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NORTHRIDGE, CALIFORNIA EARTHQUAKE:
IMPLICATIONS FOR THE CENTRAL U.S.

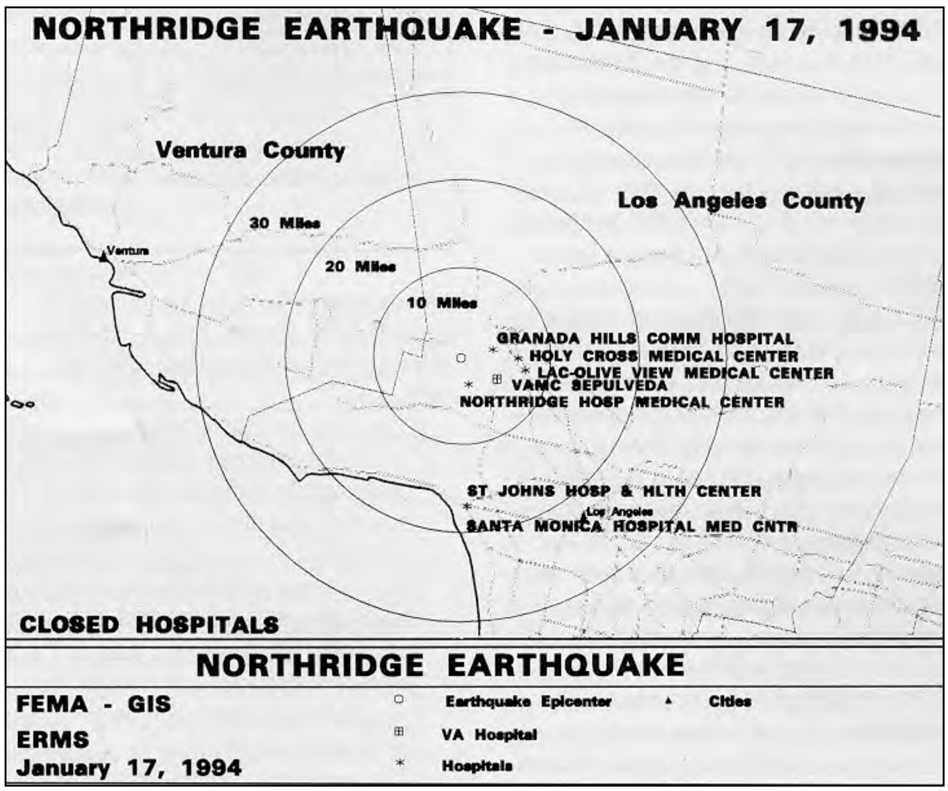
At 4:31 A.M. on Monday, January 17, a Richter magnitude 6.6 earthquake struck the densely populated San Fernando Valley, in northern Los Angeles. The epicenter was located in Northridge, on a previously unknown thrust fault. Numerous aftershocks of at least magnitude 5.0 occurred during the next few days.

The Northridge earthquake is the most destructive in the U.S. since the 1906 San Francisco earthquake. Direct economic losses are estimated currently at over $20 billion. Over 10,000 homes and businesses lost electricity; over 20,000 were without gas; and more than 48,500 had little or no water. About 4,000 structures were severely damaged or destroyed, leaving 25,000 people homeless. Tent cities sprung up in parking lots, and local parks. The Federal Emergency Management Agency (FEMA) was deluged with over 200,000 applications under its Disaster Housing Program, and over 80,000 applications for individual and family grants.

The death toll was 61, with over 5,000 people injured. These figures would have been much higher had the earthquake not occurred in the early hours of a national holiday.

The freeway system, among the busiest in the U.S., sustained major damages. Interstate 5 buckled in at least two locations; overpasses on freeways collapsed, causing massive delays. In total, portions of 11 major roads to downtown Los Angeles had to close.

In essence, the Northridge earthquake served as a vivid, dramatic reminder of how sudden—and destructive—



Map courtesy of the Federal Emergency Management Agency—Modeling Branch

earthquakes can be. In urban centers, in particular, our vulnerability is magnified. The lifelines (transportation, gas, water, electric and telecommunications) that we rely on to support our daily routines are also among the most vulnerable to ground shaking and liquefaction. Fires following an earthquake pose additional risks, notably in urban, densely populated areas.

This edition of the *CUSEC Journal* examines the Northridge earthquake, and specifically the lessons for the Central U.S. Three key areas are addressed: health and medical response, building inspections, and mass care.

HEALTH AND MEDICAL

Rick Roman, CUSEC liaison from the Centers for Disease Control and Prevention, responded to the Northridge earthquake as a representative of his agency under Emergency Support Function (ESF) #8, Health and Medical. He contributed the following section on Health and Medical.

The sudden impact of the early morning earthquake on January 17 posed an immediate challenge for State and local health and medical resources. With little warning, transportation, power, and communications systems were disrupted,

(Continued on page 2)

jeopardizing the State and local health care delivery system. In spite of these damages, quick actions on the part of local, State and Federal health and medical authorities resulted in an effective and timely medical response. The following is an overview of the key elements of a coordinated health and medical response, with an emphasis on the implications for State and local officials in the Central U.S.

Status of Hospitals and the Emergency Medical System

One of the top priorities following the earthquake was an assessment of damages to hospitals and the Emergency Medical Service (EMS) System. These assessments were undertaken by local government (public health, emergency medical services, emergency management), the State of California, the Region IX Public Health Service and FEMA.

Chart 1 depicts the range of damages to area hospitals, organized under five categories of damage and ability to function. Immediate damage assessment near the epicenter revealed loss of water, power, and major damage to interior water supply pipes at several hospitals, which prompted their closure. The majority of hospitals remained functional, but sustained varying degrees of *non-structural damage*—overturned equipment, supplies, etc.

CHART 1
INITIAL IMPACT ON AREA HOSPITALS

STATUS	HOSPITAL	DISTANCE/ EPICENTER	DESCRIPTION
1	Olive View	> 30 miles	Evacuate 377 patients
1	Granada Hills	> 10 miles	Serious water damage, no communications, needs to evacuate
1	VA Sepulveda	> 10 miles	Evacuate 300 patients to Long Beach VA Hospital
1	Holy Cross	> 10 miles	Diverting ambulance patients, water leaks, will evac. 17 ICU patients
2	Northridge Comm.	> 10 miles	Evacuate 23 neonatal patients, emergency services only
3	Kaiser, Panorama City	> 10 miles	Significant interior damage, unable to accept new patients via ambulance
3	Santa Monica	> 30 miles	Unable to accept new patients via ambulance
3	Simi Valley	> 10 miles	Unable to accept new patients via ambulance
4	St. Joseph's, Burbank	> 30 miles	Minor water Damage
4	Henry Mayo/Newhall	> 30 miles	
4	Valley Presbyterian	> 10 miles	No HVAC
4	Encino	> 10 miles	Plaster cracking
4	Kaiser, Woodland Hills	> 10 miles	Minor nonstructural cracking
4	Kaiser, West L.A.	> 30 miles	No significant damage
4	Humana	> 10 miles	No water or emergency power
4	Pacifica	> 30 miles	Possible evacuation, no water or emergency power
4	Thompson Memorial	> 30 miles	Pipes loose
4	Glendale Adventist Med.	> 30 miles	Minor crack to interior
4	Huntington Memorial	> 30 miles	Elevator service out
4	Kaiser, L.A.	> 30 miles	Concrete spaulding on adjacent parking structure
4	Cedars Sinai	> 30 miles	Expansion joint damage
4	St. Luke Medical	> 30 miles	Minor plaster cracking
4	Sherman Oaks	> 10 miles	Water pipes broken
4	Valley Hospital	> 10 miles	Minor water damage
4	Verdugo Hills	> 30 miles	Minor spalling/surface wall cracks
4	AMI Tarzana Regional	> 10 miles	Minor plaster cracking
5	Newhall Community	> 30 miles	Needs generator

STATUS CATEGORY

1= Total/Major Evacuation
2= Partial Evacuation
3= Unable to accept new patients
4= Damaged but Functional
5= Need Help to Remain Operational

Several hospitals had to evacuate patients, which was accomplished effectively, and without incident. Others moved their emergency room operation outside the hospital to adjacent parking lots or grassy areas on hospital grounds, to enable them to remain open. The Emergency Medical Services Authority (EMSA) emergency radio network to hospitals, which was activated immediately after the earthquake, had minor operational disruptions, but otherwise functioned very effectively.

Post-disaster building inspections are another important aspect of hospital damage assessment. Due to the numerous aftershocks, re-inspections of hospitals and other critical facilities had to be undertaken in a systematic way.

The Northridge earthquake highlighted some fundamental problems, issues—and opportunities—that health and medical planners in the Central U.S. will need to address—before, during and after an earthquake.

* The need for trained teams of structural engineers that can be immediately deployed to inspect hospitals and other "critical facilities."
* The decision of whether to retrofit hospitals—at a potentially high cost—or risk the consequences of a collapsed or partially collapsed structure that could result in a prolonged closure.
* The need for a comprehensive hospital response plan that addresses patient evacuation; mutual aid agreements with neighboring hospitals; reliable back-up power; and other provisions.
* Implementation of a nonstructural mitigation program that includes cost-effective measures to *reduce the potential damages* to equipment, supplies, light fixtures, and other interior objects that are vulnerable to shaking. Non-structural mitigation measures include bolting equipment to interior wall studs, installing and securing locks on cabinets, securing medical supply cabinets, and fastening sensitive equipment to walls.

Rapid Health Needs Assessment

As seen with past major disasters, assessing the public health status and medical well being of the community after the earthquake was an important initial step undertaken by health and medical response officials. Information obtained from surveying households in the affected areas assisted emergency response officials in prioritizing where to target limited resources to obtain the optimum results.

A "Rapid Health Needs Assessment Survey" was implemented within 72 hours of the earthquake by the Acute Communicable Disease Division, Los Angeles County Department of Health, with assistance from the State of California Department of Health, and the Centers For Disease Control and Prevention. The purpose of the surveys was to identify and describe the immediate health needs of the affected households. The assessments were conducted by developing a site specific, multi-lingual questionnaire, and interviewing randomly selected households to obtain a representative sample of the damages and medical needs of the victims.

The health needs assessment survey is important. In addition to providing valuable information on the health status and medical needs of victims, the surveys served an important outreach function. Interviewers provided information on the availability of medical care at disaster application centers; answered questions; curtailed rumors regarding disease outbreaks; and provided preventive public health service messages on a range of topics.

In summary, rapid health needs assessment surveys are an excellent source of valuable public health and medical status information of victims of disasters. Emergency management and health officials in the Central U.S. should consider using such a tool in developing emergency response strategies and planning activities. By developing a cadre of trained interviewers in rapid health needs assessment surveying techniques, CUSEC State Health Departments would be able to immediately implement such a tool if the need should arise. In this context, the development of a survey tool, and the training of surveyors, *should be undertaken before the disaster to facilitate the gathering of this valuable information.*

Preliminary Results of the Rapid Health Needs Assessment Survey:

* 34 % *of the households surveyed* had at least one household member 65 years or older and 21 % had at least one member under two years of age.
* 13 % had no running water.
* 12 % had no functioning toilet facility.
* 6 % had no electricity or refrigeration capability.
* Of the households that had running water, the three most frequently used treatments before ingestion included boiling (29 %), boiling/bottled (26 %), and bottled only (24 %).
* 8 % did not pretreat water before ingestion.
* 29 % reported at least one member injured. Most common injuries reported were bruises/sprains (53 %), and minor lacerations (42%).
* 43% reported at least one household member ill. The major illnesses reported were anxiety/mental health problems (61 %), gastrointestinal/diarrheal (15%), respiratory (12%), miscellaneous disorders (6%), and cardiovascular problems (4%).
* 42% reported having prepared an earthquake emergency kit.
* 34% had at least one member taking prescription medications. Of those, 59 % had enough in their homes at the time, 15 % were able to obtain medications from a pharmacy, and 15 % were unable to obtain medications.

> *"The problem is seldom availability of health and medical resources, but rather a lack of coordination and communication among local, State and Federal agencies."*

Earthquake Mortality

There were 61 fatalities from the Northridge earthquake. The deaths were a result of freeway structure collapse, building collapse, falls, death attributed to falling objects, fires, electrocution, power failures, and heart attacks.

Factors that affect death and injury rates include: magnitude of the earthquake; epicenter; time of day it occurred; presence of aftershocks; fire and other secondary hazards; and the level of preparedness of the citizens.

The bottom line for the Central U.S.: Public Health and Emergency Medical officials at all levels should assume a worst case scenario in predisaster planning for a coordinated medical response. FEMA's *An Assessment of Damage and Casualties for Six Cities in the Central U.S. Resulting from Earthquakes in the New Madrid Seismic Zone ("Six City Study")* estimates that a 7.6 earthquake would cause 10,000 casualties (25 percent fatalities) in Memphis alone. Bed capacity at hospitals and health care facilities would be reduced by one half. This scenario is dramatically different from what occurred in Northridge.

Water Potability

Water availability was a significant problem following the Northridge earthquake. Five major water mains in Los Angeles ruptured, reducing availability of water for drinking, food preparation, treatment of injured victims, and cleaning. While work relief crews immediately began repairing the water system, boil water orders were issued for the City of Los Angeles north of the Santa Monica basin for those who still had water service. The Department of Defense (DOD) played a key role in assisting State and local resources in distributing water to victims. Some 31 water distribution sites were established throughout the affected area, serviced by fleets of DOD tanker trucks. Bottled water was also effectively handled through these distribution sites. Approximately 1.6 million gallons of water (bottled and bulk) were delivered to victims in the impacted areas through January 31, 1994.

Water potability will be a primary concern following a New Madrid earthquake. The vulnerability of water lines to groundshaking is well documented. In addition to a lack of potable water for drinking and bathing, communities in the Central U.S. could face potential problems with fire suppression, particularly in large urban centers. Water potability preparedness issues need to be addressed by emergency management officials *before a New Madrid earthquake strikes.* Among the measures to be taken include: identification of water resources throughout the region; identification of methods to transport water resources; pre-determination of water distribution sites; planning for "boil water initiatives;" and identification of alternative water potability mechanisms.

Federal Public Health and Medical Assistance

In a major, intergovernmental emergency response operation, the problem is seldom *availability of health and medical resources,* but rather a l*ack of coordination and communication* among local, State and Federal agencies.

In California, the success of the health and medical response can be directly attributed to the teamwork and coordination that existed among key agencies. And the health and medical response was significant. Public Health Service regional staff responded from Regions II, III, IV, V, VI, and IX. The National Disaster Medical System (NDMS) was activated. Disaster Medical Assistance Teams (DMATs) from eight locations were deployed to damaged hospitals to augment existing hospital staff; to temporary shelter sites to provide on-site care for victims in parks; and to side-street enclaves.

The Veterans Administration (VA) and the Public Health Service provided nurses for medical coverage of all Disaster Applications Centers (DACs) and the Disaster Field Office (DFO). The VA also supplied two mobile clinic vans to supplement county and State medical mobile vans, which provide on-site medical care to victims. The VA also assisted in medical resupply of county hospitals and health centers, as requested.

The Emergency Response Coordination staff and Epidemiologists from the Centers For Disease Control and Prevention provided technical assistance and consultation to the State of California and local authorities in rapid health needs assessment surveys, establishing emergency public health prevention surveillance systems, and public health information messages to the public. Public health information messages were distributed that addressed water potability, carbon monoxide hazards, injury prevention precautions, and food storage and handling procedures.

Emergency personnel from the Substance Abuse and Mental Health Services Administration (SAMHSA) also assisted in crisis counseling and mental health assessments of victims and disaster relief workers. Approximately 12,000 victims, and relief workers were treated by Federal medical resources during the response.

In summary, there is a broad range of health and medical resources available throughout the Federal system. Yet, pre-disaster planning—involving all levels of government—is the key to effective and timely utilization of available resources (expertise, supplies, specialized equipment, etc.). In this regard, do you know the public health and emergency medical representatives in surrounding counties, regions, and at your State Health Department? Do you know your Regional Public Health Service emergency response coordinator? How involved are these individuals in your emergency planning and preparedness activities? Are emergency response plans shared among other agencies at the local, State, and Federal level?

The problems in the health and medical arena are predictable. The training, planning tools and technology are available to develop a coordinated, multi-state response to a damaging earthquake. The challenge is to capitalize on the lessons from recent disasters, and to develop a true capability to respond to a damaging New Madrid earthquake.

Temporary ER Operation from parking lot at Northridge Hospital.

BUILDING DAMAGE ASSESSMENT

Bill Wamsley, Director of Code Enforcement for the Tennessee Department of Commerce and Insurance, spent five days in the Northridge area as a member of a multi-disciplinary team from Tennessee. Bill's focus was building inspection; thanks to his counterparts in California, he was able to participate in the building inspection process. His report was used as the basis for the following section.

The severe and widespread damage from the Northridge earthquake was caused by extremely strong ground motion, among the strongest ground accelerations ever recorded. The strong ground motion, coupled with the location of the epicenter in the densely populated San Fernando Valley, made this the second most destructive earthquake of this century (after the 1906 San Francisco earthquake).

The magnitude 6.6 earthquake caused extensive damage to concrete tilt-up (light industrial), wood-frame, concrete-block, and older concrete-frame structures typically built in the 1970s and earlier. Most newer structures and large high-rise buildings had lighter damages. Shopping malls, modern precast parking structures, and residential apartment buildings were the most vulnerable, and sustained the heaviest damages.

Within hours of the earthquake, building inspection teams were assembled. In all, approximately 1200 inspectors were drawn from a number of organizations, including: American Construction Inspection Association, the Structural Engineers Association of California, the American Society of Civil Engineers, the American Institute of Architects, the U.S. Army Corp of Engineers, the L.A. Department of Building and Safety, and the L.A. Department of Public Works.

The inspection teams were divided into two categories—residential and commercial. The first task was to undertake rapid evaluations of areas and neighborhoods to determine the nature and extent of damage, a first step in developing a detailed building by building inspection strategy.

The Applied Technology Council (ATC) methodology for building damage assessment (ATC-20—*Procedure for Post-Earthquake Safety Evaluation of Buildings*) was used. These technical guidelines, which have been adopted by the CUSEC states and other jurisdictions, provide detailed criteria for building evaluation of different structural types, the assessment of geotechnical hazards, nonstructural hazards, and secondary hazards, such as fires, gas explosions, spills, and releases of toxic materials.

Two types of inspections were conducted. **Rapid evaluations** were undertaken to determine the structure's condition with respect to safety of occupants and the public. The buildings were posted with three safety categories: Inspected, Limited Entry, and Unsafe. These inspections took the California teams approximately 30 minutes per structure. **Detailed evaluations**, lasting 4-5 hours each, were conducted by teams of trained engineers for buildings that are posted Limited Entry (buildings of doubtful safety).

The building inspection operation was not without glitches. There were delays in mobilizing inspectors. There were problems in finding housing accommodations for inspectors. Supplies ran short, including food. There were coordination and communications problems, resulting in duplication of effort.

Yet, on balance, the inspection teams functioned in a *cohesive and professional manner;* over 30,000 buildings were surveyed (as of January 30), with 1,400 being "red tagged." The success of the operation can be attributed to a number of factors: 1) California has a trained, experienced pool of building inspectors to draw from in a disaster; 2) the public is sensitized to the need for building inspections, the significance of the placard system; 3) a system is in place that governs the inspection process; this system has undergone refinement through a series of earthquakes during the past decade; and 4) the area that was impacted —three counties—was relatively small (as opposed to an impact area of seven or more states in the New Madrid region).

Supplies for Inspection Teams

Area maps	Hard hats
2-way radios	Jump bags
Identification cards	Orange vests
Flashlight	Bottled water
Steel toed boots	"Meals Ready to Eat" (MREs)
Heating devices	Cellular telephones (donated)
"DO NOT CROSS" tape	Solar radios AM/FM
Supply of placards	Jump suits (well identified)
Cameras (donated)	

Standardized Placarding System.

Building Damage Assessment: Implications for the Central U.S.

Rapid building assessment in the Central U.S. will be influenced by at least four interrelated factors: 1) the concentrations of unreinforced masonry (URM) structures in urban centers; 2) the potential for widespread damages - over a multi-state area; 3) a shortage of trained inspectors for rapid and detailed surveys; and 4) the public's lack of exposure to the role of building inspections in protecting public safety.

Against this backdrop, there are several initiatives that the CUSEC states can take to develop a *comprehensive building damage assessment capability* that is closely coordinated with other emergency functions (e.g. mass care).

1. **Pre-disaster vulnerability surveys.** Tools are available that will allow local jurisdictions to undertake *pre-disaster* surveys of neighborhoods, and perform survivability studies of critical facilities and other large public and private buildings. The Applied Technology Council has developed a predisaster survey methodology (ATC-21) that has been adopted by several communities in the Central U.S. Predisaster vulnerability surveys can provide State and local planners with an estimate of the number and types of buildings that are likely to sustain moderate to heavy damages. This information is essential to planning for building inspections (e.g. number of inspectors), and short-term recovery.
2. **Adoption of ATC-20 guidelines for post-disaster safety assessment.** CUSEC states—and local jurisdictions —need to adopt the ATC-20 guidelines—or other standard procedures and criteria—to govern the inspection of damaged buildings following a disaster. Most importantly, it is critical that states and their localities conduct the necessary training to ensure that sufficient numbers of qualified volunteers and professional engineers are available to carry out the post-disaster inspections in a systematic way.
   The training should reflect the realities of post-disaster response, and prepare the inspectors for a variety of contingencies: aftershocks; the presence of hazardous materials and other "secondary hazards;" and the length of time that it may take to conduct the surveys.
3. **Development of a "strike force" approach to mobilizing inspectors.** Priority needs to be given to identifying, contacting, equipping, training, and mobilizing the qualified building inspection personnel in the first hours following a major disaster. *This requires careful planning and training, before the disaster.* For example, the urban search and rescue program (Emergency Support Function #9) has succeeded largely because it is standardized; incorporates rigorous training; and is exercised.

4. **Close coordination among states in developing public relations programs to support inspections programs.** A building inspection program can have explosive consequences if the public is not educated and sensitized on the need for inspections, and the overriding concern for public safety. Problems will be compounded following an earthquake because of the physical, psychological, and emotional conditions—and needs—of disaster victims. These issues need to be addressed through training and orientation programs.

To summarize, post-disaster building damage assessment will be one of the most challenging functions that will confront State and local officials following an earthquake. To put it another way, there are few emergency functions that are as critical, and pivotal, as building damage assessment. Other functions, such as mass care and business resumptions - are directly tied to building safety.

CUSEC can play a significant coordinating role in predisaster planning and post-disaster building damage assessments. A first step may be to develop a region-wide data base of qualified, trained inspectors. There will undoubtedly be a shortage of inspectors; a mutual aid agreement would facilitate the deployment of inspectors across state boundaries. Other components of building damage assessment need to be coordinated, including: adoption of procedures, criteria, and terminology; public relations efforts; development of rapid deployment capabilities; and coordination of tracking systems to monitor inspections and provide feedback into overall damage assessment process.

> *“To put it another way, there are few emergency functions that are as critical, and pivotal, as building damage assessment.”*

MASS CARE AND HOUSING RECOVERY

Elaine Clyburn, American Red Cross liaison to CUSEC, contributed to this section of the CUSEC Journal.

The Northridge earthquake once again drew the nation’s attention to the massive, often complex problems associated with an urban disaster, specifically the challenges of sheltering, feeding and caring for disaster victims. A pattern is developing: within hours of a major urban disaster, victims turn to government and voluntary agencies for assistance in meeting basic human needs. The combination of political pressures and media attention, in turn, can serve to undermine the *system* in place for delivering mass care, and other services.

By the end of the first week following the earthquake, 6,000 people were living in Red Cross Shelters with 20,000 more camped in parks or around their homes. The most pressing—and initially contentious—issue during the first week was whether to establish tent cities in the parks, and what level of services to provide. Local officials were sensitive to the problems with tents during Hurricane Andrew (e.g. congestion, the potential for a “short-term solution” turning into a long-term proposition). These problems were compounded by the fact that many of the disaster victims were of Latin American origin, which presented a series of challenges for service providers: language, cultural and legal (presence of undocumented aliens).

In reviewing the Red Cross experience in the Northridge earthquake, one of the positive features of the relief operation was mental health counseling. Use of mental health professionals for crisis counseling for emergency workers and victims has become an integral part of the Red Cross disaster response, in partnership with existing community organizations. One such partnership is with the American Psychological Association Practice Directorate, which activated its California members. Counseling services were provided to victims at more than forty shelters. Special disaster mental health training sessions were conducted by the Red Cross to augment the professional staff.

Logistics continues to be a major challenge for mass care providers. The Red Cross is refining the concept of “push packages,” materials ready to be deployed to the affected area in anticipation of need. Lists of high demand non-perishables are maintained; this information is shared with potential donors.

Other problems in mass care delivery during the Northridge earthquake included: damage assessment; information management and reporting requirements; coping with aftershocks;

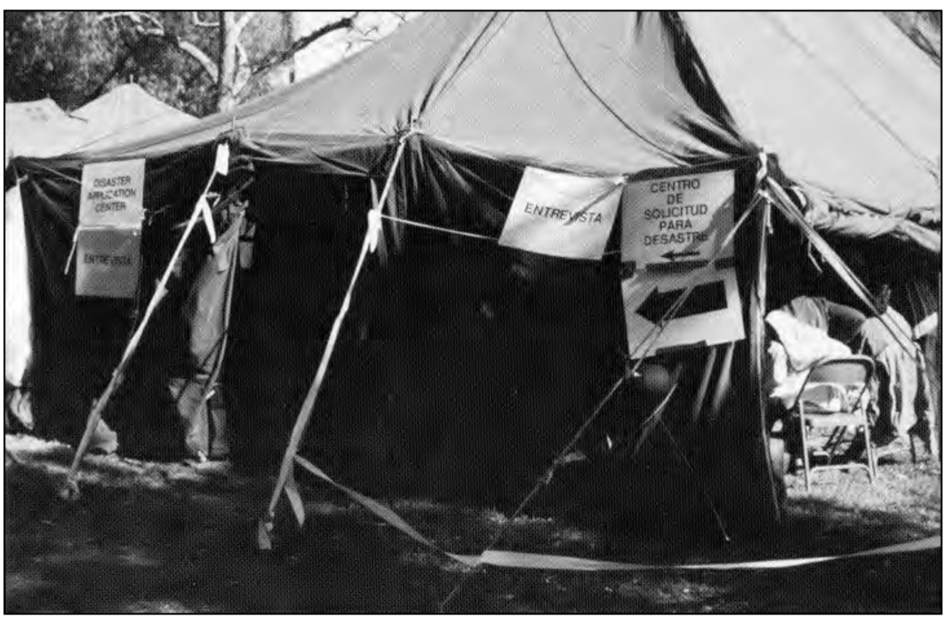


Photo courtesy Memphis/Shelby County Emergency Management Agency

Tent City Disaster Assistance.

and coordination with other aspects of mass care—building inspections, mental health counselors, advocacy groups, and community groups who were responsible for finding alternative housing for the victims.

Mass Care and Housing Recovery: Challenges for the Central U.S.

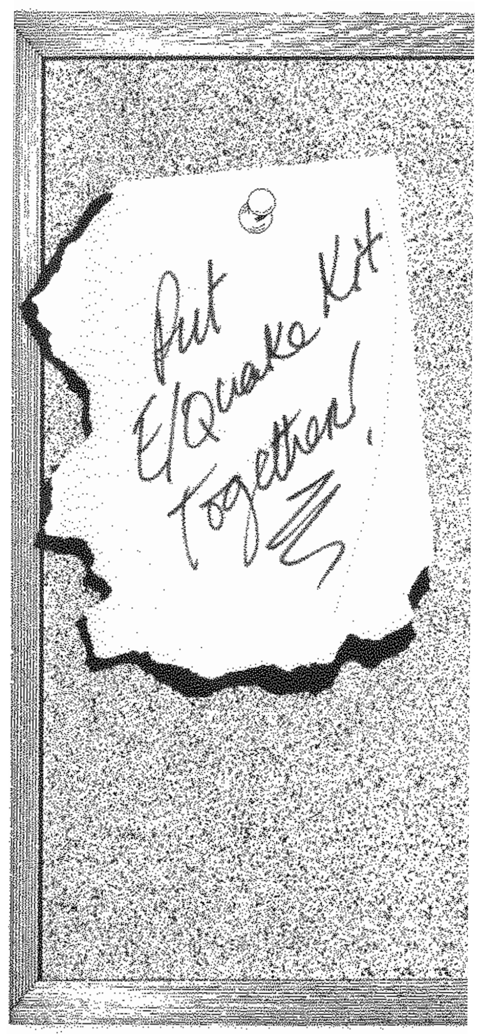
Several factors will contribute to a mass care problem in the Central U.S. following a New Madrid earthquake: 1) **Vulnerability of housing stock and lifelines**—Memphis, St. Louis and other population centers are dominated by unreinforced masonry buildings; a substantial proportion of the inner city population are apartment dwellers. Damages to water, sewage and power supply will disrupt provision of mass care. 2) **Significant levels of poverty and homelessness**—these pre-disaster problems will be compounded in a disaster; furthermore, the agencies that provide daily social services may themselves be victims. 3) **Vulnerability of shelters**—schools, churches, auditoriums, and other buildings that serve as shelters are also among the most vulnerable to earthquakes. 4) **Organizational fragmentation**—there are a number of government and non-government organizations that provide mass care and housing recovery programs and services; fragmentation of effort has hampered delivery of services in past disasters.

Improving Mass Care and Housing Recovery: Some Recommendations

Recent urban disasters - including the Loma Prieta earthquake, Hurricane Andrew, and the Northridge earthquake - have underscored the complex, yet predictable problems associated with mass care and housing recovery. The Central U.S. needs a comprehensive, focused strategy to address these issues. The key elements of such a strategy are outlined below.

1. **A comprehensive assessment of housing vulnerability and post-disaster "people needs."** There is no readily available data on *basic human needs*— shelter, feeding, medical treatment, counseling, financial assistance, etc.—following a disaster. The product of this assessment should be: 1) housing vulnerability data—including multi-family housing; low-income residency hotels, and other residences; and 2) "people vulnerability" data and profiles—including income distribution, ownership patterns, insurance availability, and other indicators of "coping abilities" after a major disaster.
2. **A "model mass care program."** This initiative would redefine the "total package" of mass care services - feeding, sheltering, medical, counseling, financial, social, etc. - and how these services would be delivered. Elements would include: disaster intelligence; logistics; pre-disaster analysis of siting and design options for emergency shelters; public information; building inspection criteria and procedures; and pre-disaster analysis of available housing resources.
3. **A pre-disaster housing recovery program and implementation strategy.** Housing recovery planning is complex, involving a variety of agencies. The first step is to identify the agencies that have a role and responsibility in housing policies and programs, and develop a "seamless" approach to addressing the housing needs of potentially tens of thousands of displaced citizens.
4. **A program to provide seismically safe low rent housing for urban poor.** The chronic shortage of housing for low-income renters is a major issue in housing recovery. A solution to this fundamental problem may require Congressional intervention.
5. **Clearly stated policies for dealing with chronically homeless.** As the pre-disaster populations of homeless continue to increase, so does the problem of addressing their needs following a disaster. Policies and programs need to reflect the conflicting demands that will be made on temporary shelter providers.
6. Consideration of two basic options following a major earthquake: 1) **temporary relocation** of victims away from disaster area; and 2) bringing in **pre-fabricated shelters** to be sited near the disaster. Each strategy has advantages, and drawbacks. Generally speaking, urban residents have strong ties to their neighborhoods, and will resist moving. If relocation is necessary, it should be a public process, and the nature of the plans should be widely disseminated.

In summary, mass care and housing issues will dominate headlines in local newspapers following a major earthquake or other disaster. The housing shortages in our urban centers will only be exacerbated by a disaster. Yet, the problems can be anticipated; policies can be formulated; and programs can be developed and implemented to at least minimize the intense pressures that will confront officials at all levels of government.



THE ROLE OF EPIDEMIOLOGY IN SEISMIC VULNERABILITY REDUCTION

AN INTERDISCIPLINARY APPROACH

This article was written by **Dr. Eric Noji**, Chief, Disaster Assessment and Epidemiology Section, Centers for Disease Control and Prevention. It originally appeared in *Stop Disasters,* the official United Nations publication for the International Decade for Natural Disaster Reduction.

INTRODUCTION

During the past 20 years, earthquakes have caused more than a million deaths worldwide. A review of the disaster medical literature reveals a general consensus among researchers and disaster planners alike on the inadequacy of preparedness programs in communities at risk of disasters such as earthquakes. Better epidemiologic knowledge of the causes of death and types of injuries and illness caused by earthquakes is clearly essential to determine appropriate relief supplies, equipment, and personnel needed to effectively prevent and respond to such situations.

Seismic Vulnerability Reduction

To date most research on seismic vulnerability reduction has focused on the geosciences and engineering aspects of structures and their resistance to damage. This research was conducted through extensive analyses of previous earthquakes and has led to major advances in our understanding of the causes of earthquakes and in the ability to design safer buildings to withstand earthquakes. However, many buildings throughout the world have not been built to such exact standards and will continue to present a considerable risk to human life. More recent work is looking at ways to make such existing buildings more resistant to damage. However, comparatively little research has been conducted that actually looks at the human vulnerability to seismic events, i.e., the injuries and deaths that result from the earthquakes.

Injury Epidemiology

Injury epidemiology and prevention has developed a framework for analyzing injury-producing events based on dividing the event into phases, each of which may suggest very different strategies for prevention. These phases are labelled pre-event, event or impact, and post event. Each phase represents a different segment of time in which injuries can be prevented. For natural disasters, the greatest potential for prevention exists in the pre-event phase. In the pre-event phase, we can either prevent the disaster from occurring or ensure people do not experience it. However methods to predict an earthquake are generally unreliable, and needless to say, there is no way that is currently known to prevent its occurrence. However, much can be done in the pre-event phase to identify populations most at risk to seismic events and to improve a vulnerable community's preparedness for earthquakes. For example, data collected by epidemiologists on potential human impacts can be used in community vulnerability analyses. Usually the province of physical scientists, a vulnerability analysis involves the collection and assessment of information on communities at risk from hazards, including data on the capability of structures (e.g. residential and office buildings) and lifeline systems (e.g. critical public services such as water, electricity and gas utilities, and health facilities) to withstand past disasters. Results of epidemiological-based vulnerability studies that identify at risk populations can assists in the design of appropriate warning systems and provide guidelines for preparedness training.

The event phase relies on preventing or reducing injuries during the actual period of the earthquake's impact. This phase is the focus of much attention by architects and engineers and much can be done through better engineering of structures to prevent buildings from collapsing. Although a building may still fail in an earthquake, injuries may still be prevented or reduced if those parts of the building likely to be occupied by large numbers of persons can be designed in such a way that there is less risk of injury to the occupants. For example, one recommendation may be for structural engineers to design safe emergency exits, especially in taller buildings. The post-event phase deals with reducing the consequences of the injuries through better search and rescue methods and more effective emergency medical care. In the post-impact phase, data is collected by epidemiologists to evaluate the effectiveness of health intervention programs and to serve as the basis for planning strategies to reduce future earthquake related morbidity and mortality.

Research Priorities

Determination of Risk Factors for Deaths and Injuries

Only by understanding how and where people are actually injured in earthquakes can we recommend safer building designs and appropriate occupant behaviors to maximize survivability and provide valuable information to direct search and rescue efforts for potential survivors.

Earthquake Injury Epidemiology

Analysis of the health and medical effects of earthquakes, as well as of the rescue and medical response, has strong implications for improving earthquake preparedness and response in seismically vulnerable parts of the world. Basic knowledge of the types of injuries caused by earthquakes as well as the severity of such injuries is also essential to determine appropriate relief supplies, hospital equipment, and emergency medical personnel needed in similar situations.

Much work has been done over the past several years on the development of methods to estimate expected physical losses within the "built environment" as a basis for risk management, life saving preparedness planning, and the development of mitigation strategies. While geological hazard maps that outline earthquake prone areas of many parts of the world are available, they do not relate to risk of death or injury. A model predictive of casualties could possibly be developed based on a combination of factors such as risk of earthquake of defined magnitude, the particular building construction of the area at risk, and the population likely to be affected. Ultimately, it should be possible to incorporate analyses of injury patterns in several past earthquakes into a model of casualty estimation that will allow us to predict the percentage of deaths and range of injury severity sustained for principal building types and occupancies. Such projected human impact effects (e.g. casualties) could then be incorporated into earthquake hazard maps and risk assessments/management strategies.

Results of earthquake casualty studies will provide a basis for improving search and rescue efforts, planning emergency health care, developing reliable methodologies for estimating deaths and injuries before the event, and improving design and construction methods to reduce casualties from future earthquakes. The integration of casualty and medical need predictions into earthquake loss estimation methodologies, community earthquake vulnerability analyses and rapid earthquake damage forecasts is a critical knowledge gap and has been identified by the IDNDR Scientific and Technical Committee as a priority for the 1990's.

Conclusion

In summary, epidemiologic analysis of earthquake-related injury patterns will help guide building construction practices in earthquake prone regions, suggest occupant actions to prevent death and injury, and provide insights that will lead to the development of better earthquake preparedness plans tailored to the characteristics of specific building types. Out of such research should come greater insight and advances which should further the overall goal of the IDNDR in minimizing the impact of natural disasters on human populations.

Vulnerability
Degree of loss (e.g. from 0 percent to 100 percent) resulting from a potentially damaging phenomenon.

Magnitude
Devised by C.F. Richter in 1935, an index of the seismic energy released by an earthquake (as contrasted to intensity that describes its effects at a particular place), expressed in terms of the motion that would be measured by a specific type of seismograph located 100 km from the epicenter of an earthquake. Nowadays several "magnitude scales" are in use. They are based on amplitudes of different types of seismic waves, on signal duration or on the seismic moment.

MICROZONATION: A PLANNER'S PERSPECTIVE

The Association of CUSEC State Geologists—with support from the USGS and CUSEC—is undertaking a project to develop a uniform methodology for seismic zonation in the Central U.S. The objective is to apply this methodology to the development of a series of maps that can be used by local and regional planners to guide development decisions. The concept of microzonation, and its usefulness for local planners, has been the subject of research conducted by **Robert Olshansky**, of the University of Illinois at Urbana-Champaign. The following article is an abbreviated version of an article, "Microzonation: A Planners Perspective," that originally appeared in the Proceedings of the Fourth International Conference on Seismic Zonation (August 25-29, 1991, Stanford University, Stanford, CA).

INTRODUCTION

The purpose of this paper is to explore the meaning of microzonation from the point of view of local planners in the United States. It is based on a research project designed to evaluate the feasibility of seismic microzonation in land use planning. The purpose of the project has been to determine under what conditions microzonation would be most useful. The work has consisted of:

1. Review of current technical capabilities in microzoning seismic hazards, including literature review and meeting of an expert panel, and conversations with other experts in the field;
2. Interviews with planners in 16 California cities and counties regarding current and potential future uses of geographically-differentiated seismic hazard information;
3. Use of a geographic information system to analyze a single study area, to determine what damage models and variables would be most useful for delineating microzones, considering the requirements of local governments.

This article focuses on the first two phases of this research; that is, the link between our technical capabilities and local institutional capabilities.

What is Seismic Microzonation?

One of the most useful definitions is offered by Dr. Joanne Nigg in a paper delivered at the Third International Microzonation Conference: *"the purpose of microzonation is to identify hazardous, small scale areas in order for earthquake mitigation planning and policy to be differentially applied to those areas exposed to specific types and degrees of earthquake threat."* Yet this definition still leaves some questions. How big is a seismic microzone? Do microzones need to have distinct boundaries? Is a probabilistic risk assessment map a microzonation map?

Seismic zonation in general is the differentiation of spatial hazard data. Its purpose is to guide land development policy or design of structures. Typical proposed functions are to: 1) Trigger a set of building design parameters, either by mandated codes or by standards of engineering practice; 2) Regulate type or density of use; 3) Prohibit construction in high hazard zones; or 4) Analyze effects, for emergency preparedness planning. In common usage, seismic zonation implies the traditional <u>macrozones</u> that have been used as a basis for regional differentiation of modeling building codes. In contrast, <u>microzonation</u> suggests spatial differentiation that is of some use to local government, where most land use planning authority in the United States rests. Our definition focuses on this end use:

Microzonation is the identification of spatially differentiated zones of relative seismic hazard, at a scale that is meaningful to local jurisdictions.

This condensed definition implies that microzonation can apply to a variety of seismic policies. Given this definition, microzonation is ultimately more a policy concept than a technical concept. It is driven by policy needs first and by technical capability to meet those policy needs second.

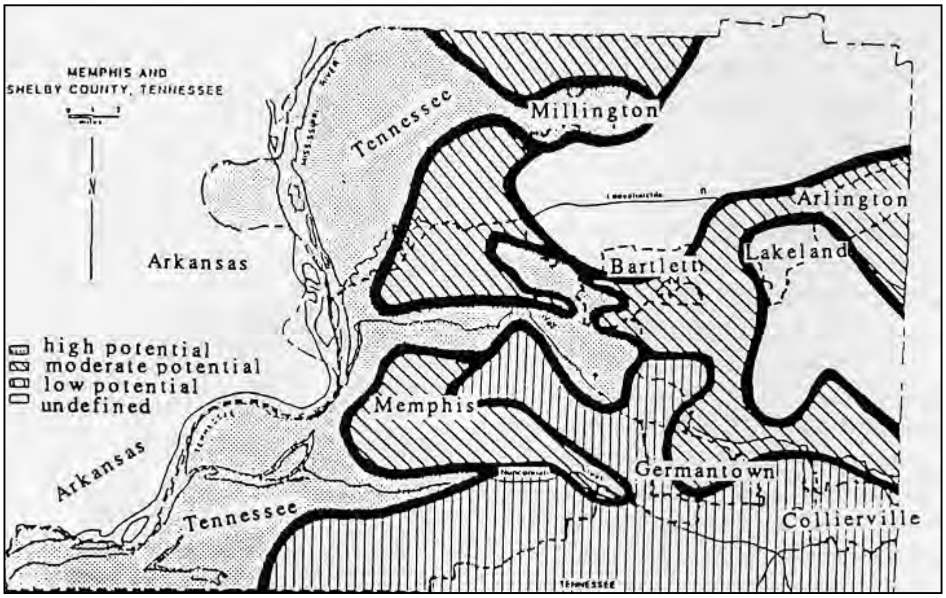
Technical Development of Microzonation

Current scientific and engineering capabilities in seismic zonation vary in their ability to meet the needs of local planners. A review of literature concludes that spatial seismic data is most reliable in the prediction of zones of ground <u>failure</u> rather than differential ground <u>shaking</u> hazard. This is partly because groundshaking is such a complex phenomenon, and partly because, in many urbanized areas, there are too many potential sources of seismic shaking. There is neither adequate knowledge nor expert agreement to be able to create maps of relative groundshaking hazard at a scale that would be useful to local officials.

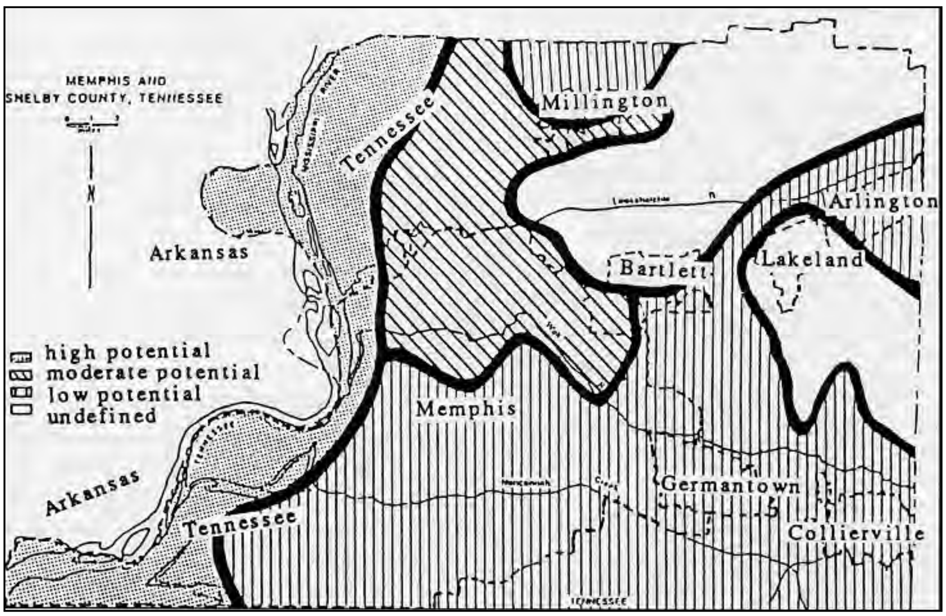
Over the past nine years, the term "microzonation" has come back into vogue among seismic professionals. This is primarily a reflection of two earthquakes during this time period: Mexico City and Loma Prieta. Based on an examination of these two earthquakes, we conclude that the technically most reliable microzones are those that delineate *potential* for surface fault rupture, liquefaction, landsliding, and tsunami runup.

Spatial Seismic Hazard Data in Local Development Decisions

This study reviewed previous literature on use of seismic information and examined the use of <u>spatial</u> hazard information in the "seismic safety element" of local California governments required general plans. Through the analysis of 16 seismic safety elements and in-depth interviews with local officials, the study examined the type, quality, and resolution of spatial seismic hazard information available to local jurisdictions and how that information has influenced land use planning at the local level.



Liquefaction Potential Map of Memphis and Shelby County (M = 7.5 Southern NMSZ Earthquake)



Liquefaction Potential Map of Memphis and Shelby County (M = 6.5 Southern NMSZ Earthquake)

Taken from the study—"Liquefaction Potential of the Memphis Area"—Memphis State University–Center for Earthquake Research and Information.

<u>Use of Seismic Hazard Data—Our Findings Confirm Previous Studies</u>

Several recent studies have focused on the implementation of policies in seismic safety elements in California. Some of the major findings of these studies relevant to this research conclude:

1. Very few jurisdictions have fully implemented even some of their seismic land use objectives.
2. Local governments have favored regulations that pass the costs on to developers on a project-by-project basis, rather than general funds to implement seismic safety land use policies.
3. The major effect of the seismic safety element has been to heighten the awareness of officials. It has given local governments a broad mandate to practice geology, and sometimes has prompted the hiring of professional geologists.
4. In general, implementation of seismic safety land use policies do not stand in the way of efforts to develop land. Most local officials rely on building design (UBC) or site-specific engineering to mitigate seismic hazards.
5. Seismic safety, in general, is not high on the priority list of local officials, in part due to the lack of political pressure from the public.

What Should Microzonation Look Like?

Technical Feasibility of Microzonation

For microzonation to have any meaning at all in guiding seismic mitigation policies, it must meet certain criteria:

1. <u>The hazard phenomenon has some intrinsic geographic variation that is significant, independent of earthquake source parameters</u> such as epicenter location and frequency content. For example, zones that may focus on ground motion from one seismic source may not do so for another, equally plausible, source. The hazard in one zone must be clearly worse, or of a different type, than the hazard in another. In addition, the zones must be based upon characteristics that are economically feasible to determine (microzonation that depends upon a 100-foot grid of boreholes is not very feasible).
2. <u>Relative hazard can be differentiated within the scale of a municipality.</u> This means that, to be a meaningful concept, there should be more than one zone in any jurisdiction. It also means that a line drawn on a relatively large-scale map must be reasonable and rationally supported by scientific data.
3. <u>Each zone implies a list of feasible policy responses.</u> A policy response must exist, or the map is not worth producing.

Our technical review and expert panel concluded that the technically most reliable microzones are those that delineate potential for surface fault ruptures, liquefaction, landsliding, or tsunami runup.

Policy Feasibility

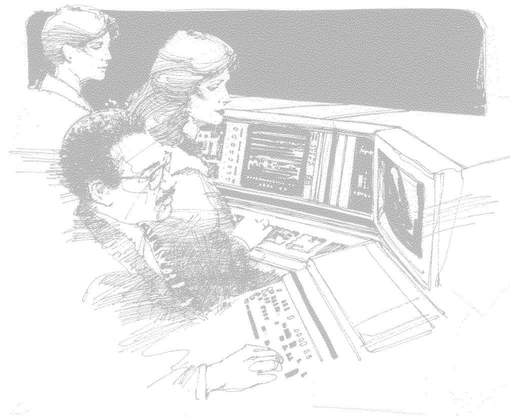
It is doubtful that seismic microzonation would ever be used to prohibit or severely restrict growth and development in hazardous areas, unless such restrictions also meet other land use goals. There are too many other concerns in local land use planning and development, and seismic hazard will never be the most dominant concern. However, there are ways in which microzonation can successfully help to reduce seismic hazards.

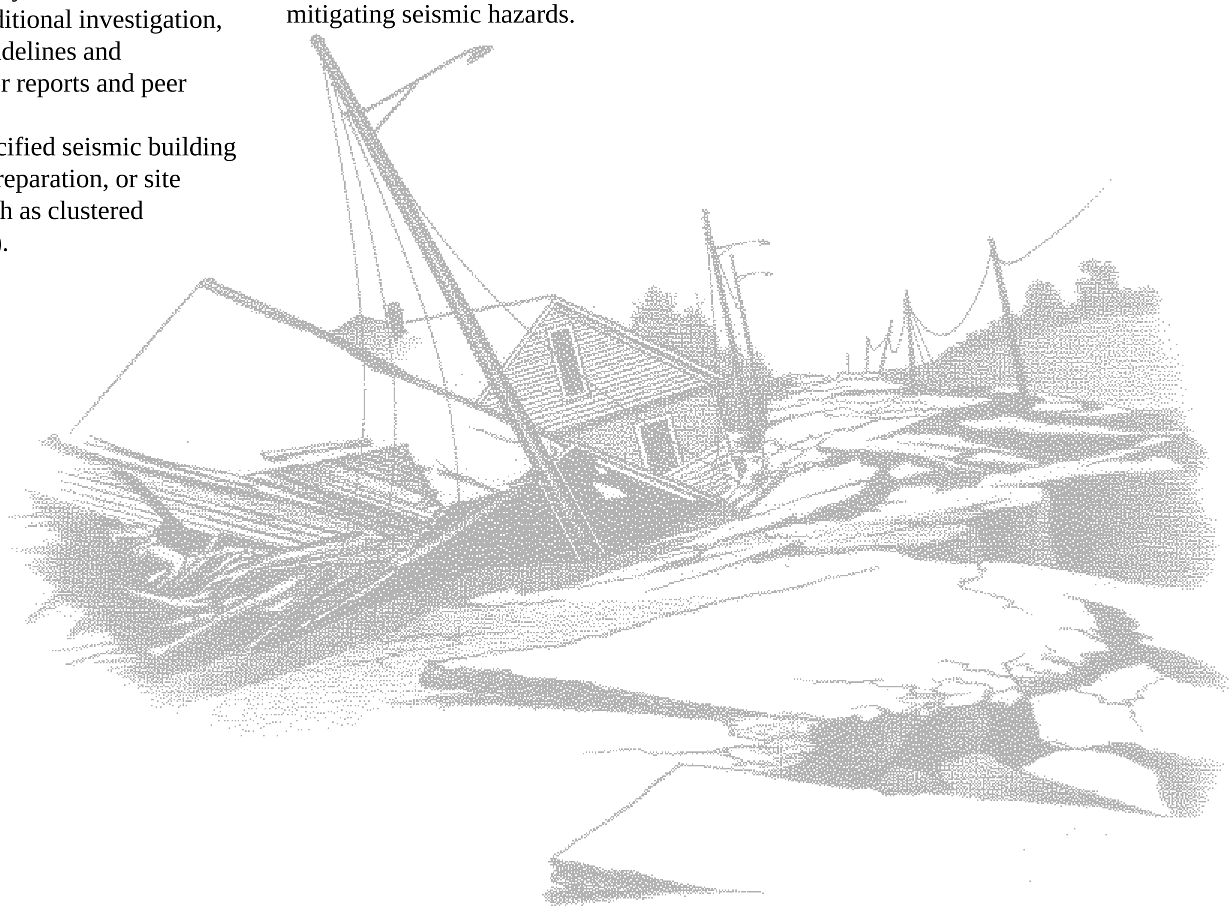
A successful microzonation program would include the following elements:

1. Emphasis on ground failure phenomena.
2. Zones distinguishable at municipality or metropolitan level.
3. Program management and map production at State or Federal level, which is credible and includes a wide range of experts.
4. Zones that identify areas
   a. requiring additional investigation, with clear guidelines and procedures for reports and peer review.
   b. requiring specified seismic building design, site preparation, or site planning (such as clustered development).
5. Zones used as input to damage-prediction models, to
   a. analyze land use alternatives.
   b. support emergency preparedness planning.
   c. support retrofit programs.

Such regulations could affect land use by resulting in lower densities or increased costs of buildings in high hazard areas (thereby internalizing the hazard cost into the market).

In conclusion, what do we mean by microzonation? If we mean strict land use controls, the concept is not politically or socially feasible. If we mean detailed maps of ground shaking intensity, it is not technically possible in most locations. If we mean generalized identification of areas of potential ground failure, it is technically possible. If we mean using these maps as input to requirements for special studies, seismic load factors in building codes, or general information to assist land use planning, then it is politically feasible. Finally, a caution: we should refrain from using the term as if its implications are self-evident and as if it will solve all our problems with respect to mitigating seismic hazards.





There is a gap between what is known about earthquakes and their effects, and what is being applied. One of CUSEC's goals is to improve the application of earthquake hazards research and information in the Central United States, and in the process begin to narrow this gap. This section of the CUSEC Journal is devoted to Research and Information Transfer. The first part provides a synopsis of current research projects. The second part is a review of useful publications.

CURRENT RESEARCH

Planning for Post-disaster Recovery and Redevelopment. *Federal Emergency Management Agency. Principal Contact: Bill Klein, Research Manager, American Planning Association (APA).*

One of the shortfalls in our current approach to developing and sustaining mitigation programs is that *Federal and State funding to support these initiatives is not available until after the disaster.* This is not the optimum time to engage in long-term planning and constituency building. In the aftermath of a major disaster, political, social and economic pressures can be intense. Emphasis is often placed on restoring the community to *normal pre-disaster conditions*. Opportunities for creative planning may be lost.

The premise of this project - a collaborative effort between FEMA and APA - is that mitigation policies and programs should be identified *prior* to a disaster, and closely integrated with the community's comprehensive planning process.

The product of this initiative will be a **Planners Advisory Service (PAS) Report** which will provide guidance to planners regarding the preparation of post-disaster reconstruction and redevelopment plans for their communities.

Estimation of Economic Losses Associated with Lifeline Disruption. *National Center for Earthquake Engineering Research. Principal Investigator: Ronald Eguchi, EQE International.*

The pace of economic recovery following an earthquake on the New Madrid fault will be greatly influenced by the availability of electric power and other critical lifelines.

The objective of this research project is to develop a methodology for assessing the economic impact of lifeline disruption during earthquakes. The methodology will be applied to the Memphis Light, Gas and Water Company (MLGW) to determine the direct and indirect economic losses resulting from disruption of electric power service. Emphasis will be placed on integrating the findings of this study with findings from previous studies of lifeline services (notably water and natural gas) to provide a composite picture of the economic consequences of lifeline disruption following an earthquake in the New Madrid Seismic Region.

This project is an important component in NCEER's ongoing research to better understand the consequences of lifeline disruption. Useful products include an electric power usage model and a restoration model for Memphis area businesses.

Estimating Societal Impacts of Infrastructure Damage Through GIS. *National Center for Earthquake Engineering Research. Principal Investigator: Steven French, Georgia Institute of Technology.*

Several attempts have been made to use geographic information systems (GIS) to model damage to urban infrastructure systems. This type of modeling typically produces an estimate of the number of breaks in the infrastructure system or an estimate of economic damage. This project, however, attempts to develop a method for estimating the *number and characteristics of the population that would be impacted by infrastructure damage at various locations.*

This study has several potential uses when adapted to GIS technology. Emergency response planners, for example, can combine demographic information with data on system damage to produce reliable estimates on the size, age, and other characteristics of the population affected by a given earthquake.

Assessment of the State of the Art Earthquake Loss Estimation Methodologies. Task Report 1. *Project conducted by the National Institute of Building Sciences (NIBS) under a cooperative agreement with the Federal Emergency Management Agency.*

This report documents an assessment of the state of the art of earthquake loss estimation methodologies as part of a three-year project to develop a nationally applicable standardized methodology for estimating potential earthquake losses on a regional basis.

The findings suggest that earthquake loss estimation, as applied to regional studies, has not advanced as rapidly as available technology (techniques have not changed much in the past 15-20 years). Several research gaps were identified, including: 1) There is a need to gather local/regional information on seismic source characteristics; 2) Focused research is needed to develop a standard classification system that is comprehensive (e.g. classifies all pertinent structures and systems), yet usable when there is only limited inventory information available; 3) Focused research is needed to develop credible loss of function relationships for emergency facilities; 4) A major research effort is needed to develop damage loss models for military/industrial facilities; 5) A major research effort is needed to develop a nonproprietary, fire following earthquakes model based on existing ignition, spread, and fire suppression components; 6) A major research effort is needed to develop a hazardous materials release model; and 7) Focused research is needed to refine and expand procedures for estimating casualties using new (worldwide) data on deaths/injuries, construction type, and degree of damage, in particular building collapse.

This study should represent a major contribution to earthquake hazards reduction field. The methodology will be adapted to advances in geographic information systems to enable increasing amounts of spatial data to be stored, analyzed and retrieved.

USEFUL PUBLICATIONS

Emergency Management Guide for Business and Industry. *Federal Emergency Management Agency. 1993. 76 pp. Limited copies available from the Central U.S. Earthquake Consortium.*

This guide, which was prepared by FEMA with assistance from the American Red Cross and a host of other organizations, provides step-by-step advice on how to create and maintain a comprehensive emergency management program. It can be used by manufacturers, corporate offices, retailers, utilities or any organization where a sizable number of people work or gather.

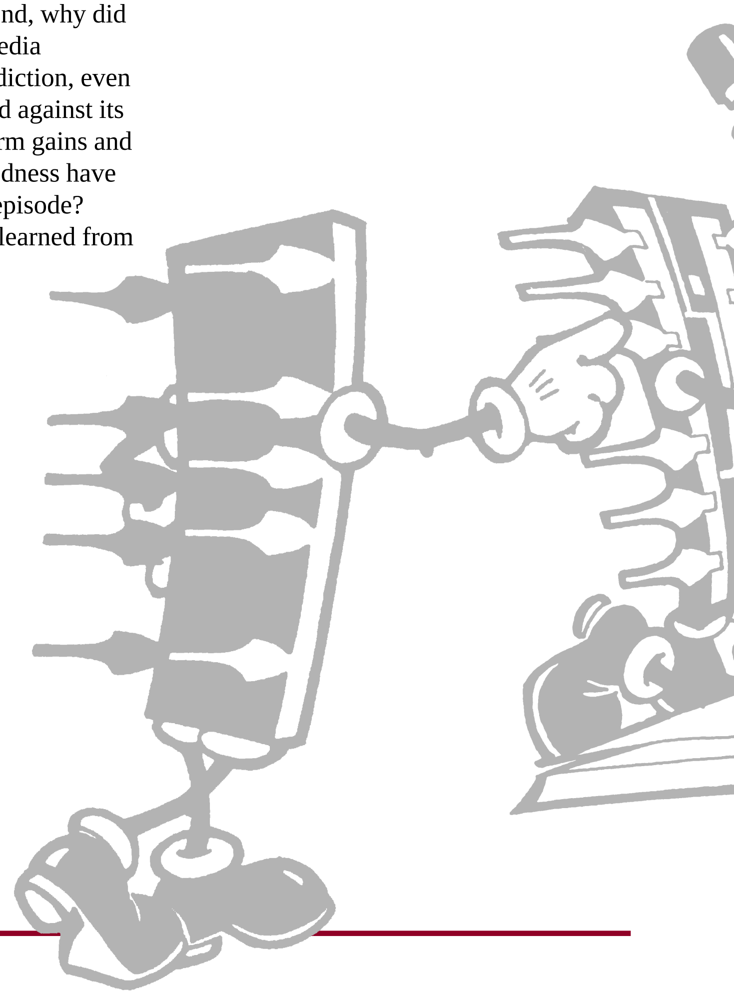
Subjects examined include: establishing a planning team; analyzing capabilities and hazards; conducting a vulnerability analysis; developing the plan; conducting training, exercises and drills; communications; life safety; property protection; community outreach; and recovery and restoration. The appendices contain additional information resources and hazard specific information for a wide range of users.

Responses to Iben Browning's Prediction of a 1990 New Madrid, Missouri, Earthquake. *William Spence, Robert B. Hermann, Arch C. Johnston, and Glen Reagor. U.S. Geological Survey Circular 1083. 1993. 248 pp. Available from USGS Map Distribution, Box 25286, Building 810, Federal Center, Denver, CO 80225.*

On December 3, 1990, residents of New Madrid, Missouri and the central Mississippi Valley region anxiously awaited the outcome of the prediction of a major earthquake by Iben Browning, an independent business consultant from New Mexico. This report documents how this prediction became credible to many members of the media, the emergency preparedness corps, and the general public. It relies on print sources, although major roles also were played by television and radio. The Browning episode draws attention to several fundamental questions which warrant further attention. First, if nearly all seismologists rejected Browning's prediction, why were they ineffective in publicly discrediting it? Second, why did print, television, and radio media intensify coverage of the prediction, even though most scientists warned against its validity? Third, what long-term gains and losses for earthquake preparedness have resulted from the Browning episode? Finally, what have scientists learned from this experience that will enable them to better cope with future predictions (whether valid or invalid) of catastrophic natural events? This report chronicles the developments of the Browning episode, and serves as a very useful record of the hype that surrounded this prediction.

A Framework for Action: Findings and Recommendations from CUSEC's 1993 Annual Meeting. *Central U.S. Earthquake Consortium. December, 1993. 53 pp. Limited copies available from CUSEC.*

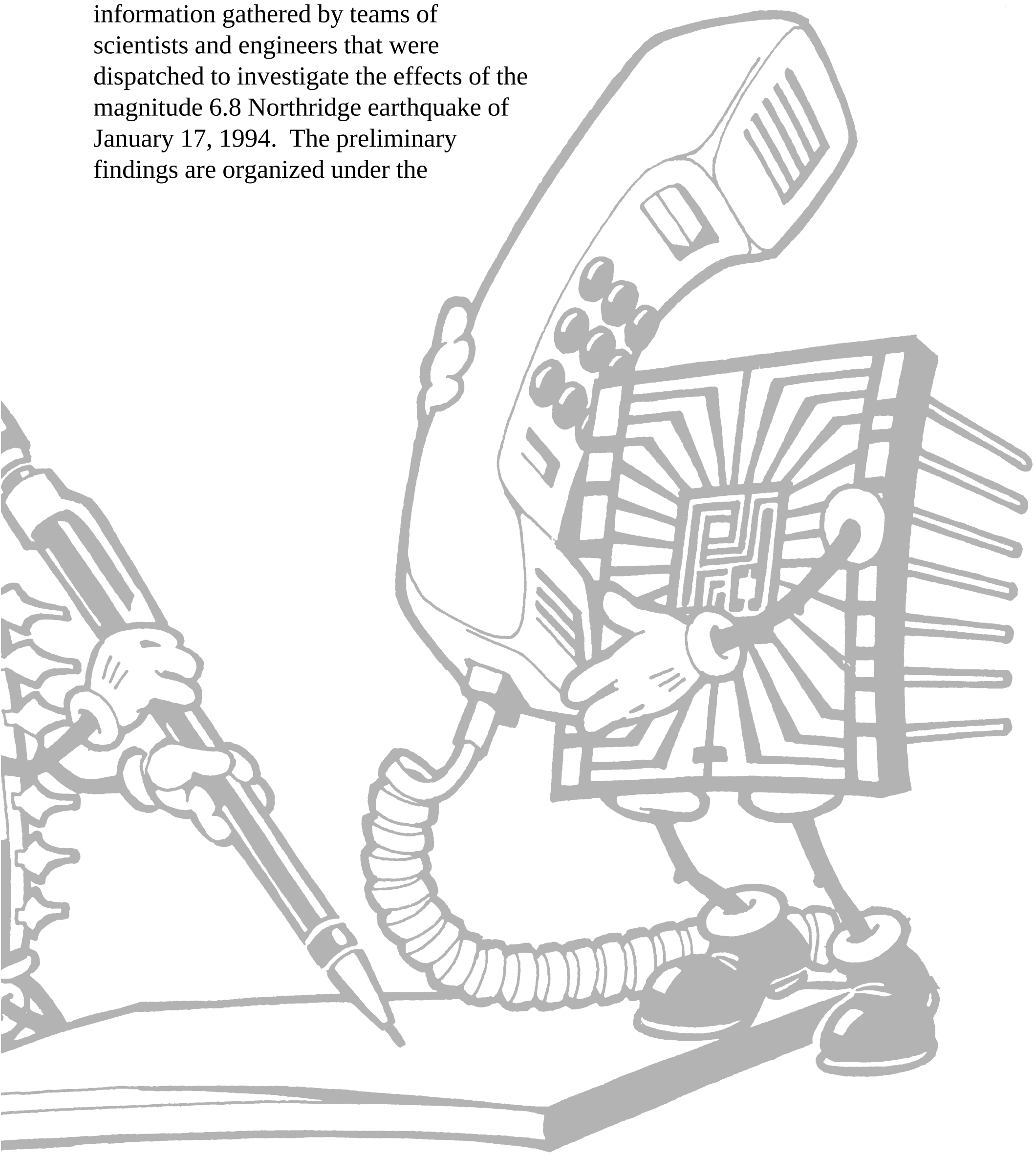
On December 15-17, 1993, CUSEC held its Annual Meeting at FEMA's Special Facility near Berryville, Virginia to address the major problems, issues - and opportunities - associated with multi-state response and recovery from a damaging earthquake on the New Madrid fault. Five key areas were examined: Disaster Intelligence; Health and Medical; Hazardous Materials; Energy Restoration; and Mass Care. This report contains the findings and recommendations of the three day meeting, which brought together a multi-disciplinary audience of experienced



emergency managers to examine the shortfalls in each of these functional areas, and to identify specific steps that can be taken, under the auspices of CUSEC, to *significantly enhance the level of multi-state preparedness and readiness*.

Northridge Earthquake, January 17, 1994: Preliminary Reconnaissance Report. *Earthquake Engineering Research Institute. March, 1994. 104 pp. Copies are available for $15.00 from EERI, 499 14th Street, Suite 320, Oakland, California 94612-1902. Telephone: (510) 451-0905.*

This preliminary report summarizes information gathered by teams of scientists and engineers that were dispatched to investigate the effects of the magnitude 6.8 Northridge earthquake of January 17, 1994. The preliminary findings are organized under the following headings: Earth Science; Geotechnical Observations; Architectural Background; Buildings; Nonstructural Components; Lifelines; Industry; Transportation; Social Impacts and Emergency Response; and Fire and Toxic Incidents. Numerous photographs and maps supplement this insightful overview of preliminary findings of the most damaging earthquake since the 1906 San Francisco earthquake.



CUSEC to Sponsor Natural Hazards Research Symposium

CUSEC will be conducting a Natural Hazards Research Symposium on May 31 (beginning at 2:00 pm) to June 2, 1994 (ending at noon) at the Galt House, Louisville, KY. The Symposium, which is supported by funding from the National Science Foundation, will bring together a broad audience of hazards researchers, emergency managers, urban planners, engineers, educators, city managers, sociologists, and others to examine the most recent research that addresses mitigation and public policy, and to explore methods and processes for improving the utilization of research findings.

Symposium topics include: *An Assessment of User Needs: National Earthquake Hazards Reduction Program; Applying Natural Hazards Research: Challenges and Opportunities in the Nineties; Constituency Building Opportunities; Effective Implementation of Mitigation Policies and Programs; the Role of Professional Associations in Promoting Successful Mitigation Strategies;* and *Towards a National Mitigation Strategy*.

The Symposium will also feature twelve research presentations that address a range of topics that are related to urban planning, mitigation, and the socioeconomic and public policy aspects of risk reduction.

In essence, this will be an exciting event. The Symposium will offer an opportunity to develop effective "working partnerships" with key practitioners—urban planners, economic and community development officials and others—who shape policy and development decisions.

For more information on this Symposium, including registration materials, please contact CUSEC. The registration fee is $50.00. Advance registration is recommended.

CONFERENCES AND TRAINING

EVENT	DATE	LOCATION
* Earthquake 101	April 27	St. Louis, MO
* Natural Hazards Research Symposium	May 31–June 2	Louisville, KY
* GIS in Business Conference and Exposition	June 5–8	San Francisco, CA
* EERI 5th Annual Conference	July 10–14	Chicago, IL
* FEMA EPIE Conference	July 11–15	Charleston, SC
* Natural Hazards Workshop	July 17–21	Boulder, CO
* Disaster Medicine 201	Aug. 4	Oxford, MS
* Electric Power Seminar	Aug. 8	Nashville, TN
* 4th U.S. Conference on Lifeline Engineering	Aug. 10–12, 1995	San Francisco, CA
* Urban Search & Rescue 101	Aug. 23	Grenada, MS
* 5th International Conference on Seismic Zonation	Oct. 17–19, 1995	Nice, France

For more information on training please contact CUSEC Headquarters or the Earthquake Program Manager with your State Emergency Management Agency.

The **Central United States Earthquake Consortium** is a not-for-profit corporation established as a partnership with the Federal government and the seven member states: Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri and Tennessee; and eight associate member states: Alabama, Georgia, Louisiana, South Carolina, North Carolina, Ohio, Oklahoma and Nebraska. The Federal Emergency Management Agency provides the basic funding for the organization.

CUSEC's purpose is to help reduce deaths, injuries, damage to property and economic losses resulting from earthquakes occurring in the central United States. Basic program goals include: improving public awareness and education, mitigating the effects of earthquakes, coordinating multi-state planning for preparedness, response and recovery; and encouraging research in all aspects of earthquake hazard reduction. CUSEC supports the International Decade for Natural Disaster Reduction.

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