



THE **CUSEC** JOURNAL

THE OFFICIAL NEWSLETTER OF
THE CENTRAL UNITED STATES
EARTHQUAKE CONSORTIUM

VOLUME 13, NO.5., FALL 2009

New Research and Tools Lead to Improved Earthquake Alerting Systems

by David Wald, US Geological Survey and Doug Bausch, Federal Emergency Management Agency

What's the best way to get alerted about the occurrence and potential impact of an earthquake? The answer to that question has changed dramatically of late, in part due to improvements in earthquake science, and in part by the implementation of new research in the delivery of earthquake information. In this article we try to answer this question by addressing background issues pertaining to pre-earthquake planning and post-earthquake situational awareness and by providing a brief update on recent and ongoing developments of earthquake information tools.

We first describe how responders, critical lifeline utilities, companies, the media, and individuals can be automatically alerted and now enhanced pre- and post-earthquake information can be used to move beyond epicenter and magnitude in making response decisions.

We then show how combining rapid shaking maps with population exposure and vulnerability can allow for rapid loss estimates. Although such loss estimates are only approximate, they provide an important resource to assess the impact of an earthquake in the minutes following the event. Other existing tools, such as Hazards U.S. (HAZUS), provide more detailed loss modeling after an earthquake, albeit with a slightly longer lag-time (hours).

Finally, by calibrating against response experiences and activities from past earthquakes, we propose alert levels that can be used for activating pre-scripted response activities in a much more timely fashion that could be done in the past.



The USGS Earthquake Hazards Program can be found online at <http://earthquake.usgs.gov>. The website has links to all things earthquake hazard related, including earthquake fact sheets and maps, as well as USGS developed tools and alert systems.

USGS / ANSS Products Overview

The U.S. Geological Survey (USGS), under the auspices of the Advanced National Seismic System (ANSS), is continuing to develop new and improved tools for post-earthquake information and response. Existing tools range from passive, web-based post-earthquake information content requiring no pre-event configuration to sophisticated damage-assessment and active notification systems that require pre-event set up, information technology expertise, and an inventory of vulnerable facilities.

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Around the Region

CUSEC and Indiana DHS Install GeoCache in New Harmony, IN

October 2009 - Recently, CUSEC and the Indiana Department of Homeland Security (IDHS) installed a geocache in New Harmony, Indiana. Geocaching is a high-tech treasure hunting game played throughout the world by adventure seekers equipped with Global Positioning System (GPS) devices. The basic idea is to locate hidden containers, called geocaches, outdoors and then share your experiences online. New Harmony is the southernmost county in Indiana, and is located within the Wabash Valley Seismic Zone. In 2002, CUSEC worked closely with officials in New Harmony to have a seismic monitoring station installed. New Harmony is also home to one of the oldest geology labs in the United States.

The geocache installation was a partnership effort between CUSEC, IDHS, the Indiana Geological Survey, Posey County Emergency Management Agency, and the New Harmony Inn. The morning of the installation, CUSEC Executive Director Jim Wilkinson and IDHS Executive Director Joe Wainscott gave several media and TV interviews in Evansville, Indiana to promote earthquake awareness and geocaching. Prior to installing the geocache, CUSEC and IDHS also held a press conference at the New Harmony Inn, where several members of the public and media were present.



This is CUSEC's eighth geocache, as part of the "What's Shaking?" series of educational geocaches. These caches contain earthquake safety brochures and takeaways for each visitor.

After the installation in Indiana, Alabama will have a geocache installed and each CUSEC member state will have a geocache.

Left to Right: Joe Wainscott, IDHS; Jim Wilkinson, CUSEC; Larry Robb, Posey County EMA; Herb Whiteway, New Harmony Inn

UPCOMING CONFERENCES, TRAINING, WORKSHOPS, ETC.

WHEN

WHAT

WHERE

October 28-29	Central & Eastern U.S. Hazards Meeting	Memphis, TN
October 30	ATC20/FEMA 154 Training	Searcy, AR
November 5-6	2009 National Earthquake Program Managers Meeting	Cambridge, MA
November 20	ATC20/FEMA 154 Training	Fayetteville, AR
December 1-2	IBHS Annual Conference	Palm Harbor, FL
December 9-11	ATC & SEI Seismic Performance Conference	San Francisco, CA
December 11	ATC20/FEMA 154 Training	Little Rock, AR

Visit the CUSEC website at www.cusec.org to learn more about upcoming events...

CUSEC Reminds Alabama Residents About the Central U.S. Earthquake Hazard

September 2009 - Representatives from the Central US Earthquake Consortium (CUSEC) helped residents in Alabama learn more about the central U.S. earthquake threat in Lauderdale County's "Be Ready Day" in Florence on September 3. Nearly 300 visitors got the chance to view and take home earthquake related information from the CUSEC display, as well as talk with representatives of CUSEC about earthquake safety and preparedness. Governor Bob Riley made a special appearance to speak to "Be Ready Day" visitors about what government officials and agencies are doing to address the issues surrounding the multiple hazards facing the state, and how each individual can prepare.

Alabama's "Be Ready Day" is an annual event that is hosted and sponsored by the Alabama Department of Homeland Security, the Governor's Office of Faith Based and Community Initiatives and the Lauderdale County Emergency Management Agency as a part of National Preparedness Month. It showcases disaster preparedness, first response, volunteer and emergency management organizations to children and residents of Lauderdale County. Other sponsors of this event include the Alabama Emergency Management Agency.



At "Be Ready Day" in Florence, Alabama, visitors pick up earthquake safety and mitigation information at the CUSEC display booth.

Central U.S. Public Information Officers Meet in Illinois

September 2009 - Public Information Officers (PIOs) from the states of Illinois, Indiana, Michigan, Minnesota, Ohio, Tennessee and Wisconsin met in Chicago, Illinois, on September 15 and 16 to assess and further develop public information and warning plans that can be used in a catastrophic New Madrid or Wabash Valley seismic zone earthquake. The workshop, which was hosted by the Federal Emergency Management Agency's (FEMA) Region Five External Affairs Division covered the following topics:

- PIO Lessons Learned from No-Notice & Internationally Visible Incidents - such as the August 1, 2007, bridge collapse in Hennepin County Minnesota and the April 18, 2008, Illinois-Indiana 5.2 earthquake
- Introduction to the 2011 National Level Exercise Scenario and Planning Challenges, and how PIOs fit into the exercise
- Planning to Work as a Regional Team by identifying team members and organizational structure as well as developing procedures that link all levels of public information officers
- Establishing Key PIO Roles, Messages and Media to help with collaborating with on scene command staff in a disaster and to put into action plans that will drive emergency information messages to the media

There was additional discussion about developing an overall public information and warning system for FEMA Region Five and building working relationships between various state agencies and organizations within the region prior to a major disaster. For more information on these efforts contact Alisa Nave, CUSEC PIO, at anave@cusec.org.

CUSEC Hosts Earthquake Town Hall Meetings

In July, CUSEC held two earthquake town hall meetings entitled Get Your Home Ready for Earthquakes on July 23 and 24. These town hall style seminars were held in Blytheville, Arkansas and Dexter, Missouri, respectively. Each meeting was geared towards a consistent theme – Earthquake Hazards, Disaster Preparedness and Earthquake Mitigation Tips for Homeowners. These tips included inexpensive and easy projects that citizens can do to reduce their risk to earthquakes.

The town hall meeting in Blytheville was held at the Arkansas Northeastern College and was cosponsored by Arkansas Department of Emergency Management (ADEM) and the Arkansas Geological Survey (AGS). Veronica Viallobos Pogue, ADEM State Earthquake Program Manager and Scott Ausbrooks, AGS' Geohazards and Environmental Geology Supervisor, gave presentations on several topics including disaster preparedness, earthquake hazards, and state planning efforts. An estimated 25 people attended this seminar. CUSEC Earthquake Program Coordinator Brian Blake also gave a presentation entitled “Get Your Home Ready For Earthquakes” - to tell attendees how to prepare their homes for an earthquake.

Hosted by State Representative Billy Pat Wright, the town hall meeting in Dexter was held at the Dexter Church of Christ fellowship building and was attended by more than 50 people. This meeting was co-hosted by Missouri State Emergency Management Agency (SEMA) and Stoddard County Emergency Management. John Prance, Stoddard EMA director, talked to local residents about creating an emergency supply kit and preparing to be on their own after a disaster. Steve Besemer, SEMA State Earthquake Program Manager, gave attendees an overview of the Missouri earthquake hazard and State EMA. Brian Blake also gave the “Get Your Home Ready For Earthquakes” presentation.

In a forum of nearly seventy-five concerned citizens, first responders and elected officials, CUSEC hosted a third town hall meeting in Caruthersville, Missouri, on September 22. In his opening remarks, Caruthersville Fire Chief Charlie Jones reminded attendees that they must be prepared for earthquakes and other disasters,

such as the recent tornadoes and ice storms in 2009. David Gaunt, with the Missouri Department of Natural Resources (MoDNR), presented an introduction to earthquakes, and Steve Besemer provided general disaster preparedness information. Brian Blake again gave his “Get Your Home Ready For Earthquakes” presentation to close out the seminar. This event was cosponsored by State Representative Terry Swinger, Missouri State Emergency Management Agency and the Missouri Geological Survey.



CUSEC would like to thank all the cosponsors, facility hosts and participants in making these town hall meetings a success. If you would like to have a town hall meeting in your area, please contact your State Earthquake Program Manager by visiting our website at www.cusec.org or send an email to cusec@cusec.org.

The Road to NLE 2011 Continues

by Paul Hogue, CUSEC Exercise/Training Officer

The CUSEC member states and FEMA are working closely on planning for the Tier One National Level Exercise scheduled for May of 2011, commonly known as NLE 2011. This is a huge undertaking involving many participants, planning conferences, strategy sessions, working group meetings, and lead-up exercises taking place through the summer of 2011. To keep readers of our journal well-informed of these activities, we will have this as a regular column to list major news and events pertaining to the exercise.

- All of the CUSEC member-states conducted “Initial Planning Conferences” in this past quarter. According to the Homeland Security Exercise and Evaluation Program (HSEEP)

methodology, an Initial Planning Conference (or IPC) meeting is "... typically the first step in the planning process and lays the foundation for the exercise...Its purpose is to gather input from the exercise planning team on the scope; design requirements and conditions (such as assumptions and artificialities); objectives; level of participation; and scenario variables (e.g., location, threat/hazard selection), and MSEL."

- The outputs of these state IPC's were reported at the Multi-State IPC/CUSEC Exercise Officers' Working Group (EOWG) meeting held in Little Rock, Arkansas on September 22-23, 2009. As with the Multi-State Concepts and Objectives meeting in April, no similar meeting had ever been held for a National Level Exercise. The meeting addressed a number of concerns and needs of the states individually and as a group, and the results of it will be fed up to the National IPC for NLE 2011 in Washington, D.C. There were a number of recommendations made to the CUSEC Board of Directors, who approved all of them during their meeting in Little Rock immediately following the IPC.
- In this past quarter, there were at least two major lead-up exercises in our states. FEMA conducted an Integrated Emergency Management Course on August 25-28 in Indiana based on a catastrophic earthquake. According to FEMA, IEMC's are "... (an) exercise-based training activity that places Emergency Operations Center (EOC) personnel under realistic crisis situations within a structured learning environment." The course culminates in a sophisticated functional exercise. On September 2, Missouri conducted a Long-Term Recovery Tabletop Exercise in Jefferson City, MO, the first of its kind in Missouri. The exercise drew a large number of registrants.
- Tony Pagano became Indiana's representative to the CUSEC EOWG. He replaced Rick Archer, who received a promotion within the Indiana Department of Homeland Security. Rick has been very important to the EOWG during his time, and CUSEC wishes him the best. Tony has very ably stepped into Rick's shoes with short notice, and we look forward to working with him.

New Madrid Seismic Zone Catastrophic Planning Update

Focusing on Multi-State Cooperation and Interoperability

By Mike Calvert, CUSEC Emergency Planner

As mentioned in the previous journal, the CUSEC member states and FEMA regional workshops were completed but there's much more to do to prepare for NMSZ earthquakes. The CUSEC member states and affected FEMA Regions continue to work together to plan and prepare, as evident in several meetings held over the last several months.

FEMA Region VII hosted the second of two planning meetings which brought together Regions IV, V, VI, & VII with the goal of having some commonality in their regional NMSZ earthquake plans and assumptions. Much valuable inter-regional coordination and sharing occurred as a result.

Missouri held several events that fostered multi-state or national coordination. The State Emergency Management Agency (SEMA) had a long-term recovery exercise to address the challenges of recovery following a major NMSZ event. For many, just thinking about the response required is overwhelming. Participants included several state and Federal agencies as well as surrounding states. Missouri also hosted a Catastrophic Mass Care Conference to address the needs of Missouri citizens following an earthquake. Both the Governor and SEMA Director spoke to a well-attended conference, leaving no doubt that they fully support NMSZ preparedness. Conference presentations were followed by tabletop exercises that involved all participants. Finally, the Missouri National Guard called together their counterparts from the other seven CUSEC states for a NMSZ Earthquake Workshop. The National Guard Bureau, SEMA and other state emergency management agencies, and Guard representatives from surrounding states and other states as far away as Washington, *continued on page 7*

RECENT CENTRAL U.S. EARTHQUAKE ACTIVITY

DATE	LOCATION	MAGNITUDE
8/14/09	Nickelsville, VA	2.9
8/25/09	Ridgely, TN	2.8
8/29/09	Summerville, SC	3.2
8/31/09	Friendsville, TN	3.3
9/27/09	Hindman, KY	2.5
10/2/09	New Market, TN	2.5
10/3/09	Laurel Park, NC	2.5
10/05/09	Tiptonville, TN	2.5
10/15/09	Greenbriar, AR	2.8
10/15/09	Greenbriar, AR	2.7
10/16/09	Higden, AR	2.8
10/18/09	Redfield, AR	2.6

IF YOU FEEL AN EARTHQUAKE, REMEMBER TO: DROP, COVER, & HOLD ON FOR MAXIMUM SAFETY



Visit <http://www.dropcoverholdon.org> to learn more ~ Image Courtesy Southern California Earthquake Center

DID YOU FEEL IT?

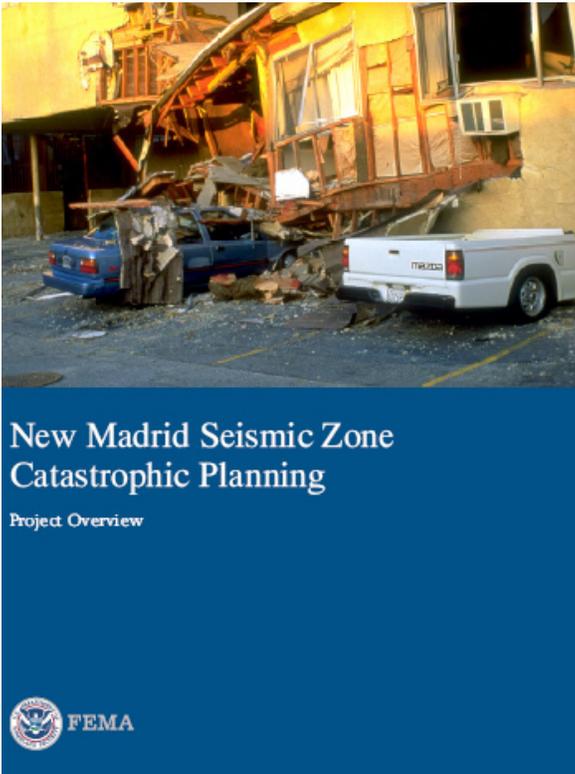
If you recently felt an earthquake, remember to go to the USGS website and log your experience on the “Did You Feel It?” webpage. The information you provide helps scientists understand how the ground shakes at different locations and helps show the wide reaching effects of earthquakes. Visit -

<http://earthquake.usgs.gov/dyfi> for more info



New Madrid Seismic Zone Catastrophic Planning Update

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Florida, and New Jersey attended. CUSEC state Guard representatives listed what military assistance they would need after an NMSZ event, and other states with the needed capability volunteered to provide it. This effort was national in scope. The cooperation shown by all attending was impressive.

FEMA Region V has an ongoing Midwest Energy Assurance Working Group to focus on the energy challenges following a NMSZ event. The September meeting included industry, state energy planners, state emergency managers, utility companies, Federal agencies, and surrounding states. It addressed the cascading impacts of a NMSZ event on the nation's energy as a whole as well as the impact on Region V. Many left this gathering knowing that their organizations needed to do more to plan, prepare, and mitigate as a result of the information discussed.

While the recent NMSZ efforts mentioned here all included multi-state and multi-agency participation, we must continually broaden our focus and include more states and agencies in our meetings, workshops, and conferences. A major NMSZ event would be a national catastrophe requiring national and

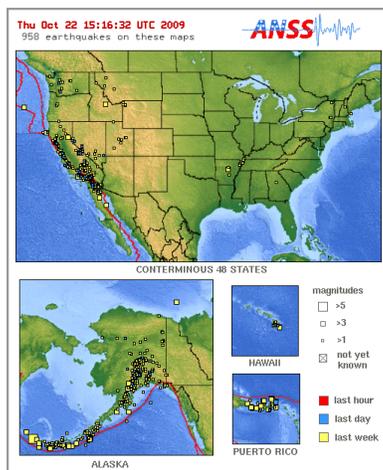
international assistance in both the response and recovery efforts. Yet as more and more organizations become involved in our effort, we still see “stove pipes” and “walls” that will hinder these efforts. We need to find ways to break down the remaining walls between our communications, reporting, and information systems. We need more interoperable or standard systems and formats. More jurisdictions, agencies, businesses, and volunteer organizations must actively reach out to each other. States, local jurisdictions, businesses, volunteer organizations, and Federal agencies must be able to work together effectively in a national effort. Some of this can be accomplished by people working together in a more open way sharing the successes as well as the failures. Some calls for investments at many levels, such as interoperability of communications and information systems.

Although it will not happen overnight, we can get there if we strive towards increased cooperation and interoperability at the local, state, and national levels.

Finally, within the CUSEC organization, we have 10 associate states that we will count on heavily following an earthquake. They are Georgia, Iowa, Kansas, Louisiana, Nebraska, North Carolina, Ohio, Oklahoma, South Carolina, and Virginia. Most of them were involved in our catastrophic planning workshops, and their guard participated in the National Guard NMSZ Earthquake Workshop in St. Louis in September. We need to share our earthquake plans with them and encourage them to participate in National Level Exercise 2011, which is based on the NMSZ. Only by working together can we make meaningful changes towards a hazard we share.

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Recent Earthquake Maps



For most users, web-based earthquake products and maps provide the starting point for earthquake information. Users typically become aware of an earthquake, go online, and find detailed USGS maps and summary information about any significant earthquake at [http://](http://earthquake.usgs.gov)

earthquake.usgs.gov. The Recent Earthquakes web pages provide general background as well as direct links to additional information and products. This passive approach to information delivery requires only a simple web search or using prior bookmarks. Automatic receipt of earthquake information requires only slightly more homework.

Earthquake Notification Service (ENS)

Customizable earthquake magnitude and location notifications provided through ENS add active alerting to the rapid earthquake information products available via USGS Earthquake Hazards Program web pages. ENS provides alerts for both domestic and international earthquakes and can be customized to receive events user-specified by location, magnitude, and time of day; users can also specify multiple email or wireless addresses for receipt of notifications.

While higher-magnitude earthquakes have greater energy release and can potentially affect a much larger area, losses depend directly on the exposure and vulnerability of a population to specific levels of

4.7 Mb - GULF OF CALIFORNIA

Preliminary Earthquake Report	
Magnitude	4.7 Mb
Date-Time	23 May 2007 23:03:23 UTC 23 May 2007 17:03:23 near epicenter
Location	23.281N 108.965W
Depth	10 km
Distances	79 km (49 miles) ENE (71 degrees) of San Jose del Cabo, Baja California Sur, Mexico 106 km (66 miles) ENE (62 degrees) of Cabo San Lucas, Baja Calif. Sur, Mexico 106 km (66 miles) ENE (65 degrees) of Cabo San Lucas, Baja California Sur, Mexico 159 km (105 miles) SE (126 degrees) of La Paz, Baja California Sur, Mexico 1101 km (684 miles) WNW (295 degrees) of MEXICO CITY, D.F., Mexico
Location Uncertainty	Horizontal: 22.8 km Vertical: 0.0 km
Parameters	Ngh = 72; Dm = 598.8 km; Rrms = 1.26 seconds; Gp = 270° M-type = Mb; Version = 7
Event ID	US 2007cscp



For updates, maps, and technical information, see:

[Event Page](#)

or [USGS Earthquake Hazards Program](#)

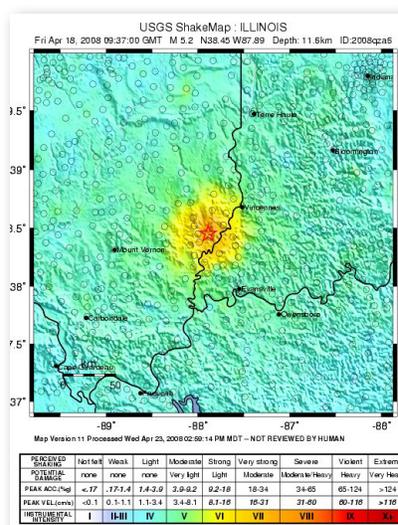
National Earthquake Information Center
U.S. Geological Survey
<http://neic.usgs.gov>

[Disclaimer](#)

This email was sent to emarin@usgs.gov. You requested mail for events between -90.090.0 latitude and 180.0/-180.0 longitude for M2.0 at 4 times. To change your parameters or unsubscribe, go to: <http://earthquake.usgs.gov/eqcenter/>

shaking. For example, large-magnitude events striking remote or rural areas may have less impact than a much lower magnitude event near a metropolitan area. Likewise, shaking intensity extends over greater areas in the Eastern US than in the West. These complexities, and the poor correlation of earthquake magnitude and impact require moving beyond just magnitude and location for making informed response decisions.

ShakeMap: Moving Beyond Magnitude and Location



Shake Map is a tool used to portray the extent and distribution of potentially damaging shaking following an earthquake by combining recorded seismic shaking levels with state-of-the-art shaking estimates. The rapid availability of these maps is of particular value to emergency response organizations, utilities,

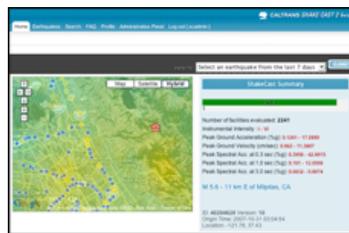
insurance companies, government decision-makers, the media, and the general public. The essential component of ShakeMap is that it provides a map of the spatial variations of shaking intensity, indicating areas with the strongest shaking in simple visual patterns and in map view. While magnitude has been traditionally used for indicating earthquake size, a better indicator of earthquake impact is earthquake strength, signified by macroseismic intensity (e.g., Modified Mercalli Intensity), which describes how shaking was experienced as well as the effects of the earthquake on the built environment. For easy, rapid assessment of the shaking pattern, ShakeMap portrays color-coded macroseismic intensity. The underlying parameters of peak and spectral acceleration, more suitable for engineering and loss assessment, are available for other applications and users.

Across much of the country, particularly in the Central and Eastern US (CEUS), ShakeMap is augmented by incorporating macroseismic intensity data directly from the USGS "Did You Feel It?" (DYFI?) system.

DYFI is an automatic web-based system for rapidly generating seismic intensity maps based on shaking and damage reports collected from internet users immediately following earthquakes. The popularity of DYFI assures large numbers of responses for any significant domestic earthquake, and such quantities of data allow for robust automatic intensity assignments and constraints for ShakeMap. Over 1,000,000 individual DYFI entries have submitted for earthquakes in the US; significant CEUS earthquakes now get tens of thousands of intensity questionnaire responses.

ShakeCast: Automatic Use of ShakeMap for Critical Facilities and Utilities

When a potentially damaging earthquake occurs, utility and other lifeline managers, emergency responders, and other critical users have an urgent need for information about the impact on their facilities so they can make appropriate decisions and take quick actions to ensure safety and restore system functionality.



Building off the ShakeMap system, ShakeCast, short for ShakeMap Broadcast, is a fully automated system for critical users to retrieve specific ShakeMap products to trigger established post-earthquake response protocols.

ShakeCast allows utilities, transportation agencies, and other large organizations to automatically determine the shaking value at their facilities, set thresholds for notification of inspection priorities (or damage levels; typically damage unlikely, moderate, or serious) for each facility, and then automatically notify (via pager, cell phone, or email) staff within their organizations who are responsible for those particular facilities so they can prioritize their response.

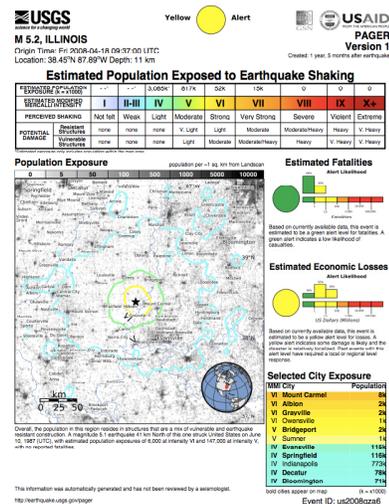
For many critical lifeline and transportation groups, particularly in the western US, ShakeCast has replaced the notion of simply drawing a circle on a map around the epicenter for initiating inspections over a potentially vast area. Since the shaking pattern is complex, and the vulnerability of infrastructure varies greatly, ShakeCast can greatly increase the accuracy of post-earthquake inspection prioritization over simplified approaches.

PAGER: Adding Population Exposure and Vulnerability

Neither earthquake magnitude nor macroseismic intensity provide sufficient information to judge the overall impact of an earthquake. The last, vital ingredients to determine the impact of an earthquake are i) the population exposed at each intensity level, and ii) how vulnerable that population is to building damage (which is dominated by the degree of seismic resistance of the local building stock).

The PAGER (Prompt Assessment of Global Earthquakes for Response) system takes a ShakeMap as the primary shaking input. Then, based on a comprehensive population database, PAGER computes the population exposed to each shaking intensity. With this approach, PAGER automatically identifies earthquakes that will be of societal importance well in advance of ground-truth or news accounts, and it can play a primary alerting role for domestic as well as global earthquake disasters.

The current version of PAGER can easily be found on the USGS earthquake event web pages, and critical users can subscribe to email or text PAGER alerts by contacting the USGS author. In the near future, USGS will be releasing a new version of PAGER that uses simplified loss modeling approaches to quantify both the human and economic impact. Losses are computed by combining shaking, exposure, and vulnerability calibrated against impacts from past earthquakes in that region.



Role of FEMA’s HAZUS with USGS ShakeMap

Once an earthquake is deemed likely to cause significant impact from the early (5 min – 1 hour) notification tools and products discussed above, it is valuable to initiate more detailed analyses, response coordination, data collection, and loss modeling. Table 1 summarizes which earthquake information tools are available for planning or response, and several of these tools are available within minutes an earthquake event.

HAZUS is short for Hazards U.S. Multi-Hazard or HAZUS-MH, a FEMA-developed and geographic information systems (GIS) based software system built around sophisticated risk-assessment methodologies designed to estimate potential losses from earthquakes, floods, and hurricane winds. The earthquake model is considered the most mature with its first release in 1997. FEMA has recently improved the HAZUS model with refined inventory databases with the release of MR-4, as well as the integration of damage functions calibrated specifically for ShakeMap input. The model generates various estimates of damage (e.g., casualties, displaced households, outages) and loss (e.g., repair and replacement costs, value of lost wages and building contents) relating to affected populations, to commercial, industrial, and residential structures, and to transportation and utility lifelines.

<i>Purpose</i>	<i>Earthquake Notification</i>	<i>Shaking Distribution</i>	<i>Population Exposure</i>	<i>Loss Estimation</i>
<i>Response</i>	ENS, ShakeMap, ShakeCast PAGER	ShakeMap	PAGER	ShakeCast
<i>Planning & Mitigation</i>	---	Probabalistic Hazard Maps, Scenario ShakeMaps	PAGER, HAZUS	HAZUS

Table 1: Products and tools associated with planning versus response. Response products are typically available within 10-20 minutes of an earthquake; HAZUS results are produced within several hours of an event. All of the Population Exposure and Loss Estimation products are based on ShakeMap inputs.

Realistic earthquake scenarios that describe the ground motions and damaging effects that large earthquakes would likely produce in particular regions, including the ongoing New Madrid Catastrophic Planning work, have developed into a popular vehicle for planning. It is in this context that ShakeMap, which projects the ground shaking likely in scenario earthquakes, is often used alongside HAZUS, which estimates the aggregate scenario losses used to measure resource requirements for response, recovery, and loss-mitigation activities.

Using HAZUS and ShakeMap in Response

In an upgrade released in 2005, FEMA calibrated HAZUS specifically for ShakeMap input, enabling the system to generate more accurate loss estimations. Rapid HAZUS loss modeling incorporating ShakeMap data for future earthquakes will provide more detail on impacts and losses than the current or anticipated PAGER products and will be developed in the first several hours following the earthquake.

The accuracy of the HAZUS loss information for New Madrid benefits from recent data and modeling improvements produced as a result of the Catastrophic Planning initiative. HAZUS results include more details on economic losses and social impacts that not only support the response activities, but also post-earthquake recovery and mitigation.

Currently, HAZUS post-earthquake impact analyses, when generated, are not made public for response coordination, but rather, they are used directly by Federal and State-level emergency managers for decision making purposes, including presidential disaster declarations. ShakeCast, which runs from within a user organization, typically provides damage or inspection priorities only to intranet and internal subscribers within such organizations. In contrast, ShakeMap and PAGER results are rapidly and widely disseminated for first response, public and media consumption.

Alerting: Proposed Activation Levels based on Past Earthquake Losses

With the advent of the PAGER system and particularly the next release which allows for rapid loss estimation, domestic (U.S.) and international earthquake responders are reconsidering their automatic alert and activation levels as well as their response procedures. To help facilitate rapid and proportionate earthquake response, we propose alerting based on two complementary criteria. One, based on the estimated cost of damage, is most suitable for domestic events; the other, based on estimated ranges of fatalities, is more appropriate for most global events. Simple thresholds, derived from the systematic analysis of past earthquake impact and response levels, turn out to be quite effective in communicating the predicted impact and response level of an event, characterized by alerts of green (little or no impact), yellow (regional impact and response), orange (national-scale impact and response), and red (major disaster, necessitating national or even international response).

FEMA Activation Alert Levels

Domestically, FEMA and other response agencies and organizations are considering moving beyond magnitude and location-based triggers alone to automatic response activation based on PAGER’s near real-time estimates of intensity and population exposure and damage. FEMA needs to make rapid decisions as to what activation levels are implemented for the National and Region Response Coordination Centers (NRCC and RRCC). Significant forward-looking response planning following the Post-Katrina Emergency Reform Act of 2006 (PKEMRA) entails developing and activating pre-scripted mission assignments and specific earthquake-response actions depending on the initial activation level. FEMA has three response activation levels: Level I (catastrophic impacts), Level II (significant impacts), and Level III (considerable damage) for rapidly activating resources. FEMA’s response activities require pre-determined executions to address the first several hours of a major earthquake to expedite assistance. FEMA territories consist of 10 Regions and 3 Divisions (East, Central and West); Level I initiates response from resources in the two closest divisions; Level II activates response of all resources in the respective division; Level III triggers resources in the respective region. Activation levels need to be appropriate for different geographic regions since overall earthquake vulnerabilities as well as response capabilities vary from one region to another.

<i>PAGER Alert Level</i>	<i>FEMA Activation Level</i>	<i>Estimated Losses (\$M)</i>	<i>Approx. Annual Occurrence</i>
Red	Level I	> \$1,000	0.1 (1.per 10 yrs)
Orange	Level II	\$100 - 1,000	0.1 (1 per 10 yrs)
Yellow	Level III	\$1-100	0.3 (1 per 3 yrs)
Green	No Activation	< \$1	4.7 per year

Table 2: Proposed PAGER Alerts linked to FEMA Activation Levels, showing associated loss triggers (millions of dollars), and the annual occurrence of each trigger level based on the past forty years of earthquakes in the United States. Green alert rates are events for which damage occurred but totaled less than \$1 million.

Continued from 11

We have recently developed recommended alert levels using loss estimates by the PAGER system along with direct dollar-loss thresholds consistent with FEMA’s activation levels. Analyses of recent and past earthquakes over the past four decades indicate that alert levels set against overall financial impacts of those events provides a relatively robust criteria for setting the FEMA activation levels. Based on PAGER intensity-population exposure estimates for the past 35 years of U.S. earthquakes derived from the ShakeMap Atlas, and by comparison with actual or estimated damage as well as activation levels implied or implemented for these events, we assigned yellow, orange and red thresholds that are triggered by estimated economic losses reaching \$1M, \$100M, and \$1B, respectively (Table 2).

In the central and eastern U.S., where actual loss data from recent earthquakes are limited, we supplemented small, recent events with ShakeMap scenarios, PAGER exposure estimates, and HAZUS damage estimates to determine the appropriate activation levels. These color-coded alerts, their triggering thresholds, and their historic response levels are summarized in Table 2 on the previous page. Also shown in Table 2, PAGER yellow, orange and red alerts correspond to FEMA’s Level III, II, and I alerts, respectively.

At present, the PAGER system tabulates and maps population exposure per intensity level, which is useful for inferring the overall impact and to activate alert levels. However, some knowledge of the relative vulnerability of the population (really, the predominant building vulnerability) is need for a detailed assessment. In the near future, the PAGER system will produce losses, and corresponding alert levels, directly. At that time, we anticipate that the PAGER alert levels can be used for prescribed response plans like FEMA’s, as well as to trigger less formal response activities.

Conclusions

For the time being, responders who currently make decisions based on magnitude and location may prefer to continue to use magnitude as a primary notification and initial “heads up” on earthquake occurrence. For these purposes, ENS should be the primary tool.

However, we expect that the continued evolution of content-rich geospatial information like USGS’s ShakeMap, ShakeCast, PAGER and FEMA’s HAZUS will increase user expectations for additional content in order to improve their post-earthquake situational awareness and decision making. PAGER-based domestic alert thresholds based on economic impact, combined with ShakeMap, ShakeCast, and PAGER maps, can provide additional and more informed initial criteria for rapidly activating appropriate levels of response and for focusing activities in the most needed areas.



FEMA

Dr. David Wald is a Seismologist with the U.S. Geological Survey at the National Earthquake Information Center in Golden, Colorado. Wald developed and manages “ShakeMap”, “ShakeCast”, “Did You Feel it?” and “PAGER” and is responsible for the research and development, management, and operations of a number of other systems for pre-earthquake mitigation and post-earthquake response and information.

Doug Bausch is the Earthquake Program Manager and Physical Scientist for FEMA Region VIII in Denver, Colorado. He assists states and communities in developing sound risk assessments to support all hazard mitigation planning, including the incorporation of FEMA’s HAZUS-MH loss estimation and Map Modernization programs. Doug is an experienced HAZUS user and one of only a few certified instructors nation-wide.

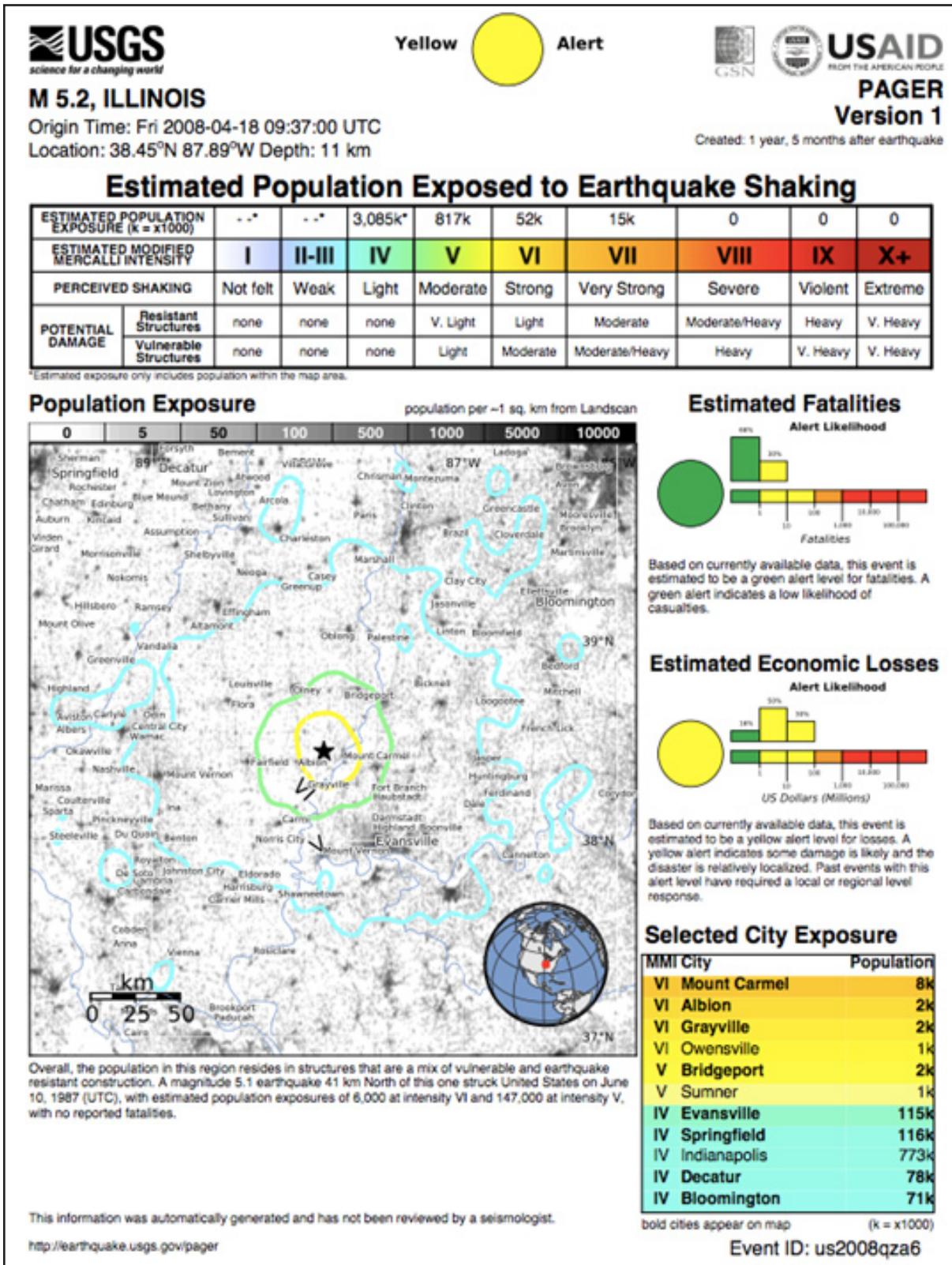


Figure 1: Prototype, summary “onePAGER” example for the April, 2008, magnitude 5.2 Illinois earthquake. Current online onePAGER figures provide only population exposure per intensity level; the next PAGER upgrade will produce loss alerts as shown here. Elements are event information (top center); the summary alert level (yellow circle, top center); intensity scale with estimated population exposed per intensity level (top center); population exposure map with superimposed color-coded contours of intensity (lower left); impact alert levels for estimated fatalities (top right) and economic damages (middle right) with model uncertainty for each range of impact (middle right); selected city list indicating population and color-coded intensity (lower right).

Other News

Central U.S. Geologist Writes Book About the New Madrid Seismic Zone



September 2009 - In addition to his authorship of more than 50 referred journal articles and more than 85 referred publications, Dr. Roy Van Arsdale, professor of Geology at the University of Memphis has added one more book to his collection.

In “Adventures Through Deep Time: The Central Mississippi River Valley and Its Earthquakes,” Van Arsdale presents the geologic history of the central Mississippi River Valley with a focus on the New Madrid Seismic Zone (NMSZ). The book outlines in detail the most important regional—southeastern United States—geologic events such the origin of the Mississippi Embayment. It also outlines how those events affected the central Mississippi River Valley and the geology and seismology of the NMSZ.

Van Arsdale has been a professional geologist for 32 years. He has worked in international mineral exploration and has conducted geological research since receiving his doctorate in 1979. He says that his long-time interest in geology and earthquake public awareness are only two of the many reasons he decided to write this book.

“I wanted to better understand the geologic history of the New Madrid Seismic Zone and surrounding area as it may help us better understand why earthquakes are occurring in our back yard”,he said. “I find that writing makes me think more deeply about a subject and to see things more clearly. I also wanted to try and bring more people into the region to conduct research by giving them something interesting to read. Lastly, I am hopeful that this book may be used in geology classes to illustrate that the geology around us really is interesting and that we better get a better understanding of the New Madrid Seismic Zone.”

Outside of his teaching duties, Van Arsdale is currently working on two major projects. The first is a NMSZ project just northeast of New Madrid, Missouri and another project involving the Wabash

Valley fault system in Kentucky. “Adventures Through Deep Time: The Central Mississippi River Valley and Its Earthquakes,” is available at - <http://www.geosociety.org/bookstore/>

2009 IBHS Annual Conference to Focus on Going Green

The Institute for Business and Home Safety (IBHS) will cap off 2009 with its annual conference on December 1 and 2 in Palm Harbor, Florida. With an eco-friendly theme “Going Green and Building Stronger,” IBHS conference organizers will tailor its agenda around issues such as green building, building code development and implementation, and the IBHS Research Center. Conference attendees will learn about the challenges insurers and reinsurers are facing in their efforts to go green - this includes risk patterns associated with green building. Attendees will also have the opportunity to learn the following:

- IBHS’ signature Fortified...for Safer Living® program
- roofing risks facing commercial insurers
- the new International Residential Code fire sprinkler requirement
- how leading reinsurers are responding to climate change
- the impact of the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) program on property losses

More information about the 2009 IBHS Conference is available at - www.disastersafety.org/conference/



DATES TO MARK

Central and Eastern US Earthquake Hazards Meeting – October 28-29, 2009. This USGS led meeting will bring together earthquake hazard investigators and interested parties to present and discuss recent research, to seek input on future research priorities, and to promote planning related to the bicentennial of the 1811-1812 New Madrid earthquakes and to Earthscope related experiments. Call (901)678-4974 for more information.

Conference on Improving Seismic Design Performance of Existing Buildings – December 9-11, 2009. This conference, to be held in San Francisco, California, will provide a forum for the presentation and exchange of new information on the seismic evaluation and seismic rehabilitation of existing buildings. If you are interested in attending, contact ATC at atc@atccouncil.org for more information.

200th Anniversary of the 1811-1812 New Madrid Seismic Earthquakes - Ongoing throughout 2011-2012. In 2011-2012, there will be events held throughout the central United States observing the 200th anniversary of the great 1811-1812 New Madrid earthquakes. Many organizations will participate in the events, which will include national conferences, earthquake exercises, public outreach events, and more. For more information visit the CUSEC website.

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

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

STAFF

Jim Wilkinson	Executive Director
Peggy Young	Associate Director
Brian Blake	Program Coordinator
Jennifer Brumley	Administrative Assistant
Mike Calvert	Emergency Planner
Paul Hogue	Exercise/Training Officer
Alisa Nave	Public Outreach Coordinator
Gwen Nixon	Accounting

CUSEC Phone Number: (901) 544-3570
Toll Free (800) 824-5817
Fax (901) 544-0544
Email cusec@cusec.org
Website www.cusec.org

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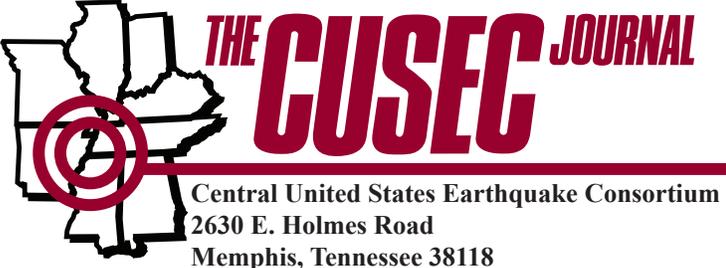
This publication is funded through a cooperative agreement with the Dept. of Homeland Security / Federal Emergency Management Agency Grant Number EMW-2005-CA-0428

CUSEC Partners

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