CUSEC After-Action Report (AAR)

CENTRAL UNITED STATES EARTHQUAKE CONSORTIUM
MISSOURI · ILLINOIS · INDIANA · KENTUCKY · ARKANSAS · MISSISSIPPI · ALABAMA · TENNESSEE

December 2011

Signature Page

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Message from the Chairman of the Board

Earthquakes are often thought of as a threat only to the Western United States. However, three of the largest earthquakes in U.S. history occurred within the New Madrid Seismic Zone (NMSZ) in the Central United States in 1811–1812. Each year, more than 150 tremors occur along this and other fault lines in this area, reminding us the threat of another devastating earthquake is real. Given the tremendous growth in population and infrastructure in this region since the early 1800s, a modern-day earthquake has the potential to inflict considerable physical damage and mass casualties in the eight-state Central United States Earthquake Consortium (CUSEC) region.

While each state in this region has embraced an all-hazards approach to tackle the wide array of emergency situations that arise—from floods to tornadoes to acts of terrorism—we recognize the effects of a major earthquake pose unique challenges that extend beyond state boundaries. Through the efforts of CUSEC, the Federal Emergency Management Agency (FEMA) funded the NMSZ Catastrophic Planning Project. The analysis and planning conducted over a period of five years culminated in the National Level Exercise of 2011 (NLE-11), the first exercise of its kind to prepare for an earthquake disaster in this region. This report outlines the unprecedented planning effort undertaken by the eight CUSEC states, with the support of FEMA, to prepare the states and region for a catastrophic disaster resulting from a NMSZ event. This is only a beginning; much more remains to be done. Continuous work is needed to press forward with preparedness efforts for all citizens. Additionally, the support of Congress and the states is needed to keep this vital project going. Through CUSEC, the region comes together to tackle the challenges, ranging from public information and education to multi-state response and recovery planning to mitigation efforts and research.

On behalf of the CUSEC Board of Directors, I hope you find this report helpful in assessing our successes and our need for continued support.

BG John W. Heltzel
Director, Kentucky Emergency Management
CUSEC Board Chairman

Executive Summary

Eyewitness accounts describe the impact of the 1811–1812 New Madrid earthquakes as a series of four large quakes and thousands of smaller quakes or aftershocks over nearly a year's time. These events remain one of the most powerful series of earthquakes ever to hit the United States. Felt strongly over 50,000 square miles and moderately across 1 million square miles, the area affected by these shocks was two to three times as large as that of the 1964 Alaska earthquake and 10 times as large as that of the 1906 San Francisco earthquake.

> "On the 16th of December, 1811, about two o'clock, A.M. we were visited by a violent shock of an earthquake, accompanied by a very awful noise resembling loud but distant thunder, but more hoarse and vibrating which was followed in a few minutes by the complete saturation of the atmosphere, with sulphurious vapor, causing total darkness. The screams of the affrighted inhabitants, running to and fro, not knowing where to go or what to do —the cries of the fowls and beasts of every species —the cracking of trees falling, and the roaring of the Mississippi—the current of which was retrograde for a few minutes, owing as is supposed, to an eruption in its bed—formed a scene truly horrible."
> (Bryan, 1816) Letter to Lorenzo Dow, 1816 (Center for Earthquake Research and Information, New Madrid Compendium, New Madrid Eyewitness Accounts)

The New Madrid earthquake hazard remains a threat. The devastation caused in the region in 1811–1812 pales in comparison with the devastation that would occur if the Central United States were struck with a similar event today. In 1811, the territory was sparsely populated with little infrastructure. Today, this same area is home to more than 43 million citizens and critical oil, gas, electric, communication, and transportation lifelines that crisscross the Mississippi River. The major metropolitan areas of Memphis and St. Louis lie in the heart of the seismic region. Conservative estimates of losses are estimated in the $300-billion range today (Elnashai, Cleveland, Jefferson, & Harrald, 2008).

Direct damage to the electrical infrastruture could cause a blackout affecting much of the Eastern Interconnection, one of North America's two alternating current power grids, which would last as long as a week in regions that are far enough from the earthquake center to experience only mild ground shaking. However, restoring the power grid in regions of the highest ground shaking intensity would take months (Corbet, Ellison, Jordan, & Taylor, 2007).

In 2006, the potential for such a catastrophic event prompted the Federal Emergency Management Agency (FEMA) to provide additional funding to the Central United States Earthquake Consortium (CUSEC) to lead an effort to develop, improve, and integrate the earthquake response plans of the eight states in the region—Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee—that would be most affected by an earthquake. Originally established in 1983 with funding support from FEMA, CUSEC has as its primary mission the reduction of deaths, injuries, property damage, and economic losses resulting from earthquakes in the Central United States. CUSEC is a partnership of the federal government and the eight states noted above; it serves as a coordination hub for the region and performs the critical role of coordinating multi-state efforts of the central region.

The priorities for the New Madrid Seismic Zone (NMSZ) Catastrophic Planning Project were set by CUSEC's Board of Directors. The CUSEC Board, composed of the state emergency management directors from the eight states, is in a unique position to know exactly what is needed to prepare the region for a catastrophic event. CUSEC is a peer-based organization where planning and response choices in the key areas of strategy, tactics, and operations are made by councils of peers drawn from every level and function for discussion and sharing of best practices.

The concept selected to achieve these priorities was a scenario-driven planning process that, at the time, was new and unique. Using a scientifically credible scenario developed by the Mid-America Earthquake Center (MAE Center) in partnership with the U.S. Geological Survey, and state geology surveys and with input from representatives from the entire spectrum of emergency management, first responders from the local level, state emergency management officials, and federal responders work in a collaborative manner, similar to the way that these people and organizations work together in responding to an incident, to develop a response plan.

Over five years, the catastrophic planning process, coordinated through CUSEC, built response plans from the ground up beginning at the city and county level and leading to a statewide planning workshop in each state. The eight state workshops led to four regional workshops, one in each FEMA region covering the eight states. In turn, the four regional workshops led to a Resource Allocation Workshop (RAW), providing an opportunity for comprehensive planning to coordinate mobilization, staging, deployment, and tracking of the vast amount of resources needed in such a catastrophic event as a New Madrid earthquake. The five years of work in scenario-driven catastrophic planning culminated with the National Level Exercise 2011 (NLE-11) that simulated a NMSZ earthquake event.

"As a new State Director, being a member of CUSEC has provided me with an invaluable resource. The relationships afforded by being a member of CUSEC transcend the earthquake arena into all areas of emergency management."
—Mr. Art Faulkner, State Director, Alabama Emergency Management Agency

The most significant result of the Catastrophic Planning Project has been the comprehensive efforts undertaken by the eight states to create a detailed response plan to any major disaster scenario. The Project allowed the states to overcome obstacles that had limited them in the past and get down to the details of linking their requirements to actual state and federal capabilities. These efforts have already resulted in direct real world benefits in recent major disasters where the eight CUSEC member states were able to provide a rapid and robust response to the large and wide spread disasters of major flooding and a super outbreak of tornadoes.

This report catalogs in detail the five years of planning efforts and highly successful results of the New Madrid Catastrophic Planning Project leading up to the National Level Exercise 2011. While the efforts of CUSEC have led its member states to their greatest level of preparedness in the past twenty-five years, it is only a beginning and requires continued support from national leadership to keep and improve all levels of preparedness. Please find in this report the Board's specific recommendations to keep this critical process going.

"Without committed leadership and support for CUSEC, this vitally needed, unmatched level of teamwork and collaboration is almost certainly impossible."
—Mr. Joseph Wainscott, Executive Director, Indiana Department of Homeland Security

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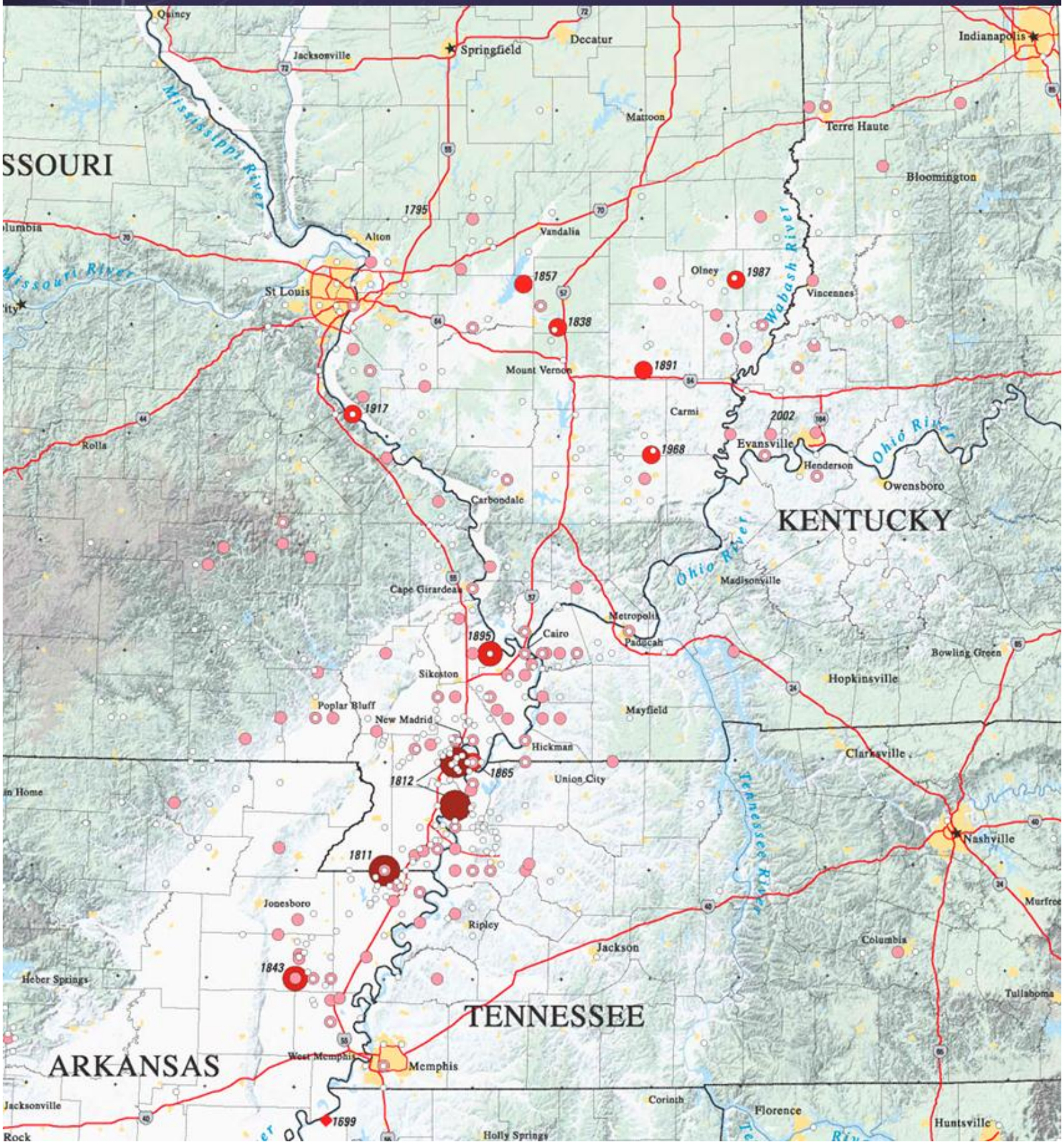
Background


Quincy
Jacksonville
Springfield
Decatur
Indianapolis
Mattoon
Terre Haute
Bloomington
SSOURI
Mississippi River
1795
Alton
Vandalia
Olney
1987
Wabash River
Vincennes
Missouri River
St Louis
1857
1838
Mount Vernon
1891
1917
Carmi
2002
Evansville
1968
Henderson
Ohio River
Owensboro
Rolla
Carbondale
KENTUCKY
Ohio River
Madisonville
Cape Girardeau
Metropolis
Cairo
1895
Paducah
Bowling Green
Sikeston
Hopkinsville
Poplar Bluff
New Madrid
Mayfield
Hickman
Clarksville
1865
1812
Union City
Tennessee River
Nashville
1811
Jonesboro
Ripley
Jackson
Columbia
Murfree
1843
Heber Springs
Tullahoma
TENNESSEE
ARKANSAS
West Memphis
Memphis
Jacksonville
Corinth
Florence
1699
Holly Springs
Huntsville

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Background

Challenges of the New Madrid Catastrophic Planning Project

The New Madrid Seismic Zone (NMSZ) is a fault system in the Central United States located between St. Louis, Missouri, and Memphis, Tennessee. The geology of the Central United States is conducive to underground movement, and potential damage is more widespread here than in other earthquake-prone areas of the United States. The series of earthquakes with the greatest magnitude in the area occurred in 1811–1812 and consisted of three major quakes within three months ranging from approximately 7.0 to 8.0 in magnitude. (Figure 1 illustrates the extent of devastation of a 6.6-magnitude quake in the NMSZ centered in Charleston, Missouri, compared to the 1994 earthquake in Northridge, California.)

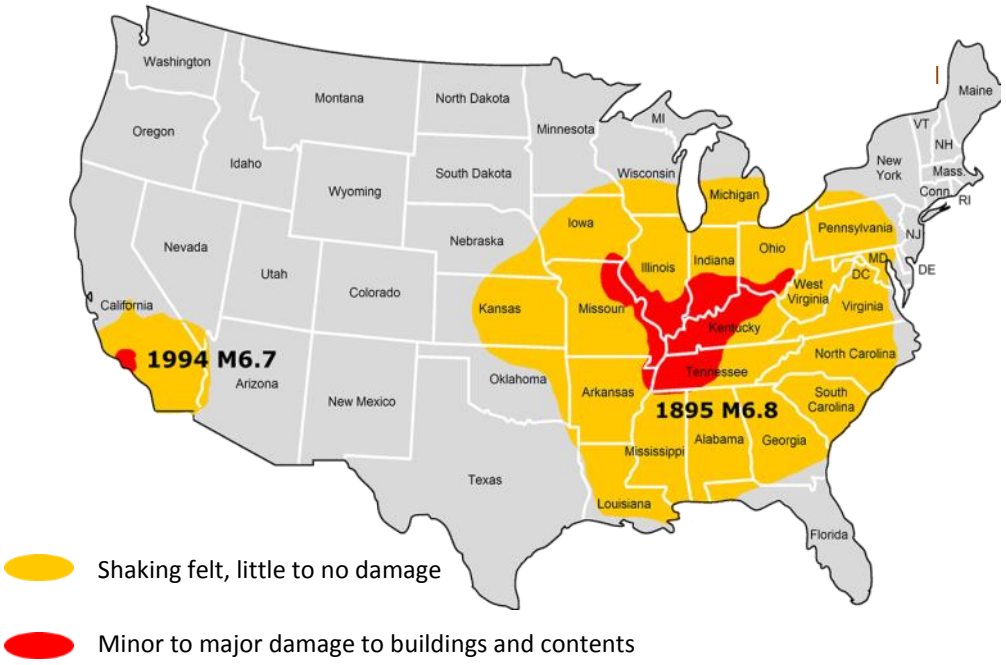

Figure 1: Comparison of the 1886 Charleston, Missouri, earthquake in the New Madrid seismic zone with the 1994 Northridge, California, earthquake. Red indicates area of structural damage, yellow indicates area where shaking was felt.

The NMSZ earthquakes were so devastating that they resulted in what may be the first recorded request for federal aid from a U.S. state or territory. On January 13, 1812, William Clark (of Lewis and Clark fame), the Governor of the Louisiana Territory (later renamed the Missouri Territory), wrote:

> "The inhabitants of the late District now County of New Madrid, in this Territory, have lately been visited with several calamities of this kind, which have deluged large portions of their country and involved in the greatest distress many families, whilst others have been entirely ruined.... In the opinion of the said General Assembly, provisions ought to be made by law for or cashiered to the said inhabitants relief, either out of the public fund or in some other way as may can meet to the cost-demand availability of the General Government."

In response, Congress pledged $50,000 for recovery and passed the first disaster relief act in 1815 (Kentucky State Fair Board, 2005).

If such an earthquake event were to occur today, providing relief and supplies to survivors will be challenging, and the impact to national infrastructure will compound relief efforts further. The Central United States Earthquake Consortium (CUSEC), the Mid-America Earthquake Center (MAE Center), the U.S. Geological Survey (USGS), and the Federal Emergency Management Agency (FEMA) have completed preliminary modeling of potential impacts of an earthquake in the NMSZ and estimate the total building loss from one quake at more than $70 billion in the region.

> "Most modeling would find New Madrid would have the longest extended damage to the Gross Domestic Product more than any other disasters in the U.S."
>
> —Mr. Patrick Rea, Chief, Accelerated Disaster Response Initiative, U.S. Small Business Administration

Key Goals

Five years ago, the original mission of the NMSZ Catastrophic Planning Project was to increase national readiness in the event of a catastrophic earthquake in the NMSZ by developing a series of annexes or supplements to existing base plans for response and recovery to a series of major earthquakes in the NMSZ and integrating them into a single document with federal, regional, tribal, state, and local components. In addition, the NMSZ Catastrophic Planning Project was tasked to identify any issues that could not be resolved based on current capabilities and to propose recommended courses of action for decision makers involved in this project.

Design

The NMSZ Catastrophic Planning Project was designed to accomplish three main objectives:

1. Improve response to a catastrophic earthquake and related hazards in the states impacted by the New Madrid Seismic Zone
2. Plan for a coordinated response and recovery effort among federal, state, and local agencies
3. Incorporate lessons from the Hurricane Katrina response, the Southeast Louisiana Catastrophic Hurricane Plan, and previous earthquakes

Definition

For the NMSZ Catastrophic Planning Project, a standardized definition of a catastrophic incident was created:

- A catastrophic incident is a sudden event resulting in tens of thousands of casualties and tens of thousands of evacuees.
- During a catastrophic incident, response capabilities and resources of state and local jurisdictions would be overwhelmed.
- Characteristics of the precipitating event would severely aggravate response strategies and further tax the capabilities and resources available to the area.
- Life-saving support from outside the area would be required, with time being of the essence.
- The likelihood of long-term impacts within the incident area as well as on the nation (to a lesser extent) exists.

"Emergency management directors should routinely evaluate the threats that impact their states and determine what events pose the biggest threats to their states. This will aid in developing a comprehensive plan for a catastrophic disaster not only on a state level but a local level as well. For example, what locals learned in the catastrophic exercise will assist in other responses. Scenario-based exercises will evaluate the efficiency of plans and assist in training local, state, and federal emergency management teams. Mississippi has seen many disasters in the last decade, some catastrophic on the local level and one catastrophic to the state, region, and nation and after every event, we plan and begin to incorporate the lessons learned to rebuild better."
—Mr. Mike Womack, State Director, Mississippi Emergency Management Agency

Concept

The scenario-driven catastrophic planning process used in the NMSZ Catastrophic Planning effort combines response and planning to develop plans based on real-world modeling. Using this method, people who respond to a disaster were integrally involved in writing the plan they would eventually use. Representatives from the entire spectrum of emergency management, including first responders from the local level, state emergency management officials, and federal responders, collaborated to develop the plan in a manner similar to the way they work together to respond to an incident.

The scenario-driven planning concept combines the planning and exercise phases of plan development in a workshop format, using breakout and action rooms to develop specific plans on such topics as direction and control, search and rescue, medical care, evacuation and transportation, temporary housing, and security. The accelerated planning process resulted in functional plans ready for immediate use.

The scenario-driven catastrophic planning process promotes communication and builds stronger relationships between federal, state, local, and volunteer agencies and business and industry that ultimately

enhance the interoperability of plans. Participants at all levels of government and the private sector take ownership of the plans, and the operational knowledge and experience captured make the plans more viable.

Participation

The following entities participated in the planning process:

- CUSEC
- The U.S. Department of Homeland Security (DHS)/FEMA headquarters
- FEMA Regions IV, V, VI, and VII (see Figure 2)
- Other federal departments and agencies including the U.S. Department of Defense (DoD), Northern Command (NORTHCOM) (DoD), the U.S. Department of Transportation, USGS, and the U.S. Department of Health and Human Services
- CUSEC member states: Alabama, Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee (see Figure 2)
- Affected city and county governments
- Business, industry, and volunteer organizations
- MAE Center, George Washington University, Virginia Polytechnic Institute and State University (Virginia Tech), and Sandia National Laboratories

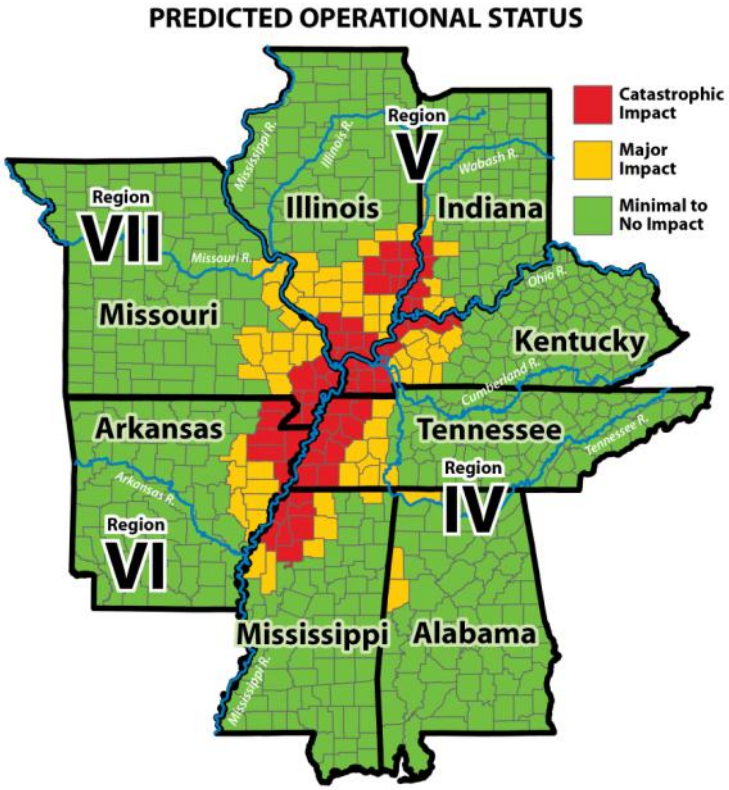

Figure 2: The eight CUSEC member states and the four FEMA regions of the New Madrid Seismic Zone

Project Structure

The original project plan called for four levels of workshops ranging from the local to the national level:

1. Initial city and county workshops as needed in the 230 high-impact counties
2. Eight state workshops
3. Four FEMA region workshops
4. A final integration workshop that included results from all the workshops

Product Achievement

The project ultimately produced a number of highly beneficial products, including:

- A comprehensive catastrophic earthquake planning scenario for the Central United States;
- State-specific Catastrophic Earthquake Response Plans, as well as local plans, where applicable;
- FEMA region-specific Catastrophic Earthquake Response Plans; and
- The Federal Interagency Response Plan for Earthquakes (FIRP-E)

All these plans were vertically and horizontally integrated into a unified response system.

ORIGINAL PROJECT TIMELINE

Quarter	Milestone	Deliverable
4th Quarter, FY 2006 **July 1–September 30, 2006**	Establish support contracts for NMSZ Catastrophic Planning	n/a
	Deploy State and Regional Planners to Sites	n/a
1st Quarter, FY 2007 **October 1–December 31, 2006**	Develop Joint Project Development Plan	Joint Project Development Plan (Draft)
	Develop Interim Contingency Plan for NMSZ (Interim National Catastrophic Earthquake CONOP)	Interim Contingency Plan (Draft)
	Brief FEMA Regional Directors and State Directors (12/11/06)	Briefing Support Materials
	Brief Secretary Chertoff on NMSZ Catastrophic Planning	Briefing Support Materials
2nd Quarter, FY 2007 **January 1–March 31, 2007**	Finalize Joint Project Development Plan	Joint Project Development Plan
	Finalize Interim Contingency Plan for NMSZ	Interim Contingency Plan
	Complete Draft Capabilities Assessments	Capabilities Assessments (Draft)
	Develop Plans of Action and Milestones for States	Plans of Action and Milestones (Draft)
	Initial Scenario and Impact Analysis	Report on Scenario and Impact Analysis
	Development of Workshop Execution Plans	Workshop Execution Plans (Draft)
	Develop Plan Templates	Plan Templates (Draft)
	Develop Presidential Briefing on NMSZ Catastrophic Planning	Briefing Support Materials
	Brief Rep. Emerson (MO)	Briefing Support Materials

	Brief House of Representatives Homeland Security Staff	Briefing Support Materials
	Brief Senate Homeland Security Advisory Committee	Briefing Support Materials
	Brief FEMA Regional Directors and State Directors	Briefing Support Materials
	Conduct Planning Conference I	Conference Support Materials
3rd Quarter, FY 2007 April 1–June 30, 2007	Finalize Workshop Execution Plans	Workshop Execution Plans
	Finalize Plan Templates	Plan Templates
	Begin Scenario-Driven Workshops	Scenario, Workshop Support Materials, Draft Annexes
4th Quarter, FY 2007 July 1–September 30, 2007	Continue Scenario-Driven Workshops	Scenario, Workshop Support Materials, Draft Annexes
1st Quarter, FY 2008 October 1–December 31, 2008	Continue Scenario-Driven Workshops	Scenario, Workshop Support Materials, Draft Annexes
	Complete Interim S-1 Decision Matrix and Playbook	Interim S-1 Decision Matrix and Playbook (Draft)
2nd Quarter, FY 2008 January 1–March 31, 2008	Continue Scenario-Driven Workshops	Scenario, Workshop Support Materials, Draft Annexes
3rd Quarter, FY 2008 April 1–June 30, 2008	Complete Plan Integration Workshop	Scenario, Workshop Support Materials, Draft Integrated Annexes
	Training and Annex Testing	Training Materials, Testing and Evaluation Support Materials, Revised Drafts of Annexes
	Development of National Catastrophic Earthquake Concept of Operations	Draft National Catastrophic Earthquake Concept of Operations
4th Quarter, FY 2008 July 1– September 30, 2008	Finalize and Disseminate Plan	Final versions of all annexes and National NMSZ Catastrophic Earthquake Concept of Operations
2009–2010	Scenario-Based Training and Exercise of Plan	TBD
	State and Regional Exercises	TBD
2011	Major Command Exercise (200th Anniversary of New Madrid Earthquake)	TBD

Results

NEW MADRID
(Continued from other side)
The New Madrid Earthquake,
series of monstrous and lesser
began Dec. 16, 1811, and continued
centered here. One of the great
of the world because of severity
it caused little loss of life in a
region. Some of the shocks were
as 1100 miles. Reelfoot Lake acros
is a result of the disaster. New M
certificates, good for public land
were provided sufferers by U.S.
1815, which benefited mostly
In 1862 Union forces captured
and by means of a "canal" sawed
submerged forest to a bayou, gained
Island No. 10 and command of the
in Mississippi Co. is Belmont battle
of an 1861 engagement in which bo
forces under Grant and Confeder
Pillow claimed victory.
New Madrid, seat
5 Spanish district
first 5 count
Cotton

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Results

In the previous chapter, we discussed the comprehensive nature of the NMSZ Catastrophic Planning Project leading up to National Level Exercise 2011 (NLE-11). Figure 3 shows the specifics and complexities of the work that was accomplished over five years of effort and the products and changes that were produced, ultimately resulting in integrated earthquake response plans at the county, state, FEMA region, and national levels, including FIRP-E. More than 200 customized workshops were planned, coordinated, and conducted at the county, state, region, and national levels.

Capabilities Assessment and Gap Analysis

As a starting point, each state engaged in a capabilities assessment and gap analysis beginning at the county level. This proved to be such a time-consuming and difficult process for the mostly part-time county emergency managers that template products were developed to assist counties to prepare the necessary information in a format that could be integrated with the state and, ultimately, with the FEMA regions and FEMA headquarters. Capabilities assessments and gap analyses were done for each of the 230 counties in the primary impact zone, each of the eight states, and the four FEMA regions.

Workshop Execution Plans

A Workshop Execution Plan (WEP) was developed for each workshop based on the capabilities assessment and gap analysis as well as a series of meetings with key participants at the local, state, and region level. The WEP allowed for customization of the workshop for specific jurisdictions while maintaining a common operating picture, thus allowing integration of all the workshops. These products, customized for each state, set the stage for the scenario-driven catastrophic planning process and integrated locally relevant objectives with the overarching objectives for the project established by the CUSEC Board.

The products produced for each workshop included:

- A state-specific scenario;
- A participant's guide; and
- Workshop-specific documents as needed.

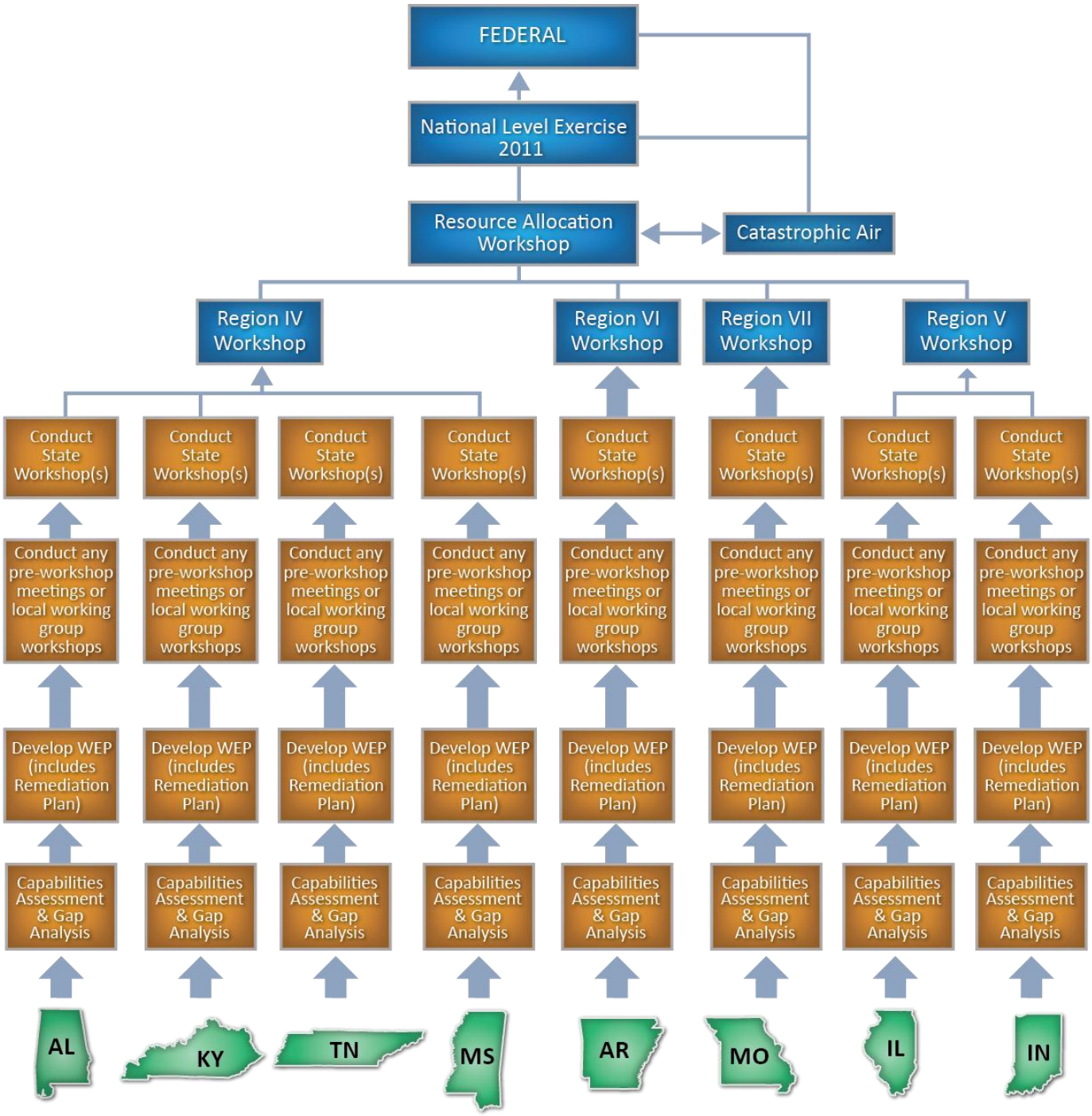


Figure 3: Workflow and organization of the New Madrid Seismic Zone Planning Project

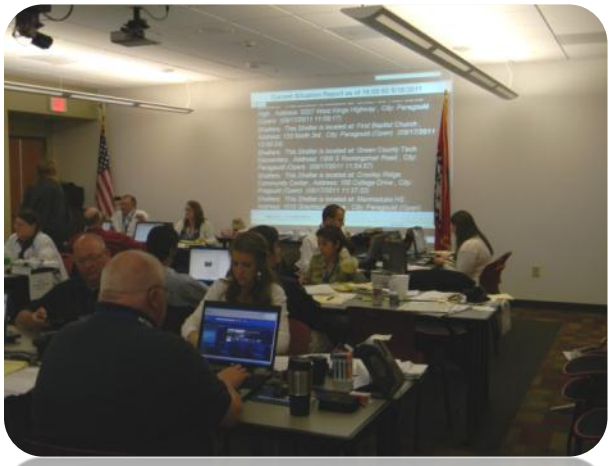
NMSZ Planning Workshops

"The New Madrid Project gave Tennessee the opportunity to create an entirely new state catastrophic response plan template. Tennessee now has coordinated catastrophic plans from the local community level to the FEMA regional level."
—MG James Bassham, State Director, Tennessee Emergency Management Agency

"Plans are of little importance, but planning is essential." This often-quoted aphorism illustrates what lies at the core of the entire NMSZ Catastrophic Planning Project—the planning workshops. The elements that make planning essential are the relationships that are formed and the barriers that are eliminated when participants from multiple jurisdictions, disciplines, and levels of government come together to focus on solving a single problem. CUSEC and the NMSZ Catastrophic Planning Project enabled local governments to develop catastrophic annexes to their emergency operations plans and provided contractor and material support for embedding them directly into each state and FEMA region. Nearly 200 workshops were conducted over the five-year period starting at the county level and working up through the state, federal region, and national levels. This effort led to the completion of 253 earthquake response plans integrated at the county, state, FEMA region, and national levels (see Figure 4).

Perhaps more importantly, the facilitated meetings and planning workshops created a venue for local leadership and disparate response disciplines to meet face-to-face and work together. Responders who work and plan together perform more efficiently and effectively in the face of a real disaster or emergency. This 'in-person' communication among stakeholders is becoming rare in the current fiscal environment and would not have happened in this instance without CUSEC and the NMSZ Catastrophic Planning Project.

In addition to developing response plans, the workshops unveiled previously unseen connections and new problems to be solved. This discovery process resulted in greater integration of disciplines and agencies outside the usual realm of emergency management response. Two major takeaways were the recognition of the huge scale of the recovery process and the fact that recovery needs to be integrated almost immediately into response activities to be successful.



Each workshop was customized to the characteristics of each state and FEMA region. Each state and region approached the process in a unique way to achieve results that best matched their individual needs but were integrated across jurisdictional lines.

Planning Tools	Emergency Services Decision Matrix Health & Medical Decision Matrix Human Resources Decision Matrix SAR Decision Matrix	Law Enforcement Decision Matrix County earthquake plan template State air operations plan template
AL	Capabilities Assessment and Gap Analysis Workshop Execution Plan County earthquake plan template	17 county earthquake plans 1 state earthquake plan
AR	Capabilities Assessment and Gap Analysis Workshop Execution Plan County earthquake plan template	35 county earthquake plans 1 state earthquake annex 1 state air operations plan
IL	Capabilities Assessment and Gap Analysis Workshop Execution Plan County earthquake plan template	18 county earthquake plans 1 state earthquake annex
IN	Capabilities Assessment and Gap Analysis Workshop Execution Plan	27 county earthquake plans 1 state catastrophic incident plan
KY	Capabilities Assessment and Gap Analysis Workshop Execution Plan	24 county earthquake plans 1 state earthquake operations plan
MS	Capabilities Assessment and Gap Analysis Workshop Execution Plan	28 county earthquake plans 1 state catastrophic incident appendix
MO	Capabilities Assessment and Gap Analysis Workshop Execution Plan	53 county earthquake plans 1 state annex Y - NMSZ earthquake plan
TN	Capabilities Assessment and Gap Analysis Workshop Execution Plan County catastrophic response template	49 county earthquake plans 1 state earthquake plan 1 disaster air operations plan
FEMA Region IV	Region Contingency Plan - Earthquake	
FEMA Region V	Region Contingency Plan - Earthquake	
FEMA Region VI	Region Contingency Plan - Earthquake	
FEMA Region VII	Region Contingency Plan - Earthquake	

Figure 4: Products produced during the New Madrid Seismic Zone Catastrophic Planning Project

A summary of the states' accomplishments during the NMSZ Catastrophic Planning Process is included here.

Alabama

The capabilities assessment and gap analysis gave Alabama a detailed risk assessment that led to several catastrophic planning workshops. By early 2009, the Alabama Emergency Management Agency had a well-organized and all-inclusive earthquake annex and a local template for county emergency management agencies to use to update their plans. This initiative laid the foundation for Alabama's NLE-11 preparations.

Arkansas

CUSEC and the NMSZ Catastrophic Planning Project enabled local governments in Arkansas to develop catastrophic annexes to their emergency operations plans (EOPs). The project provided contractor and material support for each county's planning group. NMSZ Catastrophic Planning discussions typically require materials and sometimes aggressive facilitation to find solutions for the long lists of the challenges that will be presented by a catastrophic event. The meetings held under the NMSZ Catastrophic Planning Project were the beginning of earthquake event gap analysis at the county level and of the annexes that were written for the counties' EOPs.

CUSEC and the NMSZ Catastrophic Planning Project accelerated Arkansas' shift to an Emergency Support Function (ESF) format. State and federal ESF coordinating agency points of contact became acquainted. The focus of planning at the state level widened to include more operational planning and not just roles and responsibilities. Stakeholders became aware that air assets are critical in earthquake response, which led to the formation of the Air Coordination Group in Arkansas. States surrounding Arkansas began to be included in the planning effort. With the resources made available through CUSEC and the NMSZ Catastrophic Planning Project, Arkansas has been able to make the transition to ESF response structure more quickly and smoothly.

Illinois

Although earthquake preparedness had been ongoing in Illinois for many years, the NMSZ Catastrophic Planning Project gave new emphasis to the hazard and the need to be prepared. The project allowed Illinois to conduct planning workshops, enhance response plans and procedures, and educate state and local officials on the potential impact of a catastrophic earthquake in the Central United States.

Illinois authorities developed a state-level earthquake annex to the Illinois Emergency Operations Plan as well as operational procedures for certain functions. They also updated the Illinois Department of Transportation Earthquake Plan. Additionally, Illinois developed local earthquake planning templates to enhance local jurisdictions' earthquake response and recovery plans; enhanced local earthquake plans in many municipalities

and counties throughout southern Illinois; and provided maps, charts, DVDs, and other resources to local officials to support their planning activities.

Indiana

Through the NMSZ Catastrophic Planning Project, Indiana developed its first comprehensive Earthquake Annex to the Comprehensive Emergency Management Plan in 2008. Continued work led to the revised NMSZ/Wabash Valley Earthquake Catastrophic Plan drafted in 2010.

As part of the planning process, Indiana conducted seven major state and regional planning workshops across the state and six local workshops, involving approximately 100 planning partners. By this means, state planning staff accumulated response information from 30 counties and more than 25 departments and state government agencies. During facilitated discussions and panels, participants and jurisdictions were asked what resources they possessed and what resources and personnel they would need to fulfill their response and recovery needs following a catastrophic earthquake event on the NMSZ. Participants were also asked to develop new concepts and response operations to improve reaction to citizens' disaster needs and plan for outreach and inclusion of private-sector and "Whole Community" partners in the planning process. After development of a statewide catastrophic plan document, a new template was developed for use by each of the NMSZ risk counties.

As a result of the funding and personnel provided by the NMSZ Catastrophic Planning Project, meetings were held with all response and recovery support functions, including law enforcement, emergency medical services, fire, search and rescue, and private-sector groups, and each of the 27 counties in the earthquake risk zone have been able to complete these catastrophic event jurisdictional plans, which are separate from their County Comprehensive Emergency Management Plans. Meetings were also held across the state with local emergency managers and response leaders to produce a comprehensive plan for the coordination of commodity and resource transportation flows into disaster areas using highway, rail, air, and waterway transportation systems.

Kentucky

The concept for detailed planning for a statewide response to a catastrophic earthquake event was a long-held mission for Kentucky Emergency Management. Through the NMSZ Catastrophic Earthquake Planning Project, Kentucky was able to develop a coordinated response plan fully integrating local, county, and federal resources in an informed response to a catastrophic earthquake along the NMSZ. In March 2008, the Commonwealth Earthquake Planning Workshop was held in Paducah, focusing on integrating the eight CUSEC planning priorities with the Commonwealth's planning efforts, allowing for a facilitated workshop of the event using Kentucky's planned response at the local, regional and state levels. The results of this

workshop highlighted the complexity of the event and the difficulty of implementing the potential response measures required to manage the event and its consequences.

Of significant note, the Commonwealth activated its earthquake plan in response to a major winter ice storm that struck the Commonwealth's NMSZ potential impact area in late January 2009. This response identified areas where Kentucky's response was right and areas needing significant improvement. From this disaster, the Commonwealth developed a planning process called Active Planning that revitalized planning efforts and produced actionable, meaningful plans that set goals, assigned objectives, and tasked resources to develop recognizable end-states of caring for citizens during the worst disaster the Commonwealth has ever seen. The key to Active Planning is the involvement of the whole community in the response and management of disasters and emergencies. This process was validated in late 2010 when it was used to develop plans for the World Equestrian Games and then fully implemented during NLE-11.

Mississippi

Mississippi conducted six catastrophic planning workshops between November 2007 and October 2009. From the information obtained in these workshops, several counties conducted follow-up tabletop exercises. In April 2010, Mississippi and Tennessee held a joint resource planning conference. This meeting of key ESF representatives—approximately 15 per state—allowed the two states to determine shortfalls and to collaborate on ways to improve communication and resource management.

Missouri

Over the past five years, the Missouri State Emergency Management Agency (SEMA) has worked diligently on a catastrophic planning process that revised and updated its existing earthquake response plans and resulted in Annex Y in the state EOP and Annex O in local response plans.

Thanks to the partnership, funding, planning support, and organizational efforts of CUSEC and its member states, FEMA, and FEMA Region VII, SEMA was able to convert Annex Y into the FEMA Region VII/state of Missouri Joint NMSZ Catastrophic Earthquake Response Plan and train with all state and federal ESFs, local governments, volunteer groups, and the private sector. From the ground up, beginning at the city and county level and leading to a statewide planning workshop, SEMA's exercise staff worked alongside its state and federal counterparts during multiple events to plan and prepare for a catastrophic disaster.

Missouri's regional workshop and planning sessions with state and federal ESFs prepared the state's emergency response planners and provided an opportunity for comprehensive planning to coordinate mobilization, staging, deployment, tracking, and demobilization of the vast amount of resources needed to respond to a catastrophic event such as a NMSZ earthquake.

SEMA recognized the huge scope of requirements for disaster response support sites and, as part of the planning, initiated a new planning effort, Disaster Terrain Management, to identify, secure, and deconflict (with the ESFs, the Missouri National Guard, and key critical infrastructure and private-sector partners) the use of response sites for local, state, federal, and private-sector entities. The sites throughout the eastern half of Missouri included staging areas for responders and logistics, state points of distribution (generators, heavy equipment, transportation, and fuel), communications, and State Area Coordination Centers (SACCs).

Similar to military forward command posts, SACCs have key roles in coordination and communications; reception, staging, onward movement, and integration of Emergency Management Assistance Compact (EMAC), volunteer, mutual aid, and other responder support. SACCs also coordinate and manage logistics support, such as base camps (temporary housing, feeding, personal hygiene, laundries, communications, etc.), responder and logistics staging areas, and state points of distribution. In addition, SEMA established sound working relationships with:

- Six Flags Over Mid-America amusement park near St. Louis to use a sizeable portion of its extensive parking complex for disaster support operations;
- The city of St. Charles for use of its large, modern soccer complex and the St. Charles Convention Center;
- The city of St. Louis for use of its main city park and Metropolitan Opera facilities and parking;
- The city of Sikeston, which offered the use of a huge sports complex;
- The city of Malden, which offered a former military airport, now owned and operated by the city;
- Three Rivers College in Poplar Bluff, which offered its entire campus to serve as a SACC;
- The city of Carthage, which offered a sports complex; and
- The city of Joplin, which offered a major league sports arena parking lots.

SEMA continues this effort in other cities across Missouri.

In other actions, SEMA:

- Worked to identify which federal and state Disaster Logistics Centers will serve as primary support for states west and the states east of the Mississippi River;
- Initiated ground transportation movement coordination planning to ensure responder entry (moving from areas as far away as the other side of the state) to access into the disaster area (i.e., badging and credentialing) and provide redirection and control of traffic when the highway system is disrupted by the earthquake, the response and subsequent evacuation with their attendant logistics challenges, and disaster operations;
- Developed tactical field fueling operations, including how to better interface with the National Fuel Contract and the state's large suppliers at the wholesale level, to establish field fueling sites, find and use fuel storage facilities during the disaster, incorporate federally provided supplies with state-procured supplies (if any), manage fuel rationing (if necessary), and determine how to communicate the need for such rationing (if necessary) to coordinate with local retailers for a transition back to them when repairs near completion;
- Began integrating Air Operations support for logistics and resources and more intensively coordinating for the interstate/intrastate movement of commercial resources;
- Developed augmentation/surge staffing for disaster logistics and resource management, including EMAC and contracted support and improved disaster/emergency contracting pre-disaster, during the disaster, and early post-disaster for continuing response operations over an extended period, including the use of temporary leases for facilities, employing GSA contract schedules, and determining when it is best to use U.S. Army Corps of Engineers or state contracts for food, water, and ice; and
- Developed and implemented a successful program for the full integration of Business Emergency Operations Centers to support response and recovery.

Tennessee

Using the NMSZ Catastrophic Earthquake Planning Project's embedded planner enabled Tennessee to produce five major local and state planning products:

- The Tennessee Catastrophic Response Plan (CAT Plan), which provides for multi-level statewide direction and control management of all ESFs built around a time-phased automatic activation and response principle
- The Tennessee Catastrophic Logistic Plan annex to the CAT
- Local county CAT Plan template, which integrates the state CAT Plan with local government assets and resources
- Integration of TN CAT Plan with FEMA Region IV CAT response plan
- Tennessee Resource Allocation Guide (gap analysis)

Over the five years of the Catastrophic Planning Project, Tennessee completely rebuilt and revised its catastrophic strategy for disaster response. The project allowed Tennessee to conduct a "bottom-up" approach to constructing state and local catastrophic plans. The project provided the planning support and coordination through CUSEC and the embedded project planner to organize and execute four major statewide workshops that brought together local government responders (law enforcement, emergency medical services, fire, nongovernment organization, private-sector, and emergency management) with state emergency managers, CUSEC, and FEMA Region IV decision makers.

Approximately 200 to 300 partners attended each workshop. They not only helped construct the CAT Plan but also helped verify the concept of the time-phased automatic response actions in the CAT Plan. The workshops also allowed local responders to identify and document resource gaps present in their individual jurisdictions and allowed state emergency managers to base the state CAT Plan on facts and actual responder needs.

The project planning effort also created the opportunity for multi-state coordination of response issues that would impact adjoining states. Tennessee and Mississippi held a joint-issues workshop facilitated by project staff at CUSEC that addressed common NMSZ event concerns, including transportation (route clearance and designation agreements), medical protocol assistance, shelter support assistance and strike team development, interoperability of communications systems, EMAC National Guard assets, and coordination of unit deployment.

"The RAW was the first time we had an accurate picture of just how significant the resource gap would be during an event of this size, not just for our state but for the entire region."
—Mr. Jonathon Monken, State Director, Illinois Emergency Management Agency

Disaster Air Operations Workshops

One of the early discoveries was that aviation would be critical to a successful response, especially with surface roads expected to be impassable. Each state planned to use the same aviation resources and would attempt to control airports and airspace within their states. Three Air Operation Workshops were conducted with planning ongoing for future workshops.

Resource Allocation Workshop

Another key discovery in the workshop planning process was the recognition that resources at all levels would be limited and coordination in the adjudication process would need to focus on the shortages identified by each state. The capabilities assessment and gap analysis

showed tremendous gaps between what resources were available in each state and what would be needed in a response to a catastrophic earthquake. Recognizing this was a regional and national issue, CUSEC developed the Resource Allocation Workshop (RAW), the first of its kind in the nation prior to NLE-11.

The RAW provided a forum for states to work with their federal partners, understand their strengths, and realize the gaps that exist in their resources. The RAW also focused on the use of EMAC and allowed the eight impacted states an understanding of what their border states can bring to the response.

The inter-agency discussions and solutions that were developed for the problems identified in a catastrophic incident led directly to better and more robust responses from the states to more common disasters such as the April 2011 tornado super outbreak and the spring 2011 flooding that impacted states along the Mississippi River.

National Level Exercise 2011

NLE-11 allowed states, federal departments and agencies, and the private sector the opportunity to implement local, state, and federal catastrophic incident earthquake response plans by simulating an earthquake incident in the NMSZ. NLE-11 took place on May 16–19, 2011, and featured an exercise among state and county emergency operations centers (EOCs), FEMA's Regional Response Coordination Centers, FEMA's National Response Coordination Center, and federal departments' and agencies' national and regional operations centers.

The NLE-11 Coordination Group, in addition to state and local government organization planners, were the principle entities responsible for the exercise oversight. Its membership selected six capabilities as the foundation for development of the exercise objectives and scenario. The exercise capabilities allowed the states to focus on key areas that were identified in the planning process. Those capabilities were:

- Communications
- Citizen evacuation and shelter in place
- Mass care (sheltering, feeding, and related services)
- Critical resources logistics and distribution

- Emergency public information and warning
- EOC management
- Medical surge

NLE-11 was a complex event that required detailed planning. To conduct an effective exercise, subject matter experts (SMEs) and representatives from numerous agencies took part in the planning process. This allowed for sharing of information previously known only by the SMEs.

CUSEC provided the mechanism for scenario development and regional coordination. The CUSEC Board of Directors focused on overarching objectives impacting all states in the NMSZ. This coordination would have been much more labor intensive if each state had to reach out to the other impacted states on its own.

As the first National Level Exercise to exclusively focus on a catastrophic natural hazard response, NLE-11 was a success, and feedback indicated players benefited from the scenario of the exercise. The preparation leading up to NLE-11 solved many issues, and many more were discovered. Without the planning process, NLE-11 would not have been a success. As with the Catastrophic Planning Project, each state approached planning and preparation for NLE-11 in a way best suited to its methods of operation. A summary of their accomplishments in preparing for and participating in NLE-11 is included here.

Alabama

The Alabama Emergency Management Agency conducted Concepts and Objectives (C&O) meetings with all the impacted counties. The results of these meetings were collected and presented at the CUSEC and national C&O meetings. After the National Initial Planning Conference for NLE-11, Alabama created working groups to coincide with the national working groups. These working groups conducted a series of meetings and presented the information gathered to the national and regional working groups. These working groups allowed the state to establish relationships and discussions among partners that normally would not have occurred. The working groups played a pivotal part in the state's planning by establishing a communication system that allowed tasks to be completed in an efficient manner.

On November 17, 2010, Alabama conducted an earthquake tabletop exercise to set the foundation for Master Sequence of Events List, issues, and objectives for the NLE-11. There were approximately 95 participants from 17 counties and multiple departments and agencies at the state and local levels. The tabletop exercise addressed issues associated with response coordination, public information, and public health and medical surge.

About two weeks prior to the NLE-11, Alabama experienced a disastrous outbreak of tornadoes. As a result, the state was not able to participate in the NLE-11 as planned. However, the state credited its enhanced response to the tornadoes to planning and preparation for the NLE-11 and its participation in the RAW. Alabama prepared its response to sheltering, rescue teams, damage assessments, and other areas of responding to a catastrophic disaster in detail and was able to act on those issues in a real-world response. The many relationships and partnerships established during the NLE-11 planning process made it easier for various jurisdictions and levels of government to communicate during the tornado response.

Arkansas

For many of Arkansas' new ESFs, NLE-11 was the first large exercise that those state departments and agencies participated in as an ESF. The planning process kept them engaged and educated about the importance of planning, training, and exercising as a group. NLE-11 capitalized on and enhanced collaborative relationships among state, federal, and local jurisdictions, the private sector, and nonprofit organizations.

Arkansas and FEMA Region VI jointly designed a catastrophic earthquake response plan. In preparation, an E-hour sequence defining associated actions to be performed after an earthquake occurs ("e-hour" being the hour an earthquake hits) was created, allowing state agencies to develop a timeline, pre-scripted tasks, and requests. The plan took into account previous planning efforts and was exercised in the Rehearsal of Concepts (ROC) Drill in the lead up to NLE-11 (see Figure 5). The ROC Drill outlined the importance of identifying staging areas for federal, state, and local distribution of resources.

Figure 5: Arkansas—FEMA Region VI Rehearsal of Concept Drill

Illinois

Illinois's efforts in preparation for NLE-11 included planning and exercise activities coordinated with local governments, federal agencies and other organizations. State and local leadership and emergency planners and responders hosted, conducted, and participated in these activities. Workshops were conducted to discuss a variety of issues, including logistics, commodity distribution, energy assurance, mass care, geographic information systems (GISs), external affairs, and resource allocation. Planning meetings focused on topics such as gap analysis, resource management, air operations, force protection, logistics, commodity distribution, and critical facility power assessment.

Exercises and tabletops were conducted at the state's regional and local levels. I-Quake, a full-scale state-level exercise, was conducted in 2008. In preparation for NLE-11, dozens of exercise planning meetings and conference calls on the local, state, regional, and national level were conducted in accordance with HSEEP. These included concept and objectives meetings, initial planning conferences, mid-term planning conferences, final planning conferences, scenario workgroup meetings and inject development meetings.

Indiana

Indiana's participation in NLE-11 began on May 16, 2011, and included more than 1,200 participants from 51 local, state, and federal organizations representing nearly 75 percent of Indiana's 92 counties. This exercise was the largest full-scale exercise ever undertaken in Indiana and proved to be a successful test of the state's Catastrophic Earthquake Plan. The validation of three of Indiana's 10 District Response Task Forces added to the successful outcome of the exercise. Indiana's first responders and emergency managers walked away with countless successes and lessons learned, helping them to be better prepared should a catastrophic earthquake impact the state.

During April 2011, flood conditions occurred throughout central and southern Indiana. In response, the Indiana Department of Homeland Security (IDHS) deployed a Type III District Response Task Force Incident Management Team (IMT) for the first time. The IDHS District 6 IMT was integrated into the first-ever-deployed District Multi Agency Coordination Center (DMACC), which coordinated flood-fight efforts and responded to resource

requests from IDHS District 10. Validation of the District Response Task Forces was a key element in Indiana's participation in NLE-11, and the use of the District 6 IMT prior to NLE-11 proved to be a key success of the planning process.

Kentucky

Kentucky participated in a significant number of lead-up events to NLE-11, including the CUSEC Lead Catastrophic Response Plan Effort, Resource Allocation Workshop, Commonwealth Group Planning Workshops, tabletop events, and a fully synchronized Rehearsal of Concept workshop the week prior to actual events. Exercise highlights for the Commonwealth are listed below:

- *Alert Notification.* More than 10,000 individuals and agency representative participated in a Day 1 Alert Notification exercise, which used state-of-the art web-based reporting to capture the response and message receipt effort and provided a full repository of successful contacts.
- *Citizen Participation.* Kentucky Emergency Management's (KYEM) preparedness staff used web-based technology to greatly extend citizen participation during the exercise week. Thousands took part in a four-day interactive tutorial that provided daily preparedness lessons and a quiz that captured quality assessment feedback.
- *Communication Exercise.* The integrated nature of the communications exercise raised the bar for all future exercises. Of significant note and success was the outstanding effort by members of the KYEM staff and its amateur radio network personnel to extend the boundaries of amateur radio and Military Auxiliary Radio System to the far western borders of the state.
- *Deployment of the Unified Area Command.* For the first time in Kentucky's exercise efforts, a fully functional Unified Area Command comprised of a Joint Task Force (JTF) element from the Kentucky National Guard (KYNG) and a Commonwealth Emergency Operation Center—Forward (CEOC-F) element operated in a unified manner by establishing an operating headquarters at the Wendell H. Ford Regional Training Center.
- *Deployment of the Joint Task Force.* KYNG deployed a JTF under the command of Brigadier General Mike Richie made up of members of both the U.S. Army and Air National Guard. The JTF oversaw situational awareness and task management of all military forces, both Title 32 and Title 10, in the impacted area.
- *Deployment of CEOC-F.* Using a newly constructed model initially honed in the May 2011 flood response, KYEM, along with numerous cabinet and federal partners, established a fully functional forward operating element. The CEOC-F worked side by side with the KYNG JTF to seamlessly integrate civilian-military operations throughout the response area.
- *Development and Execution of the Joint Air Operations Center (JAOC).* The Kentucky Air National Guard and KYNG 63rd Aviation Brigade Headquarters established complete control of the airspace and air tasking missions in support of the operations. The JAOC developed and implemented new strategies to deal with the complexities of air tasking, air operations, and air support across the Commonwealth.

- *Daily AM and PM Framing Injects.* To drive specific levels of play and ensure the Commonwealth was able to engage each of the target capabilities addressed in the exercise, each day began and ended with a specific set of framing injects that addressed the situation of the day and the results obtained at the end of the day.
- *Ongoing After-Action Reports.* Kentucky implemented a unique online capability to collect daily personal after-action reports (AARs) from active exercise participants and citizen participants. Several thousand ongoing observations were reported. Organizational AARs were completed on a daily basis and summarized at the end of the week in a formal "hot wash" with the principle organizational elements.

- *Deployment of Search and Rescue Task Force.* Kentucky developed and implemented a unique approach for managing the complexities and difficulties encountered when attempting to meet the needs for both urban search and rescue with a high component of technical rescue requirements and widespread search-and-rescue missions across a 24-county front.
- *Development and Execution of the Integrated Commonwealth Analysis and Assessment Group (CAAG) with Call Center and Tagged Named Areas of Interest for Tier 1 and Tier 2*. A major advancement in situational awareness was tested and proved capable throughout the exercise as more than 40 members of the newly formed CAAG established a full set of capabilities, including call-center support, on-the-move analysis, and updated situational awareness for the Commonwealth Command Group. Great strides were made in conceptualizing and executing a call-down list for critical infrastructure, bringing the response to the impacted area in record time.

Kentucky treated NLE-11 like a master's-level graduation event. The lessons learned and new techniques produced will form the training foundation for the Commonwealth for the next two to three years. The success of the planning effort was obvious as Kentucky responded to the dramatic and devastating spring 2011 floods that caused more than 64 counties to declare states of emergency and the historic flooding on the Ohio and Mississippi rivers in the Commonwealth.

Mississippi

In the six months leading up to NLE-11, Mississippi conducted initial, mid-term, and final planning conferences averaging approximately 100 participants. Mississippi representatives also attended national NLE planning conferences. As a rehearsal for NLE-11, the state planned a tabletop exercise for April 2011 based on the results of workshops and exercises; unfortunately, it was canceled due to Mississippi River flooding. Mississippi also drastically scaled back its participation in NLE-11 because of this and other actual disasters. Nevertheless, the state's response to these real-world events was enhanced because of improved

coordination among county emergency management agencies that participated in the NMSZ Catastrophic Planning Workshops and exercise planning conferences.

Missouri

Representatives from the entire spectrum of emergency management—first responders from the local level, state ESF responders, federal ESF officials who staff Joint Field Offices, volunteer organizational planners, and the private sector—collaborated to develop the plan and conduct NLE-11 in a manner very similar to the way they work together to respond to an actual incident. In fact, all this work paid huge dividends when a catastrophic level tornado struck Joplin less than two days after the end of NLE-11.

State preparations included air operations, communications, other workshops, and individual tabletop exercises with all ESFs; formation of a Business Emergency Operations Center partnership that trained and exercised in 2010 and 2011, participating in NLE-11 and activating to support Joplin following the tornado disaster in May 2011; a preliminary state-level earthquake exercise held in June 2010; a communications exercise held in in January 2011; and NLE-11 held in in May 2011, including a full-scale medical component with a mobile medical unit and patient movement efforts and private-sector demonstration cellular communications equipment that later was redeployed to support Joplin.

Tennessee

The Planning Project coordination led by CUSEC to organize and conduct the first region-wide RAW was a "ground-breaking" product. This workshop addressed regional and national disaster logistics gaps caused by a NMSZ event. Federal, state, and local government responders and planners were able to identify and document exact equipment and personnel needs for a catastrophic disaster occurring in the Eastern United States.

The NMSZ Catastrophic Planning Project and the RAW workshop was the perfect preparation for NLE-11. The changes made in strategy and operations as a result of preparation for NLE-11 had a direct impact on the state's successful response to the real world tornados and flooding that impacted Tennessee in 2011.

Summary of Significant Activity

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Summary of Significant Activity

The NMSZ Catastrophic Planning Project represents five years of effort by FEMA, CUSEC, USGS, and other organizations to raise the level of emergency preparedness capabilities in each of the eight CUSEC member states. The achievements of this project will directly reduce loss of life and property damage in all future disasters, not just earthquakes. This chapter highlights some of the notable accomplishments over the past five years.

2007 NMSZ Catastrophic Planning Conference

CUSEC and FEMA conducted this kick-off conference to present the project. Representatives from each of the eight states and four FEMA regions attended and helped shape the way forward. This initial planning conference was a key element in the success of the project. As part of the project, FEMA provided contract emergency management planners in each of the eight CUSEC member states and each of the four FEMA regions. The embedded planners were dedicated to earthquake planning, taking the load off the limited personnel in the states and the regions. They assisted CUSEC in coordinating efforts across jurisdictions, disciplines, and levels of government and with the private sector.

> "Tennessee would not have been able to complete the Catastrophic Planning Project without the Project embedded planner. There is no way to over-emphasize the importance of this planning assistance."
> —MG James Bassham, State Director, Tennessee Emergency Management Agency

Scenario Development

The concept selected to achieve success was a scenario-driven catastrophic response plan development process, which, at the time, was a new and unique approach. This process places operators in the same room with planners to develop plans based on real-world modeling. In other words, the people who respond to a disaster are integrally involved in writing the plan they will eventually use. When dealing with such a wide range of partners, it was critical that all were planning toward the same goal. To that end, CUSEC and FEMA contracted the MAE Center, George Washington University, and Virginia Tech University to develop a scientifically credible scenario. The final report covered the entire region and focused on each state individually. The scenario was the basis for all the planning workshops and led to the discovery of previously unforeseen cascading impacts. Local jurisdictions, states, and FEMA all used the same scenario to drive their planning process. The National Infrastructure Simulation and Analysis Center of Sandia National Laboratories was also contracted to produce an analysis of the impact of a catastrophic earthquake in the NMSZ on the national energy infrastructure.

"This project involved an impressive commitment from the state of Missouri, as well as our partners from the local and federal levels. I know that representatives from a number of state departments and agencies found this planning process to be very informative and rewarding. We feel this project will help us more effectively respond in the event of a significant event such as a recurrence of the 1811-12 Great New Madrid Earthquakes."
—Mr. Paul Parmenter, Director, Missouri State Emergency Management Agency

State Workshops

The scenario-driven planning concept combined the planning and exercise phases of plan development through a workshop format. Breakout rooms and action rooms were used to develop topic-specific plans. The accelerated process resulted in functional plans ready for immediate use. Each state customized the workshop process by adding state-specific topics. States started by hosting a series of small workshops with local jurisdictions and developed local planning templates that fed into the overall state plan. Once local planning workshops were completed, each state held one or more statewide workshops, bringing together all state agencies along with their local and federal counterparts, elected officials, utilities, volunteer groups, and the private sector. State response plans were developed out of these workshops and led directly to FEMA region plans.

FEMA Region Workshops

After the state workshops, each of the four FEMA regions held a similar workshop that emphasized federal coordination with the CUSEC member states in its region. Each region customized the workshop process by adding region-specific topics specific. Representatives from each FEMA regions attended each other's workshop along with representatives from the national headquarters of most federal departments and agencies. The planning process in these regional workshops led directly to the discovery of the need for a national-level workshop to deal with the allocation of the vast amount of response resources needed from the federal government as well as from states outside the impact area.

Disaster Air Operations Workshops

Among the early discoveries were that aviation would be a critical element of a successful response, given that surface roads were expected to be impassable; each state planned to use the same aviation resources; and each state would attempt to control airports and airspace within its borders. Quickly recognizing this would be an unworkable response, FEMA used a parallel program, the Mass Evacuation Planning Project, to host an Aviation Planning Conference in Memphis in 2009 that focused on catastrophic disaster response. One of the results of this workshop was a renewed interest in the state and Regional Disaster Airlift planning program. This Federal Aviation Administration planning program ended in 1998

but was revised in 2009 by FEMA, producing a planning template to assist states in integrated air operations planning. Tennessee and Arkansas led the way by conducting their own Aviation Planning workshops and producing model plans to integrate state and federal partners in the control of airspace and the use of airports and aviation resources that will be critical to a response where surface roads are impassable.

Resource Allocation Workshop

Over the five years of work on the NMSZ Catastrophic Planning Project, CUSEC recognized that, in the event of a truly catastrophic disaster—one that crossed all eight NMSZ states—resource allocation would be a critical factor. A NMSZ earthquake would require responses from the 10 states bordering the impacted states, four FEMA regions, and all 15 federal ESFs, departments, and agencies. In addition, it was recognized that the restoration of lifeline services would require the full integration and support of business and industry.

At the request of FEMA Deputy Administrator for Operations Bill Carwile, CUSEC was afforded the opportunity to meet with the FEMA Emergency Support Function Leadership Group (ESFLG) to present the concept of the RAW. CUSEC Chairman BG John Heltzel met with the executive and operational levels of the ESFLG on several occasions. The end result was a collaborative effort between CUSEC, the FEMA National Exercise Division led by Dr. Keith Holtermann, and the National Emergency Management Association (NEMA) led by Director Trina Sheets to put together the RAW, a dynamic, multi-day workshop for identifying resource requirements and developing an understanding of national

"The RAW was a groundbreaking effort that transcended Cat Planning and should be considered a powerful approach to doing regional planning in general."
—BG John Heltzel, State Director, Kentucky Division of Emergency Management

capabilities.

"The results of the [RAW] workshop cannot be underestimated in how much better the nation is prepared for the response to this catastrophic disaster."
—Mr. David Maxwell, State Director, Arkansas Department of Emergency Management

This workshop brought together 500 people representing state and federal partners, academics, volunteer groups, and the private sector to concentrate on coordinating, mobilizing, staging, deploying, and tracking the vast resources from across the nation that will be needed to respond to a catastrophic NMSZ earthquake. State planners gained an understanding of how to integrate the ideas, best practices, and experiences of participants to better solidify strategies for responding to and recovering from a catastrophic earthquake. The RAW was an outside-the-box effort for dealing with the very real problems created by the lack of communication between local government and state and federal partners concerning resource gaps and needs in communities. This bottom-up workshop became a national phenomenon and is considered by all the state directors to be a "best practice" that should be shared with all responders at any level.

The Great Central U.S. ShakeOut

In April 2011 after two years of planning, communities throughout the CUSEC member states and associate states of Georgia, Oklahoma, and South Carolina took part in the largest earthquake preparedness effort in the region's history, the Great Central U.S. ShakeOut. This was a multi-state earthquake drill where participants simultaneous practiced the recommended protective action to take during an earthquake. The event was open to the public and was designed to encourage people to think about how they would react if an earthquake were to strike and prompt them to take preventative measures before one actually hits.

Drills were held at in all states at 10:15 a.m. on Thursday, April 28, and more than 3 million people across nearly 10,000 sites participated in the event. The Great Central U.S. ShakeOut was so successful that it won the 2011 FEMA Individual and Community Preparedness Award for Outstanding Drill, Exercise, or Event. This honor recognizes the achievements of individuals who work every day to increase awareness regarding earthquake hazard in the Central United States and promote greater preparedness efforts among its

citizens, businesses, and all levels of government. Leadership from NEMA, the International Association of Emergency Managers, and FEMA selected this event as an award recipient out of numerous applicants among 36 states, Puerto Rico, and the Virgin Islands. Award submissions reflected the whole-of-community approach to emergency management and included entries from faith-based, tribal, nonprofit, private sector, community-based organizations, and individuals. Out of these many submissions, the Great Central U.S. ShakeOut was selected as a creative approach to educating and promoting earthquake readiness.

National Level Exercise 2011

Five years of scenario-driven catastrophic planning culminated in NLE-11, which was based on a NMSZ earthquake. This was the first NLE that was based on a natural disaster. CUSEC began preparing early for NLE-11, forming the CUSEC Exercise Officer Working Group in 2007. Made up of representatives of its eight member states, CUSEC led the group to consensus on the construct of the exercise. CUSEC worked to establish the objectives of the exercise, established a unified scientifically valid scenario, developed a long-term recovery objective that included the eight states conducting a recovery workshop 45 days after the NLE, linked the Great Central U.S. ShakeOut drill to the NLE and integrated the emergency management and scientific communities in the response process. Activities during the workshop included:

- Each state briefing its emergency response plan in accordance with the earthquake threat;
- Two and a half days spent in a "round robin format" in which each state met with each ESF partner to discuss what it could provide for the state; and
- A back brief, during which each ESF discussed its concept of execution and the main issues that need more discussion.

During the workshop, participants identified that they would be asking for a significant number of EMAC requests from other member states as well as the federal government during a catastrophic earthquake. Requested resources included medical and law enforcement personnel and required states to address licensing, jurisdiction, and liability issues never before dealt with at this level. The RAW workshop was the first of its kind in the nation and provided a template for future planning efforts.

Regional Presidential Video Conference

On Day 2 of the exercise, President Barack Obama conducted a multi-state, multi-regional conference call with the governors, adjutant generals, and emergency management directors of all eight impacted states. The occasion presented a rare opportunity to speak directly with the President, Vice President Joe Biden, Secretary of Homeland Security Janet Napolitano, and FEMA Administrator Craig Fugate on issues facing the states in both the real-world operation and exercise response operations. This level of access and realism lent great credibility to the efforts to understand roles and responsibilities and improve communications in an unfiltered, realistic environment. Among the critical issues discussed were resource deconfliction, implementation of the role of the dual status commander in military response missions, and fully implementing the capabilities of the federal response.

Multi-Jurisdiction Integrated Response Plans

The culmination of five years of effort was the development of more than 253 catastrophic earthquake response plans vertically and horizontally integrated at the local, state, region, and national levels. The primary significant final works were:

- Federal Interagency Response Plan for Earthquakes (FIRP-E) in 2011;
- CUSEC Multi-State Coordination Annex to coordinate the response from the eight affected states;
- CUSEC Multi-State Clearinghouse Coordination Plan to integrate the gathering of scientific data and research following an earthquake;
- Catastrophic earthquake response plans for each of the eight states; and
- Catastrophic earthquake response plans for each of the four FEMA regions.

Training Development

Going well beyond planning workshops throughout the five years of the NMSZ Catastrophic Planning Project, CUSEC also developed and conducted a number of training courses that provided valuable additions to the process.

- **Disaster Medicine 101**

  CUSEC partnered with the Centers for Disease Control and Prevention to develop an overview of the public health concepts related to the catastrophic earthquake hazard. Course material included public health surveillance and assessments, injury expectations, environmental health impacts, and mental health impacts.

- **Disaster Medicine 202**

  CUSEC brought together a variety of emergency medicine subject-matter experts to develop a two-day course on mass casualty management specific to the catastrophic earthquake hazard. Experts in the field provided training in field response, long-term emergency medical management, and public health integration.

- **Course: The Central U.S. is Earthquake Country**

  Until this course, developed by CUSEC, no standardized program of instruction existed that all eight states used for public awareness and education. All the state earthquake program managers and state geologists provided input and reviewed the content. This course was used as primary training for participants in the NLE-11.

- **Earthquake Awareness for TSA Employees**

  Building on the success of "The Central U.S. is Earthquake Country" course, CUSEC partnered with the Transportation Security Administration (TSA) to create an awareness course specifically for TSA employees at the Memphis International Airport.

Public Awareness and Education

Public awareness and education initiatives are essential to ensuring citizens know what to do in the event of an earthquake. CUSEC developed and supported public outreach projects during the five years of the project. A CUSEC Public Information Officer (PIO) Working Group continues to serve as the central think tank for public outreach ideas and implementation strategies. In addition to the PIO Working Group, CUSEC had the following accomplishments:

- Development of a standardized media release format for all PIOs
- Development of standardized pre- and post-earthquake public information messages
- Development of an earthquake education and outreach information CD
- Development of a PIO media guide

CUSEC Working Groups

CUSEC excels at bringing together disparate groups, disciplines, and agencies to build the relationships that are the core of a successful response to a catastrophic disaster. The relationships and partnerships developed in the CUSEC Working Groups break down the jurisdictional lines and silo thinking. The major CUSEC Working Groups are:

- **Operations Officers Working Group**

  This working group deals with operational issues and cross-state direct assistance. They work to increase the ability of CUSEC member states to coordinate their interstate response and early recovery efforts to deal with a NMSZ event.

- **Transportation Task Force**

  Funded by the U.S. Department of Transportation, this task force was one of the originally created groups dealing with transportation interoperability between the states.

- **Public Health and Medical Services Working Group**

  This working group addresses public health and medical issues arising out of a catastrophic disaster along with interoperability between states.

- **Earthquake Program Managers Working Group**
  Program Managers set goals and program activities each year that will be carried out in their state and in the CUSEC region. The Program Managers also help CUSEC develop products and programs that they would otherwise be unable to implement in their state, due to funding, manpower, or other limitations.

- **Public Information Officers Working Group**
  The group is comprised of the Public Information Officers from each member state emergency management agency and public information representatives from other organizations. This group has created a working relationship that allows them to easily exchange ideas and share public information plans and resources.

- **Association of CUSEC State Geologists**
  The State Geologists provide the critical link of the science and understanding of the earthquake hazard to the emergency management stakeholders. Their work provides the basis for scenario development and risk assessment. As part of the NMSZ Catastrophic Planning Project, Association members developed plans for coordinated response to an earthquake, which includes development of the "Post-Earthquake Technical Information Clearinghouse" response plan.

- **Exercise Officers Working Group**
  The working group plans and coordinates earthquake exercises such as Spills of National Significance (SONS) 2007 and NLE-11.

- **Communications Officers Working Group**
  This working group deals with all forms of communication among state and federal agencies and private-sector partners to ensure the capability to send and receive timely and accurate information.

- **Technology, Imagery, and GIS Working Group**
  This working group is focused on the seamless sharing of the common operating picture and geographic data among the state and local jurisdictions. All eight states were very involved with DHS in the Virtual USA (vUSA) project leading up to its use in the NLE-11. For example, during the Regional Operations Platform Pilot 1, Alabama participated in the exercise by testing services, providing KML feeds, and ensuring that linking to the data that other participants provided was feasible. It worked on vUSA design features and provided input as to

what changes would be helpful based on their operational style. It helped to identify missing pieces of the vUSA puzzle and promoted idea-sharing among other state points of contact.

Based on this preliminary work, the CUSEC Workgroup decided to use vUSA and its widget capabilities to share data and information dynamically. Alabama worked to upgrade its Emit Mapper Flex Tool to the 2.0 platform to be compatible with the vUSA widget. It also worked to generate as many layers of the web services requested by the group as was possible. It posted the widgets with layers of their data in the demo view of the Emit Mapper for use during the exercise. The different state EMAs that were involved managed their data differently, and all had to work around those barriers (for example, some states tended to share more than others regarding fatalities, while some states have more access to electrical outage information in a GIS format than others). Alabama worked with its state Department of Transportation to have a feed set up showing road closures as they occurred. There was quite a bit of collaboration among the various state GIS participants as well between the CUSEC states and the vUSA contractors.

Figure 6 shows the vUSA product, which allows a user to pull other user's data into his or her own viewer. The image depicts the use of vUSA during NLE-11 (and afterwards during the Mississippi River flood) and shows a screen shot of the KYEM map viewer.

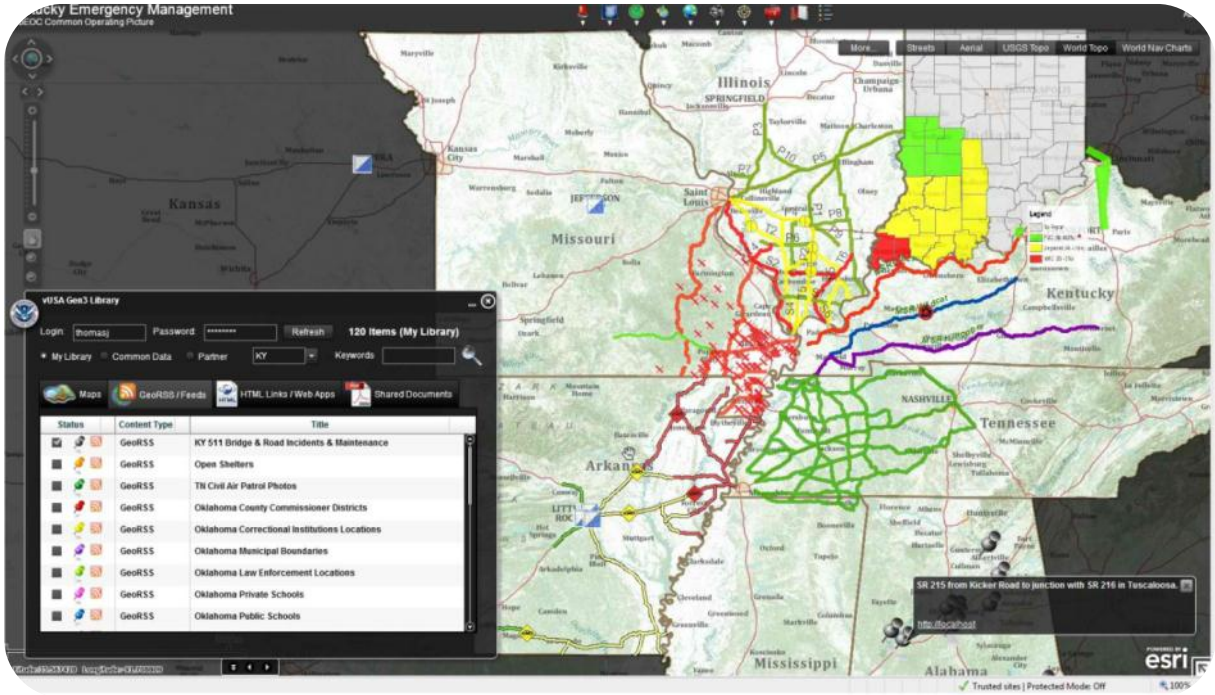

Figure 6: Virtual USA (vUSA) during National Level Exercise 2011 (NLE-11). The vUSA Library widget (lower left) allows users to see vUSA libraries in their own map viewers so that they do not have to go to another web site in an emergency. The image also shows major supply routes and closed shelters in Kentucky; security water, energy, accessibility, and telecommunications status in Indiana; Emergency Support Function #1 supply routes in Illinois and Tennessee; road status and road closures in Alabama, Arkansas, and Missouri; and the location of FEMA Region VI Mobile Emergency Response Support in Arkansas.

Recommendations

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Recommendations

"CUSEC is the catalyst that brings together local, state, and federal partners from across the entire public safety spectrum to collectively strategize an appropriate and effective response to a common threat."
—Mr. Joe Wainscott, Executive Director, Indiana Department of Homeland Security

After five years of effort, the question might be asked: "What still needs to be done?" The answer: a lot. One of the most important outcomes was the recognition of the need for a regional coordinating body, such as CUSEC, and the critical need to continue the work that has been completed to this point. The major effort of the NMSZ Catastrophic Planning Project has been a good start, but it is only a start. It is the beginning of the next phase for CUSEC. Continuity has been the key to the great strides made in disaster preparedness over the last five years. To maximize the investment that the states and the nation have put into the catastrophic planning effort, the CUSEC Board recommends that FEMA—through its regions—and CUSEC continue to emphasize the following items:

- **Implement and support a continuous planning and exercise event cycle**
  The planning effort must be supported and become a continuous cycle of planning and exercise. After the deliberate planning phase, there needs to be a synchronization period, then an exercise event followed by another planning cycle focused on turning lessons learned into lessons applied. This period should be followed by another synchronization event and a follow-up exercise of significant magnitude to test processes and procedures developed or refined subsequent to the original exercise. This cycle offers the best opportunity to avoid periods of lax preparation or readiness for any potential threat or risk environment.

- **Continue the inter-regional and federal planning effort begun during the RAW**
  The collective experiences of the RAW proved it is an essential concept for moving the whole of emergency management community to complete the planning, exercise, lessons learned, planning, and capstone exercise cycle. The RAW concept must be supported and improved as a continuous process of planning and preparedness.

- **Focus on senior leaders' awareness and involvement**
  Senior leadership involvement in catastrophic planning must continue to ensure attention to detail and synchronization efforts are focused on solving problems and advancing disaster preparedness at all levels of government.

- **Extend the opportunity for involvement to the full community**
  The RAW, ESFLG briefings, and extended workshops on specific focus items were key components to reaching the highest possible level of understanding across CUSEC boundaries. It is essential for response and exercise planning levels to engage all possible participants. The extension of the

planning and response effort to federal partners raised the level of understanding and built a platform for increased understanding of the threat, the planned response, and the issues that need to be solved.

- **Comprehensive Lifelines Recovery Strategy**

  Much of the nation's electricity, gas, oil, coal, and communication lifelines crisscross the Mississippi River through the heart of the NMSZ. Many experts predict a catastrophic NMSZ earthquake would impact the entire national power grid. Gas and oil pipelines would be disrupted, causing shortages in Midwest and Northeast cities. Coal shipments would be marooned on the Mississippi River. Telecommunication and fiber-optic lines would be severed, impacting communication east and west of the Mississippi River. Bridges, interstate highways, waterways, airports, and seaports will all be impacted to some degree. Developing action plans with local, state, federal, and private-sector partners ahead of a disaster will lessen the impact and speed the recovery of these critical infrastructures.

- **Disaster Air Operations Planning**

  Airports, air navigation and radar systems, and the national airspace will be experience wide-ranging impacts from a catastrophic NMSZ earthquake. Partnered with the Federal Aviation Administration, the U.S. Department of Defense, FEMA, and the U.S. National Guard, the state of Tennessee has begun developing a comprehensive plan for air operations following a catastrophic disaster. The initial planning process has revealed that an earthquake's impact will affect states far outside the physical damage zone. Continuation of this multi-layered effort is critical to the emergency response for the entire nation.

- **Disaster Recovery Planning**

  Disaster recovery planning requires a focus and effort equal to that of the response planning accomplished during the NMSZ Catastrophic Planning Process. The Catastrophic Planning Process revealed many gaps in recovery plans and efforts, such as ways to get survivors to safe structures in host states, identifying when it is safe for survivors to go home, and identifying issues associated with their return. (i.e., What if their home and its surrounding land mass were completely destroyed? What would be the probable social services impact on host and sheltering states? How

would limited resources be allocated? How would the needs of a host states' existing citizens be prioritized? etc.) The Catastrophic Planning Process introduced the National Disaster Recovery Framework and fostered a discussion of the pros and cons of the framework, such as providing for personnel and support for recovery support functions at a Joint Field Office. Most states are still unsure as to how they would employ a large enough workforce to staff an undertaking as large as the recovery support functions. A project similar to the Catastrophic Planning Project in scope and scale is needed for disaster recovery to focus on how best to restore, redevelop, and revitalize the health, social, economic, natural, and environmental fabric of the communities and build a more resilient nation.

- **Emerging Technologies**

  CUSEC will coordinate research into how GIS, social networks, and other emerging technologies can be used to enhance recognition, warning, and post-event information sharing so that all local, state, federal, and private-sector partners share a common operating picture. CUSEC will also provide decision makers at all levels with accurate, seamless communication and information needed to make life-saving and emergency response decisions.

CUSEC sees great value to the nation for developing, testing, and refining all portions of emergency management missions across the eight states while providing an improved process or methodology for review and adoption. The eight states are committed to maintaining a positive, cooperative, forward-looking relationship between states, the federal government, and other partners.

The consortium's involvement in the first-ever bottom-up planning effort to improve preparedness and response from the local, state and regional effort is noteworthy. CUSEC is committed to the concept of extending the planning cycle to include the lessons learned from NLE-11 to become lessons applied. CUSEC is also committed to the regional approach as the best investment of funds available for planning and exercises involving the whole community and national and federal partners.

> "Scenario-driven Catastrophic Response Plan Development gives focus and direction in a seemingly overwhelming task. No one group has the solution to all of the issues but working in a collaborative effort to brain storm and problem solve enhances the planning process. As Henry Ford said, 'Coming together is a beginning, keeping together is progress, working together is success.' "
> —Mr. David Maxwell, Director, Arkansas Department of Emergency Management

It is clear today that the need to fully integrate the private sector into the planning and exercise cycle is essential. To that end, CUSEC will collaborate on constructing concept of business sector emergency operations training and access to response information.

CUSEC will move forward toward assisting the development of the national recovery framework and is committed to advancing the national discourse in support of the next state that is faced with community recovery from a catastrophic natural or manmade event.

CUSEC is partnering with NEMA to continue to define concepts and tenets of mutual aid in support of national best practices embodied by EMAC. CUSEC has committed to moving forward, determining and documenting mission-ready packages across the region, and being a leader in adopting and using the Mutual Aid Support System as modeled on the successful work done by the CUSEC pilot data-sharing project, first used in NLE-11.

To meet these goals, CUSEC has set a timeline leading up to CAPSTONE 2014, which is envisioned as a region-wide exercise focusing on updated response plans based on the lessons learned from NLE-11. CUSEC has committed to providing leadership, planning expertise, and manpower to ensure that the cycle of planning, exercise, analysis, and exercise is applied across the region for local, state, regional, and national participation.

CUSEC will sponsor workshops for the private sector in 2012 and 2013 leading up to the exercise. In addition, CUSEC will continue to refine and develop technological solutions for implementation in 2012 and 2013.

CAPSTONE 2014 is currently planned for the week of June 14, 2014, and is to consist of three days of dynamic response and two days of community recovery operations. CUSEC intends to open the exercise up to local, state, FEMA regional, and FEMA Headquarters participation as well as all major federal ESF partners who desire to exercise their response and recovery plans.

The accomplishments of CUSEC over the past five years in coordinating multi-jurisdiction efforts for the NMSZ Catastrophic Planning Project and NLE-11 demonstrate a commitment to excellence and innovation. CUSEC's efforts have directly contributed to the preparedness of the Central United States for a catastrophic earthquake. CUSEC is well situated to lead this coordination of effort into the future.

Appendix A

Current Hazard Analysis

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Appendix A—Current Hazard Analysis

There is broad agreement in the scientific community that a continuing concern exists for a major destructive earthquake in the New Madrid Seismic Zone (NMSZ). Many structures in Memphis, St. Louis, and other communities in the Central Mississippi River Valley Region are vulnerable and at risk from severe ground shaking. This assessment is based on decades of research on the NMSZ earthquakes and related phenomena by dozens of federal, university, state, and consulting earth scientists.

Considerable interest has developed recently from media reports that the NMSZ may be shutting down. These reports stem from published research using global positioning system (GPS) instruments with results of geodetic measurements of strain in the Earth's crust. These reports argue that there has been little to no strain being accumulated at the surface in the seismic zone over the past 14 years; hence, they argue that there is no buildup of stress at depth within the NMSZ and the zone may no longer pose a significant hazard.

As part of the consensus-building process used to develop national seismic hazard maps, the U.S. Geological Survey (USGS) convened a workshop of experts in 2006 to evaluate the latest findings in earthquake hazards in the Eastern United States. These experts considered the GPS data from NMSZ available at that time that also showed little to no ground movement at the surface. The experts did not find the GPS data to be convincing enough to lower the assessment of earthquake hazard in the NMSZ region, especially in light of the many other types of data that are used to construct the hazard assessment, several of which are described here (USGS, 2009). A separate independent panel of experts also found in 2011 that the USGS national seismic hazard maps represent a reasonable consenus of the Earth sciences community at the time of its generation (2006–2008) and remain a good current estimate of overall hazard that should continue to be used until new maps replace them. The panel concluded that the

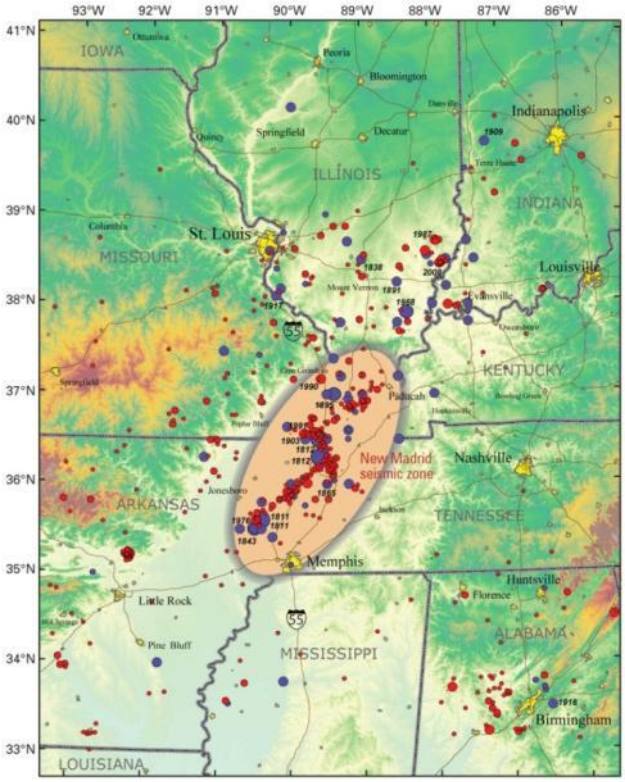

Figure 7: Topographic map showing earthquakes greater than magnitude 2.5 (circles) of the Central United States. Red circles are earthquakes that occurred after 1972 (U.S. Geological Survey Preliminary Determination of Epicenters (PDE) catalog). Blue circles are earthquakes that occurred before 1973 (USGS PDE and historical catalog). Larger earthquakes are represented by large circles. Yellow patches show urban areas with populations greater than 10,000 (USGS, 2009).

NMSZ is at signigicant risk for damaging earthquakes that must be accounted for in urban planning and development (National Earthquake Prediction Evaluation Council, 2011).

Continuing Seismic Activity

Over the past 30 years, scientists have learned that strong earthquakes in the central Mississippi Valley are not freak events but have occurred repeatedly in the geologic past. The NMSZ is a source of continuing small and moderate earthquakes, attesting to the high stress in the region and indicating that the processes that produced large earthquakes over the previous 4,500 years are still operating (Figure 7). It is, indeed, the most seismically active area of the United States east of the Rockies since detailed seismic monitoring began in the 1970s. There is no sign that the rate of these smaller earthquakes is decreasing with time, as would be expected if they were aftershocks of the 1811–1812 earthquakes (USGS, 2009).

Likely Impacts from Future Large Earthquakes

Earthquake hazards involve more than just strong ground shaking from passing seismic waves. The 1811–1812 earthquakes caused many types of ground failures, including landslides along the Mississippi River bluffs from Mississippi to Kentucky. Ground failures also included lateral spreading and ground subsidence by soil liquefaction across the Mississippi River flood plain and along tributaries to the Mississippi River over at least 15,000 square kilometers. Today, a repeat event could be expected to produce similar effects in northeastern Arkansas, southeastern Missouri, western Tennessee and Kentucky, and southern Illinois. Roadways in the Mississippi Valley of Arkansas and Missouri (such as Interstate 55) could become impassable because of bridge failures and fissuring of road surfaces. Venting of large quantities of water, sand, and mud as a result of liquefaction could flood fields and roads and disrupt agriculture for weeks to months. Flooding of farmland, where agricultural chemicals are stored onsite, could contaminate rivers and streams. Failure of levees, especially during high water, would contribute to flooding, and failures of riverbanks could make the Mississippi River and its tributaries difficult to navigate for many weeks (USGS, 2009).

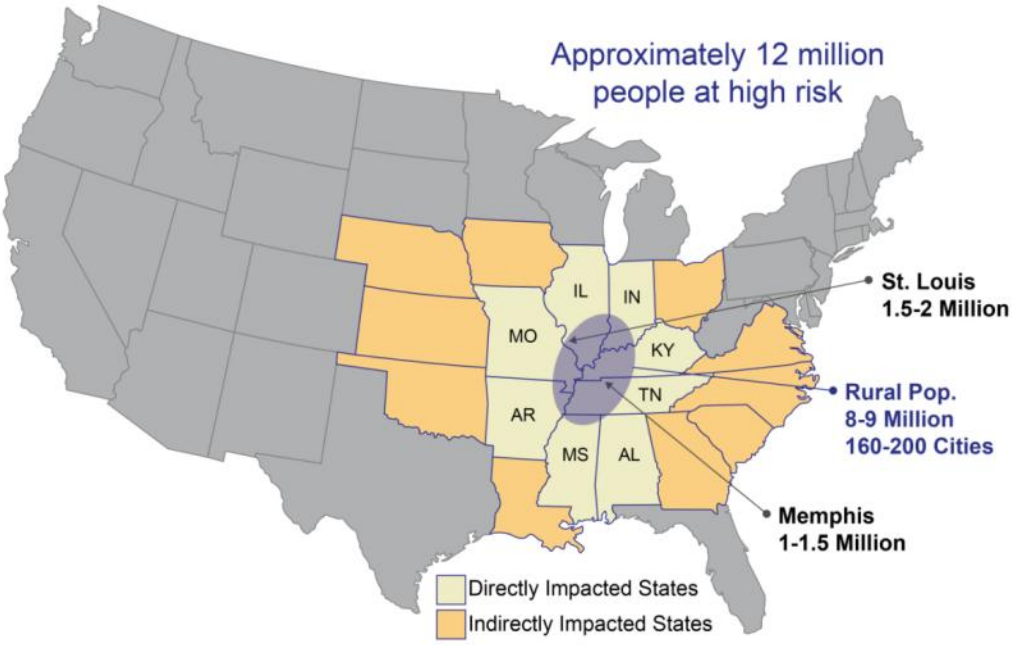

Figure 8: Modern-day population at risk in the New Madrid Seismic Zone

The city of Memphis and the surrounding metropolitan area of more than 1 million people would be severely impacted (see Figure 8). Memphis has an aging infrastructure, and many of its large buildings, including unreinforced schools and fire and police stations, would be particularly vulnerable when subjected to severe ground shaking. Relatively few buildings were built using building codes that have provisions for seismic-resistant design. Soil liquefaction and related ground failures are likely to occur in downtown Memphis along the Mississippi River and along the Wolf River that passes through Memphis. The older highways and railroad bridges that cross the Mississippi River, as well as older overpasses, would likely be damaged or collapse in the event of a major NMSZ earthquake. Some of the bridges and pipelines crossing the Wolf River might be damaged or destroyed. Although Memphis is likely to be the focus of major damage in the region, St. Louis, Missouri, Little Rock, Arkansas, and many small- and medium-sized cities would also sustain damage (USGS, 2009).

Earthquakes in the Central and Eastern United States affect much larger areas than earthquakes of similar magnitude in the Western United States. For example, the Northridge, California, earthquake of 1994 (magnitude 6.7) was felt in a much smaller area than the 1895 Charleston, Missouri, earthquake (magnitude 6.8). The Charleston earthquake provides an example of the difference in geologic makeup east and west of the Rocky Mountains. This difference causes different types of earthquake wave propagation, and results in increased shaking over larger areas in the Central and Eastern United States. Earthquakes in the Central United States also create hazards such as landslides, lateral spreading, and soil liquefaction. Liquefaction causes soil structure to lose the ability to bear weight, which may result in damage or collapse of affected structures, including buildings, roads, bridges, underground pipes and wires, and antennas/power/light/poles.

Continuing Preparedness Needed

The geologic record of repeated large earthquakes, the historical accounts of the 1811–1812 large earthquakes, and the continuing earthquake activity in the area are compelling evidence that the NMSZ region represents a high earthquake hazard. The preponderance of evidence leads to the conclusion that earthquakes can be expected in the future as frequently and as severely as in the past 4,500 years. Such high hazard requires prudent measures such as adequate building codes to protect public safety and ensure the social and economic resilience of the region to future earthquakes (USGS, 2009).

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Appendix B

Planning Scenario

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Appendix B—Planning Scenario

In support of the New Madrid Seismic Zone (NMSZ) Catastrophic Planning Project, the Federal Emergency Management Agency (FEMA) commissioned a Scenario Design Working Group at the project kick-off conference in Branson, Missouri, in March 2007. The working group was tasked with creating a credible scenario that would drive the planning and exercises during the project. The scenarios were to look at damages, loss of infrastructure, interruption of utilities, and resources required in responding to a major NMSZ earthquake event. Members of the working group included representatives from the following agencies:

- Association of Central U.S. Earthquake Consortium (CUSEC) State Geologists
- Central U.S. Earthquake Consortium
- FEMA
- George Washington University
- Mid-America Earthquake Center (MAE Center)
- State Emergency Management Agencies
- State Geological Surveys
- Sandia National Lab
- Virginia Polytechnic Institute and State University (Virginia Tech)
- U.S. Geological Survey (USGS)

At the meeting, the group worked to establish an earthquake scenario that would be catastrophic in nature for the NMSZ. Primarily, the states were interested in testing their emergency operations plans to support a worst-case earthquake scenario. After several months of deliberation, the group chose a magnitude 7.7 earthquake along the NMSZ as its scenario (this magnitude is believed to be similar to the NMSZ earthquakes of 1811–1812).

Led by the MAE Center, a multidisciplinary team was assembled to perform detailed analysis on all major segments of the population and infrastructure in the Central United States. To perform the analysis, the MAE Center and scenario team used HAZUS-MH (commonly referred to as HAZUS), a computer-based, geographic information systems (GIS) tool created by FEMA to estimate losses from earthquakes, floods, and hurricanes. It uses a default but customizable set of GIS data including population, building, and critical infrastructure data sets.

For the Catastrophic Planning Project, the team worked to identify impacts of a major earthquake along the NMSZ in the following areas:

- Casualties and fatalities
- Building infrastructure

- Transportation infrastructure (roads, bridges, rail, highways, airports, etc.)
- Critical facilities (police, fire, hospitals, schools, etc.)
- Utility systems (electrical, gas, pipelines, etc.) (Figure 9 shows natural gas lines in NMSZ)
- First response capabilities (fire and ambulance, police, and search and rescue)
- General population (sheltering, long-term housing)
- Economically and socially vulnerable populations
- Economic impacts

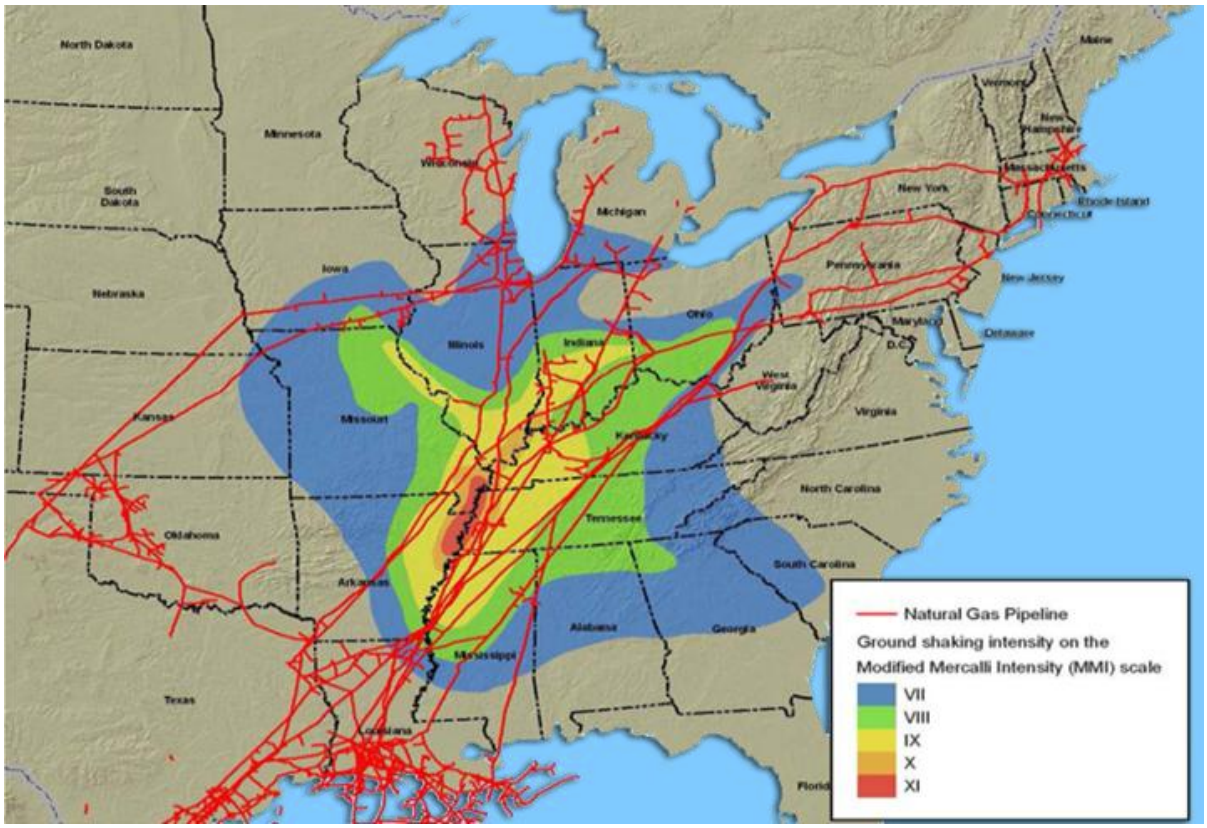

Figure 9: Natural gas pipelines throughout the New Madrid Seismic Zone

There were essentially two phases to HAZUS analysis by the MAE Center. The first phase used the basic HAZUS data or default inventory to model impacts on infrastructure. This was used to provide the states and FEMA a general set of data to begin their scenario-based planning process. With assistance from George Washington University and Virginia Tech, the second analysis phase added more detailed information to the inventory such as:

- USGS-recommended ground-shaking data
- Updated building inventory data
- Updated transportation infrastructure data

- Updated soil information (produces more realistic model)

Both Phase 1 and Phase 2 of the impact analysis resulted in a comprehensive report by the MAE Center. This report, entitled *Impacts of New Madrid Earthquakes on the Central USA* by Amr Elnashai and Lisa Cleveland of the MAE Center, Theresa Jefferson of Virginia Tech, and John Harrald of George Washington University, was the most comprehensive summary of estimated impacts since the Six Cities Study published in 1985. The Six Cities Study was done as part of the Central U.S. Earthquake Preparedness Project, a project which ultimately led to the formalization of CUSEC. As with the Six Cities Study, the MAE Center reports will likely be used as reference material for decades to come.

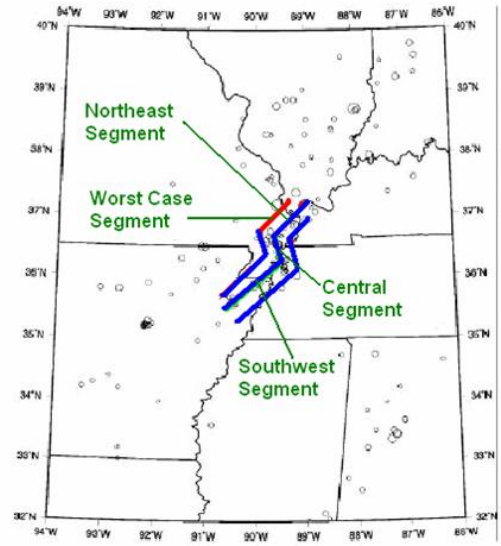

Figure 10: Modeling of the worst-case scenario

Basic Scenario Information

To create the desired baseline scenario, USGS, the MAE Center, and the scenario team used GIS to create a set of ground motions that would replicate a magnitude 7.7 earthquake along the entire NMSZ. The NMSZ has three distinct sections. It forms a zigzag pattern starting at Marked Tree, Arkansas, heading northeast through New Madrid, Missouri, and northeast again to Cairo, Illinois (see Figure 10 and Figure 11). It is important to note that the MAE Center scenario was modeled as sequential rupture of individual segments similar to the 1811–1812 series of events over several months, rather than one individual shock along only one of the segments.

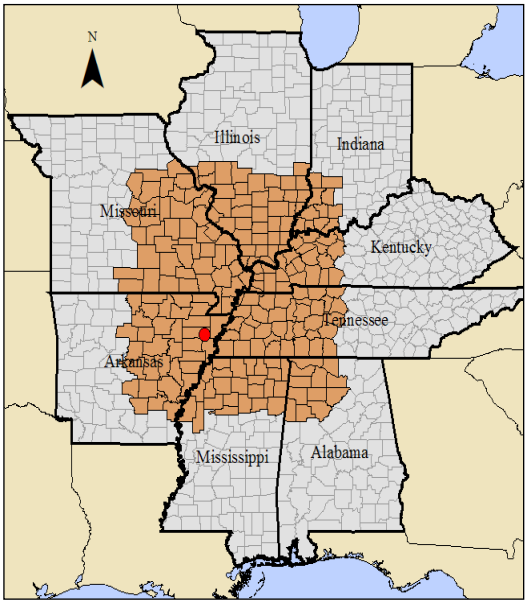

Figure 11: Epicenter of the worst-case scenario shown as the red dot at Marked Tree, Arkansas, with impacted counties in brown

This is not a scientific modeling of what happened in 1811–1812. However, in order to achieve the worst case scenario for all affected states at the same time, this method was used.

The basic earthquake scenario parameters were as follows:

- Earthquake occurs at 2 a.m. on February 7 (the same as February 7, 1811)
- Event represents rupture of three NMSZ fault segments simultaneously with magnitude 7.7 (recommended magnitude by USGS for planning purposes)
- Significant ground deformations likely in soft soils, particularly along riverbeds

- Additional shocks along the Wabash Valley Seismic Zone (southeastern Illinois and southwestern Indiana) were triggered by the NMSZ event earthquake
- Aftershocks around magnitude 6.0 likely in the days and weeks after the main shock

Notes on Modeling Assumptions

A list of 230 impacted counties was compiled based on cumulative review of direct damage and functional capabilities of infrastructure, social impacts, and direct economic losses. The counties selected in the Central U.S. region are estimated to incur the most severe damage, loss of operational capability, social impacts, and direct economic losses throughout the region, as estimated by the models used to generate the NMSZ scenario. Operational capabilities losses, social impacts, and direct economic losses are not confined to these counties but are rather most severe in these areas. All counties in the eight Central U.S. states are likely to be impacted by a NMSZ event, though the impacts will be less severe outside the areas identified as impacted counties.

Electric outages are based solely on the likelihood of any structural damage to electric substations and do not account for damage to electric power plants or the electric grid (power lines).

Water outages are based on the damages to the distribution pipe network.

While methodology provides detailed numbers, the numbers presented in the reports should be interpreted as approximations.

Certain portions of the impacted population are more vulnerable to disasters. These populations may have different needs and/or require different types of response activities based on the following characteristics:

- Income level
- Command of the English language
- Age
- Individuals with disabilities or access/functional needs
- Travelers
- Prison populations
- College students
- Those that are hospitalized/institutionalized

Based on the information provided from HAZUS, a SWEAT (security, water, energy, accessibility, and telecommunications) analysis was performed for each impacted county to help identify operational capacity of the following:

- Security: EOC, police, fire, hospital facilities
- Water: potable and waste water facilities
- Electrical: electrical and natural gas facilities

- Accessibility: major river crossings, highway bridges, and schools
- Telecommunications: communication facilities

The SWEAT analysis gave planners and responders an idea of what types of resources would be available, based upon the scenario.

Impact Overview

Based upon the modeling software HAZUS, the earthquake scenario included the following impacts to the states and infrastructure in the NMSZ.

- 8 states/7 million people affected
- 85,000 injured
- 3,500 deaths
- 2 million people seeking Shelter
- 700,000 buildings damaged
- 300,000 buildings destroyed
- 3,600 bridges damaged
- 2.6 million households without electricity
- 1 million households without water
- 2 million 25-ton truckloads of debris
- $300-billion event

In comparison with Hurricane Katrina (the costliest hurricane ever, costing an estimated $88 billion and resulting in 2,500 deaths), the NMSZ earthquake model estimated 1,000 more deaths and cost three times more than Katrina.

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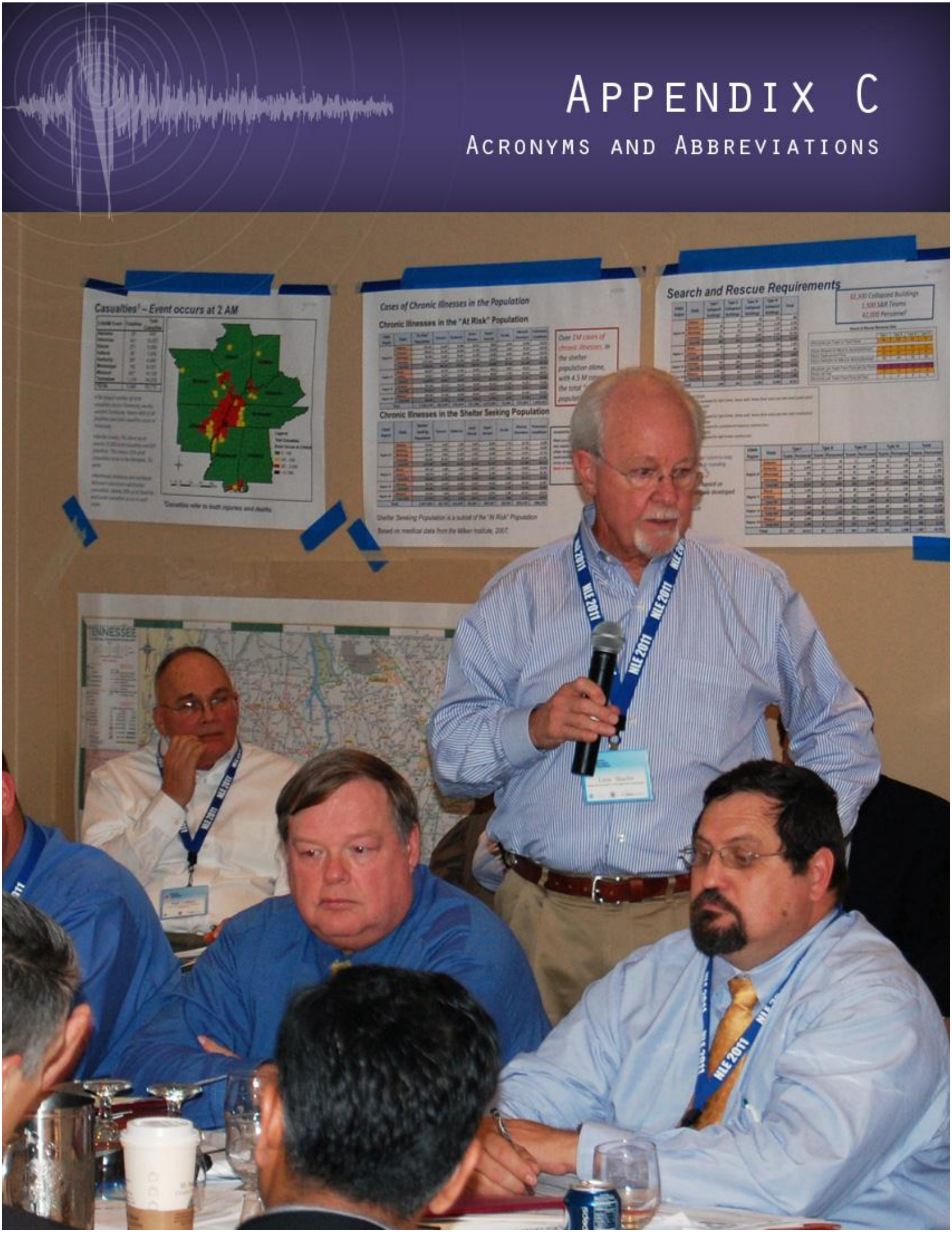
Appendix C

Acronyms and Abbreviations



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Appendix C—Acronyms and Abbreviations

AAR	After-Action Report
C&O	Concept and Objectives
CAAG	Commonwealth Analysis and Assessment Group
CAT Plan	Catastrophic Response Plan (Tennessee)
CONOPS	Concept of Operations
CUSEC	Central United States Earthquake Consortium
DHS	U.S. Department of Homeland Security
DMACC	District Multi Agency Coordination Center
DoD	U.S. Department of Defense
EMAC	Emergency Management Assistance Compact
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
ESF	Emergency Support Function
ESFLG	Emergency Support Function Leadership Group
FEMA	Federal Emergency Management Agency
FIRP-E	Federal Incident Response Plan—Earthquake
GIS	Geographical Information System
GPS	Global Positioning Satellite
HAZUS-MH	Hazards U.S. Multi-Hazard (a nationally applicable standardized methodology that estimates potential losses from earthquakes, hurricane winds, and floods)
HSEEP	Homeland Security Exercise and Evaluation Program
IDHS	Indiana Department of Homeland Security
IMT	Incident Management Team
JAOC	Joint Air Operations Center

KYEM	Kentucky Emergency Management
KYNG	Kentucky National Guard
MAE Center	Mid-America Earthquake Center
MCSA	Multi-State Coordination Annex
NEHRP	National Earthquake Hazards Reduction Program
NEMA	National Emergency Management Association
NLE	National Level Exercise
NMSZ	New Madrid Seismic Zone
NORTHCOM	Northern Command (U.S. Department of Defense)
PIO	Public Information Officer
RAW	Resource Allocation Workshop
ROC	Rehearsal of Concepts
SACC	State Area Coordination Center
SAR	Search and Rescue
SEMA	State Emergency Management Agency
SONS	Spills of National Significance
SWEAT	Security, Water, Energy, Accessibility, Telecommunications
TSA	Transportation Security Administration
USGS	U.S. Geological Survey
vUSA	Virtual USA
WEP	Workshop Execution Plan

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