

Reducing the Risk:
Earthquakes in the Central United States



A PARTNERSHIP EFFORT
Central United States Earthquake Consortium



Central United States Earthquake Consortium

Established: 1983, with funding provided by the Federal Emergency Management Agency

Headquarters: Memphis, Tennessee

Purpose: "To help reduce deaths, injuries, damage to property, and economic losses resulting from earthquakes occurring in the Central United States."

Member States: Alabama, Arkansas, Kentucky, Indiana, Illinois, Mississippi, Missouri, Tennessee

Associate States: Virginia, North Carolina, South Carolina, Georgia, Louisiana, Nebraska, Iowa, Oklahoma, Ohio

... And Its Partners

Federal Government

Department of Homeland Security
Federal Emergency Management Agency
Centers for Disease Control and Prevention
U.S. Geological Survey
U.S. Department of Energy
National Science Foundation
U.S. Department of Transportation
U.S. Environmental Protection Agency
National Institute for Science and Technology

Research / Academia

Center for Earthquake Research and Information, University of Memphis
Center for Community Earthquake Preparedness, University of Mississippi
Mid-America Earthquake Center
National Center for Earthquake Engineering Research

International

Organization of American States

Association / Non-profit / Voluntary

Earthquake Engineering Research Institute
Northeast States Emergency Consortium
American Red Cross
Western States Seismic Policy Council
Southern Building Code Congress Intl.
International Congress of Building Officials

Corporate

Simpson Strong Tie
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State Affiliate

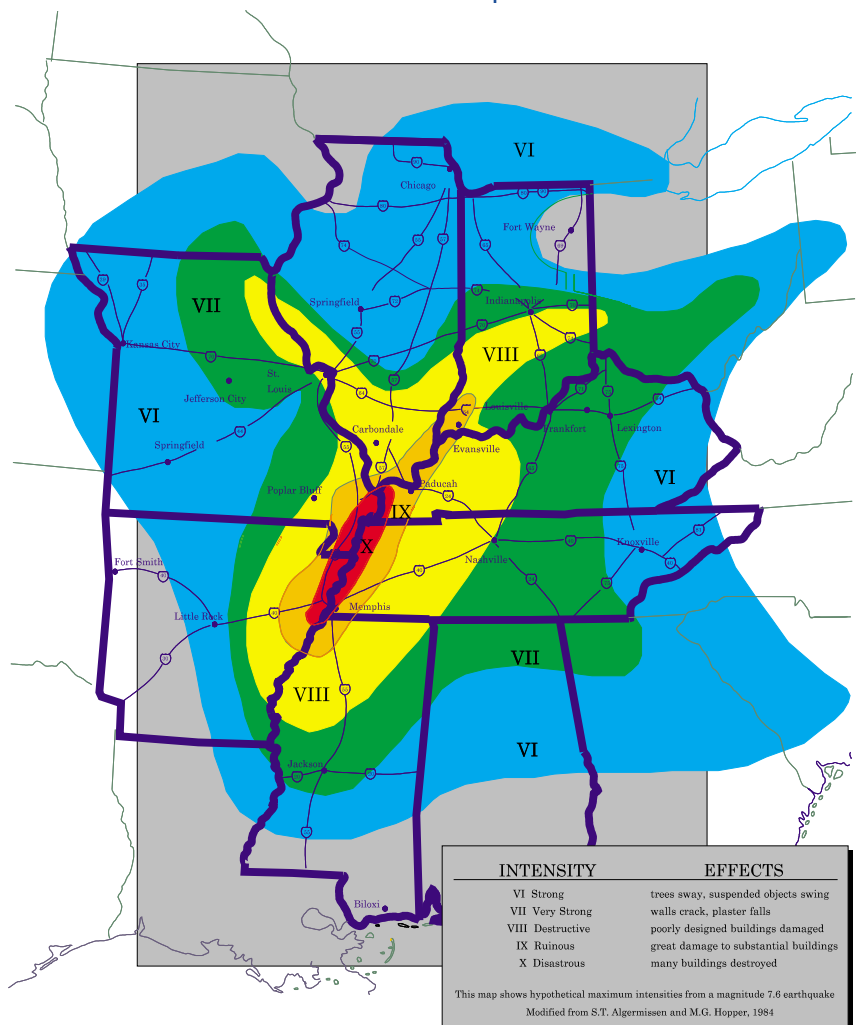
Association of CUSEC State Geologists
CUSEC Public Information Officers
CUSEC Transportation Task Force

The Earthquake Risk in the Central U.S.

The Central U.S. is vulnerable to damaging earthquakes. With little or no warning, a damaging earthquake in the New Madrid, Wabash Valley, or East Tennessee seismic zones, could strike. Depending on its magnitude and location, it could impact multiple states, causing major physical, social and economic disruption in a region that is home to more than thirty million people.

While most people associate the New Madrid seismic zone with the great earthquakes of 1811-12 - which produced four temblors near magnitude 8 and thousands of aftershocks - the Central U.S. continues to have the highest level of seismicity in the United States east of the Rocky Mountains. Earthquakes of estimated magnitude 6.4, 6.8, and 5.5 occurred in 1843, 1895, and 1968 respectively. Moderate sized earthquakes also occur in the Central U.S. In 2002, Evansville, Indiana experienced a magnitude 4.6 earthquake that toppled chimneys and caused other minor damages. Fortunately, no one was hurt in *this* instance.

The potential losses from future earthquakes of magnitude 5.5 or greater in the seismic zones of the Central U.S. are expected to be significant because: 1) the high population density of the region (Memphis, St. Louis, and many mid-sized towns); 2) the large number of structures that are not designed and constructed to withstand the effects of earthquakes; 3) the presence of thick, saturated sediments, which amplify shaking and have the potential for liquefaction; and 4) the large area that would be affected by damaging ground motion and associated ground failure (about 10 times larger than the area impacted by a California earthquake of comparable size). The following section examines in more detail the potential consequences of damaging earthquakes in the Central United States.



Sampling of Earthquakes in the Central United States

Date	Magnitude	Location
12/1811	7.5	Northeastern, Arkansas
01/1812	7.3	New Madrid, Missouri
02/1812	7.6	New Madrid, Missouri
06/1838	5.1	Southern Illinois
01/1834	6.4	Marked Tree, Arkansas
10/1895	6.8	Charleston, Missouri
04/1899	4.3	Vincennes, Indiana
05/1909	5.2	Aurora, Illinois
04/1917	4.9	Eastern Missouri
04/1925	4.8	Princeton, Indiana
05/1927	4.8	Northeastern Arkansas
11/1968	5.4	South-Central Illinois
03/1976	4.6	Northeastern Arkansas
06/1987	5.0	Southeastern Illinois
09/1990	4.8	Southeastern Missouri
12/2000	3.9	Evansville, Indiana
05/2001	4.4	Conway, Arkansas
06/2002	4.6	Evansville, Indiana
04/2003	4.6	Ft. Payne, Alabama
04/2003	4.0	Blytheville, Arkansas
06/2003	4.5	Western Kentucky
06/2004	4.2	Ottawa, Illinois

***“Communities in the Central U.S.
- both large and small -
are vulnerable to even moderate sized earthquakes
(magnitude 5.5 and greater).”***

Community Vulnerability

Communities in the Central U.S. - both large and small - are vulnerable to even moderate sized earthquakes (magnitude 5.5 and greater). One of the principal reasons is that the older downtown areas are largely constructed of un-reinforced masonry structures, which are among the most vulnerable structures from the effects of ground shaking. This is especially true in rural communities where un-reinforced masonry constructed buildings make up a greater percentage of structures.

A central question is *what will happen to the population in a damaging earthquake?* There is no simple answer. The number of casualties will depend on several factors: time of day of the earthquake, location and depth of the epicenter, and magnitude, duration of the quake, and the magnitude of aftershocks.

One lesson is clear, however: Communities that adopt and enforce building codes fare much better than those communities that do not. In December 2003, a magnitude 6.5 earthquake struck near San Simeon, California. Advanced building codes and technologies were instrumental in preventing mass fatalities and building collapse. Two people lost their lives in this earthquake and nearly fifty people were injured, while nearly three hundred buildings were damaged. Three days after the San Simeon earthquake, a magnitude 6.6 earthquake struck the city of Bam, Iran. Even though Bam is one of Iran's richest cities, the building stock was primarily comprised of adobe, or mud and straw, construction. This fact contributed to the loss of nearly 25,000 lives and damage or destruction to almost 80% of the infrastructure.

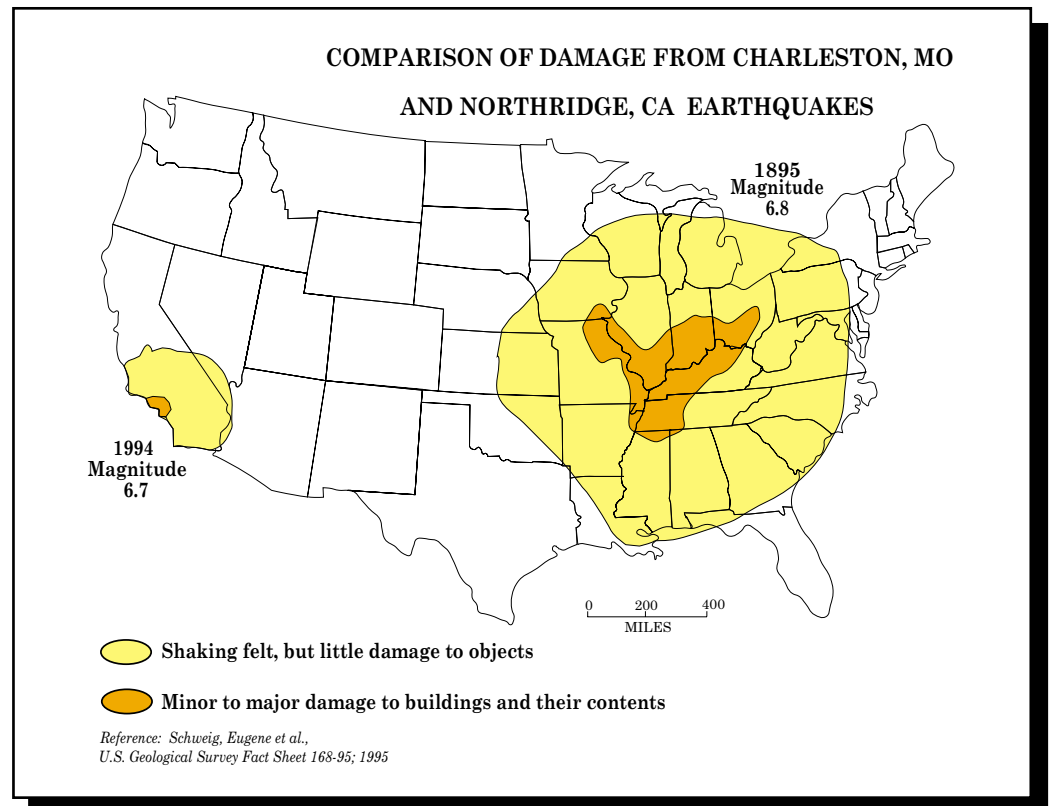
Critical Facilities

In the Central U.S., a major concern of emergency managers is critical facilities, or, those buildings and systems that are critical to effective response and recovery operations. These include law enforcement, fire, emergency operations centers, hospitals and other medical care facilities, and schools.

Schools are a special problem. Because many are constructed of un-reinforced materials, one federal study estimated that in a magnitude 7.6 earthquake (daytime earthquake with school in session), up to 25 percent of all casualties may be children. Since schools are traditionally used as shelters following a disaster, the loss of these structures will limit the availability of shelter space in communities throughout the Central U.S.

Housing the Displaced

One of the greatest challenges following a major earthquake in the Central U.S. will be meeting the short and long-term housing needs of potentially thousands of displaced persons and families. Judging from the lessons of past earthquakes, a number of factors are present that will contribute to a significant post-disaster housing problem in the Central U.S.: 1) *the vulnerability of housing stock* - Memphis, St. Louis, and other population centers are already packed with tenant occupied un-reinforced masonry structures; 2) *significant levels of poverty and homelessness* - these chronic pre-disaster problems will be exacerbated by a major earthquake; and 3) *organizational fragmentation* - there are numerous agencies that are involved in providing housing; past disasters highlight the urgent need for agency coordination in the recovery and reconstruction phases.



Transportation and Communications

The Central Mississippi Valley is a major transportation and communication corridor. Communications facilities, such as radio and microwave towers and telephone trunk lines, are fragile, principally because their structural integrity depends on stable ground.

Additionally, the vulnerability of roads, bridges, airports, and rail lines in the Central U.S. is well documented. Bridges and overpasses, in particular, are susceptible to ground shaking and liquefaction (quicksand effect), which means that access to and from disaster areas will be impeded.

The restoration of transportation routes is critical for two fundamental reasons: 1) the efficiency of disaster relief operations will be dependent on the restoration of transportation routes; and 2) the pace of the economic recovery will be a function in large part of the ability to move goods and services across the region.

In essence, even a moderate earthquake could cause major disruption across the land. Barge traffic on the river, natural gas and crude oil pipelines, interstate highways, and power lines all provide essential services, the loss of which would have a significant, long-term impact on the entire Central and Eastern United States.

Business Vulnerability

The pace of community recovery following a major earthquake will be directly tied to how quickly and effectively the business community is able to recover. In the Central U.S. and elsewhere, the central business district is the "heart and soul" of the community; therefore, the challenge of rebuilding it has enormous financial as well as psychological implications.

At least two categories of businesses will be impacted by an earthquake: first, the large retail chains that tend to be located



in local or regional shopping centers; and second, the locally owned businesses that often operate with limited capital, typically in a building that is rented or leased. For the first category, a damaging earthquake may mean the temporary closing of a few outlets; for the second category - the independent merchant - an earthquake can spell disaster: loss of building, loss of inventory, loss of utility services, and loss of market share, which in many cases, can lead up to complete loss of business.

A business recovery strategy should be an integral part of a regional strategy for economic recovery in the Central U.S. While conditions will vary from state to state and from community to community, a

a business recovery strategy should be guided by a common goal: to re-establish commercial activity to facilitate the community's recovery. Business associations and/or chambers of commerce can serve as the focal point for the development of post-disaster business recovery planning.

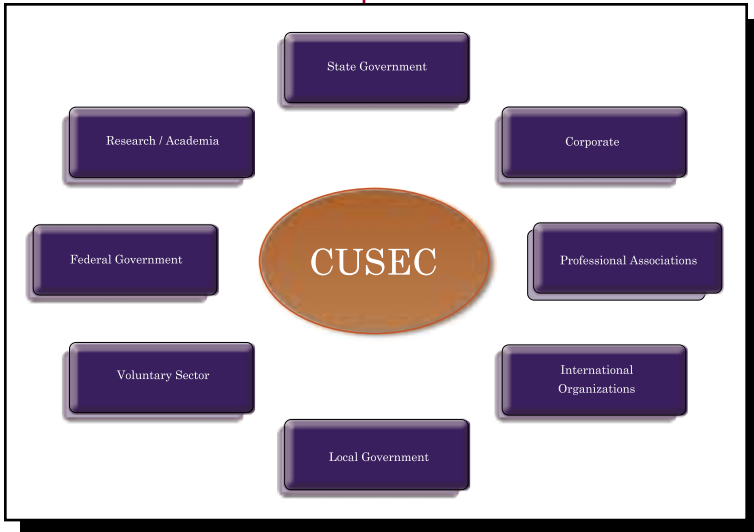
Hazardous Materials

Hazardous materials are a byproduct of the economy of the Central U.S. As a major transportation corridor, tremendous volumes of hazardous materials pass through this region by rail, highway and river. Oil and natural gas pipelines also crisscross the region. As metropolitan areas in the Central U.S. continue to grow, more and more people live and work near industrial and commercial facilities that process or store hazardous materials. Finally, the Central Mississippi Valley is one of the most productive agricultural areas in the United States. Yet, many of the fertilizers, chemicals and other potentially hazardous products that sustain agriculture are stored in silos, tanks, and cylinders that are not designed, for the most part, to withstand the effects of earthquakes. A comprehensive strategy to prevent hazardous materials releases will involve close coordination between business and industry and government.

To summarize, the Central U.S. *will* experience a damaging earthquake, the only questions are *when and where* this will occur. The good news is that through advances in earthquake loss estimation research, the nature of damages and losses can be anticipated, and steps can be taken - *before the earthquake* - to minimize casualties and damages. The following section examines CUSEC's role in a regional program to reduce the earthquake risk.



“From loss of inventory to loss of market share, earthquakes can spell disaster for businesses of all sizes”



CUSEC works with a variety of agencies and organizations to develop and implement programs to reduce the region's risk to earthquakes and other hazards.

Reducing the Risk: CUSEC's Role

The earthquake hazard in the Central U.S. presents policy makers and emergency managers with a unique combination of problems and challenges: 1) how to prepare for a hazard that has no warning; 2) how to coordinate the earthquake response and recovery planning efforts of up to ten states that will be potentially impacted; and 3) how to "market" earthquake mitigation and preparedness programs to a broad range of groups in the public and private sectors, and in the process foster a political, social and institutional environment that promotes earthquake risk reduction.

Against this backdrop, the Central U.S. Earthquake Consortium was established in 1983, with funding provided by the Federal Emergency Management Agency. The CUSEC Board of Directors is made up of the State Directors of Emergency Management Agencies of the states that are most vulnerable to seismic hazard and its associated risks in the Central U.S.: Arkansas, Missouri, Indiana, Illinois, Kentucky, Tennessee and Mississippi. In recent years, there has been an increase in earthquake activity outside of the New Madrid and Wabash seismic zones. In 2003, the Board of Directors added Alabama as a CUSEC member state. This vote was partially due to the magnitude 4.6 earthquake in April 2003, near Ft. Payne, Alabama that was generated by the East Tennessee seismic zone. Luckily, there were no reported injuries or deaths from the temblor, but the quake was felt in as many as twelve states and generated more than 17,000 felt reports through the U.S. Geological Survey's "Did You Feel It?" program, validating the regional impact an earthquake will have.

Partnership Approach

CUSEC carries out its programs in partnership with a variety of agencies and organizations.

Member states, through the Board of Directors, set CUSEC priorities. The day-to-day liaison with CUSEC is through the State Earthquake Program Managers.



FEMA News Photo

The Federal Emergency Management Agency provides financial support to operate the consortia, and other federal agencies contribute both funding and technical assistance. The US Geological Survey, for example, funds an organization of the eight State Geologists in the CUSEC region. The priority of the *Association of CUSEC State Geologists* is the preparation of seismic hazard maps for use by state and local officials.



On the international front, CUSEC has worked closely with the Organization of American States (OAS) to establish the U.S. - Latin American Partnership, a hemispheric program that promotes the sharing of research, lessons learned, and technical expertise to reduce our collective vulnerability to earthquakes and other hazards.

Funded by the U.S. Department of Transportation, the CUSEC State Transportation Task Force is one of three associations which function under the CUSEC umbrella. This task force, formed in 2000, serves two purposes: one, to help facilitate closer interaction between state departments of transportation on issues related to emergency preparedness, and secondly, to provide a central point for collaboration with other organizations on transportation issues related to both man-made and natural disasters having a regional impact.

Along with the *Association of CUSEC State Geologists*, which was previously mentioned, the CUSEC Public Information Officers (PIO's) was established in 2002 to improve public awareness and education efforts regarding the seismic hazard in the Central U.S. The PIO's work closely with the media before, during, and after a disaster to relay information to the public and private sectors.

Finally, CUSEC has a network of partners in the non-government sector - including the insurance industry, professional associations, volunteer organizations, business and industry groups, and others. These groups constitute an important constituency in view of the fact that non-government organizations carry out the bulk of mitigation and continuity planning decisions and actions in our communities.

Mitigation

Mitigation - actions taken to prevent or reduce the risk to life and property from natural hazards - is central to CUSEC's mission. Each day, substantial sums of money are invested in new buildings, facilities and lifelines in hazard prone areas in our communities. The challenge for CUSEC and others is to ensure that planners, developers, building officials, lenders, insurance representatives and other key players understand the potential consequences of earthquakes, and begin to incorporate mitigation into the daily decisions that are made on the *siting, design, and construction* of buildings and lifelines. The following section highlights some of CUSEC's programs, activities and partnerships under the Mitigation program.

Risk Assessment

The starting point for any mitigation program and strategy is an accurate assessment of the hazard and potential losses from that hazard. In other words, *what is the vulnerability of our communities, homes and businesses from the effects of earthquakes and other disasters?*

The Federal Emergency Management Agency has worked closely with CUSEC and other organizations to develop a user-friendly risk assessment tool that can be used by state and local officials to identify potential losses from earthquakes and other hazards. Using geographical information systems (GIS) and advanced national data sets, this loss estimation tool can be a primary factor in determining risk. The latest version of this software, HAZUS-MH (Hazards U.S. - Multi-Hazard) was released by FEMA in early 2004. For a given magnitude earthquake, this "loss estimation methodology" can be used to determine social impacts (e.g. casualties, shelter requirements), direct

physical damages (e.g. building and lifeline damages), induced damages (e.g. fires, hazardous materials releases, flooding), and direct and indirect economic losses (e.g. loss of productivity or impact on the labor force).

CUSEC has taken a lead role in the implementation and deployment of HAZUS-MH in the Central U.S. by providing workshops and training opportunities for states and communities using HAZUS-MH. The CUSEC Geologists, for their part, will provide interpretive maps and valuable data on the seismic hazard, which is essential to the analysis models. Since HAZUS became available, CUSEC has also taken part in joining HAZUS User Groups, or regional based groups that share data, resources, and ideas pertaining to HAZUS.



Courtesy FEMA

Mitigation Marketing Program

Armed with information on the earthquake risk, CUSEC and its member states are collaborating to develop and implement a marketing strategy that is ultimately designed to institutionalize mitigation in the Central U.S. A flexible, modular program will be developed that addresses four key aspects of a marketing strategy:

- 1) The Earthquake Hazard and Risk** - *In essence, what is the problem? How will earthquakes affect our communities?*
- 2) A Mitigation Toolbox** - *What specific measures can be taken to reduce the impact of earthquakes?*
- 3) Marketing Mitigation** - *What techniques can be used to "sell" mitigation to important constituencies?*
- 4) An Implementation Strategy** - *What sources of funding and technical assistance are available? How can partnerships be formed to implement and sustain mitigation programs?*

CUSEC will work with member states, FEMA, USGS, model code groups, and the insurance industry to pull together the critical pieces of a Mitigation Marketing Program that can be tailored to the training and information needs of a diverse audience.

Building Code Adoption and Enforcement

The most important single step that local governments can take to minimize future damages and casualties from earthquakes is to adopt *and* enforce building codes. One of CUSEC's priorities is to increase the level of awareness and understanding of building officials and inspectors of the earthquake hazard and risk, and to provide them with the knowledge and tools to administer and enforce seismic provisions of building codes in the CUSEC region. In December 2003, the CUSEC board of Directors adopted a policy position in strong support of communities adopting building codes and seismic provisions contained within them.

A Building Code Training Program has been developed by a committee with expertise drawn from FEMA, Southern Building Code Congress International, Building Safety Seismic Council, and the Institute for Business and Home Safety. Since its inception, this committee has targeted building officials throughout the Central U.S. in a program that will not only provide technical training, but will also focus on constituency building and other forms of institutional support for building officials.



Mitigation for Critical Facilities

Critical facilities - hospitals, schools, police and fire stations, medical and health facilities, electric utilities - are essential to the day-to-day functioning of our cities and towns. Historically, CUSEC has given priority to the development of mitigation training and technical assistance programs that can be utilized in member states to improve seismic resistance of these facilities, with emphasis on schools and hospitals.

While emphasis is being given to incorporating mitigation measures for new critical facilities, CUSEC continues to work with FEMA and the insurance industry to develop and sponsor projects that demonstrate how to rehabilitate existing buildings and facilities that are vital to a community's well being.



The starting point for a mitigation program is an accurate assessment of the hazard and determining potential losses from that hazard.

Mitigation through Incentives

One of the most effective ways to promote the adoption of mitigation is through financial incentives. The technical "know how" is available. The task at hand is to motivate business owners, homeowners, critical facility operators, and others to incorporate mitigation measures into design and construction decisions. There are many "non-structural" mitigation techniques - such as fastening and securing valuable equipment - that are cost-effective and easy to implement.

In summary, earthquake hazard mitigation will continue to be CUSEC's highest priority. The reason is straightforward. Every mitigation action that is taken today - including those outlined in CUSEC's strategy - will reduce the casualties, damages, and economic losses that will occur in a future earthquake. The challenge is to sustain a long-term mitigation effort in our communities, workplaces, and households.



Response and Recovery

Response and recovery from a damaging earthquake in the Central United States will pose unprecedented problems and challenges. Earthquakes occur without any warning. Damages can extend over hundreds of miles. Roads, bridges, utilities and other infrastructure can sustain heavy damages, delaying recovery for months and even years.

The good news is that the problems and issues associated with response and recovery to a damaging earthquake are largely predictable. Lessons from recent earthquakes provide emergency managers with knowledge and insight into the physical, social, political, and economic consequences of damaging earthquakes. Recently, CUSEC has initiated a series of catastrophic planning workshops that bring together key members of response agencies, such as Operations Chiefs, Donations Planners, Transportation Task Force Members, and Public Health Officials. These workshops, coupled with scenario exercises, will help better prepare officials to respond and ultimately, recover.

CUSEC's job is to coordinate the regional response and recovery planning efforts of the eight states that would be most impacted by an earthquake in the Central U.S. CUSEC is working with member states and federal agencies to identify priorities for response and recovery. Key programs are outlined below.

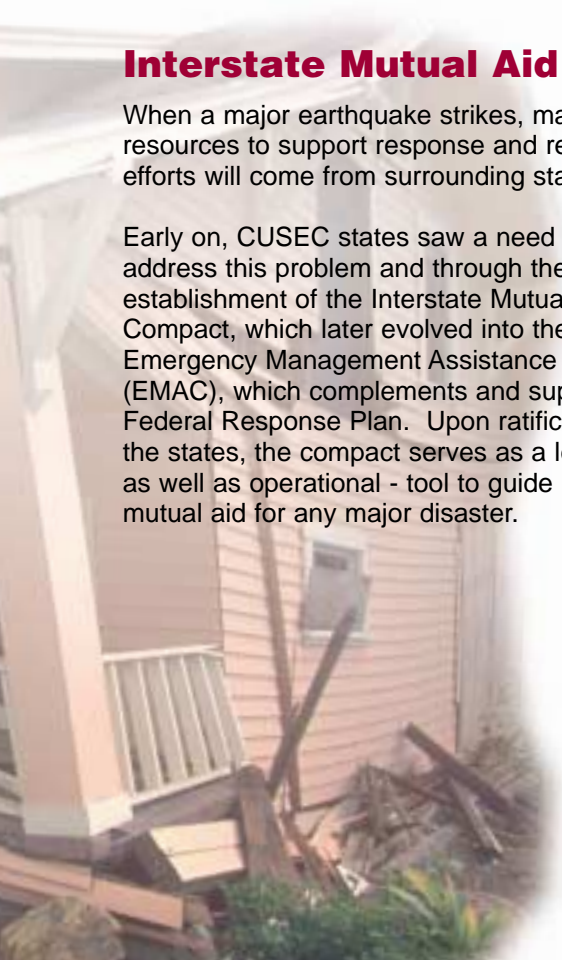
Interstate Mutual Aid

When a major earthquake strikes, many of the resources to support response and recovery efforts will come from surrounding states.

Early on, CUSEC states saw a need to address this problem and through the establishment of the Interstate Mutual Aid Compact, which later evolved into the national Emergency Management Assistance Compact (EMAC), which complements and supports the Federal Response Plan. Upon ratification by the states, the compact serves as a legal - as well as operational - tool to guide interstate mutual aid for any major disaster.



FEMA News Photo



Housing and Human Services

A major earthquake in the Central U.S. will disrupt the lives of thousands of families and individuals over a broad geographic area. A plan and strategy needs to be developed that provides for the basic human needs - shelter, food, water, emergency relief items, and medical care - for these disaster victims. Furthermore, this strategy needs to be coordinated over a multi-state region.

CUSEC is working with member states, American Red Cross, FEMA, Department of Defense, and others to develop a Housing and Human Services Recovery Plan that will provide a range of *pre-disaster policy options and actions* to guide housing recovery and decisions on how to meet the basic human needs of thousands of disaster victims. Special attention will be given to providing for the needs of the elderly, the handicapped, and other "special needs" populations.

FEMA News Photo



“After a large earthquake it is possible that hundreds, if not thousands, of buildings will be severely damaged.”

Post-Disaster Building Safety Assessment

After a large earthquake, it is possible that hundreds, if not thousands, of buildings will be severely damaged. These buildings will need to be surveyed to determine their structural safety, so that people do not enter or use unsafe buildings. This process will be compounded by at least three factors: 1) the sheer number of buildings that will need to be surveyed; 2) the widespread nature of damages; and 3) the shortage of trained inspectors to carry out the building safety assessment.

In cooperation with member states, CUSEC is helping to launch a program to recruit, train, organize, and equip safety inspection teams from throughout the region. Each state is developing its own cadre, or coalition, of inspectors. For instance, the Missouri Structural Assessment and Visual Evaluation Coalition has been organized to be a self-sustaining cadre that can mobilize for not only earthquakes, but all hazards. CUSEC's job is to help states implement the program, identify major shortfalls in trained inspectors; to assist in training efforts, both for inspectors and "overhead management teams;" and to take the lead role in developing procedures for interstate coordination and deployment of building inspectors and emergency personnel.

Geographic Information Systems (GIS)

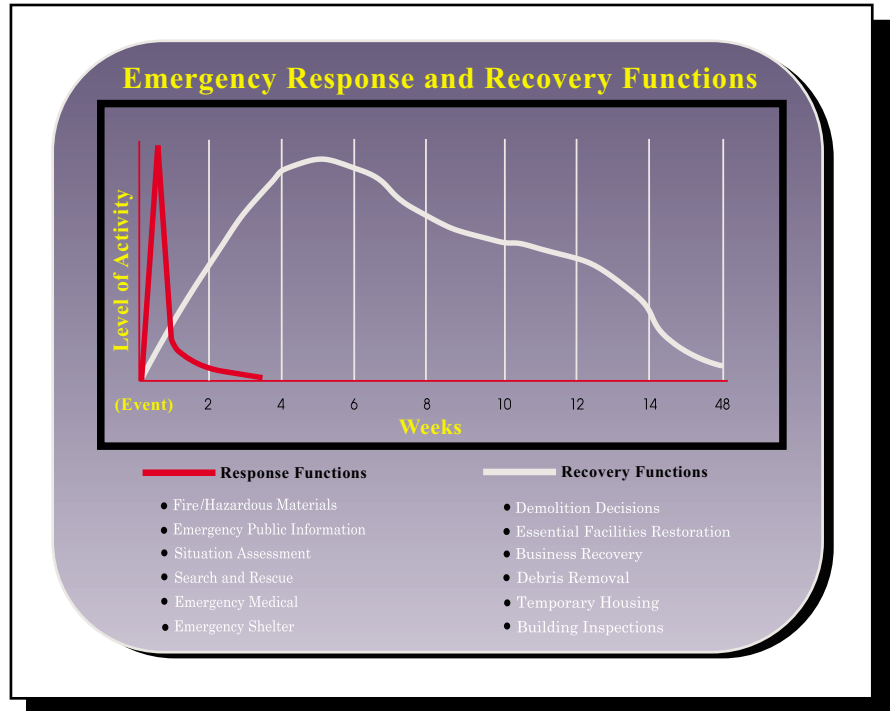
Lessons from recent disasters reinforce a central point: to effectively manage disaster response and recovery operations, it is *essential* that emergency managers have accurate and timely information on the nature of damages, people affected, resources available, and other information that is needed to support decisions in response and recovery. HAZUS-MH is one GIS tool that could be used in a response situation. HAZUS is capable of producing estimations for casualties, damage to essential facilities, and many other categories that would prove useful in responding to an event.

One of CUSEC's goals is to ensure that the member states take full advantage of GIS and other information technologies, allowing critical decisions can be made with the benefit of the best available information. Furthermore, CUSEC's role is to ensure that the systems are developed in an integrated fashion (e.g. development of common data sets) so that the states can share information, and generate maps that have common features and scales. This is a long-term initiative that will lead to a coordinated program to manage information before, during, and after a disaster.

Health and Medical Services

Because our population centers are dominated by un-reinforced masonry structures, and because these buildings cause the most casualties, even a moderate earthquake in the Central U.S. can lead to thousands of injuries across a multi-state region.

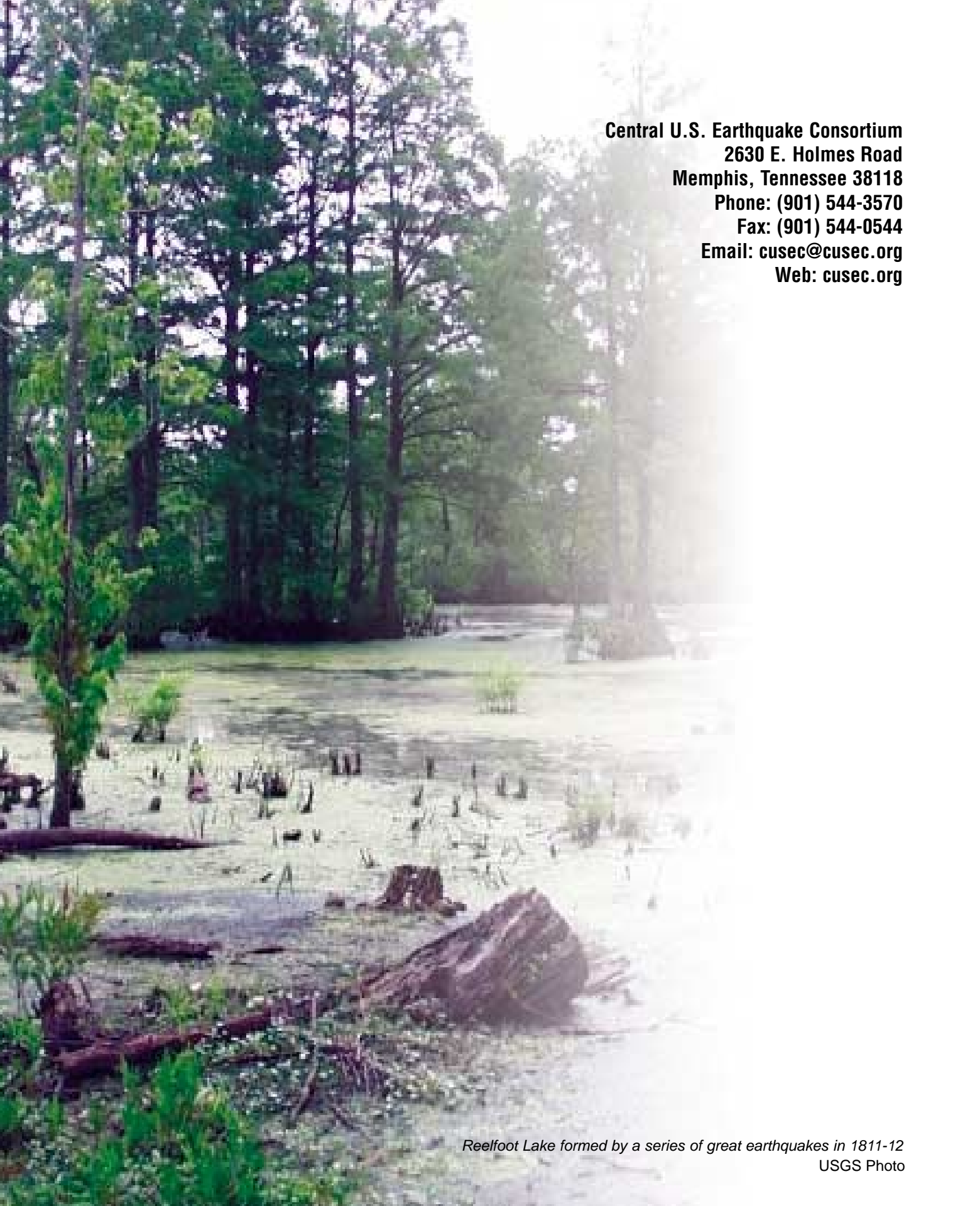
CUSEC's goal is to develop and carry out awareness, planning and training programs that will address the public health and emergency medical needs a large region that may have injury and casualty numbers in the thousands. In partnership with FEMA, the Centers



“...there is an unprecedented opportunity for a proactive, partnership-based approach to disaster preparedness and mitigation in the Central U.S.”

for Disease Control and Prevention, and the U.S. Public Health Service, a program has been developed that provides families and individuals with the "know how" to become self-sufficient for at least 72 hours following an earthquake or other major disaster.

In closing, there is an unprecedented opportunity for a proactive, *partnership-based* approach to disaster preparedness and mitigation in the Central U.S. We have the tools and expertise to make our communities, businesses and households safer from earthquakes and other hazards. The challenge is to motivate community leaders, business leaders, and the public to take steps *now* to reduce our vulnerability to earthquakes and other hazards. CUSEC and its member states are always available to assist in these efforts.



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Reelfoot Lake formed by a series of great earthquakes in 1811-12
USGS Photo