkan region, and the information contained in these records has been compiled, analysed and published in the form of catalogues and isoseismal maps. In the latter, the degree of damage has been transposed into an "intensity" on one or the other of the commonly-used macroseismic scales (i.e., Mercalli-Cancani-Sieberg (MCS), Modified Mercalli (MM), Medvedev-Sponheuer-Karnik (MSK)). A sufficient amount of information exists in this form for it to be treated statistically. However, this information is not, properly speaking, information on seismic hazard. It may be taken as such only insofar as it is borne in mind that "intensity" on any macroseismic scale subsumes a standard vulnerability for all buildings in each of a small numer (not more than three) of general building types.

In fact, maps in which seismic hazard is expressed as expected intensity on a macroseismic scale are actually maps of specific risk rather than of hazard.

But specific risk is precisely what we would like to assess. Economists and planners need not, therefore, despair if the seismologists to whom they turn for advice lack precise data on seismic hazard and vulnerability. In order to obtain an approximate evaluation of the risk to existing buildings, it is not absolutely necessary to know whether earthquakes are caused by convection in the upper mantle of the earth or by ancient heroes turning in their graves. Data on the "intensity" of past earthquakes are almost certain to be available wherever a significant seismic hazard exists, and such data may be used directly to derive an approximate assessment of risk.

A word of caution must nevertheless be added. The analysis of macroseismic data on intensity will not make possible the evaluation of the risk to any individual building but only that of the average risk to buildings in the broad categories specified in whichever scale has been used to express intensity.

RISK CRITERIA AS A RATIONAL BASIS FOR SEISMIC RESISTANCE

OF STRUCTURES OF DIFFERENT GRADES[1]

Wiratman Wangsadinata

Introduction

Economic growth of a country involves continuous rapid development in the various sectors of the construction industry. The housing sector creates particular problems in developing countries, as the demand for mass housing is very great, the majority who are in need of this housing are the low-income people and their budgets are very limited. To meet the demand for low-cost mass housing in the shortest possible time, it may be a matter of government policy to implement housing schemes in which various grades of housing are considered based on their durability, thus on their building cost. The useful lifetime of those buildings may vary from as little as 10 years to perhaps 30 years, depending on the type and grade of building material used. When these buildings are located in seismic areas, they should be seismic resistant. The problem, therefore, is how to determine the seismic design loads for these buildings, because the normal seismic loading stipulated in building codes is not intended for the design of buildings of different grades. A rational basis is to provide the building appropriate strength and stiffness, so that no matter what its lifetime (whether short or long) it will have a uniform risk with respect to onset of structural damage and with respect to incipient failure. This paper will discuss these two different risks and how to implement them in design.

Risk Criteria

Seismic activities are natural events which recur from time to time. Like a few other natural phenomena such as river floods, seismic events are stochastic processes which can be represented by a mathematical model of a given physical system that changes in accordance with the laws of probability. Therefore, by knowing the seismic history of a region obtained from observations or records made over a sufficiently long period of time in the past, the return periods of the various seismic intensities in that region can be assessed by applying the laws of mathematical statistics. It is obvious that low seismic intensities will reappear more frequently than high ones.

In connection with the recurring nature of seismic intensities, it is only logical that it is not economic to design a structure to remain undamaged when subjected to a seismic intensity with a return period much longer than the useful lifetime of the structure. A rational basis for seismic resistant design of structures is therefore a two stage process, the objective of which is first, to provide the structure sufficient strength and stiffness to resist moderate earthquakes so that the risk of occurrence of unrepairable structural damage in its useful lifetime is acceptably low, and second, to ensure that the risk of collapse leading to loss of human lives in its useful lifetime in a severe earthquake is as well acceptably low. A moderate earthquake can be defined as one which has a high probability of occurrence in the useful lifetime of the structure, while a severe earthquake is one having a low probability of occurrence. The first of these objectives can be achieved by setting the seismic design load at an appropriate level, the second objective can be achieved by providing the structure proper detailing so as to ensure proper ductile behavior in the post-elastic range.

Suppose that for a certain seismic region the mean return period of the various seismic intensitites have been assessed properly, based on the available seismic historic data. Mean return period and annual risk are reciprocally related, so that

$$R_A = \frac{1}{T} \quad (1)$$

where R_A is the annual risk and T is the mean return period of the considered intensity. The annual risk can thus be defined as the probability that, in any given year, that intensity will be equaled or exceeded. Risks in certain time periods corresponding to various lifetimes of structures can be derived from the annual risks. Assuming that risks in successive years are independent, the following relationship applies:

$$R_N = 1 - (1 - R_A)^N \quad (2)$$

where R_N is the risk in a time period of N years. Thus, within the context of this paper risk is a mathematically defined quantity, which implies the probability of occurrence of an undesirable event in a certain period of time.

A philosophical, economical, and political question to be answered now is how much risk is allowable for the occurrence of unrepairable structural damage in the useful lifetime of a structure, and how much risk is tolerable for the occurrence of structural collapse causing loss of human lives in the same period of time. One may argue about the various factors governing the selection of the above risk levels, but the author is of the opinion that for the occurrence of unrepairable structural damage, the probability must not be more than once in the useful lifetime. This means that the return period of the onset of structural damage must at least be equal to the useful lifetime itself, and based on equations (1) and (2) this implies a risk of about 60%. With regard to incipient collapse of the structure in its useful lifetime, the risk must certainly be smaller, and in this connection the author is of the opinion that it is not unreasonable to accept 20% for this risk. Based on equations (1) and (2) the return periods of seismic intensities associated with 60% risk for the onset of structural damage and 20% risk for incipient failure in any seismic region are shown on Table 1 for various lifetimes of structures.

Table 1

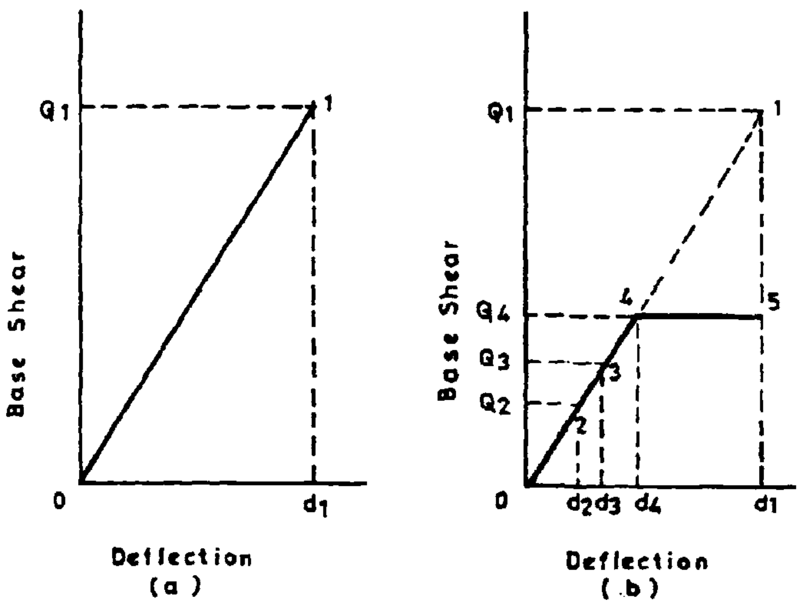
Return Periods of Seismic Intensities to be Considered in Structural Design

Structural lifetime (year)	Return period of seismic intensities (year)	
	60% risk for onset of structural damage	20% risk for incipient failure
10	10	40
15	15	60
20	20	80
25	25	100
30	30	120
40	40	160
50	50	200

Seismic Behavior of Structures

Load-Deflection Diagram

The seismic behavior of a structure can be represented by a load-deflection diagram, indicating the relationship between the seismic base shear acting on the structure and the corresponding deflection. If a structure is so strongly designed that it behaves fully elastic and thus remains undamaged up to the point of near collapse, its load-deflection diagram will be a straight line as shown in Figure 1(a). In this figure Q_1 is the base shear acting on the structure at the state of near collapse, and d_1 is the corresponding maximum deflection. As mentioned previously it is not economically feasible to design a structure that way, and a rational basis for design is to set the seismic design load at an appropriate level, so as to ensure that the structure will not be damaged in small to moderate earthquakes, and reliance is further placed on the structure performing in a ductile manner in a severe but infrequent earthquake, dissipating the earthquake energy and limiting the base shear that acts on the structure. The load-deflection diagram of such a structure can be represented by a bilinear flat top diagram as shown in Figure 1(b). At the state of near collapse the maximum deflection d_1 is approximately the same as for the full elastic system, however the base shear induced in the structure is limited to only Q_4. Points 2, 3, and 4 are successive points on the diagram corresponding to the base shear Q_2 considered in design, base shear Q_3 at first yield, and base shear Q_4 at the onset of structural damage, at which significant yielding in the structure starts to develop. Up to point 4 the structure behaves practically elastic, so that deflections d_2, d_3, and d_4 are directly proportional to their corresponding base shear.



$$f_1 = \frac{d_1}{d_4} = \frac{Q_1}{Q_4}$$

$$f_2 = \frac{d_4}{d_2} = \frac{Q_4}{Q_2}$$

Figure 1

Load-deflection Diagram of Structures

These base shears are in turn directly proportional to the corresponding earthquake intensities. Beyond point 4 deflections by increased earthquake intensities will continue to occur at a constant base shear Q_4 until the maximum deflection d_1 is reached at a state of near collapse. The ratio $f_1 = d_1/d_4$ is a measure of the ductility of the structure. From the known value of this ratio the intensity of the earthquake that causes the state of near collapse of the ductile structure can be calculated by proportionality.

For a specific type of structure designed according to a specific code, points 1 up to 5 on the load-deflection diagram shown on Figure 1(b) are known, assessed analytically or experimentally, so that the earthquake intensity at the onset of structural damage and at the state of near collapse can be calculated by proportionality from the base shears Q_4 and Q_1. The seismic risk criteria then require that the risk for the occurrence of base shear Q_4 in the useful lifetime of the structure must not exceed 60%, and the risk for the occurrence of base shear Q_1 must not exceed 20%.

The ratio f_1 depends on the type of structure and the material used. From the study of all possible combinations of types of structure and material used, it had been found that a minimum value of $f_1 = 3.5$ could be expected to be present in a properly designed and constructed building structure, regardless of its type and the material used.

From the known value of $f_2 = d_4 / d_2$ the level of the design seismic base shear Q_2 can readily be calculated. This ratio depends on the over design of the structure due to code requirements, and on the type of structure in terms of capability to absorb increases in base shear and in lateral deflection beyond field yield, to cause plastic deformations in a significant number of structural elements. From the study of several possible combinations of recognized building codes and structural types in the determination of the strength and stiffness of a structure, it had been found that the average value of $f_2 = 3.0$ could be expected to be present in a structure, regardless of its type and the material used.

Response Spectra

The strict meaning of a response spectrum in earthquake engineering is a plot of the maximum elastic response to a specified earthquake excitation for all possible single degree-of-freedom systems. The abscissa of the spectrum is the undamped natural period of the system and the ordinate the maximum elastic response. Knowing the accelerogram of the specified earthquake excitation, spectra can be obtained by solving the differential equation of motion of a damped single degree-of-freedom system using the well-known Duhamel's integral. Of particular interest is the maximum acceleration response spectrum, because it is directly related to the maximum inertial forces induced in the system. It is obvious that for natural periods approaching zero, the maximum response acceleration is approaching the maximum ground acceleration.

It is apparent that in a certain seismic zone the response spectra of different earthquakes recorded in that zone are fairly similar to each other, so that it is possible to plot average response spectra for that zone. By further modification and simplification, those average response spectra can be transformed into several plots indicating the maximum base shear coefficients for all possible elastically responding normally damped building structures in that zone.

Each plot corresponds to a selected maximum ground acceleration expectable in that zone, or to a selected mean return period of ground acceleration in that zone. The maximum base shear coefficient is the ratio of the maximum base shear acting on the elastic structure to the total weight of the structure. Normally damped structures are those having fractions of critical damping in the order of 5%. The abscissa of such design response spectra is the undamped fundamental natural period of the structure and the ordinate the maximum base shear coefficient. For natural periods approaching zero, the maximum base shear coefficient approaches the maximum seismic coefficient, which is the maximum ground acceleration expressed in 'g' (= gravity

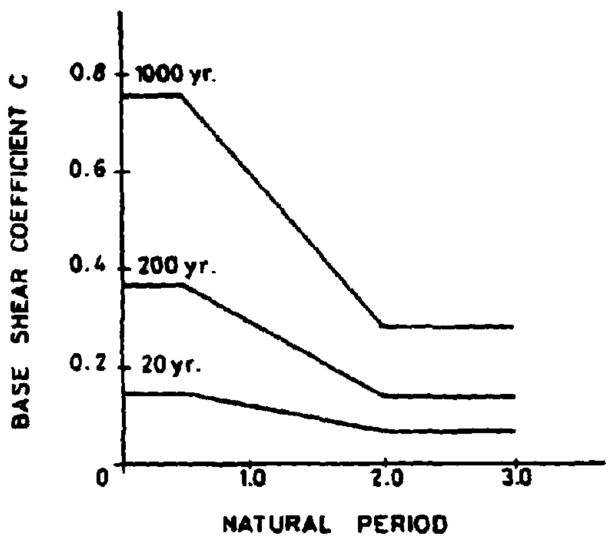


Figure 2

Typical Design Response Spectra for
a Seismic Zone in Indonesia

acceleration). To take into account the influence of local subsoil conditions on the response spectra, such design response spectra may be plotted for various subsoil classifications, for example for hard and for soft subsoils. Design response spectra are sometimes included in seismic codes, so that they are suitable for use in seismic resistant design of structures based on risk criteria proposed in this paper. Examples of such design spectra typically defined for each of the seismic zones of Indonesia are shown on Figure 2, in which each spectrum is idealized as a trilinear diagram.

The application of design response spectra as shown on Figure 2 in seismic resistant design based on risk criteria will be explained with the following example. Suppose a structure with a useful lifetime of 30 years is to be designed. From Table 1 it can be seen that to meet the two levels of risk, the return period of seismic intensity producing onset of structural damage may not be less than 30 years, and that producing incipient collapse may not be less than 120 years. Calculate or estimate first the undamped fundamental natural period of the structure. Find from the design response spectra the base shear coefficient C_{30} corresponding to the seismic intensity having 30 years return period, if necessary applying proper interpolation. Estimate an appropriate value for the f_1 factor (e.g. $f_1 = 3.5$), so that the base shear coefficient at incipient failure in an elastic structure is $f_1 C_{30}$. Find from the design response spectra the return period of this base shear coefficient, if necessary again applying proper interpolation. If it is found that the return period of $f_1 C_{30}$ is at least equal to 120 years, the minimum required risk level for incipient collapse is satisfied. If it is not satisfied, find from the design response spectra first the base shear coefficient C_{120} in an elastic structure corresponding to the seismic intensity having a 120 year return period. The base shear coefficient at the onset of structural damage which automatically will satisfy the minimum risk level of 20% is then $C_{30} = C_{120} / f_1$. Having found the proper C_{30} value, estimate further an appropriate value for the f_2 factor (e.g. $f_2 = 3.0$), so that the design base shear coefficient $C_2 = C_{30} / f_2$ is readily available. From the base shear coefficient the design base shear can be calculated directly, and following standard code procedures the distribution of the design base shear to obtain the design horizontal seismic loads acting at each of the floor levels can be determined.

From the above discussion it is apparent that it is very important to establish proper seismic zoning, each zone characterized by the various return periods of seismic intensities expressed in the form of design response spectra.

Seismic Zoning

Determination of Return Periods of Seismic Intensities

As previously mentioned, the return period of seismic intensities can be assessed analytically from the historic seismic data by applying the laws of mathematical statistics. An empirical expression for the annual cumulative frequency of earthquakes in a source area having magnitude M equal or greater than a certain lower bound magnitude m_0 as found by Gutenberg and Richter, is of an exponential form as follows:

$$N(M \geq m_0) = 10^{a' - b\,m_0} \qquad (3)$$

where a' and b are constants statistically evaluated from the historic seismic data of the source area. Assuming earthquake magnitude M at the source and distance R from the source to the considered site are continuous random variables which influence intensity I of the site, and considering that sources may occur anywhere within a source area, the total probability that intensity i is equaled or exceeded at the site can be expressed by the following double integral:

(4) $$P(I \geq i) = \int_{r_o}^{r_1} \int_{m_o}^{m_1} P(I \geq i | m \text{ and } r|) \, f_M(m) f_R(r) \, dm \, dr$$

in which:

$P\ I \geq i$ = the total probability that intensity i is equaled or exceeded at the site;

$P\ I \geq i | m$ and $r|$ = the conditional probability that intensity i is equaled or exceeded at the site given m and r;

$f_M(m)$ = density function on magnitude;

$f_R(r)$ = density function on source distance;

m_o = lower bound magnitude below which it is not of engineering importance;

m_1 = upper bound magnitude, which is the maximum magnitude that can be expected to occur in the source area;

r_o = distance to the nearest boundary of the source area;

r_1 = distance to the farthest boundary of the source area.

The above functions are all derived from earthquake statistics, except the density function on source distance, which is the spatial relation between the source and the considered site. It is beyond the scope of this paper to discuss these functions in more detail, therefore the reader is further referred to the related references listed at the end of this paper. It can merely be stated here, that the evaluation of the above double integral requires a very complicated mathematical calculation, for which the aid of computers is a requisite.

Having obtained the total probability that intensity i is equaled or exceeded at the site, the total annual number of that intensity that is being equaled or exceeded at the site is thus:

(5) $$N_A = N\ (M \geq m_o)\ \ P\ [I \geq i]$$

Assuming further that earthquake events occur as Poisson arrivals, the annual risk that intensity i is equaled or exceeded at the site can then be expressed:

(6) $$R_A = 1 - \exp\ (\ -\ N_A)$$

and the corresponding return period can be obtained from equation (1).

Determination of Seismic Zones

Applying the previously discussed theory, seismic intensities in the form of ground accelerations can be calculated at any site for which the return period is given. If for a given return period ground accelerations are calculated at a sufficient number of sites in a region, an isoseismal map of the region can be plotted, showing contours of equal ground acceleration. Such isoseismal maps can be prepared for various selected return periods. From those isoseismal maps it is apparent that for a certain return period expectable ground accelerations vary from site to site, which means that seismic risk is not uniformly distributed over the region. By selecting appropriate contour intervals, distinct zones of differing seismic risk can be identified. Those intervals are then the various seismic zones. It should be noted, that it does not matter very much, whether for the determination of seismic zones contour maps with short or with long return periods are considered. Whichever map is used to delineate the boundaries of the seismic zones, the relative risks of the zones remain approximately the same.

Determination of Design Response Spectra

In regions where practically no instrumental records of earthquake motions are available, so that no response spectra are known, it is not easy to derive average response spectra. Comparative studies in seismicity and local geology with other regions of known spectra are required to arrive at the most appropriate design response spectra for such regions.

The simplification of a design response spectrum into a trilinear diagram as shown in Figure 2 is just a matter of choice. Other simplifications may also be considered, for example a simplification into a continuous S-curve (as defined in the latest Japanese seismic code) or a hyperbola with a horizontal part for short periods (as defined in ATC-3). Because of the averaging of so many parameters, any such simplification seems to be equally justified.

Application in Indonesia

Isoseismal Maps

Return periods of earthquakes have been calculated for many sites throughout Indonesia, applying the previously discussed theory. Those sites were mostly the big cities, where important industrial, utility and other public buildings were being constructed, or locations of important projects which required strict seismic resistance such as dams, power stations, etc. In regions where the construction industry is in rapid development, isoseismal maps have been prepared. A typical example is shown in Figures 3, 4, and 5, which show isoseismal maps for the West Java region prepared by the author. The maps have been plotted for ground accelerations with return periods of successively 20 years, 100 years and 500 years.

Isoseismal maps for the whole Indonesian territory had been prepared by the Directorate of Hydraulic Engineering, Directorate of Water Resources Development, Ministry of Public Works, based on the same principles. Also other agencies have prepared similar maps, with slightly different approaches.

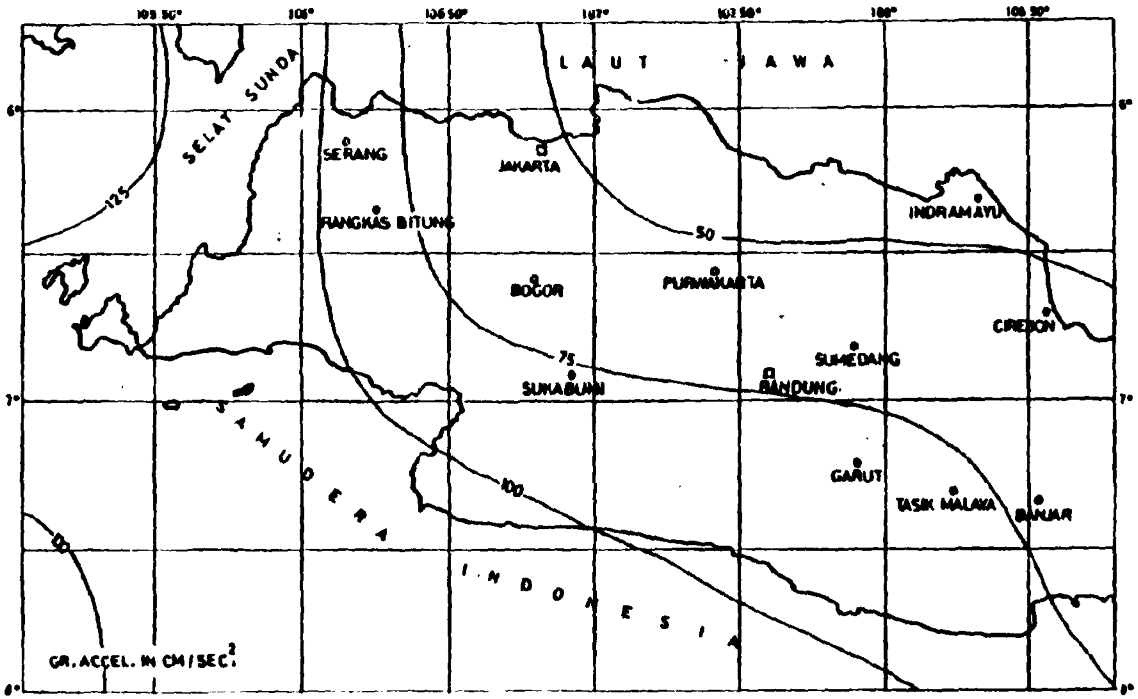


Figure 3

Isoseismal Map of West Java for Ground Acceleration
Having 20 Year Return Period

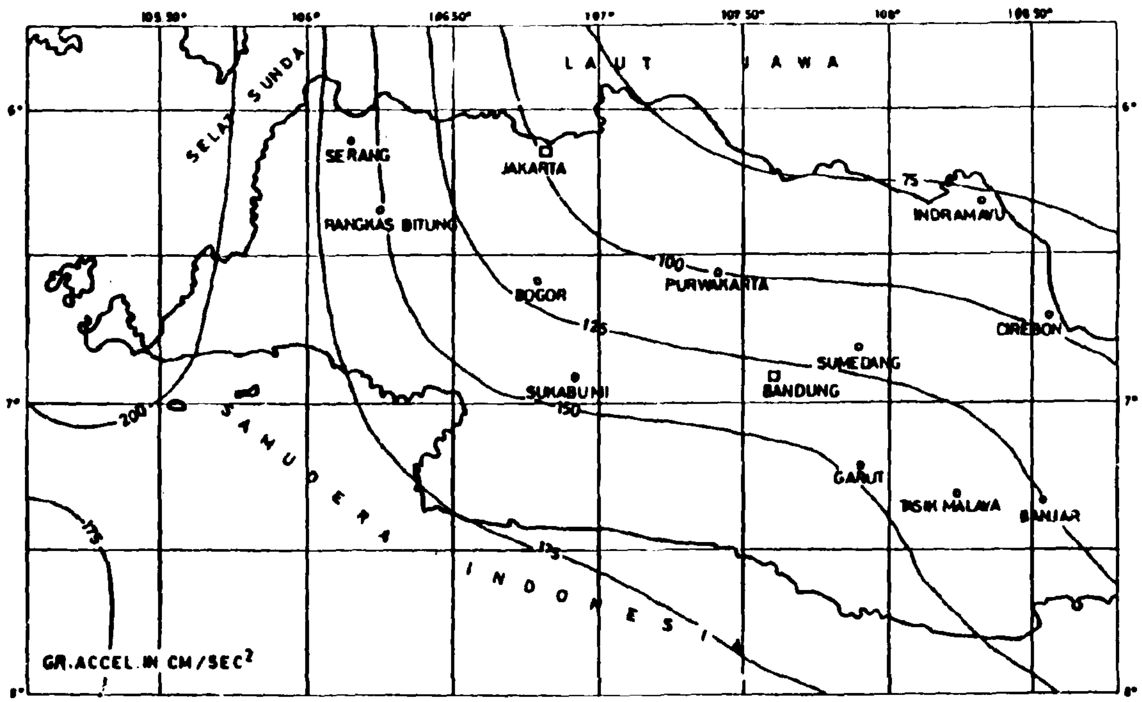


Figure 4

Isoseismal Map of West Java for Ground Acceleration
Having 100 Year Return Period

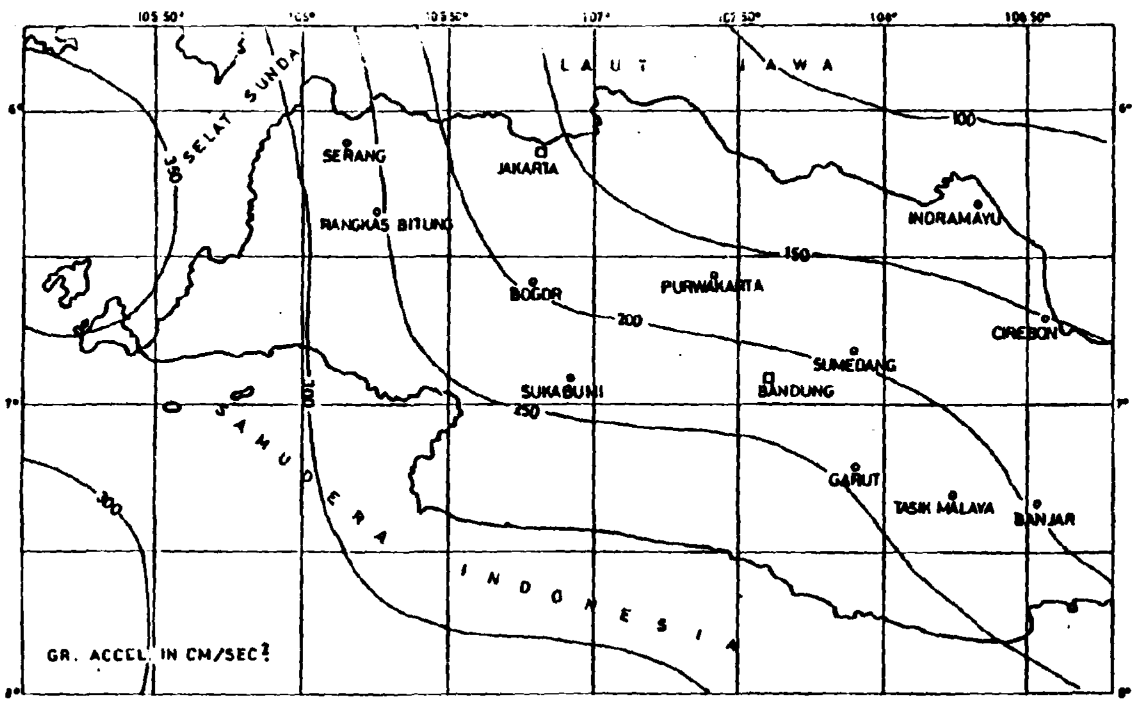


Figure 5

Isoseismal Map of West Java for Ground Acceleration
Having 500 Year Return Period

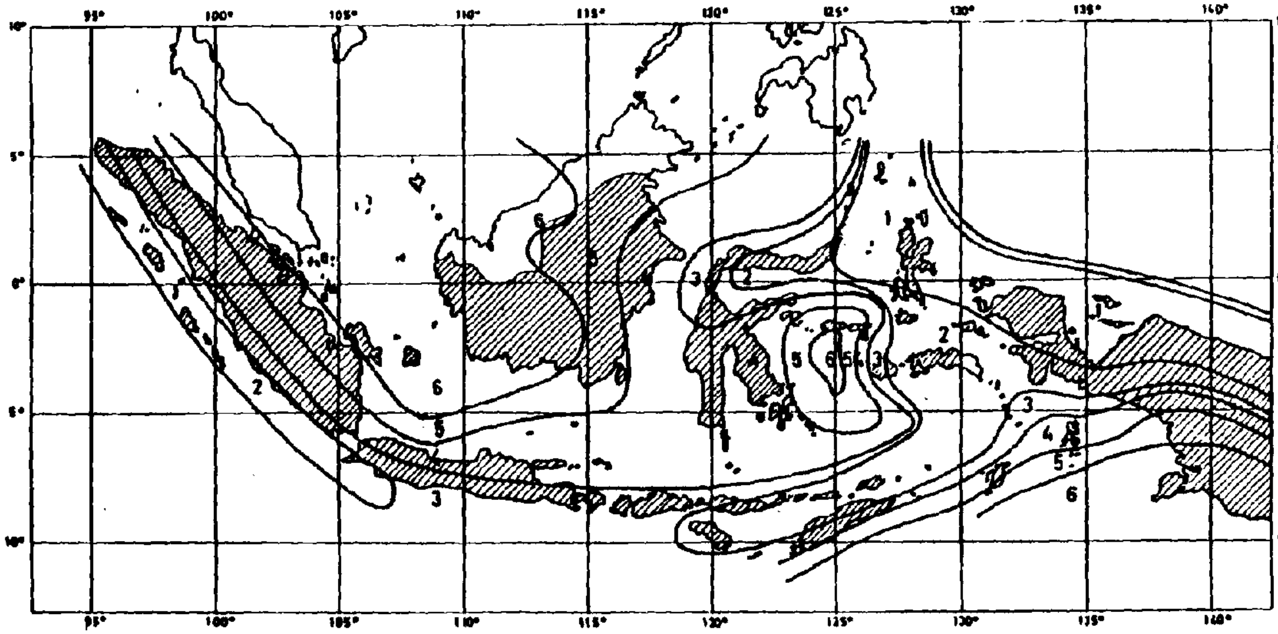


Figure 6

Seismic Zoning of Indonesia

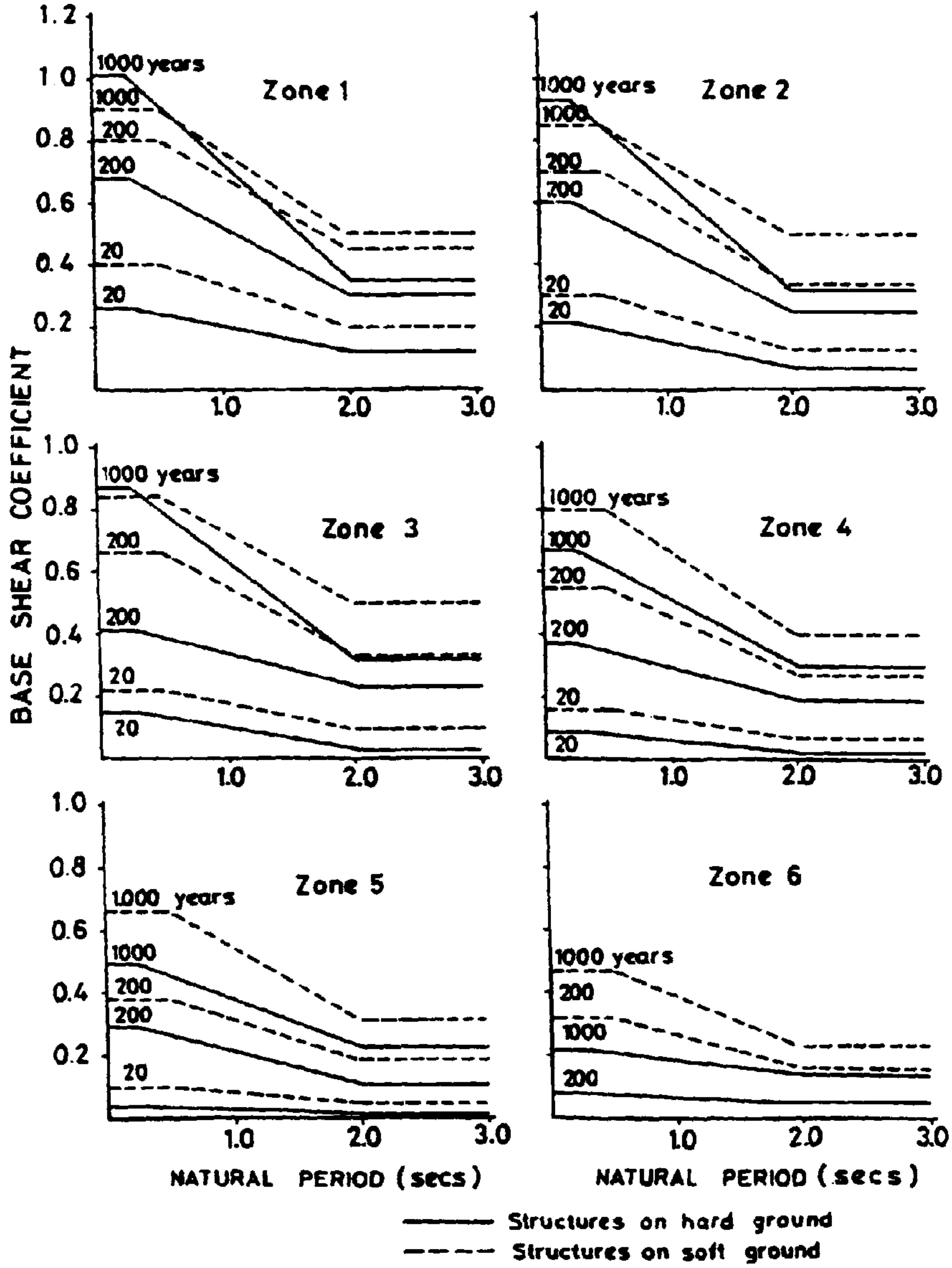


Figure 7

Design Response Spectra for the Six
Seismic Zones of Indonesia

Seismic Zoning

Based on the study of isoseismal maps, distinct seismic zones in the Indonesian territory have been identified. By selecting appropriate contour lines for the zone boundaries, 6 seismic zones have been determined in which the probability of occurrence of seismic events is approximately uniform, as shown in Figure 6. This seismic zoning map of Indonesia has been prepared as part of a project called "Indonesian Earthquake Study", conducted under a bilateral aid agreement between the Government of Indonesia and that of New Zealand. This project has been going on since 1976 with a final aim of establishing a comprehensive

Table 2

Soft Soil Designation

Description	Depth exceeding (m)
Cohesive soil with an average undrained shear strength not exceeding 50 kPa	6
Any site where the overlying soils are either cohesive with an average undrained shear strength not exceeding 100 kPa or a very dense granular material	9
Cohesive soil with an average undrained shear strength not exceeding 200 kPa	12
Very dense cemented granular soil	20

seismic code for Indonesia. A joint team of Indonesian and New Zealand experts has been involved in this project, resulting in the formulation of the above seismic zoning map of Indonesia. The 6 seismic zones are numbered in decreasing order of seismicity. Zone 1 where Central Irian Jaya and North Maluku are situated is the most severe seismic area of Indonesia, while Zone 6 where West Kalimantan is located is the most stable part.

Design Response Spectra

Another result of the Indonesia-New Zealand project has been the formulation of design response spectra for each of the 6 seismic zones of Indonesia. These are shown together on Figure 7, where they are shown for seismic intensities with return periods of successively 20, 200 and 1000 years, each plotted for hard and for soft subsoils. A structure is considered as being on a soft subsoil, if it is located on soil deposits exceeding the depths indicated in Table 2.

The establishment of the above design response spectra has been the result of an extensive study of all available response spectra of earthquakes recorded all over the world. Studies have been conducted on the influence of the magnitude, focal distance and site geology on the shape of the response spectra. Based on these studies it has been found that for each seismic zone it was not unreasonable to simplify the design response spectra into the trilinear diagrams as shown.

FOOTNOTES

1. The term "seismic risk" is used in this paper as originally proposed by Cornell, McGuire and others, which implies the probability of exceedence of a seismic quantity. Following the UNDRO definition, this should be termed "seismic hazard," and accordingly the associated map should be termed "Seismic Hazard Maps" instead of "Isoseismal Maps".

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EARTHQUAKES AS A SOCIAL PROBLEM

Viktor Turnšek

The very fact that a conference dealing with the social, economic, and planning aspects of earthquakes is taking place indicates that it is considered that the residential and other buildings used by society for its activities existing today and perhaps still under construction are not safe against earthquakes.

The majority of countries which lie in regions where strong earthquakes may occur have their own codes concerning the construction of buildings in seismic regions. However, experience obtained from recent earthquakes since 1960, as well as the fact that intensive research is now going on in many countries of the world with the aim of providing seismically safe structures, indicates that the technical regulations of the past were not able, at least in sufficient measure, to assure the safety of buildings. This is the case even though these regulations are based on the principle that in the event of strong earthquakes serious damage may occur to buildings, but their collapse should be prevented.

The conclusions of the building group of the EEC, which met in Belgrade in April 1978 and dealt with problems concerning earthquakes, proposed that the regulations be amended with respect to the calculation of resistance and the estimation of the strength of an earthquake acting on a building. This indicates the unsuitability of the older regulations. The conclusions include the following passage: "Countries and regional organizations must make maximum efforts that for the design of structures in seismic regions the limit-state method of design be used. At the same time dates must be fixed by which time transition is to take place from calculations on the basis of permissible stresses to calculations on the basis of limit-state design." An additional conclusion was: "For determining the degree of intensity of earthquakes the MSK-64 scale should be used both in the preparation of seismic maps as well as when determining the extent of damage."

If account is not taken of the results of recent research, which has indicated solutions which would be in general economically acceptable, then it must be considered that "buildings of the past" will still abound--buildings which can neither be abandoned, nor

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strengthened. Thus the fact remains that for the foreseeable future strong earthquakes are still going to be natural catastrophies.

In relation to the conference subject matter, we should like to present:

- an estimate of the seismic resistance of residential brick masonry and stone masonry buildings, which we had the opportunity to determine in the earthquake-stricken regions of Yugoslavia, and
- an indication of the possibilities provided by mortar of higher quality and by horizontal reinforcement.

As our contribution to the conference we should like to present the experience we have acquired with repair work carried out in connection with earthquakes which have occurred in Yugoslavia over the last twenty years, and to present some general ideas concerning the approach to repair work.

An Estimate of the Seismic Resistance of Masonry Buildings

Definition and estimation of the seismic resistance of masonry buildings

The shear resistance of a masonry building is defined by the shear failure (collapse) of certain walls, which can be designated as the "relevant walls". Thus the relevant walls are those walls which determine the failure mechanism of the building. If it is borne in mind that the distribution of lateral load, as defined by the Base Shear Coefficient, onto individual walls (or groups of walls) is in proportion to their stiffnesses, then the relevant walls are those walls which are relatively the stiffest and of which there are a larger number. When the resistance of these walls, and their deformability (or "ductility"), is exhausted, failure occurs. The wall or whole group of walls loses its vertical-load carrying capacity, and collapse of the whole story occurs if there is no possibility for the transfer of the vertical load onto other vertical load-bearing elements.

The safety factor of a building for seismic loads thus depends on the safety factor of the relevant wall or group of walls:

$$V = \frac{\textcircled{1}\left[\text{The shear resistance of the relevant wall}\right] \quad \textcircled{3}\left[\text{The cross-sectional area of the walls orthogonal to the direction of the seismic shock}\right]}{\textcircled{2}\left[\text{The total inertial force acting in the story}\right] \quad \textcircled{4}\left[\text{The factor of increasing or decreasing of the load acting on the relevant walls}\right]}$$

If the elements of the above equation are expressed in mathematical symbols, then the parametric form of the condition of seismic resistance of the building is obtained (Figures 1, 2, 3):

$$\frac{I}{\phi} = \frac{1}{n} \cdot n\,(\tau_k) \cdot n\,(\Psi) \cdot n'\,(Z_h\,,\,Z_v) = 1$$

The resistance of the building, expressed by means of the Base Shear Coefficient, V.K., is obtained by iteration.

Estimate of the seismic resistance of brick masonry buildings

Pre-World War I buildings, built of "German format" bricks of dimensions 25x12x6 cm, as well as buildings built of modular brick blocks of dimensions 30x20x20 cm, have been taken into consideration as widespread typical brick masonry buildings. Table 1 shows calculations for ceramic blocks and high quality mortar, and as an alternative the same walls reinforced with horizontally placed stirrups.

a. Analysis of existing brick masonry buildings (Rows 1, 2, and 3 in Table 1)

An insight into the seismic resistance of existing brick masonry buildings has been made possible by parametric analysis, the wall element tests so far carried out in the laboratory, surveys of wall layouts of actual buildings (though for only a smaller number of buildings) and an estimate of the method of construction used.

The influence of the parameter of wall layout on seismic resistance can be seen from the table in Figure 3. The value of this parameter $n(Z_h, Z_y)$ can fall from an ideal value of 100% to a very small percent. Such is the case with the so-called "tunnel construction", where all the load-bearing walls are oriented in one direction. Such buildings are demolished by an earthquake shock acting at right angles to the plane of the walls, as examples at Skopje have shown. The fashion of tunnel construction (in reinforced concrete construction, too), as well as complicated, unsymmetrical wall layout plans which cause torsional loadings, results in the inclusion of a certain number of seismically unstable masonry buildings among our existing buildings.

In the analysis presented in Table 1, relatively favorable wall layout plans have been assumed, as is the case with a large number of older buildings. From Table 1 the influence of wall thickness, which in the case of older buildings increased with increasing building height, can be seen. In the ground floor wall thickness was a minimum of 45 cm before World War I, after 1930 it was 38 cm, and after 1960, when modular measurements were introduced, 30 cm, at which time the requirement that cement-lime mortar be used for the construction of masonry buildings in seismic regions was also introduced into the technical regulations.

In the first row of Table 1 the suburban dwelling houses owned by moderate income inhabitants have been analyzed. These are mainly single story buildings with an occupied attic and walls not tied together at ground-floor ceiling level. In the Skopje and Banja Luka earthquakes failure of such buildings built of poor quality bricks and mortar occurred, consequently statistics of failures and damage indicated the false generalization that "brick masonry is not a suitable building material for seismic regions".

The safety factor of a building depends on the safety factor of one of the relevant walls. As the relevant walls are denoted those walls which define the failure mechanism of the building, according to their relatively greater stiffness and larger number.

$$V = \frac{① \left[\text{The resistance of the revelant wall}\right] \cdot ③ \left[\text{The cross-sectional area of the walls standing in the direction of the seismic force}\right]}{② \left[\text{The total inertial force acting in the story}\right] \cdot ④ \left[\text{The factor of increasing or decreasing of the load acting on the relevant wall}\right]}$$

Substituting for the expressions in the above equation with the parameters and symbols listed in the appendix, the following equation for V can be obtained:

$$(1) \qquad V = \frac{① \left[\tau_k \sqrt{1 + \frac{\sigma_{or}}{\sigma_n}}\right] \cdot ③ \left[\phi F_{tot} \ \lambda_h\right]}{② \left[K \ \phi \ F_{tot} \ n \ \gamma \ h \left(1 + \frac{q}{\gamma \ h \ \phi}\right)\right] \cdot ④ \ [\omega]}$$

The vertical bearing stress in the relevant wall σ_{or} can be expressed as follows:

$$(2) \qquad \sigma_{or} = \gamma \ h \ n + \frac{q \ F_{tot} \ n \ f}{\phi \ F_{tot} \ \lambda_h}$$

Substituting this expression into Eq. (1) we obtain:

$$(3) \qquad V = \left(\frac{1}{K \ n}\right) \left(\frac{\tau_k}{\gamma \ h}\right) \left(\frac{\lambda_h}{\omega}\right) \left(\frac{1}{1 + \frac{q}{\gamma \ h \ \phi}}\right) \cdot \sqrt{1 + \frac{\gamma \ h \ n}{1.5 \ \tau_k}\left(1 + \frac{q \ f}{\gamma h \phi \ \lambda_n}\right)}$$

If Eq. (3) is squared and solved for the number of stories n, then the following expression is obtained:

$$(4) \qquad n = \frac{1}{3 \ V^2 \ K^2} \cdot n \ (\tau_k) \cdot n \ (\phi) \cdot \left\{ Z_h^2 \cdot Z_v \left(1 + \sqrt{1 + \frac{9 \ V^2 \ K^2}{Z_h^2 \ Z_v}}\right)\right\}$$

Figure 1

Parametric Analysis of the Seismic Resistance

h_i - height of the wall,

d_i - length of the wall,

G - shear modulus of the wall,

D - deformability modulus of the wall,

F^* - cross-sectional area of the wall,

F^*_{tot} - total cross-sectional area of walls in the story,

q - weight of the floor structure (dead load + live load),

γ - volumetric weight of the wall,

n - number of stories,

φ - ratio of the cross-sectional area of the walls supporting the floor structures to the net-area of the story

f - part of the floor structure area which is supported by the walls standing in the direction of the seismic force

F_{tot} - net-area of the story,

λ_h - ratio of the cross-sectional area of the walls standing in the direction of the seismic force to the total cross-sectional area of walls in story,

λ_p - ratio of the cross-sectional area of the walls standing perpendicular to the direction of the seismic force to the total cross-sectional area of the walls in the story,

λ_v - ratio of the cross-sectional area of the walls supporting the floor structures and standing in the direction of the seismic force to the total cross-sectional area of the walls in the story,

ω - correction factor for the distribution of the total seismic force to individual walls,

s.m. - coefficient of increase of resistance due to additional structural measure, obtained from laboratory tests.

$$n(\gamma_i) = \frac{\gamma_i}{\gamma_h}$$ ....function of the equality of the walls.

$$n(\varphi) = \frac{1}{1 + \frac{q}{\gamma h \varphi}}$$ ....function of the parameter of the ratio of the area of bearing walls to the net-area of the story.

$$\frac{1}{n}$$ ....function of the number of stories.

$$Z_h = \frac{\lambda_h}{\omega}$$ ....parameter of the distribution of the total seismic force onto the walls standing in the direction of the seismic force.

$$Z_v = \frac{1 + \frac{q}{\gamma h \varphi} \cdot \frac{f}{\lambda_v}}{1 + \frac{q}{\gamma h \varphi}}$$ ....parameter of the distribution of vertical load onto the walls standing in the direction of the seismic force.

$$\Phi = \frac{12 V^2 K^2}{1 + \sqrt{1 + 36 V^2 K^2}}$$ ....function of seismic load given with the seismic coefficient K and safety factor V (base shear coefficient at failure).

$$VK = \Phi \sqrt{\frac{1}{6\Phi} + \frac{1}{4}}$$

$$n(Z_h Z_v) = \frac{Z_h^2 Z_v}{0{\cdot}25} \cdot \frac{1 + \sqrt{1 + \frac{9V^2K^2}{Z_h^2 Z_v}}}{1 + \sqrt{1 + 36V^2K^2}}$$ ....function of the structural layout of the building.

$$n(s.m) = (s.m)^2 \cdot \frac{1 + \sqrt{1 + \frac{9V^2K^2}{Z_h^2 Z_v^2 (s.m)^2}}}{1 + \sqrt{1 + \frac{9V^2K^2}{Z_h^2 Z_v^2}}}$$ ....function of parameter of structural measure

Figure 2

List of Symbols and Formulas

CONDITION OF STABILITY: $\frac{1}{\phi} \cdot \frac{1}{n} \cdot n(\varphi) \cdot n(\tau_k) \cdot n(Z_h \cdot Z_v) = 1$

$$n(\varphi) = \frac{1}{1 + \frac{q}{\gamma h \varphi}} \quad ; \quad \gamma h = 5Mp/m^2$$

q \ φ	0.06	0.08	0.10	0.15	0.20	0.30	0.40
0.400	.43	.50	.56	.65	.71	.79	.83
0.500	.38	.44	.50	.60	.67	.75	.80
0.600	.33	.40	.45	.56	.63	.71	.77
0.700	.30	.36	.42	.52	.58	.68	.74

$$n(\tau_k) = \frac{\tau_k}{\gamma h} \quad : \quad \gamma h = 5Mp/m^2$$

τ_k	1.0	1.5	2	5	10	15	20	25	Mp/m^2
$n(\tau_k)$	.20	.30	.40	1	2	3	4	5	/

$$n(Z_h \cdot Z_v) = \frac{Z_h^2 \cdot Z_v}{0.25} \cdot \frac{1 + \sqrt{1 + \frac{9V^2 \cdot K^2}{Z_h^2 \cdot Z_v^2}}}{1 + \sqrt{1 + 36V^2K^2}} \quad ;$$

$$Z_h = \lambda_h \quad ; \quad Z_v = \frac{1 + \frac{q}{\gamma h \varphi} \cdot \frac{f}{\lambda_v}}{1 + \frac{q}{\gamma h \varphi}}$$

Z_v \ Z_h	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10
1	1.00	.83	.68	.54	.42	.31	.23	.15	.11
0.80	.85	.70	.58	.47	.37	.28	.21	.14	.10
0.60	.70	.60	.50	.41	.33	.25	.19	.13	.09
0.40	.57	.49	.42	.35	.28	.23	.17	.12	.08

Figure 3

Values of the Coefficients of the Parametric Functions

Table 1

Calculation of the Seismic Resistance of Existing Brick Masonry Buildings, Assuming Favorable Wall Lay-outs

No.	Type of building (γ = 1.8 Mp/m^3)	Wall quality			Walls of building					Building resistance given by Base Shear Coef.					Corresp. earthquake intens. on MSK scale
		σ_n (exp.) kp/cm^2	τ_k kp/cm^2	n (τ_k)	Thick-ness in cm.	φ	n(φ)	z_h	z_v	No. of stories (n) 1	2	3	4	5	
1.	Suburban buildings of lowest quality. Buildings usually not tied. h = 3.5 m	0.4	.25	.50	25	.08	.44	.30	.70	.11	.07	-	-	-	VII
2.	Pre-WW II buildings, built of solid bricks ("German format") in good lime mortar h = 3.5 m	1.0	.55	.87	38 51 64	.13 .17 .21	.62 .68 .73	.40	.80		.19	.15	.13	.12	VIII
3.	Buildings built of modular brick blocks in cement-lime-sand mortar h = 2.8 m	1.8	1.0	2.00	30	.10	.50	.30	.70		.21	.15	.13	.11	VIII
4a.	Buildings with high-quality brick walls, using mortar of quality β_m = 150 - 200 kp/cm^2 h = 2.8 m	3.5	1.9	3.8	20	.08	.44	.40	.70		.42	.30	.24	.21	IX
4b.	As in 4a, with horizontal steel reinforcement ⌀ 6 mm	As	in 4a + (s.m.)	=	1.35							.41	.33	.28	IX

It also follows from Table 1 that carefully designed and built older masonry buildings built of solid bricks, but using lime-sand mortar, as well as newer buildings built using modular brick blocks and the required cement-lime mortar, can withstand earthquake shocks of intensity VIII on the MSK-64 scale.

b. Brick masonry prospects in view of new thermoinsulation requirements (Rows 4a and 4b in Table 1)

The trend towards the greater competitiveness of brick construction for residential buildings has resulted in the building of brick walls out of modular brick blocks with a thickness of 30 cm in the ground floor. The reduced thermoinsulation due to the reduced thickness of such walls has been partly compensated for by perforating the blocks. However, much greater thermoinsulation is required by today's energy crisis, which is not possible to obtain by increasing wall thickness, and so it would appear on the face of it that the great advantage of brick has been lost.

A step forward could be taken by reducing the thickness of brick bearing walls to 20 or 25 cm and simultaneously adding a layer of thermoinsulation. In this case another problem arises, that of providing sufficient load-carrying capacity, and, in particular, seismic resistance. The results of tests carried out on some walls have shown that by the use of high-quality mortar it is possible to increase substantially the shear resistance of brick walls. The analysis shown in Table 1 indicates in general a substantial increase in the seismic resistance of buildings in comparison with the method of construction so far used, so that in all cases resistance to earthquakes of intensity IX is achieved.

The supposed drawback of using mortar with a compressive strength of over 100 kp/cm^2 is that walls built using such a mortar would be brittle, i.e. without ductility. Proof that this is not the case follows from the measured values of the deformational characteristics of walls of groups II, III, V and VI, as is shown in Table 2.

Estimate of the seismic resistance of stone masonry buildings

In Yugoslavia most stone masonry buildings are in the countryside. Stone was used as almost the exclusive building material up to the end of the last century.

In cities and urban areas, stone masonry buildings represent ethnological, cultural and historical monuments of extreme value, which must be preserved in the future.

The resistance of such buildings to seismic forces, defined by the shear strength of a stone masonry wall is sometimes extremely low. Fortunately, the resistance can be substantially increased by means of cement injections. Taking into account other favorable characteristics of stone masonry buildings--greater thickness of walls, favorable structural layout--the cement injections represent a cheap solution during revitalization when the seismic resistance of buildings must be improved, which does not require additional structural elements and does not change the building aesthetically.

The constructional characteristics of stone masonry walls of various categories, as determined during the test, were as follows:

Cat. I. Two-faced stone walls whose cavities are filled with poor quality lime mortar made of clayey sand and earth. These walls were unplastered. The walls of old dwellings in the Kozjansko, Soča Valley and Friuli regions are of this type.

Table 2

Estimated Seismic Resistance of Stone Masonry Buildings

	Tensile strength σ_n	Shear modulus G	Ductility δ_{max}/δ_o
	kp/cm^2	Mp/cm^2	-
Walls of group II	1.7	4.3	3.2
" " " III	2.6	4.0	3.9
" " " V	4.7	9.4	3.4
" " " VI	3.0	4.7	3.3

Cat. II. Two-faced walls built of quarried stone whose cavities are filled with stone, fragments and lime-mortar containing clean sand as aggregate. These walls are unplastered. The dwellings of the Montenegran Littoral are built with such walls.

Cat. III. Two-faced walls built of roughly-hewn quarried stone, whose cavities are filled with stone fragments and lime-mortar containing clean sand as aggregate. These walls were plastered using cement-lime-sand mortar. The public buildings (schools) of the Montenegran Littoral are built with such walls.

Cat. IV. Two-faced walls built of quarried stone (A,B) and of rounded riverbed stone (C,D), both filled with stone fragments, plastered and grouted. As was seen from the surfaces where fractures occurred, the larger part of the grout mixture was taken up by the inner part of the wall, which had thus turned into good, "prepacked" concrete.

In Table 3 the calculations for buildings with basic and cement-grouted walls have been presented.

Experience and Suggestions in Connection with Repair Work

After the occurrence of an earthquake the most urgent task is providing aid to the survivors: rescuing people from under the wreckage, supplying medical aid to the injured, and arranging emergency shelter and medical protection, and other similar measures. However, soon questions arise as to what should be done with the damaged buildings.

These questions are not only of a technical nature, but can also be primarily of a socio-political nature, and it is to them that particular attention has been paid in this contribution.

Decisions to demolish or repair

Already during clearing up operations after an earthquake, i.e. the removal of wreckage and the demolition of badly-damaged buildings, strictly political questions can arise. This was the case in the Slovene ethnic region in Friuli, where the population, with the support of Italian progressive intellectual and political forces in Friuli, put up physical resistance to demolition work, which had been taken on by various enterprises and organizations completely from a profit-making point of view.

On the first inspection of buildings, when the removal of wreckage is to take place, the rule should be followed that the demolition should take place of only those buildings or parts of buildings which threaten the safety of passersby. Otherwise the final decision of whether or not a building should be demolished should be delayed until a damage assessment has been made, or until proposals for repair and strengthening have been made. In any case it should be delayed sufficiently so that the user of the building can make a conscious and free decision.

Damage assessment principles

When assessing damage it is not appropriate to use as a basis the insurance practice by means of which the value of the building when new is assessed and then depreciated over the period of its existence. If such a method were used, in the case of old buildings absurdly low values would be obtained, particularly in economically backward areas.

The only estimate of damage caused by an earthquake which is really appropriate is the restitutional value. This represents the financial means which will be needed to restore to the buildings their full usable value. This means that in the case of a future earthquake whose strength has been estimated a residential building must be safe, which means that it may be damaged but must not collapse.

If it is not expected that an earthquake will occur in the future with a greater intensity than the one which has already occurred, and if

Table 3

Influence of the Quality of Different Types of Stone Masonry Buildings and the Effect of Grouting on Seismic Resistance Given by the Base Shear Coefficient and Calculated by Parametric Analysis

$$n(\varphi) = \frac{1}{1 + \frac{q}{\gamma h \varphi}} \;;\quad n(\tau_k) = \frac{\tau_k}{\gamma h} \;;\quad \gamma = 2100\ kg/m^3$$

TYPE OF BUILDING	AMOUNT OF WALLS	QUALITY OF WALL		WALL LAYOUT		BASE SHEAR COEFFICIENT						EFFECT OF GROUTING
		basic	grouted			BASIC WALL			GROUTED WALL			
						STORIES			STORIES			
	φ / $n(\varphi)$	τ_k Mp/m^2 / $n(\tau_k)$	τ_k Mp/m^2 / $n(\tau_k)$	Z_h	Z_v	1	2	3	1	2	3	
A. STONE-MASONRY DWELLINGS WALLS OF CATEG. 1 $q = 0.40\ Mp/m^2$ $h = 3m$	0.30	1.5	8	0.45	0.85	0.18	0.12	0.09	0.59	0.34	0.26	3
	0.83	0.24	1.27	0.35		0.14	0.09	0.07	0.46	0.27	0.20	
B. STONE-MASONRY DWELLINGS WALLS OF CATEG. II. $q = 0.40\ Mp/m^2$ $h = 3m$	0.30	2	10	0.45	0.85	0.21	0.14	0.11	0.71	0.41	0.30	3
	0.83	0.32	1.6	0.35		0.16	0.11	0.08	0.56	0.32	0.23	
C. STONE-MASONRY PUBLIC BUILDINGS WALLS OF CATEG. III. $q = 0.50\ Mp/m^2$ $h = 4m$	0.20	5	12	0.45	0.80		0.19	0.15		0.34	0.25	1.7
	0.77	0.60	1.4									
D. STONE-MASONRY BUILDINGS. WALLS OF CATEG. IV. (CRAD) PREPACKED CONCRETE $q = 0.50\ Mp/m^2$ $h = 4m$	0.20		23	0.45	0.80					0.58	0.41	2.9 based on ungrouted wall cat. III.
	0.77		2.7									
ESTIMATE OF EARTHQUAKE DEGREE:						VII., VIII.			IX.			

a building has not been damaged to such an extent as to indicate that the building had started to collapse, then it is sufficient if the resistance of the damaged elements is restored to its original level.

Categorization of damaged buildings

An assessment of the extent and degree of damage should be obtained by means of damage categorization. A categorization scheme can be prepared by the group of experts who have inspected the earthquake-stricken region. The categories consist of: I) practically undamaged buildings, II) buildings with damage to non-structural elements (footings, chimneys, partition walls), III) buildings with damage to the vertical load-bearing elements:

a) with less serious but defined damage and
b) with more serious but also defined damage to the vertical and horizontal load-bearing elements,

and IV) buildings to be demolished with reasons given. This work, which includes obtaining data on the number of stories and the floor area, should be carried out by one group. If the damage assessment work is to be distributed among several groups, care has to be taken that a uniform coordinated approach to this work is followed. Categorization is carried out by inspecting each building individually. If mistakes are made during categorization it is always possible to correct them when repair work is started. However, categorization is the basis for the assessment of damage, its extent, and the distribution of seismic intensity over the earthquake-stricken region.

Financial evaluation of damage

A financial evaluation of the damage caused by an earthquake can be obtained by means of characteristic examples of the larger number of buildings in each category. The actual restitutional value for a building in any particular category is obtained on the basis of a uniform specification of work, which is prepared by a group of experts, taking into account calculated prices prepared by independent quantity estimators.

The other method of financial evaluation of damage consists of the use of a damage assessment questionnaire, which includes all possible repair work, and into which the necessary quantities are entered in physical units. Prices are, as before, calculated by several quantity estimators, and after coordination and final acceptance of the uniform prices the quantities obtained for individual buildings are multiplied with this uniform price, so that the restitutional value of an individual building is obtained.

We have used both methods in practice in the past. The second method can be used if only a small number of buildings are involved. However such a price provides no substitute for the actual restitutional value which is obtained when the repair plans are completed and other data about the quality of materials and other conditions of construction are obtained. The computer print out should certainly not be used as a document proving the right to assistance or loans. It should be considered only as an element of calculation, which is what this method of estimation really provides.

The financial estimate of damage, with documentation concerning the completed categorization of damage as well as documentation about the characteristic buildings on the basis of which the calculation of restitutional costs was made, is a document by means of which applications for solidarity assistance and its distribution to the various locations of the earthquake-stricken region can be justified. It must be carefully stored for future reference.

If the restitutional value is used as the basis for damage assessment, and repair work is carried out on this basis, then it is evident that the earthquake-stricken region will, particularly if it was a less-developed one where the largest damage usually occurs, make considerable progress in its development after the repair work has been carried out. As residential living conditions will essentially improve, this will create an improvement in economic conditions, too. This is logical, as investments in the standard of living result in an increase in the region's social productivity.

The programming and design of repair work

In principle, when carrying out damage assessment the method by which a building is to be repaired should be determined. So far this has not been so in the majority of cases. On the other hand rebuilding and replacement work, which was considered when making damage assessments, did not represent lower costs than the proposed methods of repair based on laboratory tests and repair work carried out on this basis. In our opinion, in all cases laboratory tests of repairs to load-bearing elements should be included in the designs and calculations of repaired buildings. These tests indicate the existing quality of the elements, which provides an estimate of the intensity of the earthquake, and also the increase in resistance which is obtained by using a chosen method of repair. Thus by means of laboratory tests of elements the intensity of the earthquake can be estimated from actual buildings, as well as the effect achieved by the repair work. This also forms the basis for an assessment of the correctness of the design.

The carrying out of repair work

For the repair and simultaneous strengthening of stone masonry walls it has been shown by lab tests that cement grouting is very satisfactory. However, there has been considerable resistance to cement grouting from those who were starting to carry out repair work, as for instance in the Soča Valley Region, where youth groups with local technical leaders with the necessary experience were employed. When carrying out repair work in regions where individual buildings are very scattered such resistance is understandable, as larger building enterprises cannot take on such work, but nevertheless the necessity of cement grouting should be insisted upon and teams capable of carrying out this work should be organized. In Friuli, where two successive strong earthquakes occurred, the experience obtained with respect to the effectiveness of methods of repair was the same as that obtained in the Soča Valley Region. The conclusions were formulated in the publication of Assessorato dei Lavori Pubblici 1976, Regione Autonoma Friuli-Venezia Giulia, which read as follows: "More than clear proof of this was provided by the behavior of already repaired buildings in the following September earthquake. Whereas superficial repairs and those unaccompanied by antiseismic strengthening frequently failed and caused the irreparable destruction of buildings, those in which repair work had been carried out technically correctly performed satisfactorily and protected buildings from repeated heavy damage."

When carrying out repair work using methods which are not yet well-known in individual regions, and in those cases in which the repair work will not be carried out by larger building enterprises, it is recommended that demonstration building sites and training be organized for working groups which will carry out the repair work.

ESTIMATES OF BUILDING STOCKS AS A BASIS FOR DETERMINING RISK[1]

Barclay G. Jones

In the event of earthquakes and other natural disasters, it is extremely useful to have as rapidly as possible approximate estimates of the total number of buildings at risk. Strong regularities and relationships characterize social systems which should make it possible to arrive at satisfactory estimates even with minimal information about the social system which has been affected. These regularities can be derived deductively from a knowledge of the nature of social systems, and a model of the relationships between the number and types of buildings and other characteristics of the system can be created. Empirical investigations can then calibrate the parameters of the model to determine within narrow ranges what the numerical relationships are likely to be. Then with minimal information about a social system subject to a disastrous event, rapid estimates can be made concerning the number of buildings at risk.

The most important concern in earthquakes and other disasters is loss of human life and physical injury. Consequently, various tabulations of major earthquakes frequently use as a threshhold criterion some stated number of deaths or some magnitude of shock. Frequently, events of high magnitude are excluded from the list, if they did not result in any loss of life. The second most important concern is with human deprivation and suffering as a consequence of the loss of buildings, structures, and artifacts. Earthquakes and other disasters are usually reported in terms of the number of individuals or households who were made homeless or who were left without shelter. In this regard homelessness or loss of shelter is used as a surrogate for the destruction of buildings and their contents. In addition to dwellings themselves, this implies clothing, furniture, utensils, stores of food, linkages to vital services such as water supply, waste water disposal, electricity, telephone, gas and other fuels. Not only are survivors without shelter from the elements, they are without heat, light, food, means of cooking, water for drinking and personal hygiene, bedding, and clothing. Homelessness also is used to imply the loss of other kinds of buildings although these are sometimes stated explicitly. The most important are places of work, and again the loss is not merely that of the structures themselves, but of the tools, machinery, equipment and inventories that were associated with these buildings. Having estimates of the number of buildings at risk can assist pre-event disaster preparedness planning and planning for disaster relief and reconstruction efforts. In the emergency period immediately after an event, such estimates can be useful in assessing the extent of the damage and determining the severity of the event. Rapidly developed estimates can aid relief efforts by determining rough quantities of material that need to be provided. In the reconstruction phase after an event, such estimates can give a first indication of what will be necessary to restore the social system to its previous state.

Estimates of building stocks even if they were quite rough would be extremely useful in a variety of ways in pre-event planning. Measures taken to reduce vulnerability often involve the adoption of seismic building codes or other similar ordinances. These frequently take cognizance of the existing building stock at the time the ordinance was passed and specify that these structures must be brought into conformity with the code within some stipulated period of time. There is almost never any indication of the number of buildings involved nor of the construction effort that would be necessary to accomplish this objective. Disaster preparedness planning could use estimates of building stocks by determining in advance rough numbers of buildings by small geographical areas subject to various kinds of natural disasters. This would aid in planning evacuation procedures and determining the number of alternate and temporary shelters and facilities that would be needed.

In the case of a disastrous event, damage assessment is usually undertaken at an early stage. Criteria for external assistance is often based on some proportion of the pre-existing stock that was lost. Such measures are used to express economic value of losses as a ratio of gross regional product. This relationship is frequently the basis for determining whether or not a stricken area is entitled to external assistance or could be expected to cope with the situation with internal resources. In the weeks that follow, careful counts of structures suffering various degrees of damage are carried out. However, there is almost always no information regarding the total number of structures that existed before the event. Damage assessment procedures could be facilitated by estimates of existing building stocks. In the emergency following a disaster, relief efforts must be mounted with great speed. To be efficient, they require rapid estimates of the magnitude of destruction. The degree of mobilization of external resources and the logistics necessary to deliver them to the stricken region must be determined very quickly. Estimates of existing building stocks that could be made rapidly and easily would greatly assist this process. The earthquake which struck Campania-Basilicata in 1980 blocked roads with rubble because all the highways went from town to town and through each settlement rather than around them. Consequently, it was several days before it was possible to penetrate into the center of the region and determine how great the magnitude of the destruction really was. With rapid estimates of the number of buildings, the type of construction, and the magnitude of the shock, it should have been possible to make a first estimate within a matter of hours.

For example, UNDRO uses three categories of buildings in the MSK-64 scale and six grades of damage. Relationships have been established between intensity of shock and percent of structures of different categories suffering various degrees of damage. Percent loss of value of structure is related to degree of damage also [United Nations, 1980]. In a short period after an earthquake, the intensity of the shock and the area impacted at various degrees would be known. Estimates could rapidly be made of the building stock in the impacted area and assumptions based on familiarity with the region could be used to develop a distribution of buildings by category. Degrees of damage could then be calculated. A rough estimate of economic loss could be determined as a first approximation. As reports come from the field providing further information, the estimates could be successively revised and refined.

Reconstruction efforts must always await detailed damage estimates made by experts over a period of weeks. However, initial reconstruction planning can proceed immediately based on information derived from building stock estimates that would serve as a first approximation.

Since the stock of buildings in an area has tremendous economic and social importance, and since information about stocks and their characteristics is so useful in disaster situations, it is extraordinary that so little information about them is readily available. Most countries in the world make no attempt to enumerate buildings, let alone gather information about their characteristics. In the United States, no federal agencies gather systematic and complete information about buildings. Some countries with highly centralized governments make serious efforts, but often the quality of the data is variable. Information about housing is normally gathered in most countries. However, relationships between housing units and residential buildings and residential structures and total building stocks are not available.[2] At the state, provincial, or regional level in most countries the situation is usually worse. Frequently, most information exists at the local level. However, the completeness and quality of data vary extremely from one locality to another. The data are usually gathered for a specific purpose such as the assessment of taxes and other levies so that there are strong incentives for avoidance resulting in underenumeration. Further, the quality of the data will not vary randomly but systematically with certain types of structures disproportionately undercounted compared with others. Categories of buildings not relevant to the purpose of the count, such as untaxed properties, may be omitted entirely. Moreover, these data are usually stored locally and may have been destroyed or made inaccessible by the disaster. In any event, attempting to seek out the data and assemble them from a large number of localities would consume so much time and effort as to obviate the purpose of making the estimates.

What is necessary is a means of making rapid estimates with tolerable degrees of accuracy that would justify the effort and cost of making them for pre-disaster, emergency, and post-disaster purposes. Fortunately, social systems are characterized by many regularities which persist with fairly stable rates of change over long periods of time.[3] Since this is the case, it is possible to make estimates about unknown characteristics of human societies on the basis of other characteristics for which data are readily available. Once the relationships have been determined either through several instances of enumeration or sampling procedures, models can be developed which permit making estimates about current or past phenomena in situations in which the desired information is not known for one reason or another. Forecasting and predicting which is so essential to decision-making both in public and private sectors are based upon these procedures. Economic forecasts generally involve establishing stable relationships between individuals and artifacts and use projections of numbers of individuals and various demographic and social characteristics that they have. The dependent variable in economic forecasts is usually some product, good or service, and often a physical artifact. The independent variables often include population and demographic characteristics. Forecasts for services, such as telephone usage, are the basis for decisions about capital equipment, such as coaxial cables and switching equipment. Housing market analysis which is concerned with forecasting the demand for additional housing units in future periods is one of the techniques that comes as close to making estimates of building stocks from other characteristics of social systems as anything currently in practice.

The problem is to devise a rapid, simple means of arriving at plausible estimates of the magnitude and characteristics of the building stock in a given place at a given point in time using some sort of information about the social system that is readily available. Perhaps the single piece of information that exists for most places at most points in time is the size of the resident population. If a relationship between the population and the building stock can be established, this would serve the present need. The purpose of buildings is to shelter the activities of people. However, the relationship between population and buildings will be different in different social systems. We can expect the relationship to vary with the demographic structure of the population, the level of social organization, the level of technology, the age of the social system, the types of activities that are carried on, and the level of income the population receives. Whether or not the system is developing or declining will be important. The size of the population, the degree of concentration or dispersion, the density of settlement will all cause variation. However, it is reasonable to start with a basic model which posits fundamental relationships and permit later refinements to elaborate upon it. Univariate models are convenient starting places and are often all that is necessary. Multi-variate models can develop as other modifying relationships are explored and factors found to be relevant. Additional variables often make models more specific to particular times and places. Forecast accuracy is gained by the sacrifice of generality.

A very simple model can be developed. Because of its high level of aggregation and lack of complexity, it may yield better estimates than more elaborate ones. The model states as a fundamental precept that buildings are some function of population.

$$B = f(P) \tag{1}$$

The building stock will have accrued through an accretionary process and will reflect relationships that prevailed at various periods in the community's history. The building stock is recognized as an aggregate of survivals of increments to the stock from previous periods.

The relationship between buildings and population will vary with population size, density, and the magnitude of the agglomerations or centers of concentration. Larger buildings tend to be found in places that have larger populations. This is a sufficiently important modification of the initial premise that it should be stated as a corollary that the population-building ratio is some function of the population.

$$\frac{P}{B} = g(P) \tag{2}$$

As the population grows, increments to the building stock will reflect the population-building ratios characteristic of the new scales of population. The relationship at any point in time will again be an aggregate of structures surviving from previous periods characterized by different ratios. The change in the population-building ratio will probably vary with population size. It will probably be low for small populations then rise and subsequently fall as population continues to grow as shown schematically in Figure 1. For very small populations, buildings represent inordinately large per capita capital expenditures and require very high levels of saving and investment. Consequently, the buildings are modest and very intensively used. As the society becomes larger, more complex, and more productive, buildings and other constructions become relatively cheaper and more plentiful. As populations continue to grow in size and social complexity, larger agglomerations of population are assembled, larger buildings are constructed, and the population-building ratio probably rises.

The way in which building stocks vary with population is not direct and simple but reflects extremely complex relationships. They are shown schematically in Figure 2. The changing slope of the curve as population grows reflects changes in building technology and changes in transport technology. When population delines in a city or a region, the building stock does not normally contract as rapidly. The building stock in many communities which suffered in the Montenegran earthquake of 1979 had been erected to shelter the activities of much larger populations than remained at that time. A classic example is the picturesque village of Perast near Kotor. This village had substantially larger populations in the 17th and 18th century than it has at present. It contains a number of large and imposing structures, the maintenance and repair of which have been beyond the capacity of the population for many years.

Buildings are not of uniform size measured either in floor area, height, or volume. A building stock will be characterized by some sort of size distribution. It is implicit in the relationships already stated that the distribution of buildings by size class intervals will be a function of the population. The relative frequency distribution of the number of buildings by area can be stated as some function of the number of buildings.

(3) $$(A_1, A_2, \ldots A_n) = h(B)$$

Changes in the number of buildings necessarily imply a change in the shape of the frequency distribution. As the number of buildings increases (as a function of population), buildings with larger areas can be expected to be built, and the distribution should move to the right. Once again, the stock of buildings at any point in time is an aggregate of the distributions characterizing survivors from previous periods.

The distribution is bounded on the left by zero and has no effective bound on the right. Therefore, a frequency distribution can be expected which is skewed to the right as shown in Figure 3. For simplicity, it is assumed the distribution conforms reasonably to the log normal.[4] Changes over time can be described easily. The mean of the distribution will increase with increasing size of population. The size of the largest building will increase and the variance of the distribution will increase also reflecting greater skewness. Such a change is shown on log normal probability graph paper in Figure 4. The lower curve t_1 represents the

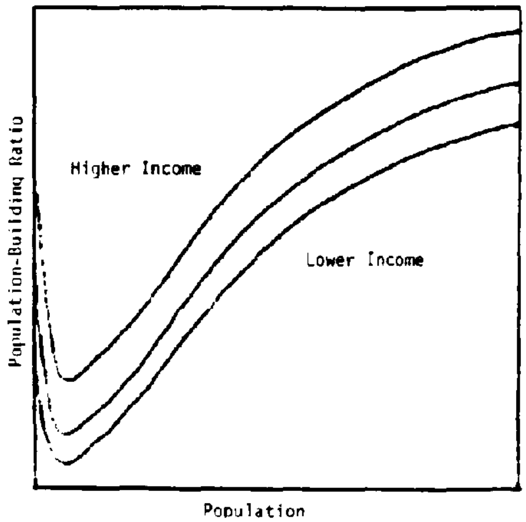


Figure 1

Schematic Relationship of Population-Building Ratio With Population for Different Levels of Real Per Capita Income

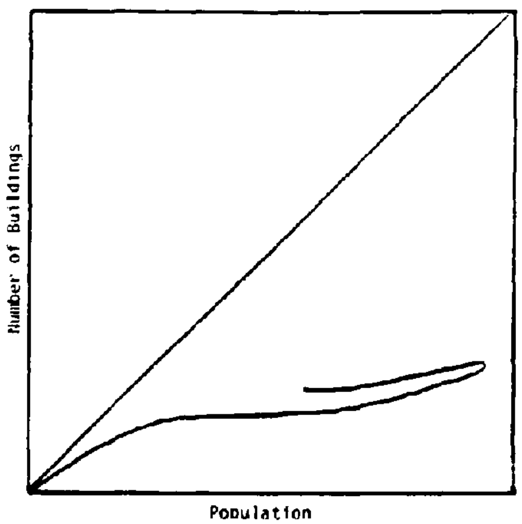


Figure 2

Schematic Relationship of Building to Population first point in time and the upper curve t_2 represents the second. The upper curve has a larger mean, a greater variance, a larger intercept, and therefore a bigger largest building, and the building stock contained by it has a greater total floor area.

Similar conditions prevail with respect to the height distribution of buildings. The relative frequency distribution of the number of buildings by height will also be some function of the number of buildings.

(4) $$(H_1, H_2, \ldots H_n) = i(B)$$

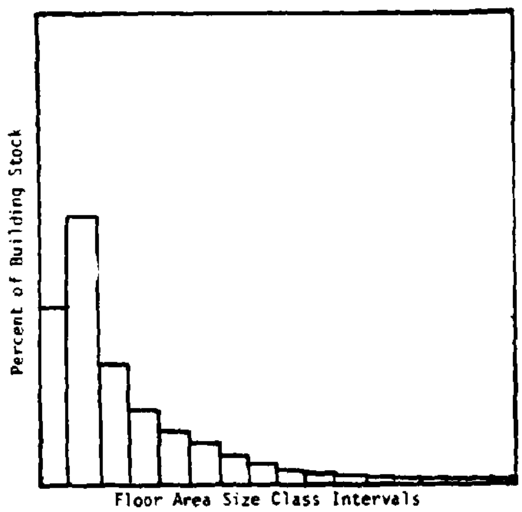
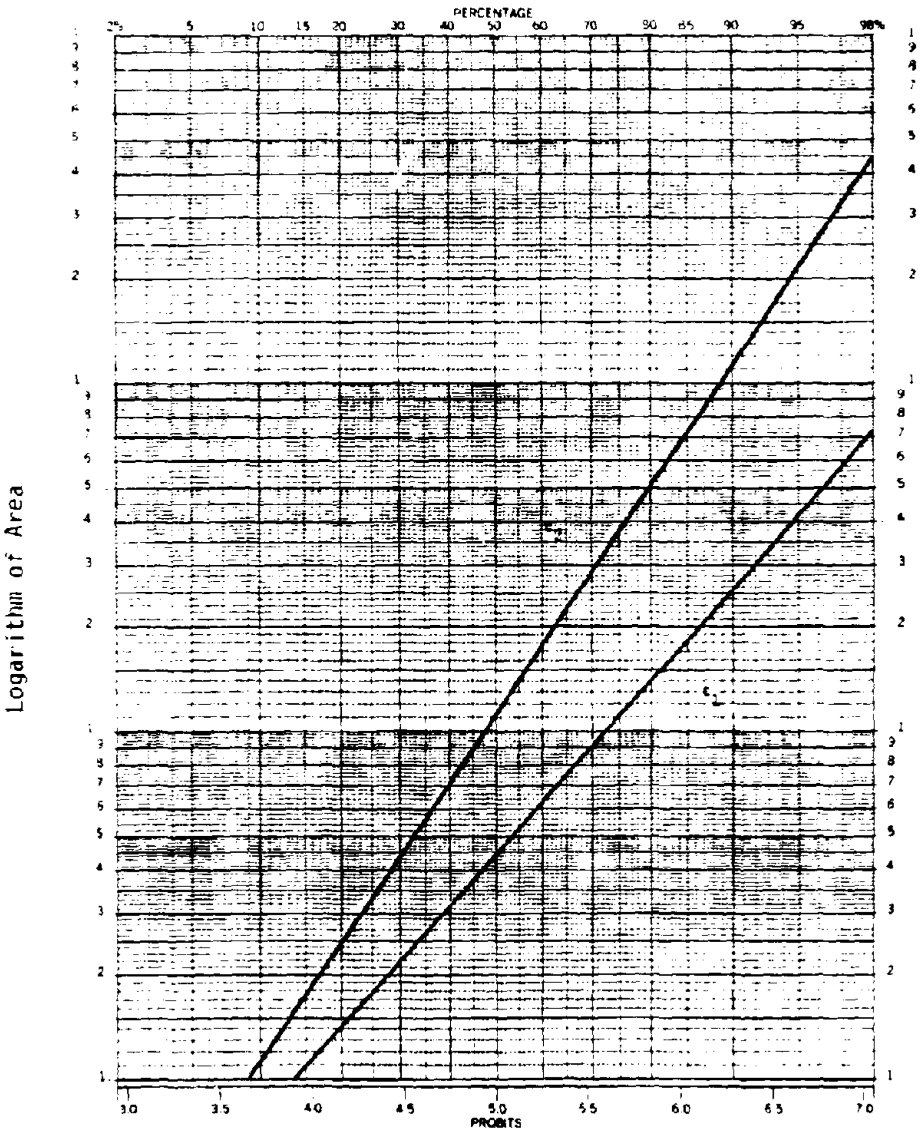


Figure 3

Schematic Distribution of Buildings by Floor Area Size Class Intervals

If buildings are classed by the number of stories, a similar distribution skewed to the right can be anticipated. Constraints of technology and cost will affect this distribution more than the one for floor area. A similar log normal distribution as for area will exist but with somewhat different parameters. Floor area and height are not independent of each other. Class intervals for floor area and height can be cross-tabulated in matrix form. Given the skewed distributions assumed above, the means of height, and the means of area will vary systematically in some such fashion as that shown in Figure 5. The resulting distribution with these assumptions is a bi-variate log normal distribution similar to the one shown schematically in Figure 6 [Yule and Kendall, 1950].

The accretionary process by which building stock accumulates that has been referred to repeatedly is portrayed schematically in Figure 7. In Period 1, N_1 buildings are built, D_1 of which are destroyed through fire, flood, demolition, and other causes, and S_1 survive to the next period.



Cumulative Probability

Figure 4

Schematic Distribution of Building Areas

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 14.

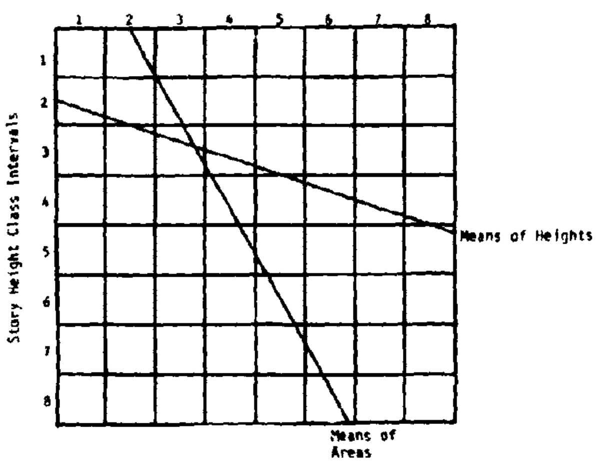


Figure 5

Schematic Cross Classification of Buildings
by Area and Height

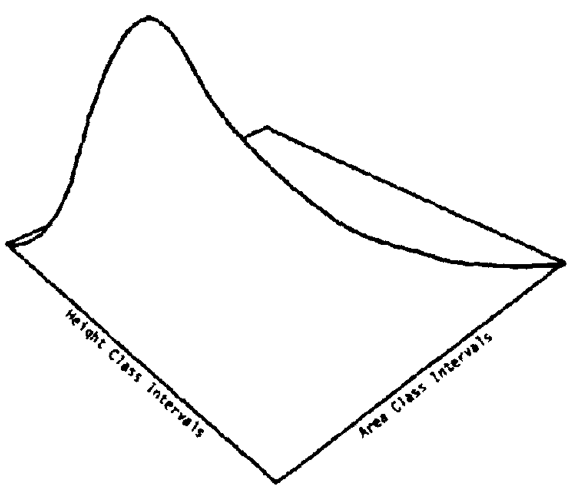


Figure 6

Schematic Joint Distribution of Buildings
by Areas and Heights

In Period 2, there is a great deal of construction activity, N_2, but also much destruction, D_2, which falls proportionately on buildings from both Periods 1 and 2. In Period 3, there is moderate building activity and considerable destruction. The way the diagram is drawn the building stock actually contracts in Period 3 as more buildings are demolished than constructed. Periods in which there is little demonstration of capability for growth of the building stock or actual contraction of it may also be characterized by little capability for maintenance. Buildings in poor repair are more vulnerable to earthquakes and other kinds of disasters, other things being equal. This experience was clearly demonstrated in both the Friuli and Montenegran earthquakes. Not only did destruction vary from urban center to urban center depending upon economic growth or decline, but also from center city to fringes in relation to levels of income and capacity for new building activity. The bottom diagram represents the situation at the end of Period 5. The surviving building stock, $S_1 + S_2 + S_3 + S_4 + S_5$, is constituted of strata of buildings from each of the periods of the community's history. The dotted lines and shaded area depict buildings that have been built at various points over time and the periods in which they were destroyed. The building accretion process is portrayed as a cohort survival model and can be expressed in terms of a matrix algebra formulation [Copur, 1976], [Rogers, 1971].

A very simple deductive model has been developed which specifies a number of characteristics of building stocks as plausible relations of social systems. The model is descriptive and macro-behavioral. Such models provide little in the way of explanation or understanding of phenomena and make few contributions to the body of theory. However, these kinds of models are often extremely useful for making estimates and forecasts with reasonable degrees of accuracy.[5] Obviously, the model can be elaborated to include buildings of different types by use and occupancy as well as other features. However, at this stage of development, such disaggregation is inappropriate.

An empirical test of the model was carried out to determine whether or not the relationships that were posited could be observed.[6] Existing sets of data had to be used, and information was found for populations and buildings for a number of cities at different points in time. Simple regression analysis of five sets of city building stocks as a function of population was carried out, and the results are shown in Table 1 and the scatter diagrams displayed in Figures 8 and 9. The estimated and actual buildings using the equations are compared in Appendix Tables A.1 through A.5. The difference is expressed as a percent of the estimate which accentuates the estimating errors. For the most part the estimated buildings are relatively close to the actual number.

Regression analysis was also carried out on the population-building ratio as a function of population using the logarithm of population. The results shown in Table 2 have, as expected, much lower coefficients of determination. The scatter diagrams show strong relationships but considerable variation from one city to another. The equations derived from this anlaysis were used to make estimates of population-building ratios for hypothetical city sizes as shown in Table 3. While there is a considerable range in the ratios depending on the equation used, there is greater convergence for the large samples of cities and the more recent years. The ratios in Table 3 can be used to make rough estimates of building stocks for analytical purposes. They were the basis for

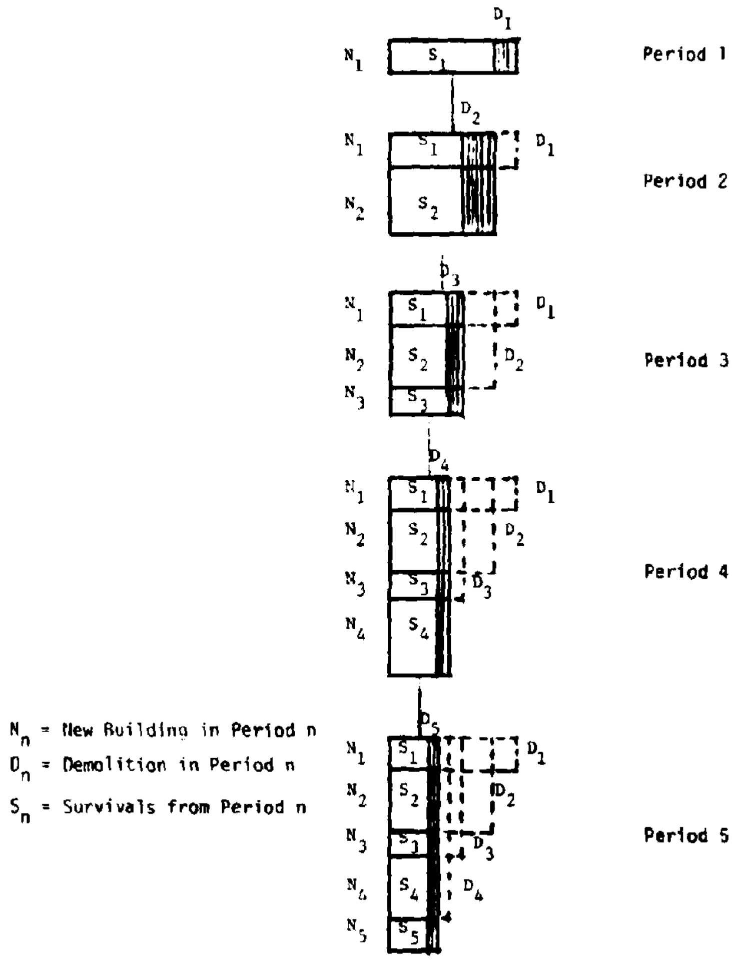


Figure 7

Schematic Representation of Different Patterns of Survival, Construction, and Demolition of Building Stock Over Several Time Periods

Source: Adapted from Ülker Copur. "Survival Through Change: A Developmental Perspective" (unpublished doctoral thesis). Ithaca, New York: Cornell University, 1976. Page 163.

Table 1

Buildings as a Function of Population: Regression Analysis. Various Cities, Various Years

City Set	a	b	Standard Error of b	R^2	F	Standard Error
Columbia (19 Cities)						
1951	1323	.12586	.00321	.98906	1536.288	2161.29
1964	3594	.11946	.00309	.98876	1495.468	4939.62
Turkey (48 Cities)						
[illegible]	5124	.10571	.00266	.97133	1558.640	6350.15
Turkey (14 Cities)						
1927	3964	.16782	.00537	.98788	977.854	3613.39
1970	[illegible]	.10345	.00506	.97211	413.304	10845.04

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 46.

Table 2

Population-Building Ratio as a Function of Logarithm of Population: Regression Analysis Various Cities, Various Years

City Set	a	b	Standard Error of b	R^2	F	Standard Error
Columbia (19 Cities)						
1951	7.0111	.6805	.2073	.3880	10.7775	1.0720
1964	6.4418	.9695	.1593	.6855	37.0550	.8961
Turkey (48 Cities)						
1940	6.4322	.9447	.1791	.3770	27.8370	1.2401
Turkey (14 Cities)						
1927	4.3610	.3051	.1971	.1665	2.3971	.8823
1970	6.6452	.8551	.2968	.4089	8.2996	1.4234

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 65.

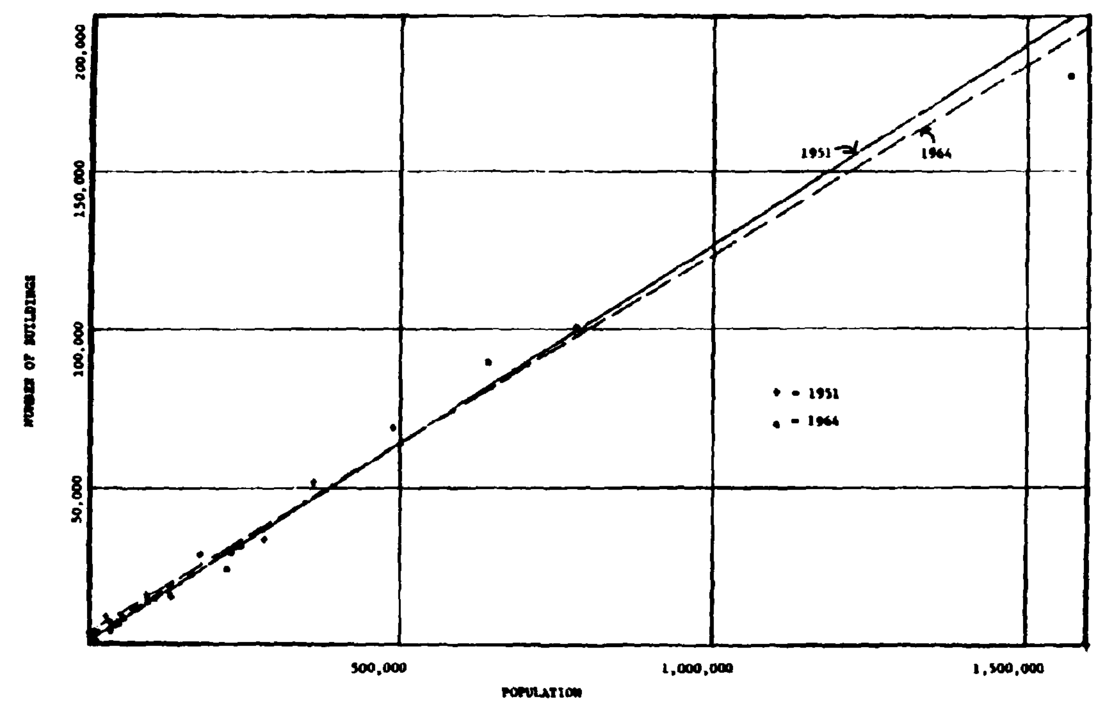


Figure 8

Scatter Diagram with Regression Lines Number of Buildings and Population Columbia (19 Cities), 1951, 1964

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 48.

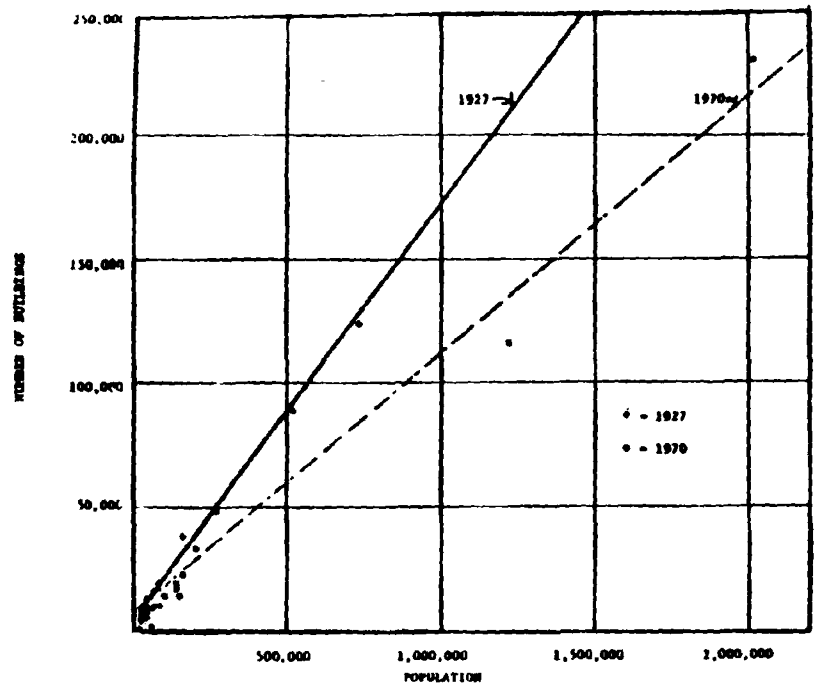


Figure 9

Scatter Diagram with Regression Lines Number of Buildings and Population
Turkey (14 Cities), 1927, 1970

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 42.

Table 3

Population-Building Ratio Estimated from Various Functions of Population Hypothetical Sizes, Various Years

	1951		1964		1970		1927		1970	
	A	B	A	B	A	B	A	B	A	B
10,000	3.87	5.44	2.09	4.21	1.62	4.26	1.77	3.66	1.24	4.68
50,000	6.57	6.54	5.23	5.77	4.80	5.78	4.05	4.15	4.09	6.05
100,000	7.19	7.01	6.44	6.44	6.37	6.43	4.82	4.36	5.75	6.65
250,000	7.62	7.63	7.47	7.33	7.92	7.30	5.44	4.64	7.59	7.43
500,000	7.78	8.11	7.90	8.00	8.62	7.95	5.69	4.85	8.51	8.02
1,000,000	7.86	8.58	8.13	8.67	9.02	8.61	5.82	5.06	9.05	8.61
1,500,000	7.89	8.85	8.21	9.07	9.16	8.99	5.86	5.19	9.25	8.96
2,000,000	7.90	9.05	8.25	9.35	9.24	9.26	5.89	5.27	9.35	9.21

Sources: A - Equation (24), parameters from Table I
B - Equation (26), parameters from Table II

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 70.

estimating the percent of the building stock in Bucharest destroyed in the Romanian earthquake of 1977.[7]

Size data for buildings by area and height that can be tabulated separately and cross-tabulated are very difficult to find. A good data set that had been subjected to a great deal of refinement and elimination of errors was obtained for a large percentage of the total building stock of the five boroughs that comprise New York City totalling about 800,000 buildings.[8] Distribution by class interval for areas is shown in Table 4, and the obvious skewness of the distribution was anticipated by the model. The distributions for total buildings are more regular than those for residential buildings and non-residential structures.

Similar results were obtained from an analysis of the height distribution of buildings shown in Table 5. The tabulation conforms to expectations. Log normal probability plots were made for residential and non-residential structures for both area and height separately. These are shown in Figures 10 and 11. Analyzed in this fashion residential structures show less conformity to expectations both for area and for height. It seems apparent that residential structures are a heterogeneous set that combine two separate populations: single family, duplex, and garden apartment units and large apartments and condominiums.

Floor area and height were cross-tabulated and the resulting distribution was much as anticipated by the model. The results are shown in numbers of structures in Table 6 and by relative frequency distribution in Table 7. The distributions were more skewed than was anticipated. One of the surprising findings was that 77% of the buildings in the five boroughs were less than three stories tall and contained 4,000 square feet or less. This is not the usual image that one has of New York City.

Empirical regularities and persisting relationships between populations and building stocks were assumed and a deductive model was constructed. Empirical tests carried out on the few sets of data that were readily available explored these regularities and estimated the parameters of the relationships. The basic tenets of the model were confirmed. Obviously, substantial additional research is necessary to refine the model and produce equations that would provide reliable estimates in a number of different kinds of situations.

It is clearly possible to develop techniques for making rapid, inexpensive estimates of building stocks in areas subject to earthquakes and other natural disasters. Such estimates would be extremely useful in pre-event situations by determining the magnitude of the task of reducing vulnerability and retrofitting and in planning to mitigate the effects of earthquakes. Using the United Nations method described earlier with more accurate information on the percent distribution of buildings by category, it would be possible to use the building stock estimates to make fairly refined forecasts of the probable economic loss from earthquakes of various magnitudes for any region. In emergency situations, such estimates would be useful to arrive at first approximations of the magnitude of the situation with which one is confronted. In post-event recovery periods, the estimates could be compared to damage assessments to obtain some concept of the relative effect of the disaster on the impacted region. The estimates would also serve to permit beginning recovery planning sooner after the event and

Table 4

*Residential, Non-Residential and Total Buildings by Floor Area Class Intervals: New York City-All Boroughs, 1972

Floor Area in thousands of square feet	Functional Use		
Size Class	Residential	Non-Residential	Total
0 - 1 K	117062	13186	130248
1 - 2	350782	9898	360680
2 - 4	164180	12733	176913
4 - 6	24301	7685	31986
6 - 10	15161	8510	23671
10 - 15	10762	4786	15548
15 - 25	7592	4434	12026
25 - 50	6469	3749	10218
50 - 100	4480	2211	6691
100 - 500	2430	1774	4204
500 -1000	105	168	273
1,000,000+	36	93	129
TOTAL	703360	69227	772587

Table 5

Residential, Non-Residential and Total Buildings by Height Class Intervals in Stories: New York City - All Boroughs, 1972

Height (in stories)	Residential	Non-Residential	Total
0	24	10	34
1	101174	38914	140088
2	657089	12798	669887
3	84609	5873	90482
4	25042	3749	28791
5	19983	3052	23035
6	11503	1575	13078
7	676	630	1306
8	273	369	642
9	312	233	545
10	144	253	397
11-15	1490	983	2473
16-20	783	377	1160
21-40	247	339	586
41-60	10	64	74
60+	1	8	9
TOTAL	703360	69227	772587

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 90.

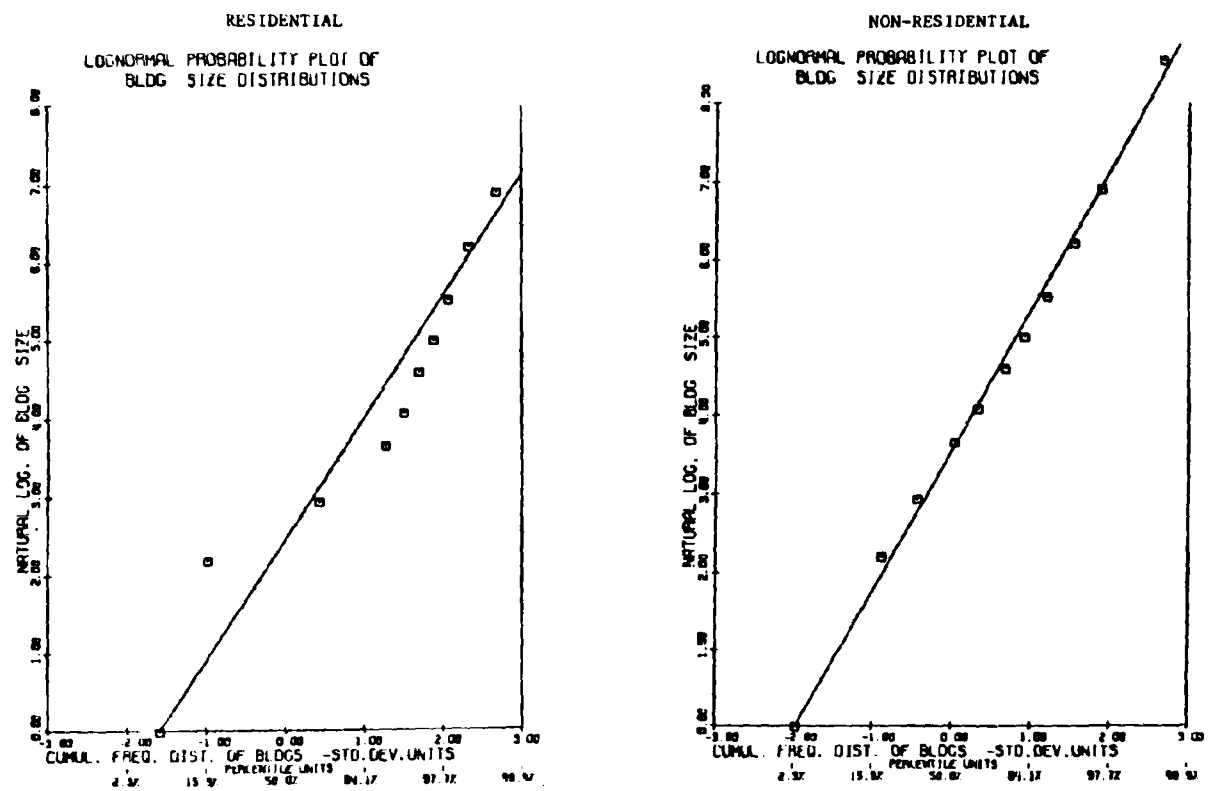


Figure 10

Floor Area Class Intervals: Lognormal Probability Plot of Cumulative Frequency Distributions
New York City - All Boroughs, 1972

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 80.

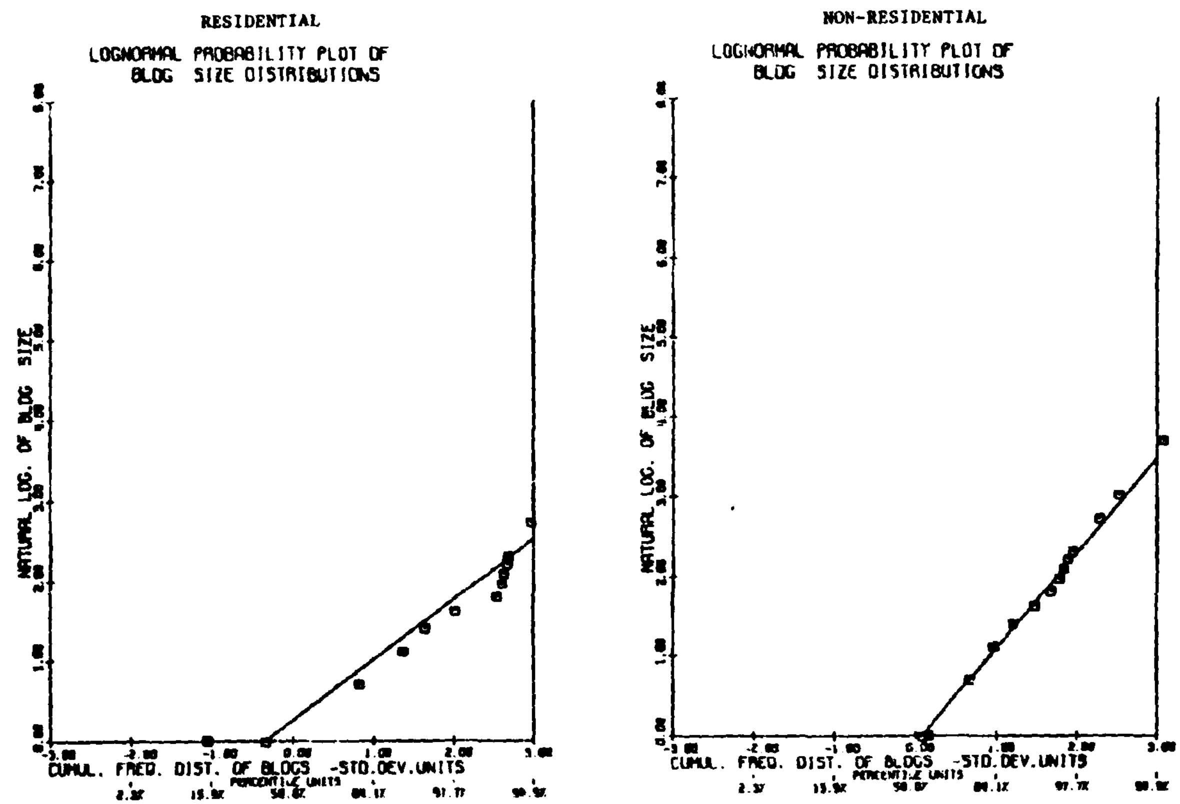


Figure 11

Height Class Intervals by Stories: Lognormal Probability Plot of Cumulative Frequency Distributions, New York City - All Boroughs, 1972

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 98.

Table 6

Cross Tabulation by Area and Height Class Intervals: Residential and Non-Residential Buildings, New York City - All Boroughs, 1972

Floor Area in Thousands of Square Feet

Height in Stories

	0-1K	1-2K	2-4K	4-6K	6-10K	10-15K	15-25K	25-50K	50-100K	100-500K	500-1M	1M+	TOTAL
0	17765	17043	3549	837	1135	397	217	83	46	37	9	8	40625
1	81683	38192	8384	4144	3996	1728	1126	574	192	87	8	4	140118
2	68324	308465	104620	2905	2989	1347	1263	677	268	159	9	14	489930
3	225	13873	57693	13836	2052	882	819	292	312	210	9	9	90306
4	4	137	6337	8117	7297	3184	1921	1778	556	384	11	3	28814
5	1	6	383	2906	7263	6268	3646	1931	487	155	5	2	23053
6	0	2	88	73	508	1885	2773	3728	3140	899	13	3	13114
7	1	0	3	5	50	199	287	423	211	129	7	0	1315
8	0	0	1	1	5	39	61	242	176	187	10	5	685
9	0	0	0	0	2	4	46	228	186	80	8	2	556
10	0	0	1	0	4	4	27	106	146	125	7	2	422
11-15	0	1	0	0	1	4	43	398	973	1117	86	22	2642
16-20	0	0	0	0	1	4	11	41	258	881	60	14	1270
21-40	0	0	0	0	0	0	1	0	1	4	10	2	18
41-60	0	0	0	0	0	0	2	1	3	61	30	42	139
60+	0	0	0	0	0	0	0	0	1	6	0	6	13
TOTAL	147506	377718	188459	32824	24001	15945	12243	10299	8736	4235	282	134	813182

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 107.

Table 7

Relative Frequency Distribution of Cross Tabulation by Area and Height Class Intervals: Residential and Non-Residential Buildings, New York City - All Boroughs, 1972

Floor Area in Thousands of Square Feet

Height in Stories

	0-1K	1-2K	2-4K	4-6K	6-10K	10-15K	15-25K	25-50K	50-100K	100-500K	500-1M	1M+	TOTAL
0	0.02125	0.02096	0.00436	0.00183	0.00139	0.00049	0.00027	0.00010	0.00006	0.00005	0.00001	0.00001	0.04996
1	0.10065	0.04497	0.01831	0.00510	0.00491	0.00212	0.00138	0.00071	0.00024	0.00011	0.00001	0.00000	0.17231
2	0.05963	0.37433	0.12792	0.00337	0.00306	0.00166	0.00135	0.00083	0.00033	0.00019	0.00001	0.00002	0.57790
3	0.00027	0.01706	0.07095	0.01701	0.00252	0.00108	0.00101	0.00073	0.00038	0.00026	0.00001	0.00001	0.11138
4	0.00001	0.00017	0.00779	0.00998	0.00897	0.00392	0.00236	0.00157	0.00041	0.00025	0.00001	0.00000	0.03363
5	0.00005	0.00001	0.00067	0.00357	0.00893	0.00771	0.00448	0.00237	0.00080	0.00019	0.00001	0.00000	0.02835
6	0.00000	0.00000	0.00011	0.00609	0.00062	0.00232	0.00341	0.00458	0.00386	0.00111	0.00002	0.00000	0.01613
7	0.00030	0.00000	0.00000	0.00301	0.00006	0.00024	0.00033	0.00057	0.00076	0.00016	0.00001	0.00000	[illegible]
8	0.00000	0.00000	0.00000	0.00000	0.00001	0.00005	0.00008	0.00030	0.00021	0.00013	0.00001	0.00001	0.00074
9	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00006	0.00028	0.00025	0.00010	0.00001	0.00000	0.00068
10	0.00000	0.00000	0.00000	0.00000	0.00000	0.01000	0.00003	0.00013	0.00018	0.00017	0.00001	0.00000	0.00052
11-15	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00005	0.00049	0.00120	0.00137	0.00011	0.00003	0.00325
16-20	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00001	0.00005	0.00032	0.00108	0.00007	0.00002	0.00156
21-40	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00002
41-60	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00004	0.00005	0.00017
61+	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00001	0.00000	0.00001	0.00002
TOTAL	0.18139	0.46444	0.22192	0.04936	0.03056	0.01961	0.01526	0.01267	0.00678	0.00571	0.00035	0.00018	1.00000

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 108.

hopefully shorten the period of deprivation and suffering of the populations subjected to the disaster. Such techniques are not conceived as a replacement or a substitute for existing processes and procedures dealing with disaster preparedness, emergency relief, damage assessment, or reconstruction planning. Instead they are offered as a means of assisting and facilitating these processes and in so doing, mitigating the effects of earthquakes and other disasters on social and economic systems.

FOOTNOTES

1. Some of the research reported in this paper was supported by the National Science Fondation through Grant Number GI-43867.

2. For a detailed description of difficulties which limit the usefulness of the U.S. Census of Housing for estimating residential structures let alone total buildings, see Hibbs [1978].

3. One of the first works to call explicit attention to the subject in spatial analysis is the section entitled "Some Empirical Regularities" in Isard [1956]. An early compilation of techniques for describing these regularities is Isard [1960].

4. The observation that various skewed distributions can be usefully applied to different kinds of urban phenomena goes back more than 50 years. There are a number of historical reviews of this literature. A classic article in the urban literature which has had much influence is that by Simon [1957]. A basic work on the log normal distribution is by Aitchison and Brown [1957].

5. The usefulness of models of this kind is argued and a comparison with micro-behavioral models is made in Jones [1977].

6. The research results reported here were first presented and described in greater detail in Jones, Manson, Mulford, and Chain [1976].

7. With apparently reliable reports on the number of buildings damaged and destroyed and census information on the population, it was possible to use the technique described here to estimate that only two to three percent of the buildings in Bucharest had been destroyed or severely damaged in the earthquake of March 4, 1970 [Jones and Avgar, 1977].

8. The original source of the data was the Real Property Assessment File of the Real Property Assessment Department of the City of New York Finance Administration. This file and the Multi-Structure Parcel Records File were acquired through the Tri-State Regional Planning Commission which had spent a considerable amount of time updating and refining the basic data. The data were unpublished and are available only on tape.

APPENDIX A

Table 1

Estimated Buildings Compared with Actual: Columbia (19 Cities), 1951

City	Population	Number of Buildings Actual	Estimated	Difference Between Actual and Estimated	Per Cent Difference is of Estimate
Bogotá D.E.	648324	82044	82921	877	1.06
Medellin	358189	52456	46405	-6051	-13.04
Cali	284186	34398	37091	2693	7.26
Barranauilla	279627	34444	36517	2073	5.68
Cartagéna	128877	15222	17543	2321	13.23
Manizales	126201	16206	17207	1001	5.82
Bucaramanga	112252	14632	15451	819	5.30
Ibagué	98695	13285	13745	460	3.34
Cúcuta	95150	15742	13299	-2443	-18.37
Pasto	81103	11678	11531	-147	-1.28
Monteria	77057	11152	11021	-131	-1.19
Neiva	50494	7910	7678	-232	-3.02
Santa Marta	47354	7179	7283	104	1.43
Popayán	44808	6234	6963	729	10.46
Quibdó	36558	6484	5924	-560	-9.45
Villavicencio	33342	4487	5519	1032	18.71
Tunja	27402	8486	4772	-3714	-77.84
Riohacha	13068	3004	2968	-36	-1.22
Leticia	3493	570	1763	1193	67.66
Total	2546180	345613	345599	-14	

Table 2

Estimated Buildings Compared with Actual: Columbia (19 Cities), 1964

City	Population	Number of Buildings Actual	Estimated	Difference Between Actual and Estimated	Per Cent Difference is of Estimate
Bogotá D. E.	1568101	181166	190919	9753	5.11
Medellin	772887	106941	95923	-11018	-11.49
Cali	637929	89426	79801	-9625	-12.06
Barranauilla	498301	68659	63121	-5538	-8.77
Cartagéna	242085	31307	32513	1206	3.71
Bucaramanga	229748	29238	31040	1802	5.80
Manizales	221916	24206	30104	5898	19.59
Cúcuta	175336	28760	24540	-4220	-17.20
Ibagué	163661	22334	23145	811	3.50
Monteria	126329	18709	18685	-24	-0.13
Pasto	112876	15876	17078	1202	7.04
Santa Marta	104471	14346	16074	1728	10.75
Neiva	89790	13531	14320	789	5.51
Popayán	76568	11305	12741	1436	11.27
Tunja	68905	11621	11825	204	1.73
Villavicencio	58430	8595	10574	1979	18.72
Quibdó	42926	7370	8722	1352	15.50
Riohacha	31897	7180	7404	224	3.03
Leticia	4013	2060	4073	2013	49.43
Totals	5226169	692630	692604	-26	

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 51 and 52.

APPENDIX A

Table 3

Estimated Buildings Compared with Actual:
Turkey (48 Cities), 1970

City	Population	Number of Buildings Actual	Number of Buildings Estimated	Difference Between Actual and Estimated	Per Cent Difference is of Estimate
Istanbul	2132407	230244	230541	297	0.13
Ankara	1236152	117464	135798	18334	13.50
Izmir	520832	87986	60181	-27805	-46.20
Adana	347454	52208	41853	-10355	-24.74
Bursa	275953	49409	34295	-15114	-44.07
Gaziantep	227652	34051	29189	-4862	-16.66
Eskisehir	216373	36387	27997	-8390	-29.97
Konya	200464	33110	26315	-6795	-25.82
Kayseri	160985	23772	22142	-1630	-7.36
Diyarbakir	149566	14953	20935	5982	28.57
Samsun	134061	18227	19296	1069	5.54
Sivas	133979	17324	19287	1963	10.18
Erzurum	133444	18845	19230	385	2.00
Malatya	128841	14924	18744	3820	20.38
Kocaeli	120694	18288	17883	-405	-2.27
Icel	112982	14852	17067	2215	12.98
Elazig	107364	13944	16473	2529	15.35
Sakarya	101283	16475	15831	-644	-4.07
Urfa	100654	14023	15764	1741	11.04
Antalya	95616	20232	15232	-5000	-32.83
Kirikkale	91658	12297	14813	2516	16.99
Balikesir	85004	15863	14110	-1753	-12.43
Denizli	82372	15656	13832	-1824	-13.19
Trabzon	80795	11594	13665	2071	15.15
Zonguldak	77135	9833	13278	3445	25.94
Tarsus	74510	12079	13000	921	7.09
Manisa	72276	13888	12764	-1124	-8.80
Hatay	66520	10959	12156	1197	9.85
Karabük	64999	8933	11995	3062	25.53
Edirne	53806	10675	10812	137	1.27
Akhisar	48796	13459	10282	-3177	-30.90
Van	46751	7265	10066	2801	27.83
Nazilli	45159	10601	9898	-703	-7.11
Kilis	43438	9677	9716	39	0.40
Salihli	34478	7818	8769	951	10.84
Kirsehir	33173	6022	8631	2609	30.23
Adiyaman	31263	5392	8429	3037	36.03
Aksaray	30138	5704	8310	2606	31.36
Kastamonu	29338	6560	8225	1665	20.25
Ereğli	28904	3817	8179	4362	53.33
Kadirli	28109	4796	8095	3299	40.76
Tire	28018	8913	8086	-827	-10.23
Lüleburgaz	27808	4771	8064	3293	40.83
Bolu	26944	4269	7972	3703	46.45
Kozan	26097	5816	7883	2067	26.22
Nevsehir	25685	5511	7839	2328	29.70
Edremit	24115	5757	7673	1916	24.97
Bitlis	20824	3279	7325	4046	55.24
Total	7964869	1087922	1087918	-4	

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 53.

APPENDIX A

Table 4

Estimated Buildings Compared with Actual: Turkey (14 Cities), 1927

City	Population	Number of Buildings Actual	Number of Buildings Estimated	Difference Between Actual and Estimated	Per Cent Difference is of Estimate
Istanbul	729457	124374	126418	2044	1.62
Izmir	153845	38165	29790	-8375	-28.11
Ankara	74784	19525	16518	-3007	-18.20
Bursa	61451	17639	14280	-3359	-23.52
Kunya	47496	12919	11937	-982	-8.23
Edirne	34669	9524	9784	260	2.66
Erzurum	31457	11984	9245	-2739	-29.63
Diyarbakir	30709	5760	9119	3359	36.84
Kayseri	30134	10098	9023	-1075	-11.92
Urfa	29918	5594	8986	3392	37.75
Sivas	28498	6467	8748	2272	25.97
Trabzon	24634	6348	8099	1751	21.62
Antakya	23550	5146	7917	2771	35.00
Iznik	2260	650	4343	3693	85.03
Total	1302862	274202	274207	5	

Table 5

Estimated Buildings Compared with Actual: Turkey (14 Cities), 1970

City	Population	Number of Buildings Actual	Number of Buildings Estimated	Difference Between Actual and Estimated	Per Cent Difference is of Estimate
Istanbul	2132407	230244	227656	-2588	-1.14
Ankara	1236152	117464	134938	17474	12.95
Izmir	520832	87986	60938	-27048	-44.39
Bursa	275953	49409	35605	-13804	-38.77
Kunya	200464	33110	27796	-5314	-19.12
Kayseri	160985	23772	23712	-60	-0.25
Diyarbakir	149566	14953	22531	75[illegible]	33.63
Sivas	133979	17324	20918	3594	17.18
Erzurum	133444	18845	20863	2018	9.67
Urfa	100654	14023	17471	3448	19.73
Trabzon	80795	11594	15416	3822	24.79
Antakya	66520	10959	13939	2980	21.38
Edirne	53806	10675	12624	1949	15.44
Iznik	10038	2131	8096	5965	73.68
Total	5255595	642489	642503	14	

Source: Barclay G. Jones, Donald M. Manson, John E. Mulford, and Mark A. Chain, <u>The Estimation of Building Stocks and Their Characteristics in Urban Areas: An Investigation of Empirical Regularities</u>. Ithaca, New York: Program in Urban and Regional Studies, Cornell University, 1976. p. 54.

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SECTION IV

ESTIMATING ECONOMIC IMPACTS OF EARTHQUAKES AND MITIGATION MEASURES

MODELING REGIONAL ECONOMIC IMPACTS OF EARTHQUAKES

Jerome W. Milliman

The Objective of the Paper

Existing earthquake economic damage estimates are based primarily upon property losses in the affected region. To structural damages are added damages to the contents of buildings, damages to public facilities, and sums are added for lives lost and injuries sustained. No estimates are made of direct and indirect regional income and employment losses. No attempt is made to estimate probable response patterns of the regional economy to the damage disruption and the expected path of economic recovery.

The purpose of this paper is to examine various types of regional economic models for their suitability of measuring economic impacts of earthquakes from a regional point of view. It also reports on a research project sponsored by the National Science Foundation[1] to develop an econometric model for the Charleston, South Carolina region to measure regional economic responses to earthquakes and to earthquake predictions. This model will link Process Analysis Models (PAM) with a regional econometric model which will make it possible to allow for substitution of inputs and outputs as well as the adoption of new technology in the recovery period. Traditional regional economic models are designed to deal primarily with changes in aggregate demand. In situations of catastrophic change where resource supply side constraints dominate, the problem is to model inadequate aggregate supply side aspects rather than the usual problems of changes in aggregate demand.

Until we have better procedures for estimating regional economic impacts and regional costs of adjustment for consumers, producers and government, we will be on uncertain ground in evaluating the benefits and costs of alternative ways to mitigate earthquake hazards. The performance of the regional economy is at the heart of the matter. How will the regional economy respond to earthquakes and to possible predictions?

Modeling Economic Consequences of an Earthquake

The economic consequences of an earthquake are primarily a function of the following variables:

1. the severity and duration of the earthquake;
2. the geology of the affected area;
3. the number and location of structures within the affected area;
4. the nature of the construction within the affected area;
5. the number and distribution of people within the affected area at the time the earthquake occurs;
6. the effectiveness of short run response in preventing secondary effects;
7. the nature and vulnerability of economic linkages; and
8. the speed and effectiveness of rehabilitation.

Furthermore, an earthquake will have distributional consequences which will be a function of the following:

1. the extent to which losses are insured;
2. the extent to which private philanthropy and government assistance become available following the earthquake; and
3. the extent to which the value of existing assets is altered as a result of changed market conditions.

The social losses as a result of an earthquake include the following:

1. deaths;
2. injuries;
3. psychological trauma;
4. social dislocation;
5. property damage; and
6. disruption of economic activity.

Only the last two classes of loss, property damage and disruption of economic activity readily lend themselves to quantification in monetary terms. Therefore, as a first approximation of the benefits of mitigation we will concentrate on these two types of loss, while recognizing that we may not be accounting for all losses averted by a warning.

At the same time, it has been pointed out [Milliman, 1975, p. 11] that caution must be taken to avoid double counting in measuring property damages and reduction of economic activity. The value of any asset is the present value of the future stream of services which that asset is expected to produce. If the asset is a "productive" asset, then its destruction could be counted as the loss of producers surplus which results from the loss of production, or as the loss of the value of the asset, but not both.

One of the central concerns of public officials is the fear that the earthquake prediction itself may cause economic disruption. It should be recognized that some economic relocation from areas at risk and some economic losses in the market value of properties at risk are to be expected. Policy makers should not be surprised at market discounting of expected future losses. Transfer of vulnerable activities to other areas may be a rational adjustment. By contrast investment in strengthening structures and other types of investment within the region could prove an economical way to reduce losses.

In a perfectly competitive market, each firm is independent of any other firm or household, and the loss of the production of any one firm would have no noticeable impact upon any other firm. In such a case, the loss of aggregate economic activity is exactly equal to the loss in value of the productive asset. For an urban economy, however, the analysis is complicated by the existence of many specialized and interdependent activities. The loss of output from one activity can affect the output of other activities.

Furthermore, the high degree of specialization implies that the value produced by a productive asset in its specialized use is considerably greater than the value produced in its best alternative use. In an urban setting, the disruption of certain activities is likely to force many resources into alternative uses, and the cost of doing so is likely to be very high. In such a case, the direct loss of value of assets is no longer a good measure of the total social costs incurred, and what is needed is some measure of the total reduction in economic activity.

To analyze these interdependencies in the face of an economic change, it will be necessary to develop a regional economic model. Such a model must be able to predict the level of economic activity in the event of an earthquake, both with and without warning.

This model must focus on the supply side constraints which are likely to arise in the event of a catastrophe, such as an earthquake. Much of the current regional modeling involves analysis based on the Keynesian model. The concern of these models is with the maintenance of an adequate level of aggregate demand and the assumption is that no supply side constraints are binding. In the event of a catastrophe, however, this is not likely to be the case. Supply constraints are likely to become paramount. Also, from recent experience in the United States, insurance payments, capital inflows, and private and public philanthropy will combine to assure a more than adequate level of aggregate demand. In the case of the Alaska Earthquake of 1964, Federal assistance and loans alone provided 115% of property damages [Dacy and Kunreuther, p. 88]. In the San Fernando earthquake of 1971, Federal loans and grants combined with insurance payments amounted to 102% of tangible damages [Munroe and Carew, Table 15].

It is true that even when the entire amount of losses in the region is offset in aggregate, there will be effects on the distribution of wealth as well as distributive effects on the structure of activities. The former will depend upon the nature of the reimbursement, e.g., the mix of insurance and government direct grant and subsidized loan payments, as has been demonstrated by Kunreuther [1968, 1974, 1973]. The latter will depend upon the spatial distribution of activities and of damages. Certain activities may be concentrated in high risk areas, such as landfill sites, or may tend to be situated in older, more vulnerable buildings. This problem of spatial distribution of damages can be treated in a rough aggregate manner. The problem of wealth distribution is less tractible because the structure of compensation is complex and not very predictible. As a first approximation in the prototype model, it will be necessary to assume that wealth redistribution will be neutral with respect to resource use decisions, and hence to the overall level of economic activity which is generated and the nature of the adjustments. At the same time it is recognized that, in addition to equity questions, redistribution of wealth can, in effect, alter the adjustment process because capital markets are not frictionless and individual preferences for investment and personal consumption expenditures will vary.

Regional Models and Supply-Side Constraints

Regional models which have attempted to incorporate supply side constraints currently fall into two categories: input-output analysis and econometric models. The input-output models specify a fixed coefficient production function based on current ratios of inputs and outputs in various sectors. Econometric regional models attempt to allow for substitution in the input and output ratios, basing their estimates of the elasticities of substitution upon historical data. However, these efforts are often incomplete because these models usually fail to model supply-side sectors explicity.

Both types of model suffer other deficiencies, which have been treated in the literature. One problem is that the observations upon which the models are based may be in disequilibria. Another problem is that the models cannot deal with new technology for which there are no observations. Perhaps the most serious problem current models suffer, at least in the present context, is their inability to deal with changes of great magnitude. These models are fairly effective in predicting in the face of small changes, because they are empirically based on past observations which generally involve small changes at the margin. Observations involving catastrophic change are rare, yet it is in precisely that type of situation that reliable prediction is most needed.

An example of an effort to apply current techniques in regional modeling to catastrophic change may be found in an attempt that was made to use input-output analysis in estimating losses from an earthquake [Cochrane, 1974]. The analysis is limited because it assumes that each industry will continue to produce the same output mix and will be constrained to the same input ratios as before the catastrophe. Changes in input constraints simply result in a commensurate reduction in output, with no possibility of input substitution. The recovery process is seen as the elimination of the input constraint, at which point the industry returns to its former level of activity, with its former product and input mix.

The imposition of the assumption that the economy is so inflexible results in a severe overstatement of the economic consequences of an earthquake in the region. Furthermore, the assumption of constant product mix probably leads to overestimation of the length of the recovery period. It is reasonable that a catastrophic event would change the level of demand for many outputs and that industries would respond to the changed demand by shifting its product mix to favor outputs which are useful in the recovery. Thus, the input-output analysis in the context of catastrophic change is unsatisfactory in the static analysis and even less satisfactory in dealing with the dynamic process of recovery and adjustment prior to events in case of prediction. To the best of our knowledge, no one has successfully developed models designed to deal with these problems of catastrophic change in the regional economy.

We propose to develop such a model for the Charleston, South Carolina area. This area has been selected for a number of reasons. It has a long history of seismic activity, including the earthquake of 1886 which took over 60 lives. It is located in the center of an area classified as Zone 3 (the highest category of earthquake risk), and was listed as one of the 13 high hazard areas in the Earthquake Hazards Reduction Act of 1977 PL 95-124, sec. 2(1) .

Charleston was felt to be an ideal and important area for study because of its history of seismic activity and high risk of being subject to another major earthquake, its similarity to other eastern, U.S. high risk areas which have not been studied, the vulnerability of the area to destruction and economic disruption, and its strategic national defense role.

The Proposed Modeling Framework

The methodology being developed is an extension of existing regional models in several respects and will concentrate upon catastrophic change from the outset. Careful attention is paid to modeling the spatial distribution of the following supply side aspects of the regional economy over time:

- demographic factors;
- financial and capital flows;
- housing and construction;
- transportation network (railroads, highways and bridges); and
- water, sewer, gas, and electrical systems.

The methodology will specify how these sectors are interrelated, both spatially and chronologically with the rest of the economic system and how they will be affected by the catastrophic event and by an accurate prediction of the event. The timing of these effects, both before and after the event, and the dynamic adjustment process of the economy are crucial and will be given careful consideration.

The following are illustrative examples of the types of spatial and chronological interrelations for a simulation of a catastrophic event with no prediction that will be incorporated into the regional model: (1) The housing stock will be specified spatially. Then a catastrophic event that severs the sewerage system to a particular area would become a constraint that would limit housing construction in that area until the sewer system was restored. (2) Location specific manufacturing may have railroads as a predisaster least cost shipping alternative. A catastrophic event could be assumed that cut both rail and truck routes initially, thus halting all output. Overtime, the truck routes may be restored prior to rail and thus allow some resumption of manufacturing activity before rail service is fully restored.

The major limitation of conventional regional models in the context of analyzing catastrophic changes is that they generally rely on historical observations. For events that cause major structural changes, this is clearly untenable. To solve this problem, the methodology will utilize the multiple equation summarization of process analysis models (MESPAM) technique for the areas where there are major structural changes.

The MESPAM approach involves the specification of alternative technologies for a particular economic and geographic sector that exists or that will exist in the future. Data on the input requirements and the outputs of these technologies are obtained from engineering studies, rather than historical observation. These technologies are collected into a process analysis model (PAM) and the optimal processes can be solved for, under various assumptions, by traditional linear programming techniques for situations under certainty or by various nonlinear programming techniques that allow the incorporation of uncertainty.

The difficulty with process analysis models is they are usually far too large and unwieldy to be incorporated in a regional economic model. This has led to the summarization of these models by continuous equations estimated on the basis of data generated by the models. The technique has recently been applied in several areas (see the papers by Griffin [1979] or Smith and Vaughan [1978]) and has many advantages as well as disadvantages (see the papers by Maddala and Roberts [1979] [1980]). However, for dealing with catastrophic changes, it would appear to solve some of the very difficult problems associated with conventional, historically based models.

The demand side equations can be modeled in a conventional manner using time series observations. The primary linkages in the model among the various sectors are illustrated in Figure 1.

The common practice would be to simulate the expected employment, wages, and capital invested which would in turn generate employment, income and government expenditure/tax base multipliers. Since regional models assume that sectors such as utilities and transportation are perfectly elastic in supply, the multipliers generated will be unbounded by any capacity constraints. Such a procedure is clearly inadequate for estimating the effects of an external shock such as an earthquake with and without the implementation of mitigation measures. Some infrastructure would be destroyed, and the recovery would be constrained on the basis of both capacity and the timing of reconstruction. Furthermore, the structure of the sectoral linkages within the model would also change.

Therefore, the proposed modeling framework will incorporate these supply considerations along with the recent extensions of traditional models. The model will be composed of six equation blocks: economic, demographic, finance-construction, government, resource, and transportation.

Estimation of the economic block will be based on the traditional economic base approach. External demands will drive local export industries, which in turn are linked to ancillary locally oriented sectors. Personal income will be affected by employment, wage rates, and nonlocal public and private transfers.

The economic block is in turn linked to population, finance and the government block in the traditional manner. Economic activity will

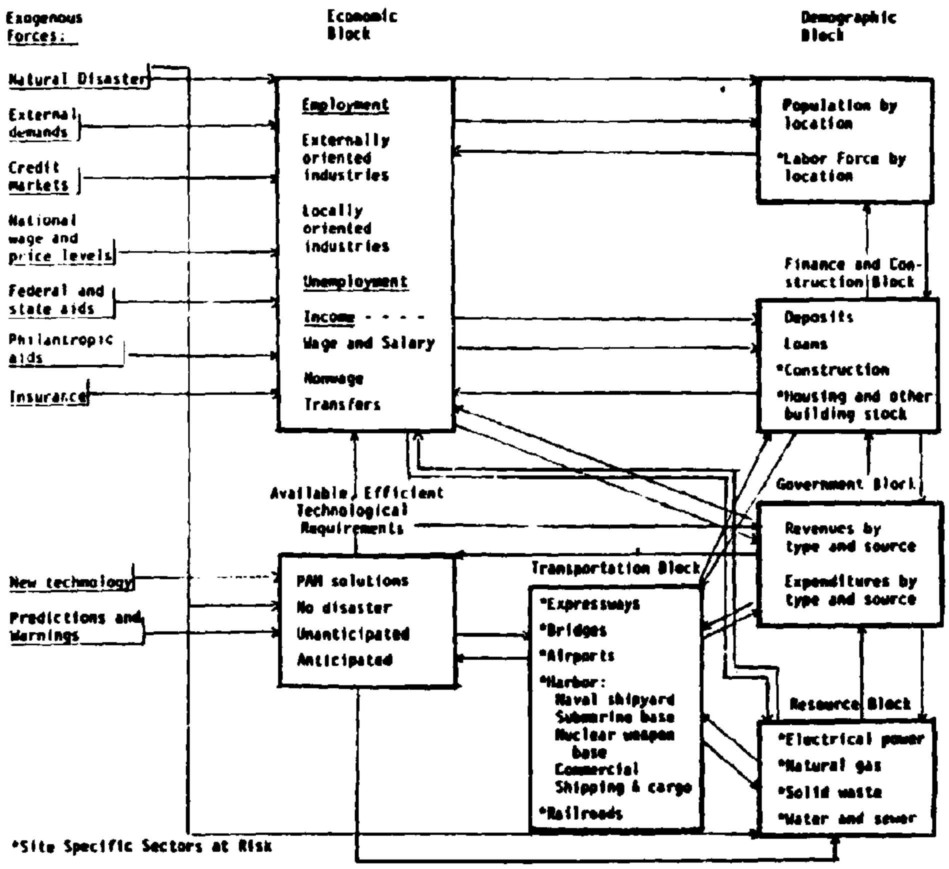

Figure 1

Basic Framework for Analysis of Economic Effects of Catastrophies and Mitigation determine savings flows and lending activity in conjunction with national credit markets. Government revenues and noncapital expenditures will also be estimated as part of the conventional component of the model.

The remaining blocks will be estimated using MESPAM techniques. These include transportation, resources, and housing. It is important to recognize that this methodology will provide information on spatial as well as the chronological characteristics of these sectors. Therefore, not only will supply side constraints be linked with the conventional sectors, but they will also be multidimensional.

Each process analysis model can be quite large by itself and even when there are only a few processes, these models are difficult to incorporate into a regional economic simulation model. One solution is to summarize these models by continuous equations. Then the continuous equations can be used in the regional model and the simulation process is much easier.

As an example, consider a manufacturing process that ships by rail. The level of economic activity will depend on costs of production and shipping as well as other factors. Historical observation will not identify the substitution of truck or other transportation for rail under conditions of extreme price changes as rail has always been the least cost alternative. In a process analysis model (PAM), one may specify the alternative processes (transportation systems) available using technological data. Then a wide variety of input and output prices are generated and the PAM solved several times to create PAM data (also termed pseudo data by Klein and Griffin). The PAM data are summarized by the fitting of continuous equations generally by least squares (termed multiple equation summarization of process analysis models: (MESPAM). Thus, large PAM can be approximated by a few continuous equations that will reflect the substitution of truck for rail under extreme, by historical standards, conditions.

At this time we are unable to identify the specific hazard mitigation alternatives that are available. One reason is that the extent of possible or likely damages by specific sites has not been completely determined. Once the hazards have been identified, we will develop alternative mitigation programs that might be undertaken in the event of a prediction. Preliminary discussions with potential user groups suggest that the potential mitigation alternatives can be adequately characterized by two or three major alternatives.

As with the estimates of damages from an earthquake, we will utilize engineering information to determine the input and output requirements for the alternative hazard mitigation technologies. The question of whether these mitigation steps will be undertaken is a challenging one. We plan to take two approaches. The first is to ask the user groups which steps, in their opinion, would be undertaken given a believable forecast of an earthquake. The second will be to identify the costs and benefits of the alternative steps that could be taken, under the assumptions of a particular model simulation, (e.g., interest rates, external demands, etc.) and to assume that the most economical steps will be undertaken. Concomitant with this effort will be the assessment of the changes in damages that could be expected with each mitigation alternative.

The summarizing equations derived from the process analysis models will then be combined with the econometric and definitional equations for the remaining sectors to create the regional economic simulation model.

Simulation of the Model

Finally we plan to develop three major simulations with variations on the third. The first simulation will be a baseline forecast of economic activity in the Charleston area with no major structural changes and no earthquake.

This is the usual type of forecasting procedure for regional simulation models. We will take data from forecasts of macro models of the U.S. for the national demand variables and generate an appropriate forecast. This forecast will be analyzed for its reasonableness and stability and may lead to revision of the MESPAM equations in the model if the forecast displays unreasonable properties.

The second simulation will be one where an unanticipated earthquake occurs; that is, where no mitigation steps are taken prior to the earthquake. The catastrophic event will change prices and costs as well as generate a number of constraints, phased out over time, and capital losses.

The third simulation will be one where a prediction is assumed with a given lead time prominent geologists feel is reasonable and the most reasonable mitigation steps are taken for the major, critical sectors in the model. A number of variations on the third simulation should be quite easy to run.

Summary

The major research reports of the National Academy of Science dealing with the socio-economic effects of earthquake prediction [1975, 1978] have stressed that the economic consequences of earthquake hazard mitigation must be viewed within the context of an overall regional economic system. How might the regional economy respond to an unanticipated disaster? For comparison, how might the same economy respond to a prediction of an impending earthquake? Finally, we need to simulate the economic effects of alternative hazard mitigation programs within the context of a regional economy. With the exception of the preliminary effort by Cochrane [1974], the regional economic approach has not been developed and utilized.

The major benefits of successful completion of this research project will be four-fold: (1) the model will constitute a pioneering effort to examine the economic effects of earthquake prediction within the context of a demand and supply based regional economic framework; (2) the potential benefits of a simulation model which can be used by officials to evaluate alternative earthquake mitigation policies will be assessed; (3) the model should advance regional economic analysis by its linking of Process Analysis Models to a regional economic system; and (4) with modification, the model can be used to examine the regional and economic effects of hazard mitigation policies for other natural disasters and catastrophic changes.

With regard to the first consequence, it is expected that the methodology developed can be applied to other earthquake prone areas in the United States where the regional economic system is at risk. Moreover, the lessons learned from this effort can serve as a base for improved regional approaches in the future. In addition, this type of model can serve as an alternative to current regional models which are not satisfactory in dealing with other kinds of catastrophic change. For example, we would expect that with appropriate modification, this approach could be applied to hurricane or nuclear hazard mitigation evaluation.

Second, we believe that the regional economic simulation model should prove to be quite useful for policy makers. Efforts will be made to introduce local public planners to the kinds of uses to which the model output could be applied.

Finally, the Process Analysis Models employed have been previously used only for single industries. The problems of how to link such models to other industries within the context of an overall regional model have not received attention. We expect some new results in this regard during this research effort.

FOOTNOTE

1. A Model for Measuring Regional Economic Responses to Earthquakes and to Earthquake Predictions, NSF Grant PFR 80-19826 by Roberts, Milliman, Ellson, and Wallace, University of South Carolina, Columbia, South Carolina.

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THE BENEFITS AND COSTS OF SEISMIC BUILDING CODES[1]

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Introduction

Perhaps the most developed institutional structure for employing earthquake hazards information is use of building codes. Communities in earthquake prone areas typically adopt the provisions of the Uniform Building Code pertaining to earthquake resistant structures. Such building codes have been developed in great part on the basis of ground shaking information. Thus, one of the principal benefits of earthquake hazard mitigation programs is embodied in building codes which reduce property damage and risk to human life from earthquakes.

In estimating benefits of any program which reduces risk to human life, great care must be taken in relating dollar values to safety. Thus, our first task undertaken in the next section is to explain just how safety programs can be valued in terms of a priori measures of the value households place on reduced risk to life. Note then, that economists try to obtain information on how individuals value their own safety, i.e., how much they are willing to pay to live and work under safer conditions, not how much a particular person's life is worth in dollar terms, an objectionable and now discarded concept.

Section 3, building on Section 2, then develops the economic theoretical basis for assessing the benefits and costs of building codes including reduced property losses. Economic analysis is based on expectations. Thus, for example, if the odds of an event which would destroy five percent of the real estate in Los Angeles County are one in one hundred per year, then annual expected losses are $E(L) = 1/100 \cdot .05 \cdot$ (value of real estate in L.A. County).[2] If building codes would reduce damage by 10 percent then annual benefits of building codes (from this source) would be $.1 \cdot E(L)$.

Calculations of the sort described in Section 3 are impossible without some estimate of probability of, at least, major events in the study area, Los Angeles County. It is the purpose of Section 4 to examine the available evidence on event probabilities and likely damages to structures. New evidence on the history of the San Andreas fault is employed to provide data for an analysis using statistical failure theory. This analysis suggests that the annual odds of a large event

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may now be about 1.2 percent. It is argued that, in terms of expected levels of ground shaking, a large event on the San Andreas in southern California is now the dominant fraction of the overall earthquake risk in Los Angeles County.

The probability analysis of Section 4 is then applied in Sections 5 and 6 in order to quantify the benefits of building codes. These sections present preliminary order of magnitude estimates of the annualized expected benefits of reduced damage to structures and increased safety, respectively, from current building codes. These estimates are made for Los Angeles County only to demonstrate the methodology, using a great number of simplifying assumptions, relying mainly on the NOAA study of 1973 [NOAA, 1973]. However, our preliminary benefit results, when compared to costs which are developed in Section 7, suggest that the net benefits of building codes may be substantial and that current codes probably can be justified on the basis of benefit-cost analysis. Section 8 contains qualifications and a summary of our results.

Valuing Safety

The benefits associated with reduced loss of life can be defined as the value to individuals of reducing risk of death from an earthquake. Mishan [1971] was the first to note--at least in the context of benefit-cost analysis--that benefits of reduced risk could be defined independently of any notion of the "value of life". Rather, individuals require compensation to accept small risks voluntarily and such compensation can be observed and analyzed using econometric modeling in market situations--e.g., riskier jobs pay higher wages--and applied as a measure of the benefits of reduced risk (see for example, Thaler and Rosen [1975], and Schulze and Kneese [forthcoming]).

Thus, Mishan distinguished between the concept of the marginal value of safety, which is perhaps ethically acceptable, and earlier efforts to value human life based on lost productivity which have now been universally rejected by economists both on theoretical and ethical grounds. Thaler and Rosen made the initial estimates of the value of safety as determined from wage differentials between jobs varying in the level of job associated with risk of death. Unfortunately, however, their study dealt with a high risk class of individuals. The Thaler and Rosen estimate suggests that in current dollars a small reduction in risk over a large number of individuals which saves one life is worth about $340,000. In another study, Blomquist [1977] examines seat belt use and suggests that the figure might be $260,000. However, this estimate may be biased downward because individuals seem to have biased perceptions of risk which involve an element of personal control such as driving an automobile. Finally, Smith and Deyak [1975], based on work relating industrial wages to job related risk, have suggested that for a more typical population and for job related risks the figure may be about one million dollars. Clearly the marginal value of safety is not precisely known, and perhaps will never be since attitudes and risk preferences presumably can change over time, between groups, and can even vary in different situations. However, these estimates provide a range of values with which to make order of magnitude estimates of the marginal value of safety. Detailed studies can reveal the value of reduced risk in special circumstances such as hazard mitigation.

The theoretical basis of the marginal value of safety concept can be shown briefly as follows: assume that an individual has a utility function $U(W)$, where utility is an increasing function of wealth, W. If the risk of death in any period is, Π, expected utility in that period is $(1-\Pi)U(W)$. If we hold expected utility constant, we have $(1-\Pi)U(W)$ = constant, and the total differential of this equation is:

$$(1) \qquad -U(W)d\Pi + (1-\Pi)U'(W)dW = 0$$

where the prime denotes differentiation. Holding utility constant then implies that the increase in wealth or income necessary to offset an increase in risk is:

$$(2) \qquad dW/d\Pi = U/(U'(1-\Pi)).$$

This is the compensating variation measure of the cost to an individual attributable to an increased risk of death or the marginal value of safety.[3]

Methodological Basis for Valuing Building Codes

Focusing on reduced property losses and on safety benefits resulting from building codes, we can derive the individual's willingness to pay for codes by using the following notation:

Let P_E = annual probability of a large earthquake;

$\Pi°$ = initial risk of death for the individual;

R = additional risk of death if a large earthquake occurs;

W = individual's wealth;

L = losses in the individual's wealth (property losses) if an earthquake occurs;

C = index of the stringency of earthquake resistive building codes;

U = utility, a strictly concave function of wealth;

and $E(U)$ = expected utility.

The individual is assumed to maximize expected utility which is

$$(3) \qquad E(U) = (1-P_E)(1-\Pi°)U(W) + P_E(1-\Pi°-R)U(W-L)$$

or the sum of expected utility if no event occurs $(1-P_E)(1-\Pi°)U(W)$ plus expected utility if an event does occur $P_E(1-\Pi°-R)U(W-L)$. Note in the latter state of the world, risk of death is increased by R and wealth is decreased by L, property losses. Codes will presumably reduce both property losses and risk of earthquake related death, so it is plausible to assume that R and L are both decreasing functions of C, $R(C)$ and $L(C)$ respectively where $R'(C)$, $L'(C) < 0$. Taking P_E and $\Pi°$ and $E(U)$ as fixed, we can obtain a compensating variation measure of the willingness to pay for codes by totally differentiating Eq. (3) and solving for dW/dC where we assume $R = R(C)$ and $L = L(C)$. This yields:

$$(4) \quad \frac{dW}{dC} = P_E \left\{ \overset{(a)}{\left[\frac{U}{P_E(1-\pi^\circ-R)U' + (1-P_E)(1-\pi^\circ)\bar{U}'} \right]} \left(-\frac{dR}{dC} \right) + \overset{(b)}{\left[\frac{(1-\pi^\circ-R)U'}{P_E(1-\pi^\circ-R)U' + (1-P_E)(1-\pi^\circ)\bar{U}'} \right]} \left(-\frac{dL}{dC} \right) \right\}$$

The term in square brackets (a) is simply the marginal value of safety (defined in the previous section as $U/(1-\pi^\circ)U'$), but now adjusted for two states of the world, one in which no event occurs and expected utility is $(1-\pi^\circ)\cdot\bar{U}$ where $\bar{U} \equiv U(W)$ and the other in which an event does occur and expected utility is $(1-\pi^\circ-R)U$ where $U \equiv U(W-L)$. Thus, where we denote the marginal value of safety as MVS and define the reduction in risk to life from codes as ΔR, replacing $-dR/dC$, we can approximate the benefits of safety from codes to the individual as $P_E \cdot MVS \cdot \Delta R$ based on Eq. (4).

The term (b) in square brackets in Eq. (4) can be shown to be approximately equal to unity if R and L are small [Brookshire, et al., p. 111]. Thus, where we define ΔL as the reduction in property losses attributable to building codes if an earthquake occurs, replacing $-dL/dC$, benefits from this source are approximately $P_E \cdot \Delta L$ from Eq. (4).

Thus, the value to an individual of an earthquake building code program can be approximated as

$$(5) \qquad P_E(MVS \cdot \Delta R + \Delta L)$$

where

P_E = annual probability of an earthquake;

MVS = marginal value of safety;

ΔR = reduction in risk of death to the individual;

and ΔL = reduction in property losses.

In summary, the benefits associated with adopting and enforcing earthquake resistive building codes result from the fact that earthquake resistive buildings will sustain less damages in the event of an earthquake compared to conventional-not-earthquake-resistive buildings, and as a result, fewer lives will be lost as well.

The Probability and Expected Damages of a San Andreas Earthquake

The odds and the detailed effects on private property (buildings) of a large earthquake in the Los Angeles area are described in this section.

Probability of Earthquake Events Affecting Los Angeles County

Two types of events might be of particular concern for the study area of Los Angeles County. First, locally damaging events such as the Long Beach or San Fernando earthquakes appear to have an annual probability of at least 1/100, perhaps as high as 1/50 based on the classic article of event probabilities by Allen et al. [1965]. Second, a large event on the San Andreas (slightly above magnitude 8) would have an average ground shaking intensity of Modified Mercalli VII over the entire county (see NOAA, [1973]) and may have a probability of about 1/145 per year. Sieh [1978] has estimated that large events occur on the San Andreas fault in Southern California with an average recurrence interval of about 145 years based on excavations of late Holocene marsh deposits at Pallet Creek. The rest of this section focuses on better estimating the latter probability of a large event on the San Andreas in Southern California, using Sieh's information on the recent history of the fault.

Figure 1 shows approximate dates of probable large events on the San Andreas taken from Sieh [1978] but updated to include a newly discovered event occurring about 1600 A.D. Figure 2 shows the distribution of the 9 intervals between the 10 events that Sieh has identified.[4] This distribution strongly suggests that statistical failure theory as typically applied to aircraft wings, automotive tires, and manufactured parts might be appropriate. This statistical approach to mechanical or structural failures from stress, strain and wearing out uses the Weibull distribution which is a cumulative distribution of the form

$$F(t) = 1 - e^{-\alpha t^{\beta}} \tag{6}$$

where F is the cumulative fraction in a given sample which has failed up to time t, from time zero. The rate at which failure occurs, f(t), is given by the probability density function which is just the time derivative of Eq. (6).

$$f(t) = \frac{dF}{dt} = \alpha\beta t^{\beta-1} e^{-\alpha t^{\beta}} \tag{7}$$

Note that if $\beta > 1$ then the cumulative distribution given in Eq. (6) is "S" shaped and asymptotically approaches one and the probability density function is bell shaped and asymptotically approaches zero. If we consider large earthquakes on the San Andreas fault in Southern California to be failures, we can take the interval between large earthquakes to be the length of time, t, until failure occurs. Thus, we can plot the cumulative data from Sieh in 25 year intervals as shown in Figure 3. For the nine recorded intervals between failures (earthquakes), zero out of nine (0/9) occurred up to 50 years after the last event, one out of nine (1/9) occurred prior to 100 years and so on. Twenty-five year intervals were chosen to reflect some of the uncertainty over the precise date of historic earthquake events. Figure 3 could be constructed on one year intervals which would, of course, exaggerate the precision of Sieh's dating techniques. Similarly, 50 year intervals might be too wide, reducing the number of observations for analysis below the number of intervals.

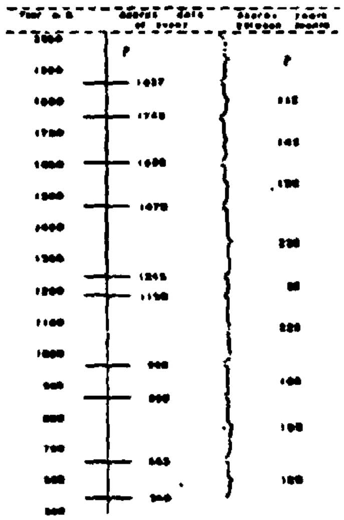

Figure 1

Approximate Dates of Past, Possibly Large, Earthquakes on the San Andreas Fault in Southern California

The geological record indicates that 10 events have occurred since 500 A.D.; on average, once each 145 years.

Only one event (of nine) has likely occurred within 100 years after the previous event and only three events (of nine) have occurred between 150-250 years after the previous events. Five (of nine) events have likely occurred between 100 and 150 years after the previous events.

The last large event on the San Andreas Fault in Southern California was the Fort Tejon Earthquake of 1857, 123 years ago.

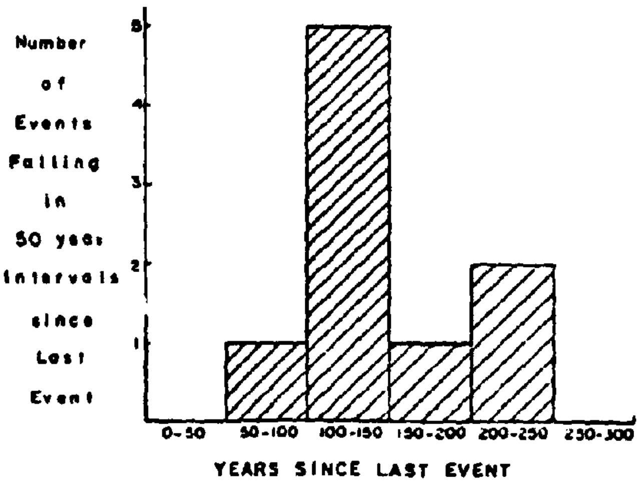

Figure 2

The Nine Intervals Between Events are Distributed as Follows

A Weibull cumulative distribution can be fitted to the nine observations shown in Figure 3 as follows: the function, $F(t) = 1 - e^{-\alpha t^{\beta}}$, can be linearized for application of linear regression by rearranging terms and taking natural logs of both sides so

$$\ln \frac{1}{1-F(t)} = \alpha t^{\beta} \tag{8}$$

Taking natural logs again gives

$$\ln\ln \frac{1}{1-F(t)} = \ln \alpha + \beta \ln t \tag{9}$$

which is linear on the right-hand side. Linear regression yields the following equation fitted to the data of Figure 3:

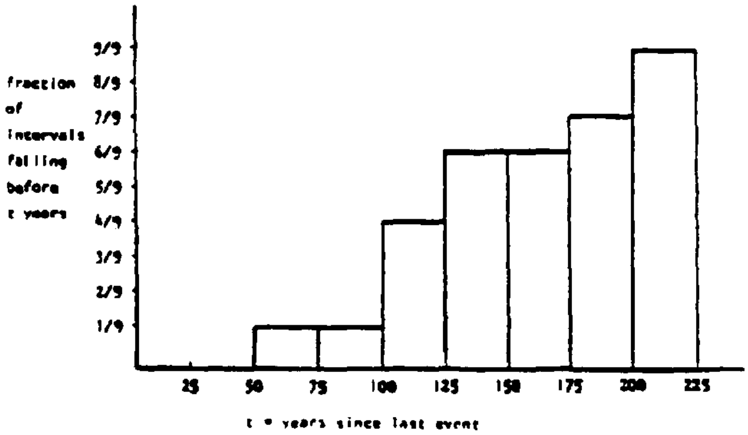

Figure 3

Cumulative Data in 25 Year Intervals

$$\ln\ln \frac{1}{1-F(t)} = \underset{(-8.19)}{-27.57} + \underset{(7.60)}{5.45} \ln t \tag{10}$$

$R^2 = .89$ $F = 57.69$ $DF = 7$

Thus, estimates for α and β are:

$$\alpha = e^{-27.57} \text{ and } \beta = 5.45.$$

The equation is highly significant statistically. Each coefficient is significant at the 99 percent level as shown by the t-statistics in parenthesis below the estimated coefficients in Eq. (10). The high R^2 indicates that a large percentage of the variation in the dependent variable is explained by the postulated distribution, and the F-statistic indicates that the entire relationship is significant at the 99 percent level as well.

Given these estimates of α and β, the resulting estimated probability density function can be plotted against one based on the actual data, and this is shown for comparison in Figure 4. Starting in the year 1857, just after the Fort Tejon earthquake, the probability of an event is about .9 for the year 1980, 123 years in the future. However, given that no event has occurred up to 1980, standing in 1980 (=T*), Bayes' Theorem implies that the probability of an event is

$$p(T^*) = \frac{f(T^*)}{\int_{T^*}^{\infty} f(t)dt} \tag{11}$$

For the Weibull distribution, p(T*) takes the form:

$$p(T^*) = \alpha\beta(T^*)^{\beta-1}, \tag{12}$$

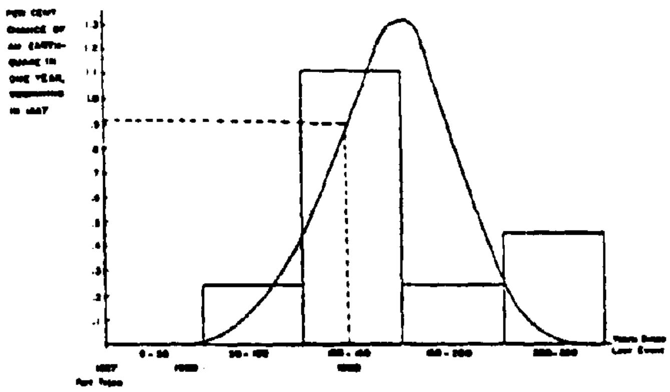

Figure 4

Probability Estimation Based on the Historical Record of Major Events

so the probability of an event occurring in the year T*, given no prior event since year zero, rises at the β-1 or 4.45 power over time. This relationship is shown in Figure 5 and implies that in 1980 the annual odds of a large earthquake on the San Andreas in Southern California are about 1.2 percent; by the year 2000, if no event has occurred, the odds will have risen to 2.3 percent. Using the same approach, the odds of an event over the next thirty years are about 45%.

In summary, given (1) that economic analysis utilizes an expected value approach; (2) that this analysis indicates current odds of a large event on the San Andreas to be about 1.2 percent; and (3) that a large event implies average ground shaking over all of Los Angeles County of MM VII (see NOAA, [1973]), we focus on analysis of a possible large event on the San Andreas throughout the remainder of the study. However, in expected value terms (expected loss in property and life) other events similar to the Long Beach or San Fernando events will, of course, contribute significantly (but to a smaller degree) to expected damages.

Finally, it should be noted that, based on a Weibull analysis similar to the one conducted here and on subjective estimates of the increased risk of an event given geophysical anomalies in the area of the San Andreas fault in Southern California, a recent report by the Federal Emergency Management Agency [1980] has estimated the odds of a large event as being from 2 percent to 5 percent this year (See Table 1. "Major California Earthquakes," p. 15). We thus use as a high estimate of risk the 5 percent figure in our analysis.

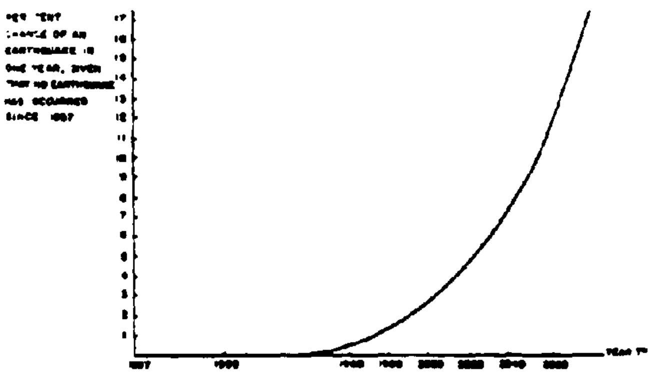

Figure 5

Probability of an Event in T*, Given no Event Occurs Before T*

Property Damage from Ground Shaking

Given an understanding of the odds of a large event, expected value of losses can be calculated if property losses are known. This section develops information on property losses.

The expected damage to single family dwellings in a major earthquake includes damages to home foundation, interior and exterior finishes, and masonry chimneys. The extent of these damages, if they occur, will depend upon the type of structure and finish of the home as well as its age, and upon the intensity of ground shaking.

Figure 6 shows estimates of expected damage to single family dwellings; that is, for each Modified Mercalli intensity level we can estimate the percentage of home value that would be damaged. These percentages have been calculated for new and old homes with chimneys and without chimneys, the lowest occurring in new and old homes without chimneys, and the highest occurring in old homes with chimneys (Figure 6 was derived from computer codes developed by Rinehart, Algermissen and Gibbons [1976]).

For commercial buildings (all structures except single family homes) damages are shown in Figure 7 (this figure is adopted from Algermissen, Steinbrugge and Lagorio [1978]). Note that potential damage is much higher than for single family dwellings, especially for unreinforced masonry, brick, or stone structures. Although such structures may no longer be built under current codes, a significant number of older buildings of this type survive in Los Angeles County, most built prior to the 1930-1940 period.

These relationships are used in the next section to develop property losses.

Benefits from Reduced Property Losses

Increasingly stringent earthquake resistive building codes have been adopted and enforced in California, following the 1933 Long Beach earthquake which killed over 100 people and resulted in 40-50 million dollars in property damage [NOAA, 1973, pp. 56-58]. Therefore, the year 1933 has been adopted as the dividing time for "old" versus "new" buildings. The "old" building desigration refers to those structures built before 1933, assumed here to be built before the implementation of earthquake resistive codes and therefore, to be less earthquake resistant than "new" buildings built after 1933 under earthquake resistant codes (although in some cases, pre- and post-1940 data are used as an approximation in order to utilize census data).

Besides age, buildings are also differentiated by type, since earthquakes result in ground shaking and the magnitude of damages sustained by buildings varies with respect to type of structure. (For example, taller and unreinforced structures suffer heavier damages in an earthquake, other things being equal [see Figures 6 and 7].) To incorporate this factor into the analysis, a distinction has been made between single family dwellings (SFD), which are one or two stories and primarily wood frame structures, and commercial-industrial (C) buildings which are three or more stories and generally constructed of building materials other than wood. Multiple family dwellings are also included in the C category. Furthermore, since single family dwelling units with fireplaces and chimneys are damaged more extensively in earthquakes, other things being equal (Figure 6), the percentage of single family dwelling units (old and new) with chimneys has been estimated and incorporated into the analysis. Summarizing the foregoing discussion, the estimation of benefits associated with property loss reduction can be formulated as:

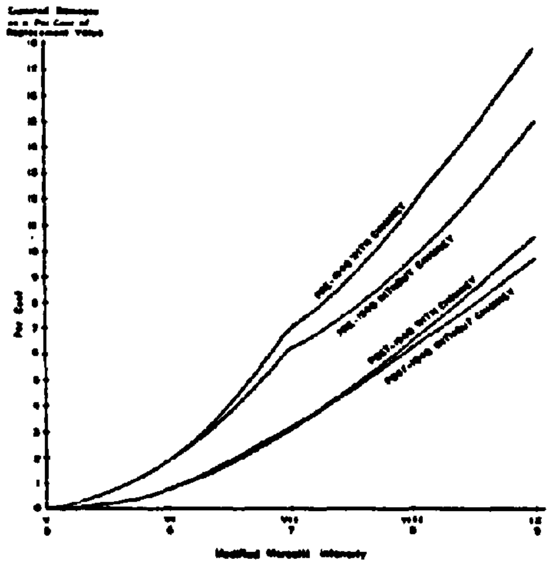

Figure 6

Damage to Single Family Dwellings

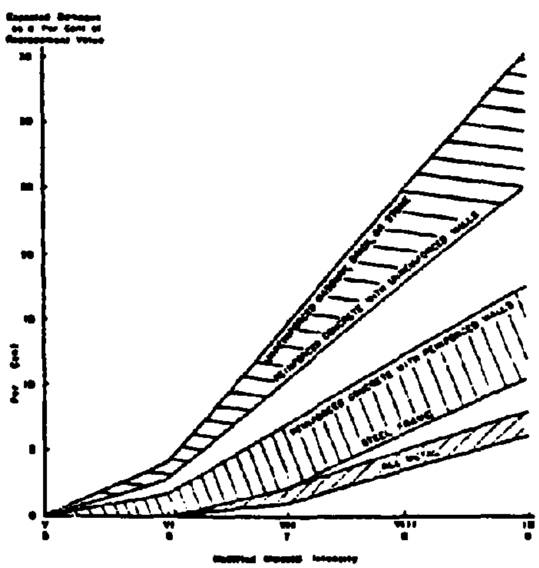

Figure 7

Damage to Buildings by Type, Excluding Single Family Dwellings

$$\Delta L = \Delta L_{SFD} + \Delta L_C$$

where:

$$\Delta L_{SFD} = (\text{value of SFD}) \cdot W_{SFD} \cdot \Delta D_{SFD}$$

$$\Delta L_C = (\text{value of C}) \cdot W_C \cdot \Delta D_C$$

where:

ΔD_{SFD} = change in fraction of damages sustained by single family dwelling units attributed to the incorporation of earthquake resistive building codes, taking into account the percentage of units (old and new) with chimneys

ΔD_C = change in fraction of damages sustained by commercial-industrial buildings (including multi-family dwellings) attributed to the incorporation of the earthquake resistive building codes

W_C = value of new commercial-industrial buildings plus multi-family dwelling units as a proportion of the value of total (old and new) commercial-industrial buildings (including multi-family dwellings)

W_{SFD} = value of new single family dwelling units as a proportion of the value of total (old and new) single family dwelling units.

Based on the information in Figures 6 and 7, for an area-wide average ground shaking intensity of VII, ΔD_{SFD} is estimated at 3.5 percent of building replacement cost, and ΔD_C is about 5 percent. These estimates of ΔD_{SFD} and ΔD_C are probably conservative because the relationship between fraction damaged and ground shaking intensities becomes nonlinear for high ground shaking levels. The fractions of replacement value damaged are applied to the valuations of private and commercial properties made by the Los Angeles County Assessor's Office of $45.9 billion and $80.46 billion respectively. These valuations are weighted by W_{SFD} and W_C, .74 and .83 respectively, which reflect the proportion of the capital stock that is "new" (post-1933). This proportion is estimated by using a "new"/"old" (pre-1933) building inventory of dwelling units conducted by the Federal Emergency Management Agency in Los Angeles.

Utilizing the available data, the reduction in financial losses (or savings) to the community due to reduced property damages in buildings built under earthquake resistive codes would amount to some $4.51 billion in 1980, in the event of a major earthquake on the San Andreas fault. If one takes the probability of such an event this year to be 1.2 percent from the Weibull analysis of Section 4, the expected value of this savings is $54 million per year. If one uses the higher FEMA estimate of 5 percent, the benefit is $226 million per year.

Benefits from Increased Safety

Because structures are made safer when they are built according to earthquake resistive building codes (i.e., property damage is reduced), fewer lives will be lost and less injury will occur in the event of a major earthquake. The benefit to the community in terms of the reduced risk to life can be approximated using the following formulation:

$$MVS \cdot (\Delta R_{SFD} + \Delta R_C)$$

where:

MVS = the marginal value of safety reflecting lives saved

$$\Delta R_{SFD} = (r^{\circ}_{SFD} \cdot \frac{\Delta D_{SFD}}{D^{\circ}_{SFD}} \cdot W_{SFD}) \cdot \text{Population}$$

$$\Delta R_C = (r^{\circ}_C \cdot \frac{\Delta D_C}{D^{\circ}_C} \cdot W_C) \cdot \text{Population}$$

where:

r°_{SFD} = risk of death per 100,000 population in single family

r°_C = risk of death per 100,000 population in commercial structures (including multi-family dwellings) without earthquake resistive building codes)

D^j_{SFD} = damage to single family dwellings, as a percent of replacement cost, in a major earthquake; j = 0, without earthquake resistive codes; j = 1, with earthquake resistive codes

D^j_C = damage to commercial structures (including multi-family dwellings), as a percent of replacement cost, in a major earthquake; j = 0, without earthquake resistive codes; j = 1 with earthquake resistive codes

$\Delta D_{SFD} = D^{\circ}_{SFD} - D^1_{SFD}$

$\Delta D_C = D^{\circ}_C - D^1_C$

W_{SFD}, W_C = weights to reflect new buildings as proportion of the totals (as previously defined).

The risk of death in an earthquake varies with the time of occurrence during the day, depending on where large segments of the population are at those times. Expected numbers of deaths have been estimated for a major event on the San Andreas fault occurring at either 2:30 a.m., 2:00 p.m., and 4:30 p.m. [NOAA, 1973, pp. 151-169]. Many of the deaths at the 4:30 p.m. hour would be caused by freeway collapse during the rush hour, a factor not accounted for by building codes. The estimate of likely deaths at the early morning hour (32.14/100,000) reflects the fact that the majority of the population in Los Angeles County would be in single family dwellings which are mostly safe wood frame structures (although about one-third of the population is in higher risk multi-family dwellings). However, the expected death rate is much higher in the afternoon (143.65/100,000), when it is assumed that only 40 percent of the population would be subject to the lower risk in dwellings and 60 percent of the population would be found in more hazardous commercial areas.

These risk of death factors are apportioned between single family dwellings and commercial structures (including multi-family dwellings) for the 2:30 a.m. and 2:00 p.m. hours. Then, a weighted average risk for any hour can be estimated; in this analysis, the 2:30 a.m. risk is assumed to be relevant for 16 hours and the 2:00 p.m. risk is assumed relevant for the remaining 8-hour work day to arrive at a conservative weighted average for risk of death if a major event occurs.

In order to estimate the reduced risk (or improvement in safety) due to earthquake resistive building codes, the average risk to life is apportioned between risk in old buildings built before codes were in effect and risk in new buildings. This is accomplished by utilizing information about the proportion of new single family dwellings and new commercial buildings to old dwellings and buildings. Assuming this approximates the proportion of the population in new/old structures, risk of death in new and old structures is derived.[5] The property damage estimates in Figures 6 and 7 indicate a 53 percent improvement with earthquake resistive building codes in new versus old single family dwellings, and a 45.5 percent improvement for commercial structures. Assuming that deaths associated with structure damage decrease proportionately with reductions in damage, then R_{SFD} can be estimated to be 10.98 lives saved/100,000 population in the new single family dwellings due to the implementation of earthquake resistive building codes in about three-fourths (W_{SFD} = .74) of total single family dwellings. Likewise, R_C is estimated to be 31.74 lives saved/100,000 in new commercial structures due to codes in 83 percent of the total current stock of commercial buildings (W_C = .83).

Applying these risk factors to a 1980 population estimate of 7.1631 million people in Los Angeles County, the expected savings in life due to earthquake resistive building codes used in structures is about 3,060 deaths avoided. Using a marginal value of safety factor of $340,000-1 million per life saved [Thaler and Rosen, 1975, and Smith and Deyak, 1975], the safety benefit in terms of lives saved due to codes is some $1.041 billion at the lower bound, and some $3.06 billion at the upper bound. Multiplying by an assumed probability of an event this year of 1.2 percent, the expected value of safety due to codes in 1980 ranges from $12.5 million to $37 million. If one uses the higher 5 percent probability of an event, safety benefits range from $52 million to $154 million.

The Costs of Earthquake Resistive Building Codes

In general, earthquake resistive building codes require such precautionary measures as extra bracing between the structure frame (either cross-bracing or sheathing of the inner walls), extra bolting and carrying through of the studs of the structure to its foundation, and extra care and reinforcement in chimney and fireplace construction. In split-level dwellings, extra costs are associated with the requirement of extra wide walls on the garage in the lower level to reduce the possibility of collapse. These types of code designations are required not only for earthquake resistance but also for wind resistant design of dwellings and commercial structures.

Efforts directed toward obtaining the impact of the earthquake resistive building codes on building cost did not succeed in locating any published or quotable estimations of associated costs. Thus, a range of cost estimates obtained from discussions with experts in earthquake resistive building design are used in this analysis. An approximation of 2-3 percent of construction costs is associated with adherence to earthquake resistive building codes in single family dwellings, and 3-5 percent in commercial structures. It should be noted, however, that these costs are not only for earthquake resistance, but also for wind resistance in structures.

Annual extra costs of construction can be derived by applying a real rate of interest of 2-1/2 percent to total costs.[6] Use of this real rate is identical to 9 percent over the life of a home or commercial loan. Therefore, the cost, to Los Angeles County for construction of earthquake and wind resistant buildings as an annualized cost is formulated as:

$$\text{Annualized Cost} = \text{CRF} \cdot [(\text{Total Construction Costs of SFD}) \cdot \Delta C_{SFD} \cdot W_{SFD} + (\text{Total Construction Costs of C}) \cdot \Delta C_C \cdot W_C]$$

$CRF = i/\{1-[1/(1+i)^T]\}$ = Capital Recovery Factor

i = the real rate of interest paid (above the inflation rate) on mortgage loans

T = length of loan (taken to be 30 years)

ΔC_{SFD} = the percentage increase in the construction cost of single family dwellings due to the incorporation of earthquake resistive building codes

ΔC_C = the percentage increase in the construction cost of commercial-industrial structures (including multi-family dwellings) due to the incorporation of earthquake resistive building codes

W_{SFD}, W_C = weights to reflect new buildings as a proportion of the totals (as previously defined).

Total construction costs of single family dwellings and of commercial-industrial structures (and multi-family dwellings) are approximated by the total values of single family dwellings and of commercial structures (and multi-family dwellings), specified as $45.09 billion and $80.46 billion respectively. Weighting these values to reflect the proportion of "new" structures which are assumed to be built according to code specifications (74 percent of all single family dwellings and 83 percent of commercial structures), the range of total costs paid out per year by the community is estimated to be $127.6 million to $207.4 million due to the incorporation of both earthquake resistive and wind resistive building codes.

Obviously, most costs could be attributed to wind resistance and incremental costs of earthquake resistance would be a minor fraction of the $127.6-$207.4 million range for annual joint costs. The proper way to treat this problem from an economic-theoretical perspective is not to apportion costs, but rather to calculate the sum of the benefits from earthquake and wind resistant structures. We will, rather, on a completely arbitrary basis, allocate half of the costs calculated above to earthquake annual cost of earthquake building codes. Thus, as an order of magnitude approximation, we estimate the annual cost of earthquake building codes to fall in a range of $63.8 million - $103.7 million for Los Angeles County.

Conclusions and Caveats

The results from analyzing the post-1933 implementation of earthquake resistive building codes in Los Angeles County are summarized below in the estimates of expected property and safety benefits compared to increased construction costs:

Expected Value of Benefits in 1980
=$67 million to $91 million for a 1.2 percent probability, and $278 million to $380 million for a 5 percent probability of an event

Annualized Costs in 1980
=$64 million to $104 million

It is important to note that benefits are biased downward for several reasons. Some important components of benefits that have not been included due to the difficulty of estimation are the expected value of savings due to codes from the possibility of a San Fernando or Long-Beach type event, expected benefits from the lessening in emergency operations requirements due to safer structures built under codes, and expected savings from the decreased economic disruption that would occur from faster restoration of damaged buildings. Furthermore, though costs due to earthquake resistive building codes are estimated as a fraction of the costs of both earthquake and wind resistant structure design, the benefits estimation covers benefits in an earthquake only and does not account for benefits due to wind resistance for comparative purposes. Finally, a comparison of benefits and costs should not be undertaken for one year on an annualized basis; rather, discounted present values over all future probabilistic states of the world should be used as the conceptual basis.

In summary, the comparison presented between the approximations of expected value of total benefits due to earthquake resistive codes in 1980 and the annual costs associated with adhering to codes in building construction reveals that benefits tend to overlap but mostly exceed costs in Los Angeles County at the present time. For the reasons stated above, this comparison of annual benefits and costs may be viewed only as a qualified justification for the incorporation of earthquake resistive building codes into structure design. (For a complete report on this research see Brookshire et al.[1980].)

FOOTNOTES

1. David Brookshire and John Tschirhart are Associate Professors of Economics at the University of Wyoming, and Ronda Hageman is Assistant Professor of Economics at San Diego State University. The research presented here was supported by a grant from the U.S. Geological Survey. We would like to thank Rich Bernknopf, John Schefter, Bill Watson, Rob Wesson, Bob Wallace, Bill Brown, Walter Hays, Chris Rojahn, Robert Yerkes, S.T. Algermissen, Reza Pazand and Bill Weirick.

2. As a first approximation, we ignore risk aversion in this example.

3. We ignore bequeathment in this simple model which, however, does give characteristics to the marginal value of safety which are consistent with existing empirical studies.

4. Note that the distribution shown in Figure 2 for recurrence intervals shows no evidence of bimodality as claimed by Sieh in his 1978 article. This is the result of including the newly discovered event at about 1600 A.D. which effectively adds two intervals to the 100-150 year column and takes one interval away from the 200-250 year column, thus giving the distribution shown, rather than the bimodal distribution implicit in Sieh's earlier speculative argument of bimodality.

5. See Brookshire, et al., Appendix B, for details on the methodology used to estimate risk of death if no earthquake resistive building codes existed.

6. The historical real annual rate of interest paid on mortgage loans has been about 2.5 percent.

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SECTION V

ATTITUDES TOWARD RISK

DISASTER SUBCULTURES IN EARTHQUAKE COUNTRY:

BETWEEN EARTHQUAKES IN SOUTHERN CALIFORNIA

Ralph H. Turner

From his investigations of hurricanes along the United States coast on the Gulf of Mexico, Harry Moore [1964] concluded that a region subjected frequently to the same disaster agent develops a disaster culture, which "serves to define situations and thereby to determine to a large degree the sorts of actions persons and institutions and communities will take when they find themselves in the stressful situation" (pp. 212-213). The disaster culture includes "those adjustments, actual and potential, social, psychological and physical, which are used by residents of such areas in their efforts to cope with disasters which have struck or which tradition indicates may strike in the future" (p. 195). Paradoxically, the disaster subculture (or more correctly, subculture themes) served both to define an appropriate emotional response to hurricanes, consisting of an often self-destructive pride in one's ability to face the danger, and rational elements that facilitated surival. Similarly, anthropologists (e.g., Cove [1978]) have pointed out that cultural myths are often the repository for disaster survival lore. In a comprehensive and systematic elaboration of the disaster subculture concept, Wenger and Weller [1973] and Wenger [1978] stress both organizational and subjective subculture components, and both adaptive and maladaptive aspects.

In the course of investigating community response to earthquake threat, following announcement by the U.S. Geological Survey of a vast uplift along the San Andreas fault that might be the precursor to a great earthquake in the Los Angeles region, we asked whether there was evidence of earthquake disaster themes in the regional subculture of southern California. Our data include a series of sample surveys of adults in Los Angeles from early 1977 to early 1979, a detailed record of newspaper and other media coverage, and reports on selected organizational and grass roots responses [Turner et al., 1979].

Wenger and Weller [1973] and Wenger [1978] have suggested three conditions that are crucial for development of disaster subcultural themes. Southern California earthquakes fit one of these conditions in producing "salient consequential damage," that cuts "across class and status lines in the community." While earthquake impact is repetitive, which is another of the proposed crucial considerations, disastrous quakes are relatively infrequent. And the seasonal periodicity that facilitates development of tornado, hurricane, and flood subculture

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themes is altogether lacking. But more frequent small tremors serve as reminders. And a combination of historical circumstances has conspired to give California a distinctive identity as "earthquake country."

The third condition, that "subcultures appear more likely to develop if the focal agent allows for some period of forewarning" [Wenger, 1978, p. 41], is definitely not met, except in preparations for aftershocks. For two reasons, the absence of forewarning may not have impeded subcultural development. First, survival knowledge for use during and immediately after a quake is widely diffused. Ninety seven percent of our respondents know they should not get near a window during a quake, 90 percent that they should avoid elevators in tall buildings, 88 percent that an inside doorway or hall is a relatively safe place, 84 percent that it is usually best to stay where you are until the shaking stops, 81 percent that it is relatively safe beneath a sturdy table, 75 percent that one should not telephone police or fire departments for instructions in the quake aftermath, and 66 percent that it is not wise to hurry outdoors. Many southern Californians have learned a repertoire of adaptations to be put into effect at the onset of the quake.

Second, belief in earthquake signs by which the individual can tell for himself that an earthquake is coming is prevalent, and was already well documented at the time of the 1933 Long Beach earthquake [McWilliams, 1933]. Seventy-two percent of our respondents would take seriously an earthquake forecast based on an epidemic of unusual animal behavior, 49 percent would take seriously their own strong premonition or a forecast issued by an amateur student of earthquakes, and 26 pecent the observation of supposed "earthquake weather." Thus folklore may incorporate belief in a period of forewarning when objective evidence provides no such assurance.

Further consideration led to the hypothesis that subcultural themes should be most sharply developed in clusters of neighborhoods where a recognizedly hazardous condition increases the risk from an earthquake or where the destructive impact of an earthquake has been acutely experienced in recent years. The main purpose of the paper is to examine this hypothesis, using the interviews taken in Los Angeles County during January, February, and March, 1977.

Vulnerability Zones

In order to test the hypothesis that distinctive subcultural themes will develop in zones where inhabitants are especially vulnerable in case of an earthquake, we identified census tracts containing the largest proportions of buildings constructed before building codes were revised to incorporate seismic safety requirements in 1934 (n = 542), tracts falling within the potential inundation zones below dams as officially mapped for the California Office of Emergency Services (n = 125), and tracts subjected to both kinds of risk (n = 199). Respondents in each of these three vulnerability zones were compared with respondents from a control sample of respondents living in less vulnerable parts of Los Angeles county (n = 503). Whenever a vulnerability zone differed significantly from the control zone with respect to age, occupational socioeconomic status, educational attainment, household income, or ethnic composition, these variables were controlled by the use of analysis of covariance or other appropriate statistical procedure. Comparisons were made on over 60 variables, including personal characteristics, attitudes and beliefs about earthquakes and earthquake survival, patterns of

Table 1

Significant Differences Between Three Special Samples and Control Sample, with Effects of Age, Social Stratum, and Ethnicity Removed

Variable compared	Old buildings	Combined hazard	San Fernando impact
Significant orientations			
Favorability toward science	—	.05	—
Accuracy of scientific prediction in future	—	.05	—
Earthquake invulnerability	(-).01	—	—
Communication			
Number of media sources	—	—	.05
Topic discussed:			
Quakes around world	—	.001	—
Old unsafe buildings	—	.05	—
Moving out	—	.01	—
Earthquake hazard awareness			
Awareness of groups at risk	—	.01	—
Self in group at risk	—	.001	.05
Know whether fault nearby?	—	.01	—
Is fault nearby?	.001	—	—
Hazard reducing action			
Measures taken and planned	.05	—	.01
Taken for future earthquake	.01	—	.01
Government expenditure for hazard reduction (inclusive)	—	.01	.01
Expenditure for prediction and warning systems	—	.01	.01
Number of suggestions for government action	—	.01	.01
Type of suggestions for government action:			
Structural safety	(-).01	(-).01	—
Emergency preparedness	.01	.01	.01
Scientific research	(-).01	—	—
Evaluation of government preparedness	.01	—	—

communication concerning earthquakes and earthquake threat, awareness of earthquake hazards facing southern California at the time of the investigation, and participation in and support for earthquake hazard reducing action. Differences that were statistically significant are summarized in Table 1, and a complete listing of comparisons made can be found elsewhere [Turner, et al., 1980 , pp. 14-15].

Residents of the inundation zone differed significantly from the control area population on only three variables. In the absence of a clear pattern, these small differences must be attributed to chance.

While residents of the old buildings zone differ from the control sample on relatively few variables, the number of highly significant differences warrants their being taken seriously. Residents are less likely to claim personal invulnerability to earthquakes. They are no more likely to mention "residents of old buildings" when asked to name groups of people in special danger, but they are more likely to include themselves in this group when they mention it. (This difference may be a function of the large Black population in the zone.) More of them think there is an earthquake fault near where they live. Although they are personally no better prepared for an earthquake by our inventory of sixteen measures, they more often attribute such precautions as having a first aid kit to concern over the earthquake danger and more often say they still plan to take further earthquake measures. They have no more suggestions for government earthquake preparedness actions, but they are more likely to suggest emergency preparedness and less likely to suggest such hazard mitigating approaches as improving the structural safety of buildings and conducting more scientific research. And they express a more positive evaluation of government efforts to prepare for a damaging earthquake.

Unlike residents of the inundation zone, these people do show awareness of their own vulnerable situation. Although this awareness has apparently not made them more attentive to news of future earthquakes, and has not moved them to concrete acts of personal and household preparedness, it may have contributed to a greater sense that one ought to be preparing. It is plausible to interpret their disproportionate attribution of actions to the earthquake prospect, and the insistence that they still plan to take additional steps to the operation of some neighborhood social norm of earthquake preparedness. It is surprising that people living in and among the County's most earthquake-vulnerable buildings are no more supportive of government expenditure to strengthen unsafe buildings and even less likely to suggest that government attempt to improve building safety. Possibly living in and among old buildings of doubtful seismic safety gives residents a sense that obstacles to correcting these conditions are insurmountable or that demolishing many of these buildings constitutes an unacceptable threat to community life. Hence they think more of what to do after the inevitable happens than of how to minimize its impact.

Residents in the combined hazard zone differ from the control sample in more respects than residents in the old buildings zone do. Like inundation zone residents, they exhibit no distinctive awareness of the risk of dam failure. Like old building zone inhabitants, they more often count themselves as being among those especially at risk because of living in old buildings. But irrespective of their individual sense of vulnerability, the distinctive plight of old building residents is more salient for them. Like old-building zone residents, they incline toward emergency preparedness rather than enhancing the structural safety of buildings when suggesting government action.

Combined hazard zone residents differ from the control sample in several additional respects. They are especially favorable toward science, have greater faith in the eventual scientific prediction of earthquakes, but also in unusual animal behavior as an earthquake sign, and they register greater support for government spending to improve earthquake prediction and warning systems. They have engaged in more discussion of earthquakes around the world, of the problem of old buildings, and of the possibility of "moving out," and they are aware of a wider range of groups subject to special risk in an earthquake. There are no differences in personal preparedness, or in ascription or intention as there was for the sample from the old buildings zone. But they do have more suggestions for government action and express more support for government expenditure to support earthquake hazard reduction.

These differences between the latter zones are better explained on the basis of the sociologically and historically distinctive natural areas represented. Combined-hazards zone tracts are concentrated on the accessible lower slopes of the several ranges of hills that divide the County, which attracted a high-status population during earlier generations but are by-passed for newer and higher locations today. The distinguished past of these neighborhoods probably contributes to a more sophisticated awareness and more "community," as indicated by the prevalence of discussion, in spite of comparable educational and economic levels and risk from old buildings.

San Fernando Earthquake Damage Zone

Except for a small corner of the old-buildings zone affected by the 1933 earthquake, our vulnerability zones have not suffered severe earthquake damage within the lifetime of even the oldest residents. Vulnerability is thus hypothetical rather than based on collectively remembered experience. Our San Fernando Earthquake zone, consisting of tracts where the greatest damage occured in the 1971 earthquake and where the entire population was evacuated for several days until danger that the Van Norman Dam would collapse had been alleviated, provides a contrast. Although the earthquake was strongly felt and minor damage occurred throughout the County, severe damage, loss of life, and evacuation affected only a restricted area.

The sample from this zone is not significantly different from the control sample on any of the control variables except ethnicity. Since it is overwhelmingly White Anglo, we controlled ethnicity by comparing only the 182 White Anglos (out of 200) in the San Fernando earthquake zone with the 348 (out of 503) in the control sample. The number of significant differences is small. Residents in the zone report more intense experience with earthquakes and more have personally experienced earthquake damage or injury, or have friends or relatives who have. There is a weak tendency for zone residents to glean earthquake information from a wider range of media sources, suggesting sensitization to the topic, but it is not converted into the more active discussion of earthquake topics. Residents are slightly more disposed to include themselves in groups disproportionately at risk from earthquakes. Like residents in the old-building zone, they are no better prepared for an earthquake as individuals and households, but they more frequently say that they still plan to take steps they have not yet completed and they are more likely to attribute whatever preparedness they have achieved to the prospect of an earthquake. Like residents in the combined-hazard zone, they have more ideas for government action and more strongly support government expenditure for earthquake prediction and the development of better warning systems. And like residents in both vulnerability zones, they are more likely to suggest emergency preparedness in making suggestions for government action.

With the San Fernando earthquake zone sample we can answer a further question that helps to deal more precisely with the concept of earthquake subculture. Do San Fernando residents hold distinctive attitudes because as individuals they remember the personal trauma of the 1971 earthquake? Or has the earthquake memory been kept alive through institutionalization and as neighborhood lore, affecting newcomers to the zone equally with those who experienced the trauma personally? This is an application of the more general question of whether a category of persons share attitudes because they are all affected similarly by a common life situation, or because the attitudes are transmitted as part of a subculture [Turner, 1958]. If only the residents who lived in the earthquake damage and evacuation zones in 1971 hold the distinctive attitudes, we should hardly be justified in speaking of a subculture or subcultural themes. On the other hand, attitudes generated by the earthquake experience in individuals may have been diffused and communicated to newcomers to the zone, and kept vital by emergent symbols and discussion.

As a preliminary step, we divided the San Fernando Earthquake zone sample into three categories: those who had lived in the same neighborhood at the time of the earthquake and who named the San Fernando quake when asked for the most recent damaging earthquake they had experienced; those who had lived in the neighborhood less than six years and did not mention experiencing the San Fernando earthquake; and an ambiguous category of people who had lived in the neighborhood less than six years but mentioned experiencing the earthquake. The observed patterns of differences and similarities suggested that both life-situation and subculture processes were at work, producing different reactions.

A more definitive test required that we combine the intrazonal and extrazonal comparisons in a single analysis. In order to avoid excessively small numbers of cases in the cells of the table, we created a simplified fourfold table that could be subjected to a two-way analysis of variance. On one dimension we separated residents in the two zones. On the other dimension we separated respondents who had experienced property damage or injury in an earthquake personally or through close friends or relatives from respondents who reported no such experience. Analysis and interpretation were simplified by the finding that there were no interaction effects. Findings are summarized in Table 2.

The fact that the independent measure of intensity of earthquake experience distinguishes between persons with personal experience of earthquake trauma and those who have not had such experience, while failing to distinguish between residents and nonresidents provides validation for the method of analytic separation we are making. The suburban nature of the San Fernando zone is emphasized by the difference in organizational ties.

Table 2

Effects of Location and Personal Experience of Earthquake Damage: Two-way Analysis of Variance

Variable compared	Significance of F-ratio		
	San Fernando versus control zone	Personal experience with earthquake damage	Two-way interaction
Groups, organizations nearby	.001	NS	NS
Earthquake experience index	NS	.001	NS
Number of media sources	NS	.002	NS
Awareness of Uplift	NS	.031	NS
Self in group at risk	.044	NS	NS
Know whether fault nearby?	NS	NS	NS
Measures taken and planned	.002	NS	NS
Taken for future earthquake	.011	.002	NS
Government expenditure for hazard reduction (inclusive)	NS	NS	NS
Expenditure for prediction and warning systems	.003	NS	NS
Number of suggestions for government action	NS	.014	NS

Gleaning information about earthquake matters from a wider range of media sources, being more aware of the uplift (Palmdale Bulge) and its potential significance, and being able to offer more suggestions for government action all follow the pattern that suggests the effect of having personally experienced earthquake trauma rather than the effects of subculture. Although three variables supply a scant basis for generalizing, they do suggest a common manifestation of sensitization to the earthquake hazard or special interest in the topic.

Another three variables fit the subculture-effects pattern. Stating the intention to make additional earthquake preparations, supporting government expenditure for prediction research and improving warning systems, and perceiving oneself as belonging to a group especially at risk distinguish San Fernando earthquake zone residents irrespective of whether they have personally experienced earthquake loss. These items convey a more normative orientation, that the government should act and that individuals ought to be prepared, while being in a special risk group provides some of the justification for the normative element.

One item, the tendency to ascribe personal preparedness measures already taken to a concern over future earthquakes, shows significant effects of both personal experience and subculture. On a strictly _post hoc_ basis this response seems plausibly to combine the element of sensitization to earthquake concerns with the normative element of an obligation to prepare for an earthquake.

For most items, the two analyses produced the same outcomes. Two items dropped out in this more definitive anlaysis and one was diagnosed differently.

We do not find evidence in these data of a comprehensive or potent disaster subculture localized in the zones of the 1971 earthquake damage and evacuation. We are left with very few differences between the people in these zones and elsewhere. Nevertheless, some plausible evidence for a modest but noticeable subculture effect has been adduced. The absence of heightened levels of interpersonal discussion seems to rule out the most effective mechanism for establishment and maintenance of disaster subculture themes. But the fact that the items providing ultimate support for the subculture hypothesis seem to incorporate a normative orientation toward earthquake preparedness lends plausibility to the conclusion that truly subcultural elements have been uncovered.

Conclusions

In reviewing these findings, we must first emphasize that an impressive array of important variables show no differences between the special zones and the control sample. There are no differences in awareness of the threatening uplift (Palmdale Bulge), number of predictive announcements remembered or taken seriously, extent of fear and concern about earthquakes, sense of increased concern during the preceding year, or level of personal and household earthquake preparedness. If these attitudes, cognitions, and actions are affected by subcultural themes, they are not localized according to zones of differential vulnerability and traumatic earthquake experience.

There is little consistency in the findings for the three zones of old buildings, combined hazard, and San Fernando earthquake. Only a disproportionate tendency to suggest improving search and rescue and other post-disaster response capabilities characterizes all three zones. While it is eminently plausible that a heightened sense of personal vulnerability could lead to greater concern with what happens _when_ an earthquake strikes, a single variable is a slender reed on _which_ to support a broad generalization.

Besides the evidence of distinctively shared attitudes and responses, we need a credible account of how the attitudes and responses are diffused through the population, if we are to accept the conclusion that there are localized subcultural variations according to disaster vulnerability and experience. Three kinds of evidence are available in this connection. First, certain characteristics can be plausibly interpreted as indicators of normative pressure. The sense that one ought to be doing more than one is, and the practice of ascribing commonplace prudence to the earthquake threat are both plausible symptoms of weak but nevertheless real social pressures, such as would be expected if subcultural process were at work. Second, interpersonal discussion among family, friends, neighbors, and co-workers should be a crucial medium for subcultural diffusion. But only the combined hazard population differs in this respect. Nevertheless, each of the three populations satisfies one of these first two criteria.

The third kind of evidence concerns the possible use of the mass media as an agent of subcultural diffusion. Content analysis of the widely read Valley News revealed disproportionate emphasis on the need to prepare for a future quake and on organizational and governmental preparedness, but not on personal preparedness. Thus the community newspaper may have contributed to the slight evidence of earthquake subcultural themes in the San Fernando earthquake zone.

There is another formulation that might fit our data more adequately than the formulation concerning zonal subcultures. A culture may be thought of as a mix of exemplary patterns and prescriptions, resources, and a map. Customs, values, mores and similar elements are familiar examples of exemplary patterns and prescriptions. Resources are the tools, including strategies and techniques, that are available for coping with a wide range of situations. As a map, the culture identifies figure and ground in the world of experience and identifies the special significance of objects, places, and experiences. The important feature of a map is that it alerts the reader to respond differently under different circumstances.

The concept of culture as a map is important because it allows us to explore the possibility that the different responses we find in different zones are the manifestations of a common culture whose carriers are responding to the various ways in which the zones are identified on the master map. We may have been on a false course in thinking of distinctive zonal subculture. The all-encompassing map would enable us to deal with the anomaly that residents in two zones seem to be under normative pressure to prepare their households for an earthquake, but report only average levels of discussion of earthquake topics with their family, friends, and co-workers. The social pressure might arise from the fact that something about their local situation is singled out on the map supplied by the larger regional subculture. It would also enable us to deal with the fact that feeling oneself to be a member of an especially vulnerable group does not imply any disproportionate awareness of especially vulnerable groups--even of the group in which significant numbers include themselves.

From this point of view there may be an earthquake awareness theme in the regional subculture of southern California. This subculture is not restricted to any zone within southern California, but is shared throughout the County and environs. Awareness of the vulnerability of old buildings is prevalent throughout the County, without being much more prevalent in neighborhoods where such buildings are clustered than in the County at large. The memory of the San Fernando earthquake is similarly stamped in the cultural tradition of the County and is not restricted to the damage zone. Old brick buildings and the San Fernando damage zone are starred on the cultural map, so people who frequent the appropriate areas feel that they are in special danger and feel that they ought to be doing something to protect themselves from the earthquake threat.

This conception provides a more plausible explanation for some of our findings than the concept of zonal subcultures or subcultural themes. Combined with the idea of natural area subcultures and ethnic or racial subcultures through which the earthquake threat is given distinctive slants, it may explain most of our findings. However, insofar as there are institutional mechanisms such as the San Fernando Valley News that foster an earthquake awareness that is rooted in the unique and recent earthquake history of the area, the idea of a distinctive earthquake theme contributing a subcultural distinctiveness to the San Fernando earthquake impact zone may continue to enlarge our understanding.

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PUBLIC RESPONSE TO MANDATED EARTHQUAKE

HAZARD DISCLOSURE BY REAL ESTATE AGENTS

Risa Palm

Among the legislative responses to the damaging Sylmar earthquake in California (1971) was the Alquist-Priolo Special Studies Zone Act. In addition to requiring the delineation of zones encompassing potentially and recently active fault traces, an amendment to the act (1975) required that prospective buyers of property within the surface fault rupture zone be informed of this potential hazard. The responsibility for disclosure was placed on the real estate agent, unless the sale was consumated without an agent. The response of the California Association of Realtors (the professional and lobbying organization representing approximately half of the licensed real estate agents in California) was that the legislation would "not only insure that buyers and potential buyers of property are aware that their land may be subject to fault displacement, but also to actually reduce projected geologic losses" through the banning or modification of construction itself [Gillies, 1976, p. 2]. Few complaints of non-disclosure were registered with the Department of Real Estate which has the power to issue or revoke real estate licenses, [Liberator, 1979], and it was assumed that the legislation was trasmitting "complex hydrologic, seismic, and other geological information...to real-estate buyers before the sale [Kockelman, 1980, p. 71]. In addition, analysis of house price trends in Los Angeles seemed to show that the legislation had "created a restructuring of demand for housing," resulting in a systematic drop in house prices within the zones [Brookshire and Schulze, 1980, p. 67].

What is interesting about this legislation to the non-Californian is the question of whether such practices are effective means of disseminating natural hazards information to the general public. The policy issue is whether legislation requiring disclosure by real estate agents of natural or human-made hazards associated with the residential environment should be adopted elsewhere. This question is of importance because of the interest shown in mandating disclosure by real estate agents in other states (such as efforts in Texas to disclose storm surge hazard areas) and by federal agencies (such as the current HUD regulations requiring the disclosure of proximity to a nuclear weapons plant). Such legislation may be considered or even adopted with only vague notions about the effects it does or does not have on the homebuying public.

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In addition to the policy issue, the legislation poses an interesting theoretical question: does the mere provision of environmental information result in a measurable change in the behavior of homebuyers? To posit an affirmative answer to this theoretical question requires a review of previous research on the conversion of information into behavioral responses.

The adjustment of individuals and societies to natural hazards has been linked to theories of decision-making, such as the maximization of expected utility, bounded rationality and the principle of "satisficing," and probabilistic information processing by human beings (such as over-generalization from a small number of cases, inaccurate perceptions of randomness, misperceptions of correlation and causality, and the use of the "anchoring and adjustment" heuristic problems of varying availability in information, and problems of integrating information obtained from multiple sources [Slovic, Kunreuther and White, 1974]. In addition, it has been suggested that research within social psychology and communications on "fear appeals" are directly related to responses to natural hazards [McClelland, 1981]. In this section, the relationships between response to disclosure of surface fault rupture zones and two of these research themes is suggested.

Research within the framework of "expected utility theory" [Von Neumann and Morgenstern, 1947] and its less deterministic and rationalistic variants provides a set of expectations which can be applied to the response of homebuyers to mandated hazards disclosure. In brief, this framework postulates that under conditions of uncertainty, the decision to take or to avoid risk can be understood as utility functions derived from combining the sets of possible outcomes with the probabilities that various outcomes will occur. People are assumed to be risk-averse, preferring a known but smaller pay-off or loss to the possibility of either a large loss or a large pay-off. However, in the case of response to low probability events such as natural disasters, several studies have observed risk-taking behavior (or seemingly convex utility functions). This anomaly may be explained by the existence of a probability threshold below which risks are not taken into account [Kunreuther, 1978; Slovic, et al., 1977], or the possibility that homebuyers do not have full and accurate information about factors such as fixed losses and pay-offs essential to decision-making resulting in risk behavior [Kunreuther, et al., 1978]. In addition, since the home purchase decision is made in the context of a larger set of decisions, it is possible that while portions of the total decision may not fit the utility maximization model, the overall decision does; in other words, environmental uncertainties may not be amenable to analysis apart from the total set of constraints and utilities influencing the household [Pashigian, et al., 1966]. This complex decision environment suggests the need to understand the context of the decision, particularly where probabilities and outcomes are uncertain [Schoemaker and Kunreuther, 1979; Hershey and Schoemaker, 1980].

A second general approach to the issue of information provision and behavior change analyzes the impact of the communications process [Zimbardo and Ebbesen, 1970; McGuire, 1968]. Studies of manipulative or persuasive communication suggest that a given source (the real estate agent) has more impact on the receiver (the homebuyer) if he/she has high credibility. Such credibility is a function of both buyer perceptions of the expertise of the agent, and the extent to which the buyers trust that the agent is providing unbiased information. In addition, the agent has more influence if the information and opinions expressed by the agent are already shared by the buyers.

Other research suggests that attitude change by the homebuyer is maximized if conclusions from the information are unambiguous, if recommendations for action are explicit and feasible, and if buyers' attitudes towards the recommended actions are congruent with the recommended behavior changes. External attitudes or beliefs may also affect response to information. In the case of homebuyers, the perception that there are no alternative locations free from earthquake hazards or the belief that there is little an individual can do to prevent death, injury, or damage from "an act of God" if one is fated to experience a natural disaster would interfere with avoidance or mitigation behavior.

Finally, the information disclosed must be instrumental to the goals of the homebuyer. The existence of surface fault rupture zones would have to be important to the buyer in his attempt to attain housing goals such as a safe and secure property. If other goals are more important in the home purchase decision, such as location in a homogeneous and high-prestige neighborhood as an expression of social status [Perrin, 1977], then information on environmental hazards may be considered to be of little importance.

In short, behavioral response to hazards information can be expected only under very special conditions [Saarinen, 1979;] [Wyner and Mann, 1978]; [Saarinen and McPherson, 1977]. Baumann [1980] suggests that the optimum conditions for a message to be heeded are that: first, the information is made personal to the homebuyer; second, information on risks, costs, and benefits be made very specific; third, information should be clear and unambiguous; fourth, mitigation measures should be precisely prescribed; fifth, information must originate from a credible source; sixth, social reinforcement of the information should be present; seventh, multiple and supporting messages should be provided; eighth, fear appeal or positive action appeal should be used appropriately based on an understanding of the intended audience; and last, previous attitudes, values, and beliefs must be considered in designing the message.

This brief review suggests that the relationship between the provision of information and behavior change is extremely complex. Yet legislative decisions have been made as if the relationship were simple and straightforward, and conclusions about market responses have been drawn as if mandated disclosure were obviously and unequivocally linked to the provision of environmental information [Brookshire and Schulze, 1980]. To bring into focus the relationship investigated, one can hypothesize the set of circumstances which would lead the buyer to a measurable response. A measurable response is defined as (1) the avoidance of the purchase of a house in the special studies zone, or (2) an attempt to bargain with the seller for a reduced price in exchange for the buyer's assumption of environmental risks--a form of self-insurance, or (3) the adoption of mitigation measures after the buyer has moved into the house. The circumstances necessary for a measurable response include: (1) the buyer must be motivated to listen to the disclosure--earthquake hazards must be viewed by the buyer as significant in the attainment of housing goals; (2) information about the zones must be accurate and unambiguous--the real estate agents must know the house is in the zone, must know the definition of the term "special studies zone," and must transmit the importance of this information; and (3) the buyer must believe that it is possible to lessen the risk by either forgoing purchase of a house in a special studies zone or by adopting mitigation measures. Evidence of buyer response would include (1) statements by buyers that disclosure resulted in an attempt to negotiate more favorable sales terms, their avoidance of the zones in favor of similar nearby areas, or their adoption of mitigation measures, (2) statements by real estate agents that they had had clients dissuaded from purchasing homes within the zones as a result of the disclosure, or (3) houses within the zones should command lower selling prices than houses with comparable characteristics in similar neighborhoods outside the zones.

The San Francisco Bay area was the setting for a survey of homebuyers and real estate agents, as well as a study of housing market activity. Two areas were selected for homebuyer and real estate agent surveys: Berkeley and central Contra Costa County. A third was included for analysis of market trends: southern Alameda County. These areas are not a representative sample of residences in all California special studies zones, and therefore the surveys and statistical analyses should be interpreted only as case studies of housing submarkets which may differ markedly from other portions of California. The Berkeley and central Contra Costa County special studies zones lie within housing submarkets [Palm, 1979], and are generally inhabited by white, upper-middle-class households in single-family detached dwellings. Their most notable contrast is that they are located on different fault traces, and that there is far more visible damage from fault creep in Berkeley than in Contra Costa County.

The Response of Homebuyers to Disclosure

Surveys of recent homebuyers were taken in 1979. All homebuyers who had purchased properties within the Berkeley and central Contra Costa special studies zones within the six months preceeding the interviews, and a sample of those in areas outside the zones but within three miles were interviewed.

Respondents within the special studies zones indicated that they placed a low priority on environmental factors in their purchase decisions. In a structured question asking the buyers to evaluate fifteen factors which might have influenced their decision, "location out of floodplain" and "distance from an active earthquake fault" were appraised as "not important" or "not considered" in the purchase decision. A comparison of the responses of buyers in nearby areas outside the zones showed a similar disregard for environmental factors--there was no significant difference in attitudes to "distance from active earthquake fault" in the two settings.

Although the survey was done within six months after change of title was recorded, a majority of the homebuyers were unaware that their house was within a special studies zone. Households in the zones were asked "is your present homein a special studies zone?" or "as far as you know is your home located in a specially designated earthquake-prone area as defined by state or federal law?" or "when you first signed a contract offering to buy the house you are living in, do you recall the real estate agent providing you with a form or an addendum to the contract indicating anything special or particular about the location of the house?" If the buyers answered all of these questions negatively, it was assumed that they did not recall the term, the concept, or the process by which disclosure took place. Of the 207 respondents, only 94 answered one of these questions affirmatively; Berkeley homebuyers were far more likely to be aware their homes were within a zone than those in Contra Costa County. It is interesting to note that there was no significant difference in the proportion of recent buyers within and outside the zones who were aware of the term "special studies zone": mandated disclosure did not increase the likelihood that residents were familiar with the designated environmental area within which they lived.

Not surprisingly, most of the within-zone homebuyers said that the location of the house within a special studies zone made no difference in their purchase decision. Perhaps more suprising was the fact that a similar percentage of residents outside the zones indicated that the location of the zones made no differences in the home purchase decision--for both groups in both study areas, the zones affected the decisions of only a small minority of homebuyers.

When asked whether people living in the zones are more susceptible to losses from earthquakes compared to those who live elsewhere in the Bay Area, the majority of the zone residents said the zones made no difference. On this question, residents of nearby areas differed: they were more likely to believe that living near a fault makes one more susceptible to losses, and were also more pessimistic about the likelihood of a major damaging earthquake occurring in the area while they were living there. Despite this, the overwhelming majority of zone residents feel that zones will affect neither the price or the house of their ability to sell it when they decide to move again.

Berkeley residents were more likely to purchase earthquake insurance, but only a small minority in either area indicated they had earthquake insurance. In addition, there was no significant difference in the percentage of those within and outside the zones that had purchased earthquake insurance--in no case did the percentage rise above 38 percent (for the Berkeley special studies zones respondents), and the lowest percentage was for the within-zone Contra Costa residents--only 2 percent had earthquake insurance.

When residents of the zones were asked about the adoption of a series of mitigation measures, most responded that they had not adopted the measures nor did they intend to do so. In comparison with a random sample of Los Angleles County residents surveyed by Turner in 1977-78 [Turner et al., 1979], Bay Area special studies zones residents were less likely to have instructed children about what to do in an earthquake, to have established emergency procedures at residence, to have made plans for a reunion after an earthquake, to have such items as a working battery radio, flashlight, first-aid kit, food, and water particularly because of an earthquake threat, or to have set neighborhood responsibility plans. Bay Area special studies zones residents exceeded the general population of Los Angeles County only in insurance inquiries and purchase, structural reinforcements, and the replacement of cupboard latches.

In short, recent homebuyers whether within the zones or outside the zones were generally unconcerned with hazards associated with surface fault rupture. The existence of the zones made little difference in the home purchase process, even when homebuyers were aware of their significance. Few had used the zones to attempt to negotiate a lower price from the sellers (less than 5 percent), only a small minority had purchased earthquake insurance, and almost no one felt that the location of the house within the zone would impair its future price or salability. Disclosure had neither dissuaded buyers from purchasing homes within the zones, nor encouraged them to adopt mitigation measures after moving in.

Surveys of real estate agents confirmed the views expressed by homebuyers. The survey was limited to agents named by the homebuyers as having helped them in their recent home purchase. This sampling method was decided upon to ensure that only those agents actively involved in selling property and presently doing business within the zones would be contacted, and so that the responses of buyers and real estate agents could be matched.

Five notable results emerged from the real estate agent survey. First, most of the real estate agents could recall that "special studies zones" refer to earthquake fault areas, although a full 12 percent incorrectly identified the term (indicated that the special studies zone was either a floodplain or an area in which transportation surveys would be taken). Second, most real estate agents used the contract addendum developed by the California Association of Realtors as the means of disclosing special studies zone location. This means that disclosure takes place at the time the purchase contract is signed, after the buyer is fairly committed to purchasing that particular property. Third, few real estate agents had ever had a client decide not to buy a home after being informed that the property was within a special studies zone. Only 16 percent had ever had such a refusal, and only 4 percent had more than three such refusals. Fourth, most real estate agents do not believe that people who live in special studies zones are more likely to suffer financial losses or physical injuries in the event of an earthquake compared to people who live elsewhere in the Bay Area. What this indicates is that even when real estate agents make the disclosure in good faith, they are not themselves convinced that what they are dislosing has any major significance for the safety or economic security of the buyers. Finally, about 96 percent answered that real estate agents should be required by law to make the disclosure of special studies zones. When their answers were probed, they indicated that this requirement provides them with a form of insurance against future lawsuits if a future major earthquake should damage the properties they sold.

Real estate agents seemed resigned to the existence of a disclosure regulation, and although they indicated they would prefer more information on the meaning of the zones, they accept the contract addendum as proof that they have not misrepresented "material facts concerning the transaction" [Smith v. Zak]. The most common disclosure procedure follows the ideal sales practice: disclosure takes place at the time it is least likely to jeopardize the sale of the house. Since few sales were adversely affected by the disclosures, the agents are relatively content with the existence of the regulation.

Finally, house price levels for houses within, adjacent to, and outside the special studies zones were analyzed for Berkeley, central Contra Costa County, and a third submarket, southern Alameda County. Hedonic price indicies [Griliches, 1967] were calculated for house price levels in 1972 (before the dislosure legislation had been passed) and in 1977 (two years after the legislation was in effect). Data on properties sold in the three study areas were obtained from the appraisal reports of the Society of Real Estate Appraisers. Equations included data on square footage of dwelling space, age of the house, quality of the house, condition of the house, size of the lot, and presence of such elements contributing to price levels as a swimming pool, fireplace, or a "view lot." Data on the general economic status of the area (percentage of professional-managerial employees among residents of the census tract), and housing stock composition (percentage of single-family dwelling units in the census tract) were added based on data from the 1970 Census of Population. It should be stressed that since these three areas were previously established as separate housing submarkets [Palm, 1979], equations were run for each of the study areas individually rather than aggregating them into a whole for the metropolitan area. It is believed that this is an important step to reduce biased estimates which may be due to submarket variations [Straszheim, 1975].

Location with respect to the special studies zone was coded as a dummy variable, and three equations were run for each study area for each year: one for houses within the special studies zone, a second for houses within one mile of the zone, and a third for houses beyond a mile of the zone. The research hypotheses were that in 1972 location in the special studies zone was unrelated to house price (the coefficient should be near zero), but in 1977 location in the zone should be negatively related to house price. In addition, it is possible that in 1977, location near the zone would have a positive coefficient because of an increased demand for houses near, but not actually in, the zones. Location outside the zones should continue to have no effect on house prices.

The results of the set of ordinary least squares equations are complex (Table 1). The study area which best approximated the research hypotheses was Contra Costa County. There, the negative effect of the special studies zones on house price level was strengthened between 1972 and 1977, the effect of adjacent areas was reversed from negative to positive between 1972 and 1977, and the effect of distant areas reversed from a weak negative to a significant positive. Location in the zones remained a negative influence on house price throughout the period, but increased in effect from -$912 in 1972 to -$4182 by 1977. Most of the research hypotheses were confirmed in this example: although the within-zone 1972 effect was negative, the coefficient was not significantly different from zero at .05; by 1977 this variable had increased to a significant negative effect. This statistical finding is somewhat surprising in light of the general lack of awareness of the existence of special studies zones on the part of recent homebuyers within and outside the zones, and the lack of salience which proximity to an earthquake fault had for all homebuyers. However it could be argued that the small effect of the few buyers concerned with proximity to fault traces might have been sufficient to weaken overall demand within the zones, resulting in a decline in prices there.

In the Berkeley area in which there was generally greater awareness and concern with proximity to a fault trace, the opposite effect on house prices is observed. Rather than weakening house prices, location in the special studies zones seemed to boost prices. Again, "view" and "social status of the area," as well as quality and condition of the dwelling unit were taken into account in the equation. Yet location in the special studies zone had a positive impact on house prices in both 1972 and 1977, increasing the overall price by $2617 in 1972 and $9618 in 1977. Location in nearby areas also had a positive impact on house prices in both years, and location outside the zones had a statistically significant negative impact on house prices in both years. Although the Berkeley equations should not be interpreted as indicating a positive preference for residence along fault traces, it can be said with some confidence that the disclosure legislation was not translated into a weakening of demand or lowering of house prices within the Berkeley zones.

The results of a third set of equations, for southern Alameda County, differed from those obtained for Contra Costa and Berkeley. Location in the special studies zone showed a weak but insignificant negative relationship with house price, a relationship which became weaker over the 1972-77 period. Location in adjacent areas had the opposite effect on house prices than that hypothesized: from a significant positive effect to a fairly weak negative effect. Location beyond the zones had no significant effect on house prices in 1972 and a weak positive effect in 1977.

To summarize the results of the hedonic analysis, the submarket effect was consistent. In areas in which buyers showed most concern for earthquake fault location, the effect of the zones on prices was positive; conversely where buyers were least informed or concerned with the zones, the zones seemed to have a negative effect.

Despite the relatively high overall explanatory power of the equations (coefficients of determination of .74 for Berkeley, .67 for central Contra Costa County, and .75 for southern Alameda County in 1970, it is likely that some unspecified variable or set of relationships affects house price levels, an effect which seems spatially correlated with the special studies zones . It is suggested that it is not the zonation itself that has had a positive or negative impact on house prices, but some other correlated neighborhood characteristics omitted from the equation.

Discussion

The combination of survey evidence and market behavior provides little indication that buyers had responded in any measurable way to special studies zones disclosure. Several of the reasons for non-response are derived from theoretical literature linking information provision with behavior change.

The seemingly risk-taking behavior may be explained by a combination of threshold effect (the probability of a major damaging earthquake over a short time-span is too low to be considered a serious threat), and the likelihood that homebuyers do not have sufficient information concerning fixed losses and pay-offs. In addition, the home purchase decision involves a complexity of factors of which environmental hazards play only

Table 1

Effects of Location in Special Studies Zones on House Prices

Location	1972 Beta for price impact in dollars (significance)	1977 Beta for price impact in dollars (significance)	Hypothesized effect	Observed effect
Southern Alameda County				
Inzone	-741 (.166)	-243 (.807)	negative	none
Adjacent	807 (.030	-1062 (.101)	positive	none
Outside	-422 (.234)	1121 (.078)	none	positive at .10
Multiple r^2 =	.74	.75		
Berkeley				
Inzone	2617 (.000)	9618 (.092)	negative	positive at .10
Adjacent	1162 (.061)	9118 (.092)	positive	positive at .10
Outside	-3121 (.000)	-1315 (.004)	none	negative at .01
Multiple r^2 =	.84	.74		
Central Contra Costa Country				
Inzone	-912 (.307)	-4182 (.000)	negative	negative at .00
Adjacent	-473 (.620)	1500 (.048)	positive	positive at .05
Outside	-623 (.377)	1705 (.007)	none	positive at .01
Multiple r^2 =	.55	.67		

Variables used: square footage of dwelling unit, lot size, condition of the dwelling unit, quality of the dwelling unit, age of house, "view," presence of fireplace, presence of swimming pool, type of mortgage, percentage of professional and managerial in census tract, percentage of single family dwellings in census tract.

a small part; while the overall purchase decision might be evaluated as maximizing subjective expected utility, the environmental component of the decision is overwhelmed by other effects.

The failure of the provision of information to result in behavioral change may be also partly attributed to the fact that the necessary conditions for effective persuasive communication are not present. First, the information source (the real estate agent) may not have sufficient credibility. This may result partly from the economic function of the agent as representing the seller in the house transaction, and partly from the finding that not all real esate agents are well informed concerning the meaning and implications of the special studies zones. Second, disclosure is not accompanied by specific recommendations of purchase avoidance or adoption of mitigation measures; obviously the disclosure is made with a minimum of flourish, and at no time does the real estate agent counsel the buyer to forgo the purchase or to invest in mitigation measures. Finally, the information provided in the disclosure is probably not perceived as instrumental to the attainment of the most important of homebuyer's goals. Since one of the primary factors in the purchase decision is the potential of the house as an economic investment, and because buyers often intend to stay in the house for only a short period of time, long-term environmental safety is of little concern. Since it is relatively unlikely that a major damaging earthquake will occur during the period that the homebuyers are living in the house they have purchased, they do not hesitate to buy a home in the special studies zones as long as they believe the house has a good potential resale value. Similarly, homeowners will not adopt costly mitigation measures, since to the individual these measures are not cost-effective and will not be recouped in a subsequent house sale.

A related issue is that of the significance of the zones. It is important to note that although the special studies zones were defined to outline traces of active faults, they were never intended to include all of the areas susceptible to damage from earthquake. Indeed it has been estimated that the damage from surface fault rupture accounts for only about 10 percent of the total damage potential associated with seismic activity: the remainder is related to liquification, shaking, or ground failure. It is therefore possible that the rare sophisticated buyer who knows his house is near, but not directly on, a fault trace may be correct in an assessment that because of the bedrock conditions underlying the property, location in the special studies zones may be safer than one on an unstable slope or landfill.

Conclusion

The problem of the utilization of land containing traces of active faults is not effectively dealt with by the mere discosure of the existence of surface fault rupture zones to prospective buyers. There has been little response to mandated disclosure for many reasons, including the problems of credibility and role conflict on the part of the information agent (the real estate agent), the emphasis placed on the house as a financial investment rather than a permanent commitment to place by buyers, and the belief by buyers (not contradicted by real estate agents) that there are few real alternatives. When this latter belief is combined with the existence of a "seller's market" with an excess of demand over supply, buyers have little choice but to purchase a home they can afford whenever and wherever it becomes available.

These findings suggest several legislative needs. First, the state legislature should consider dealing with the full range of hazards, natural and human-made, facing residents. If earthquake hazards are deemed more important than some others, and if the legislature wishes to take effective action to mitigate these, it must deal with a more comprehensive definition of earthquake hazards, and reconsider legislation to better inform residents about the hazards and mitigation strategies.

Second, the state should devote resources to multiple dissemination techniques, including public information campaigns concerned not only with emergency procedures but also with the relative likelihood of damage to various portions of the built-up urban area. The distribution of hazards maps in telephone books, public information programs on radio and television, and the periodic news releases could heighten public awareness of the spatial differentiation of areas susceptible to damage from earthquakes and the fact that the mitigation measures can be taken before a damaging earthquake to reduce loss of life and damage to property.

Finally, it has been noted that mortgage lenders seem to vary in their response to earthquake risk. Some banks require earthquake insurance on all properties within the special studies zones, while others require no mitigation measures as a condition for originating loans [Brookshire and Schulze, 1980;] [Bank of America, personal communication, 1981]. In addition, secondary mortgage lenders (such as the FHLMC) have carefully studied the issue of earthquake insurance [Kaplan, Smith and Associates, 1981]. If financial institutions were to decide to require homebuyers in particular areas to invest in earthquake insurance as a condition for a home loan, and if this policy were adopted only for mortgages on homes most susceptible to damage from seismic activity, buyers would be made more aware of the spatial variability of earthquake hazards.

It is clear that the present disclosure law has had little impact on individual homebuyers. Policy-makers at the state and federal level should be aware of the weaknesses inherent in simply assigning the task of disclosure of environmental hazards to the real estate industry and then assuming that homebuyers will, as a result, make more informed decisions. More positive action by government and private industry will be required if homebuyer decisions are to be more effectively influenced.

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SOME ASPECTS OF EARTHQUAKE PREDICTION IN JAPAN

Ritsuo Akimoto

Introduction

Currently, the major focus of disaster studies in Japan is on examining the social impact of earthquake prediction, as is demonstrated by the fact that the Japanese Diet has recently passed legislation (Large Scale Earthquake Countermeasures Act of 1978) with a view to authorizing arrangements for minimizing earthquake damage. In this respect, the Japanese Meteorological Agency already plans to establish a comprehensive national information network on seismic activity throughout the country for the purpose of producing "earthquake reports" to facilitate the early forecasting of major quakes. The importance of research on the socio-psychological impact of prediction may become even greater in the future. In fact, with the Tokai area in central Japan as the initial target for the country-wide warning network, several research groups have been undertaking surveys on the social impact of earthquake prediction in this area since 1978.

The Large Scale Earthquake Countermeasures Act of 1978 provides that the area in danger of a damaging earthquake shall be identified, and that an emergency plan against conceivable disaster shall be drawn up for this area. Article IX of the Act requires that the Prime Minister shall issue an earthquake warning and shall order preparations against disaster in response to a report by the Director-General of the Meteorological Agency on the danger signal of a major earthquake, thus providing the legal basis for the earthquake warning system.

It is well known that Japan, as compared to other countries, is highly organized and prepared against disaster and has well-prepared advance planning. The presence of counter-disaster plans on various levels in Japan is well established. The research report of the Disaster Research Center of the Ohio State University notes well-organized responses in the emergency period following the Niigata earthquake of 1964 [Dynes, Haas, and Quarantelli, 1964].

This does not, however, mean that the problem has been solved. To my knowledge, seismologists as well as government agencies can not specify accurately the time, place, magnitude and probability of occurrence of an earthquake. In addition, there has been no empirical research on the impact of earthquake prediction. Japan has only recently begun to emphasize the importance of planning based on earthquake prediction, and the Act of 1978 was the first step in this direction.

This Act led, first of all, to the installation of earthquake activity monitoring equipment such as seismographs, stereometers, clinometers, extensometers and others in the Tokai aea, where a Richter magnitude of 7 or 8 earthquake is forecast to occur in the near future, and in the South Kanto region. At present the Meteorological Agency in Tokyo electronically receives information on earthquakes from this equipment.

When this monitoring equipment detects extraordinary ground activity on a dangerous level, the Earthquake Assessment Committee is supposed to meet immediately to analyze and assess the probability of an earthquake. Consequently, the news media, local government bodies, police and fire departments are to be notified of the opening of the Committee meeting after a lapse of 30 minutes.

There is not much space here to give details of the warning system in the case of the Tokai area. However, as stated at the beginning of this paper, it is obvious that the Act of 1978 initiated a new era of earthquake prediction in Japan. Currently the notable studies by sociologists as well as social psychologists of the social impact of earthquake prediction are reported as in progress. Some of the surveys have produced suggestive findings.

For example, the Institute for Future Technology has studied human response to the aftershock warning in the case of Izu-Oshima earthquake of 1978 [Institute for Future Technology, 1980]. A research group of the Institute of Journalism and Communication has also analysed the social impact of warning in the same case and psychological response to TV news of the earthquake prediction [Institute of Journalism and Communication, 1979].

In this report I shall briefly deal with some current aspects and problems of earthquake prediction in Japan. The focus will be on an examination of some of the problems that we face in our research at present.

The Izu-Oshima Earthquake of 1978

The Izu-Oshima earthquake of Richter magnitude 7.0 occurred at 12:24 p.m., Saturday, January 14, 1978, in the wake of a series of smaller earthquakes which started Friday night. The epicenter was the seabed about 10 kilometers off the Izu peninsula. The intensity of the quake was five on the Japanese scale (80-250 gals) in Oshima Island and Yokohama City and four (25-80 gals) in Tokyo. At 2:00 p.m. in the afternoon on Saturday, the Meteorological Agency named it the "1978 earthquake off Izu-Oshima".

The main earthquake was followed by numerous aftershocks; a total of 161 tremors, mostly minor ones, occurred in the Kanto region and 158 tremors of these were recorded between 12:30 p.m. Saturday and 5:00 p.m. Sunday (see Table 1). The earthquake caused tsunamis 35 centimeters high at the beaches of Oshima Island and 12 centimers at Tateyama in Chiba Prefecture. However, there was no report of tsunami damage.

The damage to transportation routes and other facilities was caused by landslides. Notable damages to facilities occurred in the eastern parts of Izu Peninsula and Oshima Island. Landslides disrupted the National Highway in Izu Peninsula at five places and blocked other main roads. Train traffic on the Izu-Kyuko railway between Ito and Shimoda was suspended due to damage to the rails. Thus, transportation was seriously affected.

The total casualties in the earthquake were recorded as 13 killed, 14 injured, and 11 others missing as of 6:00 p.m. January 15, according to a report of the Prefecture Police Department. The danger of landslide

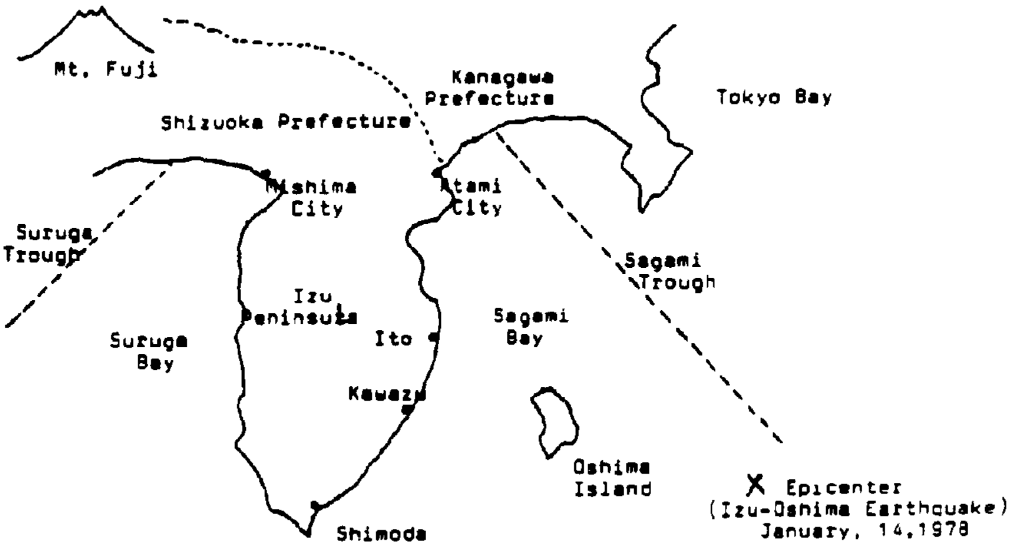
Table 1

Main Earthquakes Which Occurred On January 13 and 14, 1978

Time	Intensity (gals)				
	80-250	25-80	8-25	2.5	0.8-2.5
January 13					
8:28 p.m.,			Oshima		Yokohama
January 14					
8:12 a.m.,			Oshima		Yokohama
8:31				Oshima	
9:06			Oshima		
9:33			Oshima		
9:36		Oshima		Tateyama	Tokyo
9:38			Oshima		
9:45		Oshima	Yokohama	Tokyo	
9:47		Oshima	Tateyama	Tokyo	Niijima
12:24 p.m.	Oshima	Tokyo	Nagoya	Mito	Hachijo
	Yokohama	Mishima	Chiba	Osaka	Kobe
		Shizuoka	Kofu		Katsuyama
1:42 p.m.,			Oshima	Yokohama	Shizuoka

and rock fall continued until Saturday night. The quake damages were especially extensive in the town of East Izu. Nearly 1,000 of a total of 5,000 houses in the town were damaged at the time of the major quake; water supply and telephone communications were disrupted following the main shock.

The earthquake also produced similar situations in the Kawazu and Inatori area on Saturday. Under these conditions, the Self-Defense Force transported a total of 400 tons of drinking water to the above areas as landslides had disrupted access to these areas at many points.



Map 1

Map of Izu and Oshima

A significant consequence of the shocks was that sludge containing hydrogen cyanide flowed out of a breached reservoir near the slag dump of a metal refinery plant in Yugashima, Izu Peninsula. The sludge went into one of the rivers in the area and flowed into the Suruga Bay. The cutflow of sludge from the reservoir was estimated at 100,000 cubic meters on January 15 and 5,000 cubic meters on the next day. As a result, the water of Mochikoshi River and Kano River was contaminated with noxious hydrogen cyanide. The accident, indeed, seemed incidental to the earthquake. However, as it seemed, its main cause was attributable not only to the earthquake but also to the weak reservoir bank.

According to the report by the Disaster Headquarters on January 18, the damages to public facilities were estimated at Yen 11,637,000,000 (about $52,900,000).

Individual and Organizational Response to Aftershock Warnings

When a disaster occurs suddenly and transcends the range of preliminary training or planned arrangement, the counter-emergency activities of public agencies often lose adequate organizational response and fall into preposterous group behaviors. We can see such an instance in the case of the Izu-Oshima earthquake.

A careful observation of organizational responses in an emergency period was made in the research conducted by Prof. R.R. Dynes, E.L. Quarantelli and J.E. Haas on the Niigata earthquake of June 16, 1964 [Dynes, Haas, and Quarantelli, 1964]. The characteristic of Japanese administrative structure, as a comparative study of disaster response by Prof. B.F. McLuckie found, is that it is highly centralized as compared to its U.S. counterpart [McLuckie, 1975].

The organized activities of community teams under the mobilization plan of government agencies were evaluated highly. In the case of the Niigata earthquake, the normal lines of authority and those specified in disaster plans were effectively operative at the time of emergency in spite of the large extent of the damages.

This can also be said from the findings in the case of the Izu-Oshima earthquake of 1978. In the cities and towns on Izu Peninsula there were few local defense organizations, and they were not well equipped for emergency service. But once the Prefecture Disaster Headquarters was organized, as had been provided for in the plan, the rescue teams, with the aid of the Self-Defense Force, quickly started action and moved into these areas. They arrived in the damaged areas without delay, though disrupted highways prevented them from using normal means of transportation.

The Disaster Headquarters has a centralized command and could control all available public and private organizations. And it could also call on outside organizations for assistance. In this circumstance, volunteers' activities in the impact area were used only on a limited basis and there was no organizational competition over relief. Formal organizations consistently acted as the major source of relief work, and the activities of voluntary organizations were controlled effectively by the centralized authority.

According to Prof. A.H. Barton's cautious comment, however, the important thing to be noted here is that a case such as the emergency fighting system in Japan might be vulnerable to types of impact not covered by the working plans [Barton, 1969]. In addition, public agencies do not always perform their expected organizational role.

In the case of the Izu-Oshima earthquake, the warning about aftershocks from the Prefectural Office produced unpredicted behavior both on the individual and organizational levels. In this connection, I would like to concentrate on the problem of the social response to the earthquake warning. The discussion on this point is drawn from the data in the survey carried out by Institute of Future Technology [Institute of Future Technology, 1980, pp. 175-255]. It can be called a typical case of inadequate organizational response in an emergency system. What follows is a general description of the case.

In the afternoon of January 17, the Committee of Emergency Disaster Headquarters released information about the possibility of aftershocks in the Izu-Oshima area. On the next day, the Shizuoka Prefecture Disaster Headquarters forwarded the information to public offices and organizations in the quake-stricken area. The above action was, of course, in compliance with what the plan had set forth. However, what complicated the situation was that the Prefectural Governor officially announced the information as emergency news to newsmen in his press interview. Under the extraordinary circumstances, the information was mistaken for a "disaster warning" and further amplified on the TV and radio transmission to that effect.

I should comment on the early stage of rumor dissemination. It should be noted here that the initial announcement was too laconic and that the disaster plan had not been based on a cautious study of the response behavior to a warning on the parts of individuals and organizations in transmitting information. Upon receiving the information, they stepped up its transmission to other organizations and individual residents. For instance, the LPG Association supplying gas to Shizuoka Prefecture already had an emergency network. At that time, with the network given full play, the information was transmitted as a disaster warning from the LPG Association to other organizations and factories. But the information was inaccurate and fragmentary.

Residents were confused with the fragmentary information and sought accurate information. With rumors spreading quickly beyond imagination, prefectural and municipal offices were swamped with inquiries about the warning. By an unofficial record of the Disaster Division of the Shizuoka Prefectural Government, it received more than five hundred inquiring calls. The switchboard was overloaded and at times unable to respond.

Ambiguous information and rumors caused more apprehension among people than necessary. Some of the large factories in the Shizuoka area allowed employees to return home. On the other hand, in a number of communities the leaders of Chonaikia Associations announced warnings on their own judgement and called for evacuation. ("Chonaikai Association" is a kind of local group in Japan and it was traditionally organized as the civil defense organization on a large-scale level of neighborhood units.)

Figure 1 is a flow chart of the described information on aftershocks and the purpose of rumor dissemination on January 18. It is obvious that the cause of confusion in this case occurred from the paper plan itself without preliminary consideration of disaster warning. It should also be noted that the announcement of fragmentary information and its transmission between organizations was one of the major causes of confusion [Institute for Future Technology, 1979 pp. 102-105]. The Disaster Headquarters lacked the capacity to manage unfounded rumors and to cope adequately with such a situation.

In the above case the flow of information and rumor ran mainly through the interorganizational communication network which had been prepared for a time of emergency. The initial warning news was flashed on TV and radio broadcasting. However, we do not think that the announcement of fragmentary news by the Prefectural Governor and TV was the only cause of confusion.

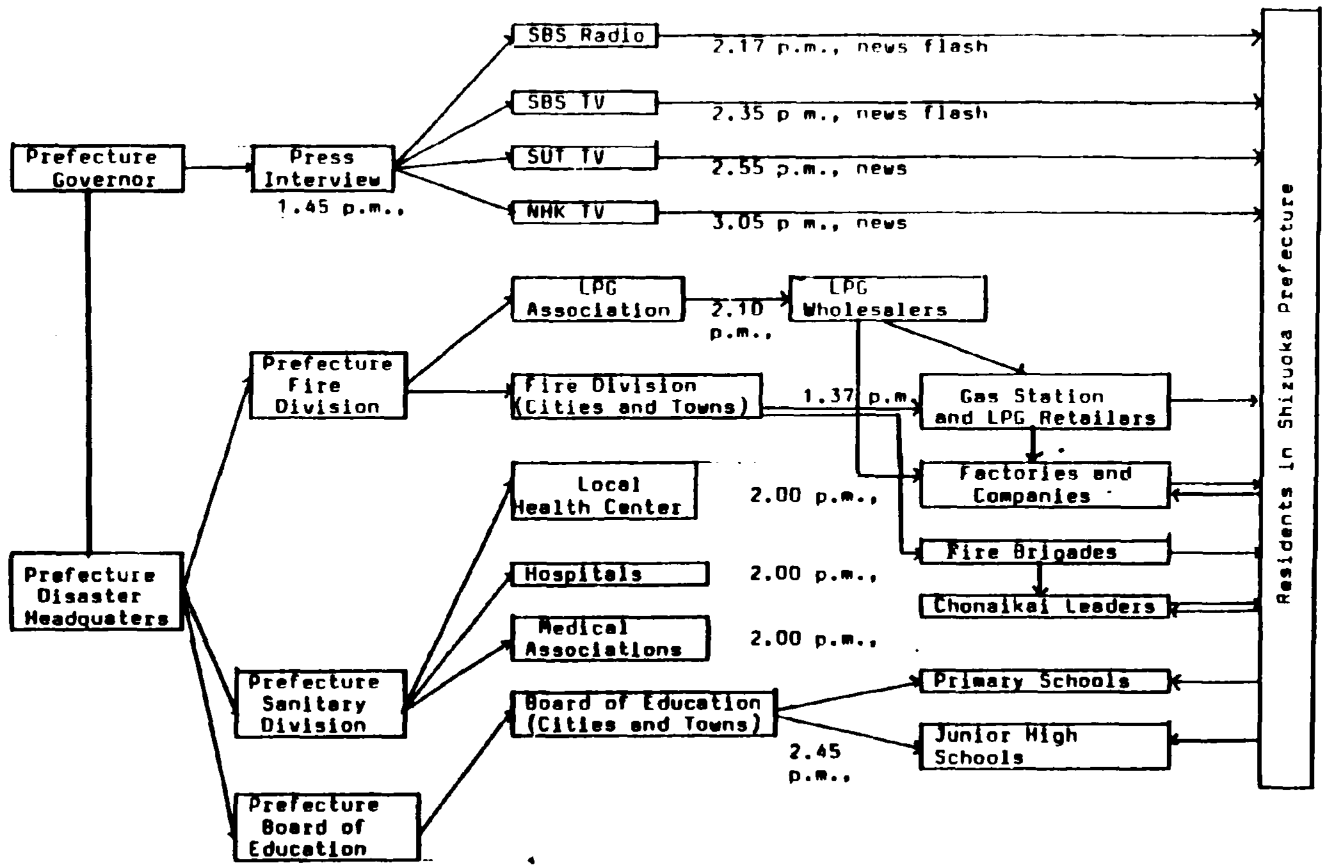


Figure 1

Communication Flow of Warning on Aftershocks and Process of Rumor Dissemination (January 18, 1978)

It can be said that the careless handling of information by some organizations on their communication channels made it misleading. A typical example was the case of the LPG Association. Rumors were amplified through telephone communications and distorted through person-to-person verbal communication between and within organizations.

There seem to have been two notable phases with respect to rumor dissemination--the first being short news flashes on TV and radio services and the second being careless information services from formal organization to others. In addition, interpersonal communication amplified inaccurate rumors by verbally passing on a shocking warning and sensational information. This was clearly pointed out by the intensive survey of the Institute for Future Technology.

Table 2

Percent Hearing Information about Aftershocks

Response	Percent
Heard	39.7%
Not Heard	60.3

Survey Results

As is well known, one of the outstanding characteristics of rumor is the verbal communication of non-confirmed information from person to person. Therefore, in a rumor analysis it is necessary to track its dissemination routes quickly. In this respect, telephone interviews might be an expedient research method to trace the source of the rumor and its communication routes though it involves qualitatively uneven data.

The interviews were made by specially trained telephone operators in the Dentsu Research Center shortly after the rumor dissemination. In addition to the above interviews, civic leaders as well as executives of public organizations were also immediately interviewed by researchers of the Institute for Future Technology.

Table 3

Percent Hearing Rumor Major Earthquake Will Occur in Shizuoka Area in a Day or Two

Response	Percent
Heard	54.1%
Not Heard	45.9

Now let us look at the survey findings and observe the mass responses to the rumor. . The survey results indicated that 39.7 percent of the respondents heard the predictive information about the aftershocks through TV or radio news (see Table 2).

Table 4

Rumored Time of Expected Earthquake

Time	Percent
Soon (within one or two hours)	2.6%
After two or three hours	7.8
4-6 p.m.,	16.9
About 6 p.m.,	4.7
After 6 p.m.,	7.0
This afternoon	1.5
This evening	4.7
Within the course of the day	7.8
In a couple of days	0.9
Uncertain	33.1
Others	13.0

On the other hand, as Table 3 shows, 54.1 percent of the respondents heard about the rumor by telephone or verbal communications with family members, friends, neighbors and others. The residents of the impact area have a much higher percentage than those of other areas. Especially, in the Izu area 87 percent of the residents heard about the rumor. This percentage indicates that the quake area residents have developed highly anxious feelings because of the disaster. The time of the expected earthquake in rumors is shown in Table 4.

Table 5

Source of First Information About Aftershocks

Source of Information	Percent
SBS TV (local broadcasting station) news	20.3%
Other TV and radio news	16.3
Announcement by loud-speaker truck (public address)	3.5
Emergency broadcast system	5.2
Telephone communication with family members	4.1
Verbal communication with friends and acquaintances	25.0
Telephone communication with friends and acquaintances	5.8
Verbal communication with family members	8.1
Hearsay	10.5
Others	1.2

As already mentioned, a primary source of information about the aftershocks was the announcement of the prefectural office which was transmitted mainly through interpersonal communication. Table 5 shows the various sources of information through which it was transmitted.

Observing chronologically the percentage of the people who heard the warning and readily received it as a rumor at the given time, as Figure 2 shows, rumor dissemination demonstrates an increasing tendency.

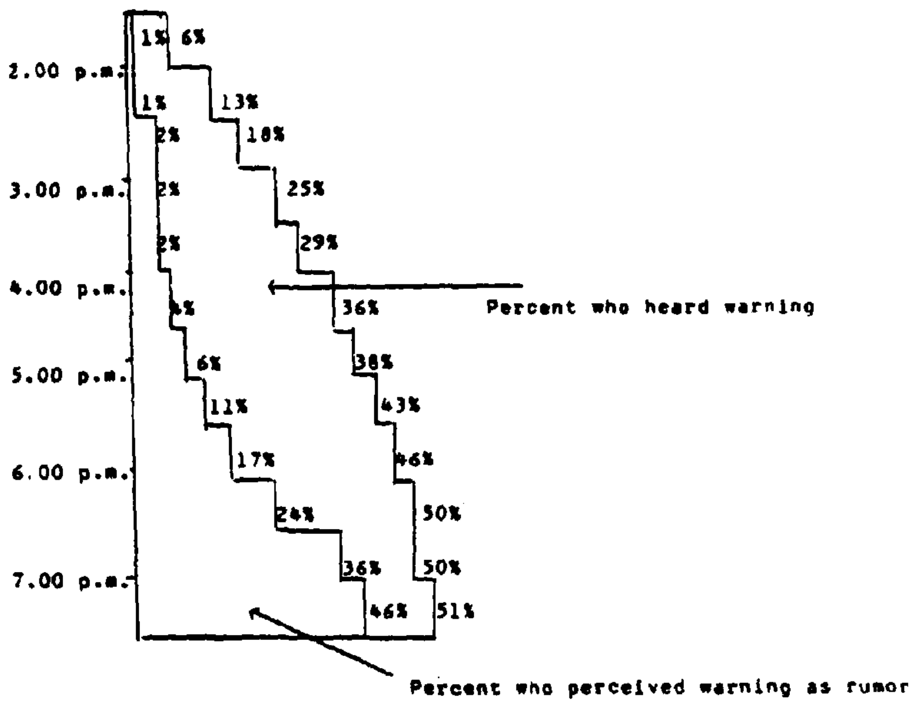


Figure 2

Percent who Heard Warning and Perceived it as a Rumor

At 5:24 p.m., TV and radio news denied the rumor, and at 6:00 p.m. the Director of the General Administration Department of the Shizuoka Prefectural Government announced accurate and detailed information in his interview for SBS TV news. Thus, the rumor was denied, and a sense of security returned to people.

Concerning the rumor itself, as Table 6 suggests, most people took the information for a warning about the danger of another earthquake. People who believed the rumor reached as high as 31 percent. When the 39

Table 6

Reliability of Rumor

Response	Percent		
Unconditionally believed it	9.6%	30.8	70.0
Believed it to some extent	21.2		
Half in doubt	39.2		
Did not believe it mostly	20.3	29.0	
Did not believe it at all	9.6		

percent who were half in doubt are added a total of 70 percent believed the rumor they had heard. These percentages tell us much about the degree of rumor dissemination.

What did people do after hearing the rumors? The answer is given in Table 7. Table 8 indicates levels of anxiety after hearing the rumors.

Table 7

Reaction to the Rumor

Response	Percent
Wanted to obtain additional information by TV or Radio	33.1%
Prepared emergency items	34.6
Talked with family members and neighbors about what to do	16.3
Telephoned to the broadcasting stations or municipal office to confirm the warning	2.3
Returned home quickly	6.4
Went out to school to collect children	1.7
Evacuated to safe place	1.2
Others	4.4

Table 8

Levels of Anxiety after Hearing the Rumors

Response	Percent
Very much worried	25.6%
Somewhat disturbed	30.0
Uncertain	13.0
Not disturbed	23.1
Not worried at all	7.8

As a result, so far as the case of the Izu-Oshima earthquake, there was no panic nor any kind of deviant mass behavior. A majority of the residents in the quake area showed an extremely low degree of sensitive behavior in the face of the rumor. This deserves admiration.

However, more important is that in the Izu-Oshima earthquake ambiguous information from formal organizations caused confusion and the communication network for use in the time of an emergency served for spreading rumors. This suggests that organizational response to the transmission of information such as a disaster warning should be based on cautious judgement.

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A FALSE ALARM AT POZZUOLI, ITALY

Charles A. Chandessais

At the beginning of December, 1971, the French press reported a panic which followed a false alarm at Pozzuoli. It was decided to undertake an inquiry on the behavior which followed this event. Because of the geological character of the region of Naples where Pozzuoli is situated and because of recent seismic events which have shaken the Mediterranean basin, it appears that a review of the observed behavior of ten years ago would still today be of some interest.

The Situation

Pozzuoli is an agglomeration of 70,000 people situated 12 kilometers from Naples. It is subject to the phenomenon of bradyseism, a term coined by Arturo Issel to designate very slow oscillations of the soil. At Pozzuoli the earth slowly subsided between the second century B.C. and the tenth century A.D. It then rose until the 15th century after which it subsided gain until 1970 at which point it started to rise again. The 24th of February, 1970, an announcement of the Ministry of Public Works reported an inversion of the bradyseism characterized by notable uplifting of the earth. Several families were evacuated as a consequence. On the third of March they decided to evacuate the Rione Terra Quarter, a decision which resulted in the spontaneous evacuation of 30 to 40,000 people. A relief plan was developed which envisioned the evacuation of the city in three days but of which the details were not made public. At the same time, 4 sirens were installed. In case of an emergency they would function in an intermittent fashion blaring six times for 20 seconds.

The population of Pozzuoli understood the general situation as well as the event of 1970 and knew that measures had been taken by the responsible authorities.

The population is in large part (69%) composed following the Italian classification of middle class, working class, lower class and housewives. That is to say individuals of a lower socio-cultural level. Furthermore, the population had the "neapolitan temperament" or according to the term of Professor Jacono, the "southern mentality" characterized by feelings of affiliation, of resignation, of futility, and of the incapacity (or the incompetence) of the authorities to handle the situation.

On the fifth of October, 1971, at 9:50 p.m. only one of the four alarm sirens started to blare without interruption for 18 minutes. This inappropriate signal threw into the street a large portion of the population, either to flee by the single evacuation route which was rapidly blocked or to take refuge in an uncovered place such as the beach or the Piazza della Repubblica, or to search for information at the police station. It was a political party which went through the streets with megaphones to calm the population and to urge the authorities to do the same.

The Study

At the end of October of 1971, Professor Jacono of the University of Naples made available to us three students who were graduates in social psychology who had research experience and who spoke French.

The aim of the research was to study:

(1) The disaster subculture of the population of Pozzuoli,

(2) the process of warning,

(3) the responses to it including eventually the manifestations of panic.

In the course of a conference, these three points were clarified. It was decided that two investigations would be carried out. One by means of a closed questionnaire of a stratified random sample, the other by means of open-ended interviews with a number of persons who knew the population well to clarify the results of the questionnaire survey and complete the information gathered by it.

The concept of a disaster subculture has been defined as follows by Stallings with reference to a society permanently menaced by a certain type of danger:

> A complex organization and technology, along with corresponding attitudes and values, is present among the residents and organizations of the city. There is not only an elaborate pattern for sensitizing the community to a particular kind of danger but equally as important, there is widespread knowledge about the appropriate course of action to follow when certain cues are presented. [Stallings, 1967, p. 18]

To what measure are these characteristics to be found in the population of Pozzuoli? This is the first object of the research.

The warning can be envisioned from two points of view:

(1) As a means of exchanging information relevant to an event presumed to be dangerous,

(2) As an individual process linking the signs of a danger to behavioral responses.

The first point of view can be dealt with only very partially, but some of the information gathered leads one to believe that there is a very great complexity and a very great variety in its realization.

At the level of the individual process, it is useful to distinguish between:

(1) The danger signals: non-intentional indices directly linked to the event, intentional signals encoded (in the present case of the sirens), non-coded intentional messages which inform, counsel and reassure.

(2) The psychological function for the elaboration of the conduct: perception of the signs, interpretation of them, choice--possibly unconscious--of a behavior or a sequence of behaviors.

(3) The responses to the perception of the warning signals: first those of the emotional order such as fear or vigilance; but above all because they are more observable, the overt responses:
- efficacious behavior of spreading the alarm, combatting the danger, seeking shelter;
- instrumental behavior of which the object is the proper functioning of the alarm network;
- feedback of the messages received (collation), accounts of activities, seeking confirmation or information about the reality of the danger;
- non-adaptive behavior of inhibition or confusion.

Among the inadaptive behavior, special mention must be made of panic, since by definition it was one of the principal objects of the study of the event at Pozzuoli. According to Professor Killian, "One cannot study panic scientifically because this concept is not defined scientifically." According to Professor Quarantelli the word panic has been applied to almost everything. Martha Wolfenstein cites six characteristics of panic mentioned in the literature without being able to say whether they should all be present or if a single one suffices for one to be able to say that there was panic. The six characteristics have been retained in the construction of the questionnaire used at Pozzuoli; to them was added "The feeling of being caught in a trap," and the notion of a "mad" crowd. The six characteristics are:

- intensive subjective terror with or without external justification;
- futile or self-destructive behavior activated by extreme alarm (which we will call confusion)
- contagion of the alarm throughout the group, the signs of fear on the part of others increasing individual apprehensions;
- precipitous flight of a group of persons far from a danger which rightly or wrongly appears impossible to combat;
- situation in a group in which the interest of an individual for his own security excludes concern for others (blind egotism);

- situation in a group where in the effort to flee, the individuals harm one another (aggression).

This last characteristic is related to the notion of augmented danger to the primary danger by panic behavior.

The questionnaire constructed to derive from these concepts was comprised of 25 questions: six questions related to the conditions of the study, eight to the disaster subculture, eight to behavior and three to the aggravation of the danger and to the information.

Each one of these 25 synthetic questions (denoted QS) was complimented by explicative questions (denoted QE) numbering from one to four for each synthetic question. Not all of the questions were asked because they were not adapted to the situation or they were generally badly formulated and badly understood or else because they would have lead to a unanimity of response.

The persons who were interrogated had to respond about what they had seen and not what they themselves had felt or done.

The stratified random sample surveyed by the questionnaire resulted in 141 responses. It consisted of 31% middle-class, students, and authorities (persons considered of higher status), and 69% of persons of more modest circumstances and lower socio-cultural level.

The open-ended interviews were conducted with 24 persons chosen by nature of their role in Pozzuoli society or for their socio-cultural level: 14 of them belonged to the public service or political organizations. These interviews permitted expansion upon, interpretation of or complementation of the statistical results derived from the analysis of the responses to the questionnaire.

Results

Preliminary Remarks

(1) As mentioned earlier, the study investigated what the subjects had witnessed and not their own sentiments or actions:

(2) Not all the questions were asked;

(3) There was very little non-response, on the average of 5%; the population of Pozzuoli appeared very concerned, this would seem to clearly indicate the existence of a disaster subculture;

(4) One component of the disaster subculture--the awareness of a permanent danger--and four kinds of behavior--confusion, contagion, terror and flight--were considered as present by more than 3/4 of the persons surveyed.

Less than 1/4 of the population surveyed noticed the presence of egotism or aggression, of the awareness of responses, of information after the alert about the situation and the behavior to adopt.

(5) The semi-directed interviews had as their object a content analysis: 683 items were retained and allocated to 51 categories. Nearly 1/4 of the items (168) are relative to only three categories: flight, communication and complaints, and nearly 1/2 belong to 7 categories, the three preceding ones plus terror, searching for information, confusion and assistance to others.

One finds flight, terror, confusion comprising the principal characteristics of the event both through the survey questionnaire and the interviews.

Three new elements appear in the interview:

(1) Complaints which were manifested by an aggressiveness principally verbal against the mayor or the police department;

(2) The search for information necessitated by deficiencies on the part of the public authorities in the matter as much before as during the event; deficiencies perceived by the individuals interrogated;

(3) Assistance to others--principally to relatives and children; this assistance was manifested principally in the form of calming explanations. It occurs on the average more than one time per interview (1.58).

On the average, an interview contained 28.45 items classifiable into the 51 categories. It can be noted that the interviews with the public authorities were the most prolix (more than 41 items on the average) and those with artisans were the least (20 on the average). Equally one can note that those who cited terror most (women, liberal professionals, and artisans) were also those who mentioned complaints least (which were mentioned principally by the political figures, municipal employees, and public servants).

The results of the questionnaire will be analyzed below.

A. The Disaster Subculture

Almost the entire population (96%) is conscious of a danger and feels some general anxiety (70%); but a little less than 1/3 (30%) are used to it. Less than 1/2 (40%) know the danger signs to which fishermen above all are the most attentive. It is essentially a question of what was called above indices (precursors) which are most directly associated with the phenomenon: heating of the water, dead fish, elevation of the level of the sea impeding landing.

As for the signals, the sirens, the population had been informed; it knew the code (six times for 20 seconds) but did not know under which conditions the sirens would be used. Certain individuals were skeptical in addition with respect to their efficacy, but this opinion appeared to be based upon political attitude. It will be shown below how this knowledge of the code of signals is shown to be fragile.

As for the verbal messages, they were made concrete in 1970 by the invitation to evacuate. The possibility of messages, explanatory and reassuring, before following the alarm signal was totally ignored as much by the public servants as by the population.

Almost no one (12%) knew the behavior to adopt when they heard the siren or when the indices appeared. Certainly 1/3 (33%) of the population thought that there existed an organization to face the danger. Putting the sirens in place was a manifestation of it. "All had been foreseen on paper...the evacuation of all the population had been foreseen, said the mayor; there had been a secret session of the council and a secret plan." This ignorance of the conduct to take is a cause of fear. In the absence of directions one thinks of what one can do and one organizes oneself. Flight appeared in general the only possible response. One can state in effect there was a substitution of an improvised response for an organized response.

The denial of danger appears in several forms: reliance on a higher authority (in the intervention of Providence) to remove the danger, or as in 1970, a belief in a campaign of intimidation to modify the structure of Pozzuoli by removing part of the population in order to develop the city as a touristic site, or habituation to an ancient phenomenon, or finally the fatalism of the neapolitan temperament.

In brief there exists among the people of Pozzuoli a disaster subculture marked by the consciousness of danger, by the absence of information and ambivalence which the subjects clearly indicated. The causes of these characteristics seemed to be the attitude of the public authorities, and the very general phenomenon of the denial of danger reinforced in the present case by the neapolitan character.

B. Behavior and Consequences of the Event

Following the spontaneous and continuous blaring of the siren for 18 minutes contrary to the code, a considerable crowd movement was created; but it didn't constitute a danger as one would fear from panic since it was possible to mention only one wound to a foot in a fall, several colds (it was quite cold), several heart complaints due to the emotion and several dents to fenders of cars. Two-thirds of the population estimated that the movement of the crowd did not aggravate the danger.

The population estimated that only a very small proportion had been informed of the exact nature of the event (14%) and of the procedure to follow (10%).

(1) Concerning the alarm, it seems that certain individuals had not heard the siren. They were told by neighbors about it and left their houses. It was then that they heard the signal. As for those that heard the blast of the siren, there were different interpretations:

(a) Some individuals were before their television sets watching a war film. They confused the real siren with that of the film.
(b) Others who knew that the siren was supposed to function in a discontinuous fashion did not pay attention to this specification of the code either because they were too surprised or because their attention was focused elsewhere.
(c) Many people correctly interpretted the signal although after a moment of hesitation.
(d) Some subjects were so excited that they had the illusion of having felt a seismic shock.
(e) Finally certain persons made a decision only after the siren signal had been completed by official or semi-official messages.

Those who understood that it was not a question of a true alert did not leave their homes; there were even those who thought it more dangerous to leave: "It is panic which kills people," said one subject who had been interrogated, "that is why I preferred to remain in my house."

(2) The search for information was the cause for leaving a house for many people; therefore, this was not a flight. They went for information either to the police or firemen. Others sought information on the telephone but the lines were rapidly clogged. The population considered it bad that the police did not immediately explain that it was a question of a mechanical malfunction. It was necessary for the leaders of the political parties to strongly insist with them before they would do it. Prior to this using their influence with the militants, they had them transmit calming messages by megaphone.

Thus one sees appearing successively:
(a) the beginning of spontaneous intervention before official intervention,
(b) the emergence of leaders (in fact, political leaders) and semi-official attempts at organization,
(c) intervention of public services and criticism of them for being late.

(3) As concerns emotional conduct we will resort to the classifications established by Martha Wolfenstein to characterize panic.

Almost all (91%) of the persons interrogated stated manifestations of terror. But this global judgment must be qualified: in effect, if nearly 2/3 (60%) estimate that the whole population was affected, others (16%) estimated that only isolated individuals manifested terror, for others (19%) only an indeterminate fraction was terrorized. This was above all, women, children, the elderly, people of the lowest classes which were affected. The manifestations of this terror were principally dynamic--cries (89%), tears (84%), gestures (50%)--typifying the neapolitan or southern character. By contrast the conduct of inhibition (fainting, dumbfoundedness...) appeared far more rare (14%). As for pathological conduct (incoherent laughter, hysterical crisis) they were even more seldom noted (11%).

Contrasting with these manifestations the absence of terror that was noted by the interrogated subjects was attribued to the true absence of terror or the spontaneous mastery of it (noted by 69%) or due to the influence of leaders (noted by 30%).

The manifestations of frenzied egotism are rarely cited (15%); it was sometimes a question of abandoning families (9%); the trampling of fallen persons which is one of the great causes of danger in panics was not cited a single time. In contrast. aid to others is cited by more than 1/2 (57%) of the persons interrogated: flight together with families (44%), aid to relatives (10%) or to strangers (3%). Aid to others is cited 38 times in the semi-directed interviews. It appears above all to have consisted of seeking to reassure and to explain that the siren had not functioned in conformance with the code, that there was a malfunction or in making an appeal to reason.

Aggression is denied by the very great majority of the subjects (82%): at the most there are cited (33%) several jostlings that were a little rude, some denting of vehicle fenders. While physical aggressiveness is rarely noted, it is in the verbal form that aggressiveness comes to light in resentment, in imputation to the public service of negligence or tardiness in their intervention. This provided the opportunity to strengthen the opposition to the public authorities.

Confusion is recognized by the very great majority (96%). It is manifested by running in all directions (87%). For a few of the respondents (4%) confusion aggravated the danger, while 12% were not precise about the manifestation of confusion. In addition, there is every reason to believe that this was the cause of forgetting the code for the alert.

Precipitous flight is acknowledged by the majority (83%) of the persons interrogated. The number of persons involved while certainly very great is not exactly known: the estimations vary between 20,000 and 40,000.

It is more important to consider the precautions taken, the feeling of anticipated imminence of danger, and the time necessary to accomplish preventative actions. In this occurrence the sentiment of urgency was foremost. One sought first of all to save one's most precious goods and one's weakest relatives. In certain cases, individuals had been prepared for a long time, "sleeping fully clothed...keeping one's jewels and one's money close at hand in a small purse," said one pharmacist.

One notes also frequently an absence of precautions against risks of injury to health by the great cold on that day: many people left in the scantiest of clothing. However, numerous others carried out something: one cited people carrying furniture but the primary precaution for many was to clothe the children.

The inhabitants of Pozzuoli who had an automobile attempted to leave the city, but the only evacuation route was rapidly clogged. Others searched in the city for an open place--the beach or the Piazza della Repubblica. Others sought refuge with their relatives. A cafe equally served as a refuge for those who found themselves there and probably others while certain customers left it in order to join their families. Numerous fleers did not have a clear destination and were prey to a great confusion.

Finally some went to search information from the police or the firemen. One can conclude that one must not hold only to the notion of precipitous flight or even centrifugal movement possibly prepared but more generally of natural displacements of people, in different directions and at different speeds.

Conclusion

From this study one can derive some characteristics of the event and the reactions that it provoked as well as some methodolgical considerations.

A) Characteristics of the event:

(1) At Pozzuoli, there certainly exists a disaster subculture characterized by the belief in a permanent menace more than an exact knowledge of the risks of bradyseism which is easily confused with earthquakes. They believe that there exists an organization for facing the danger but it is unknown and they remain skeptical in regard to its efficacy.

(2) The action of the public authorities was insufficient. If a disaster subculture exists, it is spontaneous and it is not directed by responsible individuals. This abstention as in many other cases is motivated by the intention to avoid upsetting people. (Declaration of the Secretary of the Mayor). The deficiencies of the authorities lead to rancorous recriminations.

(3) The essential point is the absence of sufficient reliable information before as well as after the alarm. The information on the code however simple for the siren was revealed to be particularly fragile. It is certain that those who knew the system for the alert and remembered it did not have intense emotional reactions. The ignorance of the lower socio-cultural elements of the population was a cause for confusion and fear.

This example shows once again the imperative necessity for information and training of the public in security matters and that the ostrich policy is more injurious than efficacious.

B) Methodological Consideration

(1) The concepts which served as the base for the development of the questionnaire revealed to be practical and except in

particular cases without ambiguity. But they were shown to be insufficient when one analyzed the semi-directed interviews. This was necessary to complete the questionnaire. There would, therefore, be a reasonable framework for further research. The distinction between synthetic questions and optional explanatory questions appears to permit a certain flexibility of use.

Its employment as a rating scale for the conduct of others more than as a scale for self-evaluation is not the happiest solution, but taking into account the resources available--a small number of surveyors, the use of different languages, the time available--it appears difficult to use it otherwise.

Would the behavior of the Pozzuoli population have been the same in the case of a real danger? In other words, does the study provide a valid means of prediction? If it difficult to reply to this question. At the same time, it is difficult to say if a different population would have reacted in the same fashion. The replication of studies of this type made under standardized conditions would permit fruitful comparisons which would provide guidance to actions to inform and train the public by responsible authorities.

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WARNING AND RESPONSE TO THE MOUNT ST. HELENS ERUPTION

Thomas F. Saarinen

The amount of foreknowledge and warning for Mount St. Helens was probably greater than for any previous geologic hazard in United States history. The public, and/or responsible officials had a series of warnings, as information on this volcano passed through successive stages from a routine research publication to the issuing of a potential hazard notification, and still later, the initiation of a hazard watch. These warnings, and the regulations developed as a result of them, did probably cut down on the death toll of the eruption. However, many people remained unwarned, or unconvinced of the danger in spite of the great amount of information disseminated to the public through government channels as well as intensive media coverage.

The abstract in the slim informative "blue book" of Dwight Crandell and Donal Mullineaux [1978] opens with the statement: "Mount St. Helens has been more active and more explosive during the last 4,500 years than any other volcano in the conterminous United States." In the publication the past behavior and future probabilities of volcanic eruptions are succinctly outlined and the areas likely to be affected clearly marked on maps. In addition, the bulletin includes step-by-step instructions for identifying the warning signs of an eruption, monitoring the premonitory events, and actions which should be taken to inform both governmental agencies and private companies. This publication was a product of an ongoing United States Geological Survey (henceforth U.S.G.S.) research program which has focused on hazards appraisals for the volcanos in the United States portion of the Cascade Range. A report discussing the Mount St. Helens hazard appraisal appeared in Science as early as 1975 [Crandall, Mullineaux, and Meyer, 1975], and geologists and some U.S. Forest Service personnel were aware of the work one or two years earlier.

In recent years as reports on various volcanos reached publication stage they were forwarded to the Hazards Information Coordinator, and after evaluation, warnings of potential hazards were issued. This is in keeping with U.S.G.S. responsibility to provide timely and effective warnings with respect to geological hazards. It has been doing so since 1977.

Mount St. Helens was the eighth hazard warning of the new U.S.G.S. hazard warning system. On December 20, 1978, a letter was sent to the governor's representative from the U.S.G.S. notifying federal, state, and local officials of the potential hazard. The Governor's representative misinterpreted the notification thinking the eruption was imminent, and a special meeting involving representatives of many State of Washington Government departments and U.S.G.S. officials was called in January, 1979, to clarify the situation. Although at the time this was regarded as an over-reaction, the meeting might, in retrospect, be seen as useful in alerting state officials to the potential problem. On the other hand, the U.S.G.S. sprinkling of cold water on the initial reaction may have tempered the later reaction to the Mount St. Helens eruption.

On March 20, 1980, the first of a series of moderate earthquakes, measuring about Magnitude 4 on the Richter scale was detected on seismographs operated by the University of Washington in cooperation with the U.S.G.S.'s earthquake studies program. The seismic activity beneath and within Mount St. Helens led to further monitoring and the decision to initiate a hazard watch for the volcano. Since then the volcanic activity has stimulated great interest which extends far beyond the area affected as may be seen in the extensive and continuous coverage in local, national, and international news. Mount St. Helens clearly qualifies as a major media event.

Within the State of Washington and the immediate vicinity of the volcano, major efforts were made once again to inform responsible officials of the potential hazard after the hazard watch was initiated. The U.S.G.S. shipped 200 copies of the Crandell and Mullineaux report to Vancouver, Washington, for distribution to appropriate persons. By then the interest level was so high that thousands of copies of the report could have been given away had they been available. Many of the U.S.G.S. geologists were now headquartered in the U.S. Forest Service offices for the Gifford Pinchot National Forest which covers a major portion of the park. Thus Vancouver, Washington, became the main information center for the developing events.

As the monitoring activity for the volcano watch continued, daily news conferences were provided under the leadership of the U.S. Forest Service. In the immediate aftermath of the eruption these news conferences were held three times a day and were scenes of great intensity as the radio, T.V., and press personnel, who had converged on Vancouver, grilled the spokesman for the U.S.G.S., the U.S. Forest Service, the State Department of Emergency Services, and the sheriffs of the local counties, demanding clarifications of statements, explanations of discrepancies, and occasionally answers to unanswerable or embarrassing questions.

The leadership of the U.S. Forest Service in organizing the daily press conferences is to be commended. These press conferences saved harassed officials, responding to the disaster, from the necessity of confronting each of the reporters separately, and it provided the media people with a single centralized source for news so they could gain an overall perspective on the most recent developments. It also helped keep rumors to a minimum level. U.S.G.S. officals were kept busy not only in explaining probable risks but in discounting imaginary ones such as fears that watermelon-sized bombs would destroy Morton, that a new bulge was developing on the south side of the mountain, that the dam of debris at Spirit Lake might break, that a lava flow might reach the Kelso-Longview area, or that Mount Margaret is a volcano. Sometimes rumors began with amateur radio operators who picked up reports from the field and drew their own conclusions before the data were analyzed and evaluated by scientists.

The U.S. Forest Service (U.S.F.S.) also took the initiative in organizing many of the local officials to cooperate in developing the Mount St. Helens Contingency Plan which laid out the steps to be taken by each official in the event of an eruption [Osmund, 1980]. Several other agencies developed contingency plans before the major eruption of May 18th. These included the Washington State Dept. of Emergency Services, 9th Army Division, Federal Aviation Administration, and the Washington National Guard.

In addition, as significant changes were noted in the monitoring, the U.S.G.S. sent letters to the directors of the Department of Emergency Services. This was done when harmonic earthquake tremors appeared and when the bulge on the north flank of the mountain developed.

From the foregoing, it is clear that there was a great deal of warning and discussion about the activity of Mount St. Helens prior to the major eruption which began at 8:32 a.m. on Sunday, May 18, 1980. This eruption consisted of a number of components. According to the U.S.G.S. information update 09:00, Tuesday, May 20, 1980:

> The first was an initial blast that totally devastated the forest over a wide swath arcing from the northwest to the north or northeast side of the volcano and extending up to 15 miles from its former summit. The blast covered the devastated area with ash that swept the ridges, collected in valleys, and flowed down the local drainages. Although the blast was hot, its temperature was not high enough to char the fallen or buried trees. The second component of the event was a combined pyroclastic flow and landslide that carried material released by catastrophic failure of the volcano's north flank across its lower slope and about 18 miles down the Toutle River Valley, burying it to depths as great at 200 feet. The third component was a pumiceous pyroclastic flow that funnelled northward through the breach in the crater formed by the north slope failure. This deposit raised the outlet of Spirit Lake by about 200 feet and raised the water level by 100-150 feet. The lake continues to rise behind the debris dam.
>
> After the initial rapid series of events, the volcano continued to erupt an ash column to altitudes of

> 50,000 to 60,000 feet and greater for several hours, generating a plume at high levels in the atmosphere that has deposited ash more than several inches thick as far east as central Montana and continues to deposit detectable amounts of ash into the central United States.

This dramatic sequence of events was exceedingly destructive. The symmetrical beauty of Mount St. Helens, sometimes referred to as the "Fuji of America" was marred by a black gaping crater and the peak was 400 meters shorter.

Preliminary estimates of $2.5 billion damage [Ranier National Bank, 1980] have more recently been succeeded by estimates of short term losses to the economy of Washington State on the order of $860 million Hunt and MacCready, 1980 . Over half was forest damage ($450 million) in the blast zone where some 229.2 square miles were either laid bare, left with fallen timber marking the direction of the blast, or merely singed. Next in amount of losses were clean-up costs ($274 million), damaged or destroyed property ($85 million) mainly roads, bridges, and other federal and state property in the blasted and flooded areas, and agricultural losses ($39 million).

Two-thirds of the clean-up costs were concentrated in the immediate area of the volcano. A major portion was due to the need of dredging of the Toutle, Cowlitz, and even the Columbia River. On the Columbia River ocean-going traffic was stopped for about a week. The channels of the Toutle and Cowlitz Rivers were filled with mud and debris which greatly limited their capacity and increased the risk of floods.

East of the Cascades the clean-up problem was ash removal. Appreciable amounts of ash fell on four states with the greatest concentration in certain Eastern Washington counties where expenses involved in ash removal exceeded the local ability to pay. In these same areas were concentrated most of the damages to agriculture as well [Cook, et al., 1981]. The major losses were to the hay crop. Wheat, apple, and potato crops were normal or above normal. Although the wheat crop was good, the ash's abrasive qualities caused damage to the mechanical equipment used in harvesting.

In assessing the preparation for and reaction to these damaging events, only the most beneficial and worst aspects of the warning system will be discussed. The major benefits were derived from the etablishment of a restricted zone which cut down on the fatalities, due to the eruption, which were the first ever on the continental United States due to a volcanic eruption. In contrast, the major oversight in the warning system was the failure to effectively warn the people in the ashfall areas. In describing these events some of the flavor of the public reactions will emerge as well as the importance of the perceptions of the various people in affecting the decisions made.

As a result of the many earthquakes and other physical indications that Mount St. Helens was building toward an eruption, restricted zones were set up around the mountain. As early as March 25 the U.S. Forest Service set up a red zone closing off the whole mountain above the timberline. From the moment the road blocks were set up to prevent people from entering the area, the officals experienced great difficulty in enforcing them. On April 3, Washington State Governor Dixie Lee Ray declared a state of emergency which allowed National Guard units to aid local law officials in keeping the public out. Running the road blocks became a game. It was easy to find alternative routes in, especially when enterprising local people began selling maps of the many logging roads in the area. This same public discounting of the hazard was documented by Green, Perry, and Lindell [1980] who interviewed residents of Toutle/Silverlake and Woodland, small communities close to the volcano.

It was not only the public which discounted the hazards. The major lumber companies did as well and were capable of exerting strong political pressure. When the red and blue zones were finally made official on April 30th, portions of the red zone boundaries bore a closer resemblance to divisions between public lands and lumber company property than to defined geologic hazard zones. All activities were to be banned from the red zone. Certain activities were allowed in the blue zone during daylight hours and access there was possible with permission. The result was that lumbering could continue very close to the western side of the volcano.

In spite of all these problems, the establishment of restricted zones did prevent greater loss of life than the 60 or so who are assumed to have perished as a result of the blast. Even so a bit of luck was involved, for the death toll would surely have been higher if the major eruption had occurred on a weekday when lumbering was in full swing rather than a Sunday. Estimates of how many lives were saved as a result of the warnings and restrictions vary from a few hundred, the number who might normally be there on a weekend in May, to as high as 100,000. The size of these estimates depends on the assumptions of the estimator as to how many people would have converged on the area to see the volcanic activity if free access had been allowed.

The interest level was high and remains so as may be seen in the growth of a thriving souvenir industry at main roadside sites from which the mountain is visible. T-shirts, ash, volcanic rock, postcards, picturebooks, refreshments, and a variety of items made from ash or volcanic rock were all available. On the first anniversary of the destructive eruption, celebrations in Toutle, Castle Rock, Silverlake, and other nearby small towns commemorated the event with parades, prayers for the dead, and sale of souvenirs [Arizona Daily Star, 1981].

The major oversight of the warning system was the failure to inform adequately the people in the ashfall areas about the problems they could face. The U.S.G.S. described them clearly in their report but did not follow through to be sure that the public east of the Cascades was aware that:

> Tephra eruptions can also result in psychological stress by blocking roads and causing people to be isolated, by causing darkness during daylight hours, by increasing acidity and turbidity in exposed water supplies, and by interrupting telephone, radio, and electrical services. Exposure to one or more of these stresses may lead to panic even though an individual's health or life is not directly endangered. Damage to property results largely from the weight of tephra, especially if it becomes water soaked, from its smothering effect, from abrasion, and from corrosion. Machinery is especially susceptible to the last two effects. [Crandell and Mullineaux, 1978, p. C11]

The U.S.G.S. scientists, with little experience in direct communication with the public, saw themselves as technical advisors. They perhaps assumed that their report would be read and people would act accordingly. The report was sent to key public officals, but there was little follow-up to see that it had reached all those likely to be affected. One might argue that people who got the information might not use it anyway, but our results plainly indicate that those who received the "blue book" were more likely to make some adjustment to the volcanic hazard than those who did not.

The U.S.G.S. scientists were not at all reluctant to relinquish the public information role to the U.S. Forest Service officals, who became heavily involved, since Mount St. Helens was within their jurisdiction. After the hazard watch was declared, the U.S.G.S. representatives were kept too busy responding to local demands for information and assessing the physical nature of the hazard to follow up on warning the public. The intensity of the demands on them during this period of high excitement forced them to work up to 20 hours a day for several weeks. Even with such long hours, they were unable to attend to all the legitimate requests for their time with which they were inundated.

The U.S. Forest Service had many members who were aware of the hazard, and they very quickly responded to the increased seismic activity by closing off the area, setting up a public information office at their headquarters in Vancouver, Washington, and developing a contingency plan for an eruption. Their main responsibility was for the forest areas. These and the areas immediately adjacent corresponded closely to the most serious geologic hazard zones identified by the U.S.G.S. Thus, they concentrated their main efforts on what were perceived to be the areas of most serious danger to life and property, essentially the areas immediately adjacent to the mountain and those in the valleys down which mud flows and floods were likely to descend. Only two of the some 66 key contacts among public officials and private industry representatives in their contingency plan were from the areas east of the Cascades, which later were covered with ash. Both of these were from Yakima.

The State of Washington Department of Emergency Services was the agency with the responsibility of warning the public. Unfortunately, it was a neglected, underfunded agency directed by an inexperienced political appointee rather than a hazards professional. It had been rated as having one of the worst disaster response programs in the country [The Oregonian, 1980]. As a result it did not have the personnel to conduct independent geological assessments. Rather than take the initiative, it followed the lead of the Vancouver headquarters. Although the department sent out information on the volcano's activities to all its county offices, it did not specify how this information was relevant to Eastern Washington. When the major eruption took place on May 18th, the county offices were still in such a state of disarray that their warning to the local communities was delayed almost two hours.

The local officials in Eastern Washington who received the reports on the increasing activity of Mount St. Helens tended to regard them as irrelevant to their activities. After all, Mount St. Helens was a distant Cascade peak. As a result the information was not acted upon. As the ash cloud approached, many people thought it was a thundercloud or dust storm and were completely unprepared for a heavy ashfall. (This is evident in eyewitness accounts from Pullman and Ellensburg, Washington [Dillman, 1980] [Ressler].) Thus, roads were soon closed, motorists stranded, and normal activity came to a standstill. Each community tended to improvise on its own in handling the emergency situation and in at least one case all emergency vehicles were soon out of commission due to dust clogging up the engines. Later as the clean-up began, problems arose related to how to handle the ash. The ash clean-up was complicated by variations in the physical properties of the ash from place to place so that it could not be handled in a uniform manner.

Questions and fears developed about medical effects. Children enjoyed the ease with which they could stir up a dust cloud, but parents worried about the potential health effects. Similar concerns arose related to the effects of the ash on vehicles or mechanical equipment or on crops. The Federal Emergency Management Agency (F.E.M.A.), which became involved when the federal disaster declaration was made official, soon developed a series of technical bulletins to answer some of these questions, but such information would have been even more useful a few weeks or months earlier.

After the May 18th eruption, people's perceptions of volcanos changed considerably. The warning system is also more effective than before. From the predictions based on physical measurements to the dissemination of data to the public, there is a much improved system. Lumbering is once more taking place, though restricted zones are still in force. Crews have emergency evaluation plans and are in direct contact with the headquarters from which warnings are issued. For some of the latest eruptions predictions were made several hours in advance, and people were evacuated efficiently. The major hazard at present is that of floods for the capacity of the river channels is much less than normal, and they could become even more clogged as loose ash is carried down by winter rains.

On a broader level one might hope that the eruption of Mount St. Helens was useful in dramatizing the fact that Cascade volcanos are active and could erupt at any time. This could encourage state and local communities close to other volcanos to develop contingency plans to improve the response to the next eruption.

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SECTION VI

GOVERNMENTAL ROLES IN REDUCING VULNERABILITY

FORMULATING AND IMPLEMENTING POLICIES FOR SEISMIC SAFETY[1]

Stanley Scott

Reducing earthquake hazards is basically an unresolved problem of politics and administration. Obviously scientific and engineering considerations must also figure in seismic safety, just as science and engineering play essential roles in most aspects of modern life. But fulfilling crucial and comparatively neglected requirements for seismic safety are fundamentally tasks of politics, administration, and implementation, i.e., getting policies formulated and adopted, and then making them work in practice.

Sources of Policy

Recurring earthquakes affecting significant populations anywhere in the world are by far the best source of information for the sophisticated and pragmatic understanding that must underlie effective seismic safety policies. A good deal of such learning from earthquakes involves seasoned professionals observing the results of earthquakes, and interpreting their observations to draw informed conclusions on what actually happened and why it happened, especially when there are anomalous or unexpected results.

One central goal, of course, is improved understanding of the kinds of ground behavior and forces at work in earthquakes, and of the responses of different kinds of structures and materials. Shaking-table experiments and computer simulations of earthquakes and structural responses can provide extremely helpful clues, but actual behavior in damaging earthquakes--which are highly chaotic events, often with significant unanticipated effects--is the most persuasive and reliable evidence on which to build policies. In any event, experimentation and research, plus observing the results of actual earthquakes, can lead to better understanding of sesismic phenomena and to improved "state-of-the-art" architectural and engineering designs. These in turn can form the basis for sound public policy.

Learning from earthquakes requires much more than simply photographing surface faulting and building damage, or recording data collected after an earthquake. Although such information is essential, probably most important is the judgment of experienced professionals who can interpret the data and make comparisons and contrasts with other earthquakes, recognize significant patterns of damage, reach tentative conclusions on the principal causes, and suggest measures that might reduce or eliminate such results in the future.

In the process, scientific and engineering research is helpful, even essential, but is not sufficient by itself. Indeed, central to the formulation of workable safety strategies are other kinds of information and communication flowing between (1) the professionals trying to interpret learning-from-earthquake findings, and (2) individuals who are concerned with policy formulation and implementation.

Improved communication is essential, because the non-technical part of the policy mix is crucial, involving a host of political, institutional, governmental, and human factors that help determine how things get done in the practical world. It is indeed probably an oversimplification to suggest that policy has two distinct sides--technical vs. non-technical or policy oriented--for they are not so easily distinguishable. For example, the very choice of a technical or scientific policy component, e.g., an engineering criterion such as a force resistance requirement, is itself a strategy choice and thus a policy issue in its own right. In any event, the technical aspects and the many other aspects of earthquake policy need to be dealt with in an integrated manner, a goal not easy to achieve for a number of reasons.

For one thing, there are weaknesses in seismic policymaking. First, the process of learning from earthquakes is still haphazard, piecemeal, and lacking in thoroughness. Observers too often concentrate on substantial descriptions of what they have seen, and give only passing attention to interpreting the significance of their observations and drawing conclusions to guide policymakers.

Another weakness relates to communication on seismic safety issues between earthquake professionals and policymakers. Typically, such communication is difficult, usually being nonexistent, or at best spasmodic, especially with hazards that occur infrequently in any one region, e.g., earthquakes. Policymakers tend to be mindful of earthquake hazard for only a relatively short time after an earthquake has affected areas in their own immediate charge. Then their principal attention shifts back to other pressing matters. Consequently a major failing has been lack of depth and continuity in policy-level concern with seismic hazards and their mitigation.[2]

Formulating and Implementing Policies

Policy formulation is a complicated and rather messy process. When most successful it should produce measures that can be adopted, will actually deal with the problems addressed, and should not have undue "unforseen" consequences. Developing effective strategies to create such policies takes a judicious mix of expertise and judgment. There must be (1) expert understanding of the problems confronted, 2) a sensitivity to political and institutional forces that will influence policy acceptance, and (3) a realistic sense of "what will work" after a policy has been adopted, i.e., during implementation and administration.

Achieving the appropriate mix is difficult enough for almost any kind of complex problem, but is especially so for seismic safety. The very infrequency of earthquakes means that seismic safety receives only sporadic attention from policymakers--this is a major part of the problem. The top administrative personnel in most organizations--the people who have been aptly characterized as "the get-it-all-together" profession [Cleveland, 1979]--are only rarely involved. Instead, planning and preparation for many kinds of disasters (especially infrequent events) tend to be relegated to second- or third-string personnel in both government and industry. Disaster preparedness simply does not have a high place on the agendas of most top administrators.

Table 1

City/County Administrators' Time Spent on Disaster Preparedness

Time spent per year	City Managers	County Administrative Officers
None	6%	2%
Less than 1 week	72	52
1 to 2 weeks	6	19
More than 2 weeks	11	10
Other	5	17
Total	100%	100%

Source: California Seismic Safety Commission, Public Official Attitudes Toward Disaster Preparedness in California (SSC 79-05, August 9, 1979), Appendices and background materials, pp. A-18, A-25.

For example, a recent California study found that "three-fourths of the city managers and over half of the county administrators said they spent less than one week per year" on disaster preparedness, concluding that it is "a low-priority business for most government leaders" [Olson, 1980]

On the scientific and technical side of the personnel equation, expert attention and academic investigations are understandably focused heavily on matters that interest geologists, seismologists, and research-oriented engineers and architects. While such work has basic, long-term importance, it often has limited immediate application to the kinds of problems that practicing engineers, architects, builders, and policymakers need to address in dealing with earthquake hazards.[3] Further, many of the more scientifically and technically oriented researchers may not be well qualified to contribute effectively to the unfamiliar process of policy formulation. To sum up, if disaster-planning personnel are typically removed from mainstream policymaking and administration, and if many scientific and technical personnel can make only limited contributions to policy development, where shall we find the human resources needed for seismic safety policy formulation?

A Small But Growing Contingent...

What has emerged in California and the United States is a rather small but growing contingent of dedicated people with a wide variety of backgrounds--a "self-selected elite"--who have taken a special professional interest in earthquakes and disaster preparedness. Many are engineers in the forefront of the state-of-the-art in structural design. Some are earth scientists, e.g., geologists and seismologists. There are representatives from a wide scattering of other disciplines, including a relatively small minority from policy fields (sometimes called "generalists").

Even in modest numbers, knowledgeable and determined individuals can be influential, especially if their ideas are well formulated enough to be effective during those limited periods when seismic hazard is temporarily the center of public attention, i.e., immediately after an earthquake, particularly one causing undue or surprising kinds of damage. Moreover the number of such individuals, as well as the general awareness of seismic issues, has been increasing in our area. Thus California observers have noted a reasonably clear progression of interest, especially since the Alaskan earthquake of 1964, which seems to have been an important contributor to the upward trend of awareness in the past two decades in California and the United States. Since then, each successive damaging earthquake has made its own contribution. While we have complained that seismic policy and disaster preparedness are still low among policymakers' priorities, we nevertheless must admit that awareness and public concern are notably higher now than they were ten or fifteen years ago.

In Southern California, at least, the level of public support for governmental action on seismic safety seems unmistakable. Recent studies in that region by Ralph H. Turner and others [1979], [1980] found strong approval of rather stringent seismic policy measures: nearly 90 percent favored posting warning signs or closing down buildings found unsafe, and 75 to 80 percent favored laws to require the strengthening or abandonment of hazardous apartments, workplaces, etc. Substantial support was also found for investing large sums of money in safety measures.[4]

Institutionalizing the Efforts

Partly in response to growing interest, there has been some institutionalizing of policy processes that in earlier times were almost entirely ad hoc. A classic ad hoc policy response came after the 1933 Long Beach earthquake, which demonstrated the extreme vulnerability of public school buildings as then designed and constructed. That same year a shocked California legislature immediately passed the "Field Act," aimed at enforcing seismic safety standards for all public schools. While such ad hoc approaches can occasionally be quite effective, as is the California law on school safety, the result is limited-purpose response to individual earthquake events. This can mean progress on a few fronts, but also usually means comparative neglect on others.

In a recent move toward greater continuity and comprehensiveness, the State of California established the State Seismic Safety Commission in 1975. The commission is an advisory body on seismic policy, whose 17 members are chosen to represent a cross-section of appropriate backgrounds and interests.[5] Its pr al role is to set realistic goals and priorities and to seek e methods of implementing them. A crucial part of its task is .dentify and recommend ways of filling major gaps in seismic safety programs. This means a continuing overview of all seismic safety efforts, keeping a watch for hazards that are not being dealt with adequately.

Other forms of institutionalization could be noted, but since a comprehensive survey is impossible here, attention will be focused on one significant example, the work of the Earthquake Engineering Research Institute. EERI is a non-profit corporation founded in California on a small scale in 1949. It has now matured into a major participant in the study of seismic safety. Beyond its principal activity of holding conferences and workshops, and publishing an informative bulletin, another important institute function is sponsoring investigations of destructive earthquakes in various parts of the world [EERI, 1979].

After roughly a decade of experience, EERI is restudying and trying to improve the methodology of its investigations. Preliminary findings suggest that while the basic task of collecting data has been handled reasonably well (often under quite adverse circumstances), still largely missing is the continuity and follow-up needed for deeper exploration of the policy significance of the investigations. In short, interpretation of the investigations' results needs considerable strengthening to give effective guidance in public policy formulation.

Several recommendations for improvement can be touched on here. First, investigation teams can be prepared beforehand with special briefing on the need for interpretation and policy guidance. Second, they could participate in debriefings as soon as possible on their return, and could contribute to workshops exploring the significance of the findings, especially with respect to the adequacy of current seismic safety policy and practices. Third, policy oriented observers should be included in the debriefings and, if possible, on the teams themselves. Fourth, there could be regular (perhaps annual) follow-up reviews of the investigations and other recent evidence on earthquake safety, posing such questions as these: What have we learned in the last two or three years? How well have we taken advantage of this new knowledge? What further investigations are needed? Are policy changes called for? Who would be responsible? Finally, the results could be disseminated to a series of audiences, including practitioners and professionals directly concerned with seismic safety, and other personnel whose activities could significantly affect seismic safety and hazard reduction.

What More is Needed?

If the investigative roles of bodies like EERI are greatly strengthened, they could provide extremely useful guidance for policy bodies like the California Seismic Safety Commission, developing new evidence from recurring earthquakes to help assess safety levels and policies and recommend new ones. The investigative and policy activities ought to be closely interrelated and coordinated: they should fit like a hand in a glove.

Other important contributors should not be neglected. For example, in the United States, the National Science Foundation funds important research efforts in the interest of improved seismic safety, and the U.S. Geological Survey has its own extensive research program. The Federal Emergency Management Agency is the key national overview agency concerned with earthquakes and other disasters. A full list would include a number of others who contribute. Furthermore, in the final analysis it is imperative to keep in mind the essential roles of the "regular" departments of national, regional, and local government, and the managers and workers in private-sector enterprises. They are the ones who will actually direct and carry out the programs that make things safer in the future--or fail to do so.

Whatever the institutions involved, a continuing, integrated dynamic process is needed to ensure that safety inadequacies are regularly reviewed and improvements formulated and implemented. The process should monitor and evaluate existing seismic safety policies, and recommend needed changes. Moreover it is unrealistic and unwise simply to pass a law, revise a code, or adopt an administrative regulation and assume that the problem addressed will thus be solved. Some remedial measures may fall short, while others may overshoot the mark, proving unduly stringent or difficult to administer, or causing unanticipated effects that may be counter-productive. An effective process of seismic safety policy formulation and implementation must be able to identify such failings and correct them.

This discussion suggests only the barest outline of some performance standards or goals for policymaking and implementation. How they can best be achieved, and through what institutional framework, will depend on many variables that are likely to differ significantly among regions and among nations. But it seems clear that a comprehensive policy process calls for permanent national or regional mechanisms having several responsibilities, including the following:

1. They should bring together the expertise needed to evaluate scientific and technical information on earthquake damage and seismic safety, and to interpret the significance of new findings about seismicity and seismic hazards.

2. They should draw on main-stream expertise in policy, administration, and management to help devise strategies and programs that will be realistic and workable, and that will be given a higher priority among policymakers than has previously been typical.

3. In implementing seismic safety policies, they should work through several appropriate kinds of vehicles, e.g., new legislation; administrative action by national, regional, or local government;

programs undertaken by public- or private-sector industries and commercial enterprises; professional education and training programs; and action by citizens' organizations and volunteer groups.

4. They should monitor and review the results of these efforts, identifying old measures that do not work well in practice, and devising new strategies when needed.

FOOTNOTES

1. This paper is based primarily on experience in the United States, especially California. With appropriate adaptation, several of the conclusions are probably also applicable to earthquake policy formulation and implementation elsewhere. On the other hand, it is acknowledged that such policy processes and their outcomes are greatly influenced by the physical circumstances (e.g., seismicity and earthquake history), institutional patterns, prevailing practices (e.g., engineering and construction), and political systems in the various countries.

2. Alan J. Wyner [1981], University of California, Santa Barbara, found a notable lack of concern among local elected officials in California, most of whom seem content to live with the status quo. Their philosophy is, in effect, "our current policies are producing a physical environment that we accept as safe enough, given the benefits, cost and risks." Wyner points out that in time such decisions, made "by default," have a greater likelikhood of producing unanticipated and unwanted consequences."

3. Winifred O. Carter, Professor of Civil Engineering, Utah State University, commented recently on engineering research: "I see a closed loop in the research community...the proposals are submitted, they are funded, the research is carried out, the report is generated, and it goes on a shelf. There is very little transfer of that research knowledge to the practicing engineering profession. It is also my perception that it is very difficult to glean useful information from most research reports." [Ward, 1981]

4. Turner cautions, however, that strong support "in principal" for such expenditures does not mean that earthquake safety equals other pressing needs, like public education, police protection, public hospitals and health care, all of which out-ranked seismic safety in the opinion sampled.

5. "...the individuals appointed to the commission are intended to represent the professions of architecture, planning, fire protection, public utilities, electrical engineering, mechanical engineering, structural engineering, soils engineering, geology, seismology, local government, insurance, social services, emergency services, and the State Legislature..." [California Government Code, sec., 8892.] Fifteen of the 17 members are appointed by the Governor, and one is appointed by each of the State Legislature's two houses, from its own membership.

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THE CALIFORNIA SEISMIC SAFETY COMMISSION, 1975-80:

PUBLIC POLICY AND A PRACTITIONER'S OBSERVATIONS

Robert A. Olson

Introduction

A recent article in a national scientific journal stated that, "The establishment of this commission is the greatest public accomplishment on earthquake hazard mitigation in California since the great study of the 1906 earthquake by the State Earthquake Investigation Commission, set up specially for this purpose." [Bolt, 1978]

After a four year (1970-74) study of the earthquake hazard in California by the Legislature, the Seismic Safety Commission was created as an independent agency in 1974. It was made independent because of the need to evaluate existing programs; provide coordination of twenty State agencies operating nearly fifty earthquake safety programs plus those of local government and related efforts of national agencies; and find practical solutions to unanswered problems of hazard reduction and seek their implementation. The Commission's primary role, therefore, is the development and implementation of public policy.

Responsibilities and Objectives of the Commission

Because of the complex nature of earthquake hazard policy, the enabling legislation is very broad. The Commission's responsibilities include:

- Advising the Governor and Legislature on earthquake programs;
- Reviewing earthquake-related programs financed by the State and recommending improvements;
- Setting goals and priorities for reducing the earthquake hazard in the public and private sectors;
- Providing a consistent policy for earthquake-related programs for agencies at all government levels;
- Proposing needed legislation and reviewing other earthquake-related legislation;
- Conducting public hearings on earthquake safety issues;
- Helping to coordinate the earthquake safety activities of government at all levels;
- Recommending program changes for earthquake safety to State and local agencies and the private sector;
- Requesting State agencies to devise criteria to promote earthquake safety;

- Recommending adding, deleting, or changing State standards when such actions promote earthquake safety;
- Reviewing construction efforts after damaging earthquakes; and
- Gathering, analyzing, and disseminating information, encouraging research, and sponsoring training.

Annually, the Commission designs a work program for the year. This work program contains specific tasks aimed at achieving several key objectives. They are: (1) To insure reasonable seismic safety standards for new design, construction, and building; (b) To reduce existing earthquake hazards; (c) To insure optimum preparedness for, response to, and recovery from earthquakes; (d) To assess and improve the state-of-the-art; and (e) To provide legislation, information, and technical assistance.

In the five and one-half years of the Commission's existence, it has provided oversight and coordination for many activities; supplied expert technical assistance to the Legislature, several State agencies, and many local governments; reviewed in detail several existing programs and sponsored successful legislation to reduce costs and improve their operation; focused on key issues needing solutions and working toward them; forged better working relationships between State agencies and several national ones; and completed other projects related to codes and standards for safer construction.

Policy Development: Selected Examples

The role of the Seismic Safety Commission in the development and implementation of public policy can best be shown by examples of its work. First, a report to the Governor and Legislature recommending a comprehensive approach to earthquake safety from now through the year 2000 is nearly finished. This report will contain a short-term improvement program recommending a level of financing for each existing or proposed new state earthquake safety program. In addition, the report will contain a summary of key unresolved policy issues needing a more thorough examination before the Commission can recommend what state laws, regulations, or programs are needed.

Second, over the years the Commission has been very active in proposing new or amending existing laws. It is seen as the initiator of most legislation in this field, and currently the Seismic Safety Commission is sponsoring legislation that will affect the construction of hospitals, the installation of mobile homes, and public education for earthquakes. In the past it has worked on laws related to standards for the rehabilitation of dangerous buildings, liability for earthquake prediction, requirements for geologic reports for development, and others.

A third example is "the vision" presented by the Commission in its report titled "Goals and Policies for Earthquake Safety in California". This report has been widely distributed and has as its purpose the stating of long-term goals and policies that represent the Commission's views about what should be accomplished in the decades ahead. Next, the Commission has designed a technique to assess the earthquake hazard of thousands of buildings owned by the state government (office buildings, university and state college buildings, hospitals, prisons, etc.). This is a major policy development in that it allows budget officials to compare the hazard and allocate funds for reconstruction based on a system of priorities.

Fifth, the Commission plays a continuing and influential role in articulating the need for adequate independent review processes related to the construction of critical facilities. An independent review means that the design, plans, calculations, and construction processes are independently evaluated and monitored so that earthquake safety is enhanced. The Commission does not do the independent reviews, but it has been instrumental in creating review processes for specific facilities, including Auburn Dam, liquid natural gas terminals, and the study of an existing building housing radioactive materials at a national laboratory.

A new project to design a comprehensive guide for post-earthquake investigations provides a sixth example. To optimize learning from future damaging earthquakes it is important that topics for which data are needed be identified and the proper information collected. Although damaging earthquakes are regularly investigated by various groups, there has not been a consistent, comprehensive, or detailed enough investigation of most of them. The Commission's guide will attempt to define the needs and hopefully will guide future investigations so that research opportunities are not missed.

A final example is demonstrated by a comprehensive regional earthquake preparedness project the Commission has begun in Southern California. Jointly financed by the state and national governments, it is an experiment designed to develop and implement a common planning process in an area with five county governments, over one hundred cities, and numerous special districts, each with its own legal authority and government. If successful, this planning process could then be used in similar metropolitan areas to produce a coordinated set of preparedness and response plans for both predicted and unpredicted events.

1975-80: Lessons from Policy Making

The Commission's deep involvement in the development and implementation of public policy has covered a wide variety of issues, some of which have been very controversial and highly politicized. It seems timely to assess the major lessons that have been learned from these experiences.

First, it is critical that political leaders and decision-makers be supportive of the Commission and its programs. These relationships have to be carefully developed, and it also requires that the Commission be politically sensitive so that its desires are seen as realistic and politically acceptable. This is an ever-changing element of the environment; for example, the Governor's Budget for 1979-80 proposed to abolish the Seismic Safety Commission, but this effort was soundly defeated. During the next two years, the Commission's life was extended for an additional six years, its authority expanded, and a special appropriation of $750,000 was made to help finance the special project in Southern California.

Second, although the pool of technically qualified people is quite large in California, the number who can successfully apply that knowledge to the development of public policy and the politics of implementation is very small. About four years ago the Commission refused a $1,000,000 appropriation because the state-of-the-art and the number of people available to do what the Legislature asked were not available. Better to explain this to the lawmakers than to accept the money and not meet their expectations. In general, the relationship between technical expertise and the policy-making process has been established only recently and is not well understood by most "earthquake experts". Translating technical knowledge into public policy causes changes, and they appear in organizations, educational processes, professional practices, governmental decisions and public opinion. Few members of the scientific and technical community realize that they are involved in a social change process, and this understanding is a key to having an effective Commission.

Factors of organization and style provide a third lesson. Experience gained during the Commission's life indicates that the expertise and reputation of its membership is critical. To maintain the degree of excellence of the past will be the challenge of the future. It has also proven critical that the Commission have direct access to the Legislature and that it maintain an active legislative program so that its presence is felt on a continuing basis. Moreover, the quality of the work done by the Commission must be of the highest order. In many cases there is sufficient substantive controversy, and it is important that the quality of work not be debatable so that decision-makers are not placed in a position of judging the competence of an "expert" Commission.

A fourth lesson is that the expectations of the people who voted to create the Commission see their expectations fulfilled. The concept of the Commission was to provide a focus for leadership and initiative as well as an organization to which problems can be referred. The Commission has performed these roles and, therefore, is seen as fulfilling its mandate by those who periodically review its work and provide its money.

Fifth, because it is concerned with general policy and is both advisory and independent, it has been able to avoid competition with regulatory or operating agencies--those that have specific technical programs or regulatory functions. This has helped insulate the Commission from bureaucratic infighting. In fact, the Commission has helped play an integrative role by helping organizations work together on common problems.

The Commission's independent review of existing programs has taught the sixth lesson. Not only have substantive changes been made as a result of these evaluations, but it has put people on notice that their efforts may be studied, and, if found wanting, the law or organizations may be changed. Consequently, the operating agencies keep a careful eye on the Commission.

Seventh, the Commission also serves as a link between the scientific, technical, and earthquake research communities and the application of knowledge for public safety. Thus, the Commission is seen as an active agent for change through which knowledge can be partially implemented. For example, the Commission regularly receives research studies that might have policy implications and periodically hears directly from researchers about their projects and recommendations. Much of this information finds its way into the Commission's work program, or in some cases these same people are asked to serve on committees to help the Commission.

Although during this period there have been several moderate damaging earthquakes in California (Oroville, 1975; Willits, 1977; Santa Barbara, 1978; El Centro, 1979; Coyote Lake, 1979; Livermore, 1980; Westmorland, 1981), none has been significant enough to raise the earthquake safety issue on the political agenda sufficiently to see enactment of the bold and innovative initiatives that followed the 1971 San Fernando earthquake. This eighth lesson suggests that in the absence of relatively major damaging events progress will be made on an incremental basis, and it will be harder to mobilize support for some proposals. Nevertheless, the Seismic Safety Commission has in its "memory" a long list of desired legislative proposals and executive changes it would like to see implemented. With a little work, the right opportunity, and support these desires could become realities.

History provides a ninth lesson. In planning the Commission, serious debates took place about its composition. At one extreme it was proposed that the Commission be solely a technical body because, it was argued, only experts in the field could properly perform the roles the Commission was expected to play. On the other hand, there was strong argument that the Commission should be composed of generalists familiar with, but not expert in, the earthquake problem, and that they should be advised on a continuing basis by a technical advisory committee. This view was based on the belief that the Commission should pay primary attention to the governmental structure and political processes in California state government. Predictably, a compromise was reached and the law establishing the Commission represents a balance between technical representatives and generalists. Looking back on five years experience, it appears that this was not only a reasonable compromise but has turned out to be very effective. One need only listen to the Commission's discussions to appreciate the variety of viewpoints and the wide range of considerations that are taken into account.

The final lesson from five years' experience is that the Commission can be effective although it is only an advisory body. Initially, it was debated whether the Commission could be effective without having regulatory powers or operating responsibilities since most formal organizations believe they must have either or both to be effective. In a practial sense, given the political environment at the time (1974), an advisory commission was all that was acceptable. The absence of regulatory or operating responsibility has given the Commission an unusual amount of freedom to explore, in the depth needed, policy issues which it feels are important and to decide what actions are warranted. Should it have been given regulatory or operating responsibilities, undoubtedly the Commission would have been preoccupied with the performance of these responsibilities and probably neglected the research and discussion of fundamental policy needs. By skillfully using the techniques it has available, the Commission has shown that it can be a very effective organization in promoting earthquake safety without having a great deal of formal power.

Surely there are other lessons that can be learned from the past five years. The Commission's unique role in earthquake safety in California would make it a valuable case study. What would be learned could help guide the planning and operation of similar policy oriented programs elsewhere.

The Commission's Environment: Factors Influencing Policy

There is little knowledge about factors which facilitate or impede earthquake safety policy development. Those who share the responsibility for the translation of knowledge into public policy would benefit greatly from a more thorough understanding of the forces involved.

From a practitioner's perspective, a number of factors seem to be influential in promoting earthquake safety. First, the occurrence of significant earthquakes presents opportunities for public action. This is due to heightened interest and the consequent motivation of public officials. Political bodies face many pressures and crises in normal times, and it is easy to understand why problems related to earthquake safety receive relatively low attention during the interim.

A second factor are the activities of advocate organizations and opinion leaders. They offer ideas, proposals, support, and the influence necessary to help achieve seismic safety objectives. Legislators, members of city councils and boards of supervisors, and private sector leaders who have some expertise in the subject play key roles in developing new public policy.

A more recent factor supporting improved seismic safety is the awareness of environmental quality. The concerns about air and water quality, resources conservation, growth management, and similar problems have supported increased attention to environmental safety, especially when it is related to natural hazards.

The rapidity of communications is a fourth major factor. Damage information communicated to the American public as a result of earthquakes in Nicaragua, Guatemala, Turkey, Italy, Romania, Iran, the Philippines, and many other countries has meant that viewers and readers can understand the effects of disastrous earthquakes almost immediately.

A fifth influence has been increased financial and human resources devoted to earthquake safety. The results of this investment primarily by the government are that the earthquake problem is better understood, knowledge of its implications has entered the field of practitioners, college and university curricula have expanded to include courses dealing partially or entirely with earthquake hazards and expanded research programs have been undertaken within, or financed by, government and other organizations. This has produced a larger community of knowledgeable people, answers--or at least approaches to answers--to problems that need study; and support of some action programs, such as the creation of the California Seismic Safety Commission.

A last and relatively new factor that may be facilitating improved seismic safety policy is the publicity surrounding earthquake prediction research. As noted earlier, the greatest advancements in earthquake safety seem to be in response to the larger damaging earthquakes. The emergence of earthquake prediction as a major research effort in the United States and elsewhere has provided the subject with continuing popularity. Although the public may get confused about the state-of-the-art, the validity of specific predictions, and the reliability of certain sources of information they are continually reminded that the earthquake threat is present and that people are working on ways possibly to predict such events.

It is also fairly easy to identify some factors that appear to impede the development of seismic safety policy. First, the absence of damaging earthquakes has an effect on the receptivity of decision making bodies to enact or support new programs. Closely related is the problem of other priorities that demand attention. Policy-making is a very dynamic process, and to a large degree it tends to be somewhat crisis oriented. The California Legislature, for example, has been concerned recently with property tax reform, public school financing, medical malpractice insurance, and other major issues. Should a big earthquake occur, one effect would be to change its priorities, and more attention would be given to earthquake safety. This was clearly demonstrated following the 1971 San Fernando earthquake. A further difficulty has been the inability to define the threat in precise enough terms so that people perceive that there is a high probability that they will be affected. This seems to be a strong factor. However, the development of a reliable and effective prediction system will almost certainly erode its influence.

Another problem which has impeded further policy actions has been the somewhat negative reaction to some programs. This has required their defense, particularly as the time between earthquakes becomes longer. People have spent time going back to California's Legislature to defend the standards for school construction enacted after the 1933 earthquake, and since the 1971 earthquake there have been such occasions with regard to programs initiated following that event. Under these circumstances, it is hard to initiate new measures. A last influential factor has been the inability to demonstrate clearly the effectiveness of many existing programs. Partly this is a function of the relative infrequency of damaging earthquakes. It is only in recent years, for example, that enough data have accumulated about the actual behavior of public school buildings built since 1934 according to the Field Act to know that the program is basically sound.

In sum, it has been traditional in summarizing the history of policy to follow a chronological sequence, usually beginning with the development of local codes following the 1925 Santa Barbara earthquake. Depending upon the observer's viewpoint, this leads to observations such as, "Look at how much we have been able to do, particularly in the recent past," or "Look at how litle we have learned and applied from past earthquakes".

However, when this chronology is separated from the dates of major policy developments, there is an interesting dichotomy. After some of the larger magnitude earthquakes in California there have been major policy changes, but this discussion must also account for the occurrence of other significant damaging earthquakes where nothing of policy significance happened, except perhaps for relatively minor "tinkering". The question is "Why not?". No major policy changes followed the 1906 San Francisco "fire," the 1952 Kern County earthquakes, the earthquakes in Eureka, California and Dixie Valley, Nevada in 1954, the 1957 Daly City earthquake, the 1969 Santa Rosa earthquake, and the 1975 Oroville earthquake.

The presence or absence of the above factors which facilitate or impede the development of seismic safety policy may help account for the different responses to historic damaging earthquakes. A valuable research project, carefully done, and tested against the public records of previous earthquakes, might show that certain combinations have produced actions. Their absence might help explain inaction.

Future Policy Issues

Some major policy issues which will continue to be on the agenda for the future include sustaining an effort to reduce hazards from non-earthquake resistant buildings; the social, economic, and policy implications of earthquake prediction; concern about the safety of critical facilities and services and the role of government in setting siting and design standards for them; assessing the role of the Uniform Building Code as a basis for minimum standards and the quality of enforcement; and the increasing need to integrate the activities of local, state and national agencies to achieve earthquake safety.

Increasing emphasis must be placed on more effectively using knowledge and speeding up the process of translating it into effective programs. Organizations such as the Seismic Safety Commission may take on added significance by acting as a link between the knowledge community and governing authorities. There will continue to be a strong need for policy oriented research to help answer some of the difficult questions related to the design, acceptance, and administration of public programs.

Conclusion

Concern about the earthquake hazard will continue in California, especially when noted scientists are quoted as saying:

> In anticipating the next big California earthquake of magnitude 7 or higher, we must conclude that time is running out. The evidence strongly suggests that such an event must

> now be considered imminent. Until recently there has been a tendency to think of such an occurrence in terms of "the next 10 or 20 years". But now, for several reasons, we can no longer keep pushing this "time window" into the future. In short, present evidence that a large earthquake is imminent in California is much stronger now than 30 years ago--or even 10 years ago. [Bolt and Jahns, 1979].

To a significant degree it will be the focus on public policy and its implementation that will lessen the risk. In all likelihood, progress will be made incrementally, and understanding the policy-making process is central to taking the constructive steps required to achieve a higher level of safety. One should probably not look for major breakthroughs until a major damaging earthquake strikes. Rather, a cumulative record of significant policy achievement should be sought.

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IMPLEMENTING SEISMIC SAFETY POLICY:

THE CASE OF LOCAL GOVERNMENTS IN CALIFORNIA

Alan J. Wyner

Accomplishing seismic safety policy objectives requires the successful implementation of action oriented programs. While there remains some disagreement about specific relationships between earthquake generated forces and the subsequent performance of certain structures, there is no disputing the general proposition that the severity of damage and the extent of human loss from an earthquake is affected by the way in which seismic safety policies are implemented prior to the event. It is evident from a growing body of academic literature that public policy implementation is almost always problemmatic.[1] Mere adoption of public policies does not guarantee the consummation of the envisioned goals. Many intervening factors stand ready to block, delay, or detour implementation efforts. Seismic safety policies are as prone to these implementation problems as any other public policy. Indeed, it is at least arguable that seismic safety policies are more susceptible than many other policies.

This paper focuses on some important aspects of efforts to implement seismic safety policies in California. The process by which seismic safety policies are adopted, as well as the substance of the policies, will be accepted as a given in this paper. More specifically, this paper draws upon research conducted in thirteen local California communities. The thirteen jurisdictions were chosen so that they would include areas that had suffered damage from a recent (within ten years) earthquake as well as those areas that have not had a damaging earthquake within the adult life of those persons currently holding positions of influence within the local government. Small cities, suburbs, and large central cities were chosen.[2]

For several reasons, local governments are an appropriate focal point in an examination of seismic safety policy implementation. Although local governments have no formal standing in the American constitutional structure, they have assumed a vital place in the arrangement of governments. Not surprisingly, the initial growth of local government importance coincided with the dramatic population growth of cities in the first several decades of this century. Suburban development after World War II accelerated efforts to increase local independence--financial and political--from state governments; these efforts were moderately successful. To some extent, the increased financial independence from state government has been achieved only by an increased financial dependence on the federal government. Today most cities function within a constitutional and political structure in which the states (and the federal government) establish boundaries or outlines for what is acceptable policy. Within these boundaries some policies must be adopted by local governments, while others remain subject to local discretion. Local governments always

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retain some room for maneuverability in the actual implementation of policy; this is true for policies that are optional as well as those policies more specifically mandated by state or federal government edict. Delegation of implementation responsibility--whether it be in education, law enforcement, or seismic safety--creates *ipso facto* an opportunity to exercise independent judgment about how to implement the policy. Seismic safety policy implementation in California illustrates these trends.

California state government has established the outlines of seismic safety policies. With the exception of school and hospital construction and dam safety, local governments are where the policies must be given operational meaning. For example, California requires that each city and county government prepare a "Seismic Safety Element" of its local land use plan. Guidelines that indicate the kind of seismological and geological data to be incorporated into the Elements are published by the state. Local governments, however, actually prepare the Element and then are solely responsible for any implementation.[3] Such land use decisions as whether to permit a residential subdivision in a certain location remain the responsibility of local government, whose judgment is supposedly informed by the state required Seismic Safety Element. This *modus operandi* also prevails in the areas of building code enforcement and emergency response planning. Therefore, the success of seismic safety policy implementation by California local governments heavily influences the fate of most earthquake mitigation efforts.[4]

Implementation: Theoretical Frameworks

Seismic safety has been on the public policy agenda in the United States, and especially in California, for most of the last decade. Using the more precise terminology of Roger Cobb and Charles Elder, seismic safety has been on the "systematic agenda" consistently and on the "governmental agenda" sporadically. Cobb and Elder define the systematic agenda as consisting of:

> all issues that are commonly perceived by members of the political community as meriting public attention and as involving matters within the legitimate jurisdiction of existing governmental authority. [Cobb and Elder, 1972, p. 85]

The governmental agenda is differentiated by defining it as:

> that set of items explicitly up for the active and serious consideration of authoritative decision-makers. [Cobb and Elder, 1972, p. 86]

The difficulty of sustaining a place on the systematic agenda should not be minimized, nor should the strategic and tactical posturing of those who wage political battles over governmental agenda items relating to seismic safety. Once having achieved governmental agenda status, many proposed policies have been adopted; again, especially in California.[5] What should concern us at this point, however, is the fate of those policies after adoption. Put more bluntly, there is no point to continued arguing over agenda status and the specifics of proposed additional seismic safety policies without having some understanding of how previously adopted policy has been implemented.

The last few years have seen an upsurge in efforts to construct a generalizable conceptual framework of the public policy implementation process. A brief presentation of several theoretical frameworks usefully precedes an examination of seismic safety policy implementation in California. Only a representative sample of this literature will be discussed, but this sample includes the frameworks most widely cited. These frameworks contribute to our present concerns because they permit a fuller explanation of seismic safety policy implementation activities and because they remind us of both similarities and differences inherent in a comparison of seismic safety policy to other policy areas.

Utilizing a systems theory perspective, Donald Van Meter and Carl Van Horn [1975] suggest the intervention of six major variables between policy enactment and ultimate performance; by performance they mean the impact of policy. Integral to any policy, they argue, is the establishment of (1) standards and objectives and the allocation of (2) resources (or lack thereof). These two variables create the opening conditions for the core of the implementation process in which (3) interorganizational communication and enforcement activities, (4) characteristics of the implementing agencies, (5) personal disposition of the implementors, and (6) the political, social, and economic environment all interact so as to produce an impact or policy performance. Although the various interactions can become quite complex, the model has the virtue of identifying the key components of any policy implementation effort.

Eugene Bardach [1977] characterizes implementation as a series of games. In a description that would also fit the Van Meter and Van Horn model, Bardach starts with the "essential implementation problem," that is:

> to control and direct the vast profusion of program related activities carried on by numerous and disparate organizations and individuals so as to achieve program objectives, keep costs down, and reduce delay. [Bardach, 1977, p. 250]

By using the metaphor of a game, Bardach can highlight actions that may have adverse effects on implementation. The games can be categorized by the stakes at issue. Four adverse effects may result from the implementation games:

> (1) diversion of resources, especially money
> (2) deflection of policy goals stipulated in the original mandate
> (3) resistance to explicit, and usually institutionalized efforts to control behavior administratively
> (4) dissipation of personal and political energies in game playing that might otherwise be channeled into constructive programmatic action. [Bardach, 1977, p. 66]

The "Budget" game diverts resources because implementors have an incentive to spend their full allocation in a given fiscal year so that funding for succeeding years will not be reduced. Deflection from original policy goals can occur in the "Up for Grabs" game when a program is ambiguously designed or when there is no enthusiasm for the program among the implementors. The game of "Tokenism" emerges from efforts to control behavior administratively. Here there are public expressions of support and agreement, but privately only token implementation is forthcoming. Probably the most pervasive game that dissipates energies Bardach labels "Territory." This game is played by bureaucrats who invest substantial energies and time in the protection and expansion of their own domain. Therefore, they are unable to devote very much to actual policy implementation. These various games, which are illustrative and not exhaustive, have effects that hinder successful policy implementation.

After praising authors such as Van Meter and Van Horn and Bardach for their pioneering efforts, Paul Sabatier and Daniel Mazmanian [1981a] argue for an approach to implementation analysis that considers the importance of three factors, two of which are not explicitly contained in previous conceptualizing endeavors. They suggest an examination of the (1) tractability (or solvability) of the problem being addressed in the policy, (2) the way in which the statute structures implementation capability, and (3) the net effect of political variables for the support given to goal attainment during implementation. Sabatier and Mazmanian forcefully make the case that a problem's tractability can be categorized along several dimensions, and that any attempt to understand policy implementation must take into account the degree of tractability posed by the original problem. This reasoning is a logical and important contribution. The second point which sets Sabatier and Mazmanian apart is their insistence that the composition and character of the enabling statute--and the way in which the statute delegates implementation responsibilities--must be carefully analyzed for its impact on implementation success. The law, in other words, should not be taken for granted in an implementation analysis.

Several important implementation issues related to seismic safety emerge from the three conceptual frameworks presented above. Only a few can be dealt with in this paper. In subsequent sections three types of implementation issues are discussed, each having a place in one or more of the frameworks, but not being a comprehensive treatment of any. I will consider the important role of key personnel, some implications for implementation of the political environment surrounding the issue of seismic safety, and the tractability of the issue itself. The operating thesis guiding this discussion can be simply put: Seismic safety is not an issue that generates consistent expressions of organized public support and, therefore, implementation will always be problematic at best unless a highly committed and motivated core of officials diligently pursue implementation. Absent these personnel, the perceived intractability of the problem and lack of visible political rewards for supporting seismic safety make seismic safety another policy area prone to unsuccessful or incomplete implementation.

Personnel

The personal disposition of strategically placed local officials is an important ingredient in determining the success of seismic safety policy implementation. While a similar statement could be advanced for almost any policy area, personal disposition seems especially important in seismic safety because non-governmental interests are not usually pressing local government for action. What policy that is implemented--and the degree of its implementation--will be determined in spite of and not as a result of public expressions of organized local interest groups. As Van Meter and Van Horn explicitly argue, and as Bardach implicitly suggests, the dispositions and attitudes of the implementors must be examined in order to understand the fate of seimic safety policy implementation.

A brief look at the seismic safety policy behavior of officials in two cities that have undertaken several successful implementation efforts as compared to the attitudes and behavior of officials in two cities that have done very little to implement seismic safety policies underscores the importance of personal dispositions. The cities of Los Angeles and Santa Rosa fall into the first category while Burbank and Oakland lapse into the latter.[6] Santa Rosa city government has several individuals, both elected and appointed, who view their city's efforts to replace old structurally unsound buildings with something approaching missionary zeal. Following the 1969 Santa Rosa earthquake, they began vigorous implementation of a local law requiring rehabilitation or demolition of many older buildings in the downtown area. Resisting the initial heavy opposition were several city officials who personally believed the unsound buildings must be fixed. Over the last ten years, a small number (3-6) of city staff members and a few elected councilmembers have persevered in supporting implementation efforts because of their own convictions and not because of any visible public demands or obvious political benefits.

The same may be said about Los Angeles, although some modest public support for seismic safety came from a few professional associations (e.g., structural engineers) and the local press. Nevertheless, it has been the determination of a few city staff members, including one in the mayor's office, that has accounted for the reasonably successful implementation of the 1975 city Seismic Safety Element. For example, the Seismic Safety Element called for the adoption of a law requiring the identification and rehabilitation or demolition or structurally unsound old buildings. Six years after making a commitment to pass such a law the city council actually did so. Those intervening years were noteworthy for the delays caused by the ever-intense opposition to such a law by the owners--and sometimes the tenants--of the 14,000 buildings possibly affected. At numerous points during the six year controversy it would have been possible to abandon the effort without anyone suffering political repercussions or embarrassment. Only the strongly held beliefs of a few councilmembers, mayor's office personnel, and high ranking city staff members kept the matter alive and eventually completed.[7]

Burbank and Oakland offer examples of cities with public officials who generally do not feel seismic safety matters are worth much attention, and, therefore, implementation of policy has been minimal or even non-existent. Burbank suffered some modest damage from the 1971 San Fernando earthquake, but the event did not seem to catalyze a heightened seismic safety awareness by city officials. Numerous city officials have expressed a belief that the city "can't do much about earthquakes and their damage". A variation on this theme is the statement that only the private sector, and not the city, should think about the risk from an earthquake. A high ranking official in Burbank indicated that the city's Seismic Safety Element, which contains many recommendations for policy implementation, has never been used; indeed, this official could not find a copy of the Element after a diligent search of his office.

In similar fashion Oakland city officials, elected and appointed, almost uniformly disavow any interest in implementing seismic safety. No one within city government feels that seismic safety goals are worth pursuing and making a high priority. It is not the case that Oakland officials want to ignore the risk from earthquakes and not implement policies designed to mitigate damage, but it is rather a matter of Oakland officials feeling that many other policy areas demand their attention because of their more immediate relevancy. Oakland does not have city officials who have made seismic safety an important goal. Studies have been completed and reports filed, and little implementation occurs. Oakland city hall itself was the subject of one such report, with the conclusion pointing to the dubious integrity of the structure in the event of an earthquake. Emergency response planning and seismic safety building code enforcement have been given very low priority because of the prevailing attitudes.

The inclinations and tendencies--in a word, dispositions--of public officials in these four communities have made a clear difference.

Political Environment

As Van Meter and Van Horn, Bardach, and Sabatier and Mazmanian all indicate, the political environment in which implementation takes place has an important bearing on the likelihood of successful implementation.[8] Three aspects of the political environment of seismic safety policy implementation deserve mention: organized interest group support, mass public support, and the political benefits or incentives for officeholders.

Seismic safety is not an issue that has stimulated the creation of new interest groups, nor, for the most part, has it been an issue that has attracted the support of already established local interest groups. When the California local governments which were studied were considering the adoption of their Seismic Safety Elements, virtually no interest groups appeared to support the concepts or the specific policies embodied in the Elements. On several occasions interest groups expressed their opposition to parts or all of the Element. Locally based interest groups have not initiated requests for new seismic safety policy.[9] Given this lack of visible support for policy adoption, it is not at all surprising that implementation of seismic safety policy has not been supported by local interest groups; any interest group involvement in implementation has been primarily opposition by affected parties.

There were only a few occasions where seismic safety concerns were part of the political behavior of local groups in the thirteen communities studied. In those few instances, local groups opposing proposed residential developments used the possibility of future earthquake damage as one of several reasons for their opposition. In no case was it the primary or sole justification for their political behavior.

Mass public support for seismic safety policy and its implementation remains latent and has not been translated into overt political behavior.

Recent research by Ralph Turner and his colleagues strongly suggests that the mass public, at least in Southern California, believes that local government should actively pursue seismic safety goals. [Turner, et al., 1980] Those attitudes, however, have not been sufficiently motivating to generate any significant political behavior.[10] Until the research of Turner, et.al., even the existence of this latent support was not realized.

Local officials do not perceive seismic safety and the implementation of policy about it as providing any political benefits to them. In their eyes, the public does not know much about seismic safety, ranks it very low on any priority list of community problems, does not communicate with officials about it, and does not engage in any sustained organized political activity regarding it. No elected or appointed officeholder in any community studied felt that seismic safety had been an issue in a recent political campaign. Political incentives and rewards are almost entirely lacking, at least as perceived by those who must implement seismic safety policy.

Tractability

Sabatier and Mazmanian introduce the concept of tractability as it relates to policy implementation by saying,

> Totally apart from the difficulties universally associated with the implementation of governmental programs, some special problems are much easier to deal with than others. [Sabatier and Mazmanian, 1981a, p. 6]

While there are surely public problems of greater complexity and difficulty, seismic safety, nevertheless, is not an easy problem. For instance, the benefits from seismic safety policy implementations are not always obvious. Rather, an act of faith is required by officials and the public, both of whom may never have experienced an earthquake nor know much about them. Lack of personal experience or acute awareness of potential earthquake damage or of possible mitigations--all of which accurately characterize most people in public office--makes seismic safety a less tractable issue. Designing buildings in a certain way or spending public money on an improved emergency communication system does not confer clear benefits immediately upon completion, but only when an earthquake occurs--and that occurrence may be a long time in coming. There is a strong probability that most of those in public office today will not be required to respond officially to an earthquake. Given the relatively short time perspective of most officeholders, it is not unusual for them to say that the actual seismic safety problems generated by an earthquake will not occur while they are in office.

The seismic safety issue itself is imbued with considerable fatalism because earthquakes cannot be prevented. This simple reality encourages some fatalism about efforts to mitigate the effects of earthquakes. Several local government officials expressed this attitude as a rationalization for their inaction in policy implementation.

The tractability of seismic safety problems is reduced by the way in which the costs and benefits of policy implementation are usually arranged. Implementation of seismic safety regulatory policies in the areas of land use and building code enforcement create costs borne by a specific target group such as the building owner or land developer. The benefits, however, are spread in a diffuse manner to all those individuals, for example, who may happen to be in or around a building that would have otherwise collapsed in an earthquake, absent successful implementation of seismic safety policy.[11]

These and other aspects of tractability make implementation difficult. This discussion of tractability also highlights the previously mentioned importance of the personal dispositions held by staff and elected officials.

Concluding Comments

This paper has argued that local government is the appropriate focus of study if our interest is in seismic safety policy implementation. As with many policy areas, local governments' discretion in implementation may lead to policy consequences which vary by jurisdiction. Some differences in California local governments were discussed, most of them stemming from various personal dispositions of certain officeholders. Several uniformities in implementation problems were also mentioned. The political environment of seismic safety in most local jurisdictions is characterized by weak or nonexistent political interest group support, opposition by interest groups directly affected, latent but not overt mass public support for local governmental seismic safety regulatory actions, and a perceived lack of political rewards for officeholders. Because of concentrated costs and widely distributed but not obvious benefits, and a fatalistic attitude, seismic safety presents policy problems that are not easily solved.

The conclusion is inescapable--successful implementation of seismic safety policy cannot be simply assumed. Rather, the norm may be delay and less than full accomplishment of the policy goals envisioned when the policy was adopted. Reasons for this are scattered throughout the paper, and in many more ideas not mentioned, but the essence of the problem lies in the inherent nature of policy implementation. It is a process filled with organizational, personal, and politically based obstacles.

A generally negative tone has been struck in this paper. Policies are described as less than fully implemented, a lack of political support for seismic safety is discussed, and the issue itself is characterized as less than solvable. While this is accurate, it is not the entire picture. In fact, some seismic safety policies have had an impact through their implementation. Most buildings in California are designed and constructed according to more stringent standards, residences and other structures are not permitted on or near known active faults, many structures which were proposed on "problem soils" have either been prohibited or special engineering has been required to reduce the likelihood of failure, and some communities, such as Los Angeles County, have improved their emergency communications systems as a result of previous earthquake experience. What is important to remember, however, is that these and other implementation efforts did not just happen. They were accomplished by exertion and in the face of the problems discussed.

FOOTNOTES

1. Some of the major research on policy implementation includes: [Pressman and Wildavsky, 1973]; [Bardach, 1977]; [Mazmanian and Sabatier, 1981]; [Van Meter and Van Horn, 1975]; [Ingram, 1977]; [Berman, 1978]; and [Edwards, 1980].

2. The larger body of research upon which this paper draws was conducted in collaboration with my colleague Dean E. Mann and was supported by a grant from the National Science Foundation. Those jurisdictions included in the research that had recent earthquake experience were: City of Los Angeles, County of Los Angeles, Burbank, San Fernando, Glendale, Simi Valley, and Santa Rosa. Those included that have not had recent experience with an earthquake were: Oakland, Alameda County, Berkeley, Hayward, Fremont, and Salinas.

3. Most jurisdictions hired private consultants to write the technical part of the Seismic Safety Element. Some jurisdictions, however, did utilize their own staff.

4. This is not to deny the potentially important contributions to seismic safety that may come from other levels of government. What I am arguing is that most of the action occurs at the local level. It is also important to remember that the private sector helps define the level of seismic safety in a community. This paper only discusses governmental regulation of certain private sector activities pertaining to land use and construction, and, therefore, does not consider any voluntary private sector mitigation.

5. Time and space constraints prevent the presentation of an inventory of California seismic safety policies adopted in the last decade. See the following for an indication of what has been adopted: [California Seismic Safety Commission, 1979] [Executive Office of the President, 1978.]

6. While there is no hesitancy to identify the jurisdictions by name, specific officials will not be identified because promises of confidentiality were made to them during interviews.

7. I have characterized the passage of this old building law as an implementation of the Seismic Safety Element, but, of course, the more important implementation issue must be the carrying out of the law itself. It is too early to make any judgments about that.

8. The concept of an "environment" for policy implementation encompasses more than politics. Social and economic circumstances as well as the physical environment should also be considered. For present purposes, however, we will confine ourselves to political aspects.

9. An exception to this generalization is the Southern California Association of Structural Engineers.

10. Joanne Nigg [1981] offers several reasons why this may be the case.

11. James Q. Wilson [1973, pp. 334-335] refers to this as a case of "distributed benefits and concentrated costs."

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SECTION VII

PLANNING AS A TOOL FOR VULNERABILITY REDUCTION

SPATIAL AND URBAN PLANNING AND DEVELOPMENT IN EARTHQUAKE-PRONE AREAS

Vladimir Braco Mušič

Introduction

In man's coping with natural and other environmental hazards, modern urban planning and design can be seen as a major preventive instrument. At least on on_ side, while on the other side these activities seem to influence only a mincr portion of environmental change. Leaving aside some of its historical aspects, e.g., the tradition of the fortified city or the recommendations of Vitruvius and others for selection of safe and healthy sites on which cities ought to be built, one is inclined to observe the history of modern urbanism as an account of activities aimed primarily at the concentration of internal urban functions, e.g., resident, production and consumption, transportation and recreation. Even the great methodological turning point initiated by Sir Patrick Geddes with his dictum "survey before plan" has meant more for the consideration of general physical, social, and economic conditions of the site, the population and its activities, than the considerations of the problematique with which we try to deal in such specific areas as earthquake engineering, or the mitigation of earthquake impacts in human settlements, for that matter.

A number of major earthquakes and other natural disasters, as well as the awareness of the fragile state of international peace and security, have--in my view--only during the last decade or so brought about a more organized and systematic specialization in urban planning and development. Therefore, it seems natural and necessary that a series of international professional deliberations on earthquake engineering end up with a link to the broad field of social and economic aspects of earthquakes and of planning to mitigate their impacts.

This being said, one must mention that the planning and development criteria introduced to increase the resistance and the resilience of both human settlements and their component parts have been appropriately formulated to cope with a variety of risks or catastrophic impacts. It is definitely very difficult, or even inappropriate, to differentiate too strictly among the requirements imposed on urban planning and development for reasons of safety against natural or other disasters. Such complexities become particularly relevant when we start to deal with various aspects of disaster-relief actions, e.g., immediate help to the affected, evacuation, temporary housing, etc.

Coming back to the more specific examination of the role of environmental planning and development, we would like to emphasize two essential conditions, related to the qualitative characteristics of our activity: First, in this context (and, of course, in many others), planning and development of human settlements ought to be seen in its broader spatial interdependency and its more narrow (physical) relationship with the building itself. Secondly, it is important to be aware of the basic nature of planning achieved or practiced in a given country, e.g., is planning primarily a corrective or an adaptive activity, or is it of more innovative or comprehensive character.

As far as the first characteristic is concerned, planning acts and documents at various levels serve to ensure upward and downward coordination. But, the second characteristic seems to be more demanding for one principal reason. What we have in mind is the fact that the incrementalism of adaptive planning and the holism of comprehensive planning do present themselves as two poles of one dialectic pair. By its virtue such a relationship helps in simultaneously dealing with the detail and with the general structure of a given system. In reality the two poles could be dealt with in different institutional frameworks, but they can still jointly influence most important decisions.

In this paper, a short account will be made of Yugoslav urbanism before the Skopje earthquake of 1963, and paths it has followed in the aftermath, since the catastrophe of the capital city of the Macedonian Republic does represent a point of reconsideration of many professional criteria in our country. At the same time, it is interesting to compare this concrete experience with the urbanistic consequences of the Ljubljana earthquake of 1895. Before I limit myself to the generalizations necessary for the presentation of "the state of the art in Yugoslavia," based on such examples, let us remind ourselves that we deal with two completely different historical and social cases. The Ljubljana earthquake at the very end of the last century was a relatively modest event, although it caused considerable damage to buildings, including some important historical monuments which were lost forever. The memory of this earthquake was very much alive with the elderly until recently, and it renders a theme, obviously worth exploring in fiction and even in a movie. It brought to this provincial and sleepy capital of the Slovenes a considerable reconstruction effort, followed by local entrepreneurship, and it also occasioned the birth of Slovenian town planning.

There was a design competition for the new master plan in which at least two important figures of that time participated. Among others who submitted entries were Camillo Sitte and Max Fabiani, the first of whom became later a world symbol of the "culturalistic" approach in urban planning while Fabiani during the years to come engaged as his assistant a young Slovenian architect who ultimately became the principal author of the first city plan of Minneapolis, Minnesota. This was Ivan-John Jager. Fabiani's urban design structure, further developed by local architects, became an extraordinarily persistent system controlling the formation of the central urban area for many decades. The Austro-Hungarian Empire poured in assistance, of which the most visible were three complexes of military barracks designed in the best tradition of 19th century eclectic architecture.

The lesson to be learned from this case--deliberately introduced here with a few anecdotes--repeated itself many times later on. The concentrated reconstruction effort, the reevaluation of the city's function, and similar circumstances gave a strong development impetus, followed by the influx of new population and many other coinciding factors.

Skopje in 1963 had a population of approximately 180,000 inhabitants. It was the fourth largest Yugoslav community. It now has more than 400,000 inhabitants and is the third largest city in this country. The Skopje earthquake was one of the most severe in Europe in recent times. Within five seconds more than a thousand people had been crushed to death, three times as many injured, and 150,000 rendered homeless.

By the nature of the emergency which prompted it, the Skopje Urban Plan Project was unlike any other operation of its kind. It was undertaken by the United Nations Special Fund, and brought together some of the best talent in urbanism of our era. The impressive volume, titled Skopje Resurgent, became not only a monumental account of the UN town planning project but also the first reference book for students of disaster relief.

The massive material assistance of the international community, and above all of the citizens of this country, the heavy emphasis on development of technical and social infrastructure, and the over-all situation of regional development in southern Yugoslavia, have been crucial causes of the extraordinary growth and change of Skopje.

The two examples cited, and the spirit of their presentation, could be interpreted as valid arguments for natural disasters as triggers of accelerated development. While they in fact remain such, these cases were brought forward to indicate another argument, i.e., the change of attitude within the planning profession, both locally and on the international level. In a certain way this Conference seems to be a late aftermath of all these events, of course strongly "supported" by other sad events that have occurred in recent years, at the least: the earthquakes of Banja Luka--Bosanska Krajina (1969), of Friuli and Soča (Isonzo) Valley (1976), and of the Montenegran coast (1979).

All this brings us to the essential questions of the frame of reference for our theme. I am indeed far from the ambition to assume that a complete frame of reference could be presented in one paper of this kind, but I also think that our Conference will help to build one to the degree needed for the articulation of adequate urban planning and design criteria for human settlements in earthquake-prone areas. I am probably sharing the views of many others, if I say that what we have right now are simply fragments of empirical knowledge and a very initial embryo of a relevant general theory.

Let me suggest (with no further explanation) that a possible frame of reference could be constructed around the following structure:

THE (EVOLVING) CONCEPT OF CONTINGENCY PLANNING

Institutional and Methodological Base	(permanent vs. emergency)
Planning and Design Criteria	(common /for disasters/ vs. specific /for earthquakes)
Information Base	(past vs. new experiences)

The State of the Art in Yugoslavia

Concepts

Among several innovations in Yugoslav planning two are particularly important and have permeated methodological discussions for several years. The first, and indeed the essential one, is the concept of self-management planning. It is an instrument of direct democracy, obliging the self-managing subjects, i.e., the basic organizations of associated labor, the self-managed communities of interest, and the local communities to play the primary role in the planning process. The second is planning for contingencies, manifested in an ever increasing importance exerted by the aspects of civil defence, disaster prevention, disaster relief facilitation, and defence and security in general.

The nature of the socio-political organization is dual, i.e., one of the state and the other of self-management exist side by side; various levels of government (and self-management organizations and communities) are engaged in the encountering planning process. This process is especially emphasized on the level of local government, the municipality, and/or the commune.

The normative concept is, as usually, much more evolved than the reality of new planning practice, but since the introduction of the new system of planning in 1974, considerable progress has been made and sophistication achieved.

Urban design in modern terms, meaning spatial and morphological conceptualization of planning and goals parameters, has not been fully integrated into the new planning system as yet. It nevertheless shows several new characteristics, primarily in the area of synchronization of site planning (and designing) with the mid-range (5 years) societal planning targets.

Urban planning and development find themelves linked to the governmental institutional structure on one side, and to the socialized decision-making of the self-managed subjects on the other. Different stages in the programming, designing, and implementation processes are functionally linked either to the binding legal requirements of the state or to the "contractual" obligations formulated by the self-managed societal factors.

Let us use an example from the area of contingency planning. The self-management part of the role dwells at the level of an organization, or a local community, or a self-management community of interest. It takes care of defence and prevention requirements at this level, including the co-ordinating procedures of self-management negotiations (of self-management subjects among themselves). On the other hand, the Communal Assemblies, and respectively the Assemblies of the Republics provide for choices of strategies and goals.

Regional Planning

At the level of regional planning which, in fact, begins at the level of one or more communes, the most important concept, emerging particularly in the S.R. of Slovenia, is the concept of polycentrism. Polycentrism means balanced development, means conscious decentralization (and deconcentration), and means--above all--a source of mobilization of creative forces of the community at large. The concept of polycentrism is visible in the system of settlements or in the network of urban centers. The inherited structure of distribution of settlements over the territory, excellent accessibility and other natural and anthropogenous factors, here definitely enhanced the polycentric pattern of development, although political reality sometimes drives it into an exaggerated dispersion or fragmentation.

The self-managing system as the basic characteristic of our socio-political reality, the awareness of the exposed position of this country (in all aspects), and the resulting forms of contingency planning, and finally the concept of polycentrism of development, form the background against which a short--but much more concrete--description of planning and development technicalities and indeed, dilemmas will be depicted.

Structural Planning Level

Here we deal with the human settlement as a whole and its immediate physical and socio-economic hinterland. The plan is long-term in principle, but must contain implementation strategies. The last "generation" of plans is gradually turning towards a very pronounced emphasis on the information base and information flows.

If we remain in the domain of seismic contingencies, we must remark that this level of plans includes a seismological analysis and seismic zoning (microseismic regionalization). On the basis of this the detailed criteria for site plans are established, taking into account social and economic (or even financial) considerations connected with a seismic contingency.

The second relevant element of the contents is the spatial articulation of urban areas, observing similar considerations as above.

Next are the communal facilities systems with a seismological sensitivity analysis, then the communications corridors, etc.

Contingency planning components bring into structural plans alternative land uses in the case of emergencies, provisional housing, and other areas, etc.

It is beyond any doubt that the legal requirements and by-laws, guiding the preparation of plans in many instances do not correspond with the reality: the real environment meaning lack of funds for analysis, lack of qualified professionals, difficulties with implementation of land use policies, let alone the land managment problems.

Detailed Planning Level

On this level, the configuration of the built environment is expressed, and we tend to link here the translations of broader urban planning and development criteria with architectural and engineering aspects of structures themselves. The latter enable us to apply very detailed structural requirements as far as seismic risk is concerned. It is here again that the mitigation of earthquake impacts must be explored and presented in operational detail.

There is one most important factor to be considered on this level of planning and development and that is the attitude of population. It spans all the way from cultural values to the time-budgeting of the individual households. Our people show a dominant preference for individual homes, they are to a large degree engaged in private initiative, as far as housing is concerned, and they also tend to cultivate a very close relationship with the social and physical environment of their origin. These attitudes are most relevant elements of any contingency planning, but as such they are not easy to cope with.

The level of economic development, and the inherited problems with housing shortage, underdevelopment of urban facilities, and many other aspects are forcing the planners into many extremes as far as settlement densities, urban development strategies, and the like are concerned.

It is probably not necessary to repeat the well-known fact that the detailed planning level is to a maximum degree linked with forms of implementation. Thereby we try to maximize the earthquake contingency criteria at this level, too.

The Problems of Conflicting Criteria

Paradoxically enough, the concept of contingency oriented urban planning and development is rather pronouncedly provoking many conflicting criteria. The planners and designers are often willing to leave their resolution to political decision making.

We do not have time to enter a thorough analysis of such conflicting criteria, but we must mention a few:

- construction economics vs. earthquake safety (expressed or one side by the height of buildings and by the density, and by the limitation of both on the other side);

- social vs. engineering aspects of settlement pattern: (compact and "socio-petal" as against dispersed and "socio-fugal" patterns; individualistic vs. controlled; continuous vs. intermittent patterns, etc.);

- architectural variety vs. safety conditioned compactness, etc.

It is clear that we should not aim at any polarization when faced with such dichotomies, but the right choice of the intermediate solution still seems to be a real art. Our own experience indicates that multiple hazard prevention requirements help. In other words, the choice depends not only on earthquake considerations, but also fire destruction, contamination, and other rights.

The problem of conflicting criteria is especially grave when we are faced with lack of buildable land, high cost of communal infrastructure, housing shortages, etc.

Detailed Urban Planning and Design Provisions for Alternative Uses of Urban Spaces and Facilties

The general guideline is simple: make possible the quick alternation of land uses and facility functions; a park becomes a hospital area, or a housing estate, a square or a stadium becomes a site of improvised municipal government offices. These examples are not fictional, the author saw them in Skopje and Banja Luka. The improvisations had a charming appeal in spite of the tragic circumstances. Both cities have later become planned in a more spacious fashion.

Our contingency plans provide for alternative uses and also for alternatives of the alternatives. In technical terms such provisions are integrated in the overall contingency plan and are not discussed publicly. The imminent problem of adjustment is solved later at the level of the local community civil defense system.

There are two elements of a conventional urban plan or site design which are extremely sensitive in terms of alternative uses, and indeed also in terms of generic use in the contingency conditions. These are roads and streets and communal utilities. We know of one general recommendation which states that sub-systems which are capable of functioning independently must be foreseen. Obvious as such a recommendation is, it is not easy to fulfill principally for economic reasons of high initial investment costs and of demanding maintenance.

By and large, the planning and development criteria, stemming from the evaluation of future contingencies, require a certain time to enter into the subconsciousness of the planner's or designer's working process. Once they are there, they in fact enrich the argumentation for additional open spaces, articulation of urban spaces, amount of greenery in the settlement, order in the pattern, etc., etc.

More elaborated planning and development controls, requested in the more responsible contingency planning system, must work against some of the concepts or habits in current urban development philosophies of the general public. For example, some limit must be imposed on the concept described as "freedom to build." Similarly the laxness of land policies ought to be corrected. Eventual loss of human life and property and of cultural values is hard to compare with the above mentioned advantages, often advocated in the populistic jargon of socially sensitive planners of today.

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URBAN SCALE VULNERABILITY:

SOME IMPLICATIONS FOR PLANNING

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Introduction: The Mandates and Imperatives of Earthquake Hazard Mitigation

The notion of intervention in the environment to mitigate the consequences of disasters--in the specific instances earthquakes--implies the use of fundamental government powers to manipulate environmental change towards the goal of achieving public safety. The question in a comparative context is what are the mandates and/or imperatives that emerge relating to institutional, political, or even cultural determinants. Secondly, as it is premised on the ability to wield these powers, what is the function of planning in this milieu?

The powers which sovereign bodies can bring to bear on disaster mitigation might be characterized as coercive on the one hand and permissive on the other. Numerous precedents exist for the use of coercive measures, or those leading to regulation by public bodies, to influence environmental change which may be useful in a pre- or post-earthquake situation. Land use regulations, such as zoning and subdivision ordinances, are now extensively utilized. These mechanisms were first employed only as a means of preventing problems arising from the juxtaposition of noxious uses, but later as a means of promoting the development of amenities. As this exemplifies, applications of police powers are dynamic.

In fact, as the understanding of environmental complexity becomes more sophisticated, the network of regulations to deal with it has become correspondingly more detailed. As a case in point, the 1969 Environmental Policy Act of the United States requiring impact statements for federal actions which have a "direct and significant" impact on the environment, is neither regulation per se nor an incentive per se, but an instance of institutionalized evaluation. By examining a proposed action for its impact--including adverse effects, feasible alternatives, long and short term applications--the assessment is relying on a systematic and selective predictive process. The relevance for hazard mitigation is obvious. As Andrews noted, the "process of planning is shot through from start to finish with judgments, intuitive predictions and assumptions about the impacts of alternative actions" [Andrews, 1975]. Coastal management planning which in and of itself is a voluntary national program precipitated by the Coastal Zone Management Act of 1972, requires that those states which choose to take federal money to develop a plan include an assessment of natural hazards in the coastal zone [The Conservation Foundation, 1980].

Precedents also exist for the use of permissive measures to achieve planning goals using incentives between and among levels of government. The national flood insurance program requires states to identify and employ development controls in floodplains in order to be eligible for national insurance, an approach which may have application in known fault zones or areas of severe ground instability. Requirements for the disclosure of hazard information in real estate transactions have been adopted in some states which then rely on the public to act in accord with the information [Kockelman, 1981]. Public education and information programs, like the State of Texas' Hurricane Awareness Program, assume the knowledge of risk provides incentive for action, whether it be for financial or personal safety reasons, although skepticism remains regarding the efficacy of such an approach. Financial incentives in general, provided primarily through the federal government, often motivate state and local governments to undertake planning programs such as coastal zone management, water quality planning or even research in the area of hazard mitigation. Although the U.S. is a federated country, the ostensible allocation of power is deceptive. For example, the dual coercive and incentive efforts of the tax power are well known, and federal, state and local government policies and programs have significant effects on investment, development and the resultant urban scene.

Urban Planning: Changing Views of the Planning Process

Before looking at earthquake hazard mitigation as a planning issue, the word "planning" must be explored. Broadly speaking, planning is an approach to problem solving; it is a process for making informed decisions about the future. But since its inception as a profession applied to the urban environment, the scope and method of planning have been the subject of continuing debate. From planning's early focus on civic design and municipal order, there was an emphasis on product. Underlying the notion of a general plan was the implicit assumption that problems and relationships could be precisely defined in physical terms; therefore the master plan identified physical relationships betweenland uses projected to a future point in time. Community decisions, such as capital expenditures or public regulatory measures, would deliberately follow from the plan. This physically deterministic perspective was intrinsically static. Much of the ensuing planning enabling legislation reflected this predisposition.

This determinist view is now held to be an untenable model of how a city functions, and the concept of planning as a dynamic if not comprehensive process has taken its place. The newer outlooks on planning emphasize the development of general goals statements and the recognition of informational feedback and iterations. Physical planning is coupled with policy and program planning where there is deliberation on goals, development of alternative physical or policy configurations related to those goals, and consideration of implementation through specific action programs. The process approach also recognizes the need for continuing adjustment to reflect changing circumstances. Significant, too, is the fact that the scope of planning expanded far beyond physical land use relationships. Problems caused by urban growth and resource development and a more sophisticated understanding of urban decision-making dynamics have led planners to consider growth management approaches and more sophisticated views of economic development; environmental quality; energy and resource conservation; historic preservation; and health, education, and welfare programs among others [American Planning Association].

Although the American Planning Association now defines planning as a "comprehensive, coordinated and continuing process," theoreticians debate whether planning can be truly comprehensive or remains relegated to the incremental [APA, 1979]. Indeed, social pressures have given rise to the advocates of "advocacy" planning, i.e., participation of pressure groups who have hithertofore been closed out of the decision-making stream of public action. Furthermore, in doing planning, many state and local governments operate from the basis of legislation that is premised on a static general plan model. There is a dilemma inherent in the process definition of planning, however. Local plans must be reliable and predictable guides for public and private community development decisions, particularly since litigation in the courts seeks precise description and analyses insofar as can be developed. Therefore, plans balance a degree of stasis with the need to recognize that they are part of an ongoing process. Consequently, in the absence of visionary guidance, most local governments prepare <u>plans</u>.

Since urban planning is an exercise of the police power which was generally reserved to the states when the Constitution of the United States was drafted, the federal role in overt planning is restricted to providing incentives, and usually those incentives have been monetary. American cities have relied to a large degree on federal programs to support comprehensive community planning and urban development programs. Programs administered by the Department of Housing and Urban Development, such as Comprehensive Planning Assistance 701, Community Block Grant and Community Development Block Grants have been the mainstays of comprehensive city planning. In recent years, other incentive programs have been institutionalized, reflecting the broadening scope of planning. For example, funding is available to support economic development planning through the Economic Development Administration; the Environmental Protection Agency's 208 planning grants provide funds for water quality planning, and the Office of Coastal Management provides funds to support comprehensive planning in the coastal zone. As an additional incentive, federal agencies agree to act in accordance with an approved state coastal management program.

They hold the purse strings, so federal agencies have a great deal of influence over the planning that is done across the nation; and in most cases, state and local planning follow the federal lead. Thus, in spite of the "Earthquake Hazards Reduction Act of 1977" (Public Law 97-124) which is aimed at reducing risks to life and property, the act focuses on action at the federal level and does not include any direct incentives for states to engage in hazard mitigation planning. Since the federal government is usually called in to bail out areas hit by large-scale disasters, it is surprising that planning incentives were not incorporated. In the absence of an incentive to plan for earthquakes as well as the absence of a sense of risk, few state or local governments have adopted planning as a means to mitigate earthquake hazards.[1]

Urban Planning: Earthquake Hazard Mitigation in California--An Example

To exemplify the American approach to planning in general and seismic hazard mitigation specifically, the State of California will be used.[2] Although it may not be at the zenith or nadir of American planning practice, California probably represents the state-of-the-art in its approach to earthquake hazard mitigation.

California is unusual in that since 1955 it has required county and city governments to adopt a general plan (Government Code Sections 65300 et seq.).[3] In addition to requiring local governments to prepare and adopt a general plan, zoning and subdivision ordinances were required to be consistent with the plan after 1971. Following the 1971 San Fernando earthquake which took 64 lives and caused over $500 million in property damage, the California legislature passed a bill requiring local governments to add a seismic element to county and city general plans as a means of reducing losses of life, property damage, and other social or economic disruptions as a result of earthquakes. Each plan must include at a minimum all of the following elements: land use, circulation, housing, conservation, open space, seismic safety, noise, scenic highway, and safety. Required to contain data and analysis, policies, and an implementation program, the seismic element must specifically include: "an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to effects of seismically induced waves such as tsunamis or seiches" (emphasis added) (Government Code 65302(f)). Mudslides, landslides, slope stability and other hazards are also to be considered. The 1980 draft General Plan Guidelines further state: "The seismic safety element is primarily a vehicle for identifying hazards that must be considered in planning the location, type, and density of development" (emphasis added) [Office of Planning and Research, 1980]. State guidelines thus give local governments latitude in determining how the identification and appraisal of hazards will be reflected in land use decision-making. Indeed, California's approach apparently relies upon structural soundness and building restriction in specified hazard zones as the major means for promoting seismic safety. Although there is no mandatory state planning review and approval process, cities and counties must submit their seismic safety elements and any related technical studies to the State Division of Mines and Geology (Government Code Section 65302(f)).

Oakland, California, a large city on San Francisco Bay which sits astride traces of the Hayward Fault, is typical of cities in the most seismically active part of the state. Its Environmental Hazards element, combining the seismic and safety requirements, is also representative of how local governments approach earthquake mitigation. The document contains four essential parts [City of Oakland, 1974]:

1. The Environmental Hazard Identification section technically describes and maps the history and current status of the various hazards as specified in the code, but at a gross scale. It also predicts some urban development implications of these hazards.

2. Structural Hazard Identification. The plan identifies areas where the potential for structural or facility damage is high. It identifies by census tract where there are concentrations of residential structures containing three or more units; of those, which dwellings were built before 1939 (date the earthquake resistant building code was instituted); number of commercial and industrial masonry buildings built before 1940; and the location of several critical facilities: schools, hospitals and fire stations. The vulnerability of utility and transporation facilities is acknowledged and the existence of stricter development standards with back-systems are noted.

3. Hazard Prone Areas. Based on analysis of the previous data, general hazard prone areas are isolated, and hazards specific to each area are described, including structural hazards, special studies zones (faulting), poor ground response, and other non-seismic hazards.

4. Policies and Programs. The policies and programs attempt to prevent the creation of new risks and eventually eliminate existing ones. To that end, programs emphasize information dissemination, hazard identification, siting key facilities and other buildings away from identified fault zones, and enforcing codes for new and old buildings.

Like Oakland, most other seismic elements for California cities stress structural safety or development setbacks near known faults. For example, a 1969 San Francisco ordinance, seldom enforced, required the removal or strengthening of unsafe parapets or building appendages [Blair, et al., 1979] and [Lu, 1978]. San Jose has identified seven ground-response zones where ground-shaking may cause serious damage to certain types of structures [Blair, et al., 1979]. Portola Valley has adopted building setbacks along known fault traces as well as hired a town geologist to review building permits, supervise town geologic mapping, and advise on General Plan amendments [Mader, et al., 1972].

To generalize from California's experience, the focus of mitigation to date has been on: (1) hazard identification and location, (2) building and structural soundness, and (3) development of setbacks--especially for critical facilities--near known faults. Facilities such as communication lines, roads, water and services are acknowledged to be susceptible to damage, but this has yet to be approached from a planning perspective.

There is yet a need to step back and look at the urban scale, that is, how the town morphology and physical form and activity patterns impinge upon urban vulnerability.

Urban Planning and Urban Scale Vulnerability--A Model

The general subject area here emphasizes the preventative. This does not preclude attention to or evaluation of detailed seismic damage to individual buildings or other facilities, but there is an additional task of anticipation, or planning, for alternative spatial and regional considerations given the potential for earthquake disasters. In so doing, however, the preparatory and remedial are not set aside, but should be considered implicit in anticipating some key factors that contribute to recovery if and when earthquakes strike. It is the nature of planning to pose alternatives and to evaluate and compare their respective consequences, but this does not seem to be incorporated into the experience or literature of disaster mitigation at the urban scale. The following proposes to isolate out significant elements and factors for study at several scales, noting the comparative issues, and then test whether these fundamentals are reflected in current planning practice.

Any effort that compares, presumably compares similarities and differences, so that the immediate problem is to abstract out the internal and external variables that pertain to the general scene or to specifically designated study areas selected for comparison. Therefore, the additional intent here is to: (a) pinpoint problems, issues, or areas for comparison and (b) construct a more abstract, or prototypical, model to compare to, while (c) suggesting methodologies for the use of proxy or surrogate measures for comparison. For planners, this implies considering systems of operation or hierarachical frameworks before focusing on the specifics.

Scale is to be considered a major issue. "Urban scale" vulnerability in this case may be conceived in both macro and micro terms. The principal concern is the context, that is where, when, and how the disaster takes place given the constraints, possibilities, and probabilities of the preventative or remedial actions that would occur. It should be emphasized, however, that territorial scale, or "where" is crucial.

The urban scale can be broken down into regions, city-wide areas, and city sectors. Although such words are ambiguous, for purposes here the area under examination encompasses a city center plus the area surrounding it that affects and is affected by the daily rhythms of urban regional life. Without differentiating between rural vs. urban or dense vs. scattered development, such an area could be construed to mean centers and subcenters encircled by a number of overlapping employment, recreational, housing, and various service or catchment areas.

Distinguishing between macro and micro analyses, it is hypothesized that the macro urban settlement form and pattern may be broken down into: (1) density and land use intensity patterns; (2) regional nodes and focal points, or the centers and subcenters of urban activity; and (3) the lines of accessibility, communication, and transportation, considering the systems of interaction, points of clustering and focusing, and fields of "traffic" generation. What should be sought is a diagrammatic portrayal of macro-scale development or redevelopment as shaped by economic intervention and socio/political factors.

Then, given the above contextual framework, micro analyses follow. The "micro" scale, as such could be construed as a residential neighborhood with its ancillary shopping facilities, schools and recreation areas. The same generics of macro scale examinations as described above apply here, but the scales - or level of dimension, texture or activity - are different. Basically, the immediate locale should be viewed within the city sector and the city region, conceptualizing the micro problem in a macro setting, but with each "zone" differentiated by measurement or evaluation characteristics. At the micro scale, there may be surveys of building groups and their existing conditions, particularly in areas of potential change or damage. It might also be relevant to examine the adaptive reuse potential of certain structures with the possibility of emphasizing inherent differences in past building practices in a sector of a city.

Before describing a hypothetical urban scale vulnerability model for use in a comparative context, two bases of comparison must be defined: the homological and the analogical. In urban and regional planning terms, the first means comparison of"a" or "the" plan for action, whereas the other emphasizes the "planning", or the process out of which a plan emerges. One contemplates a product and the other, a process. Planners must do both, but at varying scales in various places at various times.

Given, therefore, that planners are concerned with systems and interactions within macro and micro spheres of urban environments, the underpinnings of earthquake hazard mitigation must be examined apropos the foregoing. While much of the work to date has been directed towards the avoidance of structural failure of individual buildings, it is recognized that the secondary effects of urban systems failure may cause equal or even greater disruption to the urban equilibrium than specific, direct losses [Krimgold, n.d.]. Fires in the absense of a functioning water system can decimate a city reeling from a quake; transportation system failure can frustrate both rescue and long-term recovery. In addition, on a more intimate scale, the disruption of community and individual activity patterns can have longer term social, psychological and economic ramifications. Due to their nature, lifeline facilities and other network systems are certainly susceptible to earthquake disruption; moreover, because they function as a network, the failure of one element or one segment of the system can impair the function of the entire system [Krimgold, n.d.].

At the risk of oversimplification, an earthquake disrupts a physical system consisting of four major elements common to any urban environment, each of which is an integral to the whole. Therefore, disequilibrium induced in one will have ramifications for all the others. Although the distinctions blur at the edges, the four include: the urban artifact itself; the spatial dimension; an activity element; and a time element.[5]

1. The urban artifact consists of all the man-made structures and systems in the environment, including buildings and lifeline systems. Also subsumed here are considerations of land use density and

intensity, age and technology of development, types of construction, materials used, existing conditions, and the like.

2. The spatial dimension is concerned with the location of these artifacts in the physical environment--the morphology of the place--as characterized by form, spatial relationships, distribution, linkages, custom, and socio-economic forces as well as geophysical characteristics. It also includes the spatial ecology of urban residents, especially of critical groups such as the elderly, ill or the young.

3. The activity element includes the types of activities that take place in the environment--work, shop, play, rest, etc.--and look at their distribution, density configurations, and their relationship to the urban artifact.

4. Finally, the time element examines the temporal and seasonal aspects of the macro-region, recording the "pulse" of activities in time and at places. Changes in the "configuration" of these elements obviously can make a significant difference in urban scale vulnerability.[6]

The forthcoming model thus serves two purposes. First, it sets forth those elements which an earthquake mitigation strategy must address, and second, it provides a basis for comparability with other countries.

There are however two other realms that also have critical implications for earthquake hazard mitigation. The first is so obvious it only needs a passing mention here, and that is knowledge of the underlying geology of an urban area. Nevertheless, in spite of the central role it should play as the grounding for hazard mitigation, many planning agencies have shortcut this category of data collection, and in addition, planning professionals frequently do not know how to use the information if it is available.

The other realm is the overriding political decision-making system which is responsible for carrying out policies, plans, and programs. The physical environmental elements and systems are governed and managed by a complex network of federal, state, and local government agencies and private sector players. Coordination among jurisdictions, agencies and governments is essential to avoid delays, ineffective responses, and ineffectively coordinated support delivery in the event there is a catastrophic earthquake. Not only is this coordination essential to respond to a disaster, it is also essential if preparation is to be successful in mitigating the hazard. International comparisons of the organization framework to deal with disasters would also be instructive.

Thus, when addressing the issue of urban scale vulnerability to earthquake hazards from a planning perspective, the problem goes beyond public safety, least cost, and workability alone. Clearly, it becomes a matter of perception and analysis of the continuum extending from public policy actions to the achievement of community goals in a three-dimensional built or rebuilt environment. As the urban form represents the physical result of the exogenous forces embodied in public and private policy decisions, these physical outcomes must be seen in an interrelated context. Applying this logic to the issue of earthquakes implies that attention to structures or lifeline systems alone ignores the contextual issues and is therefore inadequate.

Using the model, some areas for comparison fall out:

1. The age and pace of development in selected geographic areas and the "appropriate technology" that was or was not traditionally used, and thus its consequent vulnerability. The types of construction should be a significant issue here as well.

2. The morphology of development as characterized by time, custom, socio-economic forces, and geophysical characteristics.

3. Regionalism and political decision-making. For example, what impacts do the historical as well as existing patterns of unitary vs. federated forms of government have on regulations, appropriations, and the like? (Italy represents a more unitary form of government, Yugoslavia is quite federated, while the U.S. is, comparatively at least, somewhere in between.)

These three are only gross examples of what could be considered proxy measures for international comparison that will serve as indicators of political, social, physical, and economic history.[7]

Urban Planning and Urban Scale Vulnerability--The Model Tested in Oakland

The assumption has been made in this paper that the foregoing is a reasonable model of an appropriate planning framework for evaluating urban scale vulnerability. Taking this somewhat abstract model, it may be valuable to return to Oakland's seismic element to assess the scope of planning in one of the U.S.'s most seismically sophisticated states. As an initial caveat, it should be mentioned that the analysis here is not meant to be exhaustive, rather it only highlights by key areas of coverage.

California's Government Code directs local jurisdictions to "identify and appraise" a variety of seismic hazards, which, in a summary fashion, the Oakland element does for generalized geology, known faults, susceptibility to ground shaking, and landslide potential. The mapping scale is gross, but at the same time, the general absence of precise geological information makes more detailed mapping somewhat specious and misleading.

Examination of the (1) urban artifact is limited to an overview of management structures with some attention to age, construction type, and building conditions. Density and intensity considerations as they may impinge upon vulnerability and recovery are absent. There is only a passing assessment of standards for urban infrastructure systems.

(2) Spatial dimensions -- while attention is paid to hazard location, the morphology and distribution of urban areas and activities are virtually ignored. The location of several critical facilities and certain seismically vulnerable structures represents the extent of

Oakland's attention to the complexity of the spatial aspects of vulnerability. But equally important are the relationships between the built environment and transportation, communication, and open space systems vis a vis the hazards, the location of activity nodes, special districts, and the like. A conspicuous omission is the absence of any consideration of system linkages and interactions. Earthquakes do not recognize political boundaries: while Oakland may not be physically damaged by an earthquake in San Francisco, secondary impacts on transportation, communication, flow of goods, and the general economy could be severe.

(3) The Oakland element does not examine the vulnerability of various activities and activity centers other than several critical facilities. For example, what might the implications be for a disaster occuring during work hours or rush hours vs. a major sporting event in terms of public safety, rescue, or short- or long-term recovery?

(4) Temporal or seasonal considerations are also overlooked, although it is well-known that the coincidence of the factors of time, season, and activity can significantly effect the extent of loss and the difficulty of recovery, i.e., emergency shelter in the middle of winter entails a different set of requirements than during the summer.

Oakland's implementation system relies upon codes and ordinances addressing structural soundness and the location of certain structures with respect to known hazardous areas. It recommends developing criteria or regulations for streets, utilities, transmission lines and other facilities which may traverse hazard areas, but again the focus is on structural integrity of the individual systems, not the overall pattern of the utility network and its response to disaster. Since utilities and transportation systems themselves influence the morphology of urban growth, it is essential that earthquake hazard mitigation expand its definition of the scope of the problem.

The plan acknowledges that the city has yet to identify the level of "Acceptable Risk"--or that point below which no specific local government action is deemed necessary, that is where costs, both economic and social, outweigh the value of minimized hazards. As a study which identifies and locates the hazards, discusses potential consequences, and provides information, the Oakland Environmental Hazards Element represents a step toward that end.

The City's Emergency Operations Plan, adopted in 1973 to conform to the previously mentioned federal mandate for such plans, has the stated purpose of providing governmental continuity, providing emergency services, restoring essential systems and services, and coordinating with Emergency Services organizations of other jurisdictions in the event of a significant disaster. Although the sufficiency of this emergency plan is not examined here, in 1980 the Federal Emergency Management Agency evaluated California's readiness to cope with the effects of a catastrophic earthquake. They concluded: "While current response plans and preparedness measures may be adequate for moderate earthquakes, federal, state, and local officials agree that preparations are woefully inadequate to cope with the damage and casualties from a catastrophic earthquake, and with the disruptions in communications, social fabric, and governmental structure that may follow" [FEMA, 1980]. Coordination among overlapping jurisdictions, agencies, and levels of government dealing with the panoply of urban systems and services affected by an earthquake was also found to be inadequate. As a case in point, Oakland's Emergency Operations Plan is apparently not integrated into an earthquake mitigation decision-making continuum, but considered apart from land use planning approaches.

In summing up, California's code and guidelines ask for little more than an identification of seismic hazards. There is no quality control or approval process required for the elements (although they are submitted to the California State Division of Mines and Geology), nor do the guidelines provide direction on what additionally should be addressed. In view of the fact that California may be America's most sophisticated state in dealing with earthquakes and Oakland a typical example of a local government's approach, the absence of a well-developed concept of urban scale vulnerability in the United States becomes apparent.

Applications and Directions

Planners and urban designers could examine the possibilities of developing an "urban vulnerability index" which incorporates the variety of vulnerability determinants that have been previously mentioned--from geologic data; land use type, intensity and density; structural form, age, material, and size; spatial configurations; lines of access and services; general morphology; activity patterns; time envelopes; seasonal dimensions; to the magnitude of the event and others. Such a system could be particularly versatile if it were computerized to facilitate the development and execution of numerous scenarios and allow the manipulation of a variety of intervention or mitigation approaches. Since earthquakes will continue to be unpredictable events for some time to come, a vulnerability index would allow governments and individuals to target attention to those areas most in need of code enforcement, zoning changes, land use redistribution, restoration, or any of a number of alterations.

A more sophisticated vulnerability index should also factor in the economic and other costs of mitigation. In so doing, communities may develop a repertoire of mitigative responses that respond to safety, social, cultural, economic and political considerations and range from preparation, prevention to recovery. For example, in certain areas complete retrofitting or renewal may be economically infeasible and culturally, socially, and architecturally undesirable. The community may then be willing to accept a higher level of risk exposure, but balance that with a greater emphasis on preparation for disaster and recovery should an earthquake strike. Residents or other users of the area may be the subject of an unusually intensive information campaign, "safe areas" may be provided for gathering and refuge following a disaster, temporary housing could be stockpiled, and a rebuilding strategy could be developed ahead of time so that important cultural and social attributes would be retained and extreme hazardous conditions eliminated.

The questions for urban planners operating in an international comparative context therefore revolve around new probes into:

1. Land use planning and regulation in disaster impacted urban areas considering the urban morphology and examining the applicability of existing regulatory and incentive measures to disaster mitigation, including institutionalized impact analyses. In addition, the effects of changes in land use management and seismic zonation, zero-lotline housing, and downtown development can be compared.

2. The vulnerability and rebuilding problems of an urban pattern considering: (a) land use densities and intensities, (b) nodes of activities, or centers and sub-centers, (c) the accessibility system, and (d) the upgrading of existing structures.

3. Building typology guidelines which inventory the urban fabric and volumetric aspects of the extent and character of building groups, and develop classifications and evaluations of existing buildings along with methods of documentation and assessment. Respective international experiences in developing and applying various technical methods can be investigated, such as the Yugoslavian and Italian expertise in assessing and documenting their built environment and the American experiments with remote sensing, computerized as built drawings, and computerized geo-based information systems.

4. Systems analysis of activity patterns, and the primary, secondary, and tertiary impacts of disruption.

5. Emergency planning and the continuum of hazard mitigation strategies for a range of earthquake magnitudes.

6. Preparation of risk and vulnerability maps, incorporating time and tempo of urban activities and networking of service areas. Defining "acceptable risk" at the urban scale should be considered here.

FOOTNOTES

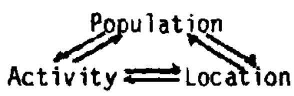
1. States are required to have Emergency Preparedness Plans as a result of the "Disaster Relief Act of 1974" (Public Law 93-288), but are not required to have hazard mitigation plans.

2. It should be noted that this paper relies almost exclusively upon American examples to illustrate key points, but it does so within a framework that is designed to accommodate extrapolations to the international scene.

3. All states have planning enabling legislation, but fewer require local jurisdictions to adopt plans, and fewer still specify their content by means of required elements.

4. For exemplification of the use of proxy measures as described above and for comparative purposes, "land use intensity" relates to activity per unit area (not "density" per se) and involves considerations of: (1) quality - measurements of, say, volumes of traffic generated within given land use areas, (2) time shape, or the variations in such traffic, (3) zones of influence - hard or soft edges of activity areas, service or catchment areas, etc., (4) material effects - sensory perceptions of noise, odor, mass, bulk, opacity - and the like [Modified from Guttenberg, 1959].

5. The implications here have been debated historically, extending from the works of those who have analyzed human activity patterns in space to those who have set up numerical models [Lösch, 1945], and [Geddes, 1950] (Appendix 1, Part 2, details Geddes' extension of Frederick LePlay's "Place, Work and Folk"). The framework and the questions coming forth are:



1. What is the population of an activity?
2. What is the activity of a population?
3. What is the population of a location?
4. What is the location of a population?
5. What is the activity of a location?
6. What is the location of an activity?

(Indebted to Professor Barclay Jones and Charles R. Wolfe for this example.)

6. One example which spans several of the four elements will suffice to illustrate the general point here. Ugo Morelli points out that the severity of the recent Italian earthquake resulted from: (1) The season and the time of day, in that at 7:35 PM on a Sunday in November, most people were at home preparing dinner and watching a soccer match; (2) The age and morphology of the towns, reflected in the unreinforced masonry construction with roofs of heavy wooden beams and clay tiles. Here is where a comparison becomes interesting. As Morelli goes on to state, in the United States, most homes are of wood frame construction, making them resilient to earthquake damage and relatively safe refuges

in the event of an earthquake. Unreinforced masonry construction, on the other hand, is typical in Italian towns and prone to collapse from earthquake shaking. (3) The inability to muster aid quickly; thus questions of responsibility become as important as physical mobility [Morelli, 1981].

7. As a case in point, one can examine and compare how patterns of development, which might now be different, may be moving toward being similar. What are the experiences in formulating regulatory measures that tend to encourage recycling in an area where, historically, preservation has been going on, yet where conservation efforts are hampered by the development of outlying centers? A more pertinent question here is: given earthquake possibilities, what potential effects can be expected, what gross and fine alternatives exist for rebuilding and/or prevention? More pointedly, are the Yugoslav and/or Italian efforts at conservation of historic structures useful for comparison with the U.S. in this context? If not "historic", are the reuse potentials greater in those countries; are the regulatory measures more efficacious, but are our distribution (transportation) patterns more efficient? Given the necessity of rebuilding, what are the urban form implications within political, social and economic constraints that make countries similar in some ways but different in others?

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EARTHQUAKE SCIENCES AND CITY PLANNING

ARE STILL DISCONNECTED[1]

Aydin Germen

It is our conviction that if city planning, and regional planning, are to contribute to disaster prevention or "mitigation", the starting points should not be in city or regional planning, but planning principles should be derived from geophysics, tectonics, structural engineering, relief and rehabilitation operations, and certain social processes. This raises the question of evaluation of each field in itself, and also the contributions they should be making to each other. In this paper the "input" from structural engineering to city planning, and certain internal characteristics of city planning will be emphasized over other relationships.

One main reason for this is that there is not a general usage at the present to rely on geophysical data for location decisions, without first having them "translated" and transformed through structural engineering.

Of the disaster phases, "prevention" and preparedness will be implicitly emphasized over relief and rehabilitation periods, even if it is clear that at the present city planning gains most significance at the rehabilitation phase, and that its major decisions are forced and formed in the relief phase. Instead of inquiring for more input from relief workers and social scientists, I prefer to leave the question open for them to express whether they see any significant role for city planning, and if so, in what phases, details, or "functions".

Still more important, do any of the earthquake sciences see the contribution of city planning through land use controls, should lifeline planning and investment be expressed through city planning, should administrative difficulties be coupled to it, or if it is to be seen mainly as a social process, could it be a good way of coordination with respect to hazard, risk, warning, disaster psychology, and relief?

The Main Thrust of Engineering Research

Japan, and the State of California possess institutions which engage in the broadest front of research with respect to earthquakes. However, much of the structural engineering research in these two leading centers seems to be removed from a broad front approach.

In California and in Japan the building codes appear to have had more success than in other areas as seismic counter-measures. Engineering practice itself may adopt new counter-measures more speedily than in other regions. In the recent, and relatively speaking, not major earthquakes of these two regions several new types of failure are analytically isolated after each earthquake. Structural engineering then addresses itself to these questions.

This type of approach neglects two major aspects of the matter: 1) site effects are not considered either statistically or analytically; 2) engineering solutions are developed which in no way can be extended to the world regions which suffer the heavier blows, nor to the structures which are likely to be built in these regions, nor to the social structures and levels of income they are likely to possess.

In my own country, in the most recent interchange between structural engineers and city planners (geophysicists also being present), the rather enlightened engineering attitude was that seismic counter-measures should be stated in terms of soil-structure interaction. Let us first observe that very few elaborate or even concede this point. Even if this is conceded in the Turkish circles, the problem still cannot be stated very much in locational or urban planning terms.

In micro-zoning approaches, which seem to have been abandoned by certain circles but are very much alive in others, it was assumed that rather small differences in the physics of the soil would lead to differences in seismic coefficients, in height and other characteristics of buildings, and particularly in construction costs.

If these various factors are taken together, and then compounded by problems of political process, social structure, control and implementation, micro-zoning and structural engineering seemed to be mainly expressible in city planning. On the other hand, even in the engineering approach which emphasizes soil-building interaction, less-than-major differences in soil physics are considered per project, and disregarded as classes of phenomena and hardly given a place in generalized research. Only the following extreme cases are constituted as classes: liquefiable ground, very soft soils, marshes.

In this type of engineering research, it is nearly impossible to follow consequences in overall costs and in incremental costs associated with any seismic coefficients. In this way the problem of costs escape comment from social groups which pay for them, or even groups which make large-scale decisions.

Urban or regional planning will have little contribution to disaster prevention measures under these circumstances, and consequently less incentive to overcome the shortcomings in their own fields.

The above exposition may be related to the experiences of the preceding several decades. At least two of the other parallel attitudes must be cited: increasingly abstract character of structural research, and neglect of the treatment of existing buildings.

Advanced structural research contains two opposite tendencies, among others. In the case of anti-seismic measures in nuclear power plants, the seriousness of the question and the relatively large funds available make possible attention to detail and to interaction among elements. But, for nuclear plants again, and in general, there is a tendency towards increasingly abstract structural problem-positing.

In the case of the most destructive recent earthquakes, however, (Tangshan, Ciudad de Guatemala) as well as in other isoseismal microzoning work (Kumamoto) there is ample evidence that: 1) intensity measurements may be more affected by urban district than by type of structure; 2) more effort should be spent on the design of statistically predominant, "mediocre" buildings than on specialized types; and 3) more effort on strengthening or retrofitting the existing buildings than on new design [Liu and Zhang, 1980] [Husid, 1980] [Migita and Tanaka, 1980]. (These conclusions are ours and not those of the authors cited).

In essence and outcome for the present, then: the modal response to earthquake disaster mitigation is in the field of engineering, and tendencies towards purely structural responses not specific to sites will keep land use and/or preventive measures at uninformed and ineffective levels.

Significance of Specificity in Urban Sites

Few researchers remember that the rural areas suffer most from earthquakes. The larger cities still hold our attention most. If we should follow such a line of emphasis in this paper, the following will have to be pointed out:

1. In spite of all attempts at prediction, and our predilection for extrapolation, disaster strikes larger cities in unexpected places. Tangshan and Skopje are good examples. (Very few areas, such as the Central San Andreas fault, show any regular tendencies for a given period; if we observe other consistencies, they are over much larger areas.)

2. This suggests: a) an emphasis on predictive methods other than extrapolation for most parts of the world, especially if we wish to have our predictions in terms of location; b) more research on the effects of hypocentral distances per characteristic region; and c) less tendency to reduce causality to a single factor.

3. Improvement in predictive techniques should make many of the counter-measures expressible through city planning, especially if we keep in mind that it may be a way of concentrating supervisory or financial resources in certain areas and sub-areas.

4. In the absence of great improvement in predictive techniques, emphasis in city planning should go to existing settlements and their structures and roads and public services, and to minor rather than exhausitve intervention.

5. In the absence of more precise information input from structural engineering with respect to zoning of sites, reinforcement or retrofitting of existing buildings will be closely allied to city planning, if not necessarily through investments, at least in terms of constituting alternatives to density decisions, or lifelines planning.

Discrete Observations on Site-Specific Research

1. The value of insurance is emphasized in various countries (U.S.A. [Sauter, McCann, and Shah, 1980] [Steinbrugge, Lagorio, and Algermissen, 1980]; U.S.S.R. [Koridze, 1980]), while it is not in others (Turkey and other countries respond by government rebuilding), and it cannot be considered a preventive measure such as city planning may become. While earthquake insurance is not widely purchased in California [Steinbrugge, Lagorio, and Algermissen, 1980] it seems to generate some funding for site-specific studies [Lev, 1980][Steinbrugge, Lagorio, and Algermissen, 1980]. Lev points out that unless information on site and other matters is detailed disaster response will be weak.

2. Even though there are attempts at definition [Lev, 1980, p. 257] [Kung, 1980, p. 98], the concepts hazard, risk, vulnerability, etc., remain fuzzy throughout the literature, especially with respect to site.

3. Parameters used in seismic risk analysis until now, and strong ground motion models raise doubts, at least in certain quarters; the impact of earthquakes on "spatially distributed systems" will be studied [Shah and Gere, 1980, pp. 133-134].

4. We must keep in mind that most of the available site-specific or zone-specific knowledge is in the form of post-earthquake iso-seismal contours. In these it is impossible to correlate precisely magnitude, intensity, strong ground motion and finer parameters. This information is further useless in practical terms for these particular epicentral zones for a long time to come, and as research goes now, no possible lessons could be drawn for other regions. It is furthermore noted that isoseismal contours are far from providing "site-by-site preciseness" because of the smoothing-out process [Ohta, Goto, Satoh, Ergunay and Tabban, 1980, p. 402].

   The need for Local Effects Arrays is recognized by the International Workshop on Strong Motion Earthquake Instrument Arrays Workshop [Iwan, 1980].

5. While even empirical research shows much tendency toward structural abstraction, the importance of site-specific research is more or less recognized, and as a minor item, only in the larger institutional programs (Berkeley, Livermore Laboratory, U.S.A. National Bureau of Standards, M.E.T.U., etc.) [Penzien, 1980] [Leydendecker, Harris, Wright, and Pfrang, 1980] [Tokarz, 1980] [Germen, 1980]. This may range towards spectral study (Livermore Laboratory), or by implication, attenuation relationships (Berkeley/Taiwan; M.E.T.U.). We find it very instructive to note the present chasm between this research, and the gross rigidities of classification adopted when governments have to produce building codes, or insurance institutions have to establish risk classess.

Discrete Observations on City Planning

1. There seem to be no grounds at the present for generalisations on "proper" planning measures against earthquakes. The cities and

their districts need case by case attention. In the absence of clear prediction or definition of risk, which will apparently change from region to region, our attention will have to focus on selection of priority for measures, case by case.

2. City planners should be rushed into disaster areas not only for reconstruction planning, but for observation and for developing new analytical approaches.

3. Perhaps a good deal of the effort now spent on prediction methodologies should be diverted into totally new instrumental techniques for zoning and micro-zoning. If new avenues are explored the need for highly precise prediction would be circumvented, and the uncertainties in risk analysis clarified.

   These remarks may be derived from the preceding observations. Now certain other remarks about the field of city planning itself.

4. It is perhaps for other disciplines of prevention and mitigation to decide whether city planning is enmeshed with their own and other activities, or their activities could be better performed independently, as a "vertical" operation.

5. Some of the information input necessary for city planning is not going to be available at the present.

6. Some others are simply not thought about, or stated. This may often be the case in preparedness, relief, etc.

7. City planning and reconstruction constitute the major response by far of most countries to earthquake disasters. Furthermore, and for example, a more swift response than others in Turkey: new town "ready" in six months, reconstruction finished in three months on a sub-region, city planning teams on site one half day after the disaster.

   But this significance accorded to city planning, for which ends, which results? Is there much that is satisfactory in the response we show to earthquakes?

   To make city planning more useful, I should think that pressure on governments should come from the fields of preparedness and relief, if they should in turn deem that it can contribute to their fields.

8. Since city planning seems to be ineffective as a prevention or mitigation measure in its normal operation, special pressures should be exerted for another mode of operation in disaster areas.

9. The developments in city planning are not sufficiently transmitted to the "earthquake sciences": there are not enough planners concerned with this purpose, and there are few takers on the other side.

10. In the country where we are meeting, there has been lively controversy over recent practices in city planning. How much of this has percolated into planning discussions on disaster prevention and mitigation?

11. Are the dominant urban models of the twentieth century suitable for earthquake response? Many fields associated with disaster prevention, including town planning itself, seem to favor use-exclusive urban zones. This attitude has not only the backing of some three centuries of Anglo-Saxon Law, half a century of CIAM and functionalism, 15 years of Turkish sociology, but also the building of many cities to show, including New Zagreb, and the argument that mixed uses will lead to secondary disaster effects. On the other hand city planning and architecture have taken to other directions. More important, can we or should we proliferate cities without mixed uses?

12. In recent engineering work there are tendencies to find previous conclusions as too "conservative" (running in the direction of larger safety factors and therefore, costs). [Hintegraber and Jungmann, 1980] [Tokarz/Livermore Laboratory, 1980]. These findings may have only very remote effect on city planning, but provide a parallel. In much of the existing planning wisdom interchanged between the professions concerned with disasters, the proposed city design uniformly emphasizes very wide streets, low gross densities, thorough "modernization" and new construction, new towns, all of which amount to much conservatism in the same sense.

FOOTNOTES

1. This paper is not intended to be exhaustive in its scope. Quite to the contrary, I have tried to exclude subjects and arguments developed in the paper submitted to the 7th WCEE September 1980 [Germen, 1980], in the booklet prepared for UNDRO in 1975-1976 [Germen, 1976], and in other previous work.

   Instead, Volume 9 of the Proceedings of the 7th WCEE was surveyed thoroughly for the new developments. All references are to that volume. Other material recently available to the author will not be explicitly referred to.

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PHYSICAL PLANNING IN SEISMIC REGIONS

Tiberije Kirijas

Introduction

Large scale destruction caused by the effects of disastrous earthquakes in areas with high seismic activity indicates the necessity for undertaking corresponding protective measures for the purpose of reducing destruction to the lowest possible level. This is especially the case because of the possibility earthquakes can affect large urban areas. With the permanent development of urban areas and consequent construction of a large number of structures requiring significant expenditures (energy, transportation, industrial and other structures) responsible authorities more and more face the requirement to protect such large investments from the destructive effect of earthquakes as much as possible.

Earthquake destruction has provided the motivation for detailed investigations of earthquake effects upon buildings and civil engineering structures as well as infrastructure systems with the basic aim of undertaking corresponding protective measures, depending on the economic and technical power of the country involved. The implementation of technical regulations for design and construction in seismic areas is the basic protective measure which provides the required resistance of the structures against earthquakes.

The implementation of protective measures against destructive earthquake effects upon structures is much more effective than mitigation of other direct or indirect consequences of earthquakes. The present level of knowledge and techniques enables effective implementation of protective measures against the destructive effect of earthquakes upon structures through the methodology of physical planning and urban design in earthquake prone areas. The physical and urban planning for seismic areas is a young discipline. It has evolved for the most part, since the disastrous earthquake of Skopje in 1963, i.e. with the development of the General Urban Plan of Skopje.

The protective measures against disastrous earthquakes through physical planning and urban design in seismic areas are carried out, mainly, through the following basic methodological elements:

- determination of land-use zones for location of urban areas (towns, industrial complexes and other settlements),

- deconcentration of production and other activities,
- determination of land-use zones within urban areas, and
- decreasing the density of construction in settled areas.

In implementing these methodological elements of physical planning and urban design in seismic areas the following results must be considered:

- by selection of construction sites for settlements or important structures in areas with lower seismic activity the damage due to disastrous earthquakes will be diminished;
- concentration of productive activities (industry and other) in densely settled areas through physical planning will result in greater damage in case of a disastrous earthquake, and vice versa;
- the land-use patterns in seismic urban areas can greatly contribute to diminishing or increasing levels of damage;
- damage will be much less when the density of development in larger urban areas is lower and vice versa.

The following maps form the basis for effective implementation of the protective measures through planning and urban design in seismic areas:

- map of seismic zoning of the region with a number of appendices
- map of seismic microzoning of the urban area.

Regional Physical Planning in Seismic Areas

Regional physical planning in seismic areas is performed in the same way as for non-seismic areas, with the difference that the map of seismic zoning of the region with appendices is also taken into consideration as basic information. Regional physical planning in seismic areas is not based exclusively on seismological engineering aspects, but these factors are considered together with other basic aspects of regional planning. Including the map of seismic zoning of a region in physical planning considerations can assuredly decrease seismic risk, i.e. mitigate the effect of a disastrous earthquake upon human lives and material goods.

On the basis of detailed regional seismological, seismotectonic, engineering seismological and other investigations a seismic zoning map of a region can be developed. Such a map defines the general seismic risk of a region. It shows the distribution of regions of different seismic intensity from VI to X degrees according to MCS scale (Mercalli-Cancani-Sieberg). The seismic areas marked with seismic intensity of VIII and IX degrees are characterized as of high seismic intensity.

The seismic risk shown on the seismic zoning map is determined by the following elements:

- seismogene zones with maximal expected seismic intensity, with their characteristics and parameters, are defined:

- fault zones and faults, as well as their relation to seismic activity are delineated:

- seismic sensitivity is established based on different geologic media in the region.

Basic maps appended to the seismic zoning map are the following:

- map of focal zones and approximate return periods of earthquakes (100, 200, 500 and more years)

- seismotectonic map, and

- seismological-engineering map.

Mitigation of seismic risk through physical planning is achieved by application of the following basic elements:

- establishing land-use areas within a region for location of urban, industrial and other settlements;

- location and expansion of infrastructure networks, and

- deconcentration of production facilities from the larger centers of the region.

These basic elements for the mitigation of seismic risk are implemented through the development of national and regional physical plans, as follows:

- In the selection of construction sites for urban, outlying, industrial and other settlements, which are considered in regional physical planning, the seismic zoning map with all appendices are analyzed in detail for the purpose of mitigating seismic risk as much as possible from the very first step of selecting locations for these settlements. The location selected should be those with smaller seismic intensity, with longer return periods without active seismic faults, and within geological media which have weak seismic sensitivity.

- All regional life-line systems (railroads, motorways, gas pipelines, oil pipelines, etc.) represent very large investments and constitute structures of vital importance. Protective measures against earthquakes are implemented through regional physical planning in seismic areas, primarily through the following elements:

  - location of life-line structures and

  - location of structures which are functionally related to life-line structures (bridges, viaducts, reservoirs, power stations, etc.)

In locating life-line systems in the context of physical planning, the seismic zoning map with all appendices should be considered along with other factors. It is of great importance to avoid regions of high seismicity, unstable terrain and potential land-slide areas. Locations should be selected far from potentially active seismic zones, and especially should not cross such zones. The procedure for selection of location for the life-line systems and related structures (bridges, viaducts, reservoirs, etc.) is the same as for settlements.

- Regional physical planning also projects the general patterns of future development for urban and other settled areas in the region. Usually, in larger towns, and especially in the centers of some regions, major concentrations of different activities are planned, such as economic (industry), public, cultural, health, education and other. In the case of strong earthquakes in such regions with high concentration of activities the vulnerability is much greater. This can have disastrous effects, not only on the economic activities in the region, but in many cases on other regions far beyond its limits. A well-considered dispersion of activities over the region provides for the safety of some economic and other activities which can continue even after a seismic event. Such considerations in regional physical planning in seismic areas are of great importance since they provide greater resiliency of the economic system to the effects of disastrous earthquakes.

Urban Planning and Designing in Seismic Areas

One of the basic elements in urban planning and design in seismic areas is the seismic urban microzoning map with its appendices. This map is developed on the basis of previously performed detailed investigations of the urban area including seismological, seismotectonic, seismological-engineering, geophysical, geological-engineering, geomechanical, hydrological and other studies.

The seismic microzoning map of an urban area should show zones of maximal expected seismic intensity, and even sub-zones. The map should also show all characteristics from performed seismotectonic, geological, geomechanical, hydrological and other investigations, i.e. the characteristic elements of the soil, which show the suitability of the terrain for construction. For this purpose the following maps are presented as appendices to the seismic microzoning map: seismotectonic, geological, goemechanical and hydrological maps as well as the map with predominant periods of the ground. This set of maps gives a clear picture of:

- the detailed distribution of seismic risk in terms of each zone and sub-zone within the urban area, and

- the suitability of the terrain for construction in different zones and sub-zones of the urban area, i.e. the bearing capacity of the ground, the ground water level, flood areas, unstable terrain, possibility of land-slides, seismically active faults, etc.

The results obtained as a result of the investigations mentioned above show the influence of the local soil conditions upon the seismic intensity and the character of the earthquake effect.

The seismic microzoning map of an urban area is used as the basis for urban planning and design for the purpose of mitigating the seismic risk from the effect of disastrous earthquakes. In the development of the physical concept of the urban plan, in addition to other considerations, the following elements are also taken as basic:

- The seismic microzoning map of the urban area shows clearly the possibilities for rational utilization of the terrain for developing the physical concept of the urban plan (zonal plan). The zones with most favorable conditions, i.e. where lowest maximal seismic intensities are expected are clearly defined. Usually, these zones are preferred for construction.

  Such seismically favorable terrains should be used as construction sites of the most important basic urban activities as well as for future urban development (center, important industrial structures, housing, hospitals, university campuses, etc.). However, the dispersion of industry into several industrial zones within the urban area of larger towns should also be considered, so that disastrous earthquakes will not have the same effect in all industrial zones.

  Terrain unfavorable for construction should be allocated in the physical concept of the urban plan, if possible, to other activities (light industry, services, warehouses, etc.).

- Terrain with unfavorable soil conditions should be considered in a similar manner as seismically unfavorable terrain, unstable terrain with most unfavorable ground characteristics, unstable terrain with potential for land-slides, terrain with high liquefication potential and flooded terrains. Such terrain in the concept of the urban plan should be used for green areas or open spaces.

It is recommended there be larger green areas and open spaces than provided by the usual urban regulations. In case of disastrous earthquakes the green areas may have a variety of useful advantages.

- Terrain with high ground water level and periodically flooded areas, if possible, should be first improved by application of various hydrotechnical measures and then be included in the general concept of the urban plan. Otherwise such terrain is seismically unfavorable.

- The position of faults and fault zones can be observed on the seismotectonic map. In designing the land-use patterns in the physical concept of the urban plan seismically active fault zones should be considered.

  Important facilities should be located distant from seismically active fault zones.

In planning and designing all structures and various types of infrastructure in large urban areas with high seismic activity special attention should be given to protective measures so that they can remain effective in case of catastrophic earthquakes. Basic recommendations concerning planning and design of infrastructure in urban areas are as follows:

- The urban plan should avoid organization of a single main traffic center, since that can result in complete disruption of normal traffic after a disastrous earthquake.

- Interregional through traffic should be accomodated by a system of roads which do not traverse the urban area but are easily connected with it.

- The complete water supply system, or at least large portions of it, of these settlements should give priority to the gravitation system if possible, since it does not require another energy source.

- The main water collectors, i.e. from the reservoir to these settlements should consist, if possible, of double pipes.

- The combined sewerage system collecting both waste and storm water is considerably more effective than other kinds (the pipes are placed deeper). This system should also consist of two pipes, if possible.

- In principle, gas systems should be avoided, if possible, since they can cause secondary damage by fire in large urban areas with high seismic activity. In case such systems are planned it is necessary to provide for automatic disconnection of the system in the event of a catastrophic earthquake, as well as for devices which will enable disconnecting damaged sectors from the system.

Preparation of a detailed urban plan often involves considerations of various aspects of structures and building complexes. In such cases in addition to other basic principles for urban design, the following measure for protection against the effect of disastrous earthquakes should also be taken into consideration:

- In principle, systems of structures should be separated from each other. If structures have some distance between them the possibility of damage due to battering each other is diminished. If structures are located at reasonable distances from each other the possibility of damage by buildings collapsing on each other is minimized.

- The detailed analysis of the causes of destruction and damage of a great number of structures due to the effect of catastrophic earthquakes has established that the shape of the base and its dimensions have considerable influence upon seismic stability. Thus, the outline of a building should be symmetric to the main orthogonal axis. It is best if buildings have square or rectangular shapes.

In case of structures with complex bases and structures where certain parts have different numbers of stories, they should be divided by seismic joints in such a way that the bases of the divided parts should have simple geometrical shapes.

Construction in rows should be, in principle, avoided. In case such construction is planned, such buildings should be separated by seismic partitions at selected intervals.

- Structures which vibrate with the same resonance as the soil are subjected to greater damage than those which have a different resonance. Because of this, when determining the number of stories of a building complex in the framework of urban plans, the map of predominant periods of the urban areas should be taken into consideration along with other factors. This map shows the distribution of zones with the same predominant periods. Thus, in areas with very small predominant periods, usually from 0.15 - 0.25 sec., it is recommended construction of low buildings be avoided, i.e. buildings of one to three stories. On terrain with small predominant periods low buildings can be constructed, as well as high ones.

The preceding discussion provides a very brief summary of considerations that should be taken into account when developing physical plans for seismic regions in order to mitigate the effects of disastrous earthquakes. It has not been possible in this short paper to elaborate the points presented. All problems discussed above have been presented in more detail in my lecture notes for the postgraduate course of studies in the field of earthquake engineering and engineering seismology organized by the Institute of Earthquake Engineering and Engineering Seismology at the University of Skopje.

SECTION VIII

EDUCATION AND INFORMATION IN REDUCING VULNERABILITY AND MANAGING EMERGENCIES

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THE ORGANIZATION OF A MASS EDUCATION PROGRAM IN ORDER TO MITIGATE EARTHQUAKE HAZARDS IN CALABRIA

Francesco Battisti

Introduction

This paper is intended to be an account of one of the first experiences in mass education undertaken by a local government in Italy, after the approval of the official rules of application of civil protection (Law No. 996 of December 8, 1970).[1] Indeed, after the last earthquake in Irpinia (November 23, 1980), many local governments situated in seismic territories, have been concerned by the lack of local emergency plans for natural calamities. The rules of application for civil protection give them the possibility of organizing a local emergency network, with the technical support of experts, engineers and scientists knowledgeable of such problems, in cooperation with central authorities. The civil protection program of the Commune of Rende was made possible by the cooperation of the local administration, interested in taking the lead in this field, of the Department of Sociology of the University of Calabria, and of the Irpi Institute of the National Research Council of Italy.[2]

The Commune of Rende (5,479 km^2; 13,157 inhabitants according to the 1971 Census) is located a few miles north of the city of Cosenza in Calabria, and actually constitutes one of the new, developing suburbs of this city. It was struck by an earthquake, affecting the whole Cosentine Valley, on the 20th of February 1980, causing considerable damage to buildings and infrastructure. A few weeks after that event, a research team from the Department of Sociology of the University of Calabria, in cooperation with Rende's Social Center, carried out a survey of 295 families living in the Commune. Four subsamples were selected according to social class and type of dwelling. Although the survey was not specifically designed to meet the requirements of a program of mass education, which was later requested by the local administration, it certainly served as a source of practical information to the research team. In this paper, indeed, some of the findings from the survey will precede the description of the structure of the program which is based upon them.

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Immediate Collective Behavior

The first actions after an earthquake strikes are intended to save one's life. Although it had no serious consequences in terms of casualties, the 20 February earthquake caught the population in the least favorable conditions for response: namely, at 3:00 a.m. in the middle of the winter. If this quake had been more violent, it could have taken a heavy toll of lives. The first shake woke up 62% of the interviewed. Twenty nine percent could feel the quake because they were not sleeping, just having returned from Carnival parties.[3] Five percent of those who perceived it did not think it was a quake; 4% continued to sleep until they were informed by other members of the family. This was a 6 to 7th

Table 1

Question B.1 "Did you feel the earthquake, on the night of February 20, with epicentre between Cosenza and Montalto?"

Response	Percent
Yes, certainly (respondent awake)	27.8%
Yes, by waking up suddenly	62.0
Yes, I felt the first shake, but did not think about an earthquake	4.7
No, I was sleeping (awakened by others)	3.7
No, I did not feel it (for other reasons)	1.7
Other answers	--
	100.0% (N=295)

degree earthquake on the Modified Mercalli Scale; that is, strong enough to wake up sleeping persons and to send people outdoors, but too weak to cause the immediate collapse of any built structure. The panic and the spontaneous flight behavior it created cannot be "simulated" by a social science experiment. The seismic phenomenon, however, was not as destructive as it might have been: it permitted the maintenance of family and social groups and the resumption of social activities a few days after the first quake. It did not require a massive intervention on the part of rescue teams from other regions. Officers on duty from the fire and police corps were sufficient to keep the situation under control.

Immediate collective behavior can be catalogued into a set of actions which are described in Table 2. As the first answer to the question, "What did you do at the beginning of the quake?" the majority of respondents (40%) said they informed other family members (e.g., children or relatives living in separate rooms).[4] Seventeen percent got dressed, 11% immediately left the living quarters, 12% preferred to stay where they were. As the second answer most people, after getting ready, said they left home. This especially applied to families with children who cannot make individual decisions about what to do, but must first collect everyone in the group. To further stimulate evacuation from housing, a second seismic wave followed the first one after a few minutes. At this second violent warning, 94% decided to leave homes.

Table 2

Question B.2 (If answers 1,2,3 to question B.1)
"Do you remember the first thing you
have done after the first quake?"

Response	Percent First Answer	 Second Answer
Stayed in bed	12.5%	0.3%
Woke up wife/husband	9.1	0.6
Informed other family members	40.1	3.1
Got up and looked out for a safe shelter	2.8	1.0
Dressed rapidly	17.4	10.1
Assisted other family members	4.9	3.1
Went outdoors	11.1	42.2
Gave help to somebody	0.7	0.3
Other actions	1.4	0.3
N.A.	--	39.0
	100.0%	100.0%
	(N=287)	

Five percent remained for the following reasons: the quake was not considered dangerous, they could not easily move out from their apartments (old age, sickness) or they had to assist close relatives in the same condition.

The patterns of immediate collective behavior can best be studied by making reference to the primary group environment. They can be classified as "little reaction" (such as staying in bed), "symbolic behavior" (waking up and informing other members of the family), "helping behavior" (assisting family members who cannot be evacuated) and "escape" (getting dressed and leaving the apartment). Table 3 (crosstab between marital status and reaction patterns) shows that both over and under response, escape and little reaction from underestimation of the danger are patterns characteristic of the unmarried, whereas family groups are more likely to engage in symbolic behavior leading to group mobilization and solidarity.

Table 3

Crosstabulation between marital status and question 8.2

First thing done at the quake	Marital Status			
	Unmarried	Married	Married w/ children	Total
Scarce reaction (1)	20.7%	9.1%	9.0%	12.5%
Symbolic behavior (2+3)	21.8	50.0	62.4	49.2
Helping others (6+8)	3.4	4.5	6.8	5.6
Escape (4+5+7)	50.5	36.4	21.3	31.3
Other reactions (9)	3.6	0.0	0.5	1.4
Total %	100.0	100.0	100.0	100.0
N	(87)	(22)	(178)	(287)

Chi sq. = 68, sign. = 99.9

Seeking Refuge

Out of 275 interviewed people who left their dwellings, most respondents (88.4%) did so because they were afraid of a stronger quake; 23.3% expressed the intention of moving the family to a safer place; 8% thought their house was much too dangerous; 7.6% gave other reasons. It should be noted that the percentage of people thinking their house dangerous rises from 2.8% for concrete buildings to 21.8% for housing made of masonry. Table 4 shows the connection between building typology and reasons for going outdoors. A comparison with other earthquakes,

Table 4

Motivations for Leaving the Apartment by Building Typology

Motivations	Building Typology Concrete	Iron and Masonry	Tradit. Masonry	Reinforced Masonry	Total Avg.
Afraid of a stronger quake	94.3%	88.4%	54.5%	55.2%	88.4%
House was dangerous	2.8	2.9	21.8	10.3	8.0
Moving the family to a safer place	20.6	24.6	16.4	24.1	23.3
Other motivations	9.9	--	7.3	10.3	7.6
N	(141)	(69)	(55_	(29)	(275)

(Column percentages add up to more than 100% because of multiple answers. Four missing cases in the crosstablulation because they could not specify building typology.)

Table 5

Question B.6 "Where did you find a shelter?"
by type of building

Type of Shelter	Building Typology Farm, Villa	House (1-2 floors)	Building (>2 floors)	Total
Safe place, near to the house	92.9%	87.5%	75.2%	81.8%
Safe place, far from the house	7.1	10.2	21.8	15.6
Shelter outside town	--	2.3	3.0	2.4
Total %	100.0%	100.0%	100.0%	100.0%
N	14	128	133	275

Chi sq. = 26, sign. = 99.9

which is not possible here, would show that an alarmed perception of one's house tends to increase with the violence and the repetition of seismic phenomena.

From Question B.6 in Table 5 it can be ascertained that people did not go very far from their living quarters (the majority, 82% moved to a "safe place, close to home"), 16% went farther away and about 2% decided to leave the town (mostly young people and residents from surrounding villages). There is a weak correlation between building typology and place of evacuation (corrected contingency coefficient = 0.22) in the sense that people living in taller buildings and in densely populated areas tend to move farther away in their attempt to evacuate. The preferred refuge is an open space within the city (large squares, parks, unbuilt spaces) and the next best one is in the countryside. For practical reasons the refuge is not located far from home, as people--after the first reaction--tend to return to their apartments to check that all is in order or to pick up what they might need for the night.

From newspaper accounts it can be determined that the search for an appropriate refuge was easier in the new neighborhoods where housing was constructed according to seismic standards and buildings were considerably distant from each other. In the old town of Rende, built at the top of a hill with narrow streets and interconnected housing, the problem of access to open space was more serious, as only two streets led out of the town. The same problem was felt by the population of the medieval city of Cosenza, built with narrow streets, tall buildings, staircases and galleries before the enforcement of seismic standards. In fact the problem of providing adequate refuge and safe avenues of evacuation from high risk areas is one which any committee for local emergency planning must face with a set of policy measures: (1) it is necessary to establish emergency evacuation routes and to keep them free from traffic, available for flight from the area and for the delivery of first aid; (2) it is necessary to improve the security of those streets, in the historical centers (not only in Italy but also in other nations) which may become bottlenecks for the evacuating population. This can be done without large scale renewal, but more simply by reinforcing buildings, walls and roofs and by removing dangerous hanging objects from the streets; (3) during the program of mass education, it is necessary to point out safe sites of convergence in each neighborhood, not far from the dwellings, where people can expect to receive the necessary help and information, and where the families can group together and wait for the shocks to cease.

It was found from the survey that private means of transportation is often used as a shelter. Seventy one percent of the respondents said they spent the night in their cars. Automobiles were first used to carry people to the hospital, to reach relatives and friends in other parts of the town, in the absence of functioning public transportation. Cars were used to reach safer locations and as a protection against cold temperatures during the night. A major problem was that the city of Cosenza and other districts remained jammed for hours by private traffic. Traffic jams have been reported in other earthquakes, including that of Naples (November 23, 1980). All emergency plans suggest that people should not use their cars to move about in disasters. This obvious suggestion, aimed at improving the delivery of first aid and rescue teams

Table 6

Question B.7 "Did you spend all the night outdoors?"

Response	Percent
No	5.8%
After the quake, came back home	1.7
Stayed outdoors 1 hour	1.7
Stayed outdoors 2-3 hours	5.8
Outdoors all the night	85.0
	100.0%
	(N=295)

Table 7

Question B.8 "Did you spend the following nights outdoors?"

Response	Percent
No	23.4%
Yes, the following night	39.0
Yes, 3 nights	16.6
Yes, 4 nights	4.7
More than 4 nights	14.9
N.A.	1.4
	100.0%
	(N=295)

does not seem to be followed in practice for a number of legitimate individual reasons. The only means of prevention seems to be that of developing a plan to regulate traffic in advance, to coordinate and to instruct officers to discourage the use of private transportation in the urban context.

Life Styles during the Emergency

The danger represented by the quake considerably modified the living habits of the disaster stricken community. Eighty five percent spent the night of the quake outdoors, especially the families with children (see Table 6). Thirty nine percent avoided sleeping indoors the following night (Table 7); 20% stayed outdoors for more than three nights. It can be said that people faced the earthquake experience with considerable prudence. The preferred shelter, in most cases, was a car stationed somewhere in an open space. However, other people succeeded in changing apartments and moved to what they thought were safer homes, located on the first floor and lived with relatives or friends from whom they could receive help (see Table 8). This was especially true for the elderly or for women with small children. A minority used tents or trailers owned for summer holidays. The extensive use of emergency shelter is reported for greater earthquakes. For at least one day, the disaster prevented the prosecution of normal working activities (42% did not go to work and 4% went to work but came back after a few hours). About 13% of the offices or factories were closed. In the following days, some office buildings which had remained open were closed by the request for a technical inspection. The respondents who did not work or could not work spent the day at home in a state of alertness ready to give their families assistance at the next sign of danger. Other people moved their families to a safer location, and others took care of the damaged housing.

Past Earthquake Experience

For 84% of the respondents, this was the first time they had experienced an earthquake. For 3% it was the second time; only 12% stated they had experienced more than two earthquakes. The data do not support the hypothesis that in regions classified as major seismic areas people have accumulated a sort of "cultural experience" of this phenomena. On the contrary, for the majority of respondents this was considered a new event in comparison with minor seismic disturbances which occasionally occur in the Province of Cosenza.

Out of 295 respondents, 26 mentioned quakes happening in Calabria and in other parts of Italy, dating as far back as 1925. Twenty three described what could be termed a "non-disastrous event", and only 3 reported being present at a major disaster. Two persons said they were present during quakes which caused several casualties, but none of them had any victims among relatives. It can be concluded that, in spite of the presence of small seismic disturbances, the inhabitants of Rende never felt seriously threatened by earthquakes, and that the disaster which happened on February 20, 1980 was a relatively new experience to them. It is hard to establish whether any psychological motivation or represion mechanism influenced the answers concerning past natural

Table 8

Question 6.9 "If you spent the following nights outdoors where could you sleep?"

Response	Percent
In a car	70.8%
In a bus	1.7
In a tent, roulotto	1.7
Apartment of friends	3.0
Apartment of relatives	18.5
Outdoors	3.9
In a hotel of another town	0.4
	100.0% (N=233)

disasters. It is, however, certain that a direct seismic experience such as that of February 20 has made the local public more aware of this issue, of broadcasts and of news about earthquakes, and that the solidarity shown for the victims of the November 23 quake in Irpinia was greatly enhanced.

If the results of this survey can be generalized to other similar cases, it can be stated that no program of mass education can rely upon the establishment of "local traditions" concerning the knowledge of quakes, since this same knowledge seems to be fragmentary and discontinuous. It must, therefore, be taken for granted that the earthquake is a new event for the community and that in general the community is not spontaneously prepared to face it.

Housing and Safety

The built environment of Southern Italy varies considerably from that of American suburbia or of Japanese cities. The prescriptions given for seismic protetion in those areas do not fully apply to Southern European housing. Homes and offices are made either of masonry or concrete; there is little use of prefabricated materials, of plastic, glass, and steel. Housing constructed before the present century is built of masonry (bricks or stones) with wooden roofing. It can be found in the historical towns or in scattered farm dwellings. Contemporary housing is mostly concrete structures, four or five floors high, organized into apartments with staircases and elevators. In comparison to wooden structures, this type of housing has some undeniable advantages: it lasts longer, under generally safer conditions, and it can be easily renewed by restoration. Housing five centuries old is still inhabited and constitutes a remarkable part of the office and

Table 9

Question C.1 "Is this your first earthquake experience?"

Response	Percent
Yes	83.7%
No, it's the second	3.4
The respondent has more experiences of earthquakes	12.2
N.A.	0.7
	100.0% (N=295)

Table 10

Question C.2 (if 1 is answered to the previous question) "How was your experience of this first earthquake?"

Response	Percent
The respondent maintains to have lived through this experience:	
Well	12.2%
Positively	16.3
Not Well	23.1
Very Badly	31.9
	100.0% (N=246)

Table 11

(If the respondent has experience of other earthquakes)

Response	Percent
Type of quake described:	
Non disastrous	88.5%
Damaging	7.7
Heavily damaging	3.8
	100.0% (N=26)
Type of damages:	
Only damages to property	92.3%
Casualties	7.7
	100.0% (N=26)

residential buildings of city centers. It is generally quite resistant to fire and to windstorms, more so than wooden housing.

However, from the seismic point of view, both concrete and masonry are subject to collapse. Being heavier structures, they leave little hope for persons crushed or buried alive under the rubble of their buildings. For this reason, it is quite important to design earthquake resistant housing.

The survey results showed that 5.4% of the respondent families lived in a farm or villa (one floor apartment), 47.1% in a small house (1-2 floors), and 47.5% in buildings taller than two floors. 15.9% of the housing was constructed before 1900, 19.4% between 1900 and 1960, 58.0% after 1960. Major urban development occurred after 1960, when the enforcement of seismic construction standards was already well established by law. This area is fairly typical of new urban development in Southern Italy. The answers given by respondents indicated 50.8% of all housing was made of concrete structures, 24.1% with masonry using iron bars for support of ceilings, 9.2% with ancient masonry and wood reinforced by chains holding opposing walls together, and 14.6% with ancient, traditional masonry, without any reinforcement. Four respondents (1.4%) did not specify type of construction. Masonry reinforced with chains is estimated to withstand shocks up to the 7th degree of the Modified Mercalli Scale, whereas concrete is supposed to guarantee against collapse up to the 9th degree. The last Irpinian earthquake, which caused some concrete buildings to collapse, was estimated to be between the 9th and the 10th degree of the Scale at the epicenter.

The structural characteristics of the buildings are a good predictor of their ability to resist seismic shocks. 16% of traditional masonry construction suffered heavy damage compared with none for concrete. The heavily damaged buildings were constructed before 1930, that is with obsolete construction technology. The data in Table 12 clearly show that older buildings are more vulnerable than newer ones. However, there are some exceptions. The table shows that 5% of all concrete buildings suffered considerable damage, and newspapers report that at least three new residential buildings, following the first earthquake, were declared non-inhabitable by firemen and local government engineers. In response to another question intended to reveal doubts about the safety of their dwellings, some families maintained that the design and the location of the structure could not guarantee any kind of safety. It can be assumed that there is a small percentage of buildings which may not be able to withstand severe earthquakes in spite of their technical specifications for a variety of reasons, such as poor site conditions, quality of construction, improper design, faulty foundations, etc. It is no wonder, therefore, that in quakes greater than the 7th degree of the Modified Mercalli Scale many masonry houses have not resisted, and some concrete housing has collapsed (at least three cases--November 23 earthquake in Naples and St. Angelo dei Lombardi).

These negative experiences with contemporary construction suggest that officials should not rely on the general technical properties of buildings, and that controls should be imposed individually for each structure and each site. If structures show signs of unexpected damage after a minor earthquake, this should be interpreted as an indication of weakness. Immediate measures should be taken for reinforcing, even though the inhabitants may not understand why so much work is needed to repair a little damage. According to the survey, 50% of all buildings in the Commune of Rende had been inspected by officials and civil engineers a month after the earthquake. These inspections, however, did not extend to all housing. They were not carried out automatically, but had to be requested by families living in the dwellings or by the owners. In the case of the city of Naples (after November 23rd) inspections were made within a few weeks after the first earthquake, but the continuation of seismic activity over several months required technicians to reinspect endangered buildings.

In response to the question, "Do you know whether your house is constructed according to seismic standards?" 25% answered that their home is too old, 17% that it does not appear so, 23% that they do not know, 16% yes, probably, and 19% were positive about it. Usually, owners are more knowledgeable than tenants about construction details. The level of education and occupation are important factors also.

Table 13 shows the majority think that their house is safe enough to withstand an earthquake (54%), but only 11% answer that they are certain

Table 12

Damages by construction typology

	Building Typology				
Damages	Concrete	Iron and Masonry	Tradit. Masonry	Reinforced Masonry	Total Avg.
No damages	46.0%	46.5%	20.9%	44.4%	42.0%
Light damages	48.7	50.7	53.5	51.9	50.5
Noticeable damages	5.3	2.8	9.3	3.7	5.1
Heavy damages	--	--	16.3	--	2.4
Total %	100.0%	100.0%	100.0%	100.0%	100.0%
N	150	71	43	27	295

(4 missing cases do not state building typology. Chi sq. = 50, sign. = 99.9)

Table 13

Perception of house's safety by building typology

	Building Typology				
The house is	Concrete	Iron and Masonry	Tradit. Masonry	Reinforced Masonry	Total Avg.
"Safe"	18.0%	4.2%	--	7.4%	10.8%
"Safe enough"	61.3	54.9	25.6	48.1	53.6
"Unsafe"	6.0	16.9	32.6	29.6	14.9
"Dangerous"	--	2.8	20.9	3.7	4.1
Doesn't know	14.0	21.1	18.6	11.1	15.9
Other/n.a.	0.7	--	2.3	--	0.7
Total %	100.0%	100.0%	100.0%	100.0%	100.0%
N	150	71	43	27	295

(4 missing cases do not state building typology. Chi sq. = 87, sign. = 99.9)

it is safe. 15% are dubious about the security of the building, and 4% think it is dangerous. The remaining 18% either don't know or give no answer. There is a strong correlation between building typology and perception of safety. In fact, in the section of the questionnaire concerning the safety of the house, building typology constituted the principal causal link. Of 71 persons who think their house is not safe, 65% mention the building is too old, 14% say it is not built with concrete, 11% say ceilings and roofs are not stable, 8% that stairs are dangerous, and 8% that stairs are too far from the exit. Those living on the top floors of apartments are afraid they might not be able to reach the exit of the building in the event of an earthquake. Other cases of complaint include not enough space in front of the building, house not well constructed, building close to a steep slope, which concern sites and design.

Future Prospects

The earthquake dispelled the belief people had in the security and safety of their natural environment. In response to a question about the possibility of another earthquake, the majority (78.0%) answered that one can happen at any time, 3.1% add the danger is continuously present, 0.7% predict them each 2-3 years, 4.7% say that quakes are rare events, and 13.6% do not know. The data basically show that the population felt threatened at any moment.

To the question, "What would you do if you were informed in advance?" 48.6% responded they would immediately leave their house until the danger was over, 16.9% would escape from the area, 24.4% would take some precautions, and only 11.5% would continue their life normally. However, according to the majority of respondents, (68%) it is not yet possible to predict earthquakes.

Finally, the risk of an earthquake is not felt to be so important as to compel families to relocate permanently. 55.6% of the respondents said that they would not move their residence because of earthquake risk. 11.2% say that--if they could--they would change the type of house and neighborhood, 18.3% say that they would change city and local government area, 14.9% do not know. It can be concluded that proneness to earthquakes in itself does not threaten the stability of a location. This has also been demonstrated by the will of the people of Friuli and Irpinia to rebuild the same towns. However, this fact makes the need imperative for emergency organization and for mass education and training directed at the younger generations in those communities which may be stricken again.

The Program of Mass Education

The role of mass education in relation to other programs of community preparedness.

First of all, a program of mass education must not be independent from a whole series of measures for increasing the general preparedness of the community against unscheduled events. In the case of earthquakes, these include knowledge of the geodynamical aspects of the territory (past seismic activity and active faults), the seismic engineering study of the resistance and the weakness of the built environment (housing and infrastructures), and the study and practical improvement of organizational response within the community. Mass education is a part of the community's organizational response program which includes, on the one hand, the intervention of the public administration, with all its emergency powers and on the other hand the active cooperation of the people. One of the effects of mass education should be that of distributing certain disaster related responsibilities--traditionally the province only of police and fire corps--to a broad base of volunteers who are not called from outside the community, but generated within the community as soon as the need for intervention arises.

Aims and limits of mass education.

The first aim of mass education is that of preventing exposure to danger by providing advance knowledge of safety measures. The results of the survey about previous experiences with earthquakes showed that, in the Cosenza area, this was a new event in comparison with minor seismic disturbances. Only a small minority shared an experience of damaging earthquakes. A second aim is that of decreasing anxiety about unknown danger by creating patterns of recognition and of discrimination between false alarms, warnings and actual threat. Any type tremor is perceived as equally threatening, whereas there are important differences between minor and major events. A third aim is that of improving ad hoc coordination of family groups and of other spontaneously emerging groups by transforming symbolic behavior (observed especially among families) into practical defense and escape. The program should direct people to safer locations by pointing out evacuation routes and should provide precise expectations about the help which can be delivered by locally based organizations. It should also indicate patterns of responsibility and roles of leadership within disaster stricken groups, sources of coordinating information which families can access. There are also long range effects of mass education which should be taken into account. Mass education should teach practical procedures for increasing the safety of the home environment by modifying furnishing and installing elementary safety devices for fire, gas, and electricity. In the second place, it should lead to an improvement of hazardous buildings by encouraging and supporting restoration and reinforcement.

The research at this stage does not permit measuring the effects and evaluating the efficacy of a mass education program. The first problem consists in the organizational ability to spread knowledge in the community over a long time period, so that people continue to be informed before the next earthquake. Since there is no sure method of predicting an earthquake, the success of such a program greatly depends upon its timing with respect to the events. Mass education is most effective if it is achieved one or two years before the earthquake; its utility decreases as time passes before such an event happens again. It is necessary to discriminate between information which is subject to obsolescence and information which may continue to be effective throughout time (see Table 14). The program should protect against obsolescence by undergoing revision every four or five years.

In the second place, the program cannot prevent by itself the destructive effects of major earthquakes (such as the collapse of buildings, massive casualties, the interruption of energy and communications). Certain items which are suggested for minor earthquakes may turn out to be irrelevant for major ones. The program was designed to be adequate for earthquakes varying between the 5th and the 9th degree of the Modified Mercalli Scale for the Commune of Rende. In the case of more severe earthquakes it is assumed that the community loses self-sufficiency with respect to rescue, and that major help must be delivered from outside. The improvement of the efficacy of the program largely

Table 14

Obsolescence in Educational Programs

Items not subject to obsolescence
1) Elementary notions of what is an earthquake
2) Patterns of recognition of earthquake
3) Personal safe behavior
4) Patterns of family organization and response
5) Procedures of evacuation
6) Home safety
7) Structural improvement of the building
Items most likely to become obsolete
1) Evacuation sites
2) Evacuation roads
3) Emergency for new districts
4) Location of health services
5) Location of administrative offices and emergency personnel
6) Channels of public communication (TV, radio)
7) Other channels of communication

depends upon the technological progress which is being made both in earthquake prediction and in the design of building resistance.

Families as Action Units

Other studies of families during disasters show, as does this one, that belonging to a family group makes individuals dependent upon collective decisions: families are more likely to engage in symbolic actions (warning and getting together) which may have the final effect of retarding their time of response to emergencies. The purpose of the program of education addressed to families is that of increasing their efficiency as action units, by making clear dangers, roles and expectations. Of course, in order to become efficient and safe the family group needs minimal support from official organizations: the help promised to families must be fulfilled in the presence of coordinating officers in evacuation sites. Instructions to families are distributed in a booklet ("How to defend oneself from earthquakes", instructions for families) which is intended to represent in a realistic manner (by making extensive use of illustrations) the earthquake situation. The booklet is prefaced by the Sindaco (the local government head) which gives an official appearance to the information being distributed. The earthquake is seen, first of all, at home, with the damages it can eventually provoke, and the dangers it can represent to human lives (such as fire, furniture collapse, falling objects, breaking glass). Families are instructed to stay where they are, to find a safe shelter within the house at the moment of the earthquake, avoiding falling objects and avoiding getting out of the building. Instructions assume that the building will be standing after the first shock. Next, the family must group together, preparing children and helping the elderly to leave the dwelling. Evacuation must be done as a group, avoiding falling objects, without using elevators. Gas and energy must be turned off before leaving the dwelling. On the streets families are able to join other members of the community who have experienced the same situation. Together, these groups must be directed to evacuation areas which also become, during the emergency, service areas for the community. Evacuating people must help each other (including the elderly and the handicapped) and as a group must discourage panic or individualistic behavior. The urban context allows evacuation on foot which improves face to face interaction and helping behavior.

The role of families, as reference groups for safety and evacuation, is particularly important if the earthquake happens at night or in the evening. During other times of the day other social groups and organizations may work as reference groups for evacuation: for children and young people the schools become the second important reference point. For the adult it is the office and the factory. For the elderly it is the neighborhood with its social services.

Mass Education in Schools

Schools, especially elementary schools, have been built to the safest seismic criteria. In previous Italian earthquakes they have often become important community coordination centers because as shelters they withstood the strongest shocks. The main problem the school must face during an earthquake is of an organizational nature. Children and teachers must know in advance their respective roles and must perform them. In particular, children should be assembled under the leadership of teachers who are responsible for their safeguard until they are returned to parents. Teachers must be knowledgeable of seismic safety measures; they must be able to group and identify their class and guide it to a safer location outside the building until the danger is over. For the purpose of drills, the danger of an earthquake can be equated to that of fire. Fire and earthquake drills can be regularly practiced in the schools at the ringing of alarms.

Another service schools can provide to the community is to teach students elementary norms of safe behavior which they can transmit to families. In particular, children should be instructed to know what to do (1) when the earthquake strikes at home during the evening or the night; (2) when it strikes at the playground or any other open space, not far from home. Besides, they should recognize and be able to reach evacuation sites in the district, where they can meet family members or other relatives they might know. Although some notions of elementary geodynamics already appear in 4th and 5th grade textbooks, children of the last two years of elementary schools can receive specific seismic training: it is possible to explain to them what an earthquake is, and how to recognize one from basic signs. More advanced training is possible in post-primary education by creating volunteer geodynamic observation laboratories, and by training scouts to intervene in natural calamities.

Training in the schools can be most effective if audiovisual material is used (movies and videotapes where actual images of earthquakes are shown). The use of audiovisual material is suggested at the junior high school level (post primary) where students have a more realistic perception of filmed images. In the elementary schools a sort of euphemistic representation of reality (by stories, cartoons, characters) can be more effective with young readers.

Mass Education in Factories

High concentrations of working personnel can be found in industrial plants during working hours. If the earthquake strikes in the morning or early afternoon, it will damage not only the plants but also endanger the lives of the working population. Therefore, it is necessary that large plants have their own local emergency plans. Factories can be divided into two types: (1) industrial establishments which do not contain any special hazard (e.g., toxic substances, flammable materials, explosives) and which can be evacuated without special procedures; and (2) hazardous establishments which may become highly dangerous in the case of earthquakes (e.g., dams, nuclear reactors, chemical plants, etc.) Type 2 is not found in the Commune of Rende, which is not characterized by a high industrial activity, but should be kept in mind for similar programs elsewhere. Emergency plans for factories are supposed to (1) assess the stability of buildings where the industrial process occurs; (2) evaluate the safety of any stockpiled material within the buildings or near them; (3) provide emergency exits which are to be kept clear, and to point out safe evacuation sites; and (4) establish terminating procedures for the work in process during a natural disaster (e.g., shutting off power, storing raw materials, etc.) It is the task of the factory management to organize a local emergency plan and to assign tasks to individual workers or teams; however, the management can receive helpful advice from the seismic safety board.

There should be a clear distinction between emergency plans for before and after an earthquake. The plan for industrial safety before the earthquake concentrates upon the safety of personnel. After the earthquake, certain factories are considered resources from which machines, operators, and technical equipment can be ordered in order to deliver first aid. The role of the construction industry becomes extremely relevant, as it owns the machinery needed to remove debris of collapsed buildings. Bulldozers and machine operators needed to remove heavy debris are most likely to come from construction plants, from mines or from highway construction. Saving lives within a few hours, can depend upon their immediate presence. For this reason, the Commune of Rende--as a result of experience accumulated in Irpinia and Friuli--has completed a classification of necessary technical equipment to be found in the local industries. Other industrial plants may contain useful equipment which may become necessary in the weeks following the catastrophe (such as tents, trailers, clothes, drugs, canned food). This equipment may never become available to the local population if no agreement has been made between the local administration of the Commune and private industry management. Therefore, it is necessary that a program of mass education in the factories be carried out by considering the double aspect of personal safety and community emergency, and by evaluating the contribution that specialized personnel can give to the social organization of community survival.

Public Administration

Mass education should also take into account office personnel in private employment (such as banks, insurance companies, commercial enterprises, power, gas, telephone companies and other public utilities) or in public bureaucracies (employees in the Commune, in general hospitals, in social and administrative services, in post offices, etc.). Many of these services should be continued after the disaster, and competent personnel should be instructed to do so. The safety of buildings is the first subject to which the program of prevention should pay attention: this includes the upgrading of unsafe structures, the construction of safety exits where they are lacking, the establishment of emergency lights and emergency power. In the Commune of Rende many communal offices are not safe because they are located in ancient buildings which may not resist stronger shocks. The city hall is located in the ancient castle. A certain degree of risk can be taken, but other structures need reconstruction to remain public offices. During the last Irpinia earthquake some important office buildings--the Prefecture of Salerno and one local Army camp in the same city--had to be evacuated. The vulnerability of offices which may become important during the emergency needs to be ascertained.

As with industrial establishments, there are offices which may be evacuated and shut down for a few days without major economic consequences and there are other public services which need to work on a 24-hour schedule, such as medical services and administrative coordination. These services need, first of all, autonomous power supply and communications. They also need the presence of specialized personnel. This study found that there was no emergency planning in the hospital, and this needs to be established as soon as possible (in fact, this is the case with most local medical facilities). In addition, no instruction has been given to administrative personnel in the case of an earthquake; for some days, communal offices were shut down after the February 20 earthquake. It is necessary to create special procedures and regulations which, approved by city hall, become effective as soon as an emergency is declared. By a set of ordinances, which are part of the local emergency plan, the Sindaco is given legal tools to recall public employees to their work, if it is considered a primary necessity. The same is more difficult to establish for private employment, where worker participation becomes more of a voluntary matter. Volunteerism must be prepared for and planned, especially when it involves some degree of personal risk. The program of mass education directed at public employment should emphasize the primary role of social and administrative services in responding to catastrophes. Expectations of the positive role civil servants can play in community protection should be emphasized.

Evacuation Sites

Throughout the educational program families and individuals are given the expectation they will find help and services in evacuation sites which are identified to them district by district. The function of these sites becomes extremely important and needs to be properly established. In the general emergency plan--of which mass education is but one part--the sites have a two-stage function. At the onset of the disaster, the evacuation sites are meeting points where families and officers from public services converge to find each other, to group and organize, to share first aid services. The site also represents a shelter in comparison to a built environment which has suddenly become dangerous. The sites are connected to each other by radio communication, each is served by emergency medical aid and ambulances. They collect, on the one hand, the weak and the disabled, the injured who need immediate help; they represent safety for women and children. On the other hand, equipment and active volunteer forces are supposed to converge on evacuation areas to organize and start rescue of victims in the surrounding districts. In the case of a minor disaster, where the number of injured is minimal, the evacuation sites have the basic passive function of sheltering. In a major disaster, it must become an alternative to the destroyed built environment, and must emerge as an active service and community center, as the number of volunteers increases and technical equipment is supplied. Evacuation sites, pre-established in the disaster plan, also become the focii for rescue, arriving from outside the disaster stricken area.

It is not the purpose of the educational program to elaborate all possible functions of evacuation sites, as many of these may remain latent in the case of a minor threat. The program simply states "know your site"; it divides and allocates the population to meeting points which can be safely reached without using transportation. Beyond emergency health services, tents and food supply, communication is another important function of the center. Immediate information, available to the site, will reduce insecurity and uncertainty about the future, and facilitate a realistic perception of the catastrophe in the disaster-stricken community.

Mass Education in the Context of the Emergency Program

Two viable alternatives were presented to the scientific committee which was requested to draft a mass educational program for seismic safety at the Commune of Rende. The first one, which had already been applied to other disaster stricken areas, was that of distributing to the population general literature about seismic risk, personal safety and first aid. This literature, once it was printed and given out, did not require any further commitment from the Commune or the University. The second alternative, feasible in a context of mutual esteem and cooperation, was that of attaching mass education to an integrated local emergency plan. Without excluding the aims of the general program mentioned above, mass education provided specific instruction about where to go, what to do, reference areas and institutions to be found in the context of everyday life. This second approach to the problem was intended to have the advantage of making people more interested in and attentive to the instructions which are given.

Mass education specific to seismic areas requires a greater effort on the part of the board which is required to study the problem and prepare plans, and on the part of the community based organizations which must fulfill the promises and achieve the services which people are told to expect. The program also needs continuity and maintenance. However, compared to the past, it represents a qualitative step forward which, hopefully, will be adopted by other collective safety programs.

FOOTNOTES

1. "Norme sul soccorso e l'assistenza alle popolazioni colpite da calamite--Protezione civile" Law No. 996, December 8, 1970. However, the norms for applications of these laws "Approvazione del regolamento di esecuzione della legge 8 dicembre 1970, n.996" have been recently passed on January 16 1981. This late application of the law shows the low interest by the government in civil protection, which was documented by newspapers after the last Irpinian earthquake.

2. I wish to thank those who have kindly cooperated in the establishment of this program: Senator Francesco Principe, who first approved the project, the Mayor of the Commune, Avv. Sandro Principe, Dr. Giovanni Perri, Chairman of the Seismic Safety Board, Dr. Lorenzo Chiappetta, Director of Rende's Social Center, Dr. Marino Sorriso of the IRPI Institute, Dr. Franco Chiappetta for data processing and Mr. Santino Fiorello for data input.

3. The actual date corresponded to Shrove Tuesday. This explains why 28% of the people were still awake.

4. According to a small sample preliminary survey in Montalto (N=120) all boys below 13 years of age remained asleep during the quake. This indicates the importance that they be awakened by other members of the family.

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MEDIA COVERAGE OF DISASTERS: THE SAME OLD STORY

T. Joseph Scanlon
and
Suzanne Alldred

> The headline of the Daily News today reads BRUNETTE STABBED TO DEATH. Underneath in lower case letters '6000 Killed in Iranian Earthquake'...I wonder what color hair they had.
>
> (Abbie Hoffman as quoted in Tuchman, [1978] frontispiece)

It might seem essential that any paper presented at a seminar on earthquakes include material on earthquakes but, given the hypothesis on which this paper is based, that inclusion is not necessary. This paper argues that the mass media behave roughly the same way when responding to all major events whether these are natural or man-made disasters, criminal occasions such as assassination attempts, hijackings, hostage takings or other acts of terrorism or simply major, unexpected events. If that argument is correct, then it follows that in order to predict media behavior in relationship to one event, say an earthquake, one merely needs to know about media behavior in other events, say a hostage incident or a flood: the behavior patterns will be very much the same. (Other papers in this volume, particularly Dynes and Quarantelli, also argue that disasters are treated generically.)

Although this proposition, as far as is known, has not been stated explicitly before, it does fit with common knowledge about the media. Newsrooms are not filled with specialists on storms, earth movements, criminal acts or air crashes. Instead, to a considerable extent, they are the working places of generalists. It makes sense therefore that it is generalists who respond to incidents and that they will apply their generalist experiences in doing so.

It also fits with what research has been done about news organizations and their operations, research which, on the whole suggests media activity is far from an ad hoc reaction to unpredictable events [Tuchman, 1978, pp. 22-23] [Gans, 1979]. To quote just one such study--Philip Schlesinger's book on BBC news:

> The news we receive on any given day is not as unpredictable as much journalistic mythology would

> have us believe. Rather, the doings of the world are tamed to meet the needs of a production system in many respects bureaucratically organized....Most news is really 'old' in the sense it is largely predictable, but a powerful occupational mythology plays this fact down.... [Schlesinger, 1978, p. 47].

Despite this general supporting evidence, the model advanced in this paper is tentative. It has been tested through interviews with journalists, through an examination of some journalistic memoirs and through an examination of some of the literature about media in crisis and disaster. It has not been field tested in the sense that the completed model has been checked against an actual event. Therefore, while the evidence to date does not seem to contradict the model's present form, it is far from clear whether all the evidence is in.

One further point. One of the authors is a journalist of some experience. His background includes coverage of such disparate events as racial unrest in the southern United States, a hijacking that ended in Brazil, a tornado in Ontario, two plane crashes in Quebec. He has also been present at two major hostage incidents, in one case spending several days with reporters covering the incident. This background of experience has been applied to the propositions in this paper. This seems perfectly reasonable given that we are developing theory rather than presenting certified fact.

What we have done, therefore, is list, point by point, some of the elements that appear to make up the crisis model. Then, in each case, we have tried to provide some supporting references and/or some expansion on the point being made. We have included contradictory evidence where that was available. We believe this form of presentation will allow individual discussion of the points raised. It will also allow testing of the entire model even those elements in it which are not, as yet, supported by any particular evidence.

It should be mentioned that the original idea for this paper was developed during a discussion at Boulder, Colorado. Those present included Tom Saarinen of the University of Arizona, Ed Epremian of the National Academy of Sciences, Paulette Gilliam, who had been involved in dealing with the media at Mount St. Helens and one of the authors of this paper. What happened is that it became apparent that much of the media behavior at Mount St. Helens paralleled media behavior at a number of Canadian hostage incidents. These similarities were later described in a letter to William Anderson of the National Science Foundation on August 1, 1980 [Scanlon, 1980]. It was hoped at that time that Ms. Gilliam would follow up on them. She has not been able to do so. The work reported here is, therefore, mainly the work of the authors although they have consulted informally with Ms. Gilliam on a number of occasions. Here, then, is the model.

1. <u>The media will hear of an event</u>.

When a major incident occurs, some citizens will usually call the media. Other will tell friends and neighbors and--as the word spreads--the news will reach the media. The media also monitor the activity and communications of such key emergency agencies as police, fire, ambulance, etc. Any major disruption is bound to be noticed. Major incidents are difficult to conceal. Though this may appear obvious, there is considerable doubt whether this will always be the case. In some countries, disasters and criminal-type activities are not reported though this is changing, especially with respect to disasters. The media response in those countries will, therefore, be quite different than reported here.

(It seems best to suggest that what is described in this paper on the whole is the activity of the "western" press. This limitation is not mentioned as a form of criticism. It is stipulated in the hope the differences among press styles will be noted and accepted without debate.)

2. The media will try to obtain more information.

The moment an incident occurs the media will start to use whatever means are available to gather further information. Among other things they will call all available sources--official and/or unofficial--by telephone. They will also use radio links. The speed of this activity may be incredible. CBC broadcaster, Barbara Frum, reports what happened when Lynette Fromme took a shot at U.S. president Gerald Ford:

> The moment the wires flashed the news...we were on the phone dialing for her room-mate and fellow Manson family member, Sandra Good Frum, 1976, p. 165 .

3. The media will use its files to add to the story.

Most major news agencies have substantial libraries--libraries which include their own reports and clippings from other publications as well as standard references. When an incident occurs they will use these resources to provide background stories. They will also rely on human sources from previous stories. This means accounts will be generated of previous comparable events and previous events in the same location. It also means past errors are extremely likely to be repeated since they will be included in the memory.

4. The media will dispatch reporters to the scene.

Even as some reporters try to get through by telephone, others will be en route. Christie Blatchford, a reporter for the Toronto Star, recalls how quickly she set out to cover an earthquake in Italy:

> The day the earthquake happened we decided to go....literally within an hour a photographer and I were at the airport and flew to London and then to Rome. We rented a car in Rome and drove down to Naples.... Blatchford, 1981 .

The same sort of response took place when the New York Times learned--it had been monitoring the shipping distress channel--of the **Andrea Doria-Stockholm** collision:

> ...raced through the incoming bulletins. When he gauged the full impact of the disaster, he ordered a special American Airlines Convair to take reporters to Boston...He had von Hartz wake Meyer Berger, Milton Bracker and Peter Kihss at their homes; had them in the city within an hour...[Adler, 1966, p. 265].

5. All staff resources will be applied to a truly major event.

The staff, technical resources, transportation facilities, support staff will all be put to work. They will collect data, run messages, answer phone calls, make calls, arrange transportation, edit copy, etc. Describing how a local paper handled the Mount St. Helens volcano eruption, one of the staff reports:

> The editors not only put their 11-member reportorial staff on the story but also drew on staffers from sports, the family page, the computer section and the composing room....[Stein, 1980, p. 105].

Harrison Salisbury reported much the same response for New York Times coverage of the Kennedy assassination:

> In New York...the assignment sheet...shows at least 32 correspondents assigned to the Kennedy story. The entire working staff in Washington...was drafted for the task. So was the network of 10 regional correspondents....The principle foreign bureaus--London, Paris, Rome, Bonn, Tokyo, Hong Kong, and the United Nations staff--were also committed to the Kennedy story [Salisbury, 1965, p. 38].

6. The media will use all of its technical resources and ingenuity.

Journalists tend to have connections which will help them gain access to specialized vehicles (e.g., snowmobiles, helicopters, etc.) and communications equipment. At Mount St. Helens the media combined access, technology, and persuasion to get a rare report:

> ...NBC took a helicopter inside the crater at a time when the USGS (United States Geological Service) regarded such flights as unsafe then persuaded a geologist to view the invaluable resulting tape. The geologist was reluctant to help them at first, but when they started showing the tape he couldn't stop talking with excitement....[Scanlon, 1980].

At Three Mile Island, the Philadelphia Inquirer used an all-out effort by its staff to tap sources normally beyond its resources:

> Reporters took down license numbers at each shift at the plant, got the names and addresses from the state motor vehicle department....Then the Inquirer started knocking on doors. Many employees were belligerent, most were exhausted but fifty agreed to interviews....[Sandman and Paden, 1979, p.48].

Numerous other instances of reportorial resourcefulness can be cited from the literature on Three Mile Island. The most striking perhaps, is that displayed by Rod Nordland, an investigative reporter for the Inquirer:

> ...parked directly across the Susquehanna from the plant, Nordland...tooled with his fancy scanner radio searching for TMI transmissions. Nothing on the utility band nor the police band. He switched to a frequency the instruction booklet said was reserved for 'federal interagency cooperation during nuclear war'. And there they were. [Sandman and Paden, 1979, p.52].

7. As information becomes available it will be reported.

Given the attention paid to immediacy as a canon of journalism it is evident news will normally be reported as available. In radio this means immediately, and this can be true in T.V. if the news seems to justify interrupting other programs. This appears to be the case however scanty or inadequate the information and however marginal the original source or sources. That perhaps explains why the disaster literature expresses concern about the accuracy of the original news flashes [Dynes, 1970, p. 26] [Baker and Chapman, 1962, p. 258].

8. Information will spread from medium to medium.

The various news media are intertwined in a way which makes information sharing inevitable. They also monitor each other in order to pick up information they may have overlooked. A story by one is soon a story for all.

To take just one example, CBC, Canada's public broadcasting organization, receives information from the main Canadian news agency CP, Canadian Press. CP is linked to Associated press (the U.S. co-operative), Reuters, the British agency, and AFP, Agence France Presse, the French agency. It gets news from and provides news to all three. CBC is also linked to two major U.S. television networks, CBS and NBC. And it has several minor connections. In addition, CBC news, as a matter of course, monitors its main rival, CTV, and watches the Toronto newspaper, the Globe & Mail, which appears on the street between CBC television's first and second evening newscast productions. Such interlocking and monitoring is common [Scanlon, observations] [Tuchman, 1978, pp. 22-23].

9. The media will attempt to fit the news into a framework.

News organizations expect disaster news to be reported in terms of loss of life, injury, persons left homeless, cost, etc. They will push very hard for this sort of information to be made available. (There is no perception that the confused aftermatch of a disaster may make this almost impossible to obtain.) This desire for conformity is even laid down as a norm by Curtis MacDougall, author of a major text, Interpretative Reporting:

> Regardless of what is played up, the occasion must be identified in the lead by the amount of loss, either in lives or in property [MacDougall, 1968, p. 282].

10. To give the news form and structure the media will demand official news conferences at which official statements can be recorded.

One of the maxims of journalism is that while it may be important to get a scoop (exclusive story) it is more important not to be scooped. It is always preferable therefore to have the news delivered in packaged form in some common place. If there are conflicts between sources, the media will try very aggressively to force the sources to clear up these conflicts. Reporters do not want to have to make their own judgments. They want to attribute their "facts" to others. The media will want news conferences to be held often, even if nothing new has happened and the official spokesman has no comment to make. This was certainly true of reporters covering a hostage taking in Oak Lake Manitoba in 1978:

> When the police had something to give out, the staff spokesman would come to the hotel, the media would gather around, the TV lights would go on, and the spokesman would issue his usual 'no comment'. Many of these news conferences which led to the 'no comment' remarks were held because the media wanted some regular contact with the police...Sometimes the police officer would say he saw no purpose in holding a news briefing, but the media indicated they preferred to have a 'no comment' session to no session at all....[Scanlon, Taylor, and Tait, 1978, p. 258].

The demand for conformity even leads some agencies to insist material not be used unless it comes from more than one source. A truly exclusive story would, therefore, be suspect.

> One of the persistent journalistic myths is that newspapers like to be 'first'....Few things could be farther from the fact....Nothing causes more alarm...than an unexpected, unasked for expose, or a story...that goes contrary to the prevailing conventional wisdom...[Worthington, 1971, p. 68].

11. This overall structure of news will not prevent various national media from shaping the story to suit particular needs.

While this nationalistic style--a story is reported as having a Canadian, United States, Japanese or British angle--has been observed it has not been well documented. It is certainly clear that reporters will focus on their own nationals. It is far less clear how much shaping of the news takes place to satisfy local news norms. Blatchford describes Canadian coverage of an earthquake in Italy.

> An awful lot of it was just trying to make people in Canada feel as though they were there--particularly Metro Italians remember the name of their village or picture their village again--how it was then and how it is now [Blatchford, 1981].

12. The location of an event will help determine its overall news significance.

Since news judgments are to some extent tied to the western and substantially caucasian characteristics of the main news agencies, it is hard to get documentation on this point. But it is clear news is to some extent tied to a story being seen as affecting "people like us".

> Italy is easier to cover than Guatemala and more reporters are immediately available. But it is mainly because Italians are seen as individuals with physical and cultural characteristics familiar to Americans. Many editors and readers have been to Italy and they recognize place names....Guatemalans are seen, on the other hand, only as faceless residents of the underdeveloped world. The standard is part of the unwritten but well-understood sliding scale: a hundred Pakistanis going off a mountain in a bus make less of a story than three Englishmen drowning in the Thames. [Rosenblum, 1979, p. 124].

News values are not determined by physical distance alone. Such perceptions are based on a number of other factors in addition to physical proximity, particularly cultural and linguistic similarity.

13. The media will persuade people to act in such a way as to conform to news norms.

In a major strike situation in Canada, virtually every visiting television news crew insisted on filming pickets carrying the appropriate signs, etc. The fact was the company almost completely shut down and formal picketing was virtually non-existent. The media could not visualize a strike without pickets; so the pickets. The same sort of thing was reported at Three Mile Island: "TV crews asked people to move indoors so they could show deserted streets" [Volkman, 1979, p. 80].

14. The media will have trouble dealing with technical matters.

As the model suggests, most correspondents go from crisis to crisis. This means they are generalists rather than specialists. It also means they are easily in trouble when stories deal with technical matters. Jim Panyard, a veteran Philadelphia Bulletin correspondent, said sources at Three Mile Island seemed to speak in a foreign language:

> You asked them a straight question about how much radiation is escaping and they answered with mumbo-jumbo about millirems, manrems, rads and picocuries. Once you had figured out what they were saying you discovered another source was saying something different--and without a nuclear physics degree, you couldn't come up with the right follow-up question.... [Sandman and Paden, 1979, pp. 44-45].

15. The various media--radio, television, and print--will act differently.

Each medium has its own news needs and its own technical and logistical problems. This will lead to differences in style. Television, for example, may have particular problems in shipping and/or sateliting film and/or videotape. Radio and print reporters have more concerns about the telephone. Print reporters, because print consumes far more news (there is more "space") than radio or television, tend to search for more background, more off-beat material. This has been expanded in Scanlon, Taylor, and Tait [1978, p. 9].

16. Despite these differences the foreign press tend to support each other and often antagonize local media.

Since the foreign correspondents travel from crisis to crisis, story to story, they are to some extent a group of associates, even if formally rivals. They are therefore likely to try to impose their own standards on an event and to support each other in demands that information be provided to satisfy their perception of what is important. This can easily lead them into conflict with local media, especially if officials are somewhat awe-stricken by the apparent importance of some visiting journalists [Scanlon, observations].

17. The media will make demands on communications, transportation and other local resources.

The arrival--during a crisis--of a group of persons who want to be able to move about, who want to communicate what they have seen and filmed, who want to talk to persons means that strains will inevitably occur on local transportation, communication and, perhaps, interpretation facilities. In situations where damage resulting from an earthquake or other natural disaster has caused a breakdown in the local communication and transportation systems, the media will create even greater problems. In the extreme case, their demands may completely tie up any surviving transportation and communication facilities. As a result, officials and agencies may find themselves responding to the needs of the visiting journalists instead of the needs of the affected population.

18. The media will operate in cycles focusing on news highs then searching for less dramatic material to fill in less spectacular periods.

Reporters [illegible]gned to major news events--particularly if they have been sent to the scene at some considerable expense--are expected to produce news. If there is no major news on any given day they must find something to write about. Thus a failure by the authorities to produce "news" means reporters will search for something to replace it. [Scanlon, Taylor, and Tait, 1978, p. 7]. The idea of what is news can be very quickly distorted. Sometimes this search will include a search for someone to blame. In man-made events, there may be an attempt to blame someone for the event. In natural disasters, the focus will be on blame for perceived inadequacy of response. Given a dearth of other information, the media can always locate someone who will have complaints.

19. In a truly major incident almost all reporters will share what they have.

Tom Wicker reports that in the wake of the Kennedy assassination there was a great deal of sharing:

> Throughout the day, every reporter on the scene seemed to do his best to help everyone else. Information came in only in bits and pieces. Every man who picked up a bit or a piece passed it on. I know no one who held anything out [Wicker, 1966, p. 28].

The same process occured at Three Mile Island:

> From the moment the Harrisburg press corps heard about the accident...we all shared information. We got drawings and pieced together events....We went out and got books on nuclear energy and compared them and discussed how a reactor works [Sandman and Paden, 1975, p. 16].

Despite these accounts, there is some evidence (obtained through interviews)that sometimes sharing does not take place. This may be especially true where reporters are employed by the same organization but work for different elements in that organization, say news and public affairs in television. They will have highly competitive instincts. (Reporters from newspapers in different countries are really not in competition with each other and thus can afford to co-operate.) In some instances, co-operation will exist in the field, but competition will begin as soon as reporters begin to phone in their stories [Tuchman, 1978, p. 77].

20. The media--whatever techniques they use to obtain information--will not publish it if they decide it could be harmful.

The media may sometimes even use discretion and block accounts that would be useful if reported. This decision-making process--what should be reported--seems to go on both in criminal type events and in disasters. According to Rodney Kueneman, the withholding of such information could be dangerous:

> The withholding of information of potential natural disasters can result in the loss of life or increased property damage...faced with the problem of crying wolf, community officials occasionally refrain from warning of a possible flood so as not to generate panic and when the warning is finally given, too little time remains to move or protect property. [Kueneman and Wright, 1975, p. 16].

Despite this potential danger, Kueneman says the media continue to withhold information from the public.

21. The media will also co-coperate with official requests that certain information be withheld.

Co-operation of this sort will continue so long as all media outlets honor the request. But if any one outlet should break the agreement, the others would follow suit. Lawrence Freiman makes this point in his autobiography:

> I called my friends in the press...to a man, they agreed to co-operate...after about a week...the Toronto Telegram broke the story. The Ottawa press could hold their silence no longer. And our lives became a circus of inquisitive reporters and determined photographers [Freiman, 1978, p. 105].

Put all this together and the result is a scenario as follows:

> An incident occurs in a particular country. Correspondents are rushed in from major news centers. Though they represent different media, these journalists know each other, have shared common experiences, have common news norms. They are generally unfamiliar with local customs, conditions, language. They will, very quickly, try to force definition of the incident in their news terms--how many dead, how many injured, how many homeless, cost. They will also strain the local transportation, communication and interpretation resources. They may demand official briefings and get into conflict with the local press. Yet, despite their common background they will interpret events from their own cultural and nationalistic

> perspective. And if the news ebbs and flows they will fill in the gaps by digging out less spectacular stories, perhaps even creating some.

Where do we go from here?

This model is not yet complete. For one thing, it needs to be filled in with information on the pre-disaster situation. This would include both warnings of impending events and mitigation reports. This model also obviously needs field testing at a number of future incidents. In the meantime, however, an examination can continue of existing material and interviews can be conducted with other journalists. News agencies can test the model against their own experience, and agencies and governments can decide whether the model suggests a need for a re-examination of their contingency plans for media relations. They can plan their response because they know how the media will act.

There is one further point. While this model is presented as a crisis model of media behavior there is no reason to assume it would not be applicable under less dramatic circumstances. If the media do as suggested operate with a great deal of predictability this crisis model may be equally applicable in normal times. It may be a model of general media behavior in the coverage of unexpected events rather than a specific crisis-oriented model. As Ruth Leeds Love suggests, the behavior of the media in a crisis situation may not be all that different from the norm.

> ...Business was as usual in that the news department was covering a story via film, live telecasting and commentary. Business was as usual in that virtually everyone carried out his normal duties. There was virtually no pinch-hitting. Business was as usual in that the news division had a bank of accumulated experience to guide its responses....Finally, business was as usual in that the norms and values of the news profession were in force more or less in the same way as they are at any other time [Love, 1965, p. 77].

She was describing U.S. TV network coverage of the Kennedy assassination.

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SECTION IX

EMERGENCY MANAGEMENT TO MITIGATE IMPACT

MODELS OF EMERGENCY PLANNING:

CONTRIBUTIONS FROM THE SOCIAL SCIENCES

Russell R. Dynes

Introduction

In modern societies, there is increasing attention given to planning for emergencies. Emergencies, simply defined, are those events which cannot be dealt with by ordinary measures or routines. Some types of events, which occur with frequency, such as fires or accidents, do evoke the development of types of social structure within community systems to deal with such "emergencies" in a routine manner. This institutionalization of day-to-day emergencies generally has narrowed the role of emergency planning to those types of events which are periodic, rather than routine, and which are community extensive, rather than institutionally focused. The prototype for most emergency planning, then, would be such events as earthquakes, hurricanes, floods, etc., which affect total community systems. While such events have a relatively low frequency, they often have the potentiality for extensive community disruption.

Emergency planning usually has focused on four interrelated phases-organized along a time continuum. The first phase, mitigation, generally refers to any activity which would eliminate or reduce the probability of occurrence of an emergency event. Such examples would be the development and implementation of building standards or land use practices which might forestall future structural damage. The next stage, generally termed preparedness, focuses on planning activities which would minimize disaster damage and which would make an emergency response more effective and efficient. Examples might be the development of monitoring systems which can be channeled into warning systems to provide emergency information on appropriate behavior to avoid injury. It also might involve the development of training emergency workers and the establishment of stockpiles of materials and equipment. In general, the activity is oriented to assisting organizations and individuals to respond to the consequences of certain disaster agents. The third stage, generally termed emergency response is designed to provide assistance for types of disaster casualties, e.g., search and rescue, emergency shelter, etc.: to reduce the possibilities of secondary damage, e.g., shutting down equipment which might produce further damage, providing security measures to inhibit access to dangerous areas; and to provide measures which would speed up recovery measures, e.g., damage assessment. The fourth stage, recovery, centers on those activities which continue beyond the emergency phase and move toward the reestablishment of the community system. Some of these activities are short-term ones, such as reestablishing vital community systems, such as utilities, transportation

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systems, food distribution systems, etc., to minimum operating levels. It would also include such activities as debris clearance and temporary shelter. There is, of course, a longer term recovery phase to stablilize all systems at normal or improved operating levels. This can involve, of course, extensive city planning, changes in land use, as well as changes in traditional notions of financing such developments. Recovery can also include the development of new mitigation measures. In many ways the process is circular.

The potential contributions of the social sciences to emergency planning can be suggested along the following lines:

1. The notion of emergency is basically a social science concept, since it refers to a disruption of a social system, rather than to physical and material damage.
2. The planning process itself is social.
3. The notion of mitigation measures involves some idea about a future, and organizing behavior in reference to that future. These are complex cultural notions, rather than universal human assumptions.
4. The notion of preparedness involves ideas of risk, value and appropriate anticipatory behavior.
5. The notion of emergency response is predicated on the social system as the primary responding unit.
6. The notion of recovery is predicated on reestablishing some form of balance between the demands made and the capabilities of the social system to deal with these demands over time.

In effect, then, the whole notion of emergency planning, although usually oriented toward abrupt changes in the physical environment, is based on actions and activities in the social environment--the proper focus for research and knowledge drawn from the social sciences.

The Dominant Model Currently Utilized in Emergency Planning

The intent here is not to detail the contributions to knowledge which are already incorporated in current emergency planning nor is the intent to develop a research agenda for "needed" knowledge. Instead I would like, first, to identify what I see as the dominant model used for emergency planning and, second, to critique that model on the basis of the assumptions that model makes about individual and social units in various types of "emergencies". This model is most evident in the two middle phases of emergency planning--preparedness and emergency response, although its assumptions also permeate, in certain ways, the mitigation and recovery phase.

On the basis of examining many different disaster plans and from discussion with a number of persons involved in disaster planning, I would characterize the dominant normative mode for planning as the "command and control" model.[1] That the descriptive terminology bears some resemblance to military usage is not surprising since many of the assumptions undergirding emergency planning had wartime and national security roots. Many emergency planners have had previous military experience and much of the planning occurs in organizations with para-military structures.

In general, this command and control model is based on the assumption that emergencies create a severe disruption in social life which lowers the effectiveness of individual behavior and that reduces the capacities of social systems. Given that basic assumption, planning efforts center on the development of mechanisms to control widespread maladaptive behavior and on the creation of ad hoc structures to replace "natural" structures. Planning efforts also are directed toward the creation of strong authority to overcome the disintegrating effects created by the disaster agent. Hence, the characterization here in terms of "command and control".

In general, planning under this model is oriented toward creating new norms for individuals marking out appropriate emergency actions. For example, "spontaneous" evacuation is often seen as inappropriate, or as manifesting a "failure of will" on the part of "disorganized" individuals but "real" evacuation is something to be ordered by authorities who are capable of making rational decisions for others. Planning also makes extensive provisions for mass care of populations based on the assumption not only that resources will be depleted but also that individuals and other units, such as families, would be incapable of coping or remedying such situations. Thus, new structures are needed to replace the old ones which will be demoralized or ineffective. Planning is also preoccupied with the development of a centralized communication and information system which can evaluate information and thus create "official" and, thus, correct messages. Such messages then are to be communicated only through correct and official channels. Decision making for the collective good is designed to be centralized and then such decisions communicated to induce the compliance of the affected populations.

The planning efforts seem to be oriented around creating an "artificial" and authoritarian structure to replace "natural" behavior and structure since these "natural" units are incapable of functioning effectively in the stress conditions which are created by the disaster event. In effect, plans are created and people are assumed to fit into such plans as parts of the rational "clockwork".

An Alternative Model for Planning

It is perhaps more effective to present a critique of the "command and control" model in the context of presenting an alternative model, called here the "emergent human resources model". That critique and the logic behind the alternative model will be based on the existing research tradition which has examined reactions to and adaptations to a wide variety of crisis events. That research tradition, which has been developed primarily, but not exclusively in the United States, suggests that the behavioral assumptions for the command and control mode are inadequate.[2] It further asserts that the planning effort should be based on existing behavior and structures (that is, pre impact) as the primary base for planning. In effect, it suggests that, instead of adapting people to plans, it should adapt plans to people.

The alternative model suggests that a much more appropriate set of assumptions would be that there is no severe and dramatic break in the continuity of behavior and social structure. Thus, the rationale in planning would be to utilize that "existing" base and to capitalize on these emergent qualities in the emergency, rather than to create an "artificial" set of norms and structures. This idea of the "continuity" and persistence of behavior and structure is evidenced in the following ways.

1. Rather than experiencing emergencies as a distinct break in "experience", there is a widespread tendency to normalize threat to define situations as normal and to continue habitual patterns of behavior.

2. Rather than exhibiting irrational and abnormal manifestations of behavior, individuals exhibit traditional role behavior--maintaining occupational and familial obligations. Irrational and anti-social behaviors do not, in aggregate, increase and, in fact, probably decrease.

3. Traditional social structures, such as families, maintain their viability and can be utilized to assume additional emergency responsibilities. For example, there is good evidence that almost all search and rescue activity is done by kin and neighborhood groups. In addition, there is evidence that "warning" messages are mediated through traditional social structures, rather than through impersonal media. There is evidence that kin and neighborhood groups provide "mass shelter" for the vast majority of affected populations and thus mass shelter is useful for only a small segment of the population.

4. Rational social structures, such as community organizations, maintain their viability and can be utilized to assume additional emergency responsibilities. For example, almost all emergency medical care is carried out in traditional health care institutions. Health care offered by "first-aid" stations or by hastily constructed emergency facilities tend to be ignored and rejected.

5. The way that people define the situation and determine appropriate behaviors require heightening, rather than restricting, communicating. The command and control model places great faith on "correct" information, officially decreed. What are officially defined as rumors to be controlled are in effect part of the definitional process. Messages and channels of communications need to be increased rather than restricted.

6. Rather than seeing self-initiated helping action as disruptive because such actions were not "planned for", it is more appropriate to see planned action as supplemental to such self-initiation.

7. Rather than attempting to centralize authority, it is more appropriate to structure a coordination model. The fact that emergencies have implications for many different segments of social life, each with their own pre-existing patterns of authority, and each with the necessity for simultaneous action and autonomous decision making, indicates it is impossible to create a centralized authority system. In addition, it is probably not necessary. The centralization of authority is usually predicated on the image of disintegration of social life. The evidence of viability of behavior and the adaptability of traditional structures suggest that authority is more of a problem in the minds of planners than a problem of life under emergency conditions. Planning should focus on the development of communication and coordination rather than on the creation of authority.

Specific Planning Implications from the Alternative Model

The basic assumption in the emergent human resources model is that the local social system provides the logical and viable base for emergency action, rather than assuming the necessity for the local social system to be held together by strengthened centralized control. Given that basic assumption, there are certain derivative implications for the direction of emergency planning. These would include the following:

1. Utilize existing habit patterns as the basis for emergency action. Knowledge of the patterns of social life and their routines is essential in facilitating planning. For example, in making plans for evacuation, it is best to utilize usual patterns, e.g., school bus routes, or usual transportation patterns, e.g., easily designated and usually traveled routes.

2. Utilize existing social units, rather than create new *ad hoc* ones. If families are the major point of resource allocation within the community, utilize that system. This is a particular problem in Western disaster assistance to Third World countries. Western notions of equity are often embodied in individualistic terms and in bureaucratic forms. That form may be appropriate in the Western world and thus consistent with the principle outlined above but, in other societies, different social forms may be the appropriate locus for emergency action.

3. If outside resources are needed, they should be consistent with local socio-cultural practices. This is perhaps a variant of the previous idea and could be illustrated by the importation of new building materials to replace damaged structures which require a technological base not present within the community.

4. Utilize the existing authority structure, rather than create new ones. The speed with which decisions are made can be more easily increased by the use of a traditional structure than by creating a new structure. The establishment of authority, which involves not only power but the acceptance of that power, takes time, and it is not reversed easily or quickly. It is better for outsiders to supplement local leadership than to assume locals are incompetent and incapable, or that outsiders are wise and competent.

5. Utilize existing channels of communication, and increase them, rather than restrict and narrow them to "official messages". Information about potential risk, potential threat and potential preventative action are not disorganizing, but the lack of information, in the quest for certainty, may be. Any effective emergency plan is based on the autonomous and independent decision of many to take appropriate action. These actions are more effective when communication is enhanced, rather than restricted.

6. The aim of any emergency planning is to move back to "normal" as quickly as possible. This means the reestablishment of commerce; the reopening of schools; the reinstitution of usual community patterns. Inconvenience is more easily adapted to than absence. And the therapeutic process, both for individuals and communities, is enhanced by the reestablishment of habitual actions.

7. The recovery stage should not be seen as the opportunity for massive (and directed) social change. Nor should possible mitigation opportunities during the recovery be implemented so as to alter drastically the traditional social structure of the community. This does not imply that there are no opportunities for mitigation during the recovery period but it does suggest that they be approached with humility rather than enthusiasm. Mitigation efforts can be effective if adapted to local community practices.

Summary

Emergency planning is a characteristic activity in modern societies to deal with infrequent but disruptive events, such as earthquakes. Such planning focuses on certain phases along a time continuum--mitigation, preparedness, response and recovery. It is suggested that since emergency usually implies disruption of social systems that research in the social sciences would provide one major knowledge base for emergency planning.

The predominant model currently used in emergency planning was identified and characterized as the "command and control" model. That model is based on certain assumptions about the response of individuals and social systems to emergency which imply such responses are maladaptive. Social science research on behavior in crises suggest that evidence for those maladaptive responses is lacking.

An alternative model, the emergent human resources model, is presented as a more realistic basis for planning. That model is based on the idea of the importance of the continuity of behavior, both individually and organizationally, from pre-emergency into the emergency period. A number of specfic implications for planning were indicated based on that model.

FOOTNOTES

1. The analysis of some of those plans can be found in Dynes and Quarantelli, [1979], and Dynes et al., [1979]. For a more general view of disaster planning, see Dynes, Quarantelli and Kreps, [1972].

2. Some of this research background can be found in Dynes, [1975], Quarantelli, [1978], Dynes and Quarantelli, [1977], Baker and Chapman, [1962], and Barton, [1969].

   I am fully aware that much of the work has been based on American society and that certain features of this analysis might be modified by particular cultural differences. See, for example, McLuckie, [1977]. On the other hand, most of the argument here rests on a general principle of the continuity of behavior and on certain common structural effects in emergencies. See Dynes, [1975].

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IN THE SPIRIT OF WILLIAM JAMES:

REFLECTIONS ON LEAGUE OF RED CROSS SOCIETIES EXPERIENCE

OF EARTHQUAKES

Enso V. Bighinatti

Conferences such as this often find it useful to have a symbolic standard-bearer, some pioneer in the field. Let me suggest William James, the American philosopher-psychologist who always stressed the need to see experience for what it was, and to keep on learning from it--also the man who lived through the April 18, 1906 earthquake that devastated San Francisco, California, and who reacted to it by studying the reactions of disaster victims.

James was a visiting professor at Stanford Univeristy in Palo Alto, California, about fifty miles south of San Francisco, at the time of the earthquake. He was awakened at about five in the morning by an ear-splitting noise and the trembling of the earth: as he lay in his bed with the world roaring and shaking all around him, he felt--he wrote in a letter soon after the event, and then in an essay first published in a magazine for boys and finally reprinted in his book, Memories and Studies--as if something had picked up his house and was shaking it "as a terrier shakes a rat". James recorded his deep awe at the overwhelming power that had suddenly been let loose, and his feeling of frightened exhilaration: "Go it!" he said he wanted to yell, "and go it stronger!"

In spite of the serious heart condition that was to kill him two years later, this man of genius who must certainly stand as one of the finest scientific observers of all time, decided to go see for himself what effect the earthquake had had on the people of San Francisco. James managed to get on the only train up to San Francisco on the day of the disaster, and to return on the only one coming back the same evening.

He spent the day walking through a city just devastated, his sensitive eyes watching the often stunned but seldom panicky reactions of those whose lives had been thrown into disorder. He saw the huddling-together of people whose common bond is that they have lived through a catastrophe, watched them as they immediately set about rebuilding their lives, even while the city was still in flames. He did not leave us his observations of the primitive disaster relief operation that began almost at once, or attempt to follow up his own observations by starting a long-term study on the psychological aftereffects of the earthquake. All that would come later, in eras of greater sophistication.

Between the lines of what James wrote about his experiences, the reader can pick up his sense of pioneering. There was little precedent for a visit by a trained scientific observer to the scene of a disaster--so little precedent, in fact, that in the early stages it fell to such disaster relief organizations as the League of Red Cross Societies to serve as the instrument for gathering and evaluating a great deal of the information we now possess about the social and economic aspects of earthquakes. Though in the half century since its foundation the League has conducted relief operations following many kinds of disaster, earthquakes have always played an important part in its work. In just the last six years, sixteen of the League's most prolonged and expensive actions have been launched in response to severely destructive tremors in Afghanistan, Algeria, the Azores, China, Greece, Guatemala, Indonesia, Iran, Italy, the Philippines, Romania, Turkey and Yugoslavia. As you well know, some of these countries have been struck more than once by earthquakes during the last six years. Moreover, as one of the first organizations to urge advance planning for the quickest and most effective response to the disasters we hope will never come, the League has learned a great deal about mitigating the impact of earthquakes.

In what follows, I want to offer some apparent constants that the League has been able to distill from a half century of disaster relief experience; I am setting these remarks forward in the spirit of William James, not as final truths, but simply as the best we have been able to do so far.

A word about the League role in any disaster will be helpful in setting the stage. The League of Red Cross Societies is the umbrella organization for the world's national Red Cross and Red Crescent Societies--126 of them at present. As their description implies, these Societies operate on a national level, each responsible for providing services within its country's borders. When disaster strikes, a Society may conclude that it lacks resources and must appeal for them outside its own national boundaries; that Society then asks the League for support, and we coordinate the influx of money, supplies and expert personnel from other national Societies--and, on occasion, from other governmental and non-governmental organizations as well. The League always works through its national Society members, always from the inside out, rather than from the outside in.

The primary disaster relief responsibility lies with the national government of an affected country. Often, however, the Red Cross can begin disaster relief action before anyone else--a point that holds as true of the League as of its members. Such speed is possible because the Red Cross/Red Crescent movement has endeavored to achieve administrative streamlining, and because it can operate without reference to politics or ideology.

Generally the League's disaster relief role is confined to the emergency period following a disaster. This role is geared to supporting its member Societies as they work to meet immediate emergency needs--often assisted, as I mentioned earlier, by support from other agencies. As the emergency phase comes to an end, the League usually phases out its operation.

This quick summary needs two major qualifications. First, there is a growing trend toward League involvement in the post-emergency recovery phase. For example, the League coordinated rebuilding of Red Cross of Yugoslavia physical facilities in certain areas following the 1979 earthquake there, and after the 1976 Guatemala earthquake assisted in providing new homes for victims most in need. Second, as pointed out earlier, the League was among the first to urge pre-planning, and its involvement is this field is expanding very rapidly.

Its general involvement with disaster situations has enabled the League to sort out certain features that are peculiar to post-earthquake situations, or at least more prominent in them. William James, you will remember, felt that he was undergoing a very special experience. Others have felt the same: earthquakes have so special a power to move and impress that they have almost developed a mystique, and their occurrence provokes great outpourings of public generosity. Unfortunately, this generosity often leads to pressure on contributing countries to send more aid than is needed or, just as often, inappropriate aid. This kind of response creates problems--if nothing else, it blatantly fails to respect the sovereignty of the affected country and the authority of national officials in charge of the overall relief action. In addition, existing channels become clogged with unneeded and--as we will see in more detail shortly--sometimes even harmful assistance or material.

The solution to this difficulty, I want to stress, is not to set up yet another agency to do the coordinating. Given the many organizations already at work, and the difficulties many of them have in surviving under present economic conditions, nothing would be gained by creating another one unless we have some imperative reason to do so. The solution, rather, is to work for more effective coordination and cooperation among the agencies now working in the disaster relief field.

The dramatic quality of earthquakes also--all too frequently--provokes a criticism that people with disaster relief experience find strange and unfair. With the attention of every television viewer, radio listener and newspaper reader riveted on an earthquake area within hours after the first major tremor, the same public that is moved to massive response is also moved to impatience. We often hear criticism because there is confusion at the scene and because, with communication out or curtailed, it is neither quick nor easy to find out the full extent of the damage, the casualties, or even the exact extent of the affected area. Although such criticism is probably inevitable in the excitement of the moment, it rests on the mistake of confusing an event with its effects. The dead, the stunned and confused survivors, the lack of communication, the disruption of public utilities, the shortage of food and medical supplies--all those things and more combined <u>are</u> the disaster. It is only a convenient ellipsis to say that an earthquake is a disaster--in strict accuracy, the earthquake causes the disaster. Praise or blame should be given out to relief organizations on the basis of speed and effectiveness with which a relief operation is instrumental in helping <u>restore</u> order.

Another special feature associated with earthquakes is the relative shortness of the emergency period immediately following the event. It is perhaps for this reason that after most earthquakes, existing medical facilities can usually cope with the increased demand, though they may need additional supplies.

Also, as William James noticed in San Francisco, there is not much panic in the aftermath of an earthquake. What there is--and James was surely among the first scientifically trained observers to draw attention to this fact--is psychological shock. The sooner a victim shakes this effect off, the better for his or her long-range psychological health. Therefore, it is extremely important to involve the victims in their own recovery efforts, and aid is patterned accordingly.

More problems lie here than are at first obvious. The donor in an industrialized nation wanting to send assistance will often send what he himself would want to receive. It does not strike most people that supplies appropriate to say, a Yugoslavian earthquake victim, might be unappealing or even religiously forbidden from the viewpoint of a victim in Afghanistan. Worse, some forms of food and medical aid create long-range expectation that cannot be sustained, or that will eventually require resources unavailable to a given population. In the most extreme cases, the wrong aid can do more damage to economic and social patterns than the disaster itself. Every effort should be made to make prospective donors aware of these problems, and the League has tried to do its share in heightening government, agency and general public awareness; but the problem persists, and may well persist for a long, long time.

While I am far from having said everything about emergency aid and post-emergency phase recovery that could be said, limited space obliges me to move on to a concluding word about planning to mitigate the impact of seismic incidents when they do occur. The most useful point I think I can make is to stress the importance of accessible scientific knowledge. Neither the League nor anyone else can plan well unless they have a good idea of what they are planning for. Some factors--for example, the need for well-stocked, accessible supply depots, and a network of trained volunteers--obviously remain constant, but other elements require specific technical advice. In the case of earthquakes, someone with an idea of fault patterns can forecast probable damage and need--and this is only one example of dealing with perhaps the only remaining natural disaster of any frequency that we still do not know how to predict accurately.

Too often, the scientific community does not do enough to bring understandable information to the attention of the administrator and field worker who will do the work of planning. An article, buried in a hard-to-find journal, given a title that modestly conceals its true significance for planning, and couched in technical jargon, can be of no help toward alleviation of suffering. Information should be made available in a form useful to those who have the disaster planning responsibilities, and made available as soon as possible. You will recall that William James did not contribute his impressions of San Francisco to an academic journal: he wrote them out for a boys' magazine, to make what he had learned accessible to a very large audience at an age when curiosity and willingness to learn are at a very high pitch.

It would be appropriate to mention at this point that as part of its general pre-planning work, the League is now conducting a study to determine whether an international convention is needed to protect the rights of natural disaster victims--victims of conflict are already protected under the Geneva Conventions and their protocols.

I want to end up with the observation that most of these brief reflections will strike people as elementary if not obvious. Some of the lessons we have learned are so elementary that it has taken decades to learn them well, and others are so obvious they can hardly be repeated too often. The insights I have reported rest on the observations of disaster relief workers who have dealt over the years with problems of victims in countless earthquakes; these insights were formulated in the spirit of the same William James who once said that in writing a long and difficult book he had "forged every sentence in the teeth of irreducible and stubborn facts".

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DISASTERS EPIDEMIOLOGY. AN EPIDEMIOLOGIST'S VIEW OF HEALTH MANAGEMENT IN DISASTERS

Michel F. Lechat

When I received the invitation to participate in this "Third International Conference on the Social and Economic Aspects of Earthquakes and Planning to Mitigate Their Impacts," two points struck me right away:

(1) There was no health section. Economics there was, and sociology, and urban and regional planning, and science, public administration, and miscellaneous, but not health.
(2) As the only medical man invited, I was included among the Sociologists! Indeed!

Still, earthquakes, like other natural disasters, do constitute a major health problem. They may kill hundreds or hundreds of thousands of people. They injure large numbers--many more than any other type of natural disasters. They leave countless numbers maimed. They destroy medical facilities, often in countries with scarce resources where such destruction can mean the loss of decades of hardwon progress.

What is more, earthquakes trigger a huge medically-oriented response from the community, both in the affected country and in so-called donor countries. Medical teams and unprepared volunteers of all kinds rush to the ruins. Blood, drugs and jumble are shipped overnight. And the radio vibrates with accounts of death and destruction interspersed with discussions about the finer points of plate tectonics.

All this is authentic, of course, and gives a true picture of the problem; that is of death, destitution and untended injuries.

As a medical man, now an honorary sociologist, I would risk a few comments:

(1) the reaction to the purely medical needs in case of natural disasters in general, and earthquakes in particular, has often been remarkably ill-judged. Let me emphasize that I do not mean to generalize to all disasters--some of them have been remarkably well managed from a medical point of view. The statement should also be qualified since definite progress has been made over the last decade or so. But often in the past, and still too commonly today, the reaction has been inappropriate.

Stereotypes have been the basis of action: that doctors are the main need--which is not true; that field hospitals are required--which arrive too late to be of any use; that any kind of supply will do, provided it has a medical connection--which is wrong.

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More important and worse, the whole context of health care in disasters has too often been viewed as a purely immediate post-disaster acute phase problem, being dissociated from its whole context of prevention and predisaster preparedness on one side and the long term effects and rehabilitation on the other.

(2) the health aspects of disasters have for a long time been serenely ignored by public health officials. One has only to look at the specialized literature of the past twenty years to be convinced of this. So, the health problem has been tackled by various other organizations such as the Red Cross. There is no doubt that such organizations with a tradition of dedication and immunity from political involvement have performed remarkably well. But the fact is that, with relative lack of interest from the medical profession, various myths have been intentionally or unintentionally perpetuated. This is related partly to the fact that these organizations had to rely on enlisting public support to allow them to carry out their humanitarian activities.

(3) the health management of disasters based on a "take each crisis as it comes" approach has been amazingly short-sighted. As soon as the acute phase of the disaster is over, interest seems to wane. After a few weeks or months, medical teams go home, medical aid (appropriate or not) is withdrawn, field hospitals are eventually left to stay as a memorial to past benificence and testimony to present incompetence.

(4) the health aspects of disasters have generally been over-emphasized as compared to other health problems currently afflicting disaster-struck countries. A couple of years ago, at a seminar in Turkey, I stated that, taking one year with another, earthquakes do no kill more people than snake bites. This, I am afraid, later proved to be a cruel joke taking what happened in Managua, Friuli, Tengshan, Montenegro, El Asnam, Guatemala and Southern Italy.

However, attending a meeting of the local association of Public Health in Guatemala City a few months after the February 1976 earthquake, I got some strong reaction from the audience for merely mentioning earthquakes as a health problem. What the Hell, I was told, is twenty thousand mostly unpreventable deaths from an unpreditable cause! What about the tens of thousands of infants dying each year from treatable malnutrition and preventable infectious diseases. In the total health context of the country, the audience was fundamentally correct, of course. Deaths and casualties from natural disasters should not be singled out. They must be viewed in proper perspective.

The approach to the management of health problems in disasters has changed considerably over the last decade. There has been a growing realization, both in the health professions and among those whom I shall call the disaster managers, that natural disasters can be viewed as an epidemiological problem, as amenable to study by appropriate epidemiological methods as any other health problem.

Let us remind ourselves what epidemiology is. Contrary to what is written in the Oxford Dictionary, it is not merely the study of epidemics. It encompasses all health problems at the population level: chronic degenerative diseases such as cardiovascular ailments and cancer, transmissible diseases such as leprosy, influenza and cholera, mental diseases, accidents, suicide, violence, malnutrition, are part of it. Disasters, including natural disasters are accidents at the community level. It is amazing that it took such a long time to realize that they were an ideal ground for the epidemiological approach. The epidemiologist seeks the answer to the questions: what, how many, who, when, where, and under what circumstances?

He has the following aims:

(1) To Define the Problem and Measure its Extent.
This can be given various names: community diagnosis, or definition of priorities. How many were injured and what types of injuries were they? Related decisions will bear on the kind and amount of resources needed for assistance: personnel, drugs, supplies, medical facilities.

(2) To Identify Risk Factors.
What kills or injures people? How are casualties caused? This requires an analysis of the effects as correlated to their supposed determinants, either behavioral or environmental. This relates to prevention. Is this or that type of house associated with higher mortality or special types of fractures. Are some patterns of flight from the disaster leading to higher mortality or on the contrary, to better survival. Such factors could then be dealt with, for example by adapting building techniques.

(3) To Define Vulnerable Population Groups.
Who dies and who is injured? Are they the children, or urban dwellers, or passers-by? The objective is not very different from the previous one, but it aims at directing the preventive measures to the groups most likely to benefit from them. An example is the study of age-specific death rates in earthquakes, which shows the special vulnerability of 5-9 year old children because they are mistakenly thought by their parents to be able to look after themselves. Educative measures for better preparedness are mostly based on this type of study.

(4) To Design Strategies.
When the health problems have been defined, what is then the best way to control them? Should we vaccinate prior to epidemics or keep the population under some kind of makeshift supervision to spot any unexpected increase in the frequency of diseases?

(5) To Evaluate Control Measures.
What is the record of performance of control measures including external assistance, both for effectiveness and efficiency in preventing or reducing the health problem, from death to long-term changes in disease patterns? For example, to what extent does high level sophisticated medical care or just plain slightly improved care jeopardize future development by creating levels of expectation which cannot be fulfilled and thus engendering counterproductive frustrations. Or more simply, for instance, does some kind of otherwise highly valuable nutritional aid induce a deficit in vitamin A, becoming responsible for large numbers of children subsequently going blind?

Disaster epidemiology seeks to achieve in the field of health what the sociologist has done regarding the psychosocial aspects of disasters.

I shall just mention the so-called "disaster syndrome", because it has directly stimulated the interest of epidemiologists. The observation made by social scientists that a large majority of the survivors of earthquakes are soon busy extricating victims from the ruins, if not efficiently, at least in an effective way, has led to the present concept that the health management of disasters is part and parcel of primary health care. Responsibility for effective rescue and relief rests first with the community involved. So its population must be given appropriate health education and its health workers must be trained to meet this need.

This view is corroborated by the few and still meagre studies of the effectiveness of external medical assistance. Patterns of health needs in populations surviving disasters and the time distribution of referral for health care, point definitely to the conclusion that field hospitals and supplies arrive too late to efficiently meet most of the demand. The same can be said of medical personnel, with its emphasis on highly skilled specialists while the need in fact is most often for unspecialized multipurpose health personnel.

A number of interesting epidemiological data have been collected in recent natural disasters. I shall quote only two examples. The ratio of the number of deaths to the type of building material employed has for a long time incriminated the concrete slabs on reinforced adobe walls as a major lethal factor in earthquakes, especially in Iran, in Turkey and in Central America. In Guatemala, the distribution of bone fractures has shown a large incidence of fractures of the clavicle associated with collapse of buildings with this type of construction. When it occurs, this type of fracture needs to be attended to in a special though unsophisticated way. Immediate attention is needed, not by specialized physicians, but by trained personnel using simple material not usually included in relief supplies.

The other example refers to the ravages of several communicable diseases with glamorous names, and the urge to indiscriminate vaccination. Just let an earthquake happen and in we go randomly shooting vaccines in all directions. Mass immunization has replaced the incantations to patron saints of yesteryear. Indiscriminate vaccination diverts resources which could be better used in other ways. It may be totally inefficient and can present definite risks when performed under strained conditions. Many studies are being conducted at present on the risk of a number of communicable diseases as related to disasters. In many cases the main requirement for control is the setting up of an adequate system of epidemiological surveillance.

The collection of epidemiological data in disaster-prone countries, both before (or between) disasters, and after the impact, is therefore essential, on the model of what has been done by the social scientists. It is now realized that collection of information, both on the spot immediately after the disasters and later, to measure long-term health consequences, is as important a component of the health management of disasters as relief and rescue. It is a necessary condition to make rescue and relief effective and also to prepare for the next disaster so that mistakes will not be repeated.

Capacity for epidemiological assessment is not developed overnight, however. It requires preparation, and the development of adequate methods, with adapted sampling techniques and relevant epidemiological indices.

Efforts along these lines are at present made by the World Health Organization and international agencies in cooperation with universities. A first international course on these two matters (WHO Course on Health Aspects and Relief Management of Natural Disasters) for senior health officials from some 25 countries was conducted in our University Department at the University of Louvain in Brussels in October 1980 under the sponsorship of WHO. Disaster epidemiology is also a field of choice for TCDC (Technical Cooperation between Developing Countries).

The health management of disasters has thus definitely moved beyond rescue and short-term relief, to encompass the whole disaster process, from predisaster planning and preparedness to long-term rehabilitation.

It should be pointed out that while natural disasters have major and dramatic consequences in the field of health, being major causes of death, casualties and permanent disability, they are far from being exclusively a health problem. Disasters, in fact are non-health problems with heavy health implications. Hence the complex interaction between their various aspects.

To be effective, the planning of health care in natural disasters must be closely associated with planning in other fields. There is still much to do to ensure proper communication between health and other disciplines in order to achieve better disaster management.

SECTION X

POST-DISASTER RESPONSE

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SOCIAL AND ECONOMIC ASPECTS IN THE MITIGATION OF EARTHQUAKE DISASTERS

Harun Alrasjid

It is a well-known fact that Indonesia is located along the equator and bordered by two continents, to wit Asia and Australia, as well as by two oceans, the Indian and the Pacific Ocean.

Indonesia is an archipelagoan country, consisting of approximately 14,000 islands and a population of approximately 147,500,000 people, the largest part whereof, approximately 92,000,000 people are located in Java with an area of approximately 130,000 square kilometers with an average population density of 700 people per square kilometer.

Indonesia itself is located on three earthquake-belts. The first earthquake-belt is known as the Alpide or Tethys mountain-system, stretching from the Asian mainland southward, west of the island of Sumatra, and subsequently turning east, south of the island of Java, towards the Moluccoan Archipelago.

The second earthquake-belt is the Pacific Circumbelt, constituting a part of East Asiatic System, stretching from the islands of Japan all the way down south through the Philippines, the northern part of Celebes and the Molucca islands. The third belt is the Australian Circumbelt, constituting a part of the East Asiatic System, going from the New Zealand islands through Australia and the Province of Irian Java.

Under these circumstances, Indonesia is subjected to an extremely high degree of seismic activities, with an average annual earthquake incidence rate of 350, where 4 to 10 earthquakes are of considerably formidable magnitudes. Relative to earthquake-mitigation and preparedness activities in Indonesia a number of seismic stations have been established, the combined capacity whereof is still inadequate however for the need of monitoring earthquakes occuring all over Indonesia, whether they be of a tectonic nature as the earthquakes that have been mentioned, above, of a volcanic nature, caused by volcanic activities or caused by landslides occuring on land as well as at sea. One hundred twenty seven volcanoes exist in Indonesia of which 70 are still considerably active. Consequently, Indonesia is subjected to a considerably high earthquake incidence-rate of volcanic nature.

In its endeavor to mitigate the sufferings of earthquake victims, whether the earthquakes are of a tectonic or volcanic nature or caused by landslides, the Government has realized the following measures:

1. Mechanisms for the mitigation of natural disaster have been created at all levels, from the Central level down to the grassroots level, to wit:

a. At the Central level - a National Natural Disasters Mitigation Coordinating Agency has been established chaired by the Minister Coordinator of People's Welfare, seconded by three other Ministers as Deputy Chairmen, namely: the Minister of Social Affairs, the Minister of Home Affairs, and the Minister of Public Works; with a membership of 21, consisting of representatives of all departments involved in disaster mitigation, the Search and Rescue Agency, the Indonesian Red Cross, etc. etc.

b. At the Province level. Provincial coordinating agencies under the name of Natural Disasters Mitigation Coordinating Units have been established, chaired by the Governor in the case, with a representative of the Armed Forces as Deputy Chairman and with a membership consisting of representatives of all agencies bearing a relation to all disaster mitigating activities.

c. With similar patterns in the organizational structure of disaster mitigation administering agencies at Regency- and Municipality levels as well as a further sub-ordinated level, namely the Village level.

2. The natural disaster mitigating apparatus has the function of implementing activities of a preventive as well as of a repressive nature.

   a. Preventive measures. Moving the population of natural disaster-prone areas to more secure sites through local settlement activities, wherein more secure sites in the vicinity of disaster-prone sites are selected as new settlement sites, or through transmigration activities wherein the population in the case is moved to either other areas or to other islands. Especially in the transmigration program the people are given agricultural sites that already have been prepared to be planted immediately, dwellings, as well as complementary elements of the social, educational, health, roadwork infrastructure, etc. etc.

   b. Relief and recovery assistance. Relief and recovery assistance covers in sequential order the following phases:

      1. Search and rescue activities to help the victims of earthquakes and other disasters, located in remote areas that are difficult to reach by conventional means of transportation.
      2. The first aid phase, wherein aid is given to the victims of disasters by the dissemination of food, clothing, shelter, medicines, hospitalization, sanitation, etc. etc.

   c. The phase of rehabilitation. This phase covers the following activities:

      1. Aid for demolished or wrecked dwellings;
      2. Aid for demolished or wrecked agricultural plant and equipment;
      3. Aid for houses of worship, such as mosques, churches, temples, etc. etc.
      4. Aid for the economic infrastructure such as shops, market places, etc. etc.
      5. Aid for the rehabilitation of public utilities such as the road network, the irrigation network, drinking water facilities, bridges, etc. etc.
      6. The rehabilitation of Government buildings such as hospitals, schools, office buildings, Government employee housing, etc. etc.
      7. Intensification of labor-intensive activities by the provision of funds for financing people to repair their agricultural equipment and strutures, irrigation systems, village roads, etc.

3. The phase of developmental assistance. As a follow-up to rehabilitative assistance developmental activities are initiated in the rehabilitated areas, such as:
   a. The construction of new roads;
   b. The construction of market places;
   c. The provision of credit assistance for economic ventures;
   d. The dissemination of agricultural packets;
   e. The expansion and multiplication of educational, social and cultural facilities, the provision of means of transportation and means of production, special seeds and seedlings, etc. etc.

4. Assistance to preventive activities. The Government has given priority to people located in areas that are chronically subjected to natural disasters, such as earthquakes, for transmigration to other secure areas within or outside of the island of Java with no limits imposed on the numbers of people that are to be transmigrated.

   Prior to their transmigration the candidates are given occupational training to equip them with skills of trade and capabilities so that in their new settlement they will be in the position to develop in the socio-cultural as well as in the economic sense.

   This system of transmigration is known as the village removal system, wherein entire village populations are transmigrated as complete communities, even including their communal equipment in the field of performing arts and other cultural fields.

   In such cases the Government even provides assistance by distributing equipment to practice their respective branch of arts, sports equipment, and equipment for the practice of worship and religion.

   The transmigration policy of the Government as implemented by the Department of Manpower and Transmigration and aimed at moving people from over-populated areas in Java and Bali with an annual target of moving 500,000 people has reserved an allotment specifically for victims of natural disasters. In addition, the Department of Social Affairs, either solitarily or in cooperation with the Department of Manpower and Transmigration, is carrying out its own transmigration program, especially for the resettlement of the population of areas that are chronically afflicted by earthquakes.

   Similarly, other departments of government such as the Department of Agriculture and more specifically the Directorate General of Forestry, in relation to the granting of forest exploitation concessions, are obligated to provide new settlement sites for people who have to be moved to new settlements.

5. Assistance for Relief and Recovery.
   a. SAR assistance, the time and duration whereof are unspecified and adjusted to the existing needs;
   b. First aid consisting of rice and secondary food supplies, as well as sanitation, medicines, health maintenance, cooking utensils distribution according to circumstance and existing needs;

c. Rehabilitative assistance, the provision of dwellings that are ready to be occupied, agricultural plots of approximately 3 ha. each, prepared for immediate planting and agricultural equipment, food supplies for a duration of 18 months, as well as assistance to overcome other needs.
d. Assistance for development activities, usually included in the budget allocation of the respective Departments.

RESCUE OPERATIONS AFTER AN EARTHQUAKE

Polde Štukelj

Carrying out rescue operations after an earthquake is a complicated and demanding task. Because rescue must be accomplished quickly, all countries in which destructive earthquakes are likely to occur must have advance preparations for rescue operations. All elements, organizations, and public services that can help in any possible way, must be prepared to do so. They must know which tasks to perform and in what ways to perform them, and they must also have the necessary assets, supplies, and equipment needed for performing the anticipated rescuing tasks.

Rescue operations after an earthquake in Yugoslavia are the responsibility of the organization called "civilna zaščita"--civil defense; this organization also undertakes rescue efforts in the case of all other natural disasters and destruction caused by war. The operations are, as a rule, directed from civil defense headquarters. These headquarters also conduct the rescuing tasks after an earthquake in which they direct the operations of all the organizations, bodies, and services involved the process.

The civil defense headquarters are operative professional bodies consisting of professionals for all the tasks that civil defense must perform in all emergencies. Each particular headquarter has a commander in chief, commanding officer, and members of the headquarter--all professionals, qualified for the specific activities of civil defense. Thus each such headquarter has a professional for first aid and treatment of the injured, a professional for extinguishing fire, a professional for rescuing people from the ruins of buildings, a professional for veterinary first aid, a professional for building shelters, for radiological-biological-chemical protection, and others.

Civil protection headquarters are organized within the working organizations, communes, local communities as the smallest socio-political communities, in towns with a number of communes, and in the republic.

Each headquarter directs the rescue operations after an earthquake within its territory. In order for the work to proceed smoothly and effectively, all the headquarters have detailed plans for rescue actions after an earthquake. These plans specify all the rescuing tasks to be performed and indicate the individuals responsible for performing them. Accordingly, these plans provide specific instructions for rescuing from ruins, taking care of the injured, taking care of the population left without homes, and all the other tasks to be performed by civil defense.

The headquarters are responsible for the performance of their tasks to the assemblies of their socio-political communities or to their self-managing bodies and their executive bodies. In turn, assemblies of socio-political communities, communes, towns, and republics and their executive bodies and self-managing bodies offer assistance to the headquarters in every possible way, so that they can effectively direct the rescuing activities. In that way the headquarters are given all possible assistance by the highest representative and self-managing bodies in their communities. These self-managing bodies bear the full responsibility to society for efficient action.

Cooperating in the rescue activities are all the inhabitants of the earthquake stricken territory that remain uninjured, units of civil defense, fire brigades, the Red Cross, working organizations in construction, health services, veterinary medicine, and public utilities. Aid to afflicted regions is a form of socialist solidarity with people who have been stricken by a great disaster, and it is also a responsibility which has been imposed by law. Cooperating also in rescue operations are units of the Yugoslav People's Army.

First aid after an earthquake has to be given to people who have been injured or wounded, buried beneath ruins, or left without homes or the basic necessities for living. This is why rescuing people buried under ruins, first aid and medical care of the injured, and temporary accommodation and material maintenance of the afflicted population are the primary rescuing tasks. The performance of other tasks has to be coordinated accordingly, in order that the most rapid most effective rescue effort possible can be achieved.

Rescuing from the Ruins

People who are not deeply buried under ruins and are within easy access can be rescued by neighbors or other nearby inhabitants not injured in the earthquake. These people can also give first aid, if necessary. Experience has shown that up to 70 percent of those buried under ruins have been rescued in this way.

It is clear that people must therefore be properly trained and qualified. It is also very important that they know how to act in the case of an earthquake and after it, so that they will not themselves become victims and that they will be able to help inhabitants who have been afflicted as effectively and as quickly as possible. People who have been informed in these matters are less liable to panic, and their actions will be more deliberate and effective than would otherwise be the case. In Yugoslavia elementary and secondary school students are instructed how to act in cases of natural disasters and wars. Similar instruction is organized for the adult population and is compulsory for the population in general.

People buried deep under ruins to whom access is difficult are rescued by technical civil defense units. This is performed primarily by rescue specialists. Units must be adequately qualified and equipped. They are directed by building technicians and engineers very familiar with the construction of buildings, types of ruins, building materials, and hazardousness of ruins. In this manner they can in each particular case choose the most suitable way of access to those buried under the ruins and the best way of rescuing them. Construction organizations help in cases where people buried under ruins are still alive and only when their techniques do not threaten to cause further destruction of buildings, and they help to remove ruins from streets and other communication lines.

The injured are given first aid while they are being rescued. If possible, this is done on the spot, if not, later, after the injured have been rescued.

Although rescue from deep under ruins is most often very complicated and calls for appropriate caution, it must all the same be peformed very quickly. People beneath ruins do not hold out long, especially if they are injured or crushed under the ruins. Most uninjured people hold out for two days, a few pople can endure up to four days, and only extremely psychologically and physically strong individuals can hold out longer.

Because rescue must be accomplished as quickly as possible, it is necessary to start with demolished buildings under which it is certain people are buried. Of course it is necessary to find out approximately where these people are. Detecting this can be done in different ways:

by inquiring among inhabitants of neighboring buildings who know the circumstances in the demolished buildings;

by calling to people beneath the ruins. This calling is done by frequent consecutive beating at regular intervals on conduits or other parts of buildings which easily transmit sound (water pipes and conductors of heat or concrete structural elements). After each beating we must listen for any response by pressing our ears against the same part of the building;

by listening with the help of geophones (devices which enable us to perceive very weak sounds coming from the ruins). Geophones are part of the equipment which civil defense technical rescue units always carry with them;

by searching for people beneath the ruins with the help of dogs specially trained for this purpose. The organization concerned with training dogs in the republic of Slovenia is the Mountain Rescuing Organization which trains dogs to be used to rescue people from under snow avalanches. These dogs are also trained to search for people who have been buried beneath ruins.

Treatment of the Injured

The number of injured in the case of severe earthquakes is very high. For that reason the health services in the afflicted territory--though widely spread--cannot take care of them all in the quickest way possible. First aid, which must be given on the spot where the wounded and injured are,is thus given by nearby uninjured inhabitants and by first aid units, civil defense units, and Red Cross units.

The inhabitants usually are not sufficiently qualified to give first aid in cases of severe injuries or wounds and can only offer first aid to the less severely injured and wounded people. For bandaging of wounds the material that is kept in houses or cars is used. According to regulations each car must have an ample quantity of different bandaging materials in a place well in sight.

The more severely wounded and injured people are treated by the units mentioned above. First aid civil defense units and other civil defense units are organized in all communities where people live and work, hence, in all places, all working organizations and collectives, and in each commune, where larger specialized units operate. The Red Cross has more specialized first aid units only in communes with larger centers. In other communes there are only Red Cross parties. Each first aid party, whether a civil defense or a Red Cross party, is fully equipped with all necessary material, stretchers for the injured and blankets.

As soon as a wounded individual has been treated by the party, he is taken to an ambulance dispensary or medical station, if it is nearby, otherwise special stations for general medical aid are formed. These stations are formed by medical organizations from the afflicted and non-afflicted regions. Each station has a physican and a medical assistant and other personnel. The station can operate in tents or, in case of good weather, outdoors. The medical organizations have all the necessary equipment for forming such stations. One station for general medical aid is formed for each ten first aid parties. If the station is too far to take the wounded, they are brought together first and then taken to the station by a motor vehicle.

At the station a physician treats the injured, if necessary, and at the same time classifies them according to the degree of the injury into three groups: the most severely wounded in urgent need of surgical aid, those who must be sent to a hospital, and the less severely wounded and injured who are sent into family treatment.

The severely wounded, requiring urgent surgical aid, are sent from the station for general medical aid or from the medical ambulance dispensary to the surgical station. The surgical stations are, like the stations for general medical aid, temporary medical institutions operating only for as long as the circumstances require. They are formed by hospitals which also have all the necessary equipment for them. For each three stations for general medical aid one surgical station is organized. Surgical stations should best be located under big tents. Here they are safe either in case of bad weather or in case of another earthquake. After the injured have been given emergency surgical aid, they are sent to a hospital.

Where earthquakes have demolished many structures, they have also demolished hospitals. Numerous aftershocks following the first demolishing earthquake further handicap working in damaged hospitals. The shocks disturb the injured and impede the work of the medical personnel. For this reason, survivors have to be evacuated to hospitals outside the afflicted area. If these are already full, new temporary hospitals have to be set up. Temporary hospitals can work under tents, weather permitting, otherwise they must be placed in adequate tourist facilities outside the afflicted territory. For transportation of the injured, ambulances, cars, and other vehicles such as vans, trucks, buses, and helicopters are used.

Providing for the Afflicted Inhabitants

After a devastating earthquake many inhabitants are left without homes, because their houses have either been demolished or so badly damaged that living in them is no longer safe. Inhabitants who have lost their homes have also lost all the other basic necessities for living: clothing and footwear, bedding, food, means for preparing food, etc.

The inhabitants themselves cannot judge which damaged buildings are not suitable for habitation because they are all potentially unsafe. To avoid further victims from subsequent shocks, parties of building professionals must examine as quickly as possible all damaged buildings and determine which buildings must be vacated.

As quickly as possible new temporary dwellings must be arranged for all the inhabitants without homes. Experience has shown that it is best to locate temporary dwelling places for afflicted inhabitants in the vicinity of their former houses. If this done, the inhabitants can help with reconstruction of the settlements, they can work in the fields, or continue their professional work, whatever it is, as soon as circumstances allow. This kind of solution is at the same time cheaper than, for instance, moving inhabitants to tourist resorts and placing them in hotels and motels.

To arrange temporary habitation facilities, tents, vans, caravans, trailers, railway coaches, buses, and the like are used.

Tents are the quickest to put up, but they are not suitable in winter and they also give poor shelter against rain and wind. Therefore, they must be replaced as quickly as possible. Large tents can be used for common purposes such as storing goods, kitchens, classrooms, and the like. In past earthquakes tents were used as accommodations for inhabitants only for a short time. They were usually sent to the afflicted area by camping organizations, trade union organizations, and the Yugoslav People's Army units.

Building sheds should be considered only when other solutions are not possible or adequate; it takes a lot of time and is also rather expensive.

In earthquakes that occurred in the the last ten years, afflicted inhabitants were temporarily accommodated in caravans or trailers. The majority of these had been lent by trade union organizations, but a number of them had been sent as a form of aid to the afflicted territories by other republics, and a certain number was bought by the afflicted republic.

Special attention must be given to areas where water supply systems have been damaged. Damaged water pipes must be repaired as quickly as possible. Until that is done, water must be brought in tanks.

Supply of food to the afflicted territory likewise requires adequate attention. Food must be brought as quickly as possible. Food can be temporarily prepared in field kitchens even when this solution is appropriate only for a short period of time. Field kitchens are set up by the Yugoslav People's Army units, civil defense units, and Red Cross units. In the meantime, arrangement of special necessary kitchens and dining facilities can be carried out. However, major attention should be directed at the same time to creating conditions in which families can prepare their own food, such as is possible, for instance, if they live in caravans.

Red Cross organizations are very important for providing inhabitants with clothing and bedding. Every year the Red Cross organizes regular collections. These actions are very succesful and, after careful survey and sorting, the collected clothing and bedding is sent to storehouses that the Red Cross maintains in numerous communes. The material collected in this way covers the most urgent needs which arise in the case of an earthquake, and serves until aid from the other republics and from the international Red Cross organization arrives. Whatever is still lacking is bought by the Red Cross or the sociopolitical community. Clothing and bedding is distributed according to need by civil defense parties for social aid with cooperation of the Red Cross and communal bodies for social security. Quickly supplying adequate warm clothing and bedding is urgent especially in case of bad weather.

Special attention must be paid to children and elderly people left without relatives. The task of the social service is to see to it that they get homes as soon as possible, either with their families, families who are willing to take them in, or in homes for elderly people. For children whose families have suffered most severely, the Red Cross organizes temporary dwellings with their families or in other convenient places, and also sees that their living together is made interesting by a variety of pleasant and useful activities.

In temporary dwellings it is very important to ensure that as soon as possible people become engaged in a variety of activities so that they can forget about the psychological stress suffered in the earthquake.

It is very important that certain necessary hygienic-epidemiologic measures are undertaken in the afflicted territory, and especially in the temporary dwellings. These must be organized so that the maintenance of personal and other hygiene is possible. Water sources must be controlled immediately after the earthquake, and they must be checked again later, especially after stronger repeated shocks. Chlorine must be added to the water to disinfect it.

The inhabitants must be vaccinated, especially in the warm seasons, against infectious diseases that are liable to erupt in the afflicted territory. It is also very important that vermin, rats, and mice be destroyed, especially in temporary settlements. All these tasks are to be performed by the medical sevice, assisted by the previously mentioned civil defense units for social work, and if necessary first aid units.

Other Urgent Tasks

In order to accomplish all these tasks, rescuing people from ruins, transporting the injured, and other tasks as quickly as possible, debris, fallen rock, and land slides must be removed from the roads. The parts of roads which have been demolished must be repaired and/or other roads constructed. These tasks are performed by road-construction and public utilities services together with construction organizations and units of the Yugoslav People's Army trained in the techniques needed for this kind of work.

In order to make living bearable in temporary dwellings and buildings which have survived, it is necessary to repair all installations that have been damaged: water pipes, sewers, electricity supply, gas pipes. These tasks are performed by competent communal organizations. In the case of a severe earthquake this work may be rather extensive, and similar professional organizations from other territories may have to send workers and technical aid, and, if necessary, also civil defense units.

Livestock in the afflicted territory must receive special attention. Wounded and injured cattle must be given first aid, while those animals for which treatment would take too long or probably not be successful must be slaughtered. First aid is given by cattle raisers and veterinary services. If necessary, veterinary professionals from other areas are called in. Where there are no slaughter houses, field slaughter houses for killing severely injured animals are organized. They are organized by civil defense units and supervised by professionals from veterinary services.

A severe earthquake destroys numerous stalls, many are damaged to the extent where they cannot be used until repaired. It is then necessary to make temporary stables using wood planks open or covered, depending on weather conditions and the time of year. This work is done by cattle raisers and, if necessary, by other workers and professionals. The material needed is supplied by wood processing industries.

The situation after an earthquake when access to damaged flats, stores, warehouses, banks, and other facilities is possible, provides temptation for all sorts of criminals. Necessary measures for safeguarding order and security must be taken and continued as long as required. Police are in charge of order and security, if necessary they are helped by teams from other regions.

Identification and burial of the dead must also be done as quickly as possible. The dead are identified by rescuing teams as soon as they are brought from beneath the ruins, either by the help of relatives or neighbors or by means of documents that have been found with the corpses. If this is not possible, identification is made by special identifying units. Such units, including experienced professionals, are organized at all medical faculties. Identifying teams are also formed within civil defense units in the communes. Thus a number of teams can be operating simultaneously in the afflicted territory. In case of severe earthquakes where there is a great number of fatalities, it is frequently not possible to perform identification in cases that call for longer identifying procedures. A number of dead may remain unidentified.

It is necessary to try to bury the dead in the place and in the way that relatives find desirable. Burial is done by appropriate communal organizations assisted by additional personnel. If the number of the dead is high, it may be necessary to use collective graves. Special machines are used to dig such graves quickly.

Inquiries about the victims and collecting of data about them are handled by communal and republican Red Cross organizations that form special teams for the purpose. These organizations give information about victims to relatives directly or through international Red Cross organizations.

Some of the rescue work must proceed continuously, day and night. This is especially important while rescuing people from ruins, giving first aid and medical treatment, arranging temporary dwellings, giving first aid to cattle, repairing communication lines, clearing streets and roads of debris, and operating civil defense headquarters. It is important to have electric light where the work is in process and in medical institutions and centers. Since the electricity supply has probably been damaged, other solutions must be found. Most medical institutions and a number of civil defense headquarters have motor generators to produce electric power and supply others. Many other working organizations also have them. Gas lamps are also quite suitable for illumination. If all that does not suffice, improvisations are necessary. Emergency conduits from power batteries to where light is needed can be installed. Ruins and other working areas can be flood-lighted temporarily by car headlights.

Motor vehicles, machines, and generators are used in rescue operations. They need a lot of oil and petrol which must be delivered in sufficient quantities. This is the task of an appointed organization regularly responsible for this section of supplies.

GUIDELINES AND PROCEDURES USED TO ELIMINATE THE IMPACT OF THE EARTHQUAKE IN THE SOČA VALLEY

Anton Ladava

The earthquakes of May 6th and 9th and later of September 11th and 15th, 1976 which struck Fruili-Venezia Guilia, Resia Valley, a region where a minority of the population is Slovene, and other places in Italy, also reached our region with destructive power. Frequent minor earthquakes throughout the summer between the two major shocks caused additional losses. A large volume of social and communal buildings, houses and industrial premises were destroyed or damaged. Fortunately, there were no fatalities.

Particularly heavy damage occured in frontier settlements such as the villages in the Breginje corner, Ladra-Smast, Kobarid and places between the villages of Žaga and Tolmin. Many of the areas most severely affected were the less developed regions of the commune, frontier areas with little economic base, where the age structure of the population is very high and from which for many years there has been high out-migration.

The earthquake affected to one degree or another all inhabited settlements in the commune of Tolmin, as ascertained and estimated by the commissions of civil-engineering professionals that inspected all settlements and buildings in the commune. Groups of civil-engineering professionals from all over Slovenia working under the direction of the Secretariat for Town Planning and Institute for Research and Testing Materials and Structures of Ljubljana determined the situation after May 6th and September 15th in 1976 as follows:

Period	Buildings to be Repaired	Buildings to be Demolished		Total
		Industrial	Housing	
May 6th	4,329	226	496	5,050
September 16th	4,467	522	1,187	6,175

The losses were high: 22% of the population in the commune was left homeless, not to mention other losses and the impact on the developent of the region. On the basis of an incomplete estimate of damage, because complete data were difficult to obtain primarily for infrastructure and some other buildings, it was ascertained that after the first earthquake, the loss amounted to 243% of annual social production and that 63% of the total housing fund was affected. Special problems existed for schools, health services, child care services, cultural and industrial buildings.

Approaches to Eliminate the Impact of Earthquake

In our political system, the role of the commune and local communities is very important, and the measures for dealing with natural hazards and disasters are the task of all working people and citizens. These tasks and responsibilities are incorporated in the work of all bodies and organizations, with the result that care for human beings is the continuous focus of our work and includes both social property and resources in citizens' ownership. The better the bodies and organizations are prepared to act in the event of natural disasters, the more efficiently the work will be carried out. The functioning of the local community and commune should be understood in the context of other republic or federal bodies, which jointly operate in carrying out required measures. My contribution is intended to show execution of measures taken in the commune and local community and I shall not discuss other bodies.

Immediately after the earthquake on May 6th, 1976 the members of socio-political activities in the commune met and began work. First, jointly with professional staff at the disposal of the commune, we organized inspection of villages and buildings to gather basic data. At the same time that the inspection parties were out in the region, we prepared organizational and other measures which had to be undertaken that day, so action could proceed in a coordinated and effective way.

On the morning of May 7th, the representatives of republic bodies, Yugoslav National Army, bodies of internal affairs and others visited Tolmin to offer us assistance, advise us, coordinate action and to undertake jointly measures which are urgently required when natural disasters occur. The management of action for ascertaining and eliminating the impact of the earthquake was assumed by the socio-political leaders in the commune, and each body executed its tasks, which were required by the conditions and general situation in the commune.

Prior to the earthquake, in the region of Tolmin commune and throughout the whole area affected by the earthquake, civil defense had been organized in accordance with the scheme and doctrine of national defense and social self-protection. Civil defense, in our social system, is the principal form of organizing, preparing and engaging the cooperation of citizens, working people and all other bodies, organizations, and communities in defending and rescuing inhabitants and material goods from acts of war and the effects of natural disasters and other large scale hazards and disasters. In the area of the commune of Tolmin civil defense headquarters and units had been formed, in addition citizens and working people had been trained to take measures for self-protection and self-assistance. Specialized organizations of associated labor (communal, health service, etc.), social organizations and societies were linked with the system of civil defense. Accordingly, before the earthquake, civil defense was organized in local communities, organizations of associated labor and communes.

In the afternoon of May 7th we dealt with the report of the situation and conditions in individual local communities (to the extent it was possible to ascertain during the morning inspection).

It was found that:

- the headquarters of civil defense in the most affected local communitities had been activated;
- citizens in the local communities were taking steps to find possibilities for setting up shelters and adopting measures for protecting property.

The following tasks were adopted:

1. Civil defense headquarters must be activated in all local communities. A group of workers was formed that immediately visited all local communitities for the purpose of assisting and advising the civil defense headquarters so their work would be efficient and directed at the most urgent problems in the local community.

2. Permanent on duty service was brought into the communes and local communities.

3. Commissions for accepting aid were initiated to transact aid to local communities:
   - commission for receiving and distribution of caravans, tents and other material,
   - commission for catering,
   - commission for defense, demolition and clearing of buildings,
   - commission for inspection of all public buildings, with special attention to schools, child care facilities and buildings for public assembly,
   - commission for social matters,
   - information centers.

Later, headquarters for evaluation of losses was established to estimate the loss caused by the earthquake, and other working bodies were also appointed, which I shall discuss later.

The position was adopted that each commission must have an overview of the position in the local community. All aid and assistance was to be offered only through the bodies of the local communities so that the aid would be allocated to the most affected villages and most needy citizens. In addition to permanent connections among the management of the activities and the commissions, on the level of the commune in the local community special groups of active members were formed by the Conference of the Socialist Alliance of Working People. In that way, for each local community one active member was responsible (for larger ones, two) to assist, follow, and submit problems to the management of activities in the commune with the aim that adopted measures would be really executed in each settlement of the commune.

Monetary assistance, which was immediately arranged, was collected on special account-funds for basic disasters of the commune of Tolmin. I have not described the tasks of individual commissions, as they are apparent from the purposes for which they were appointed. Let me stress that each comission carried out its work very well, enabling us to normalize the position rapidly, if we can use that term for such conditions.

In addition to the above tasks, the following were also undertaken:

1. Social health services had to find places in homes for the elderly from the most affected areas that had no shelter.

2. All women in advanced pregnancy and all sick people had to be admitted to the general hospital "dr. Franc Derganc" in Šempeter pri Gorici.

3. Common canteens had to be organized in Breginja and Podbela.

4. An adequate number of caravans and tents had to be immediately assured through the republic civil defense headquarters, the republic Red Cross, the republic Conference of Alliance of Socialist Youth of Slovenia and Alliance of Scouts' Organizations.

Commissions for information had to follow on a current basis the impact of all actions and performances and they had to inform citizens of these matters through the means of the media. They were also responsible for giving available data to representatives of the media.

We also organized:

1. vaccination of the population in damaged settlements against infectious diseases,

2. daily checks of water supply sources and chlorination of drinking water,

3. extraordinary measures for sanitation and hygiene in all settlements, tents, other public places, and dumps,

4. lessons in all elementary and secondary schools in premises that were safe (tents),

5. permanent telephone connections with all local communities--civil defense headquarters (later on also permanent radio connections),

6. health service worked continuously in all areas with the assistance of Yugoslav National Army group,

7. groups of scouts, members of Yugoslav National Army were formed to help in setting up tents and caravans at appropriate places,

8. some services operated from temporary locations as the premises of communal assemblies had been damaged.

It is understandable that the execution of these and many other measures in the local community depended on authority of the civil defense headquarters (it was necessary to level unsafe premises). All these activities were very useful, had a calming influence on people, and prevented additional loss and possible victims. In the local community, care was taken for the needs of the citizens, social welfare services were provided, catering and other supplies were arranged, cooperation with the health service was organized, the needs of citizens for financial assistance was assessed and decisions for distribution were made, the assistance of teams clearing ruins was arranged, lists of damaged buildings were prepared, reconstruction plans were developed, reconstruction measures for socially deprived citizens were approved, the help of youth work teams was arranged, etc., participation was arranged in decisions for the distribution of flats and buildings to be constructed, the services of civil engineering teams in the location and setting up of facilitities were also provided.

The coordinating committee for personnel matters of the communal Conference of the Socialist Alliance of Working People and the commission for nomination and election of the communal assembly created a special committee, 35 members of which were nominated by the communal assembly, 29 members were nominated from organizations of associated labor, self-managing communities of interest, local communities, socio-political organizations, assembly and the executive council, and 6 members were delegated by local communities. The assembly appointed the president and vice-president of the committee.

With the decree, the committee was ordered by the assembly:

1. to determine the losses and estimate the value,
2. to adopt a comprehensive plan for reconstruction and submit it to the communal assembly for approval,
3. to adopt terms and conditions for granting loans and distributing grants,
4. to prepare a balance sheet accounting for all funds,
5. to develop priorities for the reconstruction of buildings,
6. to decide on the use of funds,
7. to develop plans and arrange for the reconstruction of damaged buildings,
8. to supervise reconstruction,
9. to report to the assembly on its progress,
10. to arrange a system for the provision of professional services.

The special committee would continue to function until the assembly establishes that all tasks have been executed, pursuant to the overall recovery plan.

Inter-communal committees were established by the communal assemblies of Tolmin, Nova Gorica and Idrija to coordinate the work for eliminating the impact of the earthquake in the whole area of the Soča Valley.

Procedures to Eliminate Impacts of the Earthquake

1. Housing

As soon as the earthquake occured, 28 groups of civil engineering professionals were appointed to inspect and evaluate all damaged buildings and classify them into categories depending on the extent of damage. The following procedure for overall recovery and construction of housing was established:

a) for the first category of damaged buildings (damages which did not affect structural elements) the owners themselves should carry out repairs. They would have acess to loans from commercial banks, according to the decree of the executive council, on terms and conditions for consumer credit, granted to persons that suffered losses in the earthquke, in individual communes of SR Slovenia;

b) for the second category of damages (involving structural damage but not requiring demolition) reconstruction would be carried out under the supervision of the civil engineering service in accordance with the plans prepared by them.

However, consumer credit was not sufficient, nor were the available funds adequate (repayment in 10 years, interest rate: 2%) to meet the carrying capacity of the citizens. Therefore, it was necessary to augment the amount by funds (repayment in 20 years, interest rate: 2%) which were pooled by housing communities in SR Slovenia.

The self-managing housing community has offered tenders of special housing loans for repair and rebuilding and new construction of housing premises which were affected by the earthquake. Within the framework of the housing community, special commissions were set up to expedite granting of loans. The representatives of local communities took active part in these commissions. In that way information was available through familiarity with each individual applicant to supplement that provided by the documents that had to be submitted.

For the housing in social property, the self-managing housing community and basic organizations of associated labour were responsible for the elimination of the impact of the earthquake. A large percent of the Slovene civil engineering profession supplemented by engineers from neighbouring republics, working with specialized groups and youth work teams, the Yugoslav National Army (construction material for 16 building sites was brought by helicopter to the mountainous regions of the commune), one-day actions of trade unions and working organizations and the efforts of the affected population made it possible to accomplish a large volume of work in a very short period, although weather conditions were bad.

The operation was carried out in such a way that civil engineering professionals would be responsible for construction in one or two local communitities, depending on the size and capacity of the work force and on the volume of the impact of the earthquake. The housing credits would have been granted in accordance with the Regulations on terms and conditions for loans and grants to citizens affected by the earthquake in the Soča Valley - communes of Tolmin, Nova Gorica, and Idrija.

Regarding the regulations, we must point out:

a) they were formally adopted by the delegational assemblies in accordance with previous discussions with citizens;

b) they provided stipulations for grants-in-aid as well as loans; and

c) eligibility criteria varied with social situation (the lower the personal income of a family the greater the eligibility for various forms of assistance).

2. Industrial buildings

The loss to the economy was of various types:

a. direct losses of buildings and equipment which varied from partial damage to total destruction and amounted to din 221,060,000;

b. losses from lack of income, since for varying periods operations were shut down completely because of damaged fixed assets as well as the absence of workers who were engaged in reconstruction;

c. losses of revenue in production, which is objective, due to:
- absence of workers, who were engaged in reconstruction of their own living premises (in some organizations this amounted at times to 80% of the workers),
- decrease of productivity and work quality from psycho-social effects on workers,
- reduction of production when emergency premises had to be used which did not permit normal conduct of work,
- lower productivity since personnel were overburdened with reconstruction and their efficiency in the direct tasks of their jobs was decreased.

Although the importance of the recovery and further development of the economy was constantly recognized our main attention was directed to the problems of the population. Economic recovery was postponed until the most urgent housing problems had been dealt with. To assure appropriate working and living conditions for the population, it was necessary to anticipate implementation of development plans for work organizations, so reconstruction results would approach the objectives of middle-range plans. Recovery represents only one aspect of economic development. Reconstruction should be carried out in such a way as to facilitate transition.

We agreed on the following principles:

a. Work organizations should develop plans which combine recovery with development, recognizing that reconstruction of obsolete technology and production processes is irrational and inappropriate.

b. Direct losses should be completely covered by pooling investment funds of all commercial banks in SR Slovenia under the following terms and conditions:

- repayment period:	10 years
- beginning of repayment:	1979
- interest rate:	5%

c. Loss of revenues due to the earthquake must be covered by work organizations from their own funds. In the case they operate at a loss because of such circumstances, coverage will be ensured in the form of grants or by taking out loans.

d. When implementing economic recovery and development programs in less developed frontier regions, the Fund of common reserves of SR Slovenia should participate to the extent of 10% of total investment value. The funds of the reserve should be given as grants to individual users, allocated according to the financial position of the individual investor on the basis of previous consideration of the request to the bank, and in agreement with communal and inter-communal committee for ascertaining and eliminating impacts of the earthquake in the Soča Valley.

e. It is necessary to execute all procedures that are required for implementing individual programs.

Work organizations developed plans and submitted them to the Bank of Nova Gorica which adopted procedures for pooling funds.

3. Infrastructure

Damage to infrastructure (roads, water-supply networks, sewerage systems, electric supply networks) was extensive. It was agreed that the management of these systems had to prepare plans for reconstruction and repair and immediately start to implement them. That was executed also.

Social Activities

To satisfy their personal and common requirements to implement common interests in the field of social activities, working people and citizens jointly with the workers of organizations of associated labor that conduct these activities, self-managing communities of interest, in which they are implementing free exchange of work, equally and on self-management basis, together decide on the execution of such activities. Through their common interests they develop a development policy and policy for pooling funds for operating and developing such activities. The workers of organizations of associated labor which conduct these activities are assured equal socio-political positions with workers in other organizations of associated labor.

On the basis of the procedures adopted for eliminating impacts of the earthquake in the field of social activities, self-managing communities of interest and organizations of associated labor from those activities assumed responsibility for eliminating impacts of the earthquake. The funds were collected through solidarity action, pooling of funds and other approved measures to restore the activities as rapidly as possible.

The losses after the May and September earthquakes were very great. First of all we assured normal operations of organizations of associated labor in health services, schools, and child care services. The activity of these services was maintained in the following way:

a) buildings which were damaged but useable were operated for schools, child care services, and health services,

b) newly set-up premises (mainly tents) were used where buildings were destroyed.

The principle was adopted that only in extraordinary cases should schools be relocated to other places. As a result, only:

- the pupils of the branch of the elementary school Žaga were transferred to Pokljuka:

- the pupils of the branch of the elementary school Breginj in Ladna-Smast were transferred to Lovran.

Socialist republics and autonomous provinces significantly participated in the construction of new educational and training buildings. Each participated in the construction of one building.

In this manner, from solidarity aid, there were constructed or completely restored:

- 5 educational-training buildings in Tolmin commune and,
- 2 educational-training buildings in Nova Gorica commune.

In the years since the earthquake, through this organized procedure, the following number of buildings has been constructed or completely restored:

- for education and training	19 new buildings 8 restorations
- health service	3 new buildings for medical care (first-aid station in Breginje)) 2 new pharmacies
- child care service:	a) in the construction of new schools, premises were provided for child care service; b) new premises for kindergarten in Kobarid and Volarje
- social-welfare service:	a new home for elderly people in Tolmin one home for elderly people in Podbrdo was reconstructed
- culture:	4 new buildings 2 restorations A vast amount of funds was invested in reconstruction of monuments damaged by the earthquake in various places
- recreation:	on the same principles, the funds were invested in reconstruction or construction of recreation halls and grounds. Gymnastics requirements were taken into account when new schools were constructed.

This procedure made possible starting restoration of buildings for social activities during the reconstruction of the housing stock. As early as 1977, but mostly in the following years we had eliminated impacts of the earthquake on those buildings.

Working Group of Socio-Political Workers

Fast and efficient communication of measures adopted assigning tasks and rights and defining duties of citizens is very important in the process of reconstruction. The Communal Conference of the Socialist Alliance of Working People involved one socio-political worker for each local community, for some even two, in order that relations among communal bodies and local communitities should become more effective. The task of these active members was to assist the bodies in local communitities in interpretation of rights and duties, informing common bodies of inadequate work, seeing how responsible bodies progressed with their work, etc. At regular meetings they reported the position of local communitities and proposed, if necessary, additional measures.

During the first months of reconstruction these active members were out in the region. They offered invaluable assistance to the bodies in the local communities after finishing their other work obligations. This provided communal bodies regular and direct connections and relations with the local community, which beside implementing tasks for reconstruction, enabled consistent procedures. A single front was formed in that way, combining all forces, all following efficient procedures.

Only so united and closely linked to the larger solidarity support of all working people and citizens of SR Slovenia, as well as of Yugoslavia, were we able to perform the work which will be remembered by later generations in Tolmin commune.

Solidarity

The catastrophe that struck the Soča Valley and with it the whole Tolminsko, was deeply felt in the hearts of the whole population of SR Slovenia and Yugoslavia. This is attested by:

- conduct of solidarity action,
- measures undertaken by the working collectives and individuals,
- continual visits of different delegations that inspected the conditions in individual settlements and reported to the bodies of self-management and on that basis adopted concrete decisions.

The knowledge that all working people and citizens of Slovenia were with us encouraged us, and we worked hard and approved tasks and in an extremely short period life returned to normal. One cannot describe the feelings of warmth, care, and solidarity that spread through our whole society and which could be implemented only in the self-managing socialist society. The solidarity is present in all approved measures. In this disaster the solidarity among working people was once again tested and will be proven whenever required. All measures undertaken are part of our solidarity which is built into the base of our socialist society, from the first day of its beginning, representing its strong cohesive power and strengthening the feeling of security of individuals and families and implementing actual division of labor, it opens perspectives of human self-managing society.

Eliminating impacts of earthquakes does not mean only construction of new housing, but also human relations towards other persons. In such a situation, one discovers rapidly who is prepared to subordinate his own problems and difficulties to common requirements and tasks. The self-confidence of people was increased through testing the actual self-managing organization of the commune and local communities, and their initiative and readiness was strengthened to solve common problems with joint powers. This cannot be put into figures. These are elements of humanity among people and generations that should have lasting validity and positive influence on the lives and perspectives of people in those places.

Conclusion

Good organization, division of labor, coordination of all elements in the commune, and close connections with bodies in the republic and other communes were pre-conditions for successful work, which in Tolmin commune gained complete importance during the recovery from the earthquake. We must again mention the steps carried out by every citizen, the special engagement of the Yugoslav National Army and bodies of internal affairs which so largely compensated for insufficient equipment. The solidarity of the whole society in moral and material ways has most happily influenced the success of action.

SOCIAL AND INSTITUTIONAL IMPACT OF THE 1980 EARTHQUAKE IN SOUTHERN ITALY: PROBLEMS AND PROSPECTS OF CIVIL PROTECTION

Ada Cavazzani

The earthquake's characteristics

The earthquake of the 23rd of November 1980 (magnitude 6.7 Richter, duration 90") devastated a highly populated area of 28,000 square kilometers, affecting 679 communities in two southern regions of Italy, Campania and Basilicata (Figure 1). The epicenter area includes 36 communities of the internal provinces of Avellino, known as Irpinia, a traditional seismic zone, Salerno and Potenza. The same area was devastated by a similar earthquake in 1694 when the same villages were destroyed.

The 1980 earthquake resulted in 3,500 deaths (official record), 10,000 wounded and 350,000 homeless. According to official estimates 20,000 dwellings were destroyed, 50,000 seriously damaged, and 30,000 lightly damaged. The estimated damage amounts to 20 billion dollars, that corresponds to 40% of the total expenditure of the special agency for the South, the "Cassa per il Mezzogiorno", over the last 30 years.

This earthquake has been recognized as the greatest national disaster in Italy since World War II, and the social disruption it has caused is much greater than it appears from the general estimates of the damage.

This paper will focus mainly on the social and institutional implications both at the local and national level.

Structural features of the area

As several studies have already confirmed, the damage from an earthquake depends more on the social organization of the area affected than on the natural characteristics of the disaster. Many of those effects that can appear in the emergency phase as direct consequences of the earthquake or of the lack of organization are on the contrary the result of the structural features of the society.

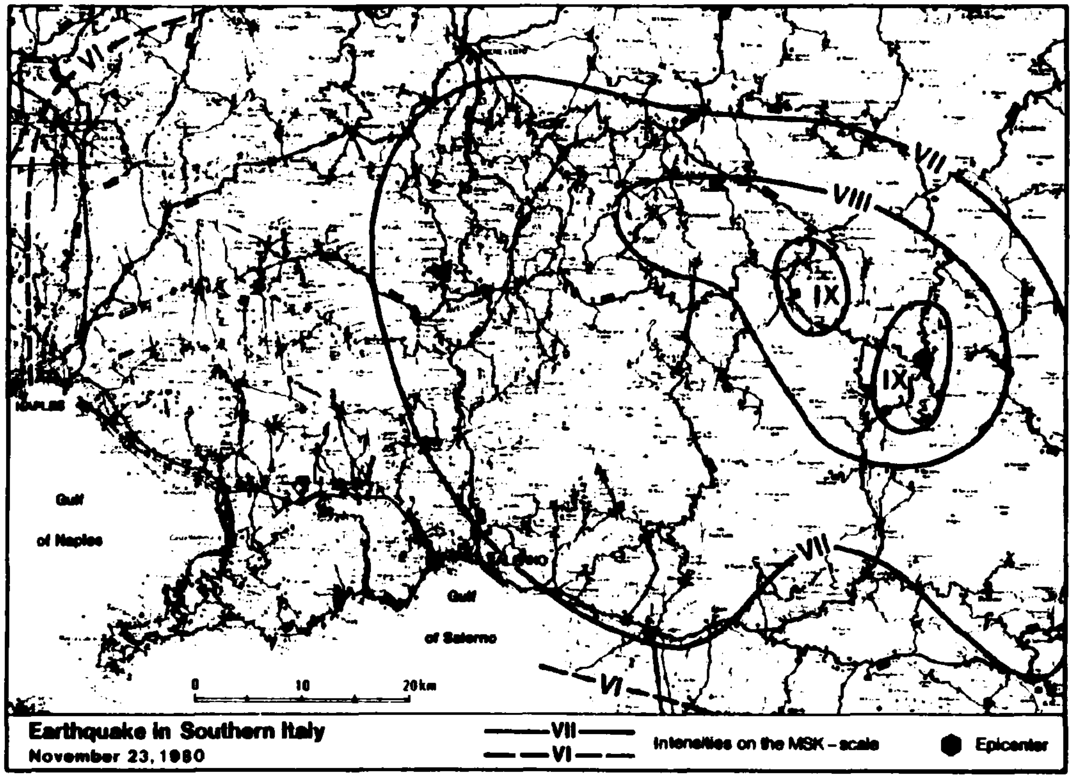

Figure 1

The Earthquake in Southern Italy
November 23, 1980

Southern Italy is usually considered as an underdeveloped region, but this image does not reflect reality. It is rather an aggregate of different "worlds", going from the extremely backward areas of the hilly and mountainous regions to the highly developed coastal zones and plains, with intermediate patterns of modernizing areas and growing urban centers.

Such an image does not result from the aggregate indicators of development usually referred to which constantly show a negative relation for the South compared with the North. The South, in fact, comprises about 40 percent of the territory of Italy and 35 percent of the total population. Yet, it accounts for only one-sixth of Italy's industrial output and has double the national rate of unemployment. The South accounts for 23.6 percent of the GNP, while the per capita GNP is one-third lower than the national average and almost half that of the northern regions (Table 1).

This is the result of a process of increasing differentiation within the South, that now has impressive islands of prosperity and growth connected with the modernization of agriculture in favorable areas and the diffusion of industry. Together with the huge industrial plants created by the special policy of the 1960's--the so-called "cathedrals in the desert"--a network of industrial development zones has grown around the urban centers as a result of the process of industrial decentralization of the 1970's. Finally, the South is characterized by the existence of a large tertiary sector that has been steadily growing as a "refuge" area, because of the lack of employment opportunities in the agricultural and industrial sectors. The tertiary activities are only marginally connected with a pattern of autonomous industrial development, but they rely mainly on the growth of public expenditures and the process of urbanization.

The role of public expenditures is crucial for explaining the particular features of the changes which occurred in the productive structure of the South, strictly controlled by a new type of ruling class, mainly bureaucratic and administrative. The huge development of the tertiary sector is practically evaluated as a social phenomenon, rather than economic. It is considered by economists as a burden sector, mainly inefficient and not apt to sustain sound development.

Some of the most striking changes that occurred in the South in the last 25 years have been the result of the massive out-migration of 5 million people, mainly young males, recruited by the industrial develoment in northern Italy and central Europe. This huge migration has left the South, mainly the internal zones, without young working forces: old people, women and children are the usual inhabitants of the southern villages. They have been able to survive by combining several sources such as the remittances from migrants, subsistence agriculture and social security. On the other side, migration has also produced return factors for the development of the South.

The first, and most visible change has occurred in the housing pattern of the villages, as one of the principal aims of the migrants has always been to provide a decent house for their families. The new houses bui't with the remittances of the migrants have practically changed the landscape of the South. Each village has a "new area", often resulting from the sum of private family enterprises governed by the principle of

Table 1

Regional Comparisons

Region	Percentage of national GNP	Per head GNP ('000 lire)	Indices (Italy= 100)	Resident population (1971 census)
Piedmont	10.3	5045	128.7	4454
Valle d'Aosta	0.3	6156	157.0	111
Lombardy	20.9	5222	133.2	8497
Trentino-Alto Adige	1.8	4709	120.1	847
Veneto	8.0	4096	104.5	4136
Friuli-Venezia Giulia	2.5	4530	115.5	1245
Liguria	4.3	5093	129.9	1868
Emilia-Romagna	8.8	4975	126.9	3853
Toscana	7.0	4309	109.9	3503
Umbria	1.3	3647	93.0	773
Marche	2.4	3820	97.4	1351
Lazio	8.8	3901	99.5	4764
Abruzzi	1.7	3042	77.6	1121
Molise	0.4	2644	67.4	300
Campania	6.2	2540	64.8	4985
Puglia	4.7	2680	68.3	3499
Basilicata	0.8	2766	70.5	560
Calabria	1.9	2082	53.1	1862
Sicily	5.7	2562	65.3	4575
Sardinia	2.2	3014	76.9	1441
Italy	100.0	3921	100.0	53745
North-Centre	76.4	4642	118.4	35402
South	23.6	2602	66.4	18343

Figures relate to GNP in 1978

__Source:__ __Financial Times Survey on Italian Regions__, July 13, 1981.

the maximum economy. The other major investment from migration has been in the sector of small commercial businesses, again resulting from private family enterprises and contributing to the enormous growth of an inefficient tertiary sector. Altogether, these changes have been supported by a particular socio-economic unit, the household, that has maintained a crucial role in the South, tightening the traditional strong ties that already were at the basis of this society.

Another massive phenomenon of social change, partly similar to out-migration, has been the steady increase of urban population and the growth of the metropolitan areas. In the last 30 years the population of the urban centers in the South has practically doubled. While the same trend has occurred in the North, connected with the industrial growth, in the South this phenomenon has been fostered by the spread of the tertiary sector, mainly characterized by small inefficient commercial and professional businesses. The diffusion of public administration activities has largely contributed to the transfer of population into the large administrative centers, typical of the southern urban structure. Nevertheless, only a minor proportion of this population has found a stable occupation, and the rate of unemployment has remained double that in the North. This unemployment is particularly difficult to bear for young people, often with higher education levels, as the school, up to the university, has been the only alternative to unemployment. The massive growth of urban centers has further increased the problems of a social structure already disrupted by severe inequalities. The lack of sound economic activities and of prospects of employment, combined with a degenerated urban structure is at the origin of the endemic social problems of the southern cities, as the case of Naples clearly shows.

Deeply rooted in the economic and social structure mentioned above is a system of political power that accounts for maintaining the South substantially "altogether". A crucial role is played by the "new" ruling class that has replaced the old agrarian block, whose source of power was the rent from land property, that ensured social peace during Fascism, but also opposed economic and social development. The new ruling class is strictly connected with the new sources of economic power in the South, resulting from the State investments in the economy and from the welfare policies. These policies have required the organization of a large bureaucratic system for the administration of public expenditures and of social security that has produced a new "social and political block", as strong as the old agrarian block and as contrary to the development of the South. Another major source of power is located in the urban areas, in the multiple interests connected with the rent of urban land and with the growth of the tertiary sector.

Altogether, this new ruling class bases its power on sources either external to the South (State) or non-productive (urban rent and marginal tertiary sector). This trend is common to all political parties that tend to govern with no autonomous initiative, except for increasing their power. Clientelism has remained the major feature of political exchange, even if the objects of transaction have changed. The capacity of the ruling class to channel public expenditures according to the rules of clientelism is seen as one of the major obstacles to an efficient use of public resources. This also explains, on the other hand, the success of maintaining concensus in the South, as any prospect of improvement is chiefly dependent on the good "relations" with those who control the distribution of resources.

Concensus and distrust characterize the relation of the people with the ruling class, reproducing the old pattern of feudal relations. As there are no other alternatives, it appears more logical to adopt a behavior coherent with the rules of the system, rather than making an effort to change them.

Impact of the earthquake in the emergency phase

In such a context, the immediate impact of the earthquake has dramatically brought to the surface the major problems of the "southern question", as well as the inefficiency of the national civil protection system. The area affected includes the largest metropolitan region in the South (Naples), other major urban centers (Salerno, Avellino, Potenza) and a vast internal area of medium-sized towns and small villages.

As in previous recent disasters the emergency phase was characterized by the tardy movement of public intervention, by the inadequate means and equipment for the rescue operations and by the absence of an effective coordination of the relief organization. It has been estimated that more than 1/3 of the victims died after several hours and days because of the lack of rescue operations.

The magnitude of the disaster was initially underestimated by the center and several days passed before the army was mobilized and transferred to the area. It was only after the visit of the President of the Republic, Pertini, to the disaster regions that the government reacted more rapidly. Pertini released a speech to the major television networks, expressing his indignation about what he had seen. As a consequence of this, the Minister of Internal Affairs, responsible for civil protection, resigned his position. His resignation was promptly rejected and only one local representative of the government, the Prefect of Avellino, was removed.

In contrast with the inefficiency of the State civil protection system, there was a massive intervention of voluntary groups, private associations, public organizations, institutional bodies, such as regions, provinces, communes, universities, trade unions. The promptness of this response often encountered various obstacles once in the damaged area; the delivery of first help supplies was delayed by the local authorities' inefficiency and by the lack of coordination. Long columns of trucks were stuck on the roads for days; others wandered around before finding someone willing to accept their help. The area was inundated with huge amounts of food commodities and clothes, piled up in stores or even abandoned along the roads.

As the local authorities were unable to cope with the extraordinary situation, a new power structure was set up by the center. A special Commissioner for the earthquake was sent by the government to Naples, the same person who had been in charge during the Friuli earthquake of 1976, Zamberletti. Generals of the army were appointed as vice-commissioners in the regions and provinces most heavily damaged with power to coordinate the operations not only of the army but also of civil intervention. This earthquake has offered an opportunity of observing the relative efficiency of the military structures, as compared with the central government. The militarization not only of the emergency phase--

as the army authorities have been appointed for six months--is the other face of the absence of an effective civil protection system in Italy.

A major role was played in the emergency phase by the mass media, which offered to all the country an immediate and realistic picture of the dramatic situation. Both the national radio and television networks and the reporters of the major newspapers made an extraordinary contribution to the diffusion of information as had never before been done in Italy. Obviously, the impact of mass media lasted only for the emergency phase and the major problems the earthquake had brought to the surface were soon neglected.

Effects at the local level and problems of reconstruction

The earthquake had various effects at the local level, related both to the magnitude of the disaster and to the characteristics of the area. On one side, the case of Naples represents an aggregate of extremely serious problems, as the earthquake has suddenly brought to the surface the endemic crisis of the city. The housing problem already critical before the earthquake, as Naples has had the highest in-migration rate in the South, cannot now be overcome by means of the old conventional policies. The large transfer of population from the old crumbling center into marginal camps on the outskirts of the city or to summer residences along the coast cannot become a permanent solution, as usually happened in previous disasters. The other major problem to solve is the increasing unemployment that after the earthquake has been strongly reconsidered as a crucial element of political action for opposition parties and new emerging groups. The situation has been recognized as extremely dangerous by the government that sent its special Commissioner Zamberletti, to Naples.

On the other hand, there are the problems of the internal areas, already impoverished by the huge migration and the lack of investments. These zones have suffered the highest human losses and entire villages have been wiped out. Hundreds of families were destroyed, mainly old people, women and children of migrants who were working abroad or in northern Italy. The reconstruction of these villages cannot simply be limited to the supply of new houses, but is firmly connected with the prospects of new employment opportunities.

At present, a conflict between multiple interests is emerging at the local level. The population's principal aim is to have a new house and this explains the refusal of the local inhabitants to leave the villages during the winter. The special evacuation plan prepared by Zamberletti for these areas has completely failed, as it was designed on a pattern that was experienced in Friuli in 1976, a completely different region.

The major concern of public authorities is to restore rapidly orderly conditions of life. This need for order has inspired all the public interventions from the center, aiming at social control. All the various groups, organizations and decentralized institutions that were acting along different lines or trying to activate local initiative were considered dangerous, often contradicted or discouraged. Special agreements were made with large bodies, such as regional governments of the Center-North, for their inclusion in a general plan of intervention, controlled by the center.

Finally, a large set of economic interests have been attracted to the area of the disaster by the huge prospects of reconstruction. This is by no means simply a technical question, but has great economic and political implications. It has been estimated that the amount of investment for reconstruction will bring into these regions 2/3 of the total annual flow of investments in the South. The past experiences of the Friuli and Belice disasters have shown that the process of reconstruction tends to reinforce the previous productive structure, and only rarely succeeds in promoting new forms of local development.

The major interests that have been immediately active in offering their "help" are medium and large firms of the building sector, principally located in the northern and central regions. They are capable of supplying highly industrialized building technologies and prefabricated structures. A study conducted in 1978 shows that 70% of the firms producing prefabricated elements and/or systems are located in the North, 16% in the Center and only 13% in the South.

In contrast with this type of interest, there stands the extremely complex network of local firms that have flourished in the last 20 years in the South in the shadow of the local political power in connection with private building enterprise and with the policy of public works. The building sector has been one of the most important areas of employment in the South. While the national average of the population active in this sector is 25.7%, the southern regions are all well above this level with peaks such as 62.2% in Calabria and 50.2% in Basilicata. Furthermore, there are the small family-firms grown upon the remittances from migrants that in the last ten years have developed low-cost techniques for private buildings. The local interests can count on the support of the local political authorities, strictly bound with them, but they cannot compete with the much greater strength of the northern groups.

These groups have been emerging in the last ten years as a result of the process of restructuring the building sector. They rely upon an advanced technological level, on a sophisticated know-how, on the control of modern industrialized techniques. Their power has already been recognized in the Friuli reconstruction, where at the end of 1980 the regional government has decided to reorganize the contracts for reconstruction, as only 1,000 interventions out of 25,000 have been completed. This reorganization has combined into 18 large projects all the interventions and only one local firm has been able to get a contract. The costs of these contracts are 15/20% higher than the average in the northern and central areas.

The conflict between the local and external groups will mark the future of these regions, where little space is left to local initiative. There have been efforts to set up new associations and cooperatives of local workers for reconstruction, but they will get only marginal opportunities. The changes that this process of reconstruction will bring about are obviously proportionate to the dimensions of the intervention.

But there are few chances that a process of local development will take place in the sense of a deep transformation of the productive structure. The existing differences will be increased and the power structure will emerge at the end even stronger. The few contradictory signs of reconstruction controlled by the local people with external support are at present only marginal exceptions.

The difficulties encountered by the large group of technical and professional experts, mainly from universities and research institutes, have greatly reduced the chances of an independent intervention. Those who have been able to remain after the emergency phase had to accept a formal submission to the organization of the special Commissioner. There has been therefore a large waste of resources, mainly engineers, architects, geologists, planners, available for a different process of reconstruction. The negative experiences of several teams that had engaged in an immediate support of local communities are frequently referred to in public conferences and debates.

Problems of the Civil Protection System

Since the earthquake the absence of a civil protection system in Italy has been officially recognized. It was suddenly discovered that the law of 1970, passed after the earthquake of 1968 in Belice, for the "Protezione Civile" was not effective because the Parliament had forgotten to approve the special regulations for its enforcement. At the same time the absolute lack of investments in scientific research applied to earthquake prevention became evident, as never before. In December 1980 one of the few groups that had been working in the last five years on this subject--the special Project "Geodinamica" of CNR--presented to the Parliament a "Relation on the Defense from Earthquakes". The dramatic state of the country was clearly illustrated in this document. Several proposals were advanced as to the up-dating of the obsolete seismic map, the regulations for new buildings and the retrofitting of existing buildings. A highly detailed program for seismic research was advanced, together with proposals for land-use planning and for the reorganization of the State services and research bodies. The Relation ended with a pessimistic note about the possibility that such measures would actually be taken by a government that traditionally represented a literary-humanistic rather than technical-scientific culture.

The lack of confidence in the scientific community is one of the most common features of the Italian political ruling class. An expert of the Special Commissioner Zamberletti recently stated during a meeting of Italian sociologists on disasters, "those who know act, those who do not know research". The implications of such a culture, at the most interested in a technical rather than scientific approach, are clearly visible in the new trend adopted by the government with reference to Civil Protection.

In February 1981 a decree of the President of the Republic established the lacking "regulations" for implementing the Law of 1970. These regulations provide instructions for the organization of a civil protection system within the Ministry of Internal Affairs, as well as special measures for intervention at the local level and rules for immediate rescue and relief operations.

The two major principles are the centralization of the system and the control of voluntary and private initiative. The paradox is that the more inefficient the State actually is, the more centralized the system becomes. An effective system of civil protection should be pivoted on the local level and supported with adequate equipment. Moreover, it should take advantage of the valuable resources of voluntary and private intervention, providing adequate coordination.

In June 1981 a second step was taken in this direction with the creation of a new "Ministry for Civil Protection" that has been given to Zamberletti, the special Commissioner in 1976 and 1980. He has been appointed because of his action capacities, that are undoubtedly greater than average.

While at the Center these have been the major effects of the recent earthquake, in the periphery there are few chances that something new will happen. The prospect of a productive integration between research activities and policy measures remains an intellectual utopia. Policy makers will continue to be guided by their short time perspective, which cannot be shared by earthquake "professionals".

New prospects of reducing seismic risk

While this is the negative state of civil defence in Italy, some new perspectives have been opened within the scientific community. The direct intervention of several universities in the area hit by the earthquake has prompted the search for special funding of research and some teams have already begun to work.

Among these, the University of Calabria, after directly intervening in the earthquake area, has developed a new multi-disciplinary project within the Center for the Study and Research on Natural Disasters. This project is specially designed for Calabria, the most seismic region in Italy, and is presented as a pre-disaster study. It results from a combined intervention of specialists working in the University, such as geologists, engineers, planners, sociologists and economists.

The principal aim of the project is to provide reliable information to the community as to measures that can be taken to reduce future seismic risk. The study will be conducted in one of the three fault areas of the region. It will imply the extension of the seismic network of the University, the introduction of new instruments for monitoring the level of bodies of water, the investigation of the state of buildings with priority given to public structures, the evaluation of land-use patterns, the appraisal of the behavior of official agencies charged with control over building standards, the study of the social and economic conditions of the area.

The research team will be connected with two national research projects of CNR, the already mentioned "Geodinamica" and the "Conservazione del Suolo", as well as with the French "Arc Calabre".

Two major problems have emerged at this stage. The first concerns the need for the researchers to change their habit of a strictly disciplinary approach and to use the tools of their discipline taking into account the contribution of the others. The initial agreement on a "common problem" will have to be constantly verified as long as the research progresses. The other question regards the relation of the research team with local communities and policy makers. Most likely the area for the study will be chosen on the basis of an active involvement of local communities. In Calabria natural disasters are quite familiar and some areas show particular elements of an "earthquake subculture".

One of the major difficulties is the lack of interest from public authorities that are as prompt in seeking the help of experts once the disaster has occurred as they are capable of forgetting it as soon as the emergency is over. Nevertheless, the need for medium and long-term studies is now clearly recognized by all those who are willing to reduce future disasters.

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SECTION XI

IMPACT OF DISASTERS ON SOCIO-ECONOMIC SYSTEMS

AN EXTENSION OF THE CONCEPT OF SPECIFIC DESTRUCTION OF EARTHQUAKES ON THE BASIS OF GROSS NATIONAL PRODUCT OF AFFECTED COUNTRIES

Vladimir Ribarič

Natural destructive earthquake hazard is defined as the probability of occurrence of a strong seismic event--mostly above the value of 5.0 on the Richter scale--in a given area and within a given period of time. This probability is expressed chiefly on the basis of seismicity, meaning that a number of seismic events within certain ranges of intensity or magnitude have occurred in a given volume of the earth within an interval of time. Seismicity parameters, seismic activity, and shakeability of a territory have been defined in many ways, and numerous results have been obtained for various regions of the world. The purpose of these definitions has been to develop measures to represent recent neotectonic activity of the region, to define potential hazard and risk at regional, local, or sub-local levels, and to provide a measure to permit making comparisons between the earthquake hazards of various regions or subregions of the world.

However, none of these definitions is able to deal with the complex picture of human loss attributed to earthquakes of a certain magnitude, intensity, or energy with material damage of various kinds, or with temporarily or permanently disabled persons. No attempt has ever been made to estimate the total damage to the landscape in the case of great catastrophic earthquakes simply because of the fact that we have not developed measures for evaluating such types of damage.

An additional concept called "specific destruction" was introduced some years ago by M. Båth [1967] and is defined as a measure of the number of human victims due to an earthquake per unit of seismic energy. In this paper an extension of this definition is developed by representing sums of human losses over a time interval of three decades in various countries versus sums of released seismic energies of events which caused these losses, compared with the gross national product of the affected countries and normalized in relation to the per capita gross national product of the United States in 1978.

The results of calculations from this new definition are suprising: the effects of earthquakes are not necessarily associated with basic seismicity or gross national product of a country alone. The

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vulnerability of a town or a region is mainly interconnected to a specific category of earthquakes which will be briefly described. A large destructive earthquake resulting in a considerable toll of human lives is not necessarily an event with a very important specific destruction, especially when introducing the economic productive capacity of the country.

There seem to exist some neurologic points in the world which contribute mainly to our new definition: densely settled regions or towns with high probability of the existence of seismic foci of considerable energy content at very shallow focal depths in a country with poor housing construction and low gross national product. Certainly, inadequate safety of buildings is correlated with low gross national product--at least to an important extent. On the other side, the natural hazard is a function of seismicity or seismic risk, if we try to extrapolate the "seismic climate" into the future.

Some Important Cases

According to data obtained from the Smithsonian Institution in the United States, natural catastrophes in the period from 1947 to 1970 have caused a death toll of 1,192,000 human lives, a number, which is comparable to casualties in a large-scale war. From this number about 190,000 human lives have been lost due to earthquakes, or on an average about 7,900 per year. Some important seismic accidents in the past decade have substantially changed these statistical figures. From May 1976 to June 1978 about 665,000 people lost their lives or about 332, 000 per year: this was due to the catastrophic earthquake in northeastern China on July 27, 1976 (655,237 victims).

A catastrophic earthquake in Peru on May 31, 1970, killed 66,794 people. Other great earthquakes in the seismic history of the earth (China, three events in years 1290, 1556, 1920, caused a loss of 1,130,000 human lives) had as a consequence a death toll which in some cases exceeds the number of victims in some past wars.

Most of these losses could be attributed to strong seismic events, but there is no direct correspondence between them. Some relatively weak events with magnitudes about 5.5 have in the past claimed hundreds of human victims, whereas some large seismic events with magnitudes over 8.0 were not associated with any death toll, for instance, if they originated in vast oceanic areas and caused no seismic sea-waves. The problem consists of how to define the susceptibility of a country to earthquakes, if we do not consider material damage and some other nonmaterial factors involved.

Basic Considerations

The concept of specific destruction does not include any economic factor, and it seems to be reasonable to provide for it in some practical way. But first, we have to define some basic facts and to explain the definition of specific destruction.

Examining the relations between I_0, the macroseismic intensity expressed in an appropriate scale, and M, the Richter magnitude (M_S, m_b or M_L), we can easily find that for most regions of the world the following expression is valid:

$$M - 0.66 \cdot I_0 = 0 \quad (1)$$

for h = 5-10 km.

This means that in regions with very poor quality of construction we could expect structural damage to begin at $I_0 = 7^0$ MSK, which further means M = 4.6 or slightly more, naturally under the condition that the hypocentral depth h is in the range from 5-10 km. The log(N) = f(M) relation which is known for many regions of the world, shows the number of earthquakes of certain magnitude intervals in terms of the distribution of their values. For Greece, for example, the relation according to Karnik [1968-1971] shows that for 50 events with magnitude 6.0 we have to expect as many as 400 seismic events of magnitude 5. This means that there is a rather high probability that earthquakes may happen which originate at shallow depths in the range of 5-10 km and have an intensity approaching 8^0 MSK, and which according to the local circumstances could have a potential to destroy buildings and to kill people.

Therefore, on the basis of the frequent recurrence rate of smaller seismic events the conclusion can be drawn that the potential hazard in this region is to be expected to be equally or even more dangerous with respect to events with M = 5.0 than M = 6.0 or more. This apparent conclusion has in fact also some physical and not only purely statistical foundation.

Defining the earthquake volume V as the size of volume which is in a state of stress and in which a simultaneous release occurs, by magnitude dependent relation:

$$\log V = 9.58 + 1.47 \cdot M \quad (2)$$

where V has to be expressed in cubic centimeters, we find that for

magnitude = 5.0 the radius of the

equivalent sphere has to be 2.7 km,

for M = 5.5, r = 4.8 km and

for M = 6.0, r = 8.4 km.

It means that for spherical shapes of foci and M = 6.0 the focal depths should exceed 8.4 km.

Of course, we could be confronted with cases where we might observe a dipole source with an ellipsoidal form of the source zone. There the minor axis of the ellipsoid could be very small, which would mean a very shallow focus and extremely pronounced seismic effects along the major axis of the ellipsoidal body, if this axis were parallel to the earth's surface.

The relation:

$$\frac{M_{max}}{h_{min}} \quad (3)$$

is in this respect very important but physically limited and yields the

Table 1

Some Results of Calculations of f
(Typical values)

Earthquake	Value of f
Agadir, Morocco (1960)	8.6
Italy (1857)	7.5
Avezzano, Italy (1915)	7.2
Skopje, Yugoslavia (1963)	7.2
Lar, Iran (1960)	7.0
Messina, Italy (1908)	6.9
Quazvin, Iran (1970)	6.8
Ambato, Ecuador (1949)	6.8
Ariano, Italy (1930)	6.6
Quetta, Pakistan (1935)	6.5

after (1)

highest specific destructions, if the earthquake originates in a densely settled area with non-resistant buildings.

The specific destruction f is by definition represented by the following equation:

$$f = \log \frac{c \cdot (N_k + 1)}{E} \quad (4)$$

The notation means: f = specific destruction,
N_k = number of human victims,
E = seismic wave energy,
M = Richter scale magnitude,
c = a constant.

Combining this with the E(M) relationship

(5) $$\log E = 12.24 + 1.44\,M$$

Table 2
Average Specific Destruction f_{av} in Seismically Active Regions of the World

Region	Number of Events Used	Average Specific Destruction f_{av}*
Mediterranean	11	6.3
Iran-Pakistan-Afghanistan	6	6.0
Central Asia	6	4.8
South America	7	4.7
Japan-Taiwan	11	4.6
India	3	4.3
New Zealand	2	3.3
North America	6	2.8

(after M. Båth)

* The standard deviation on the average is 1.0

and the condition that $f = 0$ for $N_k = 0$ and $M = 8.9$, which ensures that $f \geq 0$, we obtain the equation:

(6) $$f = \log (N_k + 1) - 1.44\,M + 12.82$$

Specific destruction f depends on many factors. Type and quality of building construction, subsoil conditions, slant distances to the focal zones, density of population, time of the day when the earthquake occurs, radiation properties of seismic waves, secondary seismic effects (sea waves - tsunamis, landslides or rockslides, inundations from dams, fires, etc.) are implicitly included in this factor. The factor of specific destruction is apt to give a good idea of which earthquakes rank as the most destructive in relation to their energy release. However, it does not account for the various categories of damage in the economic sense.

It is interesting to note that f for the above mentioned reasons is not highest on some very spectacular occasions. The Quetta, Pakistan, earthquake on May 30, 1935, with a death toll of about 30,000 human lives and M = 7.5 yields a specific destruction of only 6.49. The Peru earthquake in 1970 with N_k = 66,794 and M = 7.7 gives an f = 6.56 and the disastrous Tangshan events in China on July 27, 1976, characterized by N_k = 655,237 and M = 8.2 result "only" in an f = 6.83. On the other hand the Agadir earthquake in Morocco on February 29, 1960, yields for values of N_k = 15,000 and M = 5.8 the specific destruction f of 8.64.

An attempt to define an average specific destruction f_{av} has been made by M. Båth [1967]. Calculations of the average specific destruction f_{av} for the seismically most active regions of the world have been presented by the author. They are shown in Table 2.

Some comments are necessary on the contents of Table 2. On the basis of small sample numbers it is hardly possible to draw any conclusions about the "seismic weather" or "seismic climate" of regions. Complete data for certain regions and defined time intervals are required. However, in spite of the sometimes problematic numbers on human losses and differences in magnitudes obtained by various methods and techniques, a cumulative presentation of data for some countries and time periods seems to be justified.

Mean Cumulative Specific Destruction f_c for Selected Countries

The mean cumulative specific destruction--as it is proposed here--is defined as the sum of individual specific destructions in a given country during a time interval, expressed in decades of years. It includes all seismic events of certain magnitude classes which caused human losses in a certain country. It is defined by:

$$f_c = \frac{\sum_{1}^{n} f_i}{n} \qquad (7)$$

Where:

$\sum_{1}^{n} f_i$ = sum of specific destructions for a country during a time interval,

n = number of seismic events with human losses.

A presentation of values of specific destructions for a selected number of countries in the Mediterranean seismic belt and partly in the Transasiatic seismic belt for three decades from 1950 to 1979, as compared with figures for the United States (see Appendix 1) yields the mean values of f_c shown in Table 3.

Morrocco has had in this time period only one seismic event of considerable f, Iran with a destructive earthquake on March 21, 1977, is in the second place (f = 8.1427).

Table 3

Mean Cumulative Specific Destruction f_c, Sums of f_i and Number of Events n for Selected Countries for the Period 1950 - 1979

Country	f_c	$\sum_{i=1}^{n} f_i$	n
Greece	4.7216	42.4944	9
India	5.2168	15.6504	3
Iran	6.1026	146.4624	24
Italy	5.9934	59.9340	10
Morocco	8.6441	8.6441	1
Pakistan	5.6601	16.9803	3
Turkey	5.6568	135.7632	24
United States of America	3.9783	35.8047	9
Yugoslavia	5.4163	21.6652	4

Obviously the sums of f_i indicate a seismicity level connected with seismic vulnerability of a country. Iran and Turkey are in the first and second place. Rare events, as for instance in Morocco, contribute to mean cumulative specific destruction f_c, but they are not significant for a general long-term picture of specific destruction in the region because the sum of f_i ($i = 1...n$) is small.

Involvement of Economic Factors

The susceptibility of a country to earthquake hazard--partly included in the vulnerability definition--has been presented in a way by the mean cumulative specific destruction value f_c for the past three decades. It is obvious that f_c would not have a constant, or even an approximately constant, value over a longer period of time. It depends, as already has been said, on too many partly interdependent or independent factors, as for instance the state-of-the-art level of paraseismic construction. No attempt has been made in this paper to include damage of various kinds caused by earthquakes in our considerations.

However, the vulnerability of a country to seismic hazard on the basis of specific destruction should somehow be defined also from the economist's point of view. A long-term economic index of cumulative specific destruction f_{ce} is proposed and is referred to in this context to 3 decades of years from 1950 - 1979. It is defined as

$$(8) \qquad (f_{ce})_j = f_c \cdot \frac{GNP_0}{GNP_s} \cdot \frac{1}{d_j} = \frac{\Sigma f_i}{n} \cdot \frac{GNP_0}{GNP_s} \cdot \frac{1}{d_j}$$

The notations mean:

f_{ce} = long-term economic index of cumulative specific destruction for a country and a certain time period d_j, expressed in decades of years.

d_j = number of decades of years under consideration. For instance for $j = 3$, $d_j = 30$ years,

GNP = gross national product per capita in USA (year 1978), i.e., 9,700 US $,

GNP_s = gross national product per capita in country "s" under consideration.

The results shown in Table 4 have been obtained.

In terms of economic capability and specific destruction, f, or cumulative specific destruction, f_c, it can be clearly seen that in the past three decades India, Pakistan, and Morocco have been relatively more endangered by earthquakes--if they occur. The United States with relatively small number of seisms of this type, large territory, small f_c and high gross national product per capita is in the best position.

Normalized values in relation to $(f_{ce})_3$ = 1.00 (for USA) are presented in Table 5.

Conclusion

Sums of specific destructions, Σf_i, provide a measure of earthquake effects over the past three decades in countries compared. Mean cumulative specific destructions, f_c, provide an index for comparison in accordance with the vulnerability of a country. This index is related to

Table 4

Values of $(f_{ce})_3$ (1950 - 1979)

Country	$(f_{ce})_3$
Greece	14.00
India	289.16
Iran	27.15
Italy	14.13
Morocco	125.14
Pakistan	241.86
Turkey	45.35
USA	3.98
Yugoslavia	21.98

the economic capacity of the country by introduction of the index f_{ce}, simply because rebuilding of the damaged area could in principle mainly depend on this factor.

Table 5

Values of $(f_{ce})_3$ in Relation to
USA (in ascending order).
Time Interval 1950-1979

No.	Country	$(f_{ce})_3$
1.	USA	1.00
2.	Greece	3.52
3.	Italy	3.55
4.	Yugoslavia	5.52
5.	Iran	6.82
6.	Turkey	11.39
7.	Morocco	31.44
8.	Pakistan	60.77
9.	India	72.65

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Appendix A

List of Catastrophic Earthquakes, 1950 - 1979, in Greece, India, Iran, Italy, Morocco, Pakistan, Turkey, USA and Yugoslavia

Year	Date	Locality	Number of victims N_k	M	f
1950	AUG 15	Assam, India	1,530	8.7	3.4769
1951	AUG 13	Changra, Turkey	54	6.8	4.7684
1952	JAN 3	Eastern Turkey	62	6.0	5.9793
1952	JUL 21	Tehachapi, Kern County, USA	15	7.7	2.9361
1952	AUG 22	Bakersfield, Calif., USA	2	5.8	4.9451
1952	OCT 22	Southern Turkey	18	5.0	6.8987
1953	FEB 12	Mazandaran, Prov. Trud, Eastern Turkey	970	6.5	6.4472
1953	MAR 18	Canakkale, Balikesir, Bandirma, NW Turkey	240	7.4	4.5460
1953	AUG 12	Ionian Sea Islands, Greece	460	7.4	4.8277
1954	APR 30	Central Greece	31	6.8	4.5331
1954	DEC 21	Eureka, Calif., USA	1	6.6	3.6170
1955	FEB 18	Quetta, Pakistan	10	6.5	4.5014
1956	JUL 9	Thera, Santorin, Greece	57	7.4	3.9274
1956	JUL 21	Anjar, Cutch, Pakistan	117	6.5	5.5319
1956	OCT 31	Bastak, Prov. Laristan, SE Iran	410	6.8	5.6418
1957	APR 26	Fethiye, Turkey	23	6.3	5.1282
1957	MAY 28	Seben-Bolu, Turkey	53	7.2	4.1844
1957	JUL 2	Abegarm, Iran-Caspian coast	2,500	7.2	5.8501
1957	DEC 13	Farsinaj, Hamadan, Kermanshah, Western Iran	1,130	7.1	5.6794
1958	JUL 10	South. Alaska, Brit. Columbia Yukon Territory	5	7.8	2.3661
1958	AUG 16	Western Kermanshah, Iran	191	6.7	5.4553

Year	Date	Locality	Number of victims N_k	M	f
1959	AUG 17	West Yellowstone, Hebgen Lake, Montana, USA	28	7.1	4.0584
1959	OCT 25	Hinis, Varto, Eastern Turkey	18	6.2	5.1708
1960	FEB 29	Agadir, Morocco	15,000	5.8	8.6441
1960	APR 24	Girash, Lar-Iran	450	5.9	6.9781
1961	JUN 11	Dehkuyeh, Iran	62	6.5	5.2593
1962	AUG 21	Avellino, Ariano Irpino, Italy	16	6.1	5.2664
1962	AUG 28	Southeast of Peloponnesos, Greece	5	7.0	3.5181
1962	SEP 1	Qazvin, Danesfahan, North-western Iran	12,230	7.1	6.6835
1963	JUL 26	Skopje, Yugoslavia	1,100	6.0	7.2218
1963	SEP 2	Kashmere Valley, Pakistan border region	79	5.4	6.9471
1964	MAR 27	Prince William Sound, Anchorage, Seward, Valdez, Alaska, USA	131	8.5	2.7005
1964	OCT 6	Bursa, Balikesir, Turkey	30	6.8	4.5194
1965	APR 5	Megalopolis, Greece	18	6.2	5.1708
1965	APR 29	Puget Sound, Wash, USA	6	6.5	4.3050
1966	AUG 19	Varto, Eastern Turkey	2,520	6.9	6.2856
1967	JUL 22	Adapazari, Northwestern Anatolia, Turkey	97	7.2	4.4432
1967	JUL 26	Tunceli, Erzincan Prov., Turkey	112	5.8	6.5210
1967	NOV 30	Debar region, Yugoslavia - Albania	20	6.0	5.5022
1967	DEC 10	Koyna Nagar, India	172	6.5	5.6980
1968	JAN 15	Gibellina, Partanna, Salaparuta, Montevago, Sicily, Italy	740	6.1	6.9058
1968	FEB 19	Ayios, Efstratios, Lemnos Isl., Aegean Sea, Greece	20	6.5	4.7822

Year	Date	Locality	Number of victims N_k	M	f
1968	APR 29	Maku, Rizaiyeh, Western Iran	38	5.3	6.7791
1968	AUG 31	Khorasa, Kakhk, Dasthe Bayar, Northeastern Iran	20,000	7.4	6.4651
1968	SEP 1	Ferdows, Iran	2,000	6.7	6.4732
1969	JAN 3	Khorasan Prov., Iran	50	5.6	6.4636
1969	MAR 28	Alasehir, Western Turkey	53	6.4	5.3364
1969	OCT 26	Banja Luka, Yugoslavia	22	6.4	4.9657
1970	MAR 23	Broach, India	26	5.4	6.4754
1970	MAR 28	Gediz, Prov. Kutahya, Turkey	1,086	7.3	5.3442
1970	JUL 30	Gediz, Khorasan Prov., Northeastern Iran	176	6.6	5.5639
1971	FEB 6	Tuscania, Prov. Latium, Italy	24	4.6	7.5939
1971	FEB 9	San Fernando, Calif., USA	65	6.8	4.8476
1971	MAY 12	Burdur, Turkey	72	6.3	5.6113
1971	MAY 22	Bingöl, Genc, Turkey	863	6.7	6.1085
1972	FEB 4	Ancona, Italy	1	4.9	6.0650
1972	APR 10	Fars, Zagros Mts., Prov. Ghir, Iran	5,374	7.1	6.3263
1972	JUN 14	Ancona, Italy	2	4.7	6.5291
1973	NOV 14	Iran	1	5.5	5.2010
1974	FEB 1	Izmir, Turkey	2	5.2	5.8091
1975	APR 7	Bandar Abbas, Iran	7	5.8	5.3711
1975	SEP 6	Lice, Turkey	2,700	6.8	6.4595
1975	DEC 30	Hana, Hazr, Turkey	3	4.6	6.6240
1975	DEC 31	Aitolia, Greece	1	5.5	5.2310
1976	APR 2	Agri, Turkey	4	4.6	6.8949
1976	APR 29	Ardahan, Turkey - USSR border region	4	5.5	5.5990
1976	MAY 6	Friuli, Italy	978	6.9	5.8748

Year	Date	Locality	Number of victims N_k	M	f
1976	JUL 9	Turkey	1	4.2	7.0730
1976	AUG 19	Denizli, Turkey	4	4.9	6.4629
1976	SEP 11	Friuli, Italy	5	5.5	5.6782
1976	SEP 15	Friuli, Italy	11	6.0	5.2592
1976	NOV 7	Vandik, Prov. Khorasan, Iran	17	6.2	5.1473
1976	NOV 24	Prov. Van, Turkey	3,626	7.3	5.8675
1977	MAR 21	Bandar Abbas (Khvorgu, Qaleh Qazi) Southern Iran	900	5.3	8.1427
1977	MAR 25	Palu, Eastern Turkey	30	5.1	6.9674
1977	APR 6	Ardal, Borujen, Central Iran	500	6.5	6.1598
1977	DEC 19	Babtangal, Gisk, Sarasiab, Prov. Kermanshah, Iran	584	5.4	7.8112
1978	APR 15	Sicily, Italy	5	5.9	5.1022
1978	JUN 20	Thessaloniki, Greece	49	6.4	5.3030
1978	SEP 16	Tabas, Iran	16,000	7.7	5.9361
1978	DEC 14	Izeh, Masjed-e-Suleymon, Iran	76	5.5	6.7865
1979	JAN 16	Boznabad, Eastern Iran	200	6.1	6.3392
1979	APR 15	Montenegro, Yugoslavia, Albania	156	7.0	4.9359
1979	SEP 19	Umbria, Italy	5	5.9	5.1022
1979	NOV 6	Northwestern Greece	1	5.5	5.2010
1979	NOV 14	Northwestern Iran	280	6.0	6.6287
1979	NOV 27	Northwestern Iran	17	6.1	5.2913

(compiled by the author)

WHAT IS A DISASTER?
AN AGENT SPECIFIC OR AN ALL DISASTER SPECTRUM APPROACH TO SOCIO-BEHAVIORAL ASPECTS OF EARTHQUAKES?

E. L. Quarantelli

Introduction: The Problem Question

Kenneth Burke once wrote, "A way of seeing is also a way of not seeing" (quoted in Lindesmith and Strauss, [1949; p. 101]). One implication of this remark is that all of us are partly blind in almost all situations since we get accustomed to looking at various situations in set customary ways. People interested in the disaster area are not immune to this kind of blindness. We all have a habitual way of looking at disaster phenomena.

This paper is aimed at making us better aware, perhaps, of some of the consequences of our usual blindness. If the comments and observations made make us more conscious that the way we habitually see phenomena is not the only meaningful way possible or the only obvious one, it will have achieved its major goal. While later on, we eventually advocate one kind of perspective for certain kinds of earthquake phenomena, the purpose of this paper is less one of converting people to a particular approach than it is to try to suggest that there are different ways.

In this conference we are basically concerned with earthquake phenomena, or more specifically, with the social and economic aspects of earthquakes and planning to mitigate their impacts. Less than twelve months ago, I attended a workshop on aircraft disasters [Quarantelli, 1980a]. Just about a year ago, at the Disaster Research Center we had a national invitational meeting on preparations for and responses to acute chemical emergencies [Gray and Quarantelli, 1981]. Conferences on flash floods have regulary been held for the last several years in the United States. Earthquakes, aircraft accidents, acute chemical emergencies, flash floods--in each case, one kind of disaster or disaster agent has been the primary if not exclusive focus of attention of those in attendance. In contrast, also in the last few years, I have been at international and national conferences where the over all or basic theme of the meeting has been disasters of all kinds (e.g., The Sociology and Social Psychology of Disasters at the 9th World Congress of Civil Defence in Rabat, Morocco, November 1980) or extremely broad classes of disasters (e.g., as at the annual Natural Hazards Workshop held at the University of Colorado) or very general categorical topics, such as disaster medicine (see, for example [Quarantelli, forthcoming], or disaster relief [Baiseden, 1979]. The assumption in these conferences was that it is possible to talk of disasters generally and to take a generic approach to disaster problems. The first set of meetings I mentioned seemed instead to assume an agent specific approach to disasters and to take a particularistic approach, be it earthquakes, aircraft accidents, acute chemical emergencies, or flash floods. This polarity between an agent specific and a generic approach to disasters shows up in more than meetings of those interested in the disaster area. Planning organizations and operational agencies as well as researchers and theorists also tend to divide in roughly the same way. In other words, a polarity in orientation is pervasive among those involved with disasters, be it in mitigation, preparedness, response and recovery activities, or in studying disaster problems.

For example, in my own state of Ohio in the United States, chemical emergencies are handled by a state agency, the Environmental Protection Agency, which is totally separate from the organization responsible for planning and operational work for floods in our state. Some research institutions have a specific agent focus, others do studies across-the-board insofar as disasters are concerned. Thus, there is the Earthquake Engineering Research Institute, and there is also the Disaster Research Center which looks at a range of accidents and catastrophes from tornadoes to plane crashes, from hurricanes to acute chemical emergencies, from coastal shore erosion to forest and building fires. The literature in the area also tends to divide into agent specific and generically oriented publications. There is the journal Disasters which has articles involving a wide range of disasters from earthquakes to aircaft accidents, from agricultural frosts to famines. Then there is the Journal of Hazardous Materials which limits itself primarily to chemically generated disasters. Similarly, we have the newsletter Unscheduled Events which in practice covers civil disturbances and disorders and other mass emergencies, as well as a very wide range of natural and technological disasters. In addition there is the the newsletter The Earthquake Information Bulletin or the Bush Fire Bulletin. Not unexpectedly, funding agencies and policy groups in governments also represent a mixture of agent specific and generic disaster orientations.

This kind of polarity or dichotomy also shows up at another level, which I will only briefly and indirectly discuss, but is worthwhile noting because it involves what almost everyone would agree would represent an extreme manifested in both planning and activities as to whether wartime nuclear catastrophes and peacetime natural disasters can or cannot be treated as meaningful members of the same class, or whether the differences between the two kinds of phenomena are essentially differences in kind rather than just degree A U.S. National Academy of Science committee, of which I was a member, recently struggled with this problem. It attempted to identify similarities and differences, for example, between the detonation of privately made nuclear weapons by terrorists and the impact of tornadoes, between limited nuclear attacks and earthquakes, between nuclear power plant accidents and riverine floods, and between hazards associated with the transportation of nuclear materials and those involved in the transportation of hazardous chemicals. The comparisons attempted clearly showed a conscious belief that trying to perceive phenomena which are not usually grouped together within the same framework might prevent us from being partially blind in the way stated at the beginning of this paper. However, the committee's final report has not yet and in fact may never be published because of a strong difference of opinion among the reviewers of the report as to whether it is or is not scientifically meaningful or even possible to compare hazardous nuclear incidents and non-nuclear disasters. To some, the agent specific characteristics of the nuclear phenomena puts it into a different class than other disaster agents. Thus, there are those who argue that any type of dangerous nuclear-related happening produces such special and unique problems that neither the research findings nor the organizations' plans and operations pertaining to other types of disasters have significant relevance. Perhaps some of you may have the same view about earthquakes.

On the other hand, even in the admittedly extreme case of the nuclear area, a different position is sometimes taken by those with policy and operational authority and roles. Thus, when there was a reorganization last year of those multiple groups in the federal government of the United States most concerned with mass emergencies which had national implications, certain responsibilities for a very wide range of emergencies was in principle and nominally, if not in fact or practice, centralized in one agency, the Federal Emergency Management Agency (FEMA). This new organization is intended to deal with wartime as well as peacetime natural disaster emergencies, as well as a variety of technologically generated accidents including those in the nuclear area, plus a variety of other potential crisis situations resulting from fires or terroristic acts. Clearly FEMA was established with an all hazards approach in mind and an assumption that for many purposes the management problems of any emergency are similar irrespective of the agent involved. There is an implicit view that plans and programs designed to mitigate, prepare for, and counteract the destructive forces emanating from natural and other peacetime disasters, can be applicable to whatever efforts might be required for various nuclear hazards, including full scale nuclear war.

In the last two paragraphs, therefore, we see how an agent specific or a generic disaster approach can be taken even in the extreme case of nuclear phenomena. It also illustrates that the issue we have raised is not merely an academic exercise but has meaning in what is or is not done at policy, planning, and operational levels. Put another way, different decisions are made, different actions are taken, different resources are mobilized, etc., depending on whether or not an agent specific or an all disaster spectrum approach is assumed.

I do not think that further illustrations are needed to show we sometimes approach disasters in very specific agent terms and that sometimes our approach is in generic terms. All of us, researchers and planners, operational people and policy makers, vary in our approaches, some of us taking one approach, others assuming the opposite approach. Perhaps this bothers you; perhaps it does not. But to me this polarization or dichotomy in approach is something we should consciously and explicitly address. I think we need to clarify what we are assuming one way or another. Thus, the title of my paper and its question: An agent specific or an all disaster spectrum approach to socio-behavioral aspects of earthquakes?

The Question Behind the Problem Question

Of course, this questions begs a prior question. Why does the distinction, the polarity or dichotomy exist? What accounts for why different people and groups tend to take one or the other of these approaches? Few have attempted to answer this question. The basic imagery or model of the phenomena, which underlies how disaster planners and disaster researchers go about their work, has not been a focus of much scholarly concern or academic scrutiny. Yet, to the extent that the reasons for the polarity in approach to disaster phenomena remain unexamined, there will have to continue to be uncertainty about the relative efficiency and effectiveness of using one approach as opposed to the other.

We will not pretend we will be able in this paper to examine in totality why two perspectives exist. We will certainly not attempt to examine in historical terms how one disaster agent or limited classes of related agents became the focus of some bureaucratic domain even just in the United States. It is relatively clear, for example, that the historical fractionalization and compartmentalization of federal agencies with responsibilities in planning, research, or operational functions relating to disasters, hazards, and emergencies have tended to emphasize differences rather than commonalities among various types of disasters and have supported an agent specific orientation. Thus, we have or have had the U.S. Fire Administration, the Defence Civil Preparedness Agency (with a nuclear warfare orientation), the Environmental Protection Agency (with a focus on certain kinds of liquid, gas, and solid waste pollutants), the Nuclear Regulatory Commission (with major responsibility for nuclear reactor plants), the National Weather Service and the U.S. Geological Survey (with foci on different meteorological and geophysical hazards), etc., not to mention the National Hurricane Warning Center, the Center for Disease Control, the Tsunami Information Center, the Severe Storms Forecast Center, etc., as well as the Flood Insurance Program, the Federal Dam Safety Program, etc. Also, we will do no more than mention that at regional, state, county, and local community levels there are myriad agencies, commissions, and departments each focusing on only one separate, specific kind of disaster ranging from urban drought to rural fire problems.

Since one review a few years ago found over 100 federal level agencies alone had some formal disaster responsibility in the United States [Fritz, 1977], to trace how and when different groups were assigned or took over different specific disaster related activities or functions would be a herculean task. I do think such a historical reconstruction would be very informative. In the case histories we should be able to see what factors entered into the dynamics of how "disasters" were divided up and parcelled out to different governmental agencies (and even a few which were primarily left for the private sector as in the chemical hazards area). In addition, a cross-cultural study of which different government agencies in various societies have taken over or been assigned the phenomena of earthquakes might be especially interesting and how earthquake prediction is currently being organizationally assigned could be a fascinating examination of some of the interface between the world of science and the world of politics. However, such research and scholarly excursions are for others at some other time.

Our immediate goal is much more modest. It is to suggest that what lies behind the distinction between an agent specific and a generic approach is the simple matter of how disasters are conceptualized in the first place. I use the term "simple" here solely to indicate that what is primarily involved is basically a conceptual problem. The problem itself is very complex.

What is a disaster? Elsewhere, I recently stated that people in the disaster area have unfortunately mostly avoided explicit and systematic attention to this question [Quarantelli, 1980c]. Too many have accepted the view that "a disaster is perhaps easier to recognize than it is to define" [Barkun, 1974, p. 51]. But while there has been relatively little manifest academic attention to the problem, at an implicit level, anyone who conducts studies or undertakes planning for disasters implicitly does have to have an image or conception of the phenomena. From the few explicit discussions (e.g., [Carr, 1932] [Barton, 1963] [Barton, 1970] [Stoddard, 1968]) and the many implicit assumptions about the phenomena, it is possible to pull together what people and groups assume or think about when they use the word or term "disaster."

Different Conceptions of Disaster

There are at least seven different major ways in which disasters have been either implicitly or explicitly conceptualized. At least in ideal type terms we can say that the problem has been or is approached in these relatively distinct, although in some cases, related ways. The seven views we will note do not cover all the definitional and operational ways that have been and are used to designate "disasters" (e.g., the American National Red Cross operationally defines as disasters those situations of distress involving five or more families). They do not represent all the arguments made or all the empirical phenomena pointed to in discussions about what constitutes a "disaster" (e.g., that disasters are actualizations of structural vulnerability, see [Pelanda, 1981]). Furthermore, even the same writers or speakers are not always consistent in their usage of the term, and, of course, there is no widespread consensus about the label--it is a sponge word or concept as noted over a decade ago [Quarantelli and Dynes, 1970, p. 328]. Nonetheless, the seven ways we will discuss do represent relatively different emphases in answering the question: What is a disaster? As such, we will identify what is being pointed to, and briefly note the case made for each particular formulation. Later, by contrasting extremes, we will note what implications there are for theoretical and practical purposes in accepting one version or another of what constitutes a disaster.

In ideal type terms, disasters have been equated with:

1. Physical agents;
2. The physical impact of such physical agents;
3. An assessment of physical impacts;
4. The social disruption resulting from an event with physical impacts;
5. The social construction of reality in perceived crisis situations which may or may not involve physical impacts;
6. The political definitions of certain crisis situations; and
7. An inbalance in the demand-capability ratio in a crisis occasion.

Some general comments are first in order. There have been changes in emphasis in the course of the efforts to reformulate the term disaster. The first three formulations noted above, the earliest in the area, primarily have physical referents. For about two decades now, however, socially oriented definitions have also been advanced, with probably Fritz's [1961] statement being a turning point in setting the stage for later definitions of a more social nature. If anything, and as we will discuss below, the more recent definitional and conceptual attempts, as manifested in the last four formulations listed above, have been variants of an attempt to view disasters as essentially social phenomena of some kind. The emphasis has been changing from the physical event to a focus on social situational aspects. Thus, as an example, the physical land movement which is an earthquake, is in the later formulations, conceptualized as a disaster only if it involves certain social phenomena--an event, a construction, a political position, or an occasion with particular social characteristics.

To be sure, even most of the newer social conceptions tend to assume relatively identifiable, focused events which can be located in space-time terms [Quarantelli and Dynes, 1977]. This, as critics have noted, leaves unclear the categorical status of very diffuse occasions, such as famines and epidemics, that have traditionally been and in common sense terms are classified as being disasters. This, in turn, has led some to argue that the emphasis on a specific event as a distinguishable feature reflects a Western society bias and is unsuitable for identifying disasters in underdeveloped societies [Westgate and O'Keefe, 1976]. The most extreme attack is mounted by those who argue that the word disaster is an outmoded concept, a residue from the flow of history which captures relatively insignificant phenomena at best instead of the newer terrors and pervasive perils that have emerged in the modern world [Barkun, 1974].

The critics just noted may be making some valid points. However, it does seem premature to discard totally the concept of disaster, and it may not be completely inappropriate for theoretical and practical purposes, that the term as used in some current research, scholarly, policy, and administrative discourse does not fully capture what was caught by older, everyday usages of the term. Historically, scientific concepts are often developed by progressive refinements which exclude part of what was pointed to in the original common sense usages of words. For the time being, the better part of wisdom would seem to dictate continuing efforts to answer the question: What is a disaster?

While we will look at each of the seven formulations listed above in more detail, in no sense will the discussion be exhaustive. For the most part, we will ignore the reification and anthromorphism which is rampant in many definitions of disasters, and the misplaced concreteness and the logical flaws that permeate efforts to conceptualize disasters. Instead, for purposes of exposition, we present the formulations as they are either explicitly or implicitly advanced by users of the term, "disaster."

1. Disasters as physical agents.

The word "disaster" is sometimes equated with certain kinds of physical agents such as earthquakes, fires, floods, and explosions. The basic idea here as [Dynes 1976] has pointed out, is that there is "something" which can potentially produce an effect on the environment. These "somethings" are designated as disaster agents, with a frequent distinction being made between "natural" or "acts of God" and "human" or "man-made" agents. Thus, a natural land movement of a certain kind is called an earthquake; the accidental transformation, as a result of human error, of an inert liquid into an expansive gas is called a chemical explosion.

In this image of disaster, there is a search for primarily the physical cause of whatever occurs. Now many philosophers and scientists see a search for cause as a chimerical exercise, since in their view "causality is a property of theoretical systems rather than of the world" [Mullins, 1974, p. 4]. However, if one accepts the notion of cause, it follows that there would be different natural causal agents for different phenomena. An earthquake is caused by something different than a fire. Extremely agent specific causes are involved, and knowlege of one agent tells nothing about another. Studies of a radically different nature are necessary for different agents.

2. Disasters as physical impact.

Since a disaster agent is not the same as a physical impact, it is not surprising that in some usages the term "disaster" is only equated with the latter. In this usage, there is a disaster when there is some kind of noticeable physical impact in some part of the environment. A hurricane will move air and water; an earthquake will move land and water. But what is important in this conception is that the physical impact is discernible.

Attention is paid in this formulation to both how characteristics of the disaster agent may affect impact, and in what sphere the impact occurs. With respect to the latter, impact can be seen as occurring in the geophysical sphere or environment, in the biological environment, and/or in the socio-technical sphere [Dynes, 1976]. Also, certain characteristics of disaster agents are seen as having implications for producing particular types of impact [Dynes, 1975]. Thus, it is noted that disaster agents differ in their frequency since they are not randomly distributed over space. Localities generally have to be near a geological fault to be impacted by discernible earthquakes. Tsunamis cannot directly impact areas not bordering on large bodies of water. Disaster agents also differ as to their duration. A volcanic eruption, as in the case of Mount St. Helens may have a prolonged duration. The typical earthquake impact is relatively short, although there can be repetitive shocks or aftershocks. The usual chemical explosion is of very brief duration. Discernible physical characteristics may not be socially significant, but there is little question that the features of many physical impacts can be ascertained and often in quantitative terms.

3. Disasters as assessments of physical impacts.

Discernible physical impacts of disaster agents may occur, but depending on the assessment made, in one formulation, only some would be categorized as "disasters." The event to be classed as a disaster has to be assessed as "disastrous" in some manner or other. This seems to be the reasoning behind, for example, the old U.S. Office of Emergency Preparedness (a partial predecessor of FEMA) report on preparedness for ten natural disasters. Causes and characteristics of each of the ten agents are discussed. Thus, in the instance of earthquakes there is a discussion of their primary and secondary effects, the probability and places of their occurrences, and what they may do to people, property, economy, and ecology. [Disaster Preparedness, 1972, pp. 71-83].

In this approach, there is the notion of a benchmark or a threshold beyond which there is a negative assessment which allows for calling the event a disaster. Often the assessing criteria used are implicit, but sometimes they are semi-explicit as manifested in the Mercalli and Richter scales of earthquakes strengths. Both scales, the first measuring intensity and the second measuring magnitude, involve combinations of discernible physical impacts and some assessments of those effects. Analogous assessment measures of impact have recently been developed for hurricanes and tornadoes. In this approach to disasters, most would seem to be agreeing with some variant of a statement by Barkun, "Disaster means damage--physical, social, and psychological" [1974, p. 72] although many focus primarily on the physical effects.

The three conceptions of disasters noted above, while similar and related, do have different emphases. In the first conception, the focus is on antecedent conditions or causes responsible for the physical agent. In the second formulation, the distinguishing feature of disaster is that it is characterized by a discernible physical impact. In contrast, something is a disaster in the third conception when the effects are assessed as being notable. Put in other words, the three formulations of disaster respectively stress causes, characteristics, and consequences of physical agents and their impacts.

4. Disasters as social disruptions from events with physical impact.

Conceptions of disasters involving social aspects start to come to the fore in this fourth view of disasters. In this approach, a physical impact is characterized as a "disaster" if the magnitude of the impact, as indicated by property damage and casualties, is believed to be high enough to result in disruption of social life. Thus, if there is a degree of destruction of material goods and/or the killing and injuring of people are relatively large, the event is viewed as a disaster. It is a disaster not because of the physical impact per se, but because of the assumed consequences for social life emanating from the physical happenings. As such, this formulation of disasters differs somewhat from conception #3 just discussed because relative emphasis is on the social rather than the physical.

Thus, in this approach to disasters, physical indicators by way of dead bodies and wrecked buildings, etc., are taken primarily as a sign of probable social disruption. For example, a frequently used definition by social scientists is that a disaster is

> an event, concentrated in time and space, in which a society, or a relatively self-sufficient subdivision of a society, undergoes severe danger and incurs such losses to its members and physical appurtenances that the social structure is disrupted and the fulfillment of all or some of the essential functions of the society is prevented ([Fritz, 1961] derived from [Endlemen, 1952]).

As someone who was personally involved with the group of social scientists at the University of Chicago from whom this definition emanted, I can say that the original statement assumed a very close correlation between extensive physical impact and social disruption. In fact, disasters were to be found for study purposes by noting indications of death and damage, since it was assumed that social disruption was a necessary consequence if an event involving major impact had occurred. Although the defining group deliberately and successfully avoided the use of the term "social disorganization," it is clear, at least in retrospect, that the definers expected physical destruction or disarray to be reflected in social disorder or disorganization. This use of physical signs to find and identify a disaster, because of the assumed resulting social problems, continues to this day.

5. Disasters as a social construction of reality in perceived crisis situations which may or may not involve physical impacts.

The four conceptions of disasters noted in this point assume a physical impact of some kind. However, social scientists in particular have always been troubled by the easily made observation that there is no necessary correlation between physical impact and social activity. The New Madrid earthquake of 1811-1812 had massive physical effects on the topography of the region, even changing the course and channel of the

Mississippi River [Penick, 1976]. But many do not characterize this major physical upheaval as a disaster, since the area at that time was very sparsely populated and there was very little damage or destruction of property and possibly no loss of life. On the other hand, a completely false story circulating about a major break in a dam above a town precipitated flight and evacuation [Danzig et al, 1958]. This behavior, however, is not distinguisable from that studied in the actual Teton dam break [Golec, 1980]. So many define both of these cases as instances of disasters despite the lack of any physical impact in the first instance. From the viewpoint of social reality, both of the dam situations had been socially constructed so they were perceived in the same dangerous way by the involved populations. The principle here is an old sociological one that "if a situation is defined as real, it is real insofar as consequences are concerned." Therefore, to some, the question, insofar as a disaster is concerned, is not the presence or absence of physical impact, but whether there is a belief of threat and danger to important values such as life, well-being, property, and social order.

In this conception of disaster, there must also be a socially constructed perception of a crisis situation, that is, a situation necessitating unexpected collective action because high priority values are involved (see, e.g., [Form and Nosow, 1958] who conceptualized individual, group, and organizational actions where previous modes of behavior are no longer applicable as a crisis situation, and illustrate it from the social aftermaths of a tornado in Michigan). According to this view, actual impact is not the crucial element. As one of the very earliest researchers who grappled with the concept of disasters said: "The nature of agent--flood, fire, wind, poison, disease, explosion, etc.--has <u>meaning</u> as well as consequences; that is, it makes differences in the <u>subjective</u> response of threatened people, as well as in the measures that have, objectively to be taken against it or because of it" [Powell, 1954, p. II-22]. The relevant meaning in this conception of disaster is the perceived need for collective action, a consensus type of crisis in contrast to dissensus crisis [Quarantelli, 1970].

Clearly this approach with its differential perceptual possibilities as a result of different social constructions of reality make the concept of disaster a relativistic rather than an absolutistic term. In fact, a completely social constructionist approach to the problem can lead to the eventual position that there is no one entity as such which can be called a disaster. As I wrote elsewhere:

> a disaster is not a unitary whole. For different areas or communities, for different organizations and families, the "same" disaster may start and may stop at different chronological points. For example, a weather service may start getting involved in a disaster with the first sighting of danger cues picked up by its monitoring system, and its involvement may end after a warning message has been issued. In the "same" situation, the disaster from some governmental agricultural agency may start six months after actual impact because certain crops might not be planted until that

time due to salt water contamination, and the organizational involvement may end only two years after that.

The importance of noting this is that what is considered a disaster and its duration can vary, and usually does, even for emergency organizations which may become involved. Thus, what may appear to be an urgent matter to one group requiring immediate action, is not seen in that light at all by another organization. There are differential time involvements and differential time withdrawals from a disaster. A disaster is not a fixed entity out there with a fixed time duration. A disaster, insofar as its existence is concerned, is always a relative matter, varying according to whose perspective is being applied. [1977, p. 102].

6. Disasters as the political definitions of certain crisis situations.

Certain writers have pushed the social construction of reality approach to one extreme point and have argued that disasters are not only social constructions but basically are political phenomena [Brown and Goldin, 1973] [Westgate and O'Keefe, 1976]. As such, whether crisis situations even get defined as disasters are political decisions in the broad sense of the term. Such political decisions are reflective of the interests of the elite, or power holders in a society or community. Thus, in this view, disasters should be seen as certain kinds of political definitions.

It is noted that there have been instances of nations officially declaring that no disaster has occurred when by other definitions of disasters there has been such an occurrence. The formal denial of an earthquake, cyclone, or famine disaster in certain cases not only prevents international disaster relief, but in some instances even leads to little or almost no internal domestic response [Freudenheim, 1979]. Conversely, of course, there are opposite examples, where "disasters" have officially been declared to have occurred when disinterested outside parties could not see that the designated situation had materially changed from everyday happenings. Thus, some students of the problem argue that definitions of disasters are less related to "objective" happenings than they are to the involved interest of those who can effect the political decision making of a system at crisis time [Davis, 1975] [Glantz, 1976].

Those who define disasters in this way are not impressed by arguments that in most such cases something has actually happened and that what is involved is simply an unwillingness for political reasons officially to define a situation with a particular label. They observe, as noted above, that the formal designation can make a difference in everything from mitigation and prevention, to response and recovery activities. If, as has happened in the United States in the past, there is an official presidential declaration of a disaster or there is a denial of such a declaration, various resources can or cannot be mobilized, different programs can or cannot be implemented, etc. It makes a difference. Unless one is very naive, it would be foolish to deny that political considerations have not entered into the decision to make or not make a declaration, as well as affecting other aspects of the situation being addressed.

For a variety of reasons, disaster researchers and theorists have generally shied away from looking at the political aspects of disaster phenomena [Quarantelli and Dynes, 1977, p. 42]. Planners and policy makers involved in disaster-related matters often well understand the issue involved, but they too in general have said very little openly about the matter. Yet it seems that political processes are involved in all aspects of disaster phenomena (for specific research questions, see [Taylor, 1978]) and particularly whether an occurrence will or will not be called a disaster, with subsequent effects on what happens. For some disaster theorists and definers this is enough to argue that disaster should be conceptualized as a political statement about certain crisis situations.

7. Disasters as an inbalance in the demand-capability ratio in a crisis situation.

There are those who argue that a "disaster" is better thought of as a particular kind of crisis situation, a social occasion, different from an impacting event, a perceptual construction, or a political definition. These analysts see a disaster when the demands for action exceed the capabilities for response in a crisis occasion. There is a perceived urgent need to act because high priority values are threatened, thus the crisis, but the capabilities--intangible and otherwise--are not enough to meet the demands of the occasion. The occasion (a term taken from [Goffman, 1963] and specifically applied to disaster phenomena by [Brown and Goldin, 1973]) typically requires non-routine and emergent collective behavior. Thus an earthquake is a disaster if non-typical and new social behavior is necessary to generate an appropriate balance between the demands and capabilities present in the occasion. Emphasis in this formulation is not on social disorganization, perceptual beliefs of danger, or elite labeling processes --ideas respectively central to the previous three social conceptions of disasters discussed--but on the collective effort to terminate a particular crisis by restoring capabilities to the level of demands.

The ideas involved in this conception of disaster were first generally advanced with respect to the behavior of formal organizations in extreme stress situations (see some of the initial ideas in [Thompson and Hawkes, 1962] and later developed by Drabek [Drabek and Haas, 1970] [Haas and Drabek, 1973]). However, the notions involved are equally applicable at other analytical levels such as individual aggregations, households, non-organizational groups, interorganizational systems or networks [Taylor et al, 1976], communities or societies. Furthermore, the general idea can be used whether the occasion is a very diffuse or acute one, whether there is just a threat or an actual happening, whether the agent is of slow onset, cumulative and diffuse (e.g., some toxic substances) or rapid, impactive and focused (e.g., earthquakes), or whether the crisis is of very long or short duration. As such, some disaster researchers find value in conceptualizing disasters as crisis occasions where the demands exceed the capabilities. They would generally see their view consistent with the statement that: "on the most general level, an anticipated disaster is a contradiction in terms. Without the element of surprise, defenses both material and psychological may be erected. Much of the force of a disaster comes from the sudden manner in which it assaults unprepared societies, institutions, and psyches" [Barkun, 1974, p. 57].

Implications of the Conceptualizations

We made an excursion in the last few pages into different conceptions of disasters because we believe that the view of what constitutes a disaster mostly underlies taking an agent specific or an all disaster spectrum approach to earthquakes or other kinds of "disasters" for that matter. Instead of looking at the separate implications of each formulation, time and space considerations will limit us to making a collective contrast between the first three conceptions, and the last four conceptions. As a whole, the first three are either consistent with or require an agent specific disaster approach.

Especially with respect to conventional geophysical and meterological agents, worthwhile work has long been undertaken on specific physical agents. Even if the mysticism of causation is set aside, it is certainly meaningful to ask why, for example, the earth sometimes suddenly shakes and to answer that it results from the movement on a fracture of the earth's crustal rocks, usually by a sliding along a rupture plane or fault. It does not matter in such a framework if there are no discernible human or social consequences for the physical agents. In fact, the vast majority of earthquakes are not even discernible except by sophisticated measuring instruments Thus, it has been estimated that "perhaps as many as one million earthquakes occur each year over the globe," but that only perhaps 6,000 of these are felt by human beings [Cornell, 1976, p. 110]. Higher figures are given by others [Disaster Preparedness, 1972, p. 75]. Nevertheless, there is a physical phenomena, whether sensed directly by humans or not, the dynamics of which can be and are usefully studied.

But an important question is whether it is equally valid to also look at earthquakes as a special and unique case of a disorganizing event, a perceptual construction, a political definition, or a particular kind of crisis occasion? Put another way, will social and behavioral scientists gain more by approaching earthquakes as very agent specific disasters or looking at them as but one member of a broader class of disasters and sharing much in common with such other disasters?

Our answer, obvious by now, is that more is to be gained by taking the latter rather than the former position. It is not only defendable but necessary, for example, for seismologists to look at earthquakes as disaster agents in very specific terms. It is not as defendable for social and behavioral scientists to do so; it is far more useful for them to approach disasters involving earthquakes as part of a more generic class. In fact, we think it becomes increasingly necessary to do so as one moves from a conception of a disaster as a disrupting event to one of a crisis occasion, although we will not argue this point further.

The socially oriented conceptions of disaster force a focus on the properties of the social situation and away from the characteristics of disaster agents and impact as such. Vastly oversimplifying for purposes of illustration, was it important that in the San Fernando earthquake of 1971 approximately 60 persons were killed and two hospitals put out of commission? For certain purposes, yes. But for other purposes it is far more crucial, in understanding the social situation, that in terms of the demand-capability ratio of that occasion there were seven and one-half million "survivors" and 120 intact hospitals. If we use these simplified figures only, there is even a question whether, from a sociological point of view, there was a San Fernando earthquake "disaster."

More important is the fact that social factors can be quite similar across many social situations in a way agent characteristics cannot be (and even less than we ourselves once postulated [Quarantelli and Dynes, 1970, p. 328]. This can be more than stated. While it is an occupational disease of researchers to complain that very little is known about whatever they are studying, and this lament has been expressed about the disaster area [Mileti et al, 1975] [White and Haas, 1975], the fact of the matter is that we are not totally ignorant of socio-behavioral aspects of disasters, and that relatively speaking we have advanced tremendously in knowledge and understanding since the first social scientists took to the field to study disasters in the United States in the middle 1950s and in the early 1960s in Japan.

Crucial for the argument in this paper is that the cumulative research and theory in the disaster area shows that there are many socio-behavioral features which are not disaster specific and cut across many different types of disaster agents. Thus, it has been possible to derive principles of disaster planning and emergency management [Quarantelli, 1981]. In a recent disaster primer in a discussion of similarities and differences between community planning for natural hazards and chemical hazards, some differences are noted, but it is then observed that

> these differences do not necessarily rule out the application of principles of natural disaster planning to problems of chemical hazards. In fact...studies on natural disaster planning and response can be of value for persons connected with chemical disaster preparedness.

It is then stated

> regardless of the characteristics of a particular disaster agent and the specific demands generated by it, the same kinds of community response-related tasks are necessary in both kinds of disaster and for all disaster phases. In any community, for example, the assessment of hazards and the aggregation of disaster-relevant resources are necessary, regardless of the specific hazards and resources in question. Similarly, post-impact communication and decision-making procedures must be planned for and activated in <u>any</u> community crisis.

> To draw an analogy, a battle on land is fought with different weapons, material, personnel, and support systems than those used in sea battles, but, nevertheless, the general overall battle requirements are the same for both. In both cases, intelligence about enemy strength and movements must be gathered, resources must be collected, trained personnel must be led effectively, and so on. The same is true for disaster planning; although disaster agents and the human and material resources needed to respond to them may vary, the same generic kinds of activities must be performed in the predisaster, preimpact, response, and recovery periods, regardless of the specific threat [Tierney, 1980, p. 18-19].

At a less abstract level, we have in the disaster area, for example, substantial research findings on such disaster relevant topics as warning [Mileti, 1975], evacuation [Quarantelli, 1980b], delivery of emergency medical services [Taylor, 1977], search and rescue [Drabek et al, forthcoming], etc. We also have considerable understanding of such disaster related problems as looting [Quarantelli and Dynes, 1969], mental health consequences [Perry and Lindell, 1978], panic flight [Quarantelli, 1979]. The point in noting these few examples, from the very many other studies which could be cited, is that they are typical in their ignoring of the specific disaster agent which might be involved. The findings are generalized across-the-board because the research effort was not agent specific. Thus, when Parr wanted to understand the emergence of groups of disaster occasions, he looked at the Alaskan earthquake, but also at tornado, explosion, flood, and plane crash disaster occasions [1970]. Anderson, in order to develop our knowledge of civilian-military disaster relations, looked at earthquakes in Chile, Japan, and El Salvador, at tornadoes and floods as well as the Alaskan earthquake in the United States, and a dam disaster in Italy [1969].

It has also become increasingly clear that what has been called response generated demands are far less agent related than what has been called agent generated demands in disasters [Quarantelli, 1981]. The latter (never visualized as agent specific, however) are demands or tasks generated by a disaster when it impacts or threatens to do so and includes such activities as warning, search and rescue, care of the injured, welfare needs, restoration of community services, etc. Response demands, in contrast, are those tasks which must be carried out if the agent related demands are to be met at all and include communication, continuing assessment of the disaster situation, mobilization and utilization of human and material resources, coordination and exercise of authority. Although there is no space to document the point, Disaster Research Center studies do suggest that even agent demands are inherently related to the social situation involved and seem to have little direct relationship of any kind with any specific agent dimension. In research on planning for and response to acute chemical emergencies, we have found chemical agent related dimensions less directly important than we had originally hypothesized.

Even when social aspects seem agent specific related, closer examination frequently indicates that is not the case. For example, the concept of disaster subculture was initially linked to a specific agent, a flood subculture, a hurricane subculture, etc., [Moore, 1964] [Osborne, 1970] [Wenger, 1978], but now there is reason to believe experience and other situational factors are more important in the development of the subculture than the characteristics of the specific disaster agent per se.

I have cited mostly emergency time disaster phenomena, but this merely reflects my major professional interest and work. Other topics and issues could be cited such as resistances to hazard mitigation measures, disaster insurance [Kunreuther et al, 1978], obstacles in recovery and reconstruction work, long run demographic and economic consequences of disasters [Rossi et al, 1978]. Here too the findings are disaster generic rather than agent specific. Most of the work mentioned is derived from the American scene, and there may be cross-cultural differences in some respect, [Cattarinussi and Pelanda, 1981] [Hirose, 1981] and as suggested by McLuckie [1975], but if so, that is a social situational rather than agent specific differentiating factor.

We think an all disaster spectrum or generic approach is justified whether problems are divided by time stage, by function, or levels of response. That is, earthquake related issues could be looked at in terms of the pre-impact, the emergency, and/or the post-impact periods. Similarly, earthquake relevant problems could be divided with respect to functional tasks such as mitigation, preparedness, response, and/or recovery. The responding units may be individuals, households, groups, organizations, communities, societies, or international systems. Our view is that we will gain more regarding time stages, functions, or levels of response by considering earthquakes as a member of a more generic class of disasters. Thus, we would argue that even earthquake predictions are not that agent-specific a case, and, in fact, a recent statement by Turner [1980] seems to imply that much of what we know about how people respond to threats and warnings for other dangerous possibilities is equally applicable to prediction scenarios for earthquakes (but compare Panel on Public Policy Implications, [1975]).

It may sometimes appear that a generic approach to disasters may put together rather dissimilar kinds of physical agents or other heterogeneous elements and otherwise violate common sense. In one way this is correct, but not necessarily significant. An analogy may make this point better than a direct discussion.

Biologists have long classified whales, bats, and human beings as mammals. There are many manifest differences in sizes, structures, and functions of these three creatures, but these obvious common sense differences for purposes of biological study and application are far less significant than less overt structural and functional similarities. Thus, all mammals are warm blooded, bear their young alive, etc. For these purposes, the physical size of a whale compared with a bat, or that the former necessarily needs a water environment whereas human beings basically have to live in a land environment, etc., are unimportant and irrelevant.

To put together manifestly different physical agents or overtly distinctively different disaster related elements can be viewed in a parallel fashion. For certain theoretical and practical purposes, a case can be made for a generic rather than agent specific approach to disasters. Thus, our answer to the question in the title of our paper: we should take an all disaster spectrum approach to socio-behavioral aspects of earthquakes.

The general position we have expressed is hardly unique to us. When the United States Congress was considering the Implementation Plan required by the Earthquake Hazards Reduction Act of 1977, the Office of Technology Assessment was asked to develop "Criteria for Evaluating the Earthquake Mitigation Implementation Plan." A summary of the report which discussed the criteria said a major issue was "earthquake versus an all natural hazards strategy." With respect to this matter, the report concluded that

> While it may be convenient for researchers and the large Federal agencies to handle hazards categorically, the practicalities of State and local government organization and function increasingly require integrated planning and operations for all hazards. Similarly, federal construction and housing programs also could be responsible to all hazards, not just to one or a few selected hazards. (quoted in [The Hazard Monthly, July, 1980, p. 3] see also [Coates et al, 1979]).

Our view will not be easily accepted by others. This is understandable, even apart from differences in conceptualizing disasters. There are a number of other reasons--bad, indifferent, and good--for not accepting or agreeing with a disaster spectrum approach to earthquakes. There is a historical reason. Much early work on disasters have initially focused on the physical agent, and to some this becomes a habitual and traditional way of doing things. As said earlier, "a way of seeing is also a way of not seeing." I have observed a similar reluctance to moving away from an agent specific orientation in the fire research and the chemical hazard areas. Researchers and operational people in those two areas have been struggling with questions as to the physical agents involved and the agent specific characteristics of the agent. Accustomed to thinking in that way, they have difficulty in seeing that socio-behavioral studies of other disaster situations have direct applicability to their own areas. But even in these areas the generic disaster approach is making headway [Tierney, 1980].

Even recognizing that there may be a more valid approach than an agent specific perspective is handicapped by the fact that many of us involved in disaster problems have difficulty in communicating because our worlds of specialization and knowledge are different. Some of us are specialists and knowledgeable in depth about one kind of disaster agent--it may be earthquakes, famines, or explosions. Others of us are specialists and knowledgeable in depth about topics and questions that cut across various kinds of disasters, and thus, we may primarily think in such topical terms as warning, evacuation, medical treatment, or care of the dead. In a sense, some of us divide the disaster world horizontally; others of us divide it vertically. This does not facilitate communication from one axis to another. Furthermore, I believe that it is more difficult for vertical communicators (agent specific specialists) to understand horizontal communicators (general disaster specialists) than vice versa.

Finally, the usefulness of an agent specific and an all disaster spectrum approach to earthquakes or any other kind of disaster varies with the purposes involved. It can be quite valid to resist an all disaster approach. It is functional to take an agent specific approach for certain purposes, but it is not true for all purposes. We have tried to show why with respect to socio-behavioral aspects an all disaster spectrum approach to earthquakes would be the more fruitful approach [Dynes, Quarantelli and Kreps, 1981].

At times, when the polarity in approach is raised and discussed, a statement is made to the effect that, yes there is a difference in approach possible, but the division is a practical versus a theoretical one. Thus, it is said that operational personnel faced with dealing with an immediate emergency situation need agent specific knowledge. How far do people have to be evacuated to avoid the toxicity or flying debris if a tanker of chlorine is threatening to explode? On the other hand, it is said that those with more theoretical concerns can deal with more generic questions. What, for example, are the general factors which are involved in motivating people to evacuate?

I do not see the practical-theoretical distinction as a valid one. It seems to me to confuse tactical matters (e.g., the distance to evacuate), which would vary in any situation involving either similar or different disaster agents, with strategic matters (e.g., general principles of motivation applicable in all situations). There are strategies for dealing with disasters which cut across disasters; the tactics may be more situationally specific although even the military from where the strategy-tactics distinction is drawn seems to feel that soldiers can be taught tactical principles.

We can also note that such a practical and applied field as medicine proceeds as if planning and responses in disasters need not be agent specific. It is extremely rare to find disaster medical personnel training and preparing for only one kind of medical treatment. Disasters are viewed generally (e.g., the World Health Organization defines a disaster as "a situation which implies unforeseen, serious and immediate threats to public health" [Lechat, 1980, p. 18], and disaster medicine emphasizes general principles and organizationally focus is on triage, allocation of patients to hospitals, and other non-specific disaster agent aspects. Parenthetically, it was the Disaster Research Center's extensive studies of the delivery of emergency medical services in mass casualty situations [Quarantelli, forthcoming] which have been an important influence in my own thinking about the importance of taking an all disaster spectrum approach to very many disaster problems and issues.

However, there would be considerable theoretical and practical usefulness if we could develop a meaningful typology of disasters.

Although the first analytical typology was offered nearly a half century ago [Carr, 1932], most efforts today still do not go much beyond the simple and unrewarding distinction, for example, between acts of God versus human generated disasters. What we need in the disaster area instead is the development of a typology which uses general dimensions which not only cut across different disaster agents, but also the same disaster agent. As many have said, what is important is not the physical differences between an explosion or an earthquake, but that neither usually allows time for warning, etc. Or as other have said, "...a flash flood resulting from a broken dam might have more similarity to a sudden tornado than to a slowly rising Mississippi River flood" [Stoddard, 1968, p. 12]; "...a flood in Cincinnati for which there may be two weeks warning is simply not a comparable event to a flood in Denver with six hour warning, or to one in Rapid City where warnings were received as flood waters entered dwellings" [Mileti et al, 1975, p. 5]; or "differences between damaging events due to the same natural or man-made agent may be larger than between events initiated by a different agent" [Hewitt and Burton, 1971, p. 124]. Another extreme but illustrative example was the earlier mentioned attempt to compare different kinds of nuclear related crises with natural disaster occasions. If we could develop disaster typologies based on combinations of meaningful dimensions of social occasions, we could better grasp the commonality of socio-behavioral phenomena across different agent differences and differences within the same agent.

None of what has been said to this point argues against specific studies, including socio-behavioral ones, of earthquakes. We have a good start on such studies in a number of different countries [Abe, 1971] [Adams, 1969] [Anderson, 1966] [Bates et al, 1979] [Bolen and Trainer, 1978] [Bourque et al, 1973] [Committee on the Alaska Earthquake, 1970] [Dynes, Haas and Quarantelli, 1964] [Geipel 1979] [Haas et al, 1977] [Kates et al, 1973] [Kennedy, 1971] [Kreimer, 1978] [Kunreuther and Fiore, 1966] [Mitchell, 1977] [Oliver-Smith, 1979] [Olson and Olson, 1977] [Strassoldo and Cattarinussi, 1978] [Takuma, 1978] [Trainer and Bolin, 1976] [Turner et al, 1980] [Yutzy, Anderson and Dynes, 1969]. However, their findings should be seen as not specific to earthquakes; the results ought to be incorporated into whatever we know of other disaster phenomena. Equally important, observations about generic disaster phenomena ought to be brought to bear when socio-behavioral studies of earthquakes are undertaken. Instead of having what I consider a narrow agent specific focus, whether it be with respect to mitigation, preparedness, response, or recovery activity, we should take a generic or all disaster spectrum approach to the phenomena, at least for socio-behavioral questions and research.

Some, perhaps most of you, may not be convinced of the validity and usefulness of the approach advocated in this paper. But if I have provoked you to think consciously about your own position, my general goal has been achieved. Furthermore, if the provocation has been strong enough and you basically disagree, I would hope this will eventually evoke an explicit reply, and we can continue the dialogue at some other time in some other place.

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THE USE OF A CROSSCULTURALLY VALID LEVEL OF LIVING SCALE FOR MEASURING THE SOCIAL AND ECONOMIC EFFECTS OF EARTHQUAKES AND OTHER DISASTERS AND FOR MEASURING PROGRESS IN RECOVERY AND RECONSTRUCTION AS ILLUSTRATED BY THE CASE OF THE GUATEMALAN EARTHQUAKE OF 1976[1]

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and

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Introduction

Social science research on disasters is hampered by the lack of a commonly accepted measuring instrument for assessing the social and economic impact of disasters. A need therefore exists for a valid and reliable measuring scale through which the impact of disasters on human social systems can be measured. Furthermore, there is a need for an instrument that not only measures the impact of a disaster on the social system but which permits the monitoring of the recovery process as it takes place over time.

Even though physical science measures for assessing the impact of disaster agents are available, these instruments do not yield the kind of information necessary to social research. A Richter scale number, for example, does not furnish an indicator of the social and economic impact of an earthquake. What the social sciences need is a scale that measures the impact in terms of social indicators. In short, it must measure the impact of a disaster agent on a human system and must permit the measurement of recovery of that system as the reconstruction process takes place.

Ideally, what is needed is a scale which can be applied to many different kinds of disaster situations involving various kinds of disaster agents. It should be usable in measuring the impact of hurricanes, floods, tornadoes and earthquakes, and even man-made catastrophies such as wars, violent explosions and fires. In addition to being applicable to various forms of disasters, to be maximally useful, a social impact measure should have cross-cultural relevance.

The Richter scale used for measuring the force of earthquakes is useful anywhere on the face of the earth. This means that an earthquake occurring in the Middle East can be compared in magnitude to one occurring in Central America. Furthermore, their physical characteristics can be compared along various dimensions measured by physical science methods. The social sciences need a similar sort of instrumentation so that the results of research in various parts of the world can be accurately compared and knowledge from social research accumulated and made cross-culturally relevant. It is of course a tall order to create a scale that has both cross-cultural and cross-disaster relevance. Nevertheless, efforts need to be made in this direction.

This paper reports on one such effort. Specifically it deals with the use of a modified level of living scale technique for measuring the social and economic impact of a disaster at the household level. To create the type of instrument described above, it will be necessary to add community and societal level measures to the household level scales so that the total impact of a disaster can be measured accurately.

Theoretical Perspective

Social scientists have been accustomed to dealing with the magnitude of a disaster's social and economic impact by the use of crude indicators. For example, casualty figures in terms of the number of people killed and injured or the total population affected by the disaster are used as measures. Similarly, figures on the total value of property destroyed or damaged, or on the number of homes and businesses destroyed, often serve as crude indicators of a disaster's size. It has long been known, however, that these figures are notoriously inaccurate and form a very weak basis for scientific inquiry. They represent the sorts of figures useful to disaster relief agencies in assessing the magnitude of a disaster's impact during the first few days after it occurs so that relief and reconstruction programs can be set in motion. They are not, however, very useful for research purposes. Aside from their inaccuracy, the major fault in such measures is that they represent aggregate level data and can not be easily broken down to the household level or to the level of small geographic areas such as neighborhoods or communities. High quality social science research on disasters must use a stable measure of the impact of the disaster on specific social units upon which other data are collected to test specific hypotheses concerning the relief and reconstruction process. Most often a social scientist needs to know how a disaster has affected specific households so that hypotheses concerning the effectiveness of relief and reconstruction programs can be tested. In a sense, the impact of the disaster represents the independent variable at the first stage of social research on the disaster process since it measures the effects of the disaster agent on a social unit. Later in the research process, recovery measures based on the same scaling technique used to measure impact can be used to measure recovery and thus become a measure of the dependent variable for the reconstruction process.

This paper proposes the use of a technique based on level of living scales to measure the social impact of disasters and to monitor the recovery process. Level of living scales were originally developed to measure the socio-economic well-being of households using physical possessions as indicators of the household's life style. By using physical possessions, level of living scales also measure indirectly the socio-economic status of a household relative to others that are part of the same social system. Early scales, such as that designed by Chapin [1935] and later modified and improved by Sewell [1940] and Belcher [1951], measured level of living by merely determining the possession or non-possession of certain physical characteristics in the household. For example, households were given points on the level of living scale if they possessed such physical objects or characteristics as: (1) running water (2) electric lights (3) a radio or television (4) a refrigerator or washing machine (5) etc. One defect of such scales lay in the fact that as the economic situation of a society or community changed, the items which were used on the scale had to be changed in order to measure differences in a population. If, for example, everyone in a society owned a radio, then radios could not be used as a means of differentiating the status of various household units and another item which was unequally distributed within the population would have to be added in its place. This meant that such scales could be used in cross-sectional studies performed at one point in time but had inherent weaknesses with respect to longitudinal studies. Furthermore, they had the more serious weakness of being highly specific to a given social and cultural context. A scale that would measure level of living in Mexico would be of little value in Western Europe or the U.S. One that measured well in the U.S. in 1900 would be useless in 1980.

Still another weakness lay in the fact that the underlying dimension being measured could never be defined accurately enough to satisfy all critics. If level of living scales are intended to measure well-being, then the question arises as to what items should be included to represent such a relative state. For example, how does the possession or non-possession of a color television relate to the well-being of a household as opposed to having running water in the house? One can see a relationship between running water, health and sanitation and therefore can argue that one dimension of well-being is being tapped by such an item. Arguments concerning the beneficial effects of color television with respect to well-being are less straightforward.

In order to overcome some of these difficulties, especially those related to the use of such scales in longitudinal and cross-cultural studies, John C. Belcher [1972] created what he refers to as a cross-cultural level of living scale. It is this scale which is used as the basis for the work being discussed in this paper. It has many advantages in measuring disaster impact and recovery. Aside from its cross-cultural and longitudinal advantages, such a scale records in detail the types of physical possessions associated with the household. These include housing characteristics, urbanized services, and other household equipment. Since disasters destroy property, this offers a chance to measure impact in terms of property damage.

In creating his new cross-cultural scale, Belcher reasoned that households in every society face certain common functional problems. For example, in every society there is a need for shelter n the form of housing. As a consequence every society, no matter what its level of development or cultural preferences, provides some means of sheltering the household. Furthermore, households around the world utilize water in performing household functions, store and prepare food, dispose of human waste, utilize utensils for cooking and eating, face a problem of providing light during periods of darkness, and so forth. For any given function, however, there are alternative means by which the function is performed within a given society and between various different societies that range along the scale of economic and technological development. For example, taking the function of food preservation, there are various ways in which food may be stored or preserved within the household. One way is to simply place it on the ground or on the shelf. Another is to use a clay jar or basket or wooden box as a storage device. Still another is to employ a spring house or cellar. Finally, one might employ an ice box or an electric or gas refrigerator. These various means of preserving food can be ranged along a scale representing what Belcher called technical efficiency. Starting at the top the most technically efficient method would be an electric or gas refrigerator. Next would come an ice box or ice chest; then a spring house or cellar, and towards the bottom, clay jars, baskets or wooden boxes. For each of fourteen separate functions, Belcher identified five alternative levels through which the function could be performed at the household level and assigned scores in an arithmetic progression to these five alternatives. The alternative with the highest level of technical efficiency received a score of 5, the next 4 and so on, with the lowest receiving a score of 1. Thus an interviewer could obtain a level of living score for a household by determining how the fourteen different functions were performed within that household and giving appropriate scores to each item. The highest possible score would occur when the household performed all fourteen functions, using the highest or most technically advanced method of performing the function and the lowest scale would be obtained at the opposite extreme. A copy of the Belcher scale is given in the appendix of this article.

In connection with the Guatemalan earthquake study, eleven of the fourteen items in the Belcher scale were employed as a means of determining the level of living of households. A means was devised for using these same items to measure the impact of a disaster on the household. This was done as follows. Respondents were asked, for example, what the walls of their house were made of at the time of the earthquake. This would allow a score on the Belcher scale depending on the type of wall employed. For example, if the walls were made of brick, concrete block or masonry, they would receive a score of 5. Respondents were then asked how much damage occurred to the walls during the earthquake. Damage was rated on a scale which ranged from destroyed through heavily damaged, to slightly damaged, and finally, to no damage. These damage ratings were then used as a means of depreciating the score for the walls of the house in terms of the amount of damage which had occurred. If the walls were destroyed. the score was multiplied by 0. If they were heavily damaged, it was multiplied by .33; if slightly damaged, by .67; and if no damage occurred, by 1.00. This procedure was used for all household functional areas upon which damage could be computed. As a consequence, a post-impact level of living scale reflecting the amount of loss or damage suffered in the earthquake was obtained. The reasoning upon which this procedure was based is apparent. The house and household equipment were depreciated in value, so to speak, according to the amount of damage that they suffered, thus yielding a lower level of living scale which reflected the physical impact of the disaster on the individual household.

The modified Belcher level of living scale employed in the Guatemalan earthquake study contains items particularly suited to the Guatemalan case and is also given in the appendix of this report. For example, wall types used in Guatemala did not conform completely to the Belcher list and additional types had to be included; adobe, for example. The scoring procedure, however, is identical to that used in the Belcher scale.

The Guatemalan earthquake study utilized a quasi-experimental design which called for collecting data on four points in time on experimental and control groups: (1) T_1, pre-earthquake (2) T_2, earthquake impact (3) T_3, 2 years after the earthquake (4) T_4, 4 years after the earthquake. At each one of these time periods a level of living measure was obtained using the strategy outlined above, so that four separate level of living measures of the same households are available. The idea was to use the level of living measure as a means of measuring earthquake impact on the household and of monitoring the recovery process. Thus the amount of loss reflected in the damage scale discussed above reflects the impact of the earthquake at the household level. Measures taken two and four years after the earthquake reflect recovery in level of living as a consequence of the reconstruction process. The pre-earthquake measure furnishes the base line against which to measure both impact and recovery.

During the course of analysis of these materials, certain questions arose concerning the underlying reasoning behind the Belcher scale, especially as it is reflected in the weighting of items in terms of "technological efficiency." To resolve some of these questions, a new modified scale was created. The problem was as follows. The Belcher scale weights different alternatives for performing a given function along a 5 point scale representing technological efficiency. Each alternative is spaced equally with respect to those adjoining it. It was observed, however, that the household items represented by these scales varied considerably in cost. For example, taking the food preservation item, a clay jar or basket in Guatemala used for food storage costs in the neighborhood of $1.00 to $3.00, while an electric or gas refrigerator costs $700. If a person's clay jar were destroyed in the earthquake he would lose 1 point on the Belcher type level of living scale. Similarly, if he lost his refrigerator he would lose 5 points. This did not seem to reflect the value of the loss although it did reflect some proportional amount. Furthermore, it was observed that all items on the Belcher scale seemed to share this common characteristic. It was more like the items at the top of the scale for each function cost 500 to 1000 times what the ones at the bottom cost, while they were being weighted only 5 times as heavily. Since we were interested in measuring change it became important to weight the items according to some metric which would reflect change more accurately. Using the Belcher scale, a person could move up or down a point on the scale, either at the bottom or the top, and the amount of change would be equivalent. If, however, the items on the scale were weighted according to cost, this could not happen. Furthermore, it was observed that the two ethnic groups in Guatemala, Indian and Ladino, differed substantially in how they scored on the Belcher level of living scale. Ladinos scored near or above the middle of the scale, while Indians scored closer to the bottom. As the recovery process progressed, it appeared that the Indians were catching up with Ladinos at a fairly rapid rate. This, however, could be a function of the way in which the items on the scale were scored in arithmetic progression. If one goes from the bottom of the Belcher scale to the next highest level he has moved, so to speak, an average of one point. Suppose we were dealing with a case at the top of the scale which moved from next to the top to the top, thus gaining one point. The two would appear to have moved the same distance in level of living but the cost of making such a move in terms of investment in household equipment would be quite different. Furthermore, the economic gain would be disproportionate. It could cost as much as 500 to 1000 times as much as to make the same change at the bottom of the Belcher scale. The observation that the Indians were improving faster than the Ladinos could therefore be misinterpreted since their movement was from one very low level of living to one just slightly better, while the Ladinos at the top could be moving from a high level of living to one that is a good deal higher, economically speaking. As a consequence of these problems, data were obtained from Guatemala on the cost of various items included in the Earthquake Study version of the Belcher level of living scale. These data were used as a means of weighting the items on the scale to create a new scale. This scale reflects the cost of obtaining the capital equipment to establish a given life style. When damage scores are figured it reflects the amount of dollar loss suffered as a result of impact. This method has the advantage of using a clearly defined underlying scaler dimension, cost, as the basis for measurement. It makes no assumptions about well-being or technological efficiency in so doing and therefore escapes some of the criticisms of other level of living scales. This new scale measures the relative cost of establishing a given household life style. To distinguish this scale from other level of living scales, it can be called an "Index of Domestic Assets." For convenience in this paper it will be referred to as a cost weighted level of living scale.

Another advantage claimed for this measure relates to its cross-cultural interpretation. If an earthquake of similar magnitude strikes two different communities and does the same proportional amount of damage, but the two communities differ in household level of living, this will be reflected in the scores. For a very poor community where each household function is performed using the lowest cost, most primitive method, the value of the loss will be proportionately lower than in one where the opposite is the case. Furthermore, the cost of reconstructing the communities will be quite different. It may cost a thousand times more to reconstruct one than the other, although both suffered loss of, say 50%, of their household level resources. Similarly, a small amount of financial aid to one community will have a greater impact on changing household level of living than in the other. These facts have far-reaching policy implications for the international disaster relief community.

Another implication is that the same amount of aid given to the lower socio-economic and upper socio-economic group will have quite different change implications for household level economies. The way aid is distributed could partially close the economic gap among strata in the same society and thereby set in motion modifications in the stratification system. This too has far-reaching policy implications for how disaster relief funds are utilized. In the following pages these two forms of level of living scales will be compared in terms of what they show about the impact of the 1976 Guatemalan earthquake and what they reveal about the recovery process.

Comparison of Findings from the Guatemalan Earthquake Study Using Various Level of Living Scales

It is possible, using the design of the Guatemalan earthquake study, to compare several level of living scales in terms of how they measure the impact of the earthquake and restoration of level of living over a four year period following it. The design for this study employed a group of earthquake-affected communities as a kind of experimental group in which to test hypotheses about the recovery process against a second set of lightly affected or unaffected communities which serve as a control group. In each community a random sample of households was interviewed using three waves of interviews coming about a year apart. On the basis of these interviews, level of living measures can be constructed for four points in time as shown below:

T_1, Pre-earthquake Level of Living, 1975

T_2, Level of Living Day After the Earthquake, 1976

T_3, Level of Living Two Years After the Earthquake, 1978

T_4, Level of Living Four Years After the Earthquake, 1980

From these various level of living scores differences in levels of living, or differences in amount of change between time periods can be computed for any sub-sample group of households. For purposes of this paper, three level of living measures will be compared in terms of what they reveal about experimental control group differences through time. The first will be the Belcher scale which uses the five point weighting technique in which each individual item is equally weighted. This scale employs eleven functional dimensions and therefore scores can vary from a maximum of fifty-five to a minimum of eleven.

The second scale is one in which eight of the same items employed on the Belcher scale have been weighted according to an estimate of their dollar cost. The total score on this scale for a given household reflects the dollar value of the household possessions they use to satisfy eight of the functions on the Belcher scale. This scale is called a "cost weighted" level of living scale, or an Index of Domestic Assets. It should be understood that individual functional areas are unequally weighted on this scale since their weight is determined by actual dollar cost of the item used to satisfy a given function. All in all, the cost of housing weighs heaviest compared to other functional areas.

In general, these two scales represent the household situation quite differently conceptually. The Belcher scale posits a straight line relationship between levels of technological efficiency and level of living value, while the cost weighted scale builds in a curvilinear function. The relationship between the two can be diagrammed roughly as shown in Figure 1.

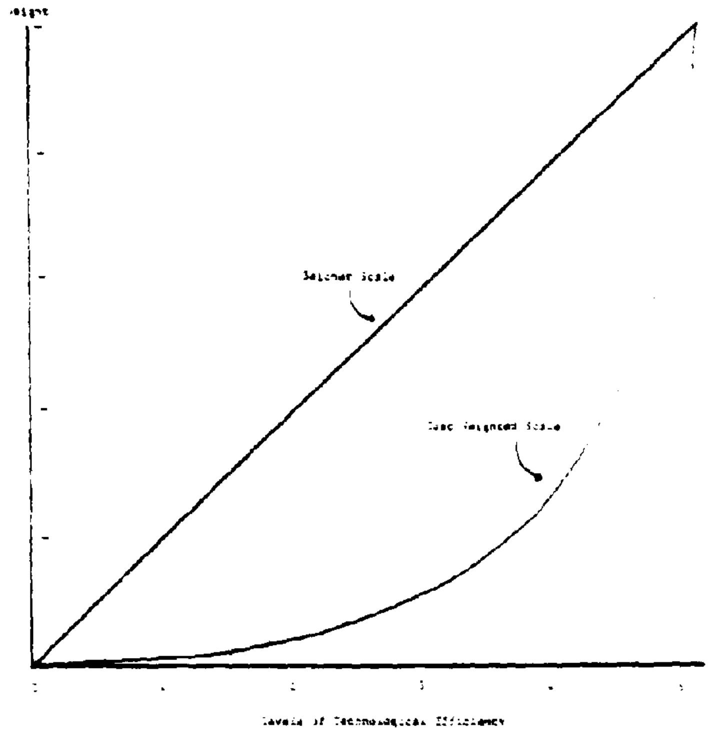

Figure 1

General Relation Between Belcher and Cost Weighted Scales of Index of Domestic Assets

In order to make the cost weighted scale more usable employing parametric statistics and, at the same time, to dampen the effects of extreme values, a third scale is presented in this paper. This scale weights each functional area by the log of cost and then sums the logs of the items to obtain a score for an individual household. This scale will be called the Log Scale in the following discussion.

Table 1 shows the mean and medians for these three scales for the control and experimental groups at various points in time. It also gives the results of an appropriate test of significance between control and experimental group values. The t test is used for the Belcher scale and

Table 1

Comparison of Three Level of Living Scales with Respect to How They Measure Disaster Impact and Recovery

Year/Scale	Experimental Group N	$\bar{X}$	Md.	S	Control Group N	$\bar{X}$	Md.	S	Significance of Difference Probability
1975									
Belcher	791	28.16	26.00	8.49	346	28.79	26.13	10.91	.336(t)
Cost Weighted	804	1212	1022	729	348	1148	935	921	.155(X^2)
Log of Cost Weighted	804	53.42	51.36	12.89	348	54.38	51.10	14.99	.299(t)
1976									
Belcher	791	19.22	17.45	9.07	346	27.58	24.66	10.91	.0001(t)
Cost Weighted	804	466	283	664	348	1009	797	883	.0001(X^2)
Log of Cost Weighted	804	32.59	32.32	19.65	348	52.80	49.14	15.59	.0001(t)
1978									
Belcher	787	29.94	28.73	8.80	341	30.45	29.06	10.80	.445(t)
Cost Weighted	804	1110	884	882	348	1205	1009	868	.007(X^2)
Log of Cost Weighted	804	53.74	51.74	12.78	348	55.92	55.10	14.38	.015(t)
1980									
Belcher	661	31.95	30.60	9.11	299	31.52	30.46	10.98	.548(t)
Cost Weighted	676	1363	1013	1015	306	1388	1130	1027	.119(X^2)
Log of Cost Weighted	676	56.36	53.80	13.40	306	56.95	56.38	14.93	.552(t)

for the log scale since both form reasonably normal distributions. The median test is employed for the cost weighted scale since it is heavily skewed toward lower values.

This rather complex table reveals several important conclusions about the earthquake and the reconstruction process, and about the three level of living scales. First is the fact that just before the earthquake in 1975 the control and experimental groups were similar in level of living as revealed by all three scales. For example, the Belcher scale shows the experimental group's average level of living as 28.16 as compared to 28.79 for the control group. Medians also show remarkable similarity on this scale, 26.00 and 26.13. The cost weighted scale shows that the average cost of household possessions contained in the scale was $1212 for the experimental group as compared to $1148 for the control group. The difference is not statistically significant. Examination of the median cost of household equipment for the two groups shows $1022 for the experimental group and $935 for the control group; again not statistically significant. It can be seen by comparing the mean and median, however, that the cost weighted scale is skewed considerably, with most of the cases falling at the lower end of the scale. Finally, the log scale, which shows a mean for the experimental group of 53.42, and one for the control group of 54.38, also does not achieve statistical significance. In short, all three ways of measuring pre-earthquake level of living show similar results for the control and experimental groups. This means that differences which emerge at the time of the earthquake or later can be viewed as a consequence of things associated with the earthquake or with the reconstruction process.

The 1976 figures represent level of living the day after the earthquake. These figures were obtained by depreciating the 1975 level of living scale by the proportion of damage to each item which occurred in the earthquake as described earlier in this paper. The first thing to note is that all three scales show a significant difference between the control and experimental groups. This is not a particularly surprising result since the control group was selected deliberately to consist of communities with very light or no damage. It can be seen that some loss of level of living did occur in the control group, but not much, compared to the experimental group. The experimental group dropped from 28.16 to 19.22 on the Belcher scale, from $1212 to $466 on the cost weighted scale, and from 53.42 to 32.59 on the log scale. Both means and medians reveal major losses in the experimental as compared to the control group.

At this point it is well to note that the cost weighted scale reveals a loss of $746 out of $1212 for the average person in the experimental group. This amounts to a 61.55 percent loss in level of living as measured by this scale. It can be assumed that at least an investment of this amount per household would be necessary to restore the level of living of families in the earthquake area to their previous level. Since the scale only measures losses on a selected group of household items, it is more useful to view this figure as an indicator of the disaster's magnitude than an actual cost figure.

Differences between the Belcher scale and the others show up as the levels of living two years after the earthquake are examined. In 1978 the Belcher scale shows that the experimental and control groups are again statistically similar on level of living, with the experimental group scoring 29.94 on an average and the control group 30.45, a difference which is similar to that observed before the earthquake. If this scale is used to measure recovery, then it appears that it has taken place by 1978. Because of the nature of the Belcher scale, however, changes at the bottom of the scale and changes at the top are counted equally and compensating errors may lead to incorrect conclusions.

As can be seen, the cost weighted scale leads to an opposite conclusion. It shows the control and experimental groups to remain unequal in 1978, with the experimental group lower in the dollar value of level of living. Similar results are obtained from the log scales. The results of the cost weighted scale reveal that the experimental group remains 8.4 percent below its pre-earthquake level of living, while the control group has increased its level of living 5 percent above its pre-earthquake level, leaving a gap of 13.4 percent between them. At the bottom of the table, change scores are given for the period 1975-1978. It can be seen that a similar situation is registered here where the cost weighted and log scales show the experimental group still below 1975 pre-earthquake levels, while the Belcher scale shows them as essentially equal. For the cost weighted and log scales it is necessary to conclude that recovery had not yet taken place in 1978.

By 1980 the three scales show no difference between the control and experimental groups and therefore would lead to the similar conclusion that recovery, as measured by household level of living, had substantially occurred by that time. However, the three scales would lead to different conclusions where the total amount of change in level of living between 1975 and 1980 is concerned. Here the Belcher scale shows a significant difference in the amount of change between the control and experimental groups, with the experimental group increasing in level of living more than the control group. This leads to the conclusion that the earthquake and the reconstruction process actually resulted in positive gains in the experimental group and not just recovery. The cost weighted scale leads to the opposite conclusion. It shows that the experimental group gained $178 in level of living as compared to $244 for the control group, but that the difference is not statistically significant. The log scale shows that the control group gained less (2.49) than the experimental group (3.10), but again the results are not statistically significant.

When the median levels of living, as represented by the cost weighted scale, are plotted on a graph, they reveal both a general economic trend which was affecting the control and experimental groups alike, gradually raising their levels of living and also the effects of the earthquake (Figure 2). They show the experimental group slightly higher than the control group at the beginning of 1975, and slightly below it in 1980, five years later. In the meanwhile, the earthquake devastated the experimental group and drove its level of living down by around 60 percent. During the next four years the experimental group recovered to very near its original level. Meanwhile the control group which was only slightly affected by the disaster gradually improved in level of living.

The conclusion that can be drawn from the data presented in Tables 1 and 2 is that the three types of scales yield similar results in most cases. The Belcher scale, however, has a tendency to mask differences at the extremes, and therefore to be less useful in dealing with change than in cross-sectional comparisons. The cost-weighted scale has certain

Table 2

Comparison of Three Level of Living Scales with Respect to How They Measure Change Between Various Time Periods

Year/Scale	Experimental Group N	X	Md.	S	Control Group N	X	Md.	S	Significance of Difference Probability
1976-1975									
Belcher	791	-8.94	-9.00	5.42	346	-1.21	0.00	2.58	.0001(t)
Cost Weighted	804	-745	-805	456	348	-139	0.00	272	.0001(X^2)
Log of Cost Weighted	804	-20.83	-22.18	15.14	348	-1.59	0.00	5.56	.0001(t)
1978-1975									
Belcher	782	1.93	1.97	4.65	341	1.71	0.00	4.79	.456(t)
Cost Weighted	804	-101	-150	658	348	57	0.00	535	.0001(X^2)
Log of Cost Weighted	804	.31	-.22	8.54	348	1.53	0.00	7.27	.013(t)
1980-1975									
Belcher	659	4.08	3.67	5.00	297	2.72	1.60	5.34	.0002(t)
Cost Weighted	676	178	15	726	306	244	57	663	.215(X^2)
Log of Cost Weighted	676	3.1[illegible]	1.81	5.04	306	2.49	.46	8.64	.323(t)
1980-1978									
Belcher	657	1.98	1.[illegible]4	3.48	266	1.[illegible]4	.03	3.22	.0001(t)
Cost Weighted	676	261	34	566	306	1.79	0.00	451	.0002(X^2)
Log of Cost Weighted	676	2.49	.60	6.14	306	.90	0.00	5.47	.0001(t)

definite advantages associated with the fact that it measures difference and change in monetary units that are easily understood. It furthermore has the advantage of giving heavy weight to losses of expensive items and light weight to the loss of less costly ones. Thus it comes closer to representing change and loss in units meaningful to policy decisions. It has the disadvantage of weighting the losses of a rich man heavier than a poor man. This is the price for using the value of what is lost as the underlying metric. The scale, however, contains the information necessary to create a proportion of loss score and thus to equate people in different economic strata in terms of how hard they were hit relative to their economic base. The log scale is most useful in dealing with change, and in using level of living as a variable in regression analysis or with other parametric statistics. Each scale has a use and is of value in analyzing disaster impact and recovery.

Now that the three scales have been examined in relation to one another, it will be useful to examine what the cost weighted scale reveals concerning the disaster's impact on various sub-samples and what it shows about the recovery process for these groups.

Political Status of Communities

Table 3 shows median cost weighted level of living scores for each type of community studied in the Guatemalan earthquake study for each year that data exist. These data are shown in graphic form in Figure 3. The highest median level of living was registered in departmental capitals before the earthquake ($1233), the next in the city, then the municipios and, finally, the aldeas or rural villages. The city sample used in this study was unlike the samples drawn in other types of units. It consisted of four urban neighborhoods which were formed after the earthquake to house lower socio-economic status disaster victims and therefore does not represent a random sample of Guatemala City. In all other cases the samples represent the type of unit listed. If a random sample of the city had been drawn, it would have undoubtedly resulted in the highest level of living being registered there. In other words, level of living in Guatemala before the earthquake varied directly with the size of place or with its political status in the Guatemalan Governmental administrative system.

The 1976 figures show that the earthquake seems to have had its greatest impact on the municipios studied and a relatively smaller impact on department capitals, with the city and aldeas ranking in between. When the 1978 and 1980 figures are examined the effects of the reconstruction process show up. Indications are that the city not only recovered quickly, but exceeded its previous level of living by a relatively large amount. Similarly, but not as dramatically, municipios recovered and exceeded their previous level. Aldeas, in contrast, recovered more slowly and from all appearances, have not yet reached pre-disaster levels of living. Interestingly enough, department capitals seem to display this same pattern, but to a lesser degree. These differences at present are believed to be the consequence of differences in housing programs in the various types of communities. In both of the department capitals studied, and in all but one of the aldeas, temporary housing programs dominated. In the municipios, and in two out of four cases in the city, permanent housing programs dominated. Permanent housing programs, for the most part, furnish more costly houses to people and, along with them, such housing amenities as running water,

Table 3

Median Scores on Cost Weighted Level of Living Scales for Various Points in Time, Showing Median Changes Between Time Intervals

	1975	1976	1978	1980	1976-1975	1975-1978	1975-1980
Political Status (Experimental Group Only)							
City	1183	501	1208	1565	-600	3	220
Dept. Capitols	1233	881	1006	1208	-850	-203	17
Municipios	1029	238	979	1202	-818	- 35	100
Aldeas	880	257	657	680	-481	-144	- 5
Ethnicity (Highlands Experimental Group Only)							
Indians	937	125	826	946	-844	-150	0
Ladinos	1087	383	940	1145	-738	-119	57
Region (Experimental Group Only)							
East	980	411	940	1157	-570	0	57
Highlands	1029	195	808	1002	-853	-160	7
Experimental Status (Excluding City)							
Control	935	797	1009	1130	0	0	57
Experimental	1022	283	884	1013	-805	-150	15

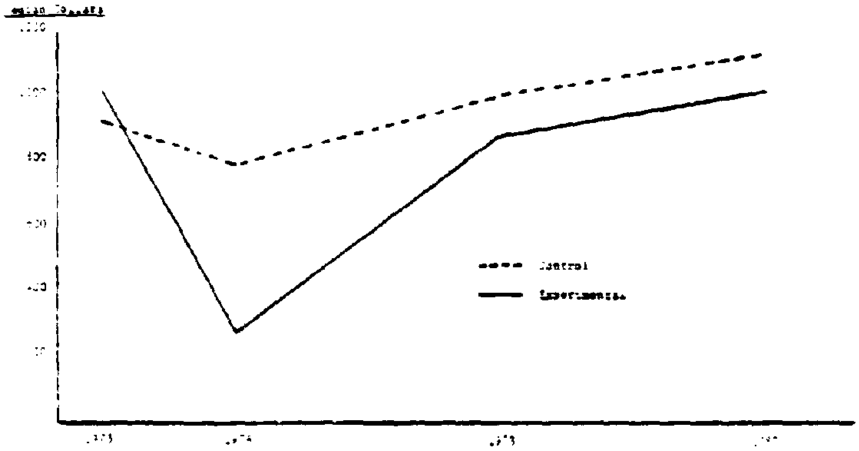

Figure 2

Change in Median Value, Level of Living, Cost Weighted Scale, Experimental and Control Groups, 1975-1980

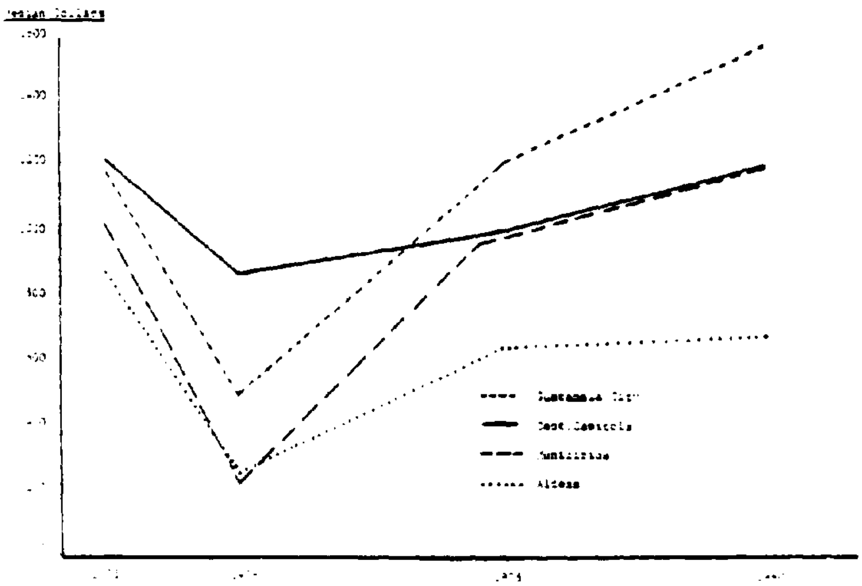

Figure 3

Change in Median Value, Level of Living, Cost Weighted Scale, By Type of Community, 1975-1980 electricity and sewage. Further analysis is needed to determine if this interpretation is correct, but if it is, then Figure 3 may present a picture of how temporary housing programs slow down recovery from a disaster.

Figure 4, along with data in Table 3, show differences between the two major ethnic groups in Guatemala comparing Indians and Ladinos from the Highlands experimental group at various points in the disaster process. It can be seen that Indians scored lower on level of living at each point in time. For a period of two years, they appear to have recovered more quickly from the disaster than Ladinos in the same communities, but during the last two years the spread between Indians and Ladinos appears to have increased. Differences at every point along this line are significant statistically. The explanation for these facts probably lies in the nature of the management of the reconstruction process during these time intervals. Most of the work by foreign agencies was done in the first couple of years following the earthquake. They seemed to prefer to work with Indians in the Highlands and may have given preference to this ethnic group in reconstruction. During the last two-year period, reconstruction became more of an internal Guatemalan effort, with self help being more important than agency programs in general. This meant that the more well-off, better placed Ladinos of the Highlands had a greater chance to improve their situation since they had greater economic and political resources to begin with.

Another comparison that can be made is between two major regions of Guatemala, the predominantly Indian Highlands, and the totally Ladino East. Figure 5, along with figures in Table 3, give comparisons along these lines for the experimental group only. These data show that no real significant difference existed between these regions at any point except in terms of disaster impact. The Highlands lost more than the East but has recovered about as fast and there are now no significant differences in their level of living scores as measured by the median on the cost weighted scale.

<u>Summary</u>

This discussion illustrates the utility of a level of living scale for measuring the impact of a disaster and for monitoring the recovery process. There are a number of weaknesses present in the scales used in this particular study that are not inherent in the technique in general. Because the idea of cost weighting did not occur to the researchers until late in the project, it was not possible to go back and change the data collected to conform to this idea. Instead, available data had to be employed. Essentially this meant that only eight household items could be employed in the final scale. These eight are treated as indicators of what overall costs would have been, had exhaustive information been available.

Future scales designed specifically to be cost weighted can easily employ a different set of items more reflective of the cost of maintaining a given level of living. It is believed, however, that the work in Guatemala demonstrates the utility of using such scales as a means of obtaining reliable measures of disaster impact and recovery. Belcher has demonstrated in his work that these scales have cross-

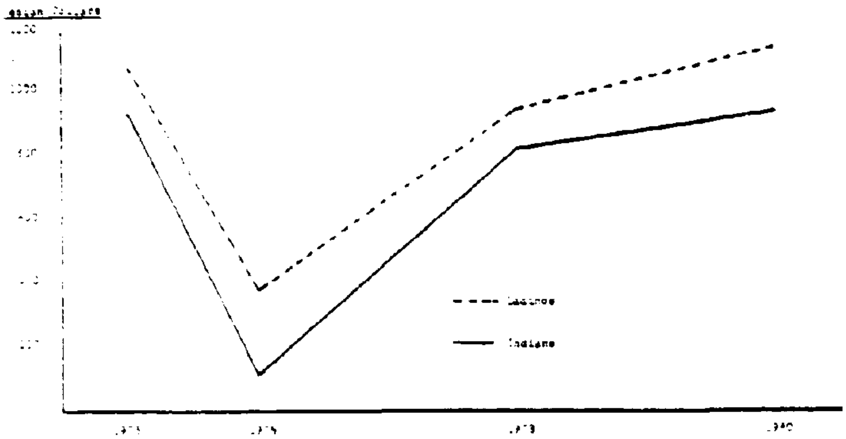

Figure 4

Change in Median Value, Level of Living, Cost Weighted Scale, By Ethnic Group, 1975-1980

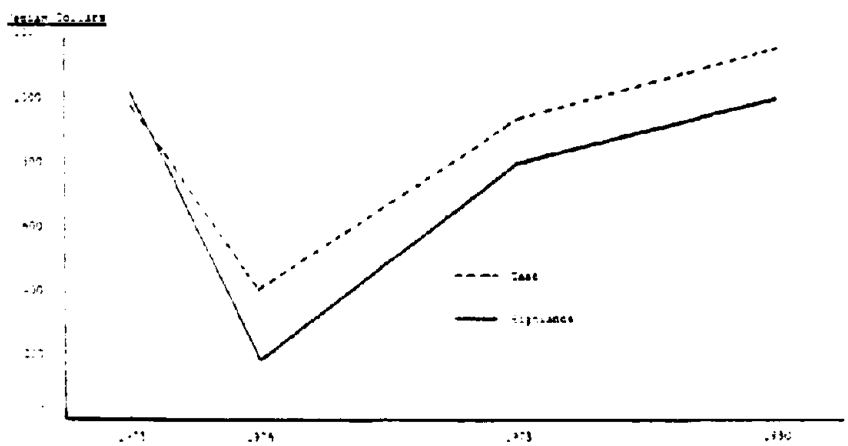

Figure 5

Change in Median Value, Level of Living, Cost Weighted Scale, By Region, 1975-1980 cultural relevance. It is obvious that they can be applied in many different kinds of disaster situations, regardless of the disaster agent, since the measure is of impact on household assets and not the force of impact as a physical measure.

FOOTNOTE

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Appendix A

Preliminary Cross-cultural Scale for Measuring Level of Living

Function	Item	Score
Function 1.	Shelter: construction of exterior walls	
	Brick, concrete block masonry, painted frame	5
	Asbestos or asphalt siding	4
	Unpainted frame	3
	Scrap wood, Coca cola signs	2
	Grass, leaves, none	1
Function 2.	Shelter: construction of living room floor	
	Finished hardwood, tile, terrazo	5
	Finished or painted softwood, bare concrete	4
	Unfinished hardwoods or softwood with tongue and groove	3
	Wood with cracks	2
	Earth	1
Function 3.	Shelter: construction of roof	
	Concrete, tile, good shingles	5
	Corrugated or sheet metal, warped shingles	4
	Roll roofing, thatch	3
	Straw, Coca-cola sign	2
	None, roof with large holes	1
Function 4.	Storage of water	
	Automatic: house piped	5
	Cistern	4
	Clay barrel designed solely for water storage	3
	Large clay jar	2
	Buckets, tin pails	1
Function 5.	Transportation of water to home	
	Automatic, faucet in home	5
	Hand pump, faucet in yard	4
	Bucket with pulley in yard	3
	Bucket from well or stream in own yard	2
	Carry over 100 yards	1
Function 6.	Lighting	
	Electric fixture, lamps	5
	Electric bare bulb	4
	Carbide or gasoline lantern	3
	Kerosene lamp	2
	Candle, open fireplace	1
Function 7.	Preservation of perishable food	
	Electric or gas refrigerator	5
	Ice box	4
	Spring house, cellar	3
	Window box, clay jar	2
	None	1
Function 8.	Eating: place settings of flatware	
	Over two per person (sets of knife, fork, and spoon)	5
	One to 1.9 per person	4
	One utensil or more per person, but less than one place setting per person	3
	Partial for entire household: fewer utensils than people	2
	None: use hands	1
Function 9.	Disposal of human wastes	
	Flush toilets	5
	Modern pit toilet	4
	Privy	3
	Trench and stick in fence corner	2
	None	1
Function 10.	Transportation	
	Owned or leased automobile; in some situations, a motor boat or airplane	5
	Motorcycle or other small motorized vehicle	4
	Horse with wagon or buggy	3
	Bicycle, horse or mule	2
	Foot only, or public facilities	1
Function 11.	Cooking food: equipment	
	Electric or gas range	5
	Hot plate, kerosene or oil stove	4
	Manufactured wood stove	3
	Clay stove, mud table, hibachi	2
	Three rocks, bare ground	1
Function 12.	Fuel for cooking	
	Electricity or gas	5
	Oil	4
	Wood or charcoal	3
	Small sticks, scrap wood	2
	Weeds, leaves, dung	1
Function 13.	Cleaning floors of home	
	Vacuum cleaner	5
	Electric broom or sweeper	4
	Purchased dust mop and/or good grade broom	3
	Native broom or mop	2
	None	1
Function 14.	Washing dishes	
	Automatic dishwasher	5
	Sink with drain	4
	Dishpan (no sink)	3
	Multipurpose pan: kettle or washpan	2
	Wash in stream or at pump	1

Appendix B

Comparison of Items Used on Belcher Scale and Scales Used in Guatemalan Earthquake Study

Function Areas on Belcher Scale	Used in Eleven Item Earthquake Study Belcher Type Scale	Used in Eight Item Cost Weighted Scale
1. Shelter: Construction & Walls	Yes	Yes**
2. Shelter: Construction of Floor	Yes	Yes**
3. Shelter: Construction of Roof	Yes	Yes**
4. Storage of Water	No*	No
5. Transportation of Water (water source)	Yes	Yes
6. Lighting in Home	Yes	Yes
7. Preservation of Perishable Food	Yes	Yes
8. Eating: Place Setting of Flatware	No	No
9. Disposal of Human Wastes	Yes	No
10. Transportation (of family members)	No	No
11. Cooking Equipment	Yes	Yes
12. Fuel for Cooking	Yes	No
13. Cleaning of Floors	No	No
14. Washing Dishes	Yes	Yes

*Distance to water used instead on 11 item scale in Guatemala. The greater the distance, the lower the weight given.

**Cost figures were applied using a standard house of 3 x 4 meters containing either one or two rooms. If house had more than two rooms, the cost of walls, roof and floor were multiplied by following factors: 3 = x1.25, 4 = x1.50, 5 = x1.75, 6 = x2.00, 7 = x2.25, 8+ = x2.50. This means that number of rooms represents an additional item used in cost weighted scale.

THE CASE OF FRIULI, ITALY

THE IMPACT OF AN EARTHQUAKE IN A HIGHLY DEVELOPED OLD CULTURE: REGIONAL IDENTITY VERSUS ECONOMIC EFFICIENCY

Robert Geipel

Introduction

During the past decade there has been a considerable increase in the number of research publications concerning natural hazards in general and earthquakes in particular. The reports on the 1964 Alaska earthquake [1970], the 1971 San Fernando earthquake [1973] and disasters in Managua, Anatolia and elsewhere provided information which could be used to develop rules for disaster management and reconstruction [Haas et al., 1977], [Friesma et al., 1979], [Wright et al., 1979]. However, the publications show the tendency to apply a systems analysis approach to these experiences and lose sight of the individual characteristics of a particular disaster. Because authors seek to fit their findings into existing models (which are taken mostly from a background of the two Americas), the individual traits of a particular disaster are often neglected, although they might be useful in giving breadth to models which are too narrow. This is especially apparent when disasters happen in the region of a highly developed older culture.

The purpose of this paper on the earthquakes of May 6 and September 15, 1976, in the Friuli area of northeastern Italy is to re-examine and extend existing knowledge about how a regional society behaves in a catastrophe. It is indispensable in doing so to take a careful account of social, economic, cultural and political circumstances in Friuli as they were before and at the time of the disaster, as well as during the period of reconstruction. The paper is intended as a contribution to the quest for a better understanding of the nature of natural hazards and the way in which inhabitants of vulnerable areas respond to them. While it draws upon the findings of research undertaken previously and especially in North America, it attempts to break new ground. Much of the previous work has been devoted to developing models of human reactions to disaster in a single city or parts of a city. In addition, many of the studies have not taken into account the problem of external influences. The Friuli earthquake affected nearly 100 rural and urban communities spread over 4800 km^2. The impact varied not only with physical circumstances but also with cultural, social and political characteristics. The results of the studies undertaken in 1976 through 1980 with the support of DFG led to the publication of four books [Geipel, 1977], [Steuer, 1979], [Geipel et al., 1979], [Dobler, 1980] and clearly indicate that the cultural context of natural disasters has an important and perhaps critical influence on how they are perceived and dealt with. It seems that, although there is a considerable variation in physical circumstances in North America, there is a certain uniformity in the perception of hazards and human responses to them. Thus, the perception of flood hazards by householders in one city in the United States might resemble very closely that of residents in another city. Similarly, because adjustments relating to such disasters have often been institutionalized (in this case through the U.S. Corps of Engineers), perceived solutions often have a certain uniformity. In the case of Europe, however, there is often considerable cultural diversity, even over very short distances. It is not surprising, therefore, that human responses to natural disasters differ sharply from one region to another and in many instances differ considerably from experiences on the other side of the Atlantic. This has been strikingly confirmed through the Naples earthquake of November 23, 1980. In spite of the fact that Giuseppe Zamberletti, the former deputy Secretary of the Interior (and since June 27, 1981, Italy's first Minister of Civil Protection), the same Emergency Commissioner who had been quite successful in the Friuli disaster was in charge of this second earthquake, the socio-political and psychological situation was totally different. Thus we have a case in which the same person using the same strategies of evacuation to nearby resort hotels in the same country led to different results.

The Events

On May 6, 1976, at 9 p.m., an earthquake with a strength of 6.4 on the Richter scale and lasting almost a minute took place in the area of Friuli in northern Italy. Its epicenter lay only 5 km below the surface. The number of dead and wounded was very much affected by the particular time of day and the weather; most people were at home, but out of doors because of the heat of the early summer evening. Nevertheless, 939 persons perished in the wreckage of the 17,000 collapsing houes, and 2,800 were injured. The homes of 32,000 people were totally destroyed. Several hundred tremors, aftershocks and the heavy rain that set in immediately after the quake pulverized the already badly damaged buildings still further, making the homes of a total of 157,000 people unusable. Altogether, an area of 4800 km^2 embracing nearly 100 communes with a population of half a million, was affected by the catastrophe, and a zone of 25 km across, containing 1766 km^2 was totally levelled. The first, somewhat exaggerated, estimates placed the damage at $6 billion.

The initial relief measures were favored by the fact that around two-thirds of the Italian Army were holding maneuvers in northeastern Italy at the time of the catastrophe, and NATO troops and Austrian and German relief organizations arrived quickly on the scene. Camps with a total of 16,000 tents sprang up, railway cars were brought into the ruined settlements and small mobile campers were set up. An Emergency Commissioner sent from Rome assumed charge of the administration in

Udine and Pordenone Provinces and set up emergency headquarters in the provincial capital of Udine.

PUBLIC DEMAND	zero-hour 1	within 24 hrs	48 hrs	3 days	within 1 week
STATE AID SUPPLIED	9:00 pm 6 May 76	rescue of people from collapsed buildings; life-saving; fire protection measures, safety test of major bridges etc.; provision of tents, camp beds, blankets.	medical aid, operations, amputations, water supply, care of aged, children and the ill. Issuing of emergency decrees.	Burial of the dead. Removal of animal carcasses to prevent epidemic. Sanitary installations. Identification of unsafe structures.	Emergency housing for the able-bodied population. Distribution of aid supplies. Closing off of ruined buildings. Public security against looting; protection of artistic treasures.

PUBLIC DEMAND	within 1 month	1/4 year	zero-hour 2	24 hrs	48 hrs...
STATE AND FOREIGN AID	Clearing of rubble under reconstruction plan. Systematic application of foreign relief supplies. Major administrative regulations and regularized law-making.	Selection of areas for rebuilding. Restoration of infrastructure (schools, hospitals). Foundations laid for prefab cities.	11:30 am 15 Sept.76 second earthquake	mass evacuation to the Adriatic Coast	

Figure 1

Synopsis of Demand and Supply
for Aid Measures

There was no mass flight from Friuli, despite the extent of the damage, even though after centuries of emigration many Friulians live all over central and western Europe, the United States, Canada, Australia and South America, keeping close connections with their homeland, and on this occasion offered their hospitality and suggested their kin leave Friuli and join them. On the contrary, the people wished to begin reconstruction forthwith and to bypass the phase of merely temporary accomodations.

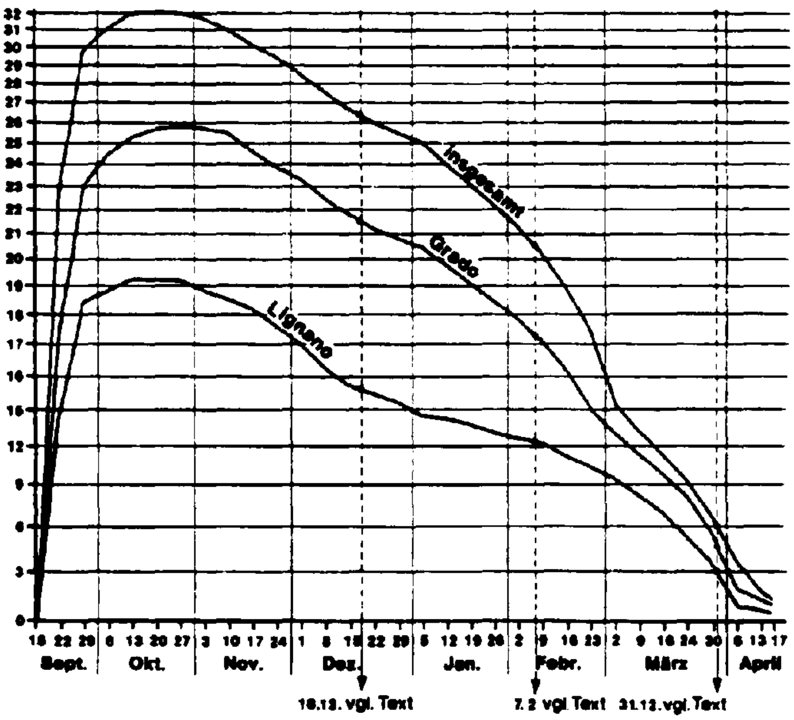


Figure 2

The Sequence of the Evacuation Operation

The fears of Friulians that the fate of victims of Sicily's Val Belice earthquake of 1968 might be repeated in their case gave rise to the motto "Dalle tende alle case" (<u>straight</u> from the tents into the houses and not into barracks first), a strategy that was followed by the Yugoslav authorities just across the border [Adamic, 1979]. An end came abruptly, at 11:30 a.m. on September 15, 1976, to the four and a half months of continuous and energetic rebuilding of houses and especially factories. After numerous light shocks a second earthquake, at a strength of 6.1 on the Richter scale, struck Friuli again. The number of homeless, which had decreased by the beginning of September to 45,000 because of the repair of less badly damaged buildings and because people found shelter with friends and relatives elsewhere, swelled again to more than 70,000.

Even though the quake was weaker than the first on May 6, the psychological effects on the people were much worse this time. Bad landslides and rockfalls blocking escape routes out of the mountains, the loss of savings that had already been invested in reconstruction, the dangers of the severe mountain winter in prospect, all overwhelmed the resistance capacity of a mountain population accustomed to privation. Although the loss of life this time was much less (only 11 additional fatalities) and despite the fact that nearly 400 tremors between the May and September earthquakes had made the inhabitants aware of the riskiness of the ruined buildings, it was only at this point that the great exodus from the afflicted area began.

The Emergency Commissioner installed on May 7, who had planned relief measures only until July 27, was nevertheless reappointed on September 13 because the regional administration was totally overwhelmed, and he received expanded powers once more after September 15. He was thus able to requisition hotels and apartments in the Adriatic coastal towns, occupied only during summer and standing empty in winter, as housing for the elderly, the disabled and women and children.

Many able-bodied people were also evacuated to the coast, however, and had to contend with a long daily journey to their jobs within the disaster area. Farmers who did not wish to leave livestock unattended, as well as persons who were determined to get on with the rebuilding of work places and homes, mostly refused evacuation, however, and spent the unusually cold winter of 1976/77 in primitive emergency quarters. Illness due to the cold and to overwork was common not only within the disaster area but also in the coastal towns, foggy, chilly, and inhospitable in winter, where many of the hospitals simply had no heating. Lignano and Grado bore the brunt of the evacuation.

Reconstruction plans after the first earthquake were hampered by the Italian parliamentary elections set for June 20, 1976, discouraging politicians from carrying out unpopular measures such as identifying and requisitioning areas suitable for building barrack settlements, or from deciding not to plan for the reconstruction of places that were too remotely located. At the end of 1976, 2,500 people were already living in newly erected prefabs, temporary shelters and railway cars; 15,000 were occupying small camping trailers; 1,000 still dwelt in tents despite the hard winter; and 25,000 remained in the evacuation centers on the Adriatic Coast. Thus housing space had to be created for some 66,000 people. A major prefabricated housing program made provision for about 21,000 units. Despite the hindrance of an extremely severe winter, the evacuees were successfully returned from the coast towns by mid-April, just before the beginning of the tourist season. At that period the Department of Geography of the Technische Universitat München started a survey among the occupants of prefabricated houses with a questionnaire: 6,568 of them, representing households with a total of

20,538 members, were returned for data processing. This 40% response rate can be regarded as reasonably high in a disaster area and under the prevailing circumstances. We will discuss the results of this survey later.

The Importance of a Specific Geographical Location

Friuli occupies the northeastern corner of Italy, wedged between Austria and Yugoslavia. Ethnic minority groups speaking German and Slovenian live within the Italian territory, which may account for the exceptionally high degree of aid given to the disaster area from the adjacent countries. At the same time, being geographically remote from the central government in Rome, the local inhabitants, 400,000 of whom were native Friulians of Romance (rhaetoromanic) language, tended to be uncertain about the roles that should be or were played by outside aid-giving agencies from Switzerland, Austria, West Germany and Yugoslavia. Such influences, overtly or otherwise, could indeed lead to a loss of authority by the central government.

The peninsular state of Italy at the moment of disaster was evidently seen by a large part of the population of Friuli as far more remote than the neighboring countries in the Alps. Since links to the Italian nation as a whole were not very strong, the previous struggle for more autonomy for the Region of Friuli--Venezia Giulia--started to become even more emphatic, and the earthquake did not appear as an Italian but as an Alpine catastrophe. The criteria for efficiency in disaster management were derived from the performance of Swiss, Austrian and German rescue and reconstruction teams and NATO troops and less from the performance of the Italian government for which the earthquake in Val Belice, Sicily, of 1968 was used as a negative example. The Friulians, in a situation of disaster, literally speaking, were looking more to the North than to the South, the more so since quite a few economic problems such as farming in high altitudes, small family farms, or possibilities of mountain tourism seemed to have more in common with the overall Alpine than with the normal Italian environment.

This can be illustrated by the example of the border settlements at high elevations. The boundary area lies relatively high in comparison to peninsular Italy and is in some cases (Sauris; Prossenico) inhabited by members of ethnic minorities. This location of settlements at high altitudes has developed over the centuries on the basis of farming in the valleys and on the slopes and of cattle raising at still higher altitudes.

This lifestyle, in the meantime, has become obsolete because of the smallness of farm units and the economic pressure from the Common Market. These villages in higher altitudes were populated mostly by elderly people, frequently single, using agriculture for self-subsistence only and living from pensions or the remittances of younger members of the family who had not emigrated. High costs for the maintenance of roads and a not very effectively used infrastructure of cribs and schools, etc., made it reasonable for the government in Rome to think of radically modifying this obsolete settlement pattern, especially since the catastrophe had put an abrupt end to the most important argument to keep the remote villages viable at all--houses and apartments. Thus, a process which might have taken two more generations to accomplish has been accelerated remarkably.

These concepts which derived from a "standpoint in the plains" conflicted with the wish of the Friulians and still more so of the other ethnic groups to stay in their harsh mountain environment; wish that was supported by the Swiss, South Tyrolian (German-speaking Italian citizens), Austrian and German aid-giving organizations for whom (in another sociocultural context) the maintenance of the border settlements at higher altitudes was an emotional value in itself, as it was across the border in Yugoslavia. So aid was concentrated on those poor, overaged and remote mountain communities which resembled the environments of the donors and which indeed might have needed it most. But it was spent in the opinion of some Italian planners in a counterproductive way. The coalition between homesick Friulians and emotionally engaged mountaineer helpers from outside outmaneuvered plans to abandon remote villages.

Regional Identity versus Economic Efficiency

The settlement pattern in Friuli consists of small towns and large villages in the plains, the hilly zone and the major mountain valleys. There are, in addition, hillside villages, hamlets and isolated groups of farmsteads in the mountains. This settlement pattern arose over a millenium of natural resource exploitation, mostly centering on agricultural land use. The catastrophe provided an opportunity to change this pattern thoroughly into a more modern one, bringing commuters, whose homes were destroyed anyway, closer to the industrial parks in the plains and provide a much more rational and economic layout for both the provinces of Udine and Pordenone, at least in their northern parts. In the most extreme case, planners could conceive of not returning large proportions of the population to their home communes from the coastal towns after the evacuation, but concentrating the people where possible in new towns. Outside the destroyed area and away from the zone in which there is a high risk of repetition of seismic disasters, away from the mountain districts that can hardly be served by an adequate infrastructure, one or several such "new towns", perhaps along the development axis of Pordenone-Udine-Gorizia-Trieste or simply just "New Udine", would be conceivable. A building program to provide emergency accomodation in temporary housing to 65,000 persons by May 1, 1977 would have been able to accomplish this, and need not be dispersed over 95 communes, but could be used to implement a growth pole theory at one or a few places. Our survey questionnaire therefore asked 'Could you imagine yourself living for the rest of your life in a town like Udine or Trieste?' The response is shown in Table 1.

Of course, rural people could be expected to say 'no,' but many of them had migrated to and lived in big cities previously and one could expect the younger ones to agree to living in a city. (It should be noted in passing that it might have been better to name other, preferably smaller, cities along with Udine and to omit Trieste completely because of the hostility in Friuli against the regional capital.) Obviously, Friuli was not to be turned into 'another monotonous suburb of Milan'. In contrast to a much more mobile society in North America, linkages to the home community are very strong. Analyzing the data from our questionnaire for relationships between (1) demography and social situation, (2) impact of the earthquake, and (3) reaction to the catastrophe, Figure 3 indicates that owning one's own house and land within the commune predisposed respondents strongly to remaining there and proceeding with reconstruction. Of the respondents, 77.3% owned a house. Most desired the reconstructed house to be of stone. Latin people are masters of stone construction and resort naturally to this native building material because of the scarcity of

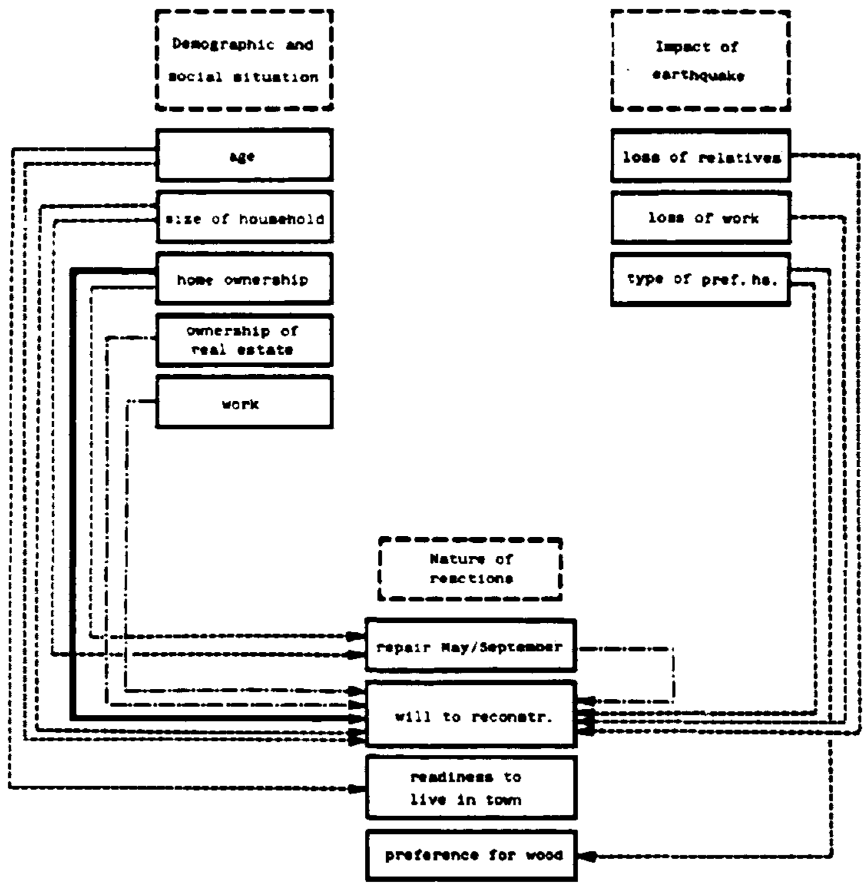
Table 1

Rural Household Interest in Relocation to Large City Environment

Response	Number of Households	Percent
No reply	261	4.0%
Yes	610	9.3
No	5,697	86.7
Total	6,568	100.0%

wood in their lands. The torrential streams of Friuli produce a specially dangerous construction material in the form of rounded river boulders often used in place of quarrystone which is superior but costs more. These rounded river stones laid up with little mortar customarily form the outer walls of older houses, mostly occupied by the older, poorer people. But even more modern houses proved to have inadequate roof-support systems, so that total collapse occurred in them as well. Furthermore, the double-rowed tile roofs sealed with mortar were very heavy and were particularly prone to collapse.

Would the people draw conclusions from the disaster that would influence rebuilding? Were the beginnings of acceptance of the wooden houses present in other Alpine regions and, of course, in earthquake-prone areas such as California, or had the unpopular wooden barracks had a negative effect? The response to the question 'In what type of house would you prefer to live in the future?' is shown in Table 2.



Shown are the significant relationships according to the contingency coefficient Cramer's V.

0,05 - under 0,15
0,15 - under 0,25
0,25 and above

Figure 3

Significant Relationships

In spite of the fact that families today are much smaller and the style of the rural economy has changed, Friuli evidently will be rebuilt in the traditional form. Elements of its material culture with a symbolic meaning, such as the fogolar (an open fireplace in the middle of the room) are experiencing a renaissance. "In time of stress, nations safeguard the physical legacy that embodies their communal spirit" [Lowenthal, 1975].

Table 2

Type of House Desired

Response	Number of Households	Percent
No Reply	347	5.3
In a wooden house resistant to earthquakes	1,110	16.9
In a cement/brick house resistant to earthquakes	5,111	77.8
Total	6,568	100.0

A similar issue, at the larger scale of reconstructing cities not only rebuilding houses, is to prevent further urban sprawl by bringing people closer together and back into the medieval cities. Venzone is an excellent example of this strategy. As a medieval city of rare completeness, Venzone enjoyed a certain income from tourism. The old town was surrounded by a high wall, Venzone's especial pride, which was strictly protected as an historic monument. Pierced by only four fortified gateways, during the earthquake it turned into a fatal trap. All four gateways became blocked with debris, and the people, for the most part advanced in years, were unable to escape from the closely built streets. Most of the 49 fatalities in Venzone died beneath the ruins of the medieval city. Hence the demand was widely expressed to fill in the city moat with the material of the wall. In the stress of the disaster the symbol and token of the city underwent a change in value. But now it will be reconstructed, together with the old town itself. This reconstruction will be based on module-elements derived from units and multiples of the classical Friulian measure of 7 m, a unit in turn determined by the length of logs used in rafts on the Tagliamento river. When such modular elements are assembled and earthquake-proof methods of building applied, the reconstruction of

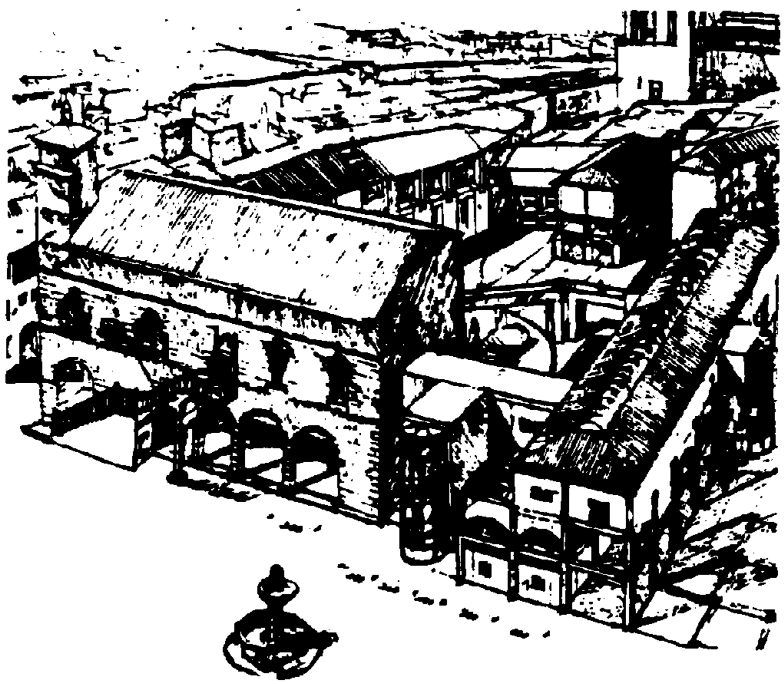


Figure 4

Modular Elements Used for the Reconstruction of Venzone

(Courtesy of R. Pirzio Biroli. In: 'documenti sulla ricostruzione. Monografie di ricostruire, 3. Udine 1977, vol. 1 nr. 3, p.5.)

Venzone is supposed to combine facade elements, such as arches, portals, balconies, elaborate stone window frames etc., rescued from the debris, with modern elements in a way that reflects the city's character but increases its functional qualities. Of course, this reconstruction process takes more time and money than just building houses, but it preserves the regional identity.

Trends Accentuated and Accelerated by the Disaster

The 'laboratory conditions' of a disaster not only bring sudden change in the physical landscape but in the potentiality of change in the social environment also.

Community Activities

Competitive political elements seek to govern the reconstruction process. Different concepts of reconstruction plans can be traced to political power relationships. Political factions struggle to control the "right" future. For example, the charitable organizations from countries providing relief were sometimes embarrassed by the task suggested to them by conservatives to "stabilize the system" by providing support primarily for single family houses on their own parcels, while elsewhere leftist communal governments were trying to achieve a decrease in the "bourgeois" character of the population by means of larger collective buildings.

Secularization

In communes that had anti-clerical majorities there was sometimes a tendency to eliminate the church as the ruins were cleared away. The Catholic Church was foresighted enough, in view of the need in which the population found itself, not to press for the collection of funds for rebuilding the churches. It spread the motto, "Prime i case, dopo i chiese" ("houses first, churches afterwards"). But the secularization that had taken place between the construction of a church in, say, the 17th century and its reconstruction in 1980 became quite evident. People had to decide for themselves and sacrifice; they could not just follow tradition.

Agriculture

Processes long overdue were set into motion, for example, abandoning farming on uneconomically small units. Once the stables were destroyed and cattle had to be slaughtered before the evacuation to the coastal areas, a development became irreversible which might have taken at least one generation to accomplish.

Industry

Industry seems to have entered a stage of accelerated development in spite of and perhaps even because of the earthquake. Factory equipment was modernized. Since the catastrophe was widely publicized, national and international credit institutions could be counted on to be sympathetic. State subsidies and low-cost loans promoted additional investments and increased the number of jobs, especially in the construction and building materials industry.

Loyalty of workforce

Friulian workers are industrious, have an enormous capacity for hard work, and are intensely loyal to their companies. This was an important factor. Being skilled do-it-yourself craftsmen, they switched from their destroyed regular work places and themselves repaired the damage to the plants. While their own dwellings lay still in ruins, the rebuilding of plants was accomplished in an astonishingly short time. This was found by Fritz as early as 1963:

> The renovation of the actors within the system and the consequent total concentration of societal energy on the goals of survival and recovery usually result in the rapid reconstruction of the society and, beyond that, often produce a kind of "amplified rebound" effect, in which the society is carried beyond its pre-existing levels of integration, productivity, and capacity for growth [Fritz, 1963].

Search for more autonomy

The earthquake stimulated the emotional feeling of identity among the Friulians. Their status as a frontier folk between three countries colors their historical experience and unifies them. The Comissario Straordinario (Emergency Commissioner) became the symbol of Roman Centralism pitted in this situation against a heightened sense of regional autonomy. The role of this public servant in the emergency brought into focus all the problems and tensions between political centralism and aspirations for regional autonomy in Italy. There is a separate regional political party that tries to channel and cultivate this sentiment. The greatest gains of the Movimento Friulano during the elections of 1978 were in the disaster area, and greater in the north than in the south of the area populated by Friulians. There is a desire for a regional university in Udine, independent of the larger one in the capital of the region, Trieste.

Integration into another spatial context

Friulians interpreted their region as the "gateway to Central Europe" and not just a northeastern appendage of Italy. On occasions, they have revealed through poster campaigns their belief that in reality they belong to a growing new transnational federal union. (Some of the posters, to the astonishment of neighboring Austria, proclaimed affection for the Austro-Hungarian Empire, 60 years after its dissolution following World War I or declared "We want a German government"). This idea of "European Federalism" was accentuated by the fact that all of the aid-giving neighbors already had a federal structure (Switzerland with its cantons, the Federal Republics of Germany, Austria and Yugoslavia). Federalism is intended to grant more individuality to distinct regions.

These seven trends discussed briefly above did not uniformly apply to Friuli as a whole. Regional differentiation followed pre-quake trends. They can be summarized in a map (Figure 5) and a model (Figure 6).

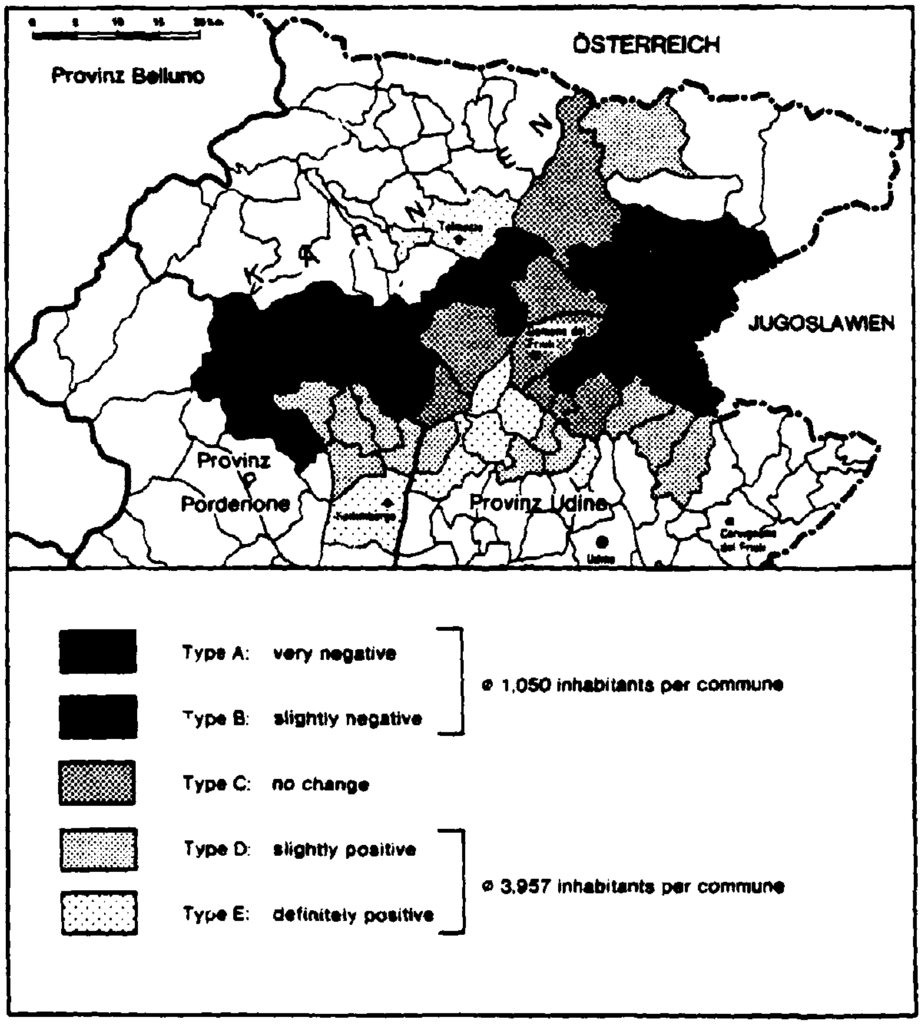


Figure 5

Supposed Future Trends of Destroyed Communes
in the Opinion of 96 Planners (1980)

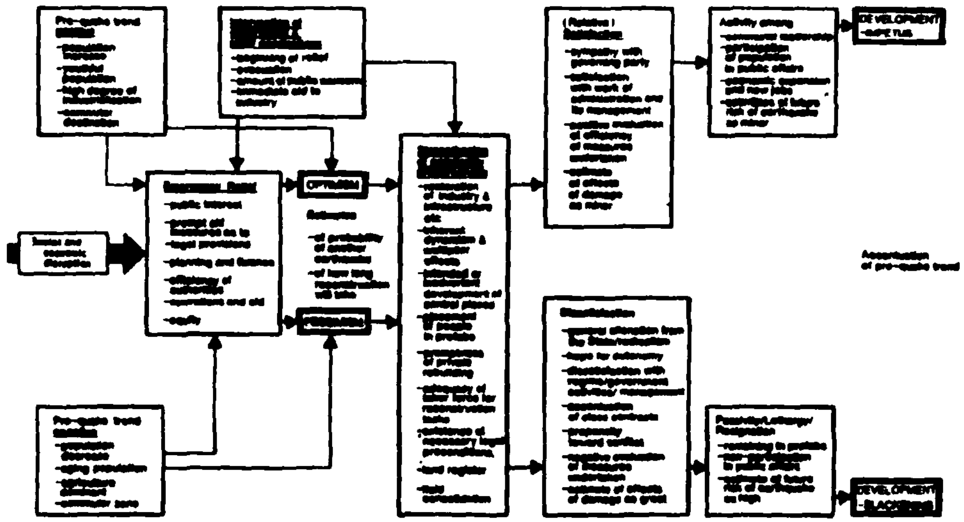


Figure 6

The Principles that Govern Regional Differentiation in the Reconstruction Process

Conclusion

The New World has supplied not only the locus for most hazard research but also the concepts and models to understand the impacts of disasters. A very rational model has emerged but it does not account for some of the imponderabilities of people's perceptions of disaster in the Old World. Some of the assertions made by some scholars [Haas, et al., 1977] apply broadly to the events here too, but based on the work in Friuli additional generalizations can be made.

a) The persistence of the previously established spatial structure increases with the strength of the historical tradition and cultural importance of a disaster area.

b) When there are ideological tensions in a country, political groups apply their ideas about society, most notably those having to do with property rights and reconstruction plans derived from them, to communes where they can realize their political ideas. This produces competitive reconstruction planning and takes advantage of the tabula raza laboratory situation for socio-political experimentation.

c) The spatial solution (the 'three-country-corner') and the peculiar cultural and linguistic status of an area, expressed in the Autonomy Statute, intensify its sense of identity and weaken the leadership authority of central government initiative. The latter is forced to compete in some cases for the loyalty of its citizens, particularly if national minorities like Slovenes or Austrians live in a disaster area.

d) Long periods of seismic inactivity within the area of a very traditional culture allow the existing stock of buildings to go for hundreds of years without proper maintenance and restorative tests of stress-loads. Since mostly the older and poorer populations are in the oldest and least maintained buildings of the city cores, the hypothesis that a catastrophe and its consequences are extremely 'inegalitarian' events hitting the most helpless hardest is confirmed.

e) If a disaster happens to coincide spatially with the approximate settlement area of a given ethnic group (in this case the 400,000 Friulians), it is extremely important not to forget the cultural identity of the people affected, which manifests itself in numerous features of the social spatial situation, when dealing with the problems of geological security and architectural form. Reconstruction planning on the part of the central government should try to incorporate regional character as much as possible into its projects. This aids regional identity and avoids fostering uniformity and anonymity.

f) Societies, as has been noted by other scholars [Friesma et al., 1979] [Wright et al., 1979] recover rapidly after disasters. The case of Friuli shows that a catastrophe may actually inspire the population of an area to a heightened self-awareness and determination to take their fate into their own hands. The return of many emigrants from abroad, the emergence of a Friulian Regional University in Udine, increased enthusiasm for a more extensive regional autonomy, and even the appearance of an avowedly ethnic Friulian political party, attest to this effect.

Table 3

Comparison of Earthquakes in Friuli 1976 and Southern Italy 1980

Facts	Friuli	Southern Italy
Date	May 6, 1976	November 23, 1980
Time	9:00 p.m.	7:35 p.m.
Magnitude	6.4 R	6.7 R
Depth	ca. 5 km	ca. 20 km
Duration	55 sec.	90 sec.
Epicenter	2 km W of Venzone	5 km E of Teora
Affected Area	4,800 km^2	28,000 km^2
Number of Communities	119	314
Deaths	1,000	3,500 ?
Homeless	100,000	300,000
Damage in $ billion	4.45	15.9 ?

In the meantime, on November 23, 1980 another even more severe earthquake of 6.7 on the Richter scale occurred in Southern Italy. The same emergency commissioner as in Friuli was again in charge of the operations in the Naples area. But there were markedly different responses to the same disastrous event, not only because of physical characteristics (Table 3) but also because of the characteristics of the inhabitants, their attitudes and beliefs.

Evidently variables such as civic maturity, neighborly solidarity and administrative integrity (difficult to measure as they are) should be given more important weighting in all models of disaster assessment. Even events in the same country and under administration of the same emergency commissioner are not guaranteed to take the same course.

On the basis of our studies, we are in agreement with the injunction that "...hazard management policy stands to gain considerably from sound comparative research" [Torry, 1979]. We believe, moreover, that our discussion of the spatial differentiation of earthquake effects and responses is the sort of study which in the future might bring a geographical view into hazard research which may be lacking now because of too much abstraction from the real world of disaster areas and their victims. Social geographers should work more closely with social psychologists, anthropologists and sociologists and perhaps less with economists and systems analysts. In this manner social geography can help to redirect hazard research from what can be a dangerously naive preoccupation with administrative technologies and procedures and bring it closer to the mainstream of humanistic geography.

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VICTIMS, PRIMARY GROUPS AND COMMUNITIES

AFTER THE FRIULI EARTHQUAKE

Bernardo Cattarinussi

Introduction

The sequence of 435 earthquake shocks that occurred over a period of two years in Friuli, a northeastern Italian region, commenced on the night of May 6, 1976, with a severe tremor (4.5 Richter) followed one minute later by an even stronger one (6.4 Richter) which lasted almost one minute. The effects were devastating: 950 persons died and more than 2,500 were severely injured. Twelve thousand houses were destroyed, 25,000 were damaged, and 191 villages were razed to the ground. In analyzing the social response to this catastrohpe we can use the scheme suggested by Mileti, Drabek and Haas [1975] which includes behavior of individuals, groups, organizations, community, nation, and international systems in the phases of preparedness, warning, mobilization, immediate post-impact, relief, and reconstruction. Since the first three phases do not apply in this case, we will limit our analysis only to social responses in the phases of post-impact, relief, and reconstruction.

Immediate post-impact

Individuals

It is necessary to distinguish between the response of victims and non-victims. As regards the first group, the literature documents extensively such responses as an absence of panic, an initial narcotizing effect which temporarily prevents people from comprehending the event, altruism, gratitude for assistance, minimization of personal losses, concern for one's family, enthusiastic participation in first aid activities. Concerning the conditions under which the catastrophe occurs, these authors find that maximum social and psychological disruption will emerge from events characterized by: suddenness, high uncertainty, prolonged duration, broad scope of physical destruction, death, and injury particularly when the events occur at night [Mileti, Drabek and Haas 1975]. All these conditions characterized the Friuli earthquake. The only favorable condition appeared to be the less-severe initial shock (4.5 Richter) which preceded the strongest one and in several cases served as an alarm.

A survey carried out by means of in-depth interviews of 80 residents in a town near the epicenter found that 50% of the persons surveyed did not stir at first because of inhibition, hindrance or previous experience. Only 12% immediately left their houses. Another 11% left their houses but returned immediately to rescue a member of the family or remained at home to switch off the TV set or to turn the water tap off. Behavior directly after the shock as reported in 74 interviews was as shown in Table 1. Altruistic behavior appeared to be twice as prevalent as self-oriented behavior. Other hypothesized behavior such as gratitude for assistance, minimization of personal loss, creation of little groups of "helpers" which form the phase that C.A. Chandessais [1975] defines as the "informal mass struggle" are confirmed by individual accounts, journalistic reports and participant observation.

Table 1

Survey Results Concerning Immediate Behavior
After First Tremor: Friuli, 1976

RESPONSE	NUMBER	PERCENT
Sought safety alone, in presence of others	16	21.6
Sought to save self and children in presence of others	16	21.6
Sought to save self and assist others	15	20.3
Too astonished to act	22	29.7
Fled or tried to escape	5	6.8
	74	100.0

The literature concerning the behavior of non-victims indicates that persons learning of a nearby disaster tend to be curious, wonder about the involvement of kin and friends and will very likely go to the stricken area [Fritz 1968]. Once there, they seek ways to help. If they cannot assume the role of helper, they feel frustrated. In these moments, class, race, rank and age differences fade out, while role conflicts may arise in choosing which group to assist: family, kin, friends, neighbors or strangers. All such hypothesized behavior was confirmed by observation and journalistic reports. In the Friuli earthquake the phenomenon of volunteers was especially prevalent. These were mostly young people who converged from all over Central and Northern Italy [Moretti 1980].

Organizations

Various organizations, frequently uncoordinated tend to converge on the site of a disaster. Among these are firemen and military organizations, which possess a more effective degree of response to disasters than civilian organizations because they have equipment essential to deal with emergency situations, their personnel have had a specific training, hierarchical relationships are precisely defined, and they have an efficient communications network [Tellia 1978]. In Friuli the intervention of the military organizations was massive and timely, because more than half of the active Italian Army is stationed in this border region. Specialized detachments sent by foreign armies, especially the Germans, created a strong impression of efficiency.

Community

One of the main findings of disaster research is that the initial reaction to a disaster is characterized by a massive response of individuals, groups and organizations that at first tend to act in an uncoordinated way and can result in a chaotic convergence of persons, material and information. The centripetal movements exceed both in quality and quantity the centrifugal ones. Some communities seem to respond better than others. The explanatory variable appears to be prior emergency experience or preparation. The earthquake of May 6, 1976, also affected some villages in Yugoslavia where a community organization exists that has been trained to deal with emergency situations. Certain accounts indicate the immediate Yugoslav response was better able to handle the demands imposed by the disaster situation [Orožen Adamič 1980]. However, the damage there was less and the stricken area was much more limited.

Barton [1970] states that disaster situations create an overload of problems local governments are often unable to handle, and they must be replaced by an emergency government that acts as an overriding coordinating superstructure. On May 7 the Central Government appointed a "Commissario Straordinario" who took charge of the direction of the relief effort until July 25.

A generalized finding of research on human behavior after catastrohpes is that there tends to be a decrease in conflict. According to Dynes and Quarantelli [1971], this happens because: 1) the precipitating event is outside the community system, 2) a consensus on a hierarchy of values quickly emerges within the community, 3) emergency period problems require immediate and obvious action, 4) disasters produce an orientation to the present which minimizes previous memories of and future opportunities for conflict, 5) disasters reduce status differences, 6) disasters tend to strengthen community identity. The reduction of conflict in Friuli is reported by interviews with children. A decrease of parochialism is also reported as is a rising sense of ethnic awareness. Along with the decreases in conflict the author and participant observers recorded a growth in internal solidarity that gave rise to an altruistic attitude resulting in cooperation and mutual help [Wolfenstein 1957] [Taylor et al. 1970].

Restoration

In the restoration phase people try to regain acceptable conditions of life and to re-establish the exercise of the essential functions of an organized life [Barbina 1976]. In this phase the damage to infrastructure, houses, economic structures, artistic heritage and so on are evaluated and indemnities are fixed. People try to salvage all that can be recovered. Tottering buildings are buttressed or demolished. Immediate relief organizations start to leave the zone. The length of this phase, also, varies according to the severity of the catastrophe, the response capability of the stricken population and the efficiency of the local authorities. We can distinguish between the behavior of victims and organizations.

Victims

The restoration phase is very delicate both from the psychological point of view, since phenomena of depression and discouragement may arise, and from the social point of view, since anomic and apathetic attitudes may develop. Symptoms of such aspects in Friuli were increases in admissions to mental hospitals, in suicides, and in the abuse of alcoholic beverages.

The destruction or extensive damage of dwellings leaves many families without shelter and makes necessary temporary housing or, when possible, refuge in the homes of friends or relatives. According to information obtained from a survey of evacuated children [Cattarinussi 1978], the solutions to housing problems during the summer of 1976 were as shown in Table 2. The earthquake and numerous aftershocks caused strong feelings of claustrophobia and a sense of insecurity in structures. Consequently many individuals whose homes were barely damaged or absolutely intact preferred to sleep in the open.

The possibility of looting abandoned buildings and evacuated areas after a disaster is a major concern. However, Dynes and Quarantelli report the number of looting cases is usually very limited. This was the case in Friuli. Only four thieves, who had come from outside the region, were discovered.

Efforts to gain relief aid fraudulently might be considered a form of looting. Drabek notes that the frequency of such phenomena and the tactics used are hardly mentioned in previous research findings. There is some quantifiable evidence from Friuli in connection with claims for damages due to the loss of furniture and fittings. According to Prefecture officials, there were about a hundred contested cases among the 16,000 claims in which the claimed damage was nearly double the actual loss. The questionnaire used for a survey carried out by interviews of shopkeepers and innkeepers of six villages destroyed by the earthquake compared the amount of damages to the premises, equipment and supplies as claimed by the shopkeepers and innkeepers and as ascertained by committees of the Chamber of Commerce. Of a total of 288 shops and inns, 8% claimed damage greater than that which was ascertained [Sambri 1979].

The Repetition of the Earthquake

The rather exceptional phenomenon of the repetition of the earthquake after an interval of four months took place in Friuli. On September 15 there were two strong shocks at 5:15 a.m. (6.0 Richter) and

Table 2

Temporary Shelter Used by Families
Friuli, 1976

TYPE OF SHELTER	NUMBER	PERCENT
Home	47	17.5
Tent	126	47.0
Garage	12	4.5
Home and Tent	45	16.8
Trailer	8	3.0
Car and Home	2	0.8
Cabin	4	1.5
Home and Hut	3	1.1
Home, Tent and Hut	21	7.8
TOTAL	268	100.0

Source: Cattarinussi, 1978.

at 11:23 a.m. (6.2 Richter), with epicenters somewhat to the north of those in May. The shocks further damaged the communities that for four months had been living in uncomfortable conditions and suffering a very large number of minor aftershocks. During this period, a great deal of psychological energy had been used up in order to adjust to new situations and to restore social and psychological balances. In September no more reserves of moral force were left, and the responses were, therefore, very different from the individual and social reactions of May. People fled the encampments as huge rocks tumbled down the mountains. Thousands of "restorable" buildings, to which people had already returned, collapsed; other homes shattered before the amazed eyes of those who had repaired them during the summer; scaffolding and bracing revealed its uselessness. Car-mounted loudspeakers urged people to leave the area and retreat to the Upper Adriatic resorts and added to the sense of impending cataclysms of still larger magnitude.

The Evacuation

The unexpected repetition of the seismic phenomenon caused the recall of the "Commissario Straordinario", who organized the evacuation of the homeless to the beaches of the Upper Adriatic Sea and devoted himself, with the Regione Friuli-Venezia Giulia, to the construction of prefabricated villages. As many as 32,500 individuals left the area. The number of evacuees over time is shown in Figure 1.

Figure 2 shows the motivations for evacuation identified by a sample of 241 persons interviewed in a town on the Upper Adriatic Sea [Boileau 1977]. The unsatisfactory living conditions of the temporary shelters were the chief reason.

Organizations

While part of the population was evacuated, the restoration activities such as barracks construction began again and were completed

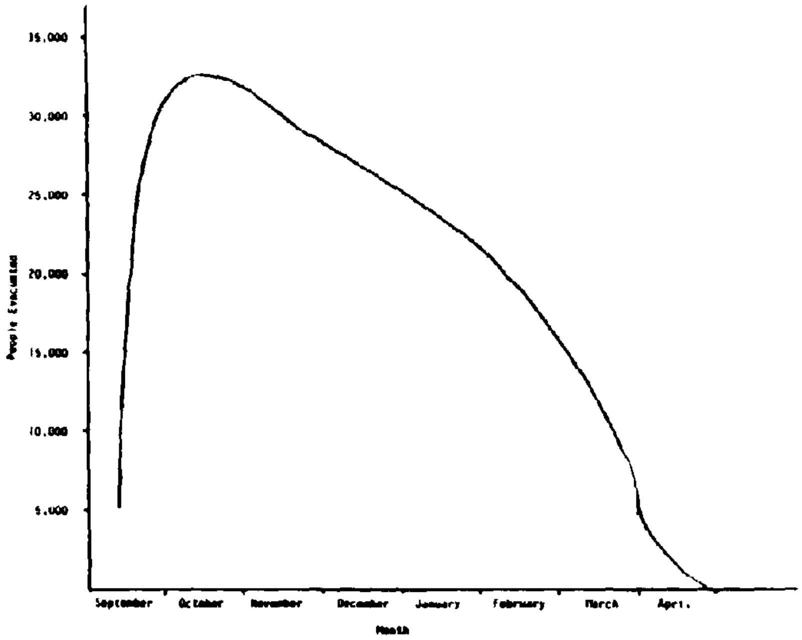

Figure 1

Number of People Evacuated by Month: Friuli, 1976-1977

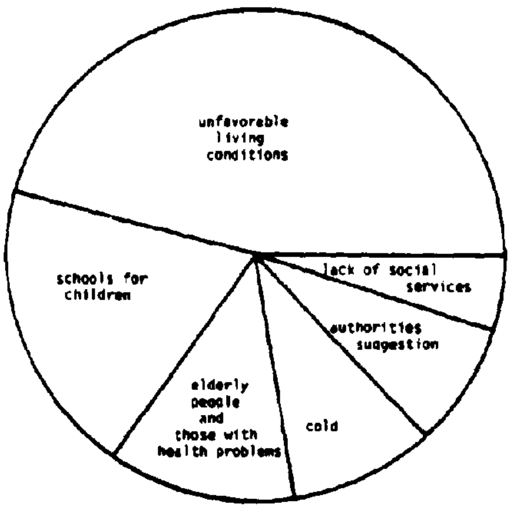

Figure 2

Motivation for Evacuation:
Friuli, 1976-1977

Source: Boileau, 1978.

by Spring 1977. During the first year after the May earthquake a number of organizations operated in Friuli. Figure 3 shows the opinion of these organizations expressed by a sample of 434 workers from 19 damaged factories [Cattarinussi, 1978]. Various levels of the government were perceived to have performed the least well. The Italian and foreign armies, the Red Cross, the Firemen and the Alpini Association were felt to have functioned best.

International Solidarity

The data on financial assistance from foreign nations to Friuli are shown in Table 3. They are drawn from the documents of the "Commissariato Straordinario del Governo" and completed by those of the Red Cross, the Charitas Internationalis and the "Ente Friuli nel Mondo". The generous financial aid of several European countries is explained by geographical proximity (Austria and Yugoslavia) and by a long tradition of Friulian emigration (Switzerland, Germany, Luxemburg and Belgium). Emigration also can explain the aid from Canada, Australia, and Venezuela. For the U.S.A. there is also the factor of the economic and political partnership with Italy [Delli Zotti 1978].

Reconstruction

The reconstruction phase that started one year after the first earthquake probably shows aspects of the response more clearly than the earlier phases, since the socio-structural characteristics of stricken communities and the socio-cultural features of the population become more relevant over the long term.

Among the socio-structural features we can consider demographic restabilization and economic aspects. The geographer G. Valussi has analyzed the former by looking at the demographic dynamics of the 45 Friulian communes most heavily struck by the 1976 earthquake. They are characterized by a steady return of migrant workers since 1971, mainly due to the European economic recession. The balance between registrations and cancellations at the registry offices in 1972 was 6.3%; in 1973, 8.7%, in 1974, 7.1%; in 1975, 5.2%. In 1976 the balance collapsed to 0.9%, but in 1977 it rose again to 4.9%.

If we examine the population movements by months for 1976, we notice that departures prevail in June, while arrivals highly preponderate in July and August. After September cancellations increase considerably and exceed registrations until April. In the ensuing months registrations are more numerous than cancellations, and at the end of 1977, they surpass the levels of 1975.

Concerning the economy, analysis of the industrial [D'Angiolini, 1979], artisan [Nodari, 1979] and trading [Sambri, 1979] sectors indicates that the speedy use of the available financial sources permitted rapid economic re-stabilization, both in terms of employment and in level of production. Other research on the industrial sector [Regione, 1977], shows that there was no decrease in employment and furthermore a 10% increase was expected by most manufacturers over the next three years (1978-80).

Another study carried out two years after the earthquake of a sample of 62 factories [Gottschalt 1980] found that the area near the epicenter

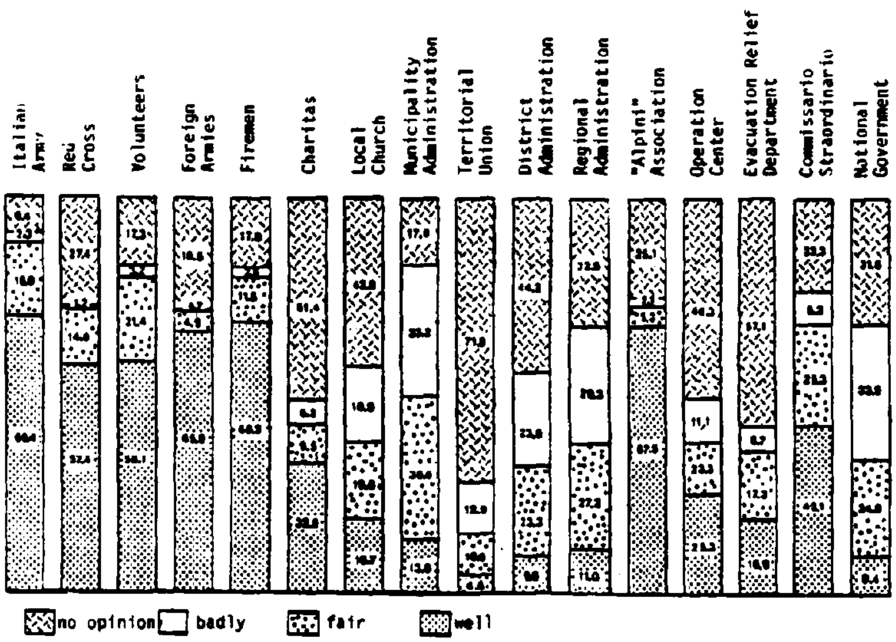

Figure 3

Evaluation of the Behavior of Organizations and Officials

TABLE 3

International Assistance: Friuli, 1976

NATION	TOTAL (It.lire)	TOTAL/POP (1972)	TOTAL x 1000/GNP (1972)
S. Marino	80,000,000	4210.52	--
Austria	9,596,020,000	1251.54	612.86
Yugoslavia	3,471,294,000	165.64	243.24
Switzerland	3,655,000,000	568.34	173.94
Norway	668,181,000	170.94	60.62
W. Germany	5,740,347,000	84.78	32.31
Luxemburg	28,000,000	79.77	29.41
Belgium	452,892,000	34.11	12.55
France	575,486,000	11.03	3.61
Great Britain	330,322,000	5.90	2.58
Holland	18,915,000	1.40	0.58
Saudi Arabia	4,325,000,000	512.25	1223.13
Canada	3,424,139,000	154.76	41.49
Australia	1,186,568,000	90.35	36.10
USA	24,142,685,000	114.74	24.32
Venezuela	171,000,000	15.15	14.55
New Zealand	40,450,000	13.65	6.41
Brazil	200,000,000	1.97	4.52
Iran	43,250,000	1.38	3.34
Tunisia	4,591,000	0.90	2.85
South Africa	30,520,000	1.25	1.76

experienced a particularly strong wave of expansionary investment which clearly indicates a positive economic response by entrepreneurs. The large investments made in the stricken area led to an absolute growth of jobs, which not only succeeded in warding off the danger of out-migration, but acted as an attraction for Friulian migrants.

A sample of 900 people was interviewed four years after the earthquake [Cattarinussi, Moretti, Tellia, 1981]. Most believed that the disaster induced economic development in the stricken areas. Indeed, 60.3% of the sample believed that in the post-seismic period there was an improvement in economic conditions and 77.1% believed that employment opportunities had increased. However, a strengthening of the industrial structure was evident only in some municipalities--those that already had a high level of industrialization before. On the contrary in other municipalities that had had a lower level of industrialization the situation worsened. As for trade establishments, most of them resumed their activity after a period of interruption of variable length.

From the urbanistic point of view the tendency to reconstruct the Friulian region "where it was and as it was" prevailed over other innovative but perhaps less realistic proposals. The choice in the reconstruction was the reaffirmation of the anthropo-geographic design existing before the earthquake. The volumetric relations among the urban spaces were reproduced [Nimis 1978].

In the political sphere no substantial change in the electoral choices were apparent in Friuli after the earthquake. This stable trend is shown by analysis of both before and after earthquake polls [Tellia, 1981] and the answers to two specific questions in the already cited research on long-term effects [Cattarinussi, Moretti, Tellia, 1981]. Other research, conducted by interviewing mayors in the stricken area, indicated that the decision making process has become more personalized. From this same research it appears that local administrators are much more highly valued than the central government and fellow citizens.

Socio-cultural changes were induced by the earthquake. This was revealed through the opinions of the sample of people interviewed in the course of the research on long-term disaster effects cited above. Respondents were asked to choose which of the following items reflected their opinion:

1) The earthquake resulted in some positive consequences.

2) No changes at all were induced by the earthquake.

3) Hardships and worries resulted from the earthquake but they were only temporary.

4) After the earthquake one's whole life-style changed for the worse and will continue so for a long time.

Almost half the sample (48.6%) selected item 3. A quarter (24.9%) chose item 4 revealing a pessimistic view of life after the catastrophe. The remaining fifth of the sample (19.6%) perceived the existence of some positive consequences of the disaster. Males, younger people and those with higher social status tended to have a more positive outlook.

Regarding physical health, almost half the sample reported a worsening. General psychic conditions were felt to be deteriorating as well (45.3%) mainly by women and older people. Personal contentment, together with family economic security ($r=.25$) is positively correlated with self-reliance ($r=.35$) and with the perception of contentment on the part of neighbors and fellow citizens ($r=.24$). Improved physical and psychical conditions are positively correlated with an active attitude towards work ($r=24$; $r=21$) and with a satisfactory sexual life ($r=.18$; $r=.21$). A rather contented atmosphere seemed to be prevalent in most families, but some intra-family relations were deteriorating because of the complex problems linked to the process of reconstruction. It appears that portion of the sample that claimed to suffer from difficulties in the rebuilding process (costs and town planning restrictions) also reported that family relations often broke down and that quarrels increased after the earthquake (r=.17). This response was more frequent on the part of families living in barracks.

By examining correlation coefficients we tried to draw up a typology, i.e., to identify social types as characterized by the presence of a set of elements.

a) Relations to the environment: "isolated" and "involved" people ("misanthropes" and "social" individuals).

The misanthrope, an isolated person with no family, neighboring, and community relations, has been defined in terms of interactions with their milieu of the people interviewed.

These types were identified by the variables "family help" (little help given to or received by one or more relatives), "neighborly interaction" (little or no confidence in neighbors), "misanthropy" (no wish to see other people), and finally "community involvement" (interest in civic affairs decreased since 1976). The emerging character of the "solitary" is not at all common within the sample: only 12 people (1.3%) possess all four traits, and rather few (86 or 9.6%) possess three.

Few people indeed seem to be far from a "normal" state, and it appears that the traditional stereotype of the Friulian as individualistic, peerish, isolated, has to be rejected. On the other hand, the opposite image does not appear clearly either. The "social individuals" the exact reverse of the former were also very few: only 13 equivalent to 1.4%. These can also be labelled as "involved people": get and give help from and to most relatives, feel that most neighbors are reliable, never wish to remain alone, are more interested in what is happening around them now than in 1976.

b) The personal state: "anxious" and "miserable" people.

Such types have been singled out by combining internal and external traits of the individual's personal situation. The anxious individuals are those experiencing hostility and irritability, are unable to cope with the earthquake aftershocks, and feel insecure in their dwellings. 145 people can be so defined equivalent to 16.1% of the sample, the highest percentage among those identifying a "type". Among them, 47 individuals (5.2%) are the most anxious.

The miserable people are characterized by a wide range of negative traits. They live in barracks, had their houses destroyed or badly damaged and are not planning to rebuild them. Moreover they have been feeling worse both physically and psychically since 1976, have lower educations and incomes, are aged 55 and over. Only 52 people, however, (5.8), can be so defined. Very often the miserable people are anxious as well. Indeed the same individuals tend to score very high on both miserableness and anxiety scales.

c) The perception of the situation: "pessimists", "complainers", "optimists".

These types were identified on the basis of the questions relative to the economic and social situation, local, national and personal. The first type, the pessimistic individual, includes those who think that, since 1976, the Friulian economy has worsened, alcoholism, crime, drug abuse have increased, the whole situation has deteriorated irremediably. There are few of these people (24 = 2.6%) but their number increases to 13.5% if we leave out the variable relative to economic development. Indeed very few believe that there was no economic improvement at all.

The second character is the "complainer" who believes that government's and the administrators', and fellow citizens' ability and honesty have decreased since 1976, and that the reconstruction process is behind schedule and inefficient. The tendency to complain is present in only 9.6% of the sample, and it is usually unrelated to objective situations of misfortune.

Finally the "optimists" are those who are more willing to be active, feel self-confident, have positive expectations for the future: those who maintain the economic situation has improved both in their families and in Friuli, single out some positive consequences of the earthquake, who believe the reconstruction process is going rather well. As with fully unhappy people, fully happy and optimistic people are very rare. Indeed only 18 individuals (2%) were so classified, fewer than the complainers, and fewer than the miserable people.

The Friuli earthquake presented a unique research opportunity for study of social responses to a disaster because of the double event of two major seismic shocks, four months apart. The reaction to tne first event very much resembled cases well documented in the literature. The second event was particularly devastating from a social and psychological point of view because it destroyed so much of the reconstruction efforts which had been made during the four months after the first shock. While the immediate effects were severe, it is remarkable under the circumstances that the long-term effects have been so moderate. Those individuals who severely suffered the most psychologically and socially tend to be late middle-aged and elderly, females and those of lower socio-economic status. The most resilient individuals tended to be males in younger labor force age groups, the young, better educated and those with higher incomes. The restoration of the economic system was amazingly rapid, the attitudes toward communities and the region optimistic and the effects as reflected in changed political behavior minimal. The long-term effects seem to confirm earlier studies but distinct patterns emerge related to demographic characteristics.

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THE EFFECTS OF THE 1976 EARTHQUAKE IN THE SOČA RIVER BASIN

Milan Orožen Adamič

The Anton Melik Geographical Institute of the Slovene Academy of Sciences and Arts of Ljubljana has among its tasks that of recording and attempting to explain from a geographical perspective various major natural disasters which occur in Slovenia. The consequences of the 1976 earthquake are the first major earthquake disaster effects analyzed by the Institute. The work demonstrated that the methodology for examining natural diasters has not been sufficiently studied and developed. A new set of problems had to be faced and could not be solved in a completely satisfactory manner. In the future, much more attention must be devoted to developing geographical methods for studying natural disasters and applying the findings in practice. The work carried out attempted to record and explain as completely as possible the consequences of the earthquake in the most severely stricken areas.

Various kinds of natural and other disasters occur relatively freqently and, therefore, must be taken into consideration and dealt with as typical phenomena for any social community within some larger regional context. For the most part disasters and catastrophies have in common the two properties that they are space and time specific. The spatial aspect is related to the extent of the disaster and to other influences in process at that time in the affected region and subareas of it. The temporal aspect of the crisis can be very different. A distinction can be made between the time duration of the occurence or event and the period necessary for recovery. This second period of time can last years or even decades, depending upon the circumstances and the severity of the impact of the event in a specific region.

The earthquake of 1976 was the most severe one in Slovenia in this century. The next most severe was that of the 7th degree MCS in the Kozje area in 1974. See Table 1. A stronger earthquake occured on April 14, 1895, with the epicenter in the neighborhood of Vodice (the well-known Ljubljana earthquake), estimated at 7th to 9th degrees MCS. The disaster striking the Soča River Basin in 1976 was the strongest earthquake in Slovenia in the last 81 years. Within the epicentral region itself this earthquake was considerably stronger and more disastrous than that of Ljubljana in 1895. The 1895 earthquake, however, had comparatively more extensive consequences for the Slovenes, occurring in the central part of Slovenia and causing considerable damage. However, if one takes into consideration the vast impact of the earthquake in the Soča River Basin, the particular problems of that region, and in addition the consequences suffered in the Venetian Slovenia, Resia and Gorica areas, this event was undoubtedly one of the greatest affecting the Slovenes in recent centuries.

Table 1

The Earthquakes Occurring in Slovenia from 1956 to 1976, Having a Strength of 6th Degree MCS or More*

Year	Number of Shocks Stronger than 6 MCS	MCS	Date	Commune (Area)
1956	16	7.5	Jan. 31	Ilirska Bistrica
1963	84	7	May 19	Litija
1964	74	6	March 18	Ilirska Bistrica
1973	53	6	Dec. 12	Škofja Loka (Polh. Dolomiti)
1974	100	7	June 20	Šmarje near Jelse (Kozje area)
1976**	478	8	May 6	Tolmin, Idrija
		8	Sept. 15	N.Gorica (The Soča River Basin)

*Statistical Yearbook of the SR Slovenia 1976, The Institute of Statistics, the SR Slovenia, Ljubljana
**Hržič, 1977

The Stock of Dwellings in the Soča River Basin, and the Consequences of the Earthquake

In the Soča River Basin there were relatively few structures made of reinforced concrete. The predominant buildings were old houses, mostly built of stone, with lime mortar and wooden roofs. According to the data of the census of population and dwellings of 1971 [Popis stanivista...1972] 50.4 percent of the dwellings in the commune of Idrija were built before 1918, 46.6 percent in the commune of Tolmin, and only 22.4 percent in the commune of Nova Gorica. Dwellings built between 1915 and 1945 comprised 30.5 percent of the dwellings in the commune of Tolmin, and 7.7 percent of those in the commune of Idrija. Dwellings constructed between 1946 and 1960 account for 9.7 percent in the commue of Tolmin, 17.4 percent in the commune of Idrija and 18.5 percent in the commune of Nova Gorica. There is a great difference between the communes in the proportion of new dwellings built from 1960 to 1971; 12.3 percent in the commune of Tolmin, 21.9 percent in Nova Gorica and 23.4 percent in Idrija. Approximately half the dwellings in the communes of Tolmin and Idrija before the earthquake were more than 50 years old. Only in exceptional cases had reinforced concrete or other up-to-date materials been used in such dwellings. Slabs made of reinforced concrete and other similar construction elements were introduced for the most part only after 1946. Before the earthquake, approximately 80 percent of the dwellings in the commune of Tolmin were built in the traditional manner, without the use of concrete, iron, bricks, or similar materials.

The considerable differences between individual places reflect urbanization and village stagnation. At Borjana 79.3 percent of the dwellings date from before 1918, 86.9 percent at Breginj, 100 percent at Podbela, 94.3 percent at Volarji. The percentage of the dwellings built before 1918 in Borjana is a little lower than in other neighboring, less urbanized places because part of the village was carried away by a snow avalanche on February 14, 1952 [Gams, 1955]. An entirely different picture is presented by the more urbanized places where there is a considerably smaller proportion of dwellings built before 1918. In 1971, 53.7 percent of the dwellings at Kobarid were from this period, but only 12.8 percent at Tolmin. Other factors account for some differences such as at Stanovišče where 95.8 percent of the dwellings have been reconstructed after 1946, since the village was burnt down during the war. In reconstructing Stanovišče in most cases the original ground-plans were preserved to the largest possible extent using the existing ruins and not materially improving the quality of the buildings. Similar situations exist in Žaga, completely destroyed during the First World War and heavily damaged again in the Second World War [Uršič, 1968]. The final picture of the damage, including that from the original earthquake on May 6 and the additional destruction caused by the second earthquake on September 15, 1976, can be estimated by the seismic effect caused by a shock of 9th degree MCS scale at the most severely impacted places of Breginj, Podbela, Žaga, Ladra-Smast, etc., and by the effect caused by an 8th degree shock at other heavily damaged places of the Upper Soča River Basin.

The Direct Effects of the Earthquake in the Region

The very first reports testified to the extensive destruction caused by the earthquake in the communes of Tolmin, Idrija and Nova Gorica and to the widespread disruption in neighboring areas in Italy, and to the severe damage suffered by the Slovenes living across the frontier. In a matter of moments, many people lost their homes, since many houses were destroyed or heavily damaged. In the most heavily stricken places the people took refuge in various kinds of emergency shelters in the open air. In less impacted places people found refuge at night in emergency shelters erected near their homes. These self-provided shelters were one of the most startling visual evidences. They were built mostly of a wide variety of light and simple materials displaying great ingenuity and inventiveness on the part of individuals [Križnar, 1977]. Gradually, as organized assistance appeared people were moved from these primitive emergency shelters, mostly covered with polyvinyl, to proper tents, automobile trailers, and wooden shacks. Alongside some of the most impacted places entire new settlements appeared with relatively well-arranged emergency dwellings, with a "main street", shops, perhaps a restaurant in an old bus, water-supply, electricity, etc. Such provisional settlements occurred at Podbela, Stanovišče, below and above Breginj, in gardens and in the sports grounds of Kobarid, and a number of other places.

With the construction of prefabricated houses in the winter of 1976/77, the population started relocating into permanent dwellings. In response to this distress, and particularly after the second strong earthquake in September, the entire Slovene public rendered assistance in many different ways. The whole Yugoslav people joined in the broadly organized solidarity action as did numerous Yugoslavs living abroad. Working establishments and individuals temporarily lent their automobile trailers on a temporary basis. Efficient relief and reconstruction efforts were accelerated at the end of September and the beginning of October when the Republic Coordination Headquarters for the reconstruction of the Soča River Basin started its successful operations. Cleanup and reconstruction efforts were hampered by impossible weather conditions, as there were more hours of rain than of sunshine that Fall with many heavy downpours. More than 3,000 workers from all over Slovenia and the rest of Yugoslavia came to the region to lend assistance to the earthquake-stricken population.

In the most heavily stricken communes of Tolmin, Nova Gorica and Idrija the damage was surveyed and assessed in a relatively short period of time. Special Commissions for the purpose were organized which included, in addition to technical construction experts, representatives of the local communities. A special survey of damage was also organized by the Monument Conservation Service. A report on the consequences of the earthquake in May 1976 was drawn up using a uniform methodology for the communes of Tolmin, Nova Gorica and Idrija. The methodology was prepared by the Institute for Testing and Research in Materials and Structures of Ljubljana [The Report...1976]. It was developed and supplemented on the basis of experiences acquired by the drafters in surveying the consequences of earthquakes in the Kozje area and elsewhere in Yugoslavia.

Each structure was individually inspected and appraised in one of three categories relating to the degree of its further usability as shown in Table 2. The survey which was designed primarily for assessing the quantitative extent of the damages suffered by individual settlements would immediately form the basis for operations for demolition and removing debris. It was completed on June 18, 1976. At later dates, the basic original survey materials were supplemented by a number of amendments and corrections (the manuscript materials prepared by the communal services) which were taken into account as much as possible. After the second stronger earthquake in September 1976 the first survey was supplemented and revised gradually in January and February, but the data processing has not been performed, and it has remained in manuscript form (February, 1977). The additional supplements and revisions resulting from the second survey have not been processed and merged with the data from the first survey.

Table 2

Classification Scheme for Damage Assessment

Category	Usability	Description of the Condition of the Construction
1	structure habitable	main structural elements damaged, lesser damage to other parts of the structure
2	structure temporarily uninhabitable, habitable only after repair	main structural elements damaged, damage to other parts of the structure, repairs economically justified
3	structure to be demolished	demolition, partial demolition or heavy damage to the main structural elements, repairs not economically justified

The damage caused by the earthquake was tabulated in two classifications:

1. the costs of repair of structures classified in the first and second categories,
2. the numbers of structures placed in the third category - those to be demolished since their repair is not economically justified.

It has been unfortunate that the value of these latter structures were not assessed, to have provided a more complete evaluation of the damage.

It is regretable that the survey covered only the structures damaged by the earthquake. For this reason, the survey materials have lost considerable value, for it is impossible to make appropriate relative comparisons. Attempts were made to eliminate this deficiency in the analysis in various ways, but were not entirely successful. It was not possible to obtain reliable data on the number of structures damaged and on their characteristics. Future similar surveys should take account of this, and a special record and survey of non-damaged structures should also be carried out. This was not taken into consideration when the damage assessment was taking place, for understandable reasons; at that time it was impossible.

<u>Assessment of Damage to Existing Developments</u>

The total number of structures damaged in the communes of Idrija, Nova Gorica and Tolmin, according to the data from the first survey, was 9226 (Table 3). In the communes of Radovljica, Škofja Loka and Ljubljana-Center the communal services assessed the damage through Local

Communities or Departments for Constructional-Communal Matters and Communal Civil Defense Headquarters (handwritten or typed material for the communes of Radovljica, Škofja Loka, Ljubljana-Center). In the commune of Radovljica it was ascertained there were no less than 356 damaged structures, of which 342 were, using the criteria for the Soča River Basin, classified in the first category, 11 in the second category, and 3 structures were so badly damaged that they had to be demolished. In the commune of Škofja Loka 95 structures were damaged, and in the local community of Ljubljana-Center 31 structures.

Table 3

The Number of the Structures Damaged by the Earthquake in Slovenia in 1976

Commune of	Degree of Damage			
	1st category	2nd category	3rd category	Total
Idrija	463	316	34	813
Ljubljana-Center	31	-	-	31
Nova Gorica	2082	625	214	2921
Radovljica	342	11	3	356
Škofja Loka	59	26	10	95
Tolmin*	3003	1744	785	5532
(Tolmin**)	(3516)	(1365)	(1455)	(6336)
First Survey Total	5980	2722	1046	9748
Including the 2nd Survey for the commune of Tolmin	6493	2343	1716	10,552

*The data for the commune of Tolmin including supplements of the first survey, before the September series of the earthquakes.
**The data for the commune of Tolmin after the September series of the earthquakes, the second survey.

An accurate count of the damaged structures cannot be ascertained. The data indicated in the summary table rely on the surveys for the communes of Tolmin, Idrija and Nova Gorica, and in addition whatever reports made by the communal services that could be collected. According to the available data and the first supplemented survey for the commune of Tolmin there were, up to the month of September 1976, 9748 structures damaged in Slovenia. By substituting the second survey for the commune of Tolmin the final incomplete number of damaged structures rises to 10552. Between the first and the second survey the number of the damaged structures in the commune of Tolmin rose by 804 or

Figure 1

Earthquake Damage in Breginj, Yugoslavia, 1976

Demolition of an old house badly damaged by the earthquake at Breginj. It was particularly difficult for aged people who lost their homes to accustom themselves to new living conditions.

Figure 2

Earthquake Damage at Podbela, Yugoslavia, 1976

A demolished wall of an old house at Podbela constructed in the traditional manner. It was built of stone without use of concrete or other more up-to-date construction materials.

by 14.53 percent. Considering this increase and the fact that outside the most stricken areas the damage has not been listed in such detail (for instance in the communes of Ljubljana, Vič-Rudnik, Aidovščina, etc.) it is safe to state that the final number of structures damaged by the earthquake in 1976 was approximately 15 to 20 percent larger than the number indicated. It is estimated that most of this increase falls in the first category of damage. As a result of the earthquakes, a total of approximately 12,000 structures were damaged in Slovenia. The Report on the removal of the consequences of the earthquake in the Soča River Basin (December 11, 1977) states that after the September earthquake a total of 11,224 structures were damaged in the communes of Tolmin, Nova Gorica and Idrija. This indicates extraordinarily extensive damage. In total the survey tabulated 1716 structures assessed as so heavily damaged their repair was not economically justified. Based upon this figure we estimate that there were in Slovenia as a whole from 1750 to 1850 such structures. In the second category of severely damaged and temporarily unsafe there were 2343 structures which means that by the end of the earthquake activity there were in Slovenia as a whole 2250 to 2350 such structures. In total in Slovenia approximately 4000 to 4200 structures were temporarily or permanently unusable, which means approximately 30 percent of all structures listed as damaged. Other structures suffered minor damage and were usable.

The finding that some 15 percent of the structures were so damaged that they had to be demolished surprisingly checks with the detail quoted by Pavlin [1895] regarding the earthquake at Ljubljana on April 4, 1895. That earthquake, with its epicenter in the neighborhood of Vodice, had the strength of the 8th to 9th degree on the MCS scale [Shebalin, Karnik, Hadžievski, 1965]. Pavlin reports on the damage: "The best picture of the entire disaster can be made by taking into consideration the estimates formed by the experts on the structures. They say that some twenty-five percent of all the houses should be partially or completely demolished, sixty-five percent should be radically repaired or reconstructed, and only the remainder could be restored to their original position at small cost". J.R. [1896] says about the same earthquake in a booklet: "There is a large portion, almost 20 percent of the houses, that should be, in any case, pulled down. Half of them should be reconstructed and repaired, before enabling them again to be safe habitations." Further, he goes on: "At first the damage was much underrated, as the damage cannot be seen from outside. Most houses suffered in their internal parts; the vaults cracked, the vault buttresses were broken, the ceilings collapsed, the staircases became dangerous, the iron reinforcements were all twisted. Every day new damage is found, and the final assessment of the damages will certainly be even much greater."

This was also the case with the damage in the Soča River Basin, for, prima facie, except for the most devastated places, it was not apparent the damage was extensive. The similarity is not surprising. The quality of the construction of housing in 1895 in Ljubljana and its surroundings did not differ essentially from the numerous older structures in the Tolmin area today, except, of course, in larger and more urbanized places.

The analysis of the number of damaged structures by local communities shows that the most severely stricken area was the Breginj

Corner including the two communities of Breginj and Borjana. This western-most part of Slovenia was nearest to the epicenter. A somewhat smaller number of damaged structures occurred across the Soča Valley in the community of Ladra-Smast. In the Soča Valley between Bovec and Kobarid the most impacted communities were those of Žaga and Srpenica. The Basin of Bovec itself was considerably less impacted than the Soča Valley between Kobarid and Most-na-Soči. In this part of the Upper Soča River Basin which in general was less stricken the most damaged places were around Kobarid while those around Tolmin were much less so. A relatively high degree of damage occured in the Bača Cleft (Baška grapa). The Bača Cleft as a whole was more damaged than the communities in the neighborhood of Tolmin, but less than the places in the surroundings of Kobarid. In the Šentvid Plateau, at places on the river Idrijca and in the Cerkno area there was considerable damage, however, considerably less than in the areas already mentioned. The only area having the same degree of damage as Kobarid and its community was the Goriška Brda (Gorica Hills), the most damaged area in the commune of Nova Gorica. Similar or lower levels of damage were found in Banjščice, Trnovski gozd (the Trnovo Woods) and in the Vipava Valley. Exceptions are the communities of Čepovan and Dornberk, whose greater damage was, probably, influenced by local tectonic and geological conditions. Of the three communes dealt with the Karst was the least impacted area, which can be explained by its more stable geological basis, and, in part, by its greater distance from the epicentral region.

In addition to the estimated damage, losses to the economy and other activities is ascertainable. In the commune of Tolmin alone the income of the social organizations was reduced by 24,386,000 dinars. The earthquake disrupted the entire activity of the region. On the other hand, however, the reconstruction assistance gave a strong impetus to the region as a whole. Similarly, as in the cases of the earthquakes of Skopje and Banja Luka, we can expect the development of the region to be promoted and changes from the past facilitated.

Analysis of Earthquake Impact by the Index of the Share of the Population Without Shelter

The number of damaged dwellings and the extent of the damage is only one index, since the total damage to all types of structures must be taken into account. A deficiency of the index of damaged structures as a measure of impact is the fact that the total number of non-damaged structures is unknown and the percentage or ratio cannot be found. The analysis of the population that is temporarily or permanently without shelter is much more indicative (Map 1), in spite of its having, in the case presented here, certain deficiencies that could not be completely eliminated. Categories were assigned according to the percent of population without shelter as shown in Table 4.

After the May series of earthquakes (the first survey) in the commune of Tolmin 4599 inhabitants were temporarily or permanently without dwellings, in the commune of Nova Gorica 2324, and in that of Idrija 1409, for a total of 8332 persons.

Table 4

Analysis of Population Without Shelter

Category	Percent Population Without Shelter	Number of Communities
1	over 50%	8
2	30 - 50	4
3	10 - 30	12
4	2.5 - 10	12
5	under 2.5	3
6	- 0 -	3

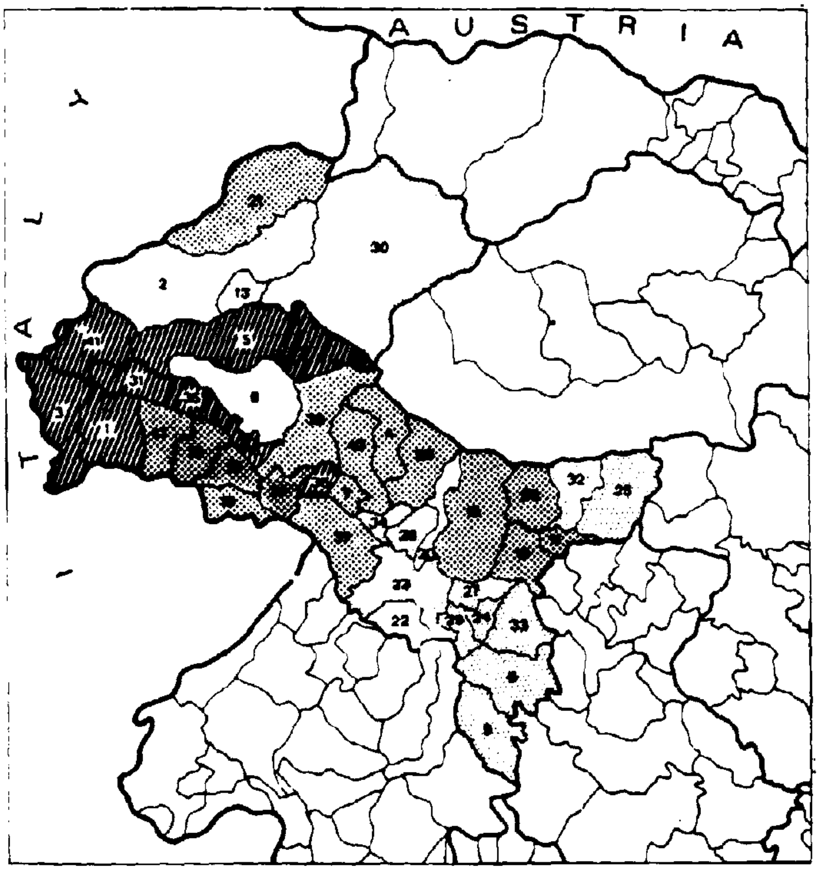
Of these, 1365 people, or 16.38 percent of the population had lived in structures assessed in the third category, to be demolished. In the commune of Tolmin the dwellings of 969 inhabitants had to be demolished and those of 3630 inhabitants were in the second category of damage; temporarily uninhabitable and requiring major repairs. In the commune of Nova Gorica 328 inhabitants had dwellings requiring demolition while the remaining 1966 lived in dwellings of the second category. In the commune of Idrija 1341 inhabitants had lived in structures in the second category and only 8 inhabitants were from dwellings to be demolished (the third category).

In the commune of Tolmin the number of structures in the third category rose by 53.95 percent after the September shock, between the first and the second surveys. Therefore, we estimate that after the September series of earthquakes there were in this commune alone approximately 2000 persons without dwellings. The situation in the two other communes was similar where, according to our estimates, the dwellings of 2700 to 3000 persons were so badly damaged that they had to be demolished. The number of the persons in structures of the second category was reduced by the extraordinary increase in the third category after September from 6967 to 5500, or by approximately 20 percent. The total number of 8332 inhabitants temporarily or permanently without shelter in May increased after the September earthquakes by approximately another 10 percent.

Lacking accurate data, we can estimate only approximately that there were in Slovenia 9000 to 9200 people for a longer c. shorter period of time without shelter. It was necessary to construct new homes for approximately one-third of these inhabitants, or 3000 people, and it was necessary to reconstruct the previous dwellings for approximately 6000 people through major repairs.

<u>The Impact of the Earthquake in Terms of Social and Demographic Characteristics of the Local Communities in the Commune of Tolmin</u>

Slovenia has experienced in recent decades a decline in the traditional agrarian structure. Consequently rapid changes have been taking place also in the demographic structure of the Slovene population. There has been a considerable decrease in the peasants as a



Map 1

Percent of Population Without Shelter, Local Communities of the Commune of Tolmin, Yugoslavia As a Consequence of the Earthquake in 1976

(hatched)	50% and above	(blank)	2.5-9.9%
(dense dots)	30-49.9%	(blank)	0.1-2.4%
(light dots)	10-29.9%	(blank)	0%

Source: Damage Survey, 1976.

share of the population which has been aging at the same time [Gosar, 1976]. The dependence of the population upon the land has become weaker. A detailed social demographic analysis of the population among other things, has been presented by Gosar [1976], and a similar analysis has been made for the commune of Tolmin by local communities by Petrle [1977]. Since this analysis shows accurately the complex conditions in the commune of Tolmin we will use the results as a comparative basis for the analysis of the population left without shelter by the earthquake.

The change in population size in the period 1961-1971 and the index of aging, the change in size of the peasant population in the period 1961-1971, the share of the peasant population in the year 1971 and the composition of the active population by sectors of activity, were used as the principle indices of the social demographic analysis. Through these indices the local communities in the commune of Tolmin were divided into types as follows:

Type 1. The areas of high outmigration, declining population, high percentage peasant population and high age structure.

Type 2. The areas with declining population, having a moderately high percentage peasant population and a high age structure.

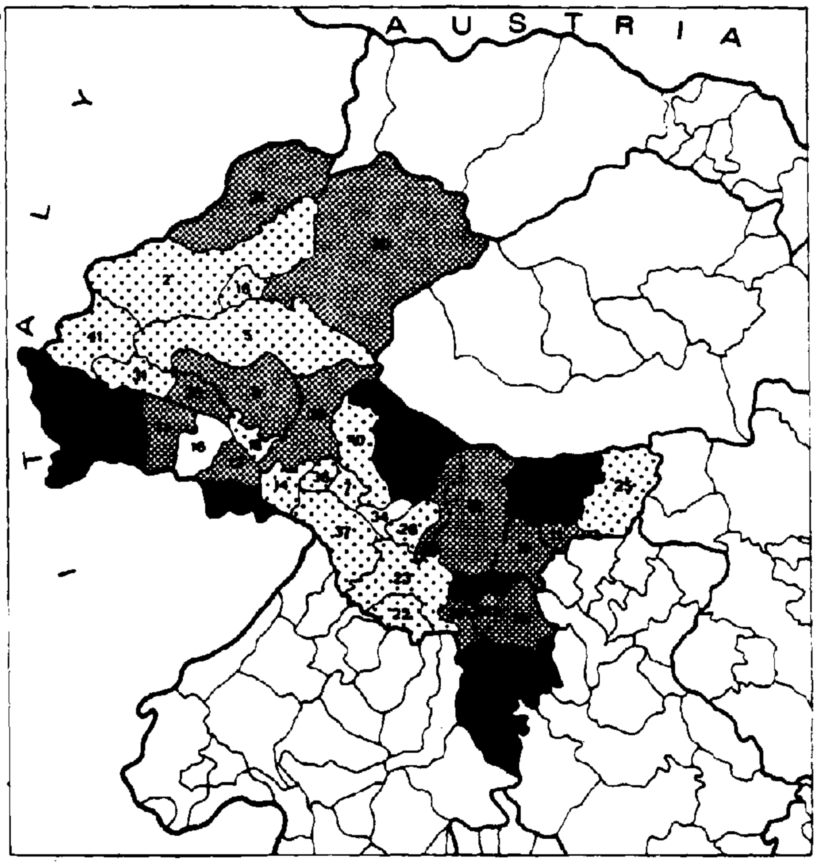
Type 3. The areas with a moderate decrease or a modest increase in the size of the population, a smaller percent peasant population and a high age structure.

Type 4. The areas with increasing population, having a low percentage peasant population and a lower age structure.

The social demographic types are shown in Map 2. We must emphasize the finding [Klemenčič, 1978] that the process of deagrarization after the Second World War was accompanied by a spatially differentiated process of social and economic restructuring of the population. Vojvoda and Tončič [1975] have described the substantial transformation of the mountain-seasonal-pastoral areas. Berginc [1978] has found that the difficult natural and economic conditions forced the inhabitants of the Bača Cleft to emigrate early. At the time of the construction of the railroad through the Bača Cleft the villages above the cleft started moving to its bottom. In addition to a considerable outmigration from the region, intraregional migration was also taking place. This was a characteristic feature of the Upper Soča River Basin as a whole. Population left the more distant mountainous areas in the valleys of the Soča and its tributaries mainly for the principal axis of the concentration of the population, Bovec-Kobarid-Tolmin-Most-na-Soči. However, the movement into this area was not so great as to cause much increase in population, but it is reflected in the more favorable social demographic structure of the places.

Ten local communities in which 13.5 percent of the population of the commune of Tolmin lived in January 1976, which account for 20 percent of the area, are classified as Type 1, having high outmigration, very high percentage peasant population and a high age structure. These are the mountainous areas, most distant from the traffic centers, and include the Breginj Corner, heavily impacted by the earthquake, the Livek area, a part of the Bača Cleft, a part of the Šentvid Plateau, and Trebuša.

There are fourteen Type 2 communities which occupy 43 percent of the area of the commune, and contained in January 1976 24.6 percent of the population. This type has similar characteristics to the first one,



Map 2

Classification by Social Demographic Type, Local Communities of the Commune of Tolmin, Yugoslavia

■	Type 1	▒	Type 3
▓	Type 2	□	Type 4

<u>Source</u>: L. Petrle, Ljubljana: Urbanisticni Institut SR Slovenije, 1977.

of which it is a variant. The chief difference is that the majority of the places are nearer to or have better access to employment centers. The two most unfavorable social demographic types comprise together 63 percent of the area and 38 perent of the population of the commune of Tolmin.

The third type, having moderate decrease or modest increase in population size, with a smaller percentaye peasant population and with a high age structure, includes 15 communities. These are mostly in the lowland, with better infrastructure. The communities of this group are concentrated around Bovec and Tolmin, including Most-na-Soči. Podbrdo is also included and is the most materially developed community in the Bača Cleft. This group of communities contains the largest share of the population, 41.1 percent, and covers 35 percent of the area of the commune of Tolmin. The areas of this type considering change in population size can be characterized as stagnant and with unfavorable age composition.

The influence of nearby centers, Kobarid and Tolmin, is not strong enough to exert a significnat influence on the social demographic structure of these communities. The local centers are too modest to influence the neighboring communities.

Only the communities of Tolmin and Kobarid have the relatively favorable social demographic structure of Type 4. While these two communities comprised only 2 percent of the area of the commune of Tolmin, they contained in January 1976 20.8 percent of the population.

Similar conclusions about conditions in the Tolmin region were reached by Gosar [1978] through the analysis of the distribution of employment in non-peasant activities, as a force for the transformation of the area through concentration of population and the economy. He emphasizes in particular that outmigration in recent decades should be attributed chiefly to poor transport access which characterizes such areas as: Gorenja Trebuša, the Šentvid Plateau, the Bača Cleft or its hinterland, the Breginj Corner, and Trenta. The main migrations flow radially from the mountainous and poor access areas to the local centers or the main transport line.

The question of the comparability of data used in the social demographic analysis and that used in the analysis of the portion of the population made homeless by the earthquake must be addressed. We have already discussed the differences between the censuses of population for 1971 and 1976 and found they are not great. The most important consideration for comparability is that the data refer to the same spatial unit--the community--and that conditions existing before the earthquake have remained basically unaltered. The technique used to combine the results of the analyses consisted quite simply of adding the two numbers together to produce a combined score and assign the sums to new categories. The most unfavorable conditions in both the analyses were indicated by 1. In the social demographic analysis the values range from 1 to 4, and in the analysis of the population without shelter from 1 to 6.

The two analyses were combined by adding the scores to form new classes designated A, B, C, D. The possible combinations of scores on the two indices that could result in the new combined classifications are shown in Table 5. The combined classification and score on both indices for each local community in the commune is shown in Table 6 and the location of the communities is indicated in Map 3.

The numerical values of the two analyses and their sums represent conceptual values of the individual analyses. Since the analysis of the shelterless population established 6 categories and the social demographic differentiation of the communities four, the combined score is a more subtle and more accurate representation of the impact of the earthquake, which is of primary interest.

Type A communities were most heavily stricken by the earthquake, and at the same time were those undergoing outmigration and aging of the population, and which had a very high percentage peasant population and a weak age composition. Of the communities within the commune of Tolmin, only those of Breginj and Borjana were of this type. This affirms the very critical conditions after the earthquake in the Breginj Corner, which suffered the greatest damage and also had very unfavorable social demographic characteristics. All other places in the Upper Soča River Basin areas which suffered equal degrees of damage from the earthquake had more favorable social demographic characteristics, a very important consideration in their ability to recover.

The second group, Type B, includes the communities which were in terms of one parameter of the comparison or the other in a more favorable position. They include communities heavily stricken by the earthquake but having more favorable social demographic characteristics. Such areas lay near the Soča River or along the central transport routes but were in the most impacted area. Since these communities were more distant from the epicenter, the degree of damage was somewhat less. In contrast, communities in the mountainous hinterland of the Tolmin and of the Bača Cleft suffered lesser degrees of damage but had unfavorable conditions, because of their unfavorable social demographic characteristics in this mountainous and inaccessible area. Supplying assistance to these places had to be accomplished by helicopter (the Yugoslav Peopl Army), because of the absence of traversable roads.

Type C includes communities which had a total of 5 or 6 points. On the one hand are communities with the most unfavorable, or next better, social demographic characteristics but considerably less earthquake damage. Such communities are along the Trebuša and in the Bača Cleft, relatively distant from the most stricken area. Nearer to the heavily impacted area are a series of communities in the Soča Valley with more favorable social demographic characteristics or even the most favorable ones (Kobarid, Kamno, Vrsno), which suffered high degrees of damage by the earthquake; 30 to 50 percent of the population were without shelter. They include above Bovec the communities of Trenta and of Log pod Mangartom. Also among them are a group of communities along the lower Idrijca River and on the Šentvid Plateau (Slap ob Idrijci, Ponikve, Pečine, Šentviška gora). The communities of Volče, Dolje and Zatolmin, on both banks of the Soča above Tolmin, have intermediate score on both indices.

Table 5

Possible Combinations of Socio-Demographic Population Without Shelter Indices Scores that Would Result in Various Combined Classifications

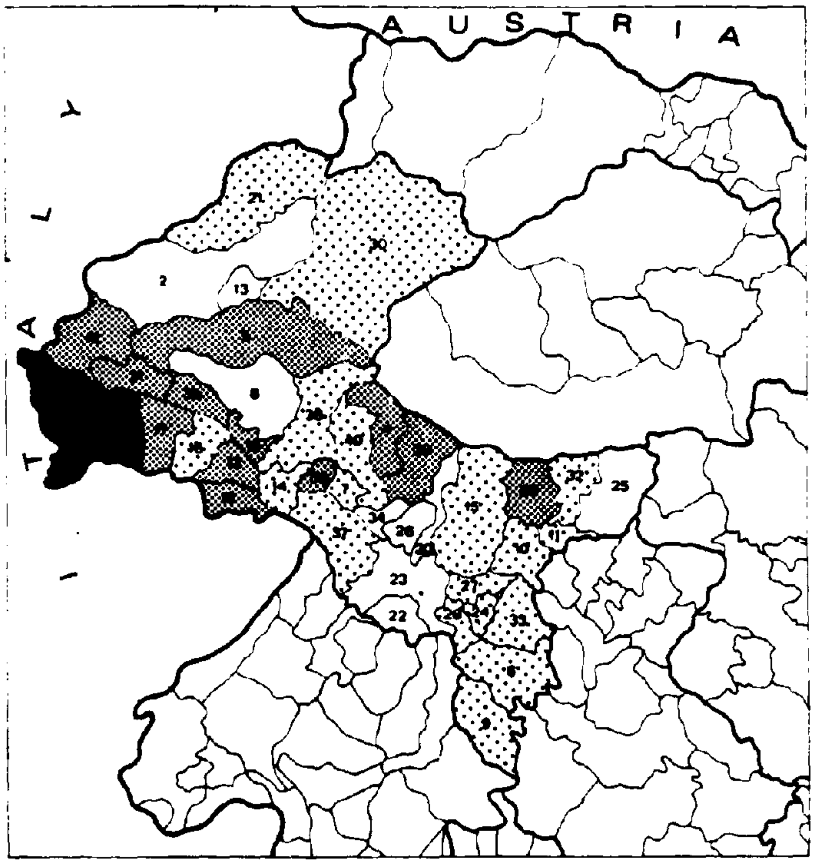
Combined Type	Social Demographic Type	Shelterless Population Type	Sum	Number of Communities
A	1	1	2	2
B	1	2	3	
	1	3	4	12
	2	1	3	
	2	2	4	
C	1	4	5	
	1	5	6	
	2	3	5	
	2	4	6	
	3	2	5	18
	3	3	6	
	4	1	5	
	4	2	6	
D	1	6	7	
	2	5	7	
	2	6	7	
	3	4	7	
	3	5	8	9
	3	6	9	
	4	3	7	
	4	4	8	
	4	5	9	
	4	6	10	

Table 6

Socio-Demographic Index, Population Without Shelter Index, and Combined Category, Local Communities of the Commune of Tolmin, Yugoslavia

Community		Social Demographic Types	Analysis of Population Without Shelter	Combined Score	Category
1.	Borjana	1	1	2	A
2.	Bovec	3	4	7	D
3.	Breginj	1	1	2	A
4.	Čadrg	1	3	4	B
5.	Čezsoča	3	1	4	B
6.	Dolenja Trebuša	1	4	5	C
7.	Dolje	3	3	6	C
8.	Dreznica	2	5	7	D
9.	Gorenja Trebuša	1	4	5	C
10.	Grahovo ob Bači	2	3	5	C
11.	Hudajužina	2	3	5	C
12.	Idrsko	2	2	4	B
13.	Kal-Koritnica	3	4	7	D
14.	Kamno	3	2	5	C
15.	Kneža	2	3	5	C
16.	Kobarid	4	2	6	C
17.	Krod	2	2	4	B
18.	Ladra-Smast	3	1	4	B
19.	Livek	1	3	4	B
20.	Ljubinj	2	6	8	D
21.	Log pod Mangartom	2	3	5	C
22.	Lom	3	6	9	D
23.	Most na Soči	3	4	7	D
24.	Pečine	2	4	6	C
25.	Podbrdo	3	4	7	D
26.	Podljubinj	3	4	7	D
27.	Ponikva	1	5	6	C
28.	Rut	1	3	4	B
29.	Slap ob Idrijci	2	4	6	C
30.	Soča-Trenta	2	4	6	C
31.	Srpenica	3	1	4	B
32.	Stržišče	1	5	6	C
33.	Šentviška gora	2	4	6	C
34.	Tolmin	4	4	8	D
35.	Trnovo ob Soči	2	1	3	B
36.	Volarje	3	1	4	B
37.	Volče	3	3	6	C
38.	Vrsno	2	3	5	C
39.	Zadlaz-Čadrg	1	3	4	B
40.	Zatolmin	3	3	6	C
41.	Žaga	3	1	4	B

Note: The serial numbers indicate the location of the Communities on the maps.



Map 3

Combined Classification by Socio-Demographic Index and Population Without Shelter; Local Communities of the Commune of Tolmin, Yugoslavia

Type A	Type C
Type B	Type D

Source: Table 6.

The last group, the relatively least stricken communities in the commune of Tolmin, Type D, includes areas with both more favorable social demographic characteristics and relatively low degrees of damage. The fine appearance of the group of communities around Tolmin (Tolmin, Poljubinj, Ljubinj, Most-na-Soči, Lom) which is probably the consequence of a generally somewhat better stock of dwellings and a larger concentration of the active population. The same is true of Podbrdo, the most developed community in the Bača Cleft [Berginc 1978], and in the Bovec area (Bovec, Kal-Koritnica), where the impact of the earthquake was surprisingly low in spite of the relative proximity of heavily stricken places, the cause being, probably, that the main fault lies more to the south. This group also includes the community of Dreznica where there was relatively little damage, which has already been dealt with. Several factors seem to have contributed, among them in particular the location of the settlements where the water content of the soil is low. This should be examined geoseismically in a more detailed manner.

The vast changes in the region are reflected in the physiognomy of the settlements. In most cases the new prefabricated houses are on new sites immediately adjacent to the old settlement nuclei. Consequently, the settlements in the most stricken areas have completely changed from their former appearance. There remain only a few houses recalling the old settlement, or the center of the old village, as for instance at Logje, where many houses were repaired using the reinforcement system (ZRMK). In the less damaged areas of Types C and D the transformations of the settlements have not been as radical. The physiognomy of the places retains the former vistas. There have been great geographical changes in living and working arrangements that are still emerging. The revitalization process in impacted places engendered a series of new relationships. In the future we can reasonably expect the revitalization process to influence the social demographic structure of the most heavily damaged areas. Since revitalization is still under way, it is difficult to assess what the effect will be. Similar revitalization measures at Skopje, Banja Luka and elsewhere in Yugoslavia would lead us to expect accelerated general development of the Upper Tolmin and other stricken areas.

The final influences and effects cannot be assessed as yet as the changes taking place in the region are not completed. The earthquake with its effects and the accompanying intensity of post-earthquake activities will be a significant factor in the transformation of the stricken areas. Pak [1978] states that the effects resulting from the earthquake in the stricken region are reflected, primarily, in the following:

1. changes in the physiognomy of the region
2. changes in the economy of the region
3. changes in the population distribution.

All three kinds of effects are closely interrelated.

New prefabricated houses or other new construction have been built mostly in the immediate vicinity of the old villages (Figure 4). When demolished structures were cleared in Breginj an open space was created (Figure 5) where individuals started constructing new houses. The appearance of old villages has been greatly altered. Some villages, such as Podbela, have almost completely disappeared, with only here and there a house to remind of the former settlement. The prefabricated houses have altered the physiognomy of the countryside, farm and industrial buildings are still missing, new roads are under construction, etc. These vast alterations happened in a very short period of time, within a few months. New social relationships are being established which should not be underrated and to which it is necessary to pay attention. In the new common stables and cowsheds things will not be the same as they were in the past. The traditional life and relationships have been fundamentally changed. This is reflected in changing patterns of migration which alters the characteristics of the population.

In the commune of Tolmin in 1975 social product amounted to 30,135 dinars per capita, and national income 26,599 dinars. National income in the commune of Tolmin was only 64 percent of that of the SR of Slovenia. The damage from the earthquake exceeds seven times the national income in the commune. The estimate of the resources needed for reconstruction in the Soča River Basin and for economic development of the area stricken by the earthquake in 1976 is 4,787,385,000 dinars. This amounts to 6.3 percent of the national income from all the sectors of the economy in the SR of Slovenia in 1975. [The Monthly Statistical Survey...1977]

The economy in the Soča River Basin has been stagnant in recent years because of the low level of investment, the lack of cadres, the configuration of the land, the isolation and inaccessibility, the location along the frontier, etc. This is true not only of the most heavily damaged commune of Tolmin but also of some areas of the commune of Nova Gorica, and because of the recent decline in mining, of the commune of Idrija. It is not possible to restore the effects of the earthquake without creating simultaneously a more stable economic and social position for the population affected by the earthquake. The progress of the region can be ensured only by promoting more rapid economic development. This is a necessary condition of a complete elimination of the effects of the earthquake.

Figure 3

Temporary Housing Soča Valley, Yugoslavia, 1976

Temporary settlements of vacation trailers collected and lent to the population of the stricken areas appeared beside the villages during reconstruction.

Figure 4

Prefabricated Permanent Housing Soča Valley, Yugoslavia, 1976

This type of new prefabricated house was built on stable foundations with reinforced concrete supports. The decision was made in the Soča River Basin not to construct temporary dwellings, but instead in a very short period of time (four to six months) to erect up-to-date, non-luxurious, but functionally arranged permanent structures.

Figure 5

View of Breginj, Yugoslavia

A view of Breginj which was the most severely damaged settlement in Yugoslavia in this earthquake. The former settlement was in the foreground, alongside the church. Most of it had to be demolished and only a few houses remained. In the background is the new settlement. However, new houses were also built on the site of the former settlement. People were free to decide whether to become owners of new prefabricated houses, or to start constructing a new house by themselves on the site of the former settlement.

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SECTION XII

FINANCING RECONSTRUCTION AND RECOVERY

GOVERNMENTAL ROLE IN MITIGATING THE IMPACT OF EARTHQUAKES

IN YUGOSLAVIA

Sergej Bubnov

Introduction

While natural phenonena cannot be avoided, at least at the present state of our knowledge and ability, nevertheless, the impact of a natural phenomenon on human lives and property can be mitigated.

Recent earthquake disasters in Montenegro, Al-Asnam, South Italy and Greece have proved once again that the main problems of earthquake protection are the disaster prevention measures to be taken by governments in order to avoid the loss of lives and the destruction of property, as much as possible. The analyses of the impacts of all these disastrous earthquakes have shown that the scope of the disaster could be substantially mitigated if appropriate governmental predisaster measures were adopted and realized before the earthquakes.

At present a great deal of theoretical and experimental research in the field of earthquake engineering has been carried out or is still in progress in many parts of the world. In the last decade tens of thousands of reports have been presented at various international conferences all over the world. Nevertheless, every new earthquake proves that the protection of human lives and property has not been essentially increased during recent years.

This is due mainly to the fact that most of the governments of the countries with earthquake prone areas, where earthquakes occur sporadically, are not sufficiently aware of the social and economic impact of disastrous earthquakes. As a consequence these governments have not prepared measures to mitigate the impact of strong earthquakes nor have they been able to organize and carry out emergency measures immediately after the earthquake disaster. Usually the first strong disastrous earthquake triggers governmental activity of this sort. Sometimes little by little this activity diminishes when no new strong earthquake occurs for a long period.

Disaster Prevention Measures

In Yugoslavia the first earthquake protection measures were instituted in Slovenia after the strong earthquake of 1895 in Ljubljana--intensity about VIII degrees MCS scale. There were no reinforced concrete structures at that time, b t the design and technology of brick structures after the earthquake were improved. Since no earthquake resistance analyses of structures were available then, increasing the seismic resistance of brick structures was accomplished by means of increasing the thickness of bearing walls, which were thickest in the first story and diminishing in the upper stories. In this way the center of gravity was lower and the bearing section was the strongest at the base, where the highest stresses from earthquake loading occurs.

After the earthquake in 1895 a seismological station in Ljubljana was established, one of the first in Europe, equipped with up-to-date instruments.

In the first part of this century between the two World Wars requirements for very low horizontal loads for seismic analysis were adopted in standards of building loading, namely uniform horizontal load of only 2% of the weight of the structure. This requirement was kept also after World War II. However, a number of small earthquakes felt in Slovenia at this time as well as the development of earthquake engineering in the world, stimulated the Slovenian ministry for industry and building to create a special governmental commission to prepare updated regulations for earthquake resistant design. These new regulations were adopted by the government of Slovenia in 1962.

After the disastrous earthquake of Skopje in 1963, these regulations with minor additions were adopted in 1964 for the whole territory of Yugoslavia. The philosophy of the regulations is as follows: since the complete protection against any damage of all kinds of buildings for the strongest possible earthquake is economically not feasible, the earthquake resistant regulations should provide security for human lives in the case of a major earthquake in a region, however, permitting some amount of structural damage.

This means that buildings in any case should not collapse nor suffer such damage as to endanger human lives. The bearing structure should resist the strongest earthquake without heavy damage. These regulations also introduce a sophisticated approach to structural design by the use of the dynamic response analysis. The influence of local geological conditions is also taken into account.

Thus the regulations insured the proper design of buildings to be built in earthquake prone areas. However, design alone cannot ensure earthquake protection. Construction on the site according to the adopted design must be assured through strict supervision of the quality of materials and technology of construction.

This problem is not completely resolved satisfactorily in our legislation as yet, but we are on the way to finding the right solutions for it. We have at present no governmental regulations about town planning in earthquake regions, but professional organizations have made a number of recommendations.

All of these regulations govern the construction of buildings to be built in the future. However, most of the buildings in Yugoslavia were constructed before the adoption of modern earthquake resistant regulations. The problem of how to provide earthquake protection for all these older buildings is a very complicated one from the juridical, economic and technical points of view.

The easiest problem is the technical one. We have developed in Yugoslavia efficient methods for reinforcing and strengthening existing buildings in order to ensure their earthquake resistance. More complicated is the problem of finding the necessary financial means for executing reinforcement, but the juridical problem is probably even more difficult. How can one justify compelling an owner to spend money for the reinforcement of his own house.

The parliament of Slovenia adopted in 1978 a law which is called: the law on the seismological service. This law not only defines the duties of the Seismological Institute of Slovenia, which is created by this law, but also institutes measures to ensure the protection of some existing buildings, built before the adoption of the seismic resistant regulations. Since it was not feasible to force the private owners of houses and dwellings to reinforce them, the requirements of this law are limited only to important public buildings, namely:

- buildings the collapse of which could cause further disasters such as nuclear power plants, warehouses of toxic materials, high dams;
- buildings which are important for relief after earthquakes such as hospitals, fire stations, water supply stations, communication centers, power stations;
- buildings where many people congregate, such as theaters, cinemas, schools, kindergartens;
- very high buildings and buildings with large spans;
- precious cultural monuments;
- the most important governmental buildings.

The Seismological Institute is a governmental body, which is empowered by this law to establish the procedures by which the analysis of the seismic resistance of these buildings should be carried out. If the analysis shows that the structures are not sufficiently resistant to the seismic intensity of the area, the users (owners) of these buildings must reinforce them. The modes of the reinforcement, specifically the time period for compliance, are to be determined by the building authority of the commune where these buildings are located. If the user of a building does not reinforce the structure within the specified time, this authority can forbid use of the building. This law is a *lex perfecta* which means also that penalties are provided for those who fail to meet its requirements.

The introduction of this law in practice is still in the very early stages, and we are aware that in the realization of its requirements many problems and difficulties will emerge. However, the law exists, and sooner or later it must be respected. The problem of the protection of rural houses and private dwelling houses is not as yet resolved by this law. Some owners reinforce their houses at their own expense, however, they are very few.

One can also consider as disaster prevention measures governmental regulations which provide funds to ensure financial means for emergency measures immediately after an earthquake and for later relief and reconstruction. Strong earthquakes cause such immense amounts of damage that stricken cities or communes cannot restore all the damage from their own resources. Therefore, in Yugoslavia there have been created at various administrative levels (commune, republic) solidarity funds which can be used in the case of severe natural disasters to provide relief and reconstruction assistance to stricken areas. These funds cannot be used for relief after every natural phenomenon which causes damage, but only for those which are considered as disasters causing an amount of damage in a specified rate to the GNP of the stricken administrative unit. The interrepublican agreement has set as the threshold for this amount the value of 3% of the GNP of the corresponding administrative unit of the year before the disaster. This means that if the amount of damage to a commune exceeds this limit, other communes, respectively the full republic, must assist by means of these solidarity funds. The very strong earthquakes of Skopje (1963), Banja Luka (1969), and Montenegro (1979) caused damage which exceeded 3% of GNP of the republics of Macedonia, Bosnia and Hercegovina, and Montenegro. Therefore, all republics of Yugoslavia, according to the agreement, were obliged to provide financial assistance from their solidarity funds or from elsewhere to ensure the relief and reconstruction of the damaged areas.

The percent of the participation of each republic in meeting the full amount of the damage is determined by the ratio of the GNP of the republic to the national GNP of Yugoslavia. If the amount in the solidarity funds of all the republics is not sufficient to cover the full damage, a special federal law is issued which imposes a special personal tax based on a percent of wages for the entire population of Yugoslavia for several years. The solidarity funds in each commune and republic are created according to the above mentioned agreement of 1974 in such a way that every year the amount of 0.2% of GNP of the year before must be paid into the solidarity fund. This payment continues until the amount of the fund reaches the value of 2% of the GNP of the year before in the commune and republic respectively.

Post-Disaster Measures

Councils (staffs) for civil protection against natural disasters are established in all administrative units of the country (commune, republic, federation). The local council of the commune (respectively of the republic if the disaster exceeds the bounds of the commune), leads the local emergency relief of the stricken area and contacts the councils of other communes (or republics), in order to obtain necessary assistance (tents, medicine, surgeons and physicians, engineers, etc.).

One of the first important tasks of the local civil protection staff after a disastrous earthquake is to determine the serviceability of damaged buildings. During an earthquake many buildings, houses, and dwellings suffer damage to the bearing and nonbearing elements of the structure. The inhabitants usually are not able to assess the meaning and importance of various cracks of the structure. Fear caused by the earthquake and the uncertainty of the security of their houses leads the population to approach civil protection staffs requesting temporary shelter. This may complicate the actions of emergency relief staffs, which at the first moment usually do not have enough temporary shelters available.

The evaluation of the serviceability of damaged buildings after an earthquake is one of the most important tasks of the emergency staffs. This task can be accomplished only by specialized engineers familiar with the problem of the statics and dynamics of structures. Disastrous earthquakes cause such quantities of damage that the local available staff of engineers is not sufficient to fulfill this task in a short time. Therefore after major Yugoslav earthquakes (Skopje, Banja Luka, Montenegro), engineers from all Yugoslav republics were engaged to accomplish this task. The involvement of engineers recruited from other republics was on a free basis.

For engineers from enterprises and companies, the loss of income was restored from the solidarity funds.

The main task of the first staff of engineers is to determine the serviceability of buildings. Therefore, all buildings in the stricken area are marked with one of the following colors:

- green for serviceable buildings;
- yellow for buildings which must be repaired before using; and
- red for heavily damaged buildings beyond repair.

This classification by means of three colors was used in the earthquakes of Skopje (1963), Banja Luka (1969), Slovenia (Friuli 1976), and Montenegro (1979). In the case of Montenegro subdivisions of each color (one, two, or three lines) were used to show the degree of damage, primarily for later evaluation of the cost of repair or rebuilding.

The evaluation of damage from the point of view of serviceability is a very responsible and complicated task, since it is impossible to predict if new strong shocks can occur in the near future. Frequently within one to five months after the first strong shock a second shock, usually slightly weaker than the first one, can occur. This can be even more dangerous for buildings than the first one, since the bearing capacity of the structure was already weakened by the first shock. Therefore, the decision about the serviceability of buildings must be taken with a great deal of caution, having in mind the possibility of the occurrence of aftershocks. The second task of engineers and technicians is to evaluate the amount of damage in order to determine the financial resources required for the repair and reconstruction of buildings.

The evaluation of damage must be carried out uniformly since in the case of a disastrous earthquake all republics participate in collecting the financial resources for reconstruction. In order to avoid disagreement between recipients and donors of assistance, a federal unified methodology for evaluation of damage after natural disasters was adopted in 1979. This methodology defines how to evaluate the damage to buildings and civil engineering structures, the damage to equipment, the loss of income due to shutdown in the industry, the cost of the emergency relief, etc. The problem of reconstruction of damaged buildings has to consider the previous level of resistance of the damaged building before the earthquake as well as the requirements for resistance according to the seismological map of the region. The resistance of old buildings usually was not sufficient for the seismic intensities, which have been defined in recent times on the basis of the new seismological maps. Problems arise in reconstruction as to whether the building should be restored to its status prior to the earthquake or should be reconstructed to ensure higher resistance, corresponding to the seismological maps of the country where the strongest intensity of the earthquakes to be expected in the region are indicated.

The solution of this problem in Yugoslavia was the following: the reconstruction of public buildings should be carried out in such a way that the resistance of the reconstructed structure should correspond to the requirements of seismic resistance according to the seismological map. For private houses it is up to the owner to decide how to use the loans which are granted under favorable conditions for the reconstruction of his house. From the technical point of view various methods for reinforcement and strengthening of brick and stone buildings are developed. The program for the reconstruction of the area stricken by the earthquake is to be developed by the commune or republic respectively and should be approved by the council for civil protection and other authorities in the republic or federation respectively.

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FINANCING THE LOSSES AND THE RISKS DUE TO EARTHQUAKES

Branko Zelenkov

In this paper, three topics will be discussed, elaborated, and clarified.

1. A brief definition will be given for the way in which the terms financing the losses and risks due to earthquakes is used here;

2. A comparative analysis will be made of the basic approaches and mechanisms for financing the losses due to earthquakes in Skopje in 1963 and Montenegro in 1979;

3. A model will be presented of a way in which losses and especially risks due to earthquakes can be financed.

Defining the Terms: Financing the Losses and the Risks Due to Earthquakes

For the purposes of this paper, it is necessary to define how the terms financing the losses and risks due to earthquakes will be used. This involves addressing three issues:

- what the term financing denotes;
- how losses due to earthquakes are defined and determined;
- how risk due to earthquakes is defined.

The term financing the losses and the risks denotes supplying financial resources to mitigate or eliminate the material and human losses that result from earthquakes. It means that financial resources should be made available to compensate the losses.

Financial resources can be obtained from various sources: domestic and foreign credits, loans, percentage assessments of the national product, bank reserves, monetary remissions and transfers, etc. It is important to identify the specific sources of financial resources to be used, the precise amount, and the means and terms of repayment, if the resources are assigned as returnable, as precisely as possible.

In addressing the problem of financing the losses and the risks due to earthquakes, attention should be given to several considerations.

First of all, to determine the total amount of financial resources necessary to restore the losses that occurred;

Second, to determine the various sources of the resources;

Third, to identify those who will make the resources available;

Fourth, to determine the time period over which the resources will be collected, and

Fifth, to determine the way of establishing the magnitude of the losses (in value indicators) that have resulted from earthquakes in as objective a way as possible.

The term losses due to an earthquake denotes all those losses (material and human) that occur as a consequence of an earthquake disaster. This term comprises both direct material and human losses and indirect losses and damages, the amount of which are difficult to determine. Indirect losses are the results of the interrruption of normal economic and social life for a more or less protracted period in a region which has suffered an earthquake. Determination of these losses which occur much after the event is also very important in order to eliminate completely all the losses due to earthquakes.

In any case, it should be noted that the magnitude (the value) of the total of all the losses should be determined as objectively as possible, and the estimate should be based on a uniform methodology which is objectively defined for the evaluation of losses due to earthquakes and other natural disasters.

The term risks due to earthquakes denotes those losses (human and material) that are expected to occur as a result of future earthquakes. Risks due to earthquakes apply to future expected losses. The evaluation of risk should be determined on the basis of experience over a period of ten or more years, i.e., on the basis of evaluated losses due to earthquakes in earlier periods in a region either geographic or seismic. This region can be a country, a region in a country, a continent, or larger regions within a continent, etc.

A Comparison of the Systems and Mechanisms of Financing the Losses Due to Earthquakes in Skopje in 1963 and in Montenegro in 1979

A comparison of the approaches followed after the earthquakes in Skopje in 1963 and in Montenegro in 1979 can serve as the basis for inquiring as to the most appropriate system for financing losses and risks.

Financing the losses and the damages which resulted from the earthquake in Skopje in 1963 was carried out by a system characterized by the following basic and more important rules:

1. Law or Legislative Act which created the Fund for renewal and reconstruction of Skopje:

2. Law or Legislative Act establishing the method by which contributions were to be made to the Fund for renewal and reconstruction of Skopje;

3. Law or Statute determining the total amount of resources that the social community was to provide for the renewal and reconstruction of Skopje;

4. Law or Statute establishing the level of contributions for renewal and reconstruction of Skopje, and;

5. Law or Statute establishing the level of public loans for renewal and reconstruction of Skopje.

The purpose of the first two temporal laws or acts was to create a Fund for the renewal and reconstruction of Skopje for restoring the damage to the city, and to establish a means for supplying financial resources by which the larger social community was able to participate in the effort with the SR Macedonia and the city of Skopje to eliminate the consequences of the earthquake.

The resources of the Fund were created by:

a) contributions from the resources that are designated for investments,

b) contributions from the resources designated for material expenses for general consumption or operating expenses,

c) contributions from the resources available for personal income of the employees both in payments and benefits,

d) contributions from a special levy or tax on income paid to individuals,

e) grants from the social-political communities at various levels,

f) domestic and foreign grants and loans,

g) annuities and income on the loans issued from the resources of the Fund, and interest on the resources of the Fund deposited in the banks.

The total amount of the resources of the Fund were determined by the law or statute under number three above. It was based on the estimated cost of executing the programme for renewal and reconstruction of Skopje as it was adopted by the Assembly of the City of Skopje. This law or statute was enacted by the end of 1964. Until its enactment, for the first part of 1964, the Law cited under number two temporarily determined the level of contributions cited in item (a) to item (d) from the sources identified above.

That Law, when enacted, established the level of contributions from the resources designated for investment, the contributions from the material expenses for general consumption, and the contributions from the taxation on the resources available for personal income at the level of 2% of the quoted resources, and the special levy or tax on the personal income of the empoyees was set at 1%. These types and levels of contributions and rates were also determined later in the Law of contributions for renewal and reconstruction of Skopje. The total amount of resources for renewal and reconstruction of Skopje was set at four hundred billion old dinars. The time period over which these resources were to be collected was established as the five years from 1965 to 1970.

The resources of the Fund were to be used especially for renewal and reconstruction of economic productive capacity, residential areas, community facilities, social service facilities, public facilities required for the provision of state services, equipment for technical assistance, for cleaning up the ruins, and for research, planning and design for the reconstruction of the town, and for building temporary shelters for the population that lost their dwellings. The resources of the Fund were assigned to the beneficiaries primarily as grants without obligation for repayment, and also to some extent in the form of loans.

As mentioned above, at a later point, Article No. 11 of the Law determining the total amount of resources with which the larger social community participated in the renewal and reconstruction of Skopje, the Fund for renewal and reconstruction of Skopje was eliminated, and its resources and all other rights and obligations were transferred to the Assembly of Skopje. According to the Law, the resources governed by it were to be assigned to the Assembly of Skopje as a grant without obligation for repayment.

Another instrument for supplying resources designated for restoring the consequences of the earthquake in Skopje was the Law or Statute providing for public loans for the renewal and reconstruction of Skopje. By this Act resources were supplied for public loans which amounted to thirty billion old dinars above and beyond the amount of the contributions.

In summary, it can be seen from the brief description above that:

1) The resources required for the elimination of the consequences of the earthquake in Skopje were supplied, for the most part, in the form of gifts and contributions from various sources throughout the economy of Yugoslavia as a whole, and a portion of them were supplied in the form of public loans for the renewal and reconstruction of Skopje.

2) The resources for elimination of the consequences of the earthquake were assigned to various beneficiaries largely as grants without obligation for repayment, and to a lesser extent in the form of loans.

3) The total amount required for elimination of the consequences of the earthquake in Skopje was determined on the basis of the cost of carrying out the Programme for the renewal and reconstruction of Skopje, which was adopted by the Assembly of the City of Skopje.

In comparison, the financial aspects of dealing with the consequences of the earthquake in Montenegro in 1979 were quite different. The main features are as follows. The system and the mechanism that was established for financing the consequences of the earthquake in Montenegro in 1979 is basically regulated by two legislative acts: The Law for supplying resources for the elimination of the consequences of the earthquake disaster that hit the region of Montenegro in 1979, and Law of resources for elimination of the consequences of the earthquake disaster that hit the region of Montenegro in 1979.

The effect of these acts was to establish the following system and mechanism for financing actions dealing with the consequences of this earthquake:

1. The resources for elimination of the consequences of the earthquake disaster in SR Montenegro are to be supplied by contributions from the republics and the autonomous provinces.

2. The contributions of the republics and provinces is determined by their proportional share of the nominal national product of the whole economy of SFR Yugoslavia as of the year prior to the earthquake, calculated on the basis of net product, and on the basis of official statistical data that are available at the time of determination of the contribution.

3. The amount of the total resources for the elimination of the consequences of the earthquake disaster in Montenegro is determined to be and is to be supplied in the total amount of 53,637,000,000 dinars.

   The largest share of the amout, 39,937,000,000 dinars, is to be supplied by the contributions of the republics and the provinces, and these resources are assigned to SR Montenegro without obligation for repayment.

   The remainder of the resources, 13,699,635,000 dinars, also to be supplied by contributions of the republics and the provinces, are assigned to SR Montenegro in the form of loans to be used to provide loans to citizens for renewal and reconstruction of residential buildings and economic production facilities within the region of Montenegro.

4. The time period over which the republics and the provinces are to supply the resources required for eliminating the consequences of the earthquake in Montenegro by their contributions is set at 10 (ten) years, from 1979 to 1989.

5. The amount of total resources is determined on the basis of the final evaluation of the magnitude of the losses incurred. The estimation of the magnitude of the loss is determined on the basis of an Instruction for a unified methodology for evaluating the losses due to natural disasters. This methodology was adopted in 1979.

As can be seen from this brief description, the standards and approaches taken in financing the actions dealing with the consequences of the earthquake in Montenegro differs considerably as compared with the procedures regulating the financing of the consequences of the earthquake in Skopje in 1963. The chief differences are as follows:

1) Unlike previously, it is now the republics and the provinces which supply financial resources by their contributions, and not the whole economy, as was the case with the earthquake in Skopje in 1963.

2) As previously, the financial resources are supplied, for the most part, without obligation for repayment, but in this case a much larger share of the total is in the form of loans, with the obligation for repayment.

3) The amount of total resources is determined on the basis of

evaluated magnitude of the loss incurred as determined on the basis of a unified methodology for evaluation of the losses due to natural disasters, and not as previously on the basis of the cost of execution of a reconstruction programme.

This comparison of the differences in the approach and procedures followed in supplying the financial resources for eliminating the consequences which resulted from the earthquakes in Skopje in 1963 and in Montenegro in 1979 establishes several points. Until now this problem has been solved partially not comprehensively, on an ad hoc basis case by case, and not systematically by a unified approach, nor based on permanent sources of resources.

The conclusion derived from this review is that the problem of ensuring financial resources for dealing with the consequences resulting from earthquakes and other natural disasters should be resolved on a permanent and unified basis, in the sense of ensuring a permanent source of resources for this purpose. In short, the conclusion is that these resources should be ensured by establishing a Fund against risks from earthquakes and other natural disasters. We shall discuss this concept in detail in the following section.

A Model for Financing the Losses Resulting from Earthquakes and Other Natural Disasters

Regarded from a systemic point of view, there are two basic approaches that can be taken for financing the losses and the risks due to earthquakes and other disasters.

1) By creating a Fund for financing the renewal and reconstruction of regions which have suffered losses by earthquakes and other disasters. In essence, it would mean creating a Solidarity Fund such as are currently established.

2) By creating a Fund against the risk of financing the elimination of the consequences of earthquakes and other disasters.

From all that has been stated above, it is clear that we speak in favor of a solution which assures a permanent supply of financial resources for eliminating the consequences which result from disasters. Rather than creating funds after the fact for the renewal and reconstruction of regions which have suffered losses from earthquake, it calls instead for creating a fund against the risk of the elimination of the consequences of earthquakes. In short, not financing the concrete losses due to earthquakes ex post, but rather financing the risks of losses due to earthquakes ex ante.

This approach to the problem presupposes the capability to determine the risk first of all, i.e., determining future value of anticipated losses that would occur by future earthquakes.

One question that must be addressed is the way of creating such a Fund against risk and accumulating resources by which the consequences due to earthquakes would be eliminated, i.e., the losses that would result from eventual earthquakes would be restored.

Resources in a fund against risk for eliminating the consequences due to earthquakes could be created in two ways:

1) in the same way as the resources for risk insurance of fixed assets of organizations of associated labor are presently created;

2) in the same way as the obligatory resources of the Federation fund for development capital for the undeveloped republics and socialist autonomous province of Kosovo are presently created.

Resources in both cases would be ensured obligatorily and permanently as a percentage of the national product or of the national income of the whole country. Every organization of associated labor, the social-political communities, and eventually the citizens would be obliged to contribute to this fund.

This amount of resources which should be accumulated each year would be determined on the basis of the value of the calculated losses resulting from earthquakes over some previous period, say the last five or ten years. Consequently, the basis would be established in accordance with the actual experience concerning value of losses over a determined period of time.

If the resources accumulated in this way do not prove adequate for the requirements of a year or in the long term, then the basis can be adjusted in light of experience and additional resources can be supplied.

The Fund would be organized and would operate as an autonomous and self-managed institution. The resources of the Fund against risk would be assigned to those regions where losses occur from earthquake disasters and other similar natural hazards covered within the risk.

The resources would be assigned for the most part without obligation for repayment, and to a lesser extent for specified purposes with such an obligation in the form of loans.

It is our opinion this way of financing the losses resulting from earthquakes is superior to the existing one which is rather partial and not sufficiently efficient and rational. Certainly this way of financing is more difficult in application because of the difficulties in determining the risk of eventual earthquakes: the probability of disasters, and the magnitude of the losses.

Although there are difficulties in developing this system, we consider the approach to financing the losses resulting from earthquakes by creating a fund against risk to be a better, more justified, more efficient, and more rational procedure than the existing one. The present approach has considerable shortcomings in practice, especially in the supply of financial resources on short notice, and this is extremely important and decisive in the efficient elimination of all the losses due to earthquakes and other disasters.

EARTHQUAKE INSURANCE AND
EARTHQUAKE RECONSTRUCTION:
THE NEW ZEALAND CASE

Arnold R. Parr[1]

Introduction

> The most practical way to approach the questions of earthquake damage is by way of insurance against it. [Freeman, 1932, p. 1].

This view, expressed by an American engineer in 1932, was manifested in New Zealand society, commencing in 1944 and continuing up to the present. Since 1944, a national, compulsory program of earthquake insurance has operated in New Zealand.

The major problem that is thought to characterise New Zealand's national compulsory earthquake insurance program is that sufficient funds will not be available to bring about complete restoration after a serious earthquake in a major urban area. This paper, through analyzing the origins and the 37 years of functioning of the program, hypothesizes that a number of other problems as well as insufficient funds will be associated with earthquake insurance and earthquake restoration in the event of a serious earthquake in a major urban area.

Origins

Officially, the earthquake insurance program came into existence when the Earthquake and War Damage Act was passed by Parliament in 1944.[2] However, the program actually arose out of developments which had started as early as 1941. In that year, the War Damage Act was passed by the New Zealand Parliament.

The Act was modelled on the British example, which had been passed in the same year, but some differences existed. Both Acts established War Damage Commissions. In Britain, the Commission was empowered to levy a charge against the assessed value of all property in England and Wales, whereas in New Zealand the levy was on buildings only, excluding land and property such as fences and perimeter walls, and the levy was based on

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the value of the buildings as assessed for fire insurance. In Britain, the rate of levy was 2s. in the pound for buildings and 6d. in the pound for all open and agricultural land, and in New Zealand, the rate of levy was 5s. per 100 pounds of fire insurance coverage ($ .25 per $100). The Commission funds in both societies were to be used for compensation for war damage. [O'Riordan, 1971, pp. 4-7].

A fairly strong case can be made that developments in New Zealand over war damage recompensation were at least initially a result of diffusion from Britain. But diffusion is not a complete explanation for New Zealand setting up a War Damage Commission. The British model did not diffuse to Australia, for example, suggesting that the situation was more conducive for its adoption in New Zealand.

From the very beginning, the War Damage Act was oriented toward general disaster coverage. The introduction of a national earthquake insurance program in New Zealand was foreshadowed in the Parliamentary debates in connection with the War Damage Act in October, 1941. In these debates, there was discussion about the use of surplus funds for covering other disasters. Coverage of earthquake disasters was specifically mentioned. "It was decided...that any surplus in the fund should be set aside to meet any disaster that might arise, such as an earthquake." [Prime Minister Nash, House of Representatives' Debates, Tuesday, 7 October 1974].

The possibility of refunding to premium payers any surplus in the fund at the end of the war was considered, but discarded in favor of making "grants to persons who have had damage done to their property as a result of earthquakes or other disasters..." [Wilson, Leader of Council, Legislative Council Debates, 9 October, 1941]. Thus, the War Damage Fund was always viewed as a general disaster fund.

The most important aspect of the origins of the earthquake insurance program is that the Earthquake and War Damage Commission arose during a period of international crisis. A situation of stress, which directly affected New Zealand society, was the setting in which the earthquake insurance program emerged.

The national earthquake insurance program was a war-time development for New Zealand. In a national emergency, sectional interests in a society are often downgraded in the national interest. In the early years, at least, of the war, there was considerable overall consensus, solidarity, and unity in New Zealand society. This was conducive to the emergence of a disaster fund that was based on equity of costs and benefits. Thus, the war situation initially produced and then led to the consolidation of the fund which became a means of reconstruction after earthquakes and other disasters.

The New Zealand earthquake insurance program was based on ideological commitment to equity. This was first manifested in the fact that recompensation for war damage to property was to be shared by all property owners. In the case of earthquake insurance, Freeman speaks of spreading the risk, and he is referring to geographically spreading the risk over as many communities as possible and also over a long term of years [Freeman, 1932, p. 23].

Spreading the risk is a collective strategy for achieving equity of costs and benefits. The operation of the program over a long period of time disperses the costs and permits the accumulation of funds. A pool of accumulated funds is then available to be disseminated on a widespread basis when an earthquake occurs. The compulsory nature of the programme achieves equity by assuring that the costs are spread over the entire population of the society.

The earthquake insurance program in New Zealand originated as a state initiated and controlled enterprise. Freeman, a major analyst of earthquake insurance, was not in favour of government earthquake insurance [Freeman, 1932, p. 691]. He thought it would remove the incentive for building earthquake resistant structures, it would be difficult to determine a premium rate for manifestly unsafe structures, and it would also be difficult to discriminate between the different degrees of risk in different localities. He did, however, feel that government, in this instance, state governments in the United States, could offer some sort of concurrent excess insurance.

New Zealand, with a documented history of considerable state involvement in social life, particularly in the area of national economic policies and developments, did not accept Freeman's views. Instead, the government established national, compulsory earthquake insurance, and furthermore, all earthquake insurance issued by the Commission is government guaranteed.

From its origins, the New Zealand earthquake insurance program has been coupled with fire insurance. New Zealand's decision to base earthquake insurance on property insured for fire is perhaps related to Freeman's claim that "it is easily possible to combine earthquake insurance with fire insurance <u>in the same policy</u> at an increase in cost which would be exceedingly small..." [Freeman, 1932, p. 3]. In any case, the main motive of combining fire and earthquake insurance is to reduce overhead costs such as office expenses, soliciting, inspection, and commission of agents.

Freeman's hypothesis that compulsory earthquake insurance would result in building construction being less earthquake resistant than it could be, has not eventuated in New Zealand. The argument that incentive to increase resistance would be lost because coverage would be available for the less as well as the more resistant structures at the same rate has not proved sound. After 37 years of compulsory insurance in New Zealand, there is no evidence that building standards have lowered or even remained static. On the contrary, research on earthquake resistant construction and implementation of building codes have been emphasised in New Zealand society.[3]

<u>Functioning</u>

By 1944, when the War Damage Act was repealed and replaced by the Earthquake and War Damage Act, the Commission fund had accumulated to $7,944,956. By 1980, the accumulated amount was $410,384,512. (See Appendix A.) Freeman in 1932 pointed out that the success of earthquake insurance depended upon "<u>The building up of a reserve</u>; recognising that earthquake insurance...meets its severe loss <u>only once in a quarter-century or half-century</u>, with many intervening years without noteworthy loss, and that funds well into the millions of dollars, must at all times be kept in readiness to meet this rare emergency." [Freeman, 1932, p. 24]

In terms of this criterion, the New Zealand earthquake insurance program has not been successful. Up to the present time, sufficient funds have not accumulated to cope with a severe earthquake. The existing amount in the fund would constitute only a small fraction of the total liability if a serious earthquake affects a major urban area.

This weakness in the earthquake insurance program has been carefully analysed by Sherburd [1981, p. 4-6]. In his analysis, the following earthquake specifications were used.
Magnitude: 7.5 on the Richter Scale
Intensity: X on the Modified Mercalli Scale
Source Region: Close to Wellington, capital, population 350,000
Depth: Shallow, less than 40 kilometres
Aftershocks: One 6, one 5, numerous tremors
Time: 10:30 a.m. on a working and school day.

The Earthquake and War Damage Commission has estimated that such an earthquake would produce a claims cost of $2,000,000,000. This is based on a 20 per cent loss ratio on the total sum insured at risk in the greater Wellington area. This estimated claims cost greatly exceeds the existing reserves in the earthquake insurance fund, and also exceeds any previous claims cost, the highest being $2,513,321 in 1969 (see Appendix B). Since the earthquake insurance of the Commission is government guaranteed, the funds for meeting claims in excess of existing reserves will probably be obtained through substantial overseas borrowing.

However, dependency upon overseas resources, particularly for loan capital, may not be a straightforward matter. In 1968, after a major earthquake occurred in a sparsely populated part of New Zealand, it was claimed that "with the economy now strained to the limit of overseas resources and available investment, and likely to remain so, the possibility of sufficiently substantial loans to ensure quick recovery would be slight indeed." [Power, 1968, p. 26]

One proposed solution to the problem of insufficient accumulation of funds is to increase the rate of levy. When the earthquake insurance was officially made a component of the Commission's programme, the rate of levy was lowered from $.25 to $100 of fire cover to $.05 per $100 of cover. The rate has remained the same ever since.

The premium rate is uniform throughout the society; there is no variation from one region to another. All parts of the society are treated as of equal risk. Critics make the case that low risk areas are subsidising areas of high risk since the program is uniformly compulsory with no variation in rate according to degree of risk.

However, field assessment of risk is a challenging task. It involves consideration of local ground conditions and an engineering knowledge of the expected performance of the existing building.

Very recently, on the basis of submissions from the Earthquake and War Damage Commission, a Commission of Inquiry recommended significant changes in the premium levy system. (Report of the Commission of Inquiry into the Abbotsford Landslip Disaster, 1980: 162-163). The proposed changes are:

1. The premium should be collected by local authorities as part of the rating demand.

2. There should be an annual premium based on the unimproved value of each landowner's land.

3. The local authorities should account to the Earthquake and War Damage Commission for collected premiums.

4. An annual premium of $.02 for each $100 of unimproved value.

5. The level of the premium should be reviewed after three years.

6. The insurance should not cover rural land used for growing crops, standing timber, orchard trees, fences, gates, irrigation works, and other similar classes of rural improvement.

The liability and benefits of the earthquake insurance programme have developed into quite an unsatisfactory situation. The liability of the Commission is the lesser of (1) of the sum insured or (2) the indemnity value at the time of loss. Thus, most liability payments are on the basis of the assessed indemnity value at the time of loss. The Earthquake and War Damage Act does not define indemnity value and a legal definition of the concept is not readily available.

Especially in the 1970's, replacement insurance has become more available, and it is interesting to contrast liability for indemnity and replacement value. In the case of a 50 year old dwelling, the replacement value could be $60,000 whereas the indemnity value would be only $20,000 [Sherburd, 1981, p. 2]. The owner in the event of complete earthquake destruction of the building would receive an insurance benefit of $20,000 from the Commission and to accomplish complete restoration another $40,000 would have to be obtained privately.

It is simply the case that an insurance program which provides coverage on the basis of indemnity value of property is not going to provide sufficient funds to satisfactorily accomplish earthquake restoration. The indemnity value payments will not come close to meeting the actual costs of reconstruction.

When considering earthquake insurance as a strategy for accomplishing earthquake reconstruction, a number of other problems arise in the New Zealand context. Scale of activity is one of these problems. New Zealand is a small, island society of 3,000,000 residents. The over-all economy operates on a relatively small scale. Thus, a serious earthquake would disrupt the entire economy and set back development of the society for a decade. In contrast, a similarly strong earthquake would have only a minor effect on the over-all economy of Japan because of the difference of scale.

Another problem area centers on the relationship between the state and private sector in New Zealand society. Virtually all earthquake insurance is handled by the Earthquake and War Damage Commission which is a state agency. When earthquake insurance is available only from the private sector, a number of difficulties arise. In areas of low risk, very little insurance coverage will be taken out. In high risk areas, insurance companies will be reluctant to issue much insurance and the amounts insurable will be relatively small. Also, premiums will be relatively high. The policies will be characterized by strict limitations, making them largely unacceptable to the insuree.

In New Zealand society, these difficulties have been circumvented by the state requiring compulsory earthquake coverage on fire insured property at a very modest uniform premium of $.05 per $100 of cover. However, involvement of the state in assuring the existence of earthquake insurance does not resolve all the problems in a capitalist society. In New Zealand there is a tension between the state and private sector when it comes to earthquake reconstruction, as the building industry is largely private enterprise. The tension manifests itself in a number of ways.

Competition can become extremely intense and stressful. Even though some financing may be available for earthquake reconstruction from insurance payments, in New Zealand society there will be strong, and at times invidious, competition for scarce building resources which will be largely controlled by the private sector. A scarcity of both material and labour resources will occur for the building industry in the area of impact. In fact, because of the small scale of the New Zealand economy, if the entire building industry largely diverted all of its resources to reconstruction there would be complete disruption of the over-all economy.

The last major earthquake affecting a built-up area occurred in 1968 when New Zealand society was experiencing a severe economic recession. One consequence of this was that the building industry in the earthquake area was quite run-down. There was a shortage of skilled tradesmen, equipment, building supplies, and other resources crucial for earthquake restoration. Coupled with this was the reluctance of the building industry to extend credit. The building industry claimed that it was not in a position to carry book debts [Gill, 1969, p. 117]. Thus, those who were able to pay cash were able to have their property restored immediately, if the building industry had the available resources. This means that socio-economic differences played a significant part in how earthquake restoration was actually accomplished. A program which is philosophically based on equity does not produce equity in practice when it comes to what actually happens during earthquake restoration.

The existence of a state insurance program does not mean that the state will control priority over which tasks should be done first. In New Zealand, the mobilisation of material and labour resources will be largely controlled by the private sector. This mobilisation and deployment of resources will be largely influenced by monetary incentives rather than altruistic consideration of societal needs and goals. In other societies, with socialist economies, earthquake reconstruction could become a rallying point for intensified efforts for the good of the entire society. Resources would be allocated in the national interest. Moral and collective incentives would prevail.[4]

Another problem is whether insurance payments are used for earthquake reconstruction or are diverted to some other possibly quite unrelated use. This was of minor significance, at least, following the 1968 Inangahua earthquake in New Zealand. According to the Secretary of the Earthquake and War Damage Commission, "in some cases it was found that all earthquake repair work was not being carried out, with the possibility that some, if not all of the settlement monies being used for other purposes." [Gill, 1969, p. 117]

This problem, of course, relates to whom the payments are made and when they are made. Perhaps the payments should be made directly to the parties who actually carry out the restoration and as progress payments once the reconstruction is underway. At the present time in New Zealand, in the case of encumbered property, a proportion of the insurance payment is made to the mortgagee.

Conclusion

As has already been noted, some changes have been recommended in the premium levy system for the New Zealand earthquake insurance programme, and at this point the possibility of other changes will be considered. The general question is: what is the future of this unique strategy for earthquake restoration?

What will happen ultimately to the New Zealand Earthquake and War Damage Commission if it has to respond to a severe earthquake in a major metropolitan area? The fund is government guaranteed and so coverage of insured properties is assured.

Once the earthquake crisis is looked after, will the Earthquake and War Damage Commission survive and continue to operate as it has in the past? Perhaps not. The New Zealand egalitarian ideology may no longer be sufficiently strong and viable to sustain a societal development which is based on sharing costs and benefits equitably. There will probably be a strong move to have the private sector assume complete responsibility for earthquake insurance. This would end national, compulsory coverage and bring about insurance on a user pay basis. In the event the Commission has to respond to a major earthquake in a built-up area, the end result may be that monetary incentives will supercede moral and collective incentives and the Commission will cease to operate as it now does.

A major conclusion of this paper is that the possible demise of the Earthquake and War Damage Commission and its program of national, compulsory insurance is a totally unacceptable option and should not be permitted to occur under any circumstances. A compulsory earthquake insurance programme, as a national policy for disaster response, is a fairly unique option for a society to pursue. In New Zealand's case, it has operated with considerable success, but should not be regarded as the utopian solution to earthquake restoration. On the other hand, even though national compulsory earthquake insurance is associated with certain problems, it is proposed that the program be modified rather than abandoned. In western capitalistic societies, there seem to be very few alternatives that could bring about earthquake restoration on a similar equitable basis.

The modifications to the program which have already been suggested in this paper are in the context of a national model of earthquake response. The major recommendation is that all property be levied as a source of capital for a disaster fund. The ultimate aim should be to accumulate sufficient funds within the society to be able to financially bring about satisfactory restoration after a serious earthquake. This approach is based on the strategy of self-reliance and progressive nationalism.

Another approach to modifyng the existing program uses an international model. The main recommendation is that overseas insurance be taken out for purposes of earthquake coverage. A case for the placement of insurance overseas is made by Power. "Although the premium rate may be high, there is no question of the ability of the insurance companies to pay out, and to pay from overseas fund sources - an important factor" [Power, 1968, p. 26].

Both the national and international model seem to be viable possibilities but with each having certain weaknesses. The national model has the weakness of requiring a widespread and prolonged period of commitment. To be successful in a small society such as New Zealand, the program would have to be comprehensively compulsory and operate for many years in order to bring about the accumulation of a reservoir of sufficient funds to handle major earthquakes as they occurred. For New Zealand, at least, the national model involves extremely long-term operation and very comprehensive support and participation from the entire society.

The international model has the weakness of creating an undue degree of dependency in New Zealand society. Once insurance is placed overseas, New Zealand loses some control of the situation. For example, control over how the insurance premium funds are invested would no longer be a New Zealand decision. In the case of Earthquake and War Damage Commission funds, at the present time most of the funds are invested internally in local body and government stocks.[5] Carrying overseas earthquake insurance would mean that New Zealand no longer controlled this investment capacity and would, in effect, put New Zealand in a very dependent position and subject to considerable foreign influence.

A further weakness of the international model, possibly of the national model too, is that attention is almost exclusively devoted to the purely financial aspects of earthquake restoration. It must be realised that the availability of adequate funds will not be sufficient on their own to bring about satisfactory earthquake restoration after a serious earthquake in a built-up area in New Zealand society. Adequate funds are a necessary but not a sufficient basis for earthquake restoration.

Adequate funds are a material resource. Social and organizational resources are also essential for earthquake restoration. The sociological aspects of disaster response are as important as the material and technological aspects. For example, perhaps one of the least recognised problems with New Zealand's earthquake insurance and reconstruction program is that the mixing of state and private sector activities can produce severe difficulties.[6] This is a problem area that will not be resolved by simply making available more funds.

In very general terms, the sociological aspects of earthquake response in New Zealand are generally analysed from only one perspective which can be narrow, confining and restrictive. Implicit in much of the discussion about the problems that would occur over earthquake insurance in the event of a severe earthquake is the view that New Zealand society usually operates as a finely-tuned and well-balanced entity, especially in the economic sphere. Power, for example, claims: "At the very best only a proportion of the building industry could be directed to the job of reconstruction without complete disruption of the economy, so that this burden would set the country back for possibly 10 years." [Power, 1968, p. 26] Thus, it is evident that much of the thinking about earthquake reconstruction in New Zealand is strongly influenced by the consensus, equilibrium model of social life.

The final conclusion of this paper is that sociologists and others concerned with disaster response need to consider alternatives to the consensus model, especially when dealing with the restoration phase of disaster response. Is it possible to view earthquake restoration as a creative, adaptive, and dynamic process for the entire society, rather than emphasising disruption and dislocation with a view to restoring the status quo as soon as possible?

FOOTNOTES

1. The research assistance of Mr. Gregory Seymour is gratefully acknowledged.

2. It should be noted that in 1949 the Earthquake and War Damage Act was extended to cover extraordinary disaster, storm and flood damage. The premium levy remained unchanged. A separate account, the Disaster Fund, was created by diverting one-tenth of the premium levy from the Earthquake Fund into the newly created Disaster Fund.

3. Seismic building regulations were introduced in New Zealand in 1932.

4. A capitalist and a socialist society, the United States and China are compared by Gimenez in her analysis of social response to earthquake prediction. She found that moral and collective incentives predominated over monetary incentives in the socialist society of China. [Gimenez, 1976]

5. In 1980, $372 million was invested internally and $40 million was invested overseas.

6. This situation is similar to "The Tragedy of the Commons" where severe problems arose because the grazing land was owned publicly while the cattle were owned privately. [Hardin, 1968]

Appendix A

Earthquake and War Damage Fund Statistics

Year	Amount Insured ($ Millions)	% Increase Over Prev Year	EQWD & Disaster Premiums	Amount of EQWD Fund	% Increase Over Prev Year	Ratio % Of Fund to Amount Insd
1944	1,139		2,846,610	7,944,956		.70
5	1,281	12.5	640,548	8,762,426	10.3	.68
6	1,463	12.4	731,722	9,678,456	10.5	.66
7	1,640	12.0	820,130	10,656,162	10.1	.65
8	1,980	20.7	989,876	11,858,626	7.3	.60
9	2,163	9.2	1,081,408	12,458,652	5.0	.56
50	2,349	8.6	1,174,334	13,904,584	11.6	.59
1	2,810	19.6	1,405,220	15,476,740	11.3	.55
2	3,351	19.3	1,675,360	17,372,012	12.2	.52
3	3,823	14.0	1,911,278	19,546,538	12.5	.51
4	4,174	9.2	2,086,794	21,948,278	12.3	.53
5	4,732	13.4	2,365,784	24,708,788	12.6	.52
6	5,209	10.0	2,604,392	27,784,912	12.4	.53
7	5,761	10.6	2,880,414	31,186,314	12.2	.54
8	6,143	6.6	3,071,512	34,918,642	12.0	.57
9	6,703	9.1	3,351,266	39,071,760	11.9	.58
60	7,031	4.9	3,515,306	43,483,966	11.3	.62
1	7,643	8.7	3,821,736	48,424,026	11.4	.63
2.	8,296	8.5	4,147,970	53,982,904	11.5	.65
3	8,764	5.6	4,381,868	59,956,578	11.0	.68
4	9,426	7.6	4,713,000	66,590,374	11.1	.71
5	10,229	8.5	5,114,288	73,904,248	11.0	.72
6	10,827	5.8	5,413,660	81,702,826	10.6	.76
7	11,716	8.2	5,857,896	90,333,840	10.6	.77
8	12,630	7.8	6,314,856	101,137,652	12.0	.80
9	13,711	8.6	6,855,681	109,449,876	8.2	.80
70	14,233	3.8	7,116,523	121,211,258	10.7	.85
1	16,242	14.1	8,121,212	134,928,640	11.3	.83
2	17,567	8.2	8,783,464	150,306,030	11.4	.86
3	21,384	21.7	10,692,037	164,896,127	9.7	.77
4	23,892	11.7	11,946,006	181,969,232	10.4	.76
5	30,275	26.7	15,137,399	208,269,594	14.5	.69
6	38,327	26.6	19,163,416	239,967,920	15.2	.63
7	45,202	17.9	22,601,021	267,773,163	11.6	.59
8	51,500	13.9	25,749,896	310,535,210	16.0	.60
9	59,526	15.6	29,763,175	360,157,057	16.0	.60

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behalf of Earthquake and War Damage Commission, 1980)

Appendix B

Earthquake and War Damage Claims

Year	Number of Claims	Amount($)
1942	Nil	
1943	29	1,912*
1944	16	110*
1945	2	164
1946	82	1,014
1947	134	3,558
1948	401	15,834
1949	343	25,752
1950	306	4,322
1951	544	38,682
1952	232	8,088
1953	69	1,786
1954	457	24,392
1955	86	4,186
1956	125	9,108
1957	318	17,150
1958	308	17,394
1959	140	10,426
1960	624	73,542
1961	228	31,036
1962	357	16,658
1963	2,381	248,224
1964	221	10,184
1965	86	4,742
1966	1,945	242,574
1967	1,749	193,018
1968	300	19,850
1969	13,005	2,573,321
1970	288	120,373
1971	240	35,048
1972	1,848	210,897
1973	3,700	272,747
1974	567	91,515
1975	4,274	419,988
1976	1,728	181,757
1977	2,113	337,236
1978	856	80,198
1979	270	21,021
1980	639	122,965

*War Damage

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behalf of Earthquake and War Damage Commission, 1980)

Appendix C

Claim Statistics for Larger Natural Disaster Occurrences (Earthquakes from which more than 200 Claims have Resulted)

DATE	GENERAL EPICENTRAL AREA	MAGNITUDE	CLAIMS RECORDED	APPROX COST OF CLAIMS ($000)
23.5.1948	North Canterbury	(5.0+) Force VII	239	25
11.1.1951	North Canterbury	(6.0) Force VII-VIII	380	30
29.9.1953	Opotiki & South	(5.0) Force VI	365	20
22.5.1959	Picton	5.0	461	50
10.5.1962	Westport	5.9	2,243	225
5.3.1966	Gisborne	6.2	1,900	225
23.4.1966	Seddon	6.0	1,575	180
24.5 1968	Inangahua	7.0	10,500	2,430
25.9.1968	Puysegur (Southland)	5.5	250	3
1.11.1968	Wellington	5.5	2,200	136
9.1.1972	Te Aroha	5.1	1,300	150
6.1.1973	Hawkes Bay	6.7	2,300)	200
22.3.1973	Hawkes Bay	5.7	800)	
26.3.1973	Wellington	5.5	350	25
19.4.1974	Dunedin	5.0	2,767	300
21.3.1976	Wairoa	5.5	829	130
5.5.1976	Milford Sound	7.0	450	50
18.1.1977	Cape Campbell	6.0	980	150
1.6.1977	Edgecombe	5.25	360	30

(From: Abbotsford Landslip Commission of Inquiry: Phase 4: Submissions on Behal. of Earthquake and War Damage Commission, 1980)

Appendix D

Seismicity of New Zealand: Shallow Earthquakes of Richter Magnitude 6 or Greater

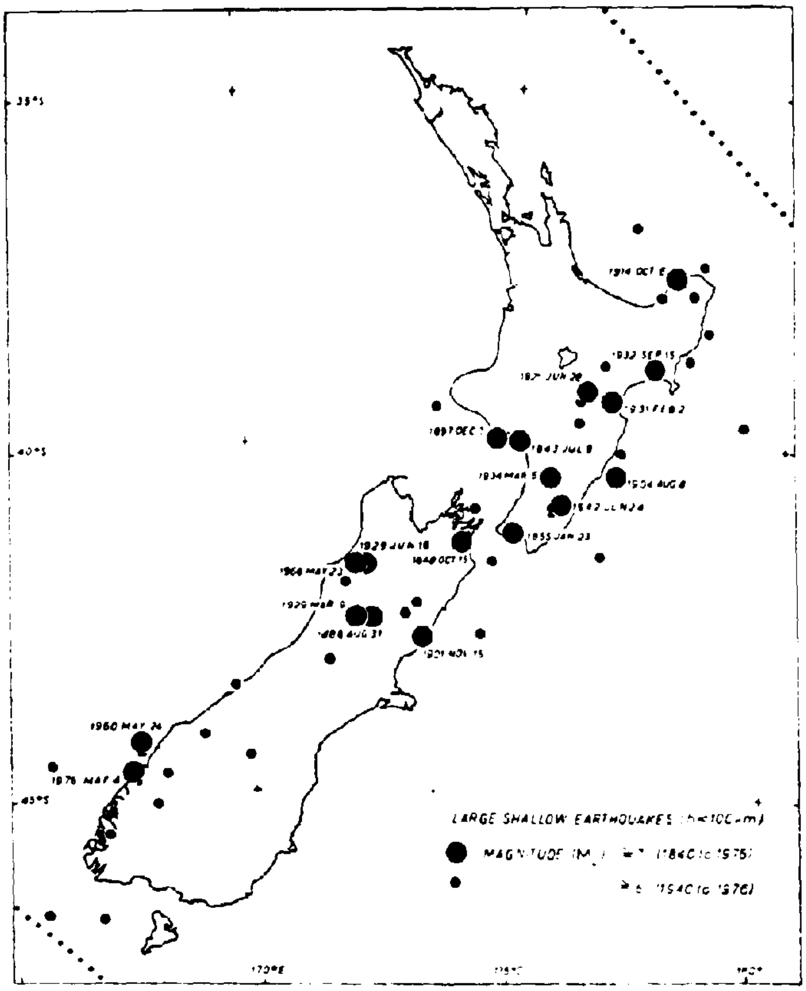

FIGURE 1: LARGE SHALLOW EARTHQUAKES IN NEW ZEALAND

(Supplied by the Seismological Observatory, Department of Scientific and Industrial Research, Wellington).

(From A.V. Hatrick, "Dams and Earthquakes in New Zealand", Bulletin of the New Zealand National Society for Earthquake Engineering, 11 (June, 1978) 100.)

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SECTION XIII

RECONSTRUCTION FOLLOWING EARTHQUAKES

LAND USE PLANNING AFTER EARTHQUAKES[1]

George G. Mader

This study has two objectives: 1) to determine why land use planning after earthquakes has not been more effective as a method of reducing seismic risk, and 2) to recommend ways to improve post-earthquake land use planning. The study stems from observations that typically little attention has been given to avoiding or restricting development or reconstruction in areas revealed by an earthquake as especially hazardous. An underlying concept of this project is that well-planned land use changes following an earthquake can effectively reduce risk from future earthquakes. Possible land use responses include changes in land use plans and regulations, changes in land use or occupancy, relocation of facilities, redevelopment, and land acquisition. Furthermore, it is believed that planning for reconstruction can take place without unreasonable delay or hardship.

Of course, many pressures foster rebuilding as rapidly as possible and tend to ignore longer-range land use planning issues. Quite naturally, the prevailing attitude after an earthquake is a desire to help those who have suffered injuries, disruption of their lives, and property damage. Given this attitude, actions to reduce future risk can be seen as interfering with rapid recovery. The overriding concern is with immediate needs, not with future disasters.

In addition, land use planning has tended to be ignored because of an emphasis on improving safety by rebuilding and repairing structures to withstand shaking better. Also, operating against effective land use planning after earthquakes is the very nature of land use changes--changes which can dramatically affect the value of land and are therefore politically very sensitive. Nonetheless, the potential role of land use planning after earthquakes is seen as very significant and worthy of investigation.

To deal with the questions relevant to post-earthquake land use planning, case studies of reconstruction after three recent U.S. earthquakes formed the major research base. The three case studies were selected to illustrate as broad a range of earthquake effects and response as possible. The selection of these earthquakes made it possible to interview people who participated in the post-earthquake reconstruction efforts, gave reasonable assurance that information on geologic and seismic effects and structural damage was at or close to the state-of-the-art, and set the investigations in the context of modern planning practices and procedures. In fact, the choice was very limited. From 1959 to 1978, eleven earthquakes occurred in the United States which

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caused damage in excess of $1 million (dollars at the time of the earthquake). Of these, only three (Alaska 1964, Puget Sound 1965, and San Fernando 1971) were federally-declared major disasters.

As by far the largest and best documented recent earthquakes, Alaska and San Fernando were obvious choices for study. In addition, Santa Rosa, 1969, was chosen because of the interesting local effort to abate existing structural hazards throughout the city after the earthquake. For each case, the project team reviewed available background material related to the earthquake, geologic and structural effects, and reconstruction efforts. Key people involved with the reconstruction were then interviewed to learn further what actions were taken and, to the extent possible, the factors that influenced the decisions made.

Reconstruction experience following selected other domestic and foreign earthquakes and natural disasters was reviewed and summarized. This part of the study involved reviewing published accounts and other records of reconstruction following the tornadoes in Xenia, Ohio in 1974 and Omaha, Nebraska in 1975; the flood in Rapid City, South Dakota in 1972; the tsunami in Hilo, Hawaii in 1960; and the earthquakes in Managua, Nicaragua in 1972 and Skopje, Yugoslavia in 1963. In addition, the Bluebird Canyon landslide of October 1978 in Laguna Beach, California was studied and revealed valuable lessons. The information was used to confirm or to raise questions about conclusions from the detailed case studies and to explore possible similarities between reconstruction problems after earthquakes and other disasters.

To investigate the problems and potentials of post-earthquake land use planning an interdisciplinary research team was formed. The team included members from the firms of Earth Sciences Associates, a geotechnical firm, H.J. Degenkolb and Associates, structural engineers, and William Spangle and Associates, Inc., city and regional planners. In addition, special consultants in public administration and law were retained.

A Discussion Group Panel composed of recognized experts in various aspects of post-disaster response was organized and met with the study team four times during the two-year study providing comments on the work program, case study reports, and the conclusions and recommendations emerging from the study. After completing the case studies, the project team assembled the comments of the Discussion Group Panel and other reviewers of the case study reports, reviewed the material on other earthquakes and disasters, and reassessed the conclusions and recommendations drawn from the case studies. From this evaluation, recommendations were developed for improving post-earthquake reconstruction, particularly with respect to land use planning.

The project team recognizes that the three case studies are a small sample to illustrate the wide variety of possible conditions and problems pertaining to post-earthquake reconstruction. However, common threads are identified and reinforced by the review of reconstruction following other natural disasters and earthquakes. These commonalities form the basis for the conclusions and recommendations to improve post-earthquake land use planning.

Major Factors Affecting Post-Earthquake Land Use Planning

A central objective of this study has been to identify the factors influencing land use decisions following a damaging earthquake. A key finding is that realistic options for land use change after an earthquke are more limited than the study team expected at the outset of the study. Usually improved safety can be more easily achieved through improved structural design and construction than through changing land use. However, in specific instances, changing land use is the best response. The major findings regarding whether land use changes are appropriate and likely to be carried out can be grouped under four headings:

- cause and extent of damage
- hazard and risk evaluation
- capabilities of local government
- role of the federal government

Cause and Extent of Damage

The need for land use change following an earthquake depends, in part, on the cause and extent of damage. Rarely, if ever, will a U.S. city be leveled; areas are not equally hazardous and most damage is likely to be scattered. Every major earthquake seems to yield its photograph of the totally collapsed building next to a seemingly similar one standing unscathed. The greatest loss of life, injury and property damage in North American earthquakes result from the failure of man-made structures. Most structural failures are caused by ground shaking and the results can be extraordinarily capricious, related in some degree to variations in ground conditions, but more importantly, to building design and condition. In addition, different earthquakes produce different ground shaking characteristics such as intensity, predominant frequency, and duration of motion, which result in correspondingly different effects on different types of structures. Damage from ground shaking alone rarely justifies a change in land use, because improving structural design and construction can usually reduce risk to an acceptable level.

An exception arises when heavy damage from ground shaking is concentrated in areas of older and poorly constructed buildings, particularly where unreinforced masonry is a widely used building material. Often such areas are deteriorating, functionally obsolescent, and in need of redevelopment before an earthquake. The earthquake presents the chance to move ahead with redevelopment as an integral part of reconsruction. However, even in such cases, reducing seismic risk is usually achieved through improvements in structual characteristics and not necessarily because of changes to less vulnerable land uses or occupancies.

Land use change is most likely to be appropriate in areas where ground failure has occurred, whether from surface fault rupture, landsliding, soil liquefaction, or other causes, and in areas where flooding has occurred, whether from seiche or tsunami runup or dam or dike failure. Achieving reasonably safe reconstruction in such areas is often difficult and usually expensive. Where there is a high risk of future ground movement, either the area must be stablized to prevent further movement or structures must be designed and constructed to overcome adverse site conditions. Adequate protection against future flood damage requires construction of flood control works, flood-proofing or elevation of structures. In both cases, restricting land use and occupancy may be the most economical and effective method of reducing future risk.

Changing land uses in areas of ground failure and flooding may not only reduce future seismic risk, but also contribute to other community objectives. Ground failure often occurs in steep hillsides, on coastal bluffs, and in low-lying areas along rivers, streams, lakes, and other bodies of water. Low-lying areas may also be subject to flooding. These areas can often be beneficially used for park, or other low-intensity open space uses. Some seismically hazardous areas may also be subject to other natural hazards such as wild fires, high winds, non-seismic flooding, or storm surges. Reducing intensity of land use in these areas after a damaging earthquake may not only avert future needs for disaster assistance because of earthquake damage, but also reduce exposure to damage from other natural hazards.

Hazard and Risk Evaluation

Efforts to reduce risk from natural hazards through land use planning and regulation depend on the ability to delineate hazardous areas and evaluate the level of risk pertaining to potential uses in those areas. Delineating hazardous areas is often easier after an earthquake than before. For example, it is possible to delineate areas where the ground failed, flooding occurred, a fault ruptured at the surface, and ground shaking was unusually intense or damaging. In all of the earthquakes studied, hazardous areas were readily identified in studies made soon after the earthquake. The most systematic hazard evaluation after a U.S. earthquake was that conducted by the federal Scientific and Engineering Task Force after the Alaska earthquake.

Although delineating hazardous areas after an earthquake is fairly readily accomplished, evaluating risk is far more difficult. Risk is exposure to loss of life, injury and property damage. Its level depends on the probability of a hazard recurring and the use and occupancy of the hazardous area.

In the cases studied, risk was assessed by engineers. In San Fernando, risk was explicitly considered in the structural design for rebuilding Juvenile Hall and Olive View Hospital. The objective was to design buildings to overcome hazardous site conditions and to meet commonly accepted engineering standards for the safety of high-occupancy and critical structures. In Alaska, the Scientific and Engineering Task Force delineated hazardous areas, determined that the areas could be unstable in future earthquakes and made recommendations for stabilization and/or use limitations to reduce risk. No explicit consideration was given to the probability of recurrence and risk was expressed in relative terms (high risk, nominal risk, etc.). Explicit assessment of risk was made by engineers in the design of the Fourth Avenue buttress and in the development of specific building restrictions.

A determination of risk expressed as the annual probability of loss of life, injury, or damage is unlikely to be available after an earthquake to guide land use decisions. However, decisions will still be made and should be based on the best information and professional judgment available. Information regarding the level of risk can significantly help public decision makers make the necessary value judgments concerning the acceptable level of risk.

It would be helpful to have some standard or guideline as to acceptable risk, such as the 100 year flood standard, to serve as a basis for federal decisions to fund reconstruction projects. It is not likely that as specific a standard for acceptable earthquake risk can be set. The many variables affecting acceptable risk make wide agreement very doubtful.

Improved techniques of hazard evaluation and risk assessment, including advances in earthquake prediction, will help in making decisions. As presently defined by the earthquake reseach community, an earthquake prediction reduces uncertainty about when an earthquake can be expected and its location and magnitude. This allows more precise definition of risk in areas known to be hazardous and more accurate assessment of the benefits or results of public actions to reduce those risks. Still, for the foreseeable future, except in the area of structural standards, federal funding decisions will likely have to be based on imprecise judgments of risk.

Capabilities of Local Government

Through grants of authority from the states, local governments appear to have adequate authority under the police power to respond to a damaging earthquake. However, local public attitudes may strongly inhibit the full use of this authority, especially to plan and regulate land use. After an earthquake (or other disaster) local public officials and political bodies are understandably anxious to do everything possible to help disaster victims. Although local government has the power to impose limitations on rebuilding in hazardous areas, public sentiment, in the absence of adequate public information and strong leadership, is more likely to favor relaxing restrictions rather than increasing them. The desire to return quickly to normal usually overrides concerns about future safety unless strong incentives for change are present. These incentives are usually of two kinds--first, strongly held community objectives which are consistent with actions to reduce seismic risk, and second, conditions attached to the use of disaster relief funds. Understanding community objectives helps predict where changes to achieve risk reduction are likely to be most acceptable to a local community. The use of disaster relief funds offers the major opportunity to accomplish greater safety through reconstruction.

The post-earthquake performance of local government is largely determined by pre-earthquake actions. If a community has acted before an earthquake to adopt and enforce adequate building codes, abate structural hazards, locate critical facilities on safe sites, and prevent or appropriately control development in hazardous areas, then clearly it will suffer less damage and face less of a problem in recovery after an earthquake. These actions are of primary concern and have been gradually taken by many local governments. Less obvious are the pre-earthquake actions which, although they do not in themselves reduce damage from the next earthquake, assist a local government in managing reconstruction. The actions include:

1. preparing and keeping up-to-date realistic land use, circulation, and public facilities plans. The community which has a well-established planning function, experienced planners, and realistic plans is more likely to recognize and seize opportunities for community improvements during reconstruction than other communities. Having well-defined community development objectives helps federal, state, and local officials set reconstruction priorities and judge the public acceptability of potential land use changes or restrictions.

2. enacting and enforcing land use regulations, building codes, and project review procedures. Experience in plan implementation and appreciation of the importance of consistent and equitably applied regulations can help a local government cope with the usual overload in building permit applications, requests for exemptions, and pressures to alter established procedures after an earthquake.

3. establishing a redevelopment agency and carrying out redevelopment or rehabilitation projects. Such experience is invaluable after an earthquake if redevelopment is to be used in reconstruction. Pre-existing powers and familiarity with techniques of redevelopment planning, project execution, and funding requirements make it easier for a local agency to use redevelopment in reconstruction after an earthquake. A community with up-to-date redevelopment plans or specific plans for older areas likely to be damaged in an earthquake is in an excellent position to move quickly into redevelopment, if needed, after the earthquake.

4. obtaining and using geologic and other natural hazard related information. Familiarity with the techniques and products of hazard evaluation will greatly assist the local government staff and public officials in making use of the technical information that will be forthcoming after a major earthquake. Less time will be needed to explain the nature of seismic hazards and the range of appropriate responses.

The effectiveness of local response will also be affected by factors such as the size of community, degree of isolation, existing land use pattern, economic health, and a variety of social and cultural factors. These are factors that cannot be readily altered before a disaster, but which help define the options and problems of reconstruction. Changes of land use may be more difficult to achieve in a large metropolitan area with its complex and interdependent land uses and infrastructure than in a relatively small and isolated community. Opportunity for major relocation of all or part of a community is greater if the community is small and isolated than if it is an integral part of a metropolitan area. Isolation implies vacant land that may be available for relocation and the chance to contain the disrupting impacts of relocation. Relocation was a feasible option for the town of Valdez after the 1964 earthquake and for a portion of Hilo after the 1960 tsunami. The impacts of large-scale relocation multiply with the size of the community and its degree of interdependence with surrounding communities.

The existing land use pattern, largely determined by local actions, is very important in defining options for land use change after an earthquake. The feasibility of relocating uses or structures is affected by the availability of suitable alternative sites and by the presence of reasonable alternative uses for the damaged site. The possible cost of engineered solutions to hazardous site conditions has to be weighted in terms of the importance of the location for a particular use or structure and realistic options for changing location.

A community with a growing economy may even benefit economically in the long run from a damaging earthquake with the stimulation provided by federal disaster relief funds, increased construction activity, and, sometimes, the modernization of previously obsolete industrial and commercial operations. The fish processing plants destroyed in the Alaska earthquakes were replaced by more modern and efficient facilities.

The effect of economic conditions on opportunities for land use change after an earthquake is mixed. In a growing economy, political pressures and the economic means to reconstruct quickly can act against efforts to reduce land use intensity in hazardous areas. This is seen in the privately-funded recontruction and new high-density construction in the L Street slide area in Anchorage. In a declining economy, the private economic incentive to rebuild is far less intense. In Seward, where Standard Oil, Texaco, and a fish processor chose not to rebuild their destroyed facilities in the town, little economic pressure has developed for new building in the waterfront area. In spite of public investments in the Alaska Raiload terminal and small boat harbor, Seward's economy continues its pre-earthquake decline.

The Santa Rosa case illustrates another potential effect of economic conditions on response to an earthquake. The city's healthy and growing economy with concomitant increases in property values has made redevelopment an attractive and economically viable option and has provided a climate conducive to the abatement of structural hazards through privately-funded rehabilitation.

The contrast between the accomplishments of Anchorage and Santa Rosa, both with growing economies, illustrates an important point. With insufficient funds for stabilization or purchase of the L Street and Turnagain slide areas, Anchorage's only real option for reducing future risk was to prohibit or severely limit new development in these areas. In a growing economy with strong development pressures, this is difficult to achieve. In Santa Rosa, however, future risk could be reduced by gradually upgrading structural safety. This approach presents no direct challenge to development and can be aided rather than undermined by economic growth.

Role of the Federal Government

The major conclusion derived from the study is that the availability of, and conditions for the use of, federal funds for post-earthquake recovery largely determine the actions and decisions of local governments. Financing recovery from a major earthquake is likely to be beyond the fiscal capacity of state governments and almost certainly of the affected local governments. Private funds may be available for reconstruction of private property, but such reconstruction is often dependent on repair or restoration of public facilities, especially streets and utilities. Relatively few property owners carry earthquake insurance. The federal role in financing reconstruction has been crucial in past earthquakes and is likely to continue to be crucial in the foreseeable future.

The scope and limitations of federal aid to disaster victims and state and local governments are set forth in the Federal Disaster Relief Act of 1974 and regulations issued May 28, 1975. The major provisions of the Act are, as of July 1979, administered by the Federal Emergency Management Agency (FEMA). Observations of the strengths and weaknesses of the federal role under prior legislation has provided a basis for evaluating the adequacy of the present legislation and regulations as they apply to earthquake disasters. Seven problems are identified.

1. Lack of specific authorization and funding for redevelopment projects. Where used for reconstruction, publicly-funded redevelopment proved to be a particularly effective tool for achieving changes in land use and safe reconstruction in heavily damaged areas. However, current programs and funding for redevelopment following earthquakes is seen as inadequate. A special fund has been set aside for use at the discretion of the Secretary of Housing and Urban Development for disaster-related projects. However, the present appropriation is a small percentage of this discretionary fund and likely to be inadequate to cover needed projects following a major earthquake in a metropolitan area.

2. Lack of requirements, procedures, and funding for planning and implementing plans for long-term reconstruction. Title V of the Disaster Relief Act provides for establishment of a Recovery Planning Council to prepare a 5 year "recovery investment plan" recommending "revision, deletion, reprogramming, or additional approval of Federal-aid projects and programs within the area..." (Sec. 802). The main objective of the Title is to assist a disaster area in achieving long-term economic recovery. The Title has not been implemented and no federal agency has been assigned responsibility for carrying out its provisions. Title V imposes no planning requirement for use of federal funds in reconstruction of heavily damaged areas and fails to authorize funding for such planning and implementation of plans. Project applications for repair and reconstruction of public facilities are considered individually and there is no requirement for coordinating the restoration of public facilities and services with private repair and reconstruciton.

   In many of the U.S. communities studied, plans for reconstruction were quickly prepared after the disaster. Most of the plans were for redevelopment projects and dealt with the most severely damaged areas. Redevelopment plans for areas with hazardous site conditions effectively addressed those conditions. However, several problems were observed in the planning efforts: 1) Small Business Administration loans were often approved for repair or rebuilding of privately-owned structures without regard for planned uses or decisions of other federal agencies to fund rebuilding of public facilities, 2) limitations of federal funds for redevelopment led to restriction of the scope of some projects and abandonment of others, and 3) projects that required adoption of local land use and building regulations or acquisition of significant amounts of private property for public uses seemed to generate strong local opposition. There appears to be a need after a disaster, for preparation of a plan for long-term reconstruction, and also for procedures to ensure that federal and local decisions affecting rebuilding are consistent with the plan.

3. Disincentives for relocating public facilities or repairing and reconstructing facilites to improved standards not in force at the time of the earthquake. Section 2205.54 of the Rules and Regulations states that the federal contribution for permanent repair or restoration of public facilities "shall not exceed the net eligible cost of restoring a facility based on the pre-disaster design of such facility and on the current codes, specifications, and standards in use by the applicant for similar facilities in the locality." The regulations permit 100% federal funding for the repair or reconstruction of public facilities. The Regional Director of FEMA may authorize relocation of a facility to a less hazardous site; however, any additional cost must be borne by state or local government.

   The effect of this provision is to discourage relocation of damaged facilities to less hazardous sites unless suitable, publicly-owned sites are available. After a damaging earthquake, local governments rarely have the financial resources to purchase new sites for relocation of public facilities and the tendency is to seek engineering solutions to hazardous site problems with little consideration of possible advantages of relocation.

4. Lack of guidelines for determining price to be paid for properties to be acquired as part of a post-earthquake redevelopment project or a planned relocation. Establishing criteria for determining the price to be offered for properties to be acquired for public purposes after an earthquake is a major issue. In several cases studied, the failure to come to terms on property value resulted in rejection of projects which would have significantly improved future safety. Reasonable criteria for establishing compensation are needed. Property values after an earthquake are usually lower. A recurring question is to what extent an owner should be compensated for pre-earthquake value.

5. Little consideration of long-term hazard mitigation in administering disaster assistance. Although explicit consideration of hazard mitigation is required in Sec. 406 of the Act, no rules have been adopted to implement this section. Section 406 states:

   > As a further condition of any 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, in accordance with the standards prescribed or approved by the President after adequate consultation with the appropriate elected officials of general purpose local governments, and the State shall furnish such evidence of compliance with this section as may be required by regulation.

   In April 1979, the Federal Disaster Assistance Administration, now the Office of Disaster Response and Recovery in FEMA, issued proposed rules for implementing this section of the Act following a major disaster declaration. The rules call for a Survey Team to be formed by Hazard Mitigation Coordinators (HMC's) from federal, state, and local governments to identify significant hazards, evaluate the impacts of the hazards and possible mitigation measures, and recommend appropriate mitigation measures. The recommended measures would be required by FEMA as a condition of receiving federal funds, authorized under Sec. 402 of the Act, for the repair, restoration, reconstruction, or relocation of public facilities. The state would be responsible for verifying compliance of local governments with hazard mitigation requirements.

These proposed rules would help correct the lack of consideration of hazard mitigation in reconstruction decisions after natural disasters. Because of the importance of federal funds in post-earthquake reconstruction, the proposed federal requirements are likely to be particularly effective in encouraging safer reconstruction after earthquakes. However, local ability to meet hazard mitigation requirements after an earthquake is likely to depend on the availability of funds.

6. <u>Lack of explicit consideration in administering disaster assistance of opportunities to achieve other federal community development objectives</u>. Federal community development objectives as set forth in the Housing and Community Development Act of 1977 (Sec. 101) include:

(1) the elimination of slums and blight,

(2) the elimination of conditions which are detrimental to health, safety, and public welfare,

(3) the conservation and expansion of the Nation's housing stock,

(4) the expansion and improvement of the quantity and quality of the community services,

(5) a more rational utilizaton of land and other natural resources,

(6) the reduction of the isolation of income groups within communities and geographical areas,

(7) the restoration and preservation of properties of special value for historic, architectural, or aesthetic reasons, and

(8) the alleviation of physical and economic distress through the stimulation of private investment and community revitalization in areas with population outmigration or a stagnating or declining tax base.

Often after a major earthquake, reconstruction can be carried out in a way that significantly furthers one or more of these objecties, typically through redevelopment of heavily damaged areas. Such opportunities need to be considered in federal decisions to fund recovery projects. Successful projects are likely to be those clearly related to damaged areas and consistent with community needs and objectives. However, trying to accomplish too much or extending projects significantly beyond damaged areas is likely to be rejected locally unless the public is convinced the projects will not interfere with the return to normal and will lead to substantial benefits. Some redevelopment (or development) projects may be needed to accommodate uses displaced from high hazard areas.

7. Lack of flexibility in administering disaster assistance sometimes leading to federal/local conflict. In spite of the presumably altruistic nature of disaster relief efforts, there are elements of conflict in the relationship between federal and local officials in the post-disaster situation. Local people are striving to maximize assistance to victims and local governmental agencies, while the federal officials are anxious to minimize the cost of relief, insure that funds are spent only for authorized purposes and avoid any possible irregularities that might bring criticism at a later date. Even when officials have broad authority, there is a tendency to interpret it narrowly. The effect of this conflict is to slow down the reconstruction effort and create uncertainties which can lead to private actions undercutting public attempts to reduce future risk. Procedures are needed to encourage sufficient flexibility in administering disaster assistance to take account of variations in local conditions and minimize chances for conflict.

Recommendations for Land Use Planning Following a Major Earthquake

Land use planning after a damaging earthquake can be an effective tool to reduce future seismic risk. It can and should be a significant part of the total intergovernmental response to a major earthquake. Presently, when a large damaging earthquake occurs, the governor of the affected state requests that the President of the United States declare a major disaster--by definition a catastrophe of such severity and magnitude that effective response is beyond the capability of the state and the affected local governments.

If the President declares a major disaster, a federal/state agreement, specifying the categories of federal assistance to be made available for recovery, is signed by federal and state representatives. Federal funds may be available for: temporary housing assistance, mortgage and rental payments, unemployment assistance, individual and family grants, food commodities, relocation assistance, emergency public transportation, repair and restoration of public (and certain private) facilities, debris clearance, and loans to cover substantial losses of local tax revenues. Less extensive assistance may be authorized for federally-declared "emergencies"--disasters of less severity and magnitude than the "major disasters."

The Presidential declaration formally inaugurates coordinated federal, state, and local efforts in response to a disaster. The organization and procedures governing these efforts are geared primarily to handling emergency response. However, there is a need for more explicit consideration of hazard mitigation in actions related to long-term recovery from major earthquakes. Thus, the recommendations are presented in the form of suggested federal regulations and procedures to incorporate hazard evaluation, land use planning for hazardous areas, and funding for plan implementation into the present framework for federal disaster assistance. State legislation and regulations may be needed to authorize the participation of state agencies and local governments in the activities recommended.

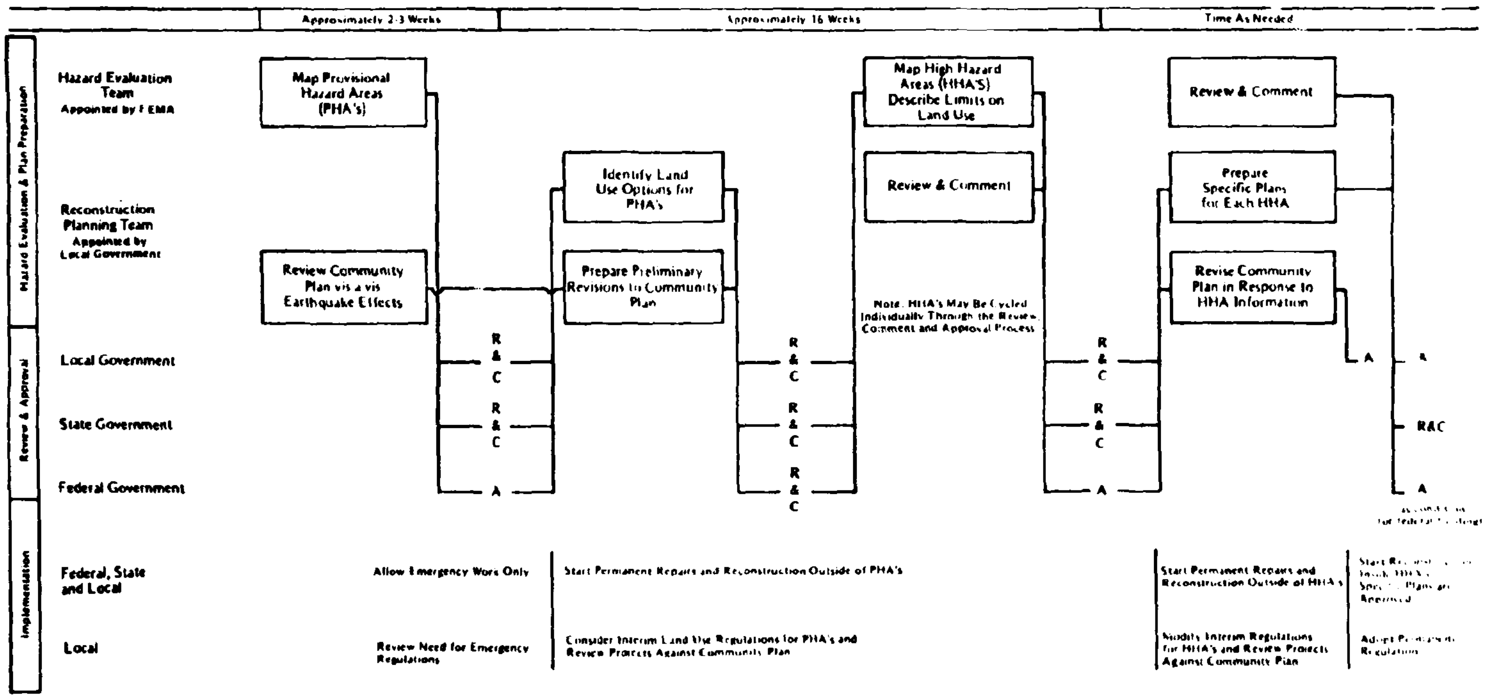
Figure 1 outlines the sequence and interrelationships of the governmental activities essential to land use planning in a post-earthquake context. The key functions, as shown on the left side of the diagram, are hazard evaluation and plan preparation, review and approval of maps and plans, and implementation of land use plans for hazardous areas. Figure 1 also shows the sequence of steps needed to provide hazard area information for use in preparing plans and for hazardous areas within the framework of a community-wide plan. As shown, the functions of hazard evaluation and reconstruction planning are interrelated, but, carried out by two teams which would work together during reconstruction. Procedures for review and approval and implementation actions are described for each map or plan which emerges from the actions shown in the figure.

Hazard Evaluation

The need for timely and credible evaluation of hazards after a damaging earthquake is clear. The function is viewed as essentially a federal responsibility to insure that federal funds for reconstruction are allocated in a way that reduces damage potential in future earthquakes and, in particular, reduces the likelihood of repeated federal assistance in areas which have already experienced earthquake damage.

Hazard Evaluation Team. Immediately after a major earthquake disaster is declared, the Director of the Federal Emergency Management Agency (FEMA) should appoint a Hazard Evaluation Team (HET). The purpose of the HET should be to provide scientific and technical information and recommendations needed to plan for the safe reuse or reconstruction of hazardous areas. Members of the HET should be selected from a list previously prepared by federal and state agencies and professional organizations. Professionals with experience in, and familiarity with, the local area should be included on the team. In most cases, the team would include geologists, engineering geologists, geotechnical engineers, structural engineers, and seismologists, but the composition should be determined by the characteristics of the earthquake hazards involved. Expenses of the team should be paid by FEMA.

Provisional Hazard Areas. Within two to three weeks of appointment, the HET should prepare a report including maps showing Provisional Hazard Areas (PHA's). PHA's should include areas of ground failure, flooding, and concentated structural damage. The PHA's should be drawn large enough so that refinement of data is more likely to result in a decrease in size than an increase. The report should describe the reasons for the designation of PHA's and recommend design and construction standards for federally-assisted repair and reconstruction throughout the earthquake damaged area. The report should be released simultaneously to the federal and state disaster relief personnel, officials of affected local governments, property owners, local financial institutions, and the news media for review and comment. Following approval of the maps and recommended standards by the Regional Director of FEMA, federal funds to assist property owners and public agencies with permanent repairs in areas outside the PHA's should be made available. The maps and recommended standards should be used by special districts and the state government to guide post-earthquake planning activities.



A - APPROVAL
R&C - REVIEW & COMMENT

Figure 1

Post-Earthquake Land Use Planning Recommended Governmental Actions and Interactions

High Hazard Areas. After completion of the provisional hazard area maps, the Hazard Evaluation Team should conduct, or call in appropriate experts to conduct more detailed evaluations of the PHA's to determine: 1) potential for damage in future earthquakes, 2) potential means of mitigating the hazard and estimated costs, 3) appropriate building design and construction standards, and 4) more exact boundaries of areas subject to high seismic hazard. In evaluating uses for the PHA's, the HET should consider those uses identified by the Reconstruction Planning Team (RPT) as potentially appropriate. Following the detailed evaluation,the HET should issue maps delineating High Hazard Areas (HHA's) and final recommendations. This should be accomplished within 16 weeks of the disaster declaration. HHA's should include the PHA's or those portions of the PHA's in which there is 1) a high probability for recurrence of ground failure or flooding, and 2) a need for redevelopment or reconstruction to improved building standards to achieve reasonable safety. Results should be fully communicated to the public and to affected public and private agencies. Following review and comment by affected state and local governmental agencies, the Regional Director should approve, with any modifications deemd neessary, the maps and the HET final recommendations. No federal funds should be allocated for permanent repairs or reconstruction in the HHA's until plans for reuse or reconstruction, consistent with the recommendations of the HET, have been adopted by local government. The federal funding agency should be responsible for determining consistency of the locally adopted plan with the HET recommendations.

Reconstruction Planning

Planning for long-term reconstruction after a damaging earthquake is an important responsibility of local governments. However, because of the wide variability in local capabilities, federal and state assistance is often needed in planning and in providing information on federal and state assistance programs. The following sections outline procedures for reconstruction planning and ways to link such planning to the hazard evaluation and, ultimately, the funding of reconstruction projects.

Formation of the Reconstruction Planning Team. Following a Presidential declaration of a major disaster or an earthquake, each affected local government should appoint a Reconstruction Planning Team (PT). The team should be headed by the planning director or the staff member responsible for planning and include staff members from key departments such as public works, building inspection, and engineering. Other professionals, such as experts in land use and redevelopment planning, land appraisal, property acquisition, finance, social planning, housing, and economic development should be called in to work with the team as needed to provide the expertise to address the particular situation. FEMA should fund the work of the RPT and provide technical assistance either by assigning federal personnel to work with the RPT or by funding contracts with private firms to provide the needed expertise.

The purpose of the RPT should be to guide and assist local governments in 1) revising community land use plans which recognize altered conditions brought about as a result of the earthquake, and 2) preparing specific reuse or reconstrution plans for the HHA's designated by the HET, including relocation plans, if needed. The RPT should work closely with the HET in preparing plans for the HHA's.

Revised Community Land Use Plan. The first task of the PRT is to review existing land use and circulation, community plans and regulations, and the location of critical or high-occupancy facilities in relation to the initial damage assessment. The review should be completed within two to three weeks of the disaster declaration. Following issuance of the maps of Provisional Hazard Areas, the RPT should make preliminary revisions in the community land use plan to provide a community-wide perspective and framework for planning for the reconstruction or reuse of the PHA's, identify areas suitable for relocation of major facilities or for the location of temporary housing, identify specific problems related to reconstruction, particularly of critical and high-occupany facilities and lifelines outside the PHA's, and evaluate the land use and circulation relationships between the PHA's and the rest of the community.

The preliminary revisions should be reviewed by the HET, appropriate federal and state agencies, and local legislative bodies and serve as a guide to further planning. Comments from the public and, in particular, property owners in the PHA's should be solicited. Reconstruction projects outside of the PHA's should be reviewed for consistency with the preliminary revisions to the plan. The plan should be considered a working document to be progressively modified and refined as a guide to the reconstruciton effort and specific planning for the PHA's. Following release of the maps of the HHA's and initial planning for the PHA's, the community land use plan should be revised as needed and such revisions adopted by the appropriate local government legislative bodies.

Options for PHA's. On release of maps of the PHA's, the RPT should prepare a preliminary report outlining the options for reuse or reconstruction of each designated PHA. The preliminary community land use plan should serve as a guide in defining the range of possible land use options. The report should be used by the HET in determining the range of land uses which should be evaluated for potential reuse of the PHA's. It should also be used in establishing final boundaries of PHA's designated because of concentrated structural damage. The report should also be used in preparing or revising the community land use plan.

Review and comments on the report should be sought from the FEMA Regional Director, state government, local government, affected special districts, property owners, and the general public.

Specific Plans for HHA's. As maps are released designating HHA's, the RPT should prepare a specific plan for the reconstruction or reuse of each HHA. Each specific plan should include:

1. Map of the High Hazard Area.

2. Recommended land uses, regulations, and building standards for each HHA.

3. Description of any recommended engineering or stabilization measures for each HHA.

4. Location, capacity, and design standards for any public facilities, lifelines, critial or high occupancy structures to be repaired, reconstructed or relocated in a HHA.

5. Identification of properties to be acquired, demolished, or rehabilitated.

6. Owner-participation options and relocation plans as needed.

7. Cost estimates and specification of federal, state, and local share of costs for implementing each plan.

8. A time schedule for implementing each plan.

Each plan should be adopted by the appropriate local legislative bodies and, if federal funding is proposed for implementation, should be consistent with the recommendations of the HET. The federal funding agency should make the determination of consistency. No federal funds for permanent repair of public facilities or non-emergency aid to private property owners in a High Hazard Area should be committed until a plan has been locally adopted and determined by the funding agency to be consistent with the recommendations of the HET. Adoption and determination of consistency should represent a federal commitment to provide the specified share of funds needed for implementation. In redevelopment projects, covenants should be placed in deeds to ensure continuity of the restrictions contained in the plan.

Long-Term Monitoring

Both the HET and RPT should be responsible for recommending procedures to ensure that their recommendations are followed after the teams are offically disbanded. The HET should recommend procedures to ensure that its design and construction standards are complied with, to authorize changes in the boundaries of HHA's based on new information, to arrange for the installation and monitoring of any instruments needed in the HHA's, and to advise local officials concerning other potential hazards in future earthquakes. The RPT should recommend procedures to ensure that plans for reuse or reconstruction of the HHA's are carried out and to authorize changes in the plans consistent with changes in the HET recommendations.

FOOTNOTES

1. The paper draws extensively from a study for which the author was principal investigor, Land Use Planning After Earthquakes (1980). The study was financially supported by National Science Foundation Grant ENV 76-82756 and carried out by William Spangle and Associates, Inc. as principal contractor.

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HOUSING RECONSTRUCTION

IN THE CARIBBEAN AND IN LATIN AMERICA

Alcira Kreimer

Introduction

In recent years we have seen the development of a renewed concern for the conflicts posed by the impact of uncontrolled urban growth in Latin America, the frequent occurrence of damaging disasters, and the lack of appropriate policies to guide reconstruction, to minimize adverse effects of emergency activities, and to promote the adoption of preventive and mitigating measures. This paper focuses on the problem of housing reconstruction and attempts to identify several issues that are key in the response to housing needs after natural disasters.

Housing is an important component of human life, its nature and form structure everyday life. Adequate, safe, and sanitary housing conditions are basic to health, productivity, personal well being, and self-esteem. Housing is a complex phenomenon that comprises not only the dwelling itself but also the necessary infrastructure and public utilities (electricity, water supply, sewage disposal, storm drainage, roads, transportation, communications), land use and land tenure, and access to employment and to social services (health, education). The form and organization of housing reflect cultural values, traditions, and the social organization of different groups.

Disaster impact and deficient housing conditions are two interrelated phenomena. The housing situation of the poor in Latin America and the Caribbean is a very critical problem. Shanty towns, slums, and marginal settlements are rapidly developing as a result of uncontrolled urbanization, uneven distribution of economic activities, and increasing differences in the distribution of income. It is estimated that in Latin America in 1970, 40 percent of the population lived under poverty conditions, that is, with an income that could not cover the cost of essential goods and services. That percentage supposes the existence of 113 million of poor people [Economic Commission of the United Nations for Latin America, 1980, p. 38]. In the Caribbean, per capita incomes for 1973 showed that the richest group of islands had an average income per head forty-five times that of the poorest. Thus, although there are relatively rich territories, the majority of Caribbean people are poor [Cross, 1979, p. 44].

Low-income settlements are plagued by problems of access to land tenure, high densities, deficient infrastructure, poor health, and lack of public services. In rural areas, the lack of services and infrastructure and the dispersed nature of settlements tend to aggravate the conditions of housing. Under "normal" conditions the poor are excluded from access to adequate housing through several mechanisms such as the distribution of service costs that prices services out of their reach; regulatory mechanisms like zoning and financing that excludes them; the costs of land, construction materials and labor that are beyond their ability to purchase; and requirements of high construction standards that place housing beyond their reach.

Despite its importance for human life housing is often treated as a residual category in the national plans of developing countries. Improvements in the housing sector are often regulated by national governments until a higher level of economic development is reached. Investment in housing, erroneously considered to be unproductive by government officials in many developing countries who disregard the significant impact of housing on income and employment through multiplier linkages [Grimes, 1976, p. 32], is often postponed in favor of investment in other sectors. However, waiting until a country reaches a certain level of development to address its housing needs may allow the deficit to reach intolerable proportions and it may jeopardize the development objectives of the country [United Nations Educational, Social, and Cultural Organization, 1977]. National development policies that increase regional imbalances by promoting a high concentration of industry, commerce, and amenities in major cities are factors that contribute to increased deficiencies in the housing sector.

Disasters and Human Settlements

Large areas in the Caribbean and Latin America are prone to disasters. Severe earthquakes, volcanic eruptions, droughts and floods bringing about heavy destruction were factors beyond control which inhibited growth even before the time of the Conquest. The Economic Commission of the United Nations for Latin America (ECLA) has estimated that the damage caused by natural disasters in the five countries of the Central American Common Market reduced the average annual growth rate of Gross Domestic Product (GDP) by approximately 2.3 percent over the 15 year period between 1960 and 1975 [United Nations, 1979, p. 2]. This figure does not take into account the indirect effects of disasters or the cumulative effect of many disasters of secondary importance whose overall impact is nevertheless substantial. For instance, there was an overall deficit of approximately $200 million in Honduras during the two years following Hurricane Fifi--this figure is greater than the country's total gross annual investment (U.S. $154 million in 1973) and is equivalent to four years of public investment. In Guatemala after the earthquake of 1976, the deficit increased six times in relation to 1975 [United Nations, 1979, p. 8].

Major disasters cause significant damages and losses to the housing sector of stricken countries. Conditions predominant in "normal" times are aggravated when a catastrophe occurs. Examples from Latin America in the past decades illustrate this phenomenon. The 1965 earthquake that affected the central and most populated region of Chile destroyed approximately 8,500 houses and damaged 11,800 [Thompson and Thompson, 1976]. The 1971 earthquake that affected the same region destroyed approximately 25,300 houses and damaged 31,400 houses [Thompson and Thompson, 1976]. The earthquake that struck the north central region of Peru in 1970 destroyed over 70,000 houses [Doughty, 1980]. In the earthquake that struck Managua, Nicaragua, in 1972 it is estimated that a quarter of a million people lost their homes [Kreimer, 1978]. The storms and floods of June-July 1974 in the Central and Southern areas of Chile severely affected three important urban areas (Santiago, Valparaiso, and Concepcion), damaged and destroyed thousands of homes and disrupted the infrastructure [Agency for International Development, 1974]. About a million persons--a sixth of the population--found themselves homeless after the earthquake in Guatemala in 1976 [Kreimer, 1978]. After Hurricane Fifi in 1974 it is estimated that 10,000 people were made homeless in Honduras [Snarr, Neil, and Brown, 1978, p. 239]. It is estimated that approximately 125,000 housing units were destroyed or damaged in the Dominican Republic [Agency for International Development, 1981] and 80 percent of the houses were destroyed or damaged in the southern half of Dominica [Economic Commission for Latin America, 1979] as a result of Hurricanes David and Frederick in 1979. These disasters not only aggravated the shortage of dwellings, but the housing sector, considered in its broader definition, was affected. In all these cases damages to infrastructure (roads and bridges), to the power section (generating facilities, transmission and distribution network), and to the industrial sector were extensive. The economies were severely affected by the destruction of crops and livestock, the interrruption of services, and the impact on production due to impairment of productive capacity.

The extent and nature of the damage to housing depends on the type of disaster (earthquake, floods, high winds, fires), the intensity of the impact, (the severity and magnitude of the earthquake, the velocity of winds, the extent of flooding), the construction materials used (adobe, tiles, bamboo, taquezal, timber, masonry, concrete, etc.), and the topographic location of buildings (in low lying plains, in ravines, coastal areas, near fault lines, etc.). In earthquakes, the distribution and intensity of damage is influenced chiefly by the type of construction, geometry, mass distribution, and degree of flexibility. During an earthquake, ground motion is transmitted to structures through their foundations. Unreinforced load-bearing walls of masonry or concrete construction are highly susceptible to earthquake damage because of their relatively low in-place shearing capacity. The strength of such walls is further reduced by window and door openings [Fattal, 1974, pp. 3-12]. Defects in foundations, wall construction, and roofing are a major cause of building failure in earthquakes. For instance, some of the construction defects that can be found in adobe houses--a material widely used in developing countries--are poor adobe-making techniques, use of insufficiently dried adobe, incomplete fill of the vertical points between adobe blocks, poorly aligned walls, poor interlocking wall intersections, and timber tie-beams connected with carelessly executed joints [United Nations, 1975, p. 110].

The damage associated with tropical cyclones results from the direct action of winds (e.g. during Hurricane David in the Caribbean winds reached surface velocities of 150 miles per hour), from rainfall, and from storm surges [Simiu, 1974, pp. 28-37]. The critical wind pressure depends on the geometric characteristics of the house--configuration of the house, angle of the roof, configuration of the roof, connections between the roof and the walls, and between the walls and the ground--and on the arrangement of buildings in a group. Wind may cause a building to slide or overturn, and the storm surges and heavy rainfall characteristic of typhoons and hurricanes may cause floods that damage the foundation soil or the foundation itself [Simiu, 1974, pp. 28-37].

Housing Reconstruction

Disasters destroy considerable investments in housing and in some areas deplete the housing stock of low-income groups. Next, we will explore a number of issues that characterize the problem of housing reconstruction.

1. Predisaster housing conditions help to configurate the extent of post-disaster housing damage and needs.

The extent and characteristics of losses in the housing sector are not only consequences of each specific disaster agent, but also of the housing conditions prevalent before the disaster in the affected country. In Latin America and the Caribbean, substandard housing conditions are an endemic problem, an important component in the vulnerability of the population to hazards. Vulnerability can be defined as the susceptibility to loss of a population at risk when a hazard of a certain magnitude occurs [Committee on International Disaster Assistance, 1978, p. 43]. Population groups living in highly vulnerable conditions--poorly built houses located in unsafe areas, crowded, and lacking sanitation--are more likely to suffer damage and losses than groups who live in safer environments that facilitate their survival. Vulnerable conditions in normal times result in greater damage after disasters. For instance, accelerated urban growth in Latin America in recent years, massive urban migration, and the increased cost of urban land controlled by a speculative land market have accelerated the construction of settlements in vulnerable areas. In Kingston, Jamaica, new buildings are constructed on alluvial and unconsolidated soils, highly unstable in earthquakes [Burton et al., 1978, p. 14]. Inflammable materials, high densities, and limited accessibility for fire engines that often characterize squatter and marginal settlements increase the chances and intensities of fire incidences. About 95 percent of disaster-related deaths occur among the two-thirds of the world's population that occupy developing countries [Burton, et al., 1978, p. 14].

Figure 1 summarizes the relationship among predisaster and postdisaster components of housing reconstruction and indicates the interaction between hazards and socioeconomic conditions.

Disasters create a situation in which the demand for housing increases substantially and to which the supply side cannot adequately respond because of the prior shortages of housing, the constraints posed by the lack of institutional organizations to address the problem of low-income housing, the control by market forces of costs of land and materials, and the polarization of resources in countries where those with certain means can respond to the needs posed by the disruption while the poor are confronted with restricted opportunities. For instance, the housing needs and the reconstruction process following Hurricanes David and Frederick in 1979 in the Dominican Republic were shaped by the deficiencies that affected the housing sector during normal times (i.e., a vast proportion of substandard housing, shortage of services and infrastructure, lack of a national policy for low-income housing, a housing strategy based on the provision of housing subsidies to the middle class). After the hurricanes the reconstruction process was hampered by all those factors and compounded by the lack of coordination between the agencies responsible for the development of specific sectors such as urban and rural housing, rural development, water provision, and land acquisition and distribution.

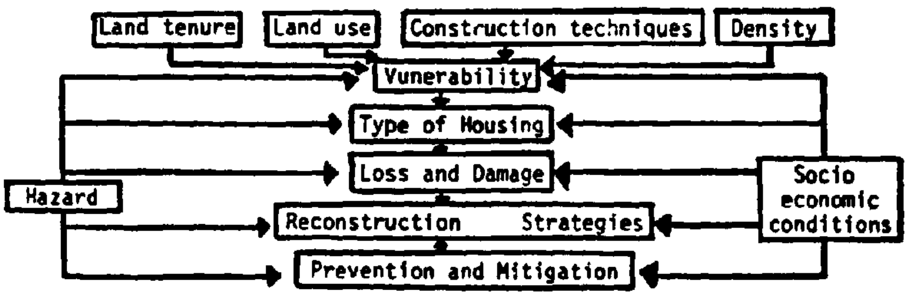

Figure 1

Interaction Among the Dimensions that Help Configurate the Predisaster-post-Disaster Situation

It should be noted that the predisaster situation affects the postdisaster context at the level of the overall economy. According to a study conducted by the United Nations Disaster Relief Organization (UNDRO), the weaker the external situation in the country at the time of the disaster, the more acutely it will feel the effects on its balance of payments. In the case of Honduras, after Hurricane Fifi in 1974, while direct personal losses were estimated at U.S. $150 million in 1974, it was estimated that exports of goods and services would decline by U.S. $144 million in the same year and by U.S. $115 million in the following year in relation to the anticipated performance (i.e. with no disaster) in 1974. At the same time, imports increased by some U.S. $26 million during these two years in order to meet the demand for priority consumer goods and as a result of the additional investments made necessary by the disaster [United Nations, 1979, p. 13].

2. The increased visibility of housing shortages caused by a disaster can bring about changes in housing.

Under "normal" conditions new housing in developing countries is usually planned and built very slowly for a small fraction of the population. Investment in housing is often delayed and the few housing programs that are implemented are addressed to economically stronger people. Even the programs that are designed to provide housing subsidies through low-interest loans or tax exemptions cannot be afforded by those groups whose incomes are too low to allow them to qualify. Low-income groups usually build their houses on the basis of high personal and kin-related labor time with occasional use of skilled labor for specialized tasks. Construction materials are rudimentary and in many cases do not have a commercial value and often land costs are avoided by the illegal occupation of unused land.

Disasters change these conditions. As mentioned above housing shortages are substantially aggravated. Housing deficiencies achieve visibility and usually there is an increased sensitivity on the part of the national government and the international community towards the social and political repercussions of housing shortages. Both the national government and the international community have to respond to the problem. Efforts to solve the housing shortage by national, bilateral and international agencies become concentrated in terms of time and capital investment. Disaster-stricken communities face problems requiring rapid and extensive departures from routine activities. In general they have great resourcefulness and adaptability and there is considerable spontaneous and highly organized social action [Committee on International Disaster Assistance, 1979]. Funds to build low-income housing, to subsidize construction materials, to form associations, and to create jobs become more easily available.

Housing losses and the increased visibility of the housing shortages can generate some positive actions. But also massive, uncoordinated responses from a number of agencies with different degrees of previous experience in the affected country and in disaster assistance, each of which has its own priorities and peculiarities, may hurt the victims they are intended to help. In addition, the use of relief and reconstruction as political tools by certain governments can have serious negative repercussions. The political manipulation of the reconstruction process by the government of Nicaragua after the 1972 earthquake is a case where the emergency was one of the factors that contributed to sharpen the tensions existent during the decade prior to the earthquake [Economic Commission of the United Nations for Latin America, 1979, p. 7].

3. The indirect effects of disasters, although often overlooked are sometimes as important for the housing process as the direct effects.

Indirect effects, although in many cases are not taken into account by damage assessment mechanisms, can be as important as the main effects of the disaster [United Nations, 1979, p. 3]. The direct effects include losses of capital, destruction of housing, damage to infrastructure, loss of stocks, etc. Indirect effects can be varied and range from a reduction in family income to a reduction in the health of the population. Michel Lechat provides a good example of the importance of the indirect effects of a disaster in the increase of malaria in Haiti following Hurricane Fifi in 1963. That hurricane caused extensive damage to housing in Haiti, about 68 percent of the houses in the affected area were destroyed, and most of the roofs were blown away. The disaster occured during the course of an extensive malaria eradication campaign and flushed away the residual insecticide that had been sprayed on the walls of dwellings. A severe malaria epidemic, involving about 75,000 victims, developed approximately two months after the hurricane. Haiti's subsequent problems with malaria may have been in some way related to the occurrence of this hurricane [Committee on International Disaster Assistance, 1978, p. 44].

4. In most cases, housing reconstruction strategies in Latin America and the Caribbean follow a repair or palliative approach rather than a preventive approach.

Disasters generate a substantial increase in the demand for housing and the postdisaster situation provides a very conducive context to adopt measures to prevent adverse effects of potential hazardous events. In a very hypothetical ideal case, major changes and the reduction of vulnerability in the reconstruction of the housing sector require not only the provision of housing to the homeless, but also the introduction of preventive measures in the development of housing. As shown in Figure 2, there are a number of options for addressing prevention in reconstruction.

Preventive measures vary substantially and they include non-structural methods (legalization of tenure, regulation of land use, definition of appropriate building codes and safety measures, training and technical assistance, etc.) and structural methods (improved construction techniques, improved land use, improved urban design, construction of dikes to prevent river flooding, etc.).

Reconstruction proceeded in the Dominican Republic after Hurricane David, in Peru after the 1970 earthquake, and in Nicaragua after the 1972 earthquake, without really implementing structural or non-structural measures that could have changed the reconstruction strategy from palliative to preventive. According to Ian Davis [1978, p. 36], one of the most disappointing aspects of the massive reconstruction effort in Guatemala has been the fact that virtually all the relief agencies have placed their emphasis on building large numbers of houses, ignoring the opportunity the disaster presented to instigate training procedures in safe construction.

In some cases, the introduction of new technologies not adapted to the hazard risk of an area can increase the vulnerability of housing. For instance, precolonial architecture in Latin America was characterized by a natural regulation of the climate and environment. As new models from more developed societies progressively took over, there were changes in housing forms and construction methods that increased the vulnerability of housing. A study conducted by Glass et al. in Guatemala after the 1976 earthquake in the village of Santa Maria Cauque [1977, pp. 638-643] established that all of the deaths and serious injuries in the village were associated with housing and in every case the collapse of an unreinforced adobe structure was involved. Either the adobe or the beams that supported it were identified as the instruments of trauma. Adobe was a relatively new construction material in the village. In 1942 all of the houses were built of cornstalk, mud-covered slats and similar materials attached to a simple wood frame. In the earthquake of 1918 there were no deaths and few injuries from these houses, even though every structure in the village was destroyed. In 1925 the adobe houses were introduced in the village modeled after the houses built by the Spaniards in Guatemala City, in spite of the fact that the Spanish city dwellers had suffered many deaths in the earthquake of 1918 from adobe brick.

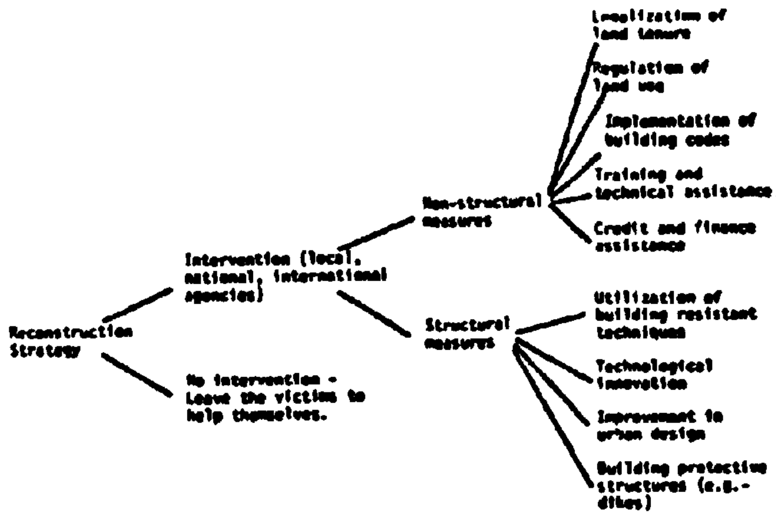

Figure 2

Options for Addressing Prevention in Reconstruction

According to Glass et al., to the Indians, the adobe houses represented the status and prestige associated with the Spanish culture.

In the reconstruction in the Dominican Republic and in Dominica, very few of the houses rebuilt during the first year and a half after the hurricanes incorporated any wind resistant techniques, in spite of the fact that both countries are prone to high winds and that between 1973-1974 Dominica experienced twenty-six tropical storms.

The ability of society to adopt a preventive vis-a-vis a palliative approach after a disaster depends upon the organization of the society, the orientation of the government, and the availability of resources. It is obvious that a reduction in vulnerability comes not only from specific measures to reduce risk for the population but also from an overall improvement in the quality of life of the involved population.

5. In most cases, housing reconstruction in Latin America and the Caribbean focuses primarily on the provision of shelter and ignores other elements that are essential to the housing process.

As defined by Linn [1979, p. 208], the most important attributes of housing are the following: (1) access to employment opportunities, to services such as health and education facilities, and to community contacts; (2) space as reflected by the size of the lot; (3) security of land tenure; (4) on-site services such as water, energy supply, waste disposal, drainage, and security from crime and fires; and (5) shelter structure to provide protection from the elements, privacy, and domestic living spaces. The majority of post-disaster housing programs in Latin America and the Caribbean reflect concern with only one aspect of these five attributes: shelter structure. Most of the programs in the past have been concerned with the provision of the material structure of the houses and ignored the other four attributes. The importance of those attributes is based on the issues that are described next.

Location. The differential advantage of various locations derive essentially from their differential access to employment opportunities. According to Grimes [1976, p. 40] the location of a dwelling is as much a part of its essence as its plaster and bricks. A dwelling located far from employment opportunities and social services is more expensive than one with better access, because travel expenses must be included in the cost of living at that location. Space as reflected by the size of the lot is not only important for the possibility of progressive development and evolution of the house, but it can also affect the safety of the house. Plots too small to permit an adequate separation between buildings can increase the risk in earthquake-prone areas and the vulnerability to fires. Security of tenure is an essential component in the housing equation. According to Dunkerley [1978, p. 7], tenure arrangements are of prime importance in projects directed to stimulating dwelling construction or improvement, since they affect security of occupancy and hence the willingness of occupants to invest their efforts and savings in buildings on their own plots. The provision of land tenure can be an important incentive to the rapid reconstruction and consolidation of housing. In Dunkerley's words, "the investment by plot holders in the building or improvement of their dwelling is largely conditional on their perception of the risk that their tenure will be contested on their investment and lost by forced removal by a private landlord or public action, without satisfactory compensation" [1978, p. 24]. On-site services are another essential component of housing. Adequate sanitation, electricity, waste disposal, and drainage are not only important to the health of the population, but to the success of the reconstruction process. Lack of services creates added costs to low-income populations. A study conducted by Thomas in Peru measured spatial differences in poverty and estimated that the price of water sold by water vendors in those areas that are not serviced by piped water is as much as twenty-five times that of water from metered connections. Alternative sources of light (e.g. candles), are estimated to be over twice as expensive as electricity [1978, p. 78]. If services are not considered from the outset, upgrading may be a very slow or non-existent process. After the 1972 earthquake in Nicaragua, $3 million were spent in building Las Americas, temporary settlement of 11,000 housing units that immediately became permanent. Although an additional $15 million were provided in concessionary loan funds to improve and expand the basic housing structures and to add individual water and sewage connections, improvements to the existing homes proceeded very slowly. The drainage system was ill-maintained, garbage collection was poor, malaria was a problem, and fire protection was barely adequate four years after the settlement was built [Comptroller General of the United States, 1977, p. 47].

The emphasis of reconstruction programs on the shelter structure without an adequate consideration of the other four major components of housing is a widespread tendency in Latin America and the Caribbean. Post-disaster reconstruction is an instance when the physical and social characteristics of housing for vast sectors of the population are determined. Given the increased housing needs posed by disasters and the massive investment they require, an understanding on the part of housing-related agencies of the importance of access, land tenure, size of lots, and provision of services is crucial.

6. Under the traditional economic mechanisms, the equilibrium between supply and demand may bring about a rise in the price of housing-related items.

Unless a strict control of prices is established by the government of the affected country, the context of scarce resources will create a rise in the prices of basic construction materials, land, and labor. Considerable inflationary pressures were felt after Hurricane Fifi in Honduras in 1974, after the earthquake in Nicaragua in 1972, in Guatemala in 1976, and after the hurricanes in the Dominican Republic and in Dominica in 1979. This phenomenon is the result of a rapid increase in the prices of imported goods (i.e. roofing materials), shortages of labor, and inelasticity in the supply of certain local products affected by the disaster [United Nations, 1979, p. 16]. For instance, in the case of Guatemala, at the end of 1976, the Reconstruction Committee estimated that the effect of inflation following the earthquake would raise the costs of construction from $1,021 million to $2 billion. By that time, the price of bricks had already increased to three times the predisaster level [United Nations, 1979, p. 23]. In the Dominican Republic after Hurricane David, increases in the prices of essential building materials were substantial and the cost of low-income housing suffered a 41 percent increase in the year following the disaster [El Listin Diario, 1980]. Inflation and speculation are promoted by the lack of actions on the part of the involved government to control and regulate individual activities in the private sector. Price controls, control of speculation, and hoarding of materials should be established at all points in the housing reconstruction process. For instance, in the reconstruction of

Guatemala, the government failed to control the add-on transportation costs that were applied to lamina and cement. When distributing these commodities throughout the country, the cost of cement that was U.S. $2.00 at the factory per bag rose to as much as five dollars a bag, less than 100 kilometers from the point where it was produced [Cuny, 1978].

Conclusion

The type of disaster agent, the magnitude of the damage, historical and cultural factors, access to resources, the new visibility attained by existing housing shortages and deficiencies, and the characteristics of the built environment are elements that help configurate the nature of changes in housing during the reconstruction following disasters.

In disaster-prone countries, it is not hazards in general but specific disasters that generate support. However, the frequency and magnitude of disastrous events in the Caribbean and Latin America, indicates that ad hoc responses and emergency measures are not enough. Predisaster planning and prevention are critical strategies that should be emphasized. Disasters have the potential to be accelerating factors of housing changes. Preventive actions rather than palliative approaches are essential for development and frequently ignored by the short-term considerations that prevail immediately after a disaster. Government could use the emergency situation to play an important role in land acquisition, regulation of tenure, and provision of services. Special efforts should be made to minimize the adverse effects of emergency activities on housing, and to use the opportunity for developing an improved structure for human settlements.

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HOUSING PATTERNS AFTER A LANDSLIDE

Örjan Hultåker

Evacuation is a common response to disasters, and many students have looked upon the short term aspects of evacuations [Hultåker, 1976] [Perry, Lindell, and Greene, 1980]. Much less is known about long term consequences.

Studies have shown the importance of family and kin when people decide to evacuate [Bates et al., 1963] [Drabek, 1969] and their preferences for staying with relatives rather than in public shelters [Young, 1954] [Moore et al., 1963] [Haas, 1978]. Families gather to decide if they should evacuate and where they should go. They want to keep together if they leave their homes, and they try to stay with their kin or with friends if they lack relatives. Hultåker [1979] has analyzed some factors affecting the family decision to leave and to stay away from a disaster site. People compare the disaster site with their best alternative available, i.e., they compare their home with their potential place of evacuation. Among factors taken into account are the standard of living, the risk of injuries, the cultural values, and the social norms. Mileti, Drabek, and Haas [1975, p. 12] have indicated the shortage of research on reconstruction following natural disasters. Others, like Cuny [1978], have stressed the need to evaluate housing programs, their efficiency and consequences. There is a need for more empirical studies and for systematic analysis of permanent housing.

The length of time before people can move into permanent houses is of great importance after a disaster. Two out of three necessary houses were constructed within ten months after an earthquake in Turkey, which is a developing country [Mitchell, 1977], but three years were not enough in northern Italy. Four years after the event, Pelanda [1980] characterizes the disaster site of the 1976 earthquake in Friuli as a temporary housing system; so-called temporary housing often becomes permanent [Davis, 1977]. Cuny [1978] has made a summary of difficulties in providing permanent housing after a disaster. He observes that houses cannot be efficiently provided without taking into consideration the process through which houses are normally provided in the society.

Iklé [1951] and [1958, p. 221 ff.] reports that Germans wanted to return to their earlier living areas when their cities and towns were reconstructed after the Second World War. Local business men returned as well, and the various parts of the cities conserved their social character. It is also reported that people want to repair their own houses rather than look for a new one after a disaster [Dacy and Kunreuther, 1969, p. 142]. One reason given for the return is the fact that land holdings often represent the only asset of the disaster victims, and that they want to retain it [Hawley, 1955].

Other students have observed the social differences between people who return and those who stay away during the reconstruction period (e.g., [Moore, 1958, p. 137]). Hingson [1977] reports that after an earthquake in Guatemala many disaster victims fled the area and that 80 percent of the remaining people owned their own homes. Similar results are reported by Weymes and Holt [1977]. Few studies have recorded the quality of repaired and rebuilt houses, but some reports indicate increased quality of the permanent houses as compared with the pre-disaster ones [Moore, 1958, p. 138] [Snarr and Brown, 1978].

The construction of buildings in a disaster area does not guarantee that the victims will get permanent housing. The houses and the environment must be acceptable to the victims or they will not live there. Mitchell [1977] reports from the earthquake in Lice, Turkey, that many of the victims did not accept the permanent houses provided for them; the houses were abandoned, and the victims returned to their original or other villages.

Housing patterns are instances of the structural and individual change that occur after a disaster. It is thus necessary to study the pattern of movements, not just the housing at a given period of time. The movements of families must be looked upon as a process. It is not enough to classify different dwellings as pre-disaster, temporary, and permanent; there are degrees of permanency, and some families pass through more temporary homes than others. A family may move into a temporary house but decide to remain there since it suits the wishes of the family. Others may leave a home intended to be permanent.

It is necessary to consider the societal conditions under which the disaster recovery occurs, since the social meaning of homes and houses differs between cultures. The place and type of a house may be entirely determined by the social position of a family or it may be only one indicator of social status. The quality of housing may be related to the stratification system of the society, so that the geographical mobility of families is interrelated to their social mobility in the stratification system. Families will change their social position simultaneously with a change of house. The economic importance of a family's house and land tenure will differ between cultures as will the propensity to move after a disaster. Some families in some cultures can enhance their social and economic standing by moving, and they will accordingly be likely to do so. Others will not have the same option, and they will show a tendency to remain where they lived before the disaster. Ownership of land and houses will have varying consequences.

The rest of this paper will report on the housing pattern after a land-slide that occurred in Sweden. The housing problems were of a magnitude that should be handled fairly easily by a welfare state, and there was no real lack of resources. The major problems centered around the allocation of resources during the recovery period as in Dyne's [1975] Type III society. Data will show the number of dwellings occupied after the disaster, the length of time that families remained in their houses and flats, and the time that elapsed between the disaster and the day when the families moved into what they believed to be their permanent residence. There will be an analysis of change in housing quality caused by the disaster.

The Landslide

On November 30 in 1977 a landslide occurred at Tuve, a parish situated twelve kilometers north of Sweden's second largest city, Göteborg. The stricken area consisted of quick clay in a river valley where the slide was caused by rainy weather. Excessive rainfall saturated the clay which could then no longer carry the weight of the houses in the area.

The slide moved 65 houses and flats within a triangle whose base was 1800 feet and whose sides were 2,400 feet. Some houses moved as far as 900 feet and were totally destroyed. Another 130 houses and flats remained outside the border of the directly affected area, but they were immediately evacuated since it was feared that more slides could follow. Some of the houses were left hanging on a steep cliff of about 45 feet.

A fortnight afterwards 46 families were able to return to their homes which were then judged to be outside of the dangerous area. Nevertheless, 84 other families had to remain out of their homes for extended periods, and responsible authorities evaluated their needs for temporary and permanent housing to be similar to that of people directly affected.

The slide happened at four o'clock in the afternoon, and the majority of the family members were at home, especially women and children. Some of the families had visitors. It seems as almost a miracle that no more than nine persons in four houses were killed.

The Victims

The disaster-stricken area was a well established suburb with a fairly homogeneous, middle-class population. Most families owned their terraced houses or bungalows, while a few lived in flats in condominium houses of two stories. There was little movement in or out of the area, and the majority of the families had lived in their houses for more than ten years, i.e., since their houses were built. Some of the people had been born in Tuve.

The educational level was high, and one man out of four had studied at a university. Three out of four women were gainfully employed. Sixty percent of the families had children living at home, and every third family had preschool children. The majority of the adult population was between 36 and 52 years old.

Some of the neighboring areas were profoundly different. They consisted of flats in large buildings owned by the city of Göteborg, and the population had entirely different characteristics. Although empty flats were available in these buildings, many families refused to move into them even for a short period, since the areas had bad reputations.

Methods

The families directly and indirectly affected were interviewed about their responses after the disaster. The interviews were highly structured but unstandardized. They were conducted by trained interviewers who generally talked with several family members for at least an hour. Among the topics covered were the movement of the family after the disaster.

A mail survey was conducted three years after the landslide in order to follow up on changes that had occurred after the interviews. Many of the questions were devoted to housing changes and problems. Official descriptions of the landslide was gathered through 68 interviews with responsible authorities and other representatives of disaster relevant organizations.

Most of the data in the present paper will be taken from the mail survey. The population consists of the 65 directly affected families and the 84 indirectly affected families who could not return to their homes until long after the landslide. The directly affected families had 215 members among whom 100 were children, whereas the other group of families had 255 members (100 children). The study therefore concerns 149 families with 470 members of which 206 were children.

The sample included all 149 families except those where at least one member was killed by the slide. There remained 145 families to be studied, but one family died before the questionnaires were posted. Ten families refused to be interviewed, and 14 families did not return their questionnaires. The response rate was 93 percent for the interviews and 90 percent for the mail questionnaires.

Economic Consequences

All directly affected victims lost their houses and most of their property kept at home. Objects were scattered all around the area, and many families could only rescue a few things of great personal value. All the directly affected houses were destroyed.

The houses of indirectly affected families remained intact, but they could not be used for an extended disaster period because of the danger of their collapse. Some of these houses were hanging on a steep cliff, and there was the risk that successive landslides would demolish them. It was possible to remove furniture and other family property from most of these houses.

Half of the families had valid insurance covering most of their losses, but half of them were insufficiently insured. They were promised, however, that the government should cover all their losses, when the Secretary of the State for Home Affairs visited the disaster site two days after the landslide. He was asked in public about the economic consequences for the victims.

There was some discussion afterwards about the meaning of the promise, but the government paid 50 percent of the value of lost property not covered by insurance. The government also reimbursed the affected victims for their houses at the market price. Some of the houses closest to the edge of the slide area were also reimbursed at the same price level.

The rest of the families living in the indirectly affected area had two options to choose between. They could either sell their houses at the market price, or they could move back into their own house after a period of seven to eighteen months after the ground had been strengthened.

The disaster area was entirely reconstructed after 18 months. No new houses were built, but the majority of the houses had been repaired in the indirectly affected disaster area. Some were used by the same families as before the disaster, but most of the houses and flats were sold on the market at a price somewhat lower than the one at which the government had bought them.

There are at least three markets for houses in Sweden. The economically most favorable one is the market for new houses and building plots, which are generally distributed through municipality offices. The prices are fairly low, and it is possible to borrow most of the money at a favorable rate of interest. The second hand market is much more expensive, and it is harder to borrow the full price. Nevertheless, most people believe it to be more favorable to own than to rent a home because of the fiscal system.

The regular distribution of new houses and plots was stopped immediately as a consequence of the landslide. Local authorities decided that all available resources should be used for the disaster victims. A large number of families who had queued up for new dwellings for many years were by-passed in this process.

About 100 dwellings were available to the victims less than two months after the slide, and 19 of them were fairly close to the disaster site in Tuve. People could have moved into them a little more than one year after the slide.

The disaster stricken families had four alternatives:

> To rent an apartment or to buy one in a condominium (available within a few months);
>
> to buy a house on the second hand market (available within a few months);
>
> to buy a new dwelling from the town (available in twelve to eighteen months);
>
> to return to their pre-disaster dwelling (available to most of the indirectly affected families within seven to eighteen months).

Results

Number of temporary dwellings and length of residency

The average disaster victim lived in three to four different places since the landslide occurred, and there was almost no difference between the directly affected families and those indirectly affected. No family was able to move directly to a permanent home from their destroyed pre-disaster home, but 14 families needed to pass through only one temporary dwelling.

Two families did not find a permanent home until they arrived in their seventh house, and two families were on the move until they reached their sixth. More than ten percent of the families had to stay in at least five places, and almost every second family moved to at least four homes.

The median family lived in temporary dwellings more than two years before they could move into a permanent home. More than four out of ten families had to wait between two and a half and three years, and the situation was the same for indirectly as for directly affected families. No family had to wait more than three years for a permanent home. A small minority of ten percent were able to move into a permanent home within a year, and less than five percent could do so within six months.

There is no simple association between the number of dwellings and the length of time that people had to wait for a permanent home. Families with only one temporary dwelling had generally to wait more than two years and a half in order to get a permanent house.

The victims stayed for only a few days in their first temporary dwellings. One third of them had moved out within three days, and every second family left before a week. Nevertheless, 20 percent of the victims stayed in their first temporary home for more than a month.

The families stayed longer in their second and third temporary dwellings, and the latter seems to have been the most long-lasting. Forty percent of the families stayed more than a year, and two out of three stayed more than six months. The fourth dwelling was more transitory, and half of the families moved out of it within three months after their arrival there. It has to be noted, however, that there was a limited number of families who stayed in more than three temporary dwellings.

Many of the families had very vague ideas about their intended length of residency when they moved into their various temporary homes. They planned to live there for the immediate future, or they were simply unable to answer questions about their intentions. An analysis shows, however, that many of the families stayed for longer periods than intended, especially in their third and fourth temporary houses.

The wait for permanent homes was much longer than expected. Some families said that they would have acted differently if they had known how long the waiting time would be. They should either have chosen a

Table 1

Number of Dwellings Occupied by Disaster Victims During Three Year Period

Families	Number of Dwellings							Total
	1	2	3	4	5	6	7	
Directly affected	0	3	19	19	5	2	2	50
Indirectly affected	0	11	32	28	9	0	0	80
All families	0	14	51	47	14	2	2	130

Table 2

Number of Months in Temporary Dwellings before Moving to Permanent Homes

Families	Number of Months						Total
	6	7-12	13-18	19-24	25-30	31-36	
Directly affected	1	0	15	8	7	19	50
Indirectly affected	5	8	13	10	5	36	77
All families	6	8	28	18	12	55	127

Table 3

Proportion of Disaster Victims by Length of Residency in Temporary Dwellings

Dwellings number	Length of residency: days 1-3	4-7	8-30	months 2-3	4-6	7-12	13-	
1	.32	.17	.30	.17	.02	.03	.00	N= 113
2	.07	.04	.15	.24	.17	.10	.24	N= 103
3	.00	.04	.07	.11	.12	.25	.40	N= 57
4	.00	.06	.12	.35	.06	.12	.29	N= 17

Table 4

Relationship between Permanent Homes of Victims and Type of Residence before Landslide

Permanent residence	Residence before Disaster: Bungalow	Terraced house	Condominium flat	Total
Bungalow	13	68	10	91
Terraced house	0	16	3	19
Flat	0	2	6	8
Total	13	86	19	81

type of permanent house that was available earlier than the one actually chosen, or they should have organized their temporary homes in a different way. The number of different temporary dwellings seemed to be more annoying than the length of residency in each of them.

The quality of permanent homes

The majority of the victim families, 73 percent, lived in terraced houses before the landslide, 16 percent lived in condominium flats, and only 11 percent in bungalows. Their living standard had changed entirely three years after the landslide.

An overwhelming majority of the disaster victims had moved to bungalows, and the proportion of families in flats and terraced houses had diminished. The number of families who lived in bungalows had increased from 13 to 91, or to 77 percent. No family who lived in a bungalow before the disaster had left that type of housing, but the majority of those living in flats or in terraced houses had moved into bungalows. This change was in accordance with the wishes of the victims, among whom the majority declared that they wanted to move into bungalows irrespective of their predisaster type of home.

Dwellings as well as people can be rank orderd in a stratification system, where bungalows represent the upper status, terraced houses the middle, and flats the lowest. There are, of course, exceptions: some terraced houses are more exclusive than many bungalows, and there exist high quality flats in central areas of the cities. Nevertheless, the general pattern holds, and some families used this opportunity to move up the ladder. This was not, however, the only reason for people to prefer bungalows to terraced houses. There was at the time of the landslide a shortage of terraced houses.

A few families wanted to return to their pre-disaster home. Some of them did so, although after a few months many of them moved to a new permanent house. Other families wanted to live in Tuve, but they preferred a new bungalow to their pre-disaster house. Almost half of the victims, 59 families, returned to Tuve, where the disaster occurred. An additional 17 families moved into neighboring parishes north of Göteborg, and 26 families preferred to move to the southern part of the city, often to popular areas. Three families left Göteborg and the remaining were scattered around in diverse areas of the city. The disaster victims were aware of the reputation of different areas of Göteborg. One out of four families said that they wanted to avoid bad living areas.

Many families wanted to return to Tuve, but there were others who wanted to stay away from the parish. Every fifth family was afraid of the risk of future landslides. Another group wanted to stay away because of disaffection over conflicts which mostly concerned the allocation of houses and plots. Still another group wanted to live near other families hit by the disaster.

Many families mentioned that they wanted to live close to relatives and friends or near certain institutions such as their jobs or schools. It is worth noticing that the institutions of children were more

Table 5

Areas Where Families Relocated Permanently

Area	Number of families
The parish of Tuve	59
Other Parishes close to Tuve	17
Southern Göteborg	26
Other parts of Göteborg	13
Outside Göteborg	3

Table 6

Proportion of Families Considering Various Factors in Choice of Permanent Residence (N=130)

Factor	Proportion
Wanted to avoid bad areas of the town	.27
Wanted to stay away from risky disaster area	.20
Wanted to live near other families hit by the disaster	.09
Wanted to get away from the conflicts in the disaster area	.10

important than the institutions of adult persons. Only 13 families, ten percent, indicated that they had no choice between alternative dwellings. They said that they had to take the only alternative offered to them. A majority of 90 percent made choices.

Summary and Conclusions

Housing problems occur in all types of societies after a disaster, including welfare states where there are enough resources to provide good housing for all citizens. About 150 families lost their homes in a landslide that occurred in a middle-class suburb close to the center of the second largest city of Sweden, Göteborg. Most observers would guess that the victims would find new permanent homes which would be acceptable to them fairly soon. Nevertheless, three years passed before they all had moved into permanent houses, and half of the families had to wait for more than two years. They also had to occupy a great number of temporary dwellings. Every second family lived in at least four different homes after the landslide, and some families lived in as many as seven different homes.

The same pattern could be found in many different societies at various levels of development. The social and economic causes are different, however. Sweden is a Type III society in Dyne's [1975] typology, while developing countries belong to Types I and II. The latter have problems after a disaster because of their lack of material resources; a society of the third type has the resources needed for reconstruction, but it faces problems of allocation. Both the lack of resources and allocation problems may have the same consequences: a prolonged period until permanent dwellings are provided.

The allocation of resources concerns the bureaucratic structure of decision-making. No Swedish family is allowed to construct a new house without being permitted to do so. Various bureaucratic organizations have to study the plans and approve of them. There are certain standards that must be met, and all houses have to fit into a general plan.

Nevertheless, many of the bureaucratic problems were efficiently handled after the landslide at Tuve. The decision-making process was coordinated in a way that made things move faster than usual, and the rules were changed in order to help the disaster victims. But, three years passed before the families moved into their permanent houses.

One of the characteristics of modern western societies is the type of market through which resources are allocated. People can improve their material and social situation by choosing between alternatives offered to them. There are, however, always limitations, and people must have economic or social resources in order to support their demands in an exchange situation.

The largest part of a family's resources generally are not available to be used on the market of exchange since they are already invested. Their material resources are found in their houses, furniture, and other private objects. Their social resources are invested in their friends, their relatives, and their neighbors. These resources cannot easily be made available.

A disaster changes that situation; material and social resources are suddenly set free. Families have lost their homes, but they have cash money received from insurance companies and official authorities. These funds can be used to buy an entirely new house.

There are more options open to the families than ever before because they can start from scratch; they can decide where to invest their housing money, in what type of home they should invest it. They are in a new situation. To choose between, say, a terraced house in a southern suburb and a bungalow in a northern one, is quite different from choosing between painting and not painting the old terraced house.

The same type of change in social resources; investment in social surroundings are often lost during disasters. Families first experience an increase in the disaster area solidarity, but it is usually weakened when the victims are spread outside the disaster site. The families are reimbursed in social resources since they are the focus of a general interest. It becomes a matter of public concern to help the disaster victims, and they are often welcomed, at least during an initial period. The families can use their social resources as well as their economic ones to invest in their future. They can choose between alternatives that they have never had before.

Only ten percent of the victims in Tuve said that they had no options to choose between, while the rest of the families compared different housing areas in several respects. They thought about the general reputation of different parts of the city, the risk of a new landslide, the type of people they wanted to have in their neighborhood, and their proximity to various types of social institutions. The families also used their social and economic resources in order to improve their general level of living; they moved upwards in the stratification system of houses. Few of the victim families had lived in bungalows before the disaster, but an overwhelming majority did so three years afterwards.

The situation is very different in a society where there is a lack of economic and material resources. There are not many alternatives open to the victims; they have lost their houses without receiving any cash money instead. The social resources may also diminish since they not only have to compete with their fellow victims but also with all other members of a poor society. A developing country cannot afford the same priority to disaster needs as can be given in developed countries. Thus, disaster victims in a poor society lose their homes and houses without being reimbursed, either economically or socially. They often stay on the disaster site because they may own a parcel of it, or it is the only social context where they feel that they are welcomed.

The decision to stay in the disaster area or to leave it is not a question of universal human propensities. Nor is it a difference between the western culture and other cultures. Whether people stay or leave is a consequence of the reward system of a society hit by a disaster. Human beings try to make the best of their situations; they also try to find the best possible home that is available to them.

Disaster responses cannot be analyzed without taking into account the social and economic context in which they occur. There is no need to ask whether people stay or leave a disaster stricken area or whether they evacuate or not before a disaster. It is necessary to understand the rewards and costs of a given society. It is also necessary to understand the change that occurs in the social and economic resources available to the disaster victims.

Just a word of caution: To say that disaster victims increase their available social and economic resources is not to say that the victims profit from the disaster. On the contrary. They receive their increase in available resources as small and insufficient compensation for their overall losses. Moreover, many of the victims at Tuve had to pay an additional price: they had to wait almost three years before they got a permanent house. Some of the families drew the conclusion that they would have employed their resources differently if they had known about the waiting time. They might have chosen different houses or made other arrangements during their period of temporary housing.

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SECTION XIV

CONCLUSION

CLOSING REMARKS

Michael P. Gaus

It is a pleasure for me to offer some comments at the closing of the Third International Conference on the Social and Economic Aspects of Earthquakes and Planning to Mitigate Their Impacts. I have been particularly interested in this conference for two major reasons. The first is that this conference is being held approximately ten years after cooperative projects in earthquake research between U.S. and Yugoslavian researchers were initiated under National Science Foundation Programs. I have had the honor of participating in the establishment of a number of these programs, and it is gratifying to reflect on the progress that has been made through these efforts. The second is that the subject matter of the Conference is an indication of success in achieving a more comprehensive approach to the earthquake problem in which social and economic consequences are being studied in addition to considerations of physical damage to constructed facilities.

In looking back at the research programs of the last ten years, many successful accomplishments can be identified. These programs were of great assistance in establishing a network of strong-ground motion instruments in Yugoslavia. This network has recorded a number of significant seismic events and has provided data which improve our knowledge of how the ground actually moves at different locations during an earthquake. Such information is an important key to establishing design levels and conditions for various types of structures. A comprehensive program of laboratory testing, computer modeling, and dynamic tests on real buildings has improved our capabilities during the design stage to predict in advance the seismic behavior of structures. One computer program, which is known under the acronym TABS or XTABS has made dynamic analysis of three dimensional structures much more feasible. The original versions of this computer program were developed under the cooperative research program, and the computer program is being extensively used by both designers and researchers. A great deal of valuable research on masonry structures is being carried out. In the planning area joint studies have been carried out leading to new procedures for estimating building stocks and for reconstruction planning. Many other valuable accomplishments could be listed, but this sampling provides an indication of the success of these cooperative programs.

It is hoped that the momentum and linkages which have been built up through these cooperative research efforts can be maintained in the future. This conference and the two preceding ones have provided a basis for continued joint efforts which include cooperation between disciplines which have too frequently followed separate paths even within a single country. I hope that in the future fruitful interaction between researchers and professionals in the U.S. and Yugoslavia will continue.

Finally, I would like to acknowledge the substantial efforts of Professor Barclay Jones and Dr. Jože Vižintin, Co-chairmen of this Conference. It is through their unusual skills in organization and investment of substantial amounts of energy that this Conference was organized in a very short amount of time--particularly considering the complexities of international communication. I would also like to express my appreciation to the large number of people in both countries, and I will not even try to name all of them, who worked to make this Conference a success. I have found the Conference to be stimulating and to provide me with a broader insight into approaches for understanding and dealing with the earthquake problem in a more comprehensive way. I hope you have found it to be a similar experience.

APPENDICES

APPENDIX A

FINAL CONFERENCE PROGRAM

THIRD INTERNATIONAL CONFERENCE: THE SOCIAL AND ECONOMIC ASPECTS OF EARTHQUAKES AND PLANNING TO MITIGATE THEIR IMPACTS

June 29-July 2, 1981

Grand Hotel Toplice
Bled, Yugoslavia

FINAL PROGRAM

SUNDAY, JUNE 28
ARRIVAL OF PARTICIPANTS AT BLED

MONDAY, JUNE 29

0800-0845 REGISTRATION

0900-1000 OPENING CEREMONY
Chairmen: Dr. Jože Vižintin
Dr. Barclay G. Jones

Welcome: Mrs. Marija Zupančič-Vičar
Representative of the
Socialist Republic of Slovenia
Dr. Muris Osmanagić,
Chairman of the US-Yugoslav Joint
Board on Scientific and Technological Cooperation
Acad. Prof. Dr. Janez Milčinski
President, Academy of Science and Arts,
Republic of Slovenia
Prof. Sergej Bubnov, President,
European Association of Earthquake Engineering

Opening Remarks: Mrs. Marija Zupančič-Vičar
Dr. Charles Zalar
Dr. Jakim Petrovski
Dr. William A. Anderson

1000-1030 Coffee

1030-1230 SESSION I
Subject: Macro- and Micro-Economic Considerations

Chairman: Dr. Vladimir Frankovič

1) Dr. Jerome W. Milliman "Modeling Regional Economic Impacts of Earthquakes"

2) Dr. Randall Baker "Land Degradation in Kenya: Economic or Social Crisis?"

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Monday, June 29, Continued

3) Prof. Sergej Bubnov "Governmental Role in Mitigating The Impact of the Earthquake Disasters in Yugoslavia"

4) Dr. Branko Zelenkov "Financing the Losses and the Risk Due to Earthquakes"

5) Dr. William D. Schulze "The Benefits and Costs of Seismic Building Codes"

6) Prof. Vladimir Ribarič "An Extension of the Concept of Specific Destruction of Earthquakes on the Basis of Gross National Product of Affected Countries"

1600-1700 SESSION II
Subject: Risk Evaluation

Chairman: Dean Myer R. Wolfe

1) Dr. Janez Lapajne "Social and Economic Aspects of Seismic Risk"

2) Mr. Wiratman Wangsadinata "Risk Criteria as a Rational Basis for Seismic Resistance of Structures of Different Grades"

3) Prof. Jakim Petrovski "Post Catastrophic Earthquake Studies for Planning of Immediate Actions and Seismic Risk Reduction"

4) Dr. E.M. Fournier d'Albe "The Problem of Assessing Seismic Risk to Existing Buildings"

1700-1730 Coffee

1730-1830 SESSION III
Subject: Attitudes Toward Risk

Chairman: Dr. Stane Saksida

1) Prof. Ritsuo Akimoto "Some Prospects of Earthquake Prediction in Japan"

2) Colonel (ER) Charles Chandessais "Fausse Alerte à Pouzzoles"

3) Dr. Thomas F. Saarinen "Warning and Response to the Mt. St. Helens Volcanic Eruption"

4) Dr. Risa I.K. Palm "Public Response to Mandated Earthquake Hazard Disclosure by Real Estate Agents"

1830-2000 Reception, Grand Hotel Toplice

TUESDAY, JUNE 30

0800-1000 SESSION IV
Subject: Social System Vulnerability

Chairman: Dr. Jerome W. Milliman

1) Dr. Russell R. Dynes "The Contribution of the Social Sciences to Emergency Planning"

2) Prof. Carlo Pelanda "Disasters and Sociosystemic Vulnerability"

3) Dr. Enrico L. Quarantelli "An Agent Specific or an All Disaster Spectrum Approach to Socio-Behavioral Aspects of Earthquakes?"

4) Dr. Ralph H. Turner "Disaster Subcultures in Earthquake Country: Between Earthquakes in Southern California"

5) Dr. Vit Karnick: "Problems of Earthquake Hazard Assessment and Vulnerability Analysis"

6) Michel L. Lechat, M.D. "Disasters Epidemiology: An Epidemiologists's View of Health Management in Disasters"

1000-1030 Coffee

1030-1230 SESSION V
Subject: Preparedness Measures

Chairman: Prof. Sergej Bubnov

1) Dean Myer R. Wolfe "Urban Scale Vulnerability: Some Implications for Planning"

2) Prof. Aydin Germen "Earthquake Sciences and City Planning Are Still Disconnected"

3) Mr. Vladimir Braco Mušič "Spatial and Urban Planning and Design in Earthquake-Prone Areas"

4) Mr. Stanley Scott "Formulating and Implementing Policies for Seismic Safety"

5) Mr. Robert A. Olson "The California Seismic Safety Commission, 1975-80: Public Policy and a Practitioner's Observations"

6) Dr. Alan J. Wyner "Implementing Seismic Safety Policy: The Case of Local Governments in California"

Tuesday, June 30, Continued

1600-1700 SESSION VI
Subject: Emergency Situations

Chairman: Dr. Ralph H. Turner

1) Mr. Harun Alrasjid "Social and Economic Aspects in the Mitigation of Earthquake Disasters"

2) Prof. Bernardo Cattarinussi "Victims, Primary Groups and Communities After the Friuli Earthquake"

3) Prof. Enso V. Bighinatti "In the Spirit of William James: Reflections on League of Red Cross Societies Experience of Earthquakes"

1700-1730 Coffee

1730-1830 SESSION VII
Subject: Education and Information in Disasters

Chairman: Prof. Viktor Turnšek

1) Prof. Francesco M. Battisti "The Organization of a Mass Education Program in Order to Mitigate Earthquake Hazards in Calabria

2) Prof. T. Joseph Scanlon "The Mass Media in Crisis: A Predictive Model"

3) Mr. Polde Štukelj "Rescuing Actions After Earthquakes"

2000-2200 Dinner, Grand Hotel Toplice

WEDNESDAY, JULY 1

0800-1000 SESSION VIII
Subject: Disaster Impacts and Effects

Chairman: Mr. Stanley Scott

1) Dr. Frederick L. Bates "The Use of a Crossculturally Valid Level of Living Scale for Measuring the Social and Economic Effects of Earthquakes and Other Disasters and for Measuring Progress in Recovery and Reconstruction as Illustrated by the Case of the Guatemalan Earthquake in 1976."

2) Dr. Robert Geipel "The Case of Fruili/Italy: The Impact of an Earthquake in a Highly Developed Old Culture: Regional Identity versus Economic Efficiency"

Wednesday, July 1, Continued

3) Prof. Viktor Turnšek "Earthquakes as a Social Problem"

4) Prof. Ada Cavazzani "To Be Announced"

5) Mag. Milan Orožen Adamič "The Consequences of the Earthquakes which Occured in 1976 in Slovenia"

1000-1030 Coffee

1030-1230 SESSION IX
Subject: Post Disaster Response

Chairman: Mr. Vladimir Braco Mušič

1) Prof. Tiberije Kirijas "Physical and Urban Planning and Design in Seismic Areas"

2) Mr. Anton Ladava "Guidelines and Procedures to Eliminate the Impact of Earthquakes in Soca Valley"

3) Dr. Alcira Kreimer "Housing Reconstruction in the Caribbean and Latin America"

4) Mr. George G. Mader "Land Use Planning After Earthquakes"

5) Prof. Örjan E. Hultåker "Housing Patterns after a Landslide"

6) Dr. Barclay G. Jones "Estimates of Building Stocks as a Basis for Determining Risk"

1400-1945 SESSION X
Study Trip to Institute

1500-1700 Visit to the Institute for Research and Testing Materials and Structures in Ljubljana

1700-1730 Closing Ceremony: Cultural Center "Ivan Cankar"
Chairmen: Dr. Jože Vižintin
Dr. Barclay Jones

Greetings: Dr. Marjan Rožič
President, Assembly of City of Ljubljana

Closing Remarks: Vladimir Braco Mušič
Dr. Michael P. Gaus

1730-1900 Reception: Cultural Center "Ivan Cankar"

1900-1945 Return to Bled

THURSDAY, JULY 2

0630-2000 SESSION XI
Study Trip

Excursion by bus to the Soča-Valley, damaged by the 1976 Friuli Earthquakes (Via Kranjska gora-Vršič-Bovec-Kobarid-Tolmin-Cerkno-Skofja Loka)

0930-1100 Visit to Podbela and Breginj

1200-1400 Lunch at Breginj

1500-1700 Visit to Partisans' Hospital Franja

2000 Return to Bled

APPENDIX B

LISTS OF ATTENDEES AND AUTHORS

THIRD INTERNATIONAL CONFERENCE: THE SOCIAL AND ECONOMIC ASPECTS OF EARTHQUAKES AND PLANNING TO MITIGATE THEIR IMPACTS

June 29-July 2, 1981

Grand Hotel Toplice
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