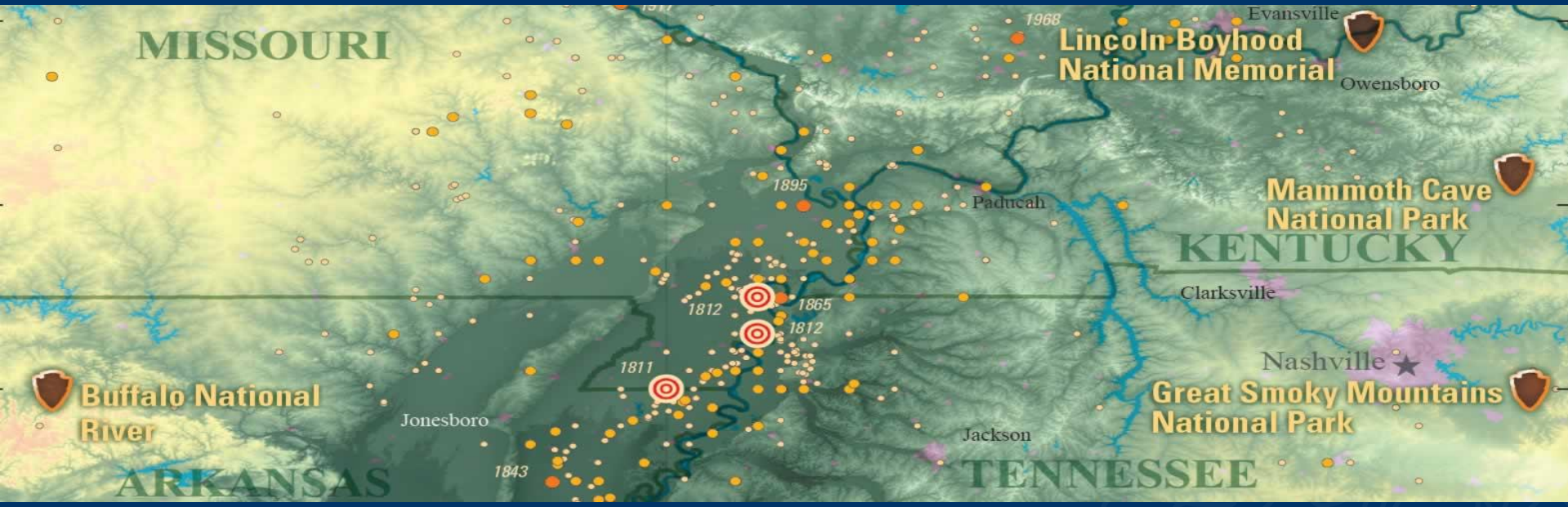
Good Morning Colleagues
Welcome to the



Central United States Earthquake Consortium
New Madrid Seismic Zone

Earthquake Tabletop Exercise

March 20, 2019

NATIONAL EXERCISE PROGRAM

Welcome and Opening Remarks

Scott Swinford
Deputy Director, Illinois Emergency Management Agency

James Joseph
Regional Administrator, FEMA Region V

Michael Dossett
Director, Kentucky Emergency Management Agency

NATIONAL EXERCISE PROGRAM

Administrative Remarks

Bobby Gillis, MA

Planning Section Supervisor

Kentucky Emergency Management

- Registration
- Cell phone etiquette
- Exit and rally point
- Restroom locations
- Lunch
- Participant Feedback Forms
- Laptop – Doug Eades

Ted Robinson, Facilitator

Exercise Program Manager

National Exercise Division, FEMA

NATIONAL EXERCISE PROGRAM

Exercise Schedule (1 of 3)

Event	Presenter/Facilitator	Time
Registration		08:30 a.m.
Welcome & Opening Remarks	Alicia Tate-Nadeau, Dir, *Illinois EMA* James Joseph, RA, *FEMA Region V* Michael Dossett, Dir, *Kentucky EM*	09:00 a.m.
Administrative Remarks	Bobby Gillis, Planning Section Supervisor Kentucky Emergency Management Agency	09:20 a.m.
Exercise Guidelines & Overview	Ted Robinson, *FEMA, NED, Facilitator*	09:30 a.m.
Additional Resource Briefings	Martha Kopper, *Geohazards Supervisor, Arkansas Geological Survey* Greg Shanks, *Kentucky Emer. Mgmt. Agency*	10:00 a.m. 10:15 a.m.
Situational Assessment	Ted Robinson, *FEMA, NED*	10:30 a.m.
BREAK		11:00 a.m.

NATIONAL EXERCISE PROGRAM

Exercise Schedule (2 of 3)

Event	Presenter/Facilitator	Time
Module 1 Scenario Update	Ted Robinson, *FEMA, NED*	11:15 a.m.
Module 1 Group Discussion: Information Sharing, Operational Reporting, Tracking and Mgmt.	Table Leader	11:20 a.m.
Module 1 Plenary: Discussion Questions	Ted Robinson, *FEMA, NED*	11:40 a.m.
LUNCH		**12:30 p.m.**
Module 2 Scenario Update	Ted Robinson, *FEMA, NED*	1:30 p.m.
Module 2 Group Discussion: Energy/Fuel Prioritization, Transportation, Geologist Resources	Table Leader	1:40 p.m.
Module 2 Plenary: Discussion Questions	Ted Robinson, *FEMA, NED*	2:10 p.m.

NATIONAL EXERCISE PROGRAM

Exercise Schedule (3 of 3)

Event	Presenter/Facilitator	Time
ENDEX		2:45 p.m.
BREAK		2:45 p.m.
Hotwash	Ted Robinson, *FEMA, NED*	3:00 p.m.
Closing Remarks	Jim Wilkinson, *Executive Director, CUSEC*	3:30 p.m.

NATIONAL EXERCISE PROGRAM

Exercise Guidelines & Overview

NATIONAL EXERCISE PROGRAM

Exercise Guidelines

Participants are expected to provide decisions, recommendations and feedback according to their established plans and procedures

- The TTX is held in an **open, low-stress, no-fault, and non-attribution environment**
- **Varying viewpoints** are expected
- **Decisions are not precedent-setting**
- The exercise is exploratory and serves to **exercise plans, test capabilities, and identify opportunities for improvement**

NATIONAL EXERCISE PROGRAM

Participant Roles and Responsibilities

- **Facilitators** guide exercise play and ensure that module discussions remain focused on exercise objectives, provide additional information and resolve questions as required, and make sure different viewpoints are recognized and discussed
- **Players** actively discuss their institution's activities during the exercise. Delegations of players discuss situational response actions based on expert knowledge of procedures, as well as how they would perform their functions on their respective campuses
- **Observers** do not actively participate in exercise discussions; they may view selected segments of the exercise. In this exercise, observers may interact with exercise players to support the development of player responses or provide subject-matter expertise
- **Support Staff** perform administrative and logistical support tasks during the exercise
- **Evaluators/Note-takers** assist with capturing exercise discussions to inform the After-Action Report

NATIONAL EXERCISE PROGRAM

Exercise Overview

Overview:

The Tabletop Exercise discussion will be centered a 7.7 magnitude earthquake scenario that occurs near the southern fault line in the New Madrid Seismic Zone. The earthquake causes significant damage throughout the immediate area northeast and southwest of the epic center. The earthquake impact areas in Alabama, Arkansas, Indiana, Illinois, Kentucky, Missouri, Mississippi, and Tennessee.

The general discussion will focus on your organization or jurisdiction most likely response to the earthquake based on your strategic and operational plans.

Exercise Structure

The CUSEC Earthquake TTX event consists of six main activities.

Two 15-minute Resource Briefings:

- State Geology Resources
- Reimbursement and Mission Ready Packages

One 30-minute Situational Assessment Overview:

- Review earthquake impact information to support response planning and decision making

Two 60-minute Exercise Modules:

- Facilitated discussion on response efforts

One 15-minute Hotwash Review:

- Summary of Outcomes

NATIONAL EXERCISE PROGRAM

Exercise Objectives

1. Test **information sharing and information integration** as well as agreements and relationships established to address **energy/fuel prioritization, main supply route command and control, evacuation routes, and state geology resources**.
    - Core Capability
        - Intelligence and Information Sharing
        - Operational Coordination

2. Discuss **operational reporting, tracking, and management of deployed EMAC resources**.
    - Core Capability
        - Operational Coordination

NATIONAL EXERCISE PROGRAM

Resource Briefings to Support Decision Making

NATIONAL EXERCISE PROGRAM

Resource Briefings

Martha Kopper
Geohazards Supervisor
"Geological Survey Capability After an Earthquake"

Greg Shanks,
Kentucky Emergency Management Agency
"Mission Ready Packages for EMAC"

NATIONAL EXERCISE PROGRAM

Resource Briefings

Martha Kopper

Geohazards Supervisor

"Geological Survey Capability After an Earthquake"

NATIONAL EXERCISE PROGRAM

Central United States Earthquake Consortium TTX

State/Federal Geological Survey Capabilities &Products
CUSEC TTX

March 20, 2019
Springfield, IL

Martha T. Kopper
Arkansas Geological Survey
Martha.Kopper@arkansas.gov
501-683-0119

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

- During an Event- Shaking Intensity
- After at Event -
  - Aftershocks
  - Liquefaction
  - Landslides
  - Lock/Dam/Levee Failure/Flooding/Inundation
  - Lateral Spreading
  - Karst/Sinkholes

These geohazards prevent access/response/evacuation/recovery to impacted areas

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

Impacts

- Buildings
- Agricultural Lands
- Communication Infrastructure
  - Cell/Microwave/Repeater Towers
  - Landline
- Utility Infrastructure
  - Sewer Lines/Pump Stations
  - Gas
  - Water
  - Power Generation/Distribution
  - Fire Hydrants (Firefighting Capabilities)

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

Impacts

- Groundwater Well and Surface Water Supply Infrastructure
  - Water Lines, Water Towers, Water Treatment, Well Pumps/Pump Stations
  - Disruption of groundwater aquifers
- Water Transportation Infrastructure
  - Bridges, Navigable Riverways, Locks/Dams
  - Piers/Docks/Ports
- Air Transportation infrastructure
  - Airport/Runway Access
- Land Transportation Infrastructure
  - Bridges, Roads, Rail

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

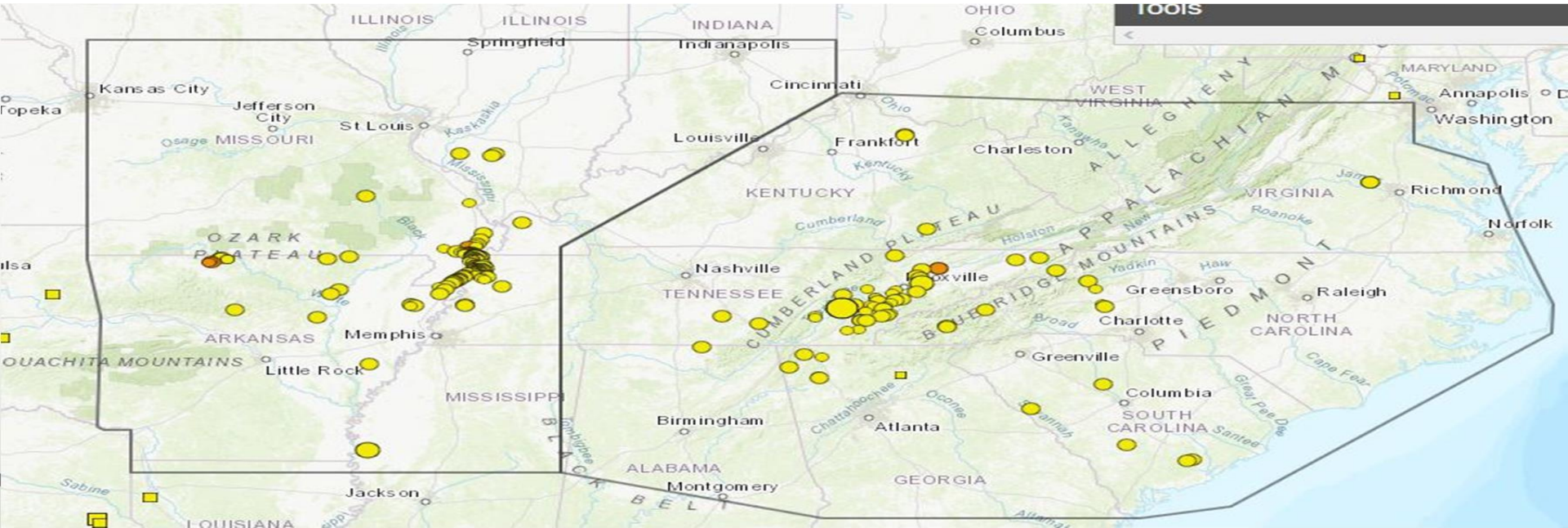
Impacts

- Environmental/Toxic Pollutants (Pipelines, Hazardous Waste/Materials, etc.)
  - Surface and Groundwater Water Quality/Quantity
  - Soil Contamination
  - Air Contamination
  - Human/Plant/Animal Biota

NATIONAL EXERCISE PROGRAM

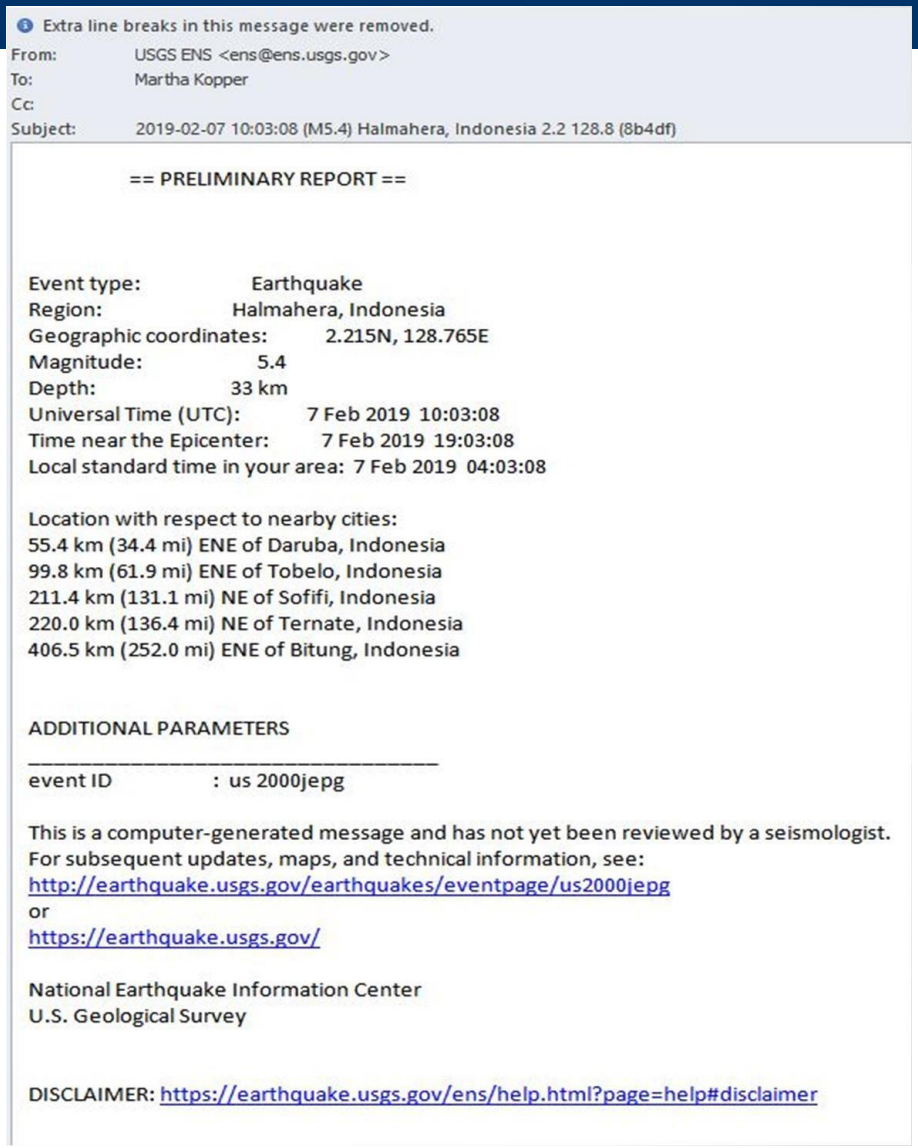
CUSEC State Geologist Collaboration

- University of Memphis & Center for Earthquake Research Information (CERI)
  - CUSEC state geologists collaborate with faculty and staff regarding seismicity and events
  - CERI seismologists have an agreement with the United States Geological Survey to offer solutions/issue Earthquake Notification System (ENS) alerts in the central and eastern portions of the United States (see map below)



CUSEC State Geologist Collaboration

- United States Geological Survey offer solutions and issue ENS alerts for the rest of the US in their 'authoritative polygons':
  - California, Pacific NW, Northeast, Nevada, Utah, Puerto Rico, Alaska, Hawaii
  - Texas and Oklahoma may have their authoritative polygons established



Extra line breaks in this message were removed.

From: USGS ENS <ens@ens.usgs.gov>
To: Martha Kopper
Cc:
Subject: 2019-02-07 10:03:08 (M5.4) Halmahera, Indonesia 2.2 128.8 (8b4df)

== PRELIMINARY REPORT ==

Event type: Earthquake
Region: Halmahera, Indonesia
Geographic coordinates: 2.215N, 128.765E
Magnitude: 5.4
Depth: 33 km
Universal Time (UTC): 7 Feb 2019 10:03:08
Time near the Epicenter: 7 Feb 2019 19:03:08
Local standard time in your area: 7 Feb 2019 04:03:08

Location with respect to nearby cities:
55.4 km (34.4 mi) ENE of Daruba, Indonesia
99.8 km (61.9 mi) ENE of Tobelo, Indonesia
211.4 km (131.1 mi) NE of Sofifi, Indonesia
220.0 km (136.4 mi) NE of Ternate, Indonesia
406.5 km (252.0 mi) ENE of Bitung, Indonesia

ADDITIONAL PARAMETERS

event ID : us 2000jepg

This is a computer-generated message and has not yet been reviewed by a seismologist.
For subsequent updates, maps, and technical information, see:
http://earthquake.usgs.gov/earthquakes/eventpage/us2000jepg
or
https://earthquake.usgs.gov/

National Earthquake Information Center
U.S. Geological Survey

DISCLAIMER: https://earthquake.usgs.gov/ens/help.html?page=help#disclaimer

NATIONAL EXERCISE PROGRAM

NIMS Structure and the State geological Surveys

- Within NIMS structure, Geological Surveys are ESF #5 (Planning)

- These geological surveys' capabilities and products will support the disaster by
  - o Providing a common operating picture
  - o Situational awareness
  - o Common operational data (multiple electronic formats)
  - o Planning support (as Subject Matter Experts) for all phases of response and recovery of the affected areas

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

- Product/Analysis – geological surveys will notify the EM of geohazards
    - Analysis of affected areas - no access/limited access
    - Soil Liquefaction Map Updates Geologic Fault Map Updates
    - Landslide Inventory/Susceptibility Map Updates
    - Karst/Sinkhole Map Updates

NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

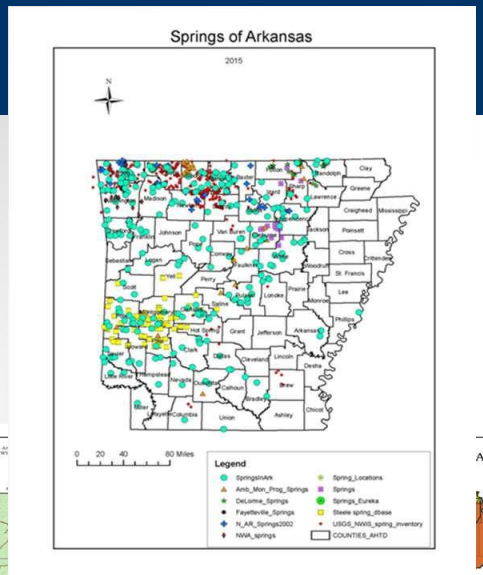
- Product/Analysis –
  - Deployment/Monitor additional seismic stations
  - Interpretation of seismic data from earthquake events
  - Mapping/GIS - Geohazards with Potentially Impacted Regions- Common Operating Picture
  - Acquisition/Process remote sensing data – Aerial, Satellite, LiDAR

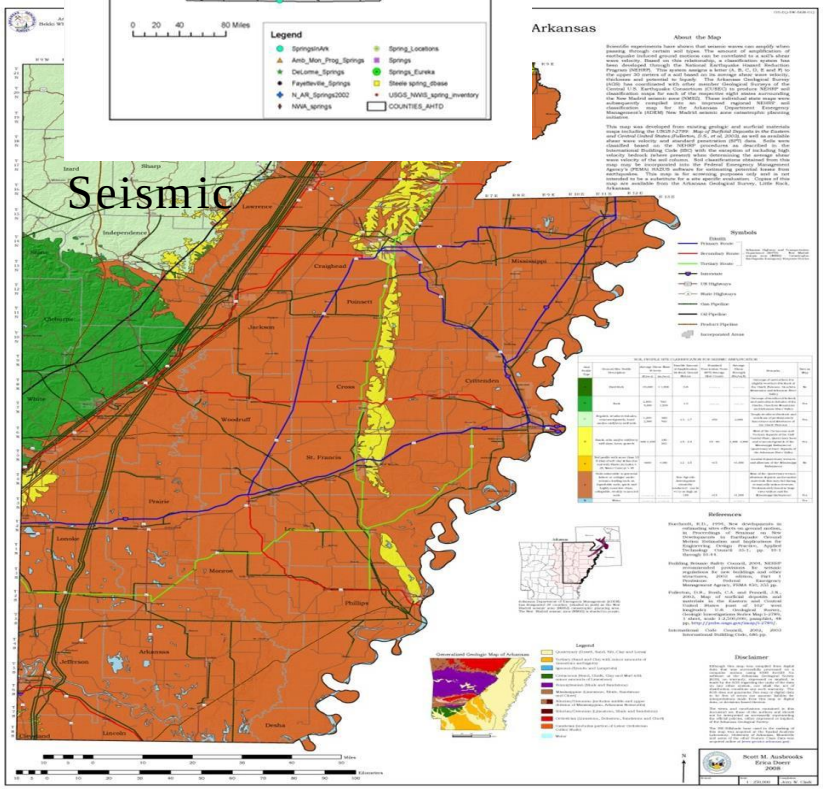
NATIONAL EXERCISE PROGRAM

State/Federal Geological Survey Capabilities & Products

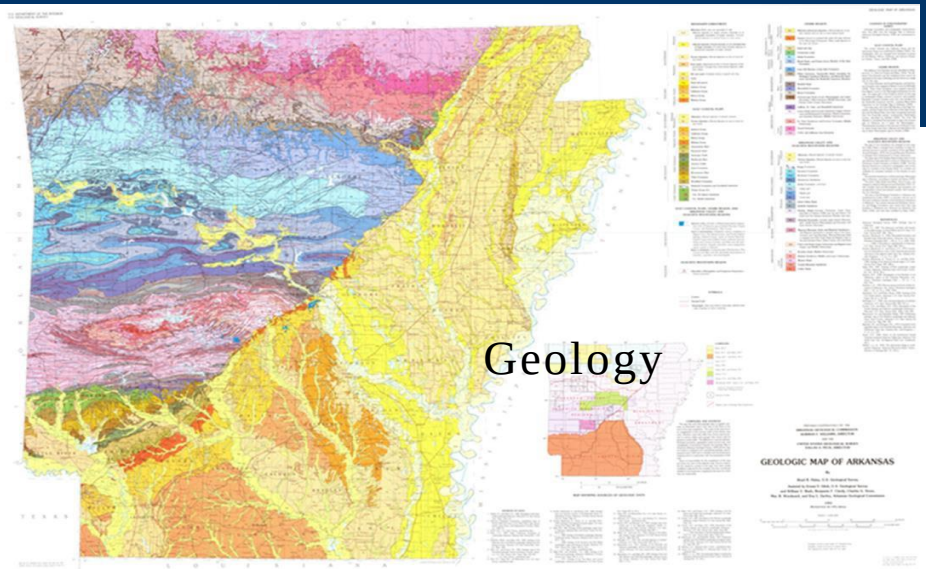
- Product/Analysis –
  - Analysis - Tracking long term damage/recovery efforts to landscape, natural resources, and demographics
  - Geologist Mission Ready Package (EMAC) - field, liaison, GIS trained geologist resources available for deployment
  - Analysis of Debris Removal, Storage and Location of Acceptable Landfill Sites

Arkansas Geohazard Resources



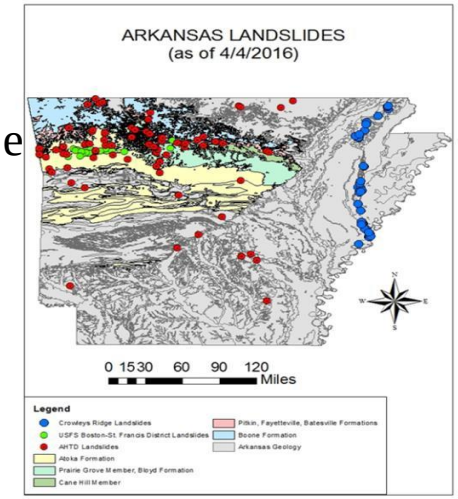


Seismic



Geology

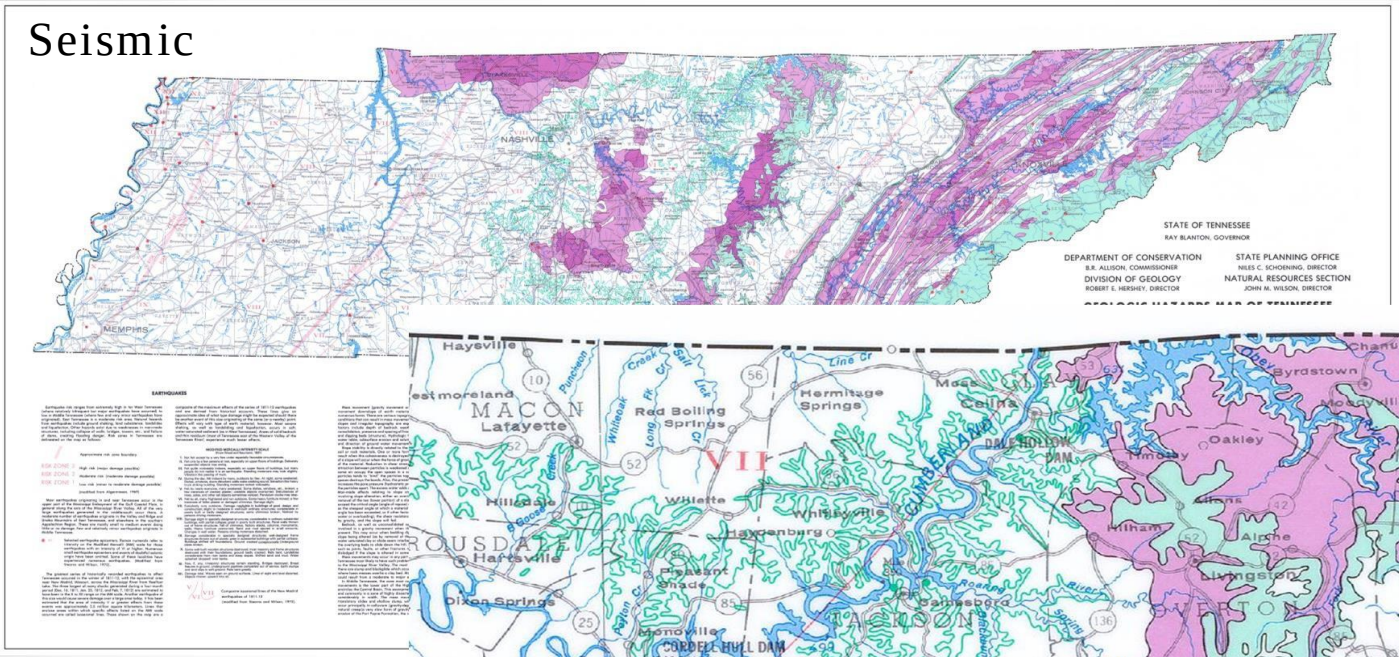
Landslide

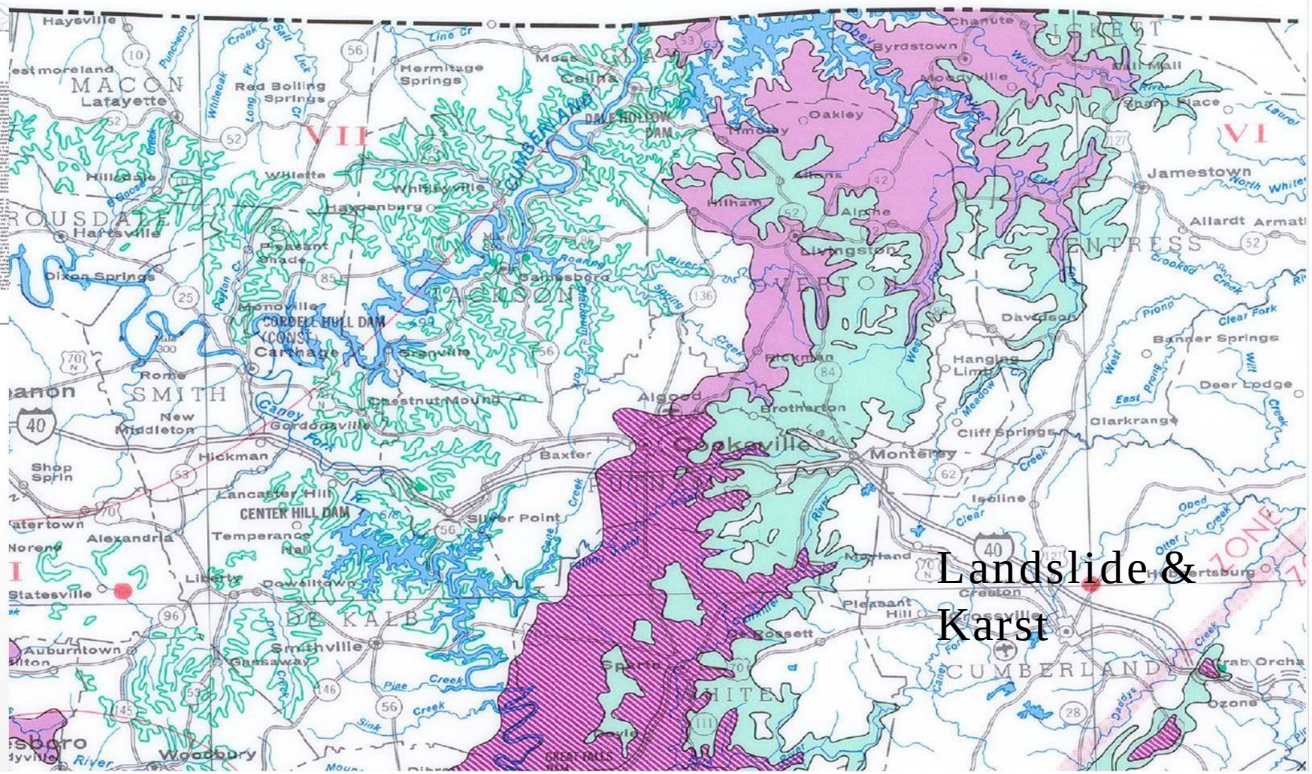


NATIONAL EXERCISE PROGRAM

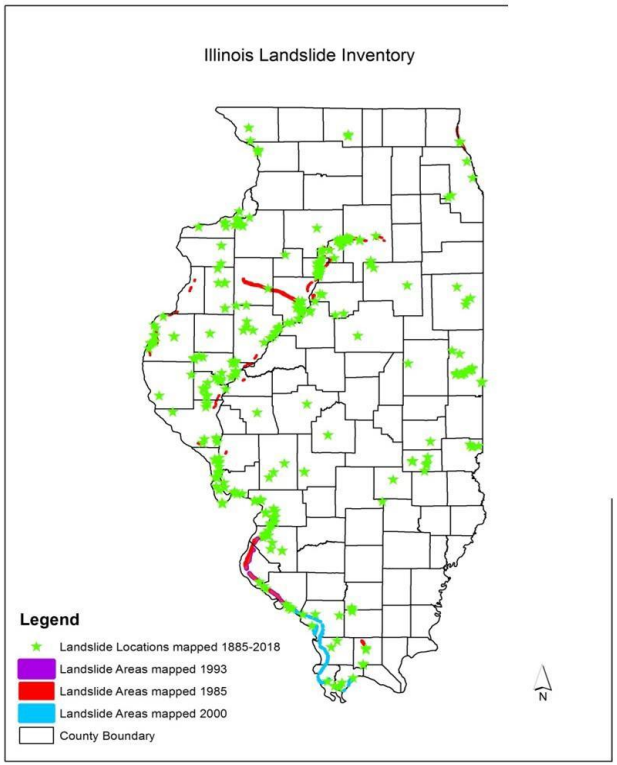
Tennessee Geohazards Resources

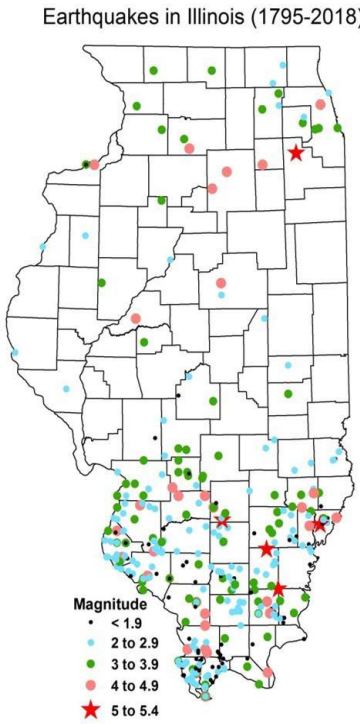
Seismic

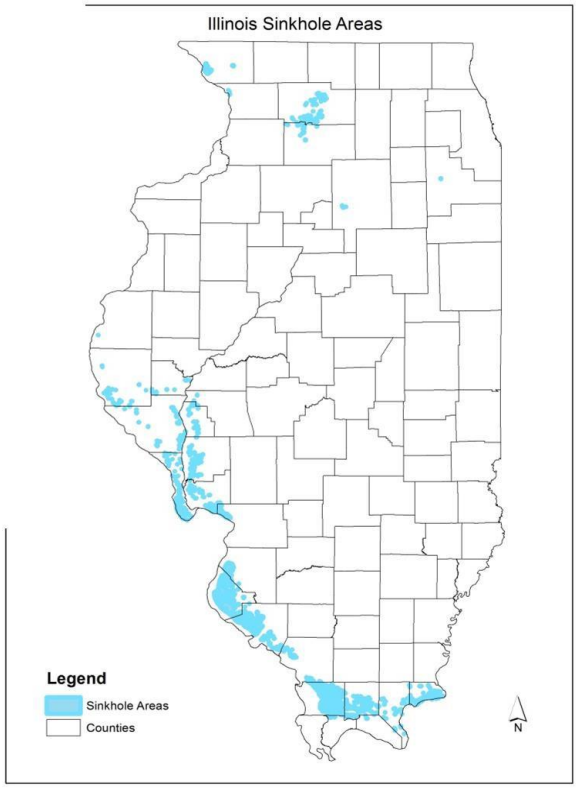




Illinois Geohazards Resources

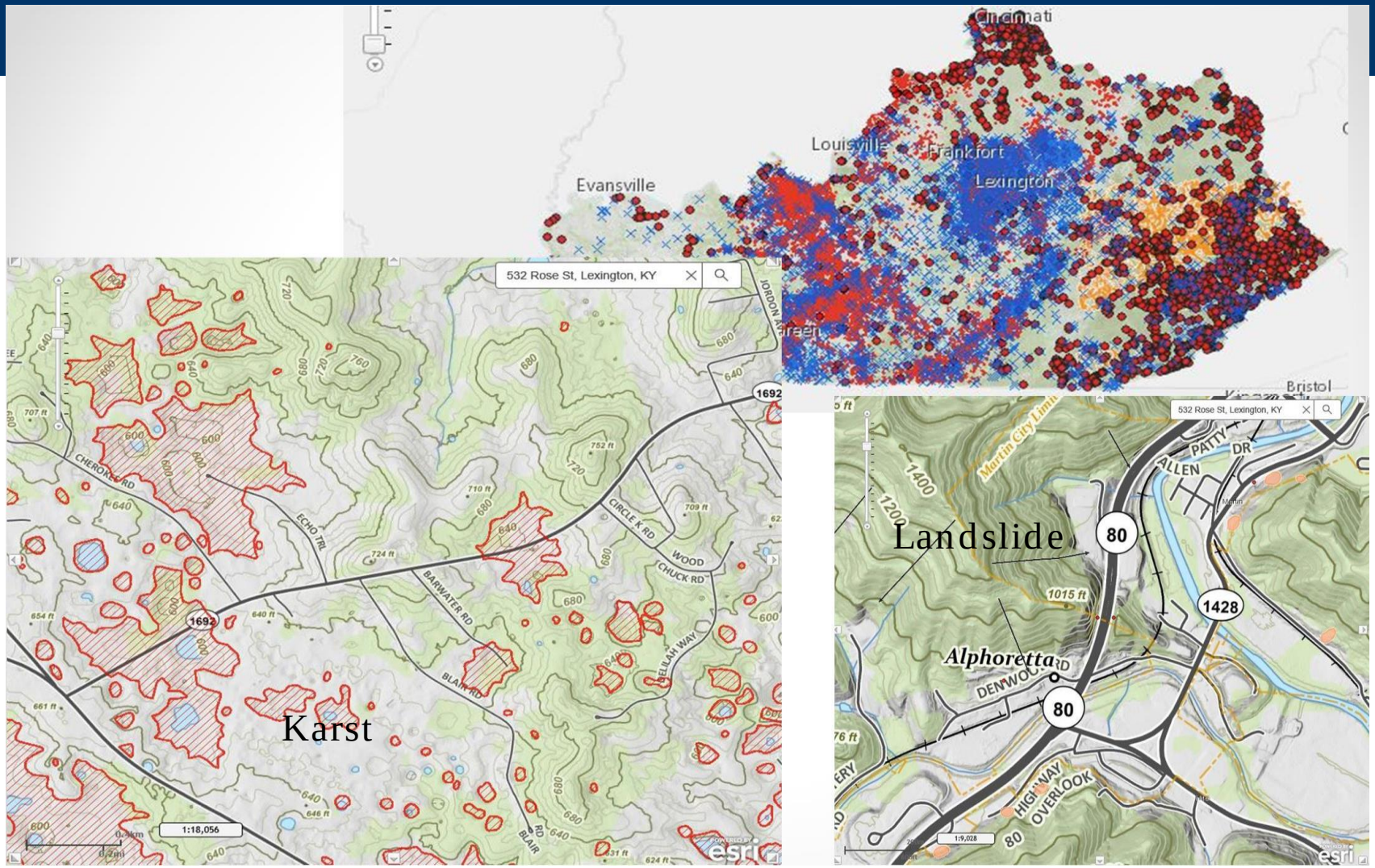




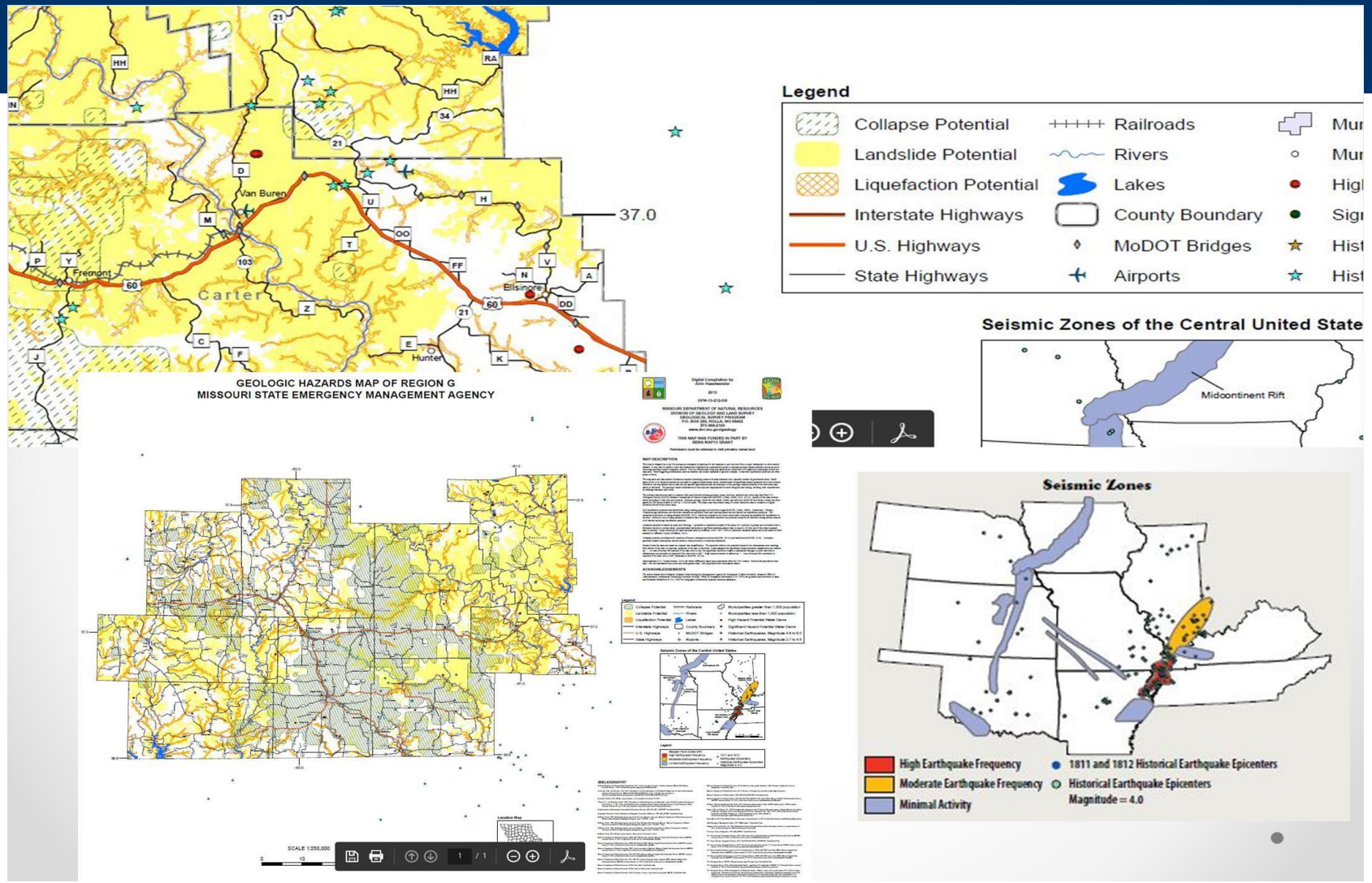


NATIONAL EXERCISE PROGRAM

Kentucky Geohazard Resources

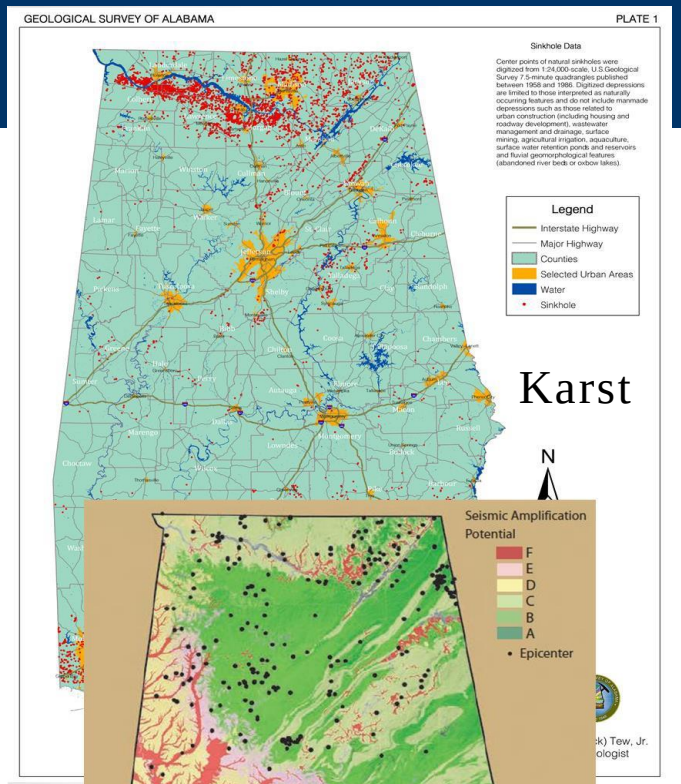


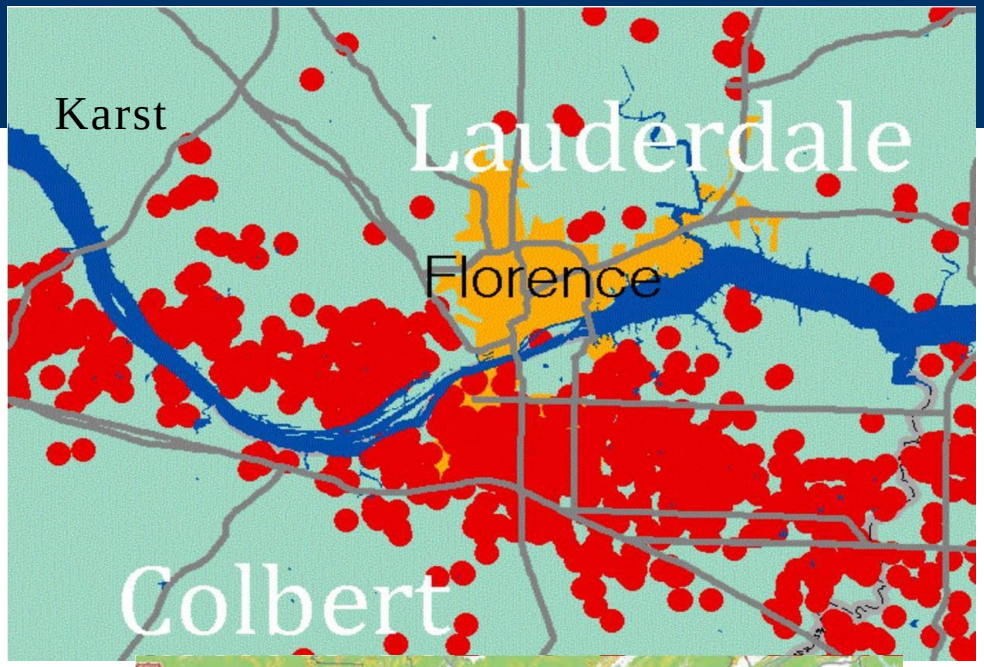
Missouri Geohazard Resources

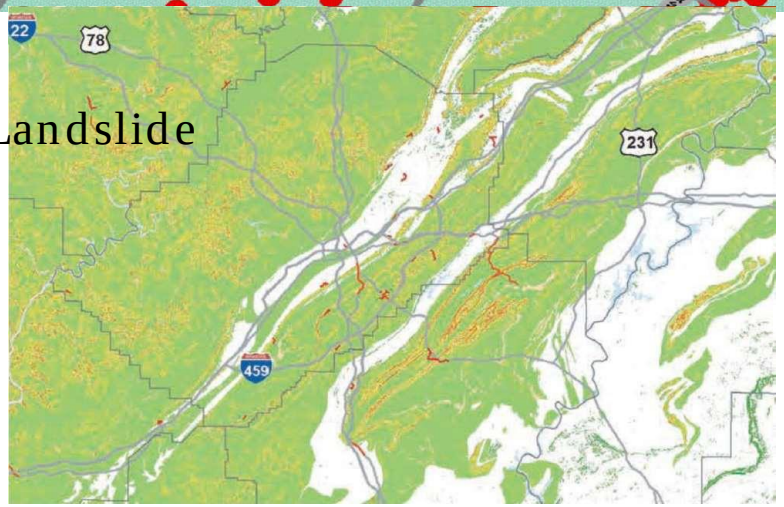


NATIONAL EXERCISE PROGRAM

Alabama Geohazards Resources







NATIONAL EXERCISE PROGRAM

United States Geological Survey Resources

- Products
  - USGS Resources
    - ShakeMap
    - ShakeCast
    - Did-You-Feel-It
    - PAGER
    - onePAGER
    - Ground Failure

NATIONAL EXERCISE PROGRAM

USGS science for a changing world

EARTHQUAKE CENTER

Earthquake Hazards Program

MENU

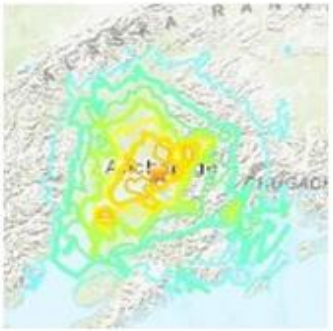
Latest Earthquakes

M 7.0 - 14km NNW of Anchorage, Alaska

2018-11-30 17:29:29 (UTC) | 61.346°N 149.955°W | 46.7 km depth

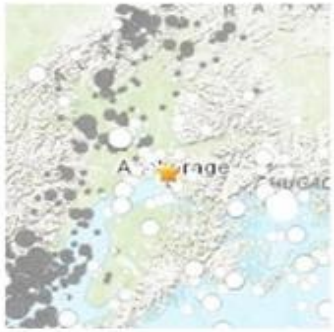
- Overview
- Interactive Map
- Regional Information
- Impact
- Felt Report - Tell Us!
- Did You Feel It?
- ShakeMap
- PAGER
- Ground Failure
- Technical
- Origin
- Moment Tensor
- Finite Fault

InteractiVe Map



Contributed by AK

Regional Information



Contributed by AK

Felt Report - Tell Us!

000703

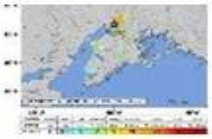
Responses

Contribute to citizen science. Please tell us about your experience.

Citizen Scientist Contributions

Did You Feel It?

VOI

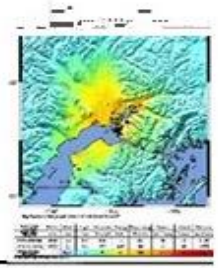


Community Internet Intensity Map

Contributed by US

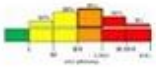
ShakeMap

VOI



PAGER

ORANGE



Estimated Economic Losses

Ground Failure

Landslides

Significant area affected
Little or no population ex

Review Status
REVIEWED

Magnitude
7.0 mww

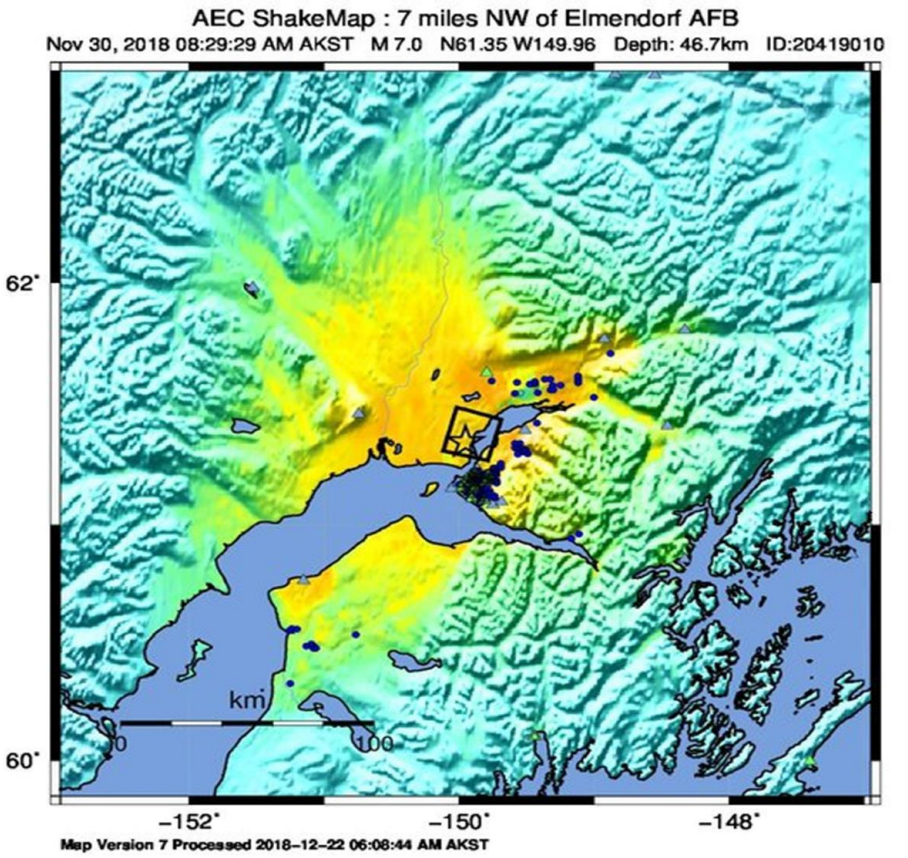
Depth
46.7 km

NATIONAL EXERCISE PROGRAM

ShakeMap

- ShakeMap - describes the shaking inmore remote areas
  - o ShakeMap in urban regions are expected to be most accurate where the population at risk is the greatest
  - o where emergency response/recovery efforts will likely be most urgent and complex

ShakeMap



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

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ShakeCast (V3)

- Critical users (i.e. lifeline, utilities) can receive automatic notifications within minutes of an earthquake indicating
  - Level of shaking
  - Likelihood of impact to their own facilities.

NATIONAL EXERCISE PROGRAM

PAGER – Prompt Assessment of Global Earthquakes for Response

- Automated system – gathers remote seismic data
- Rapidly estimated earthquake shaking/scope and impact of earthquakes around the world.

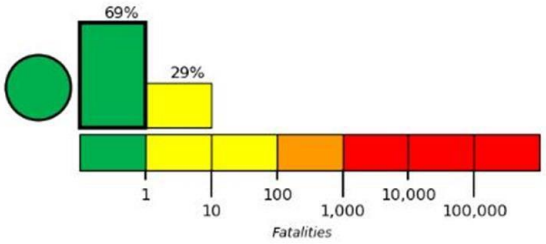
- PAGER provides order of magnitude estimates of
  - Potential fatalities
  - Approximate economic impact
  - PAGER loss estimations available in advance of ground-truth observations - they can play a primary alerting role for earthquake disasters
- For M > M5.5, PAGER estimates are available within 20-30 minutes; domestic earthquake PAGER estimates available within 10 minutes
  - Used by EOC, USAID/Red Cross, media, businesses, engineers, scientists, educators, civil/earthquake engineers

NATIONAL EXERCISE PROGRAM

PAGER

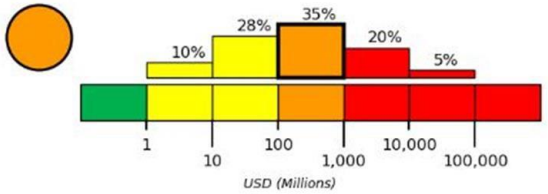
- Felt Report - Tell Us!
- Did You Feel It?
- ShakeMap
- PAGER
- Ground Failure
- Technical
- Origin
- Moment Tensor
- Finite Fault
- Waveforms
- Aftershock Forecast
- Download Event KML
- View Nearby Seismicity
- Earthquakes
- Hazards
- Data & Products

Estimated Fatalities



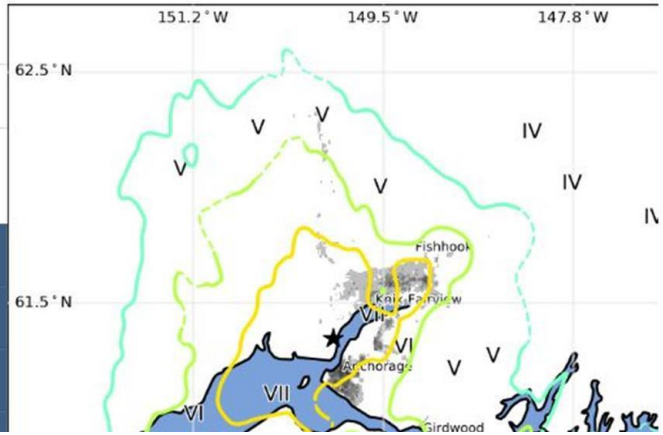
Green alert for shaking-related fatalities. There is a low likelihood of casualties.

Estimated Economic Losses



Orange alert for economic losses. Significant damage is likely and the disaster is potentially widespread. Estimated economic losses are less than 1% of GDP of the United States. Past events with this alert level have required a regional or national level response.

Estimated Population Exposure to Earthquake Shaking



Structure Information Summary

Overall, the population in this region resides in structures that are resistant to earthquake shaking, though vulnerable structures exist. The predominant vulnerable building types are unreinforced brick masonry and reinforced masonry construction.

Secondary Effects

Recent earthquakes in this area have caused secondary hazards such as tsunamis, landslides and liquefaction that might have contributed to losses.

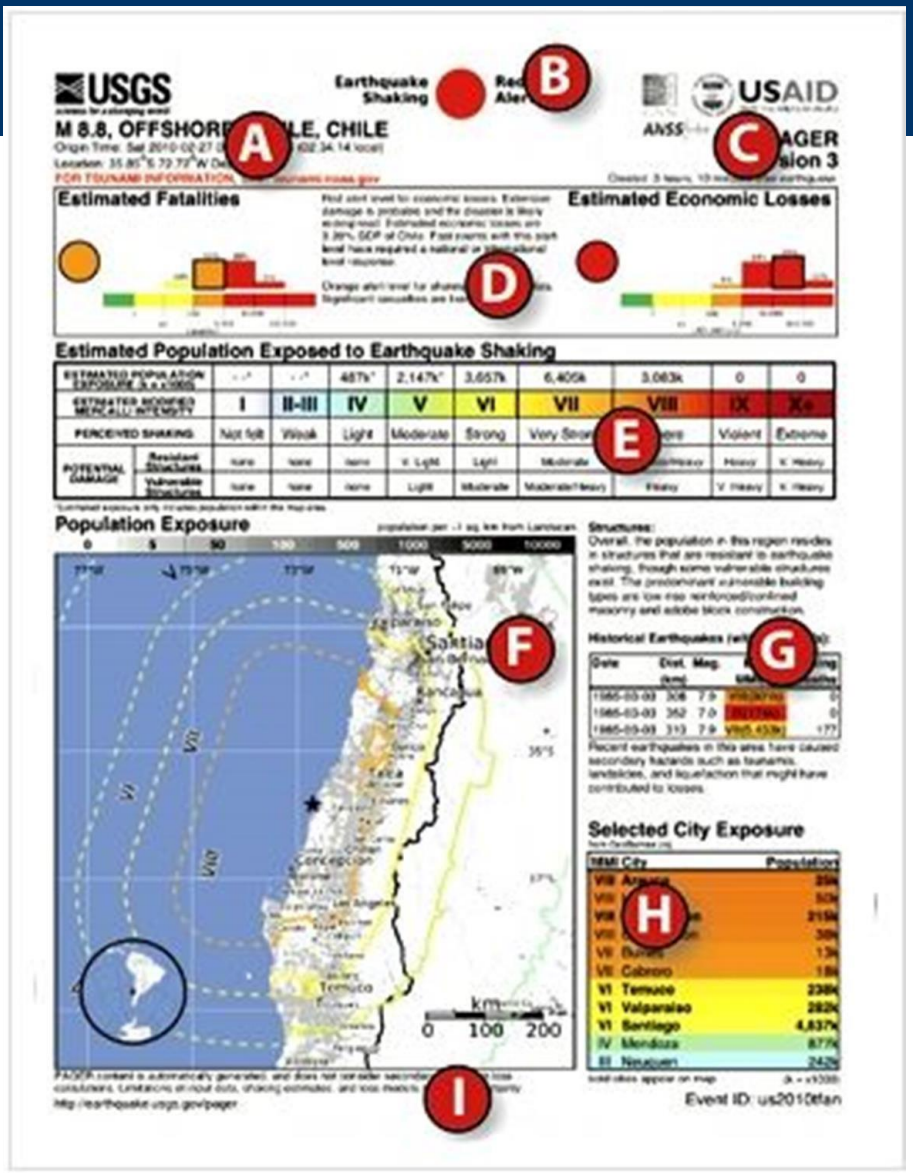
Selected Cities Exposed

☐ Show All Cities

NATIONAL EXERCISE PROGRAM

onePAGER

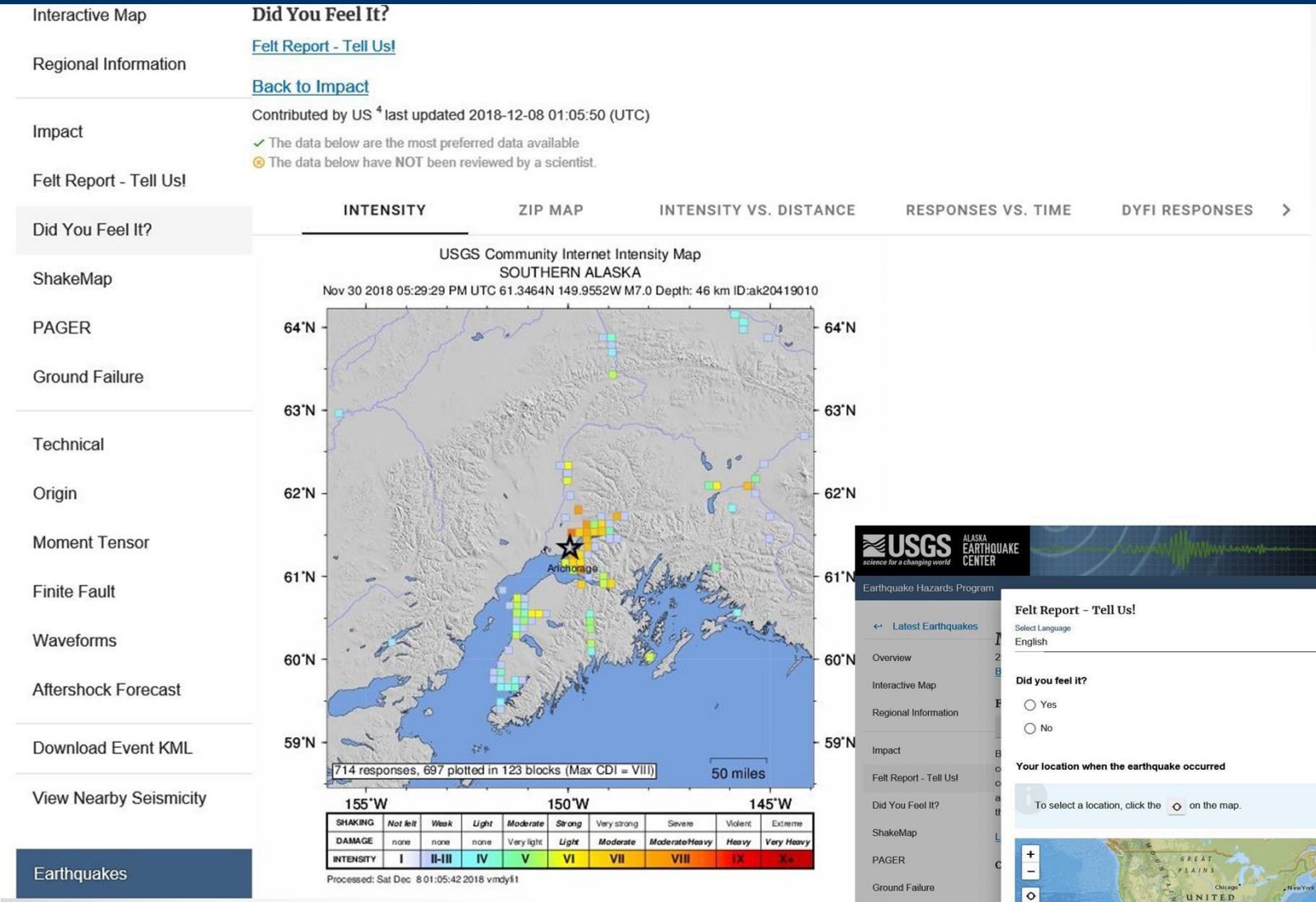
- Concise summary of major elements produced by PAGER
- Available via link on PAGER event web pages
  - https://earthquake.usgs.gov/data/pager/onepager.php



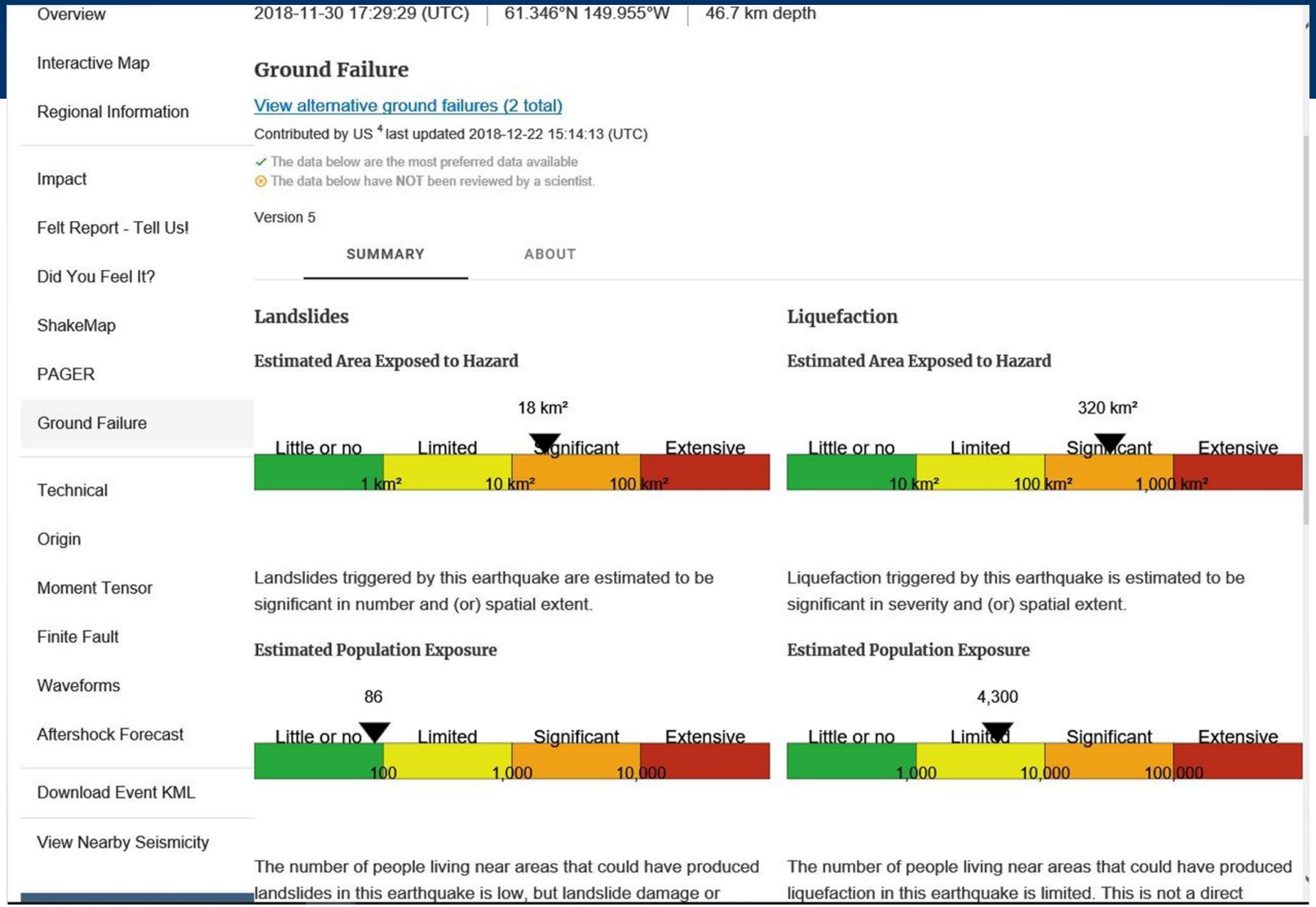
Did-You-Feel-It?

- DYFI
  - Collects information from people who felt an earthquake
  - Created maps show:
    - What people experienced
    - Extent of damage

Did-You-Feel-It?



Ground Failure



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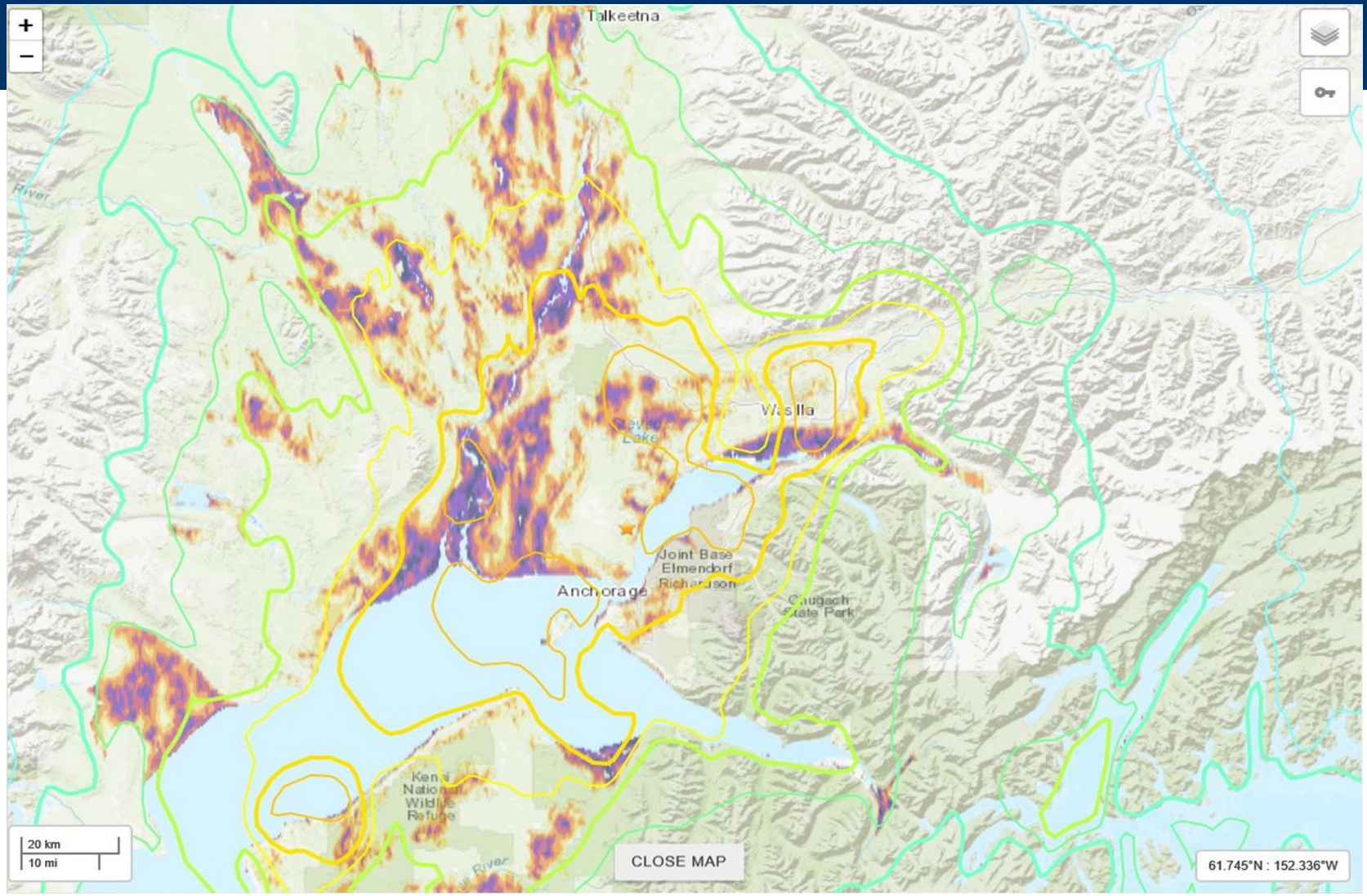
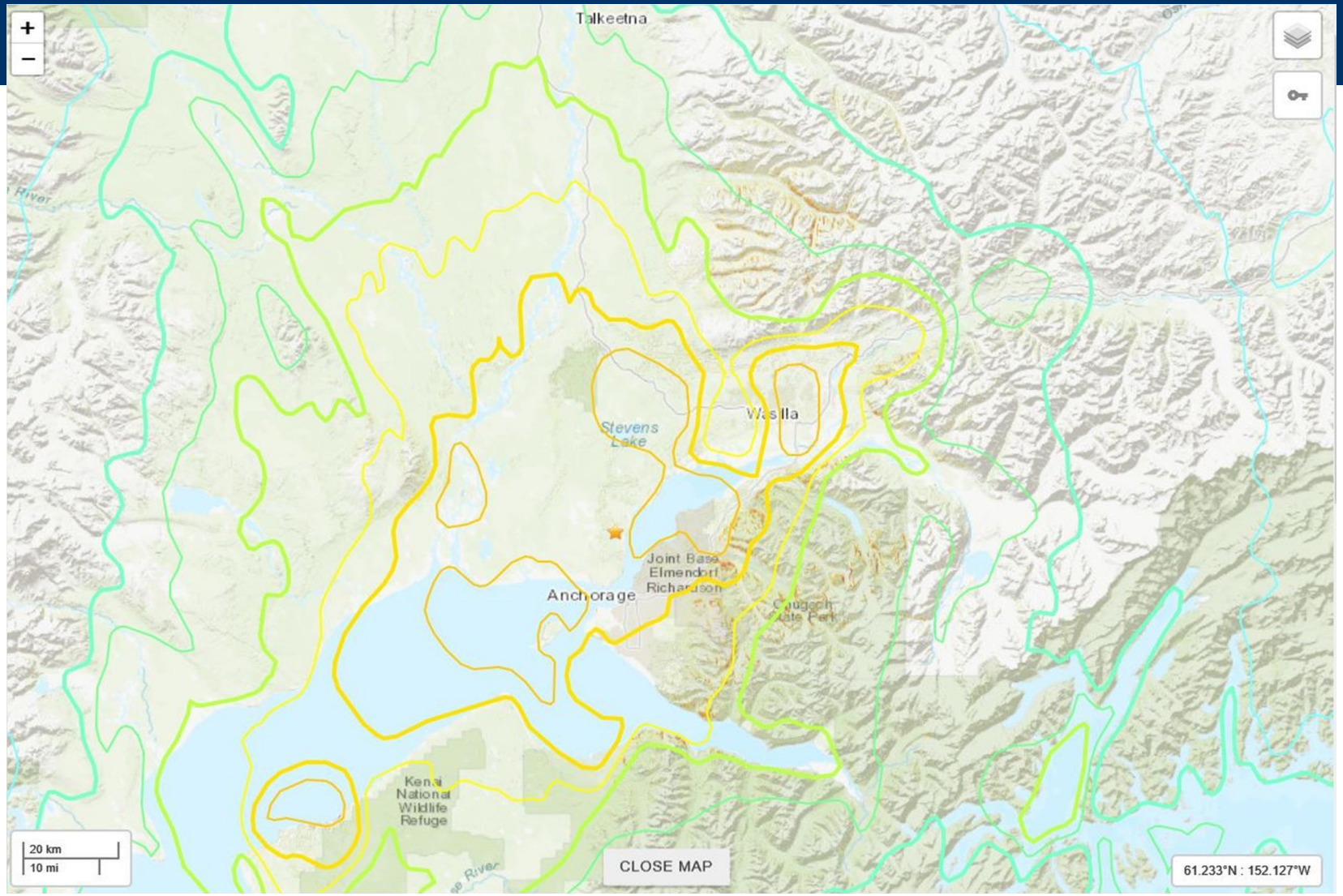
Liquefaction



NATIONAL EXERCISE PROGRAM

Landslide



NATIONAL EXERCISE PROGRAM

Earthquake Planning

- Difference between earthquakes and other disasters
  - No notice of an earthquake
  - Widespread cascading impacts likely (fire, explosions, building/transportation collapse, etc.)
  - Not a seasonal event
  - Aftershocks may be as large or larger than initial event
    - Aftershocks restart evaluation/analysis
    - Previously damaged areas may incur additional damage
    - New damage may have occurred

NATIONAL EXERCISE PROGRAM

Earthquake Planning- Working with Geological Surveys

- Encourage collaboration
  - Get to know the geological survey staff
  - Build trust
  - Engage them in exercises and activities
  - Conduct multiple conversations with your geological survey
  - Set up meetings now (for next week/next month) to strategize
  - Identify and share
    - Types of information necessary for a disaster
    - Timeframes necessary during response and recovery
    - Types and categorization of data needed
    - Ask questions
- Geological surveys can assist in response and recovery activities

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Thank you

- For your attention
- Your future collaboration with the surveys

Any questions?

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NATIONAL EXERCISE PROGRAM

Resource Briefings

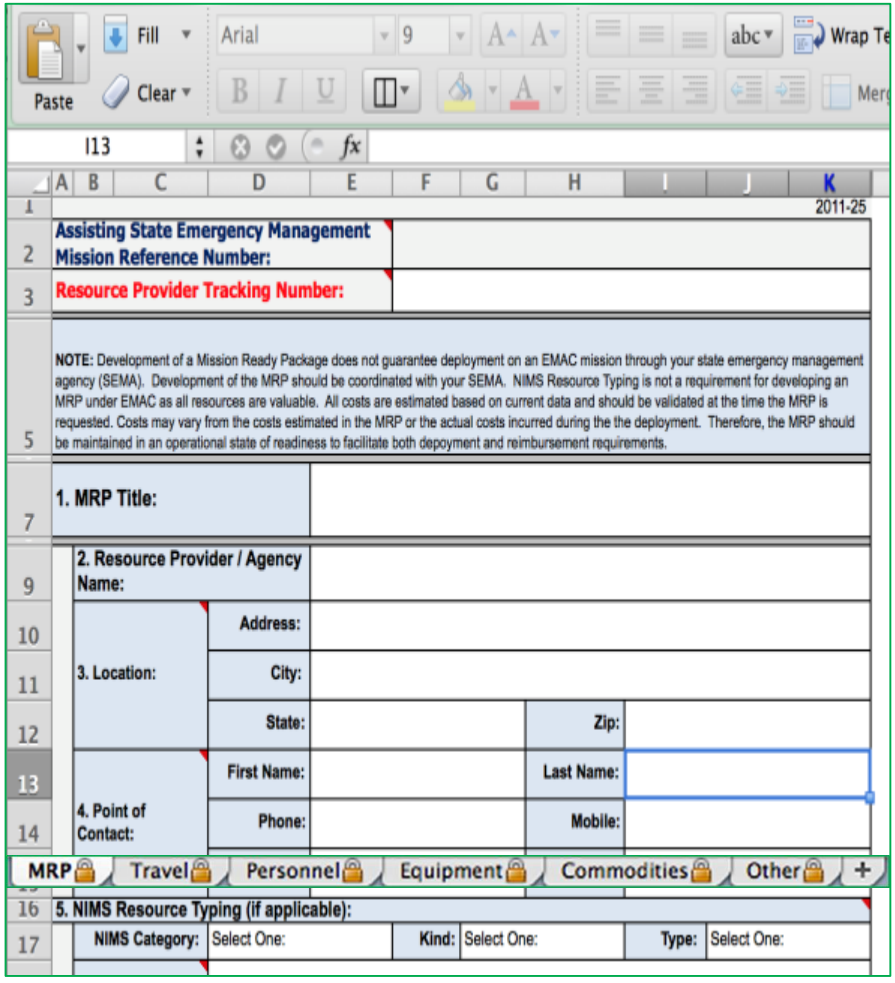
Greg Shanks,

Kentucky Emergency Management Agency

"Mission Ready Packages for EMAC"

Mission Ready Package (MRP)

What Is a Mission Ready Package (MRP)?



					2011-25
2	Assisting State Emergency Management Mission Reference Number:				
3	Resource Provider Tracking Number:				
5	NOTE: Development of a Mission Ready Package does not guarantee deployment on an EMAC mission through your state emergency management agency (SEMA). Development of the MRP should be coordinated with your SEMA. NIMS Resource Typing is not a requirement for developing an MRP under EMAC as all resources are valuable. All costs are estimated based on current data and should be validated at the time the MRP is requested. Costs may vary from the costs estimated in the MRP or the actual costs incurred during the the deployment. Therefore, the MRP should be maintained in an operational state of readiness to facilitate both depoyment and reimbursement requirements.				
7	1. MRP Title:				
9	2. Resource Provider / Agency Name:				
10	3. Location:	Address:			
11		City:			
12		State:		Zip:	
13	4. Point of Contact:	First Name:		Last Name:	
14		Phone:		Mobile:	
16	5. NIMS Resource Typing (if applicable):				
17	NIMS Category:	Select One:	Kind: Select One:	Type:	Select One:

MRP | Travel | Personnel | Equipment | Commodities | Other

- Specific response and recovery resource capabilities that are organized, developed, trained, and exercised prior to an emergency or disaster.
- Based on NIMS resource typing.
- Mission description and capability.
- Estimated mission costs.
- Footprint, limiting factors, and logistical support requirements.

Value of the Mission Ready Package

PROBLEM

Nationally, regionally and across local government entities we lack the visibility of mutual aid capabilities (people, equipment, resources) to meet local incident requirements efficiently.

SOLUTION

We can Increase efficiency and overall effectiveness by gaining visibility of existing capabilities and capacities through creating Mission Ready Packages (MRP) and by publishing them in the Mutual Aid Support System (MASS).

The Value of the MRP

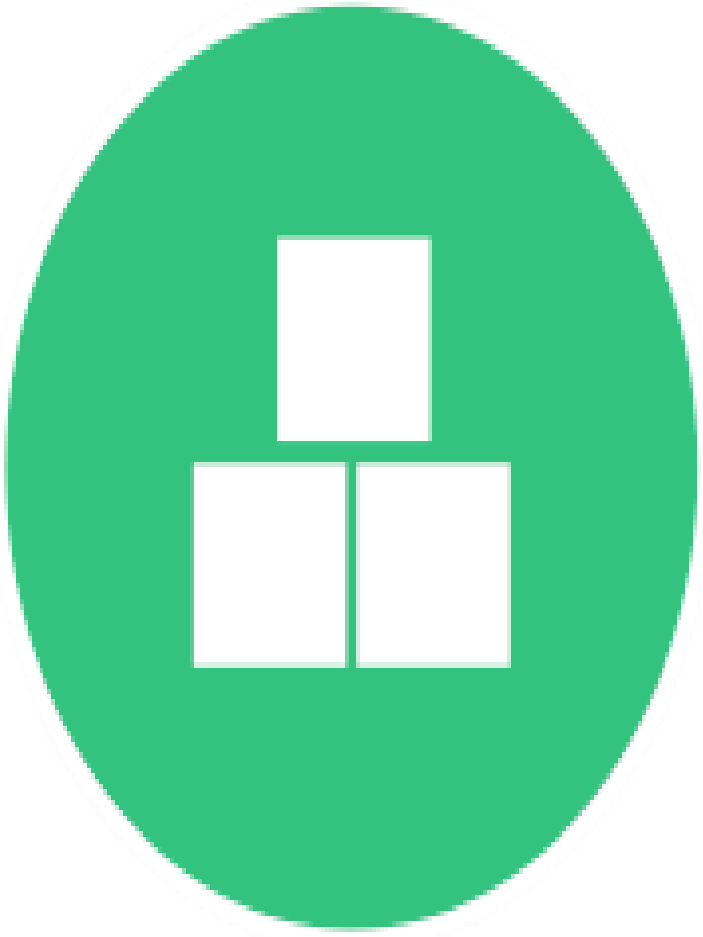
- Personnel, skill sets, credentials, salaries, benefits and overtime are all included.
- Specific equipment and associated costs are included.
- Logistical support, necessary supplies, and space requirements are part of the MRP.
- An accurate estimate of costs can be determined before the MRP is deployed.

States that had developed MRPs were able to develop offers for assistance faster and more accurately than the Assisting States who did not use MRPs.

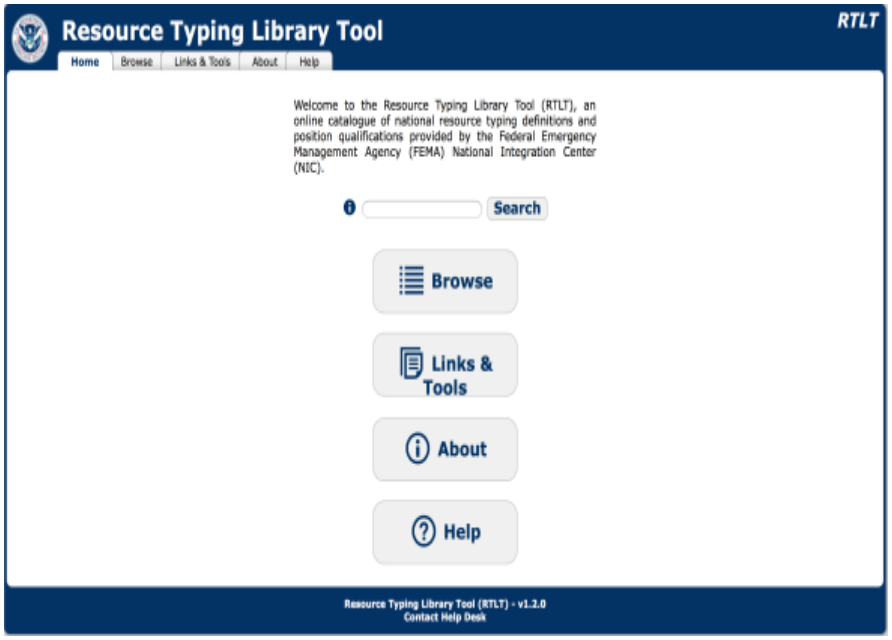
- 2017 Hurricane Season AAR

Building the Inventory

- Allows local governments, tribal leaders, private sector and volunteer organizations the opportunity to participate.
- Each resource provider is responsible for maintaining MRP information.
- Each resource provider controls the availability of their own MRPs.
- Statewide agreements can allow for jurisdiction to jurisdiction mutual aid, or for a state managed mutual aid system through the State EOC.

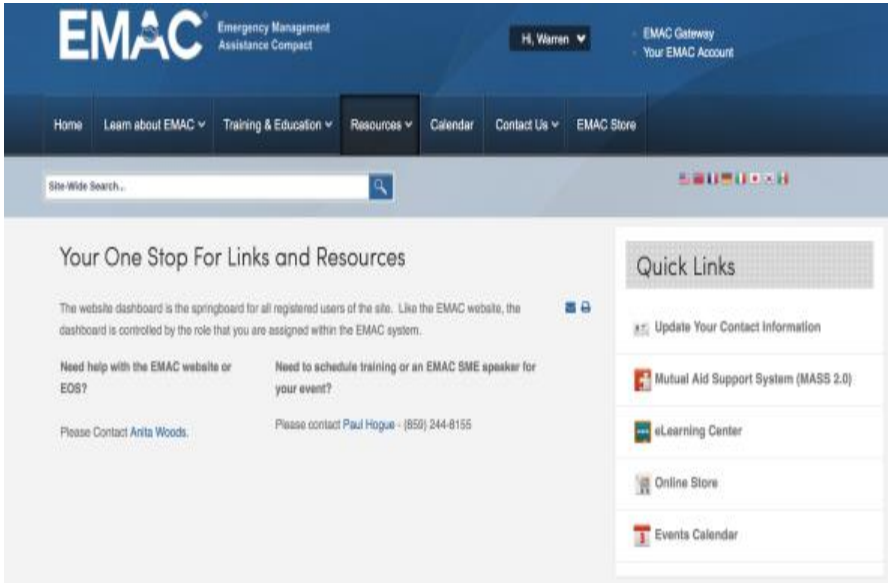


Building MRPs to National Standards



- Resource Providers should reference the Resource Typing Library Tool (RTLT) released by FEMA in support of the implementation of the NIMS.
- Building to national standards will improve understanding and reliability of MRPs used for mutual aid.
- MRPs can be built even if they do not align with NIMS resource typing definitions.

Accessing the Mutual Aid Support System (MASS)

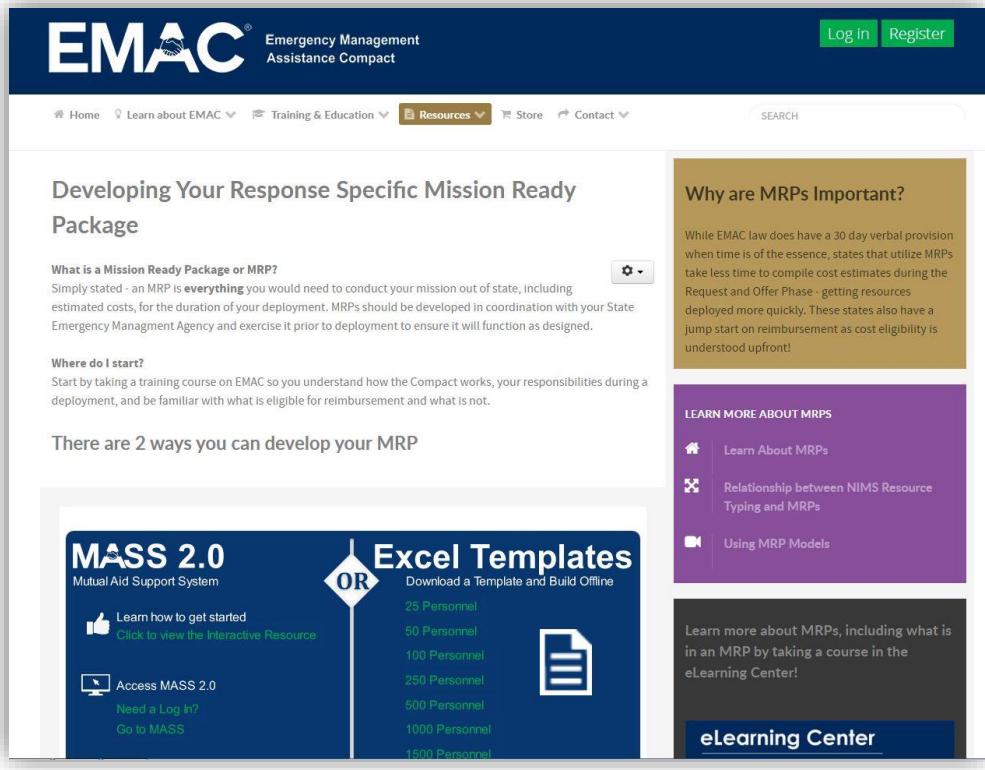


After Login:

- Find the "Quick Links" box on the right side of the page.
- Right click on "Mutual Aid Support System (MASS 2.0)"
- Wait for the next screen which will be a notice to the resource provider of the responsibility to keep the MRP updated.
- The resource provider will have to agree to the terms to proceed.

Resources

- State EMAC Coordinators
- EMAC Executive Task Force – LSRs
- Understanding EMAC Course @ EMI (E431)
- EMAC eLearning Center
- MRP Development Workshop (State Instructed)



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Assumptions and Artificialities

Assumptions

- The exercise scenario **is plausible and events occur as they are presented**
- Exercise players will use their **existing plans, policies, procedures, and resources** to discuss response planning and recovery operations
- Capture moments of opportunity to **improve or enhance current operational plans**

Artificialities

- There is no "**hidden agenda**" nor **trick questions**
- The scenario **assumes certain player actions and scenario conditions** throughout each of the modules so **players should openly discuss response actions** stipulated by the scenario

NATIONAL EXERCISE PROGRAM

Scenario Source References

Amr S. Elnashai, Lisa J. Cleveland, Theresa Jefferson, and John Harrald. (2008). *Impact of Earthquakes on the Central USA.* Urbana, IL: Mid-America earthquake Center, Institute fro Crisis, Disaster and Risk Management.

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Michael L. Wilson, Thomas F. Corbet, Arnold B. Baker, and Julia M. O'Rourke. (2015). *Simulating Impacts of Disruptions to Liquid Fuels Infrastructure.* Albuquerque, New Mexico and Livermore, California : Sandia National Laboratories.

Stewart Cedres. (2010). *U.S. Department of Energy, DOE New Madrid Seismic Zone Electric Utility Workshop Summary Report.* Washington DC: U.S. Department of Energy.

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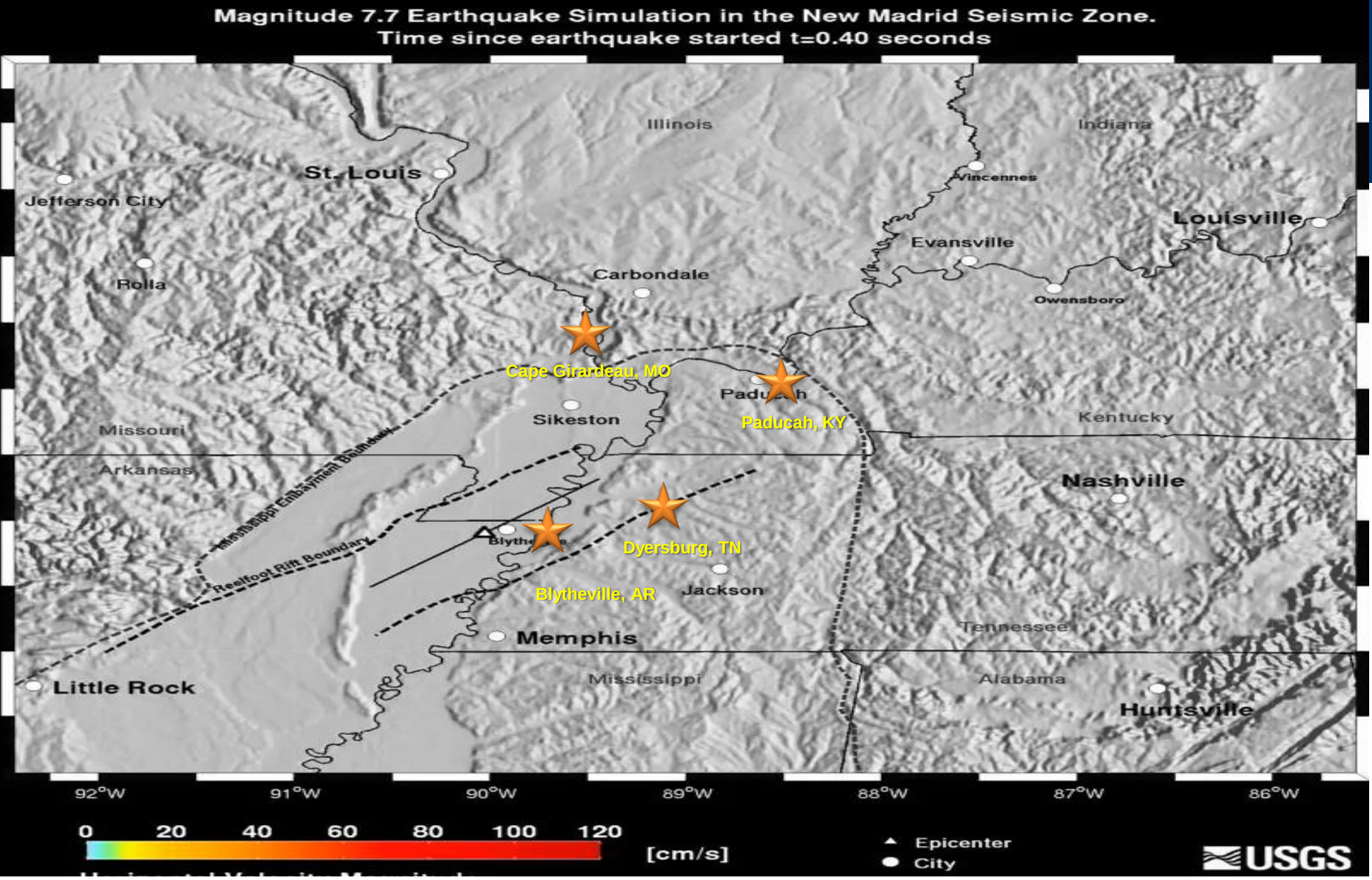

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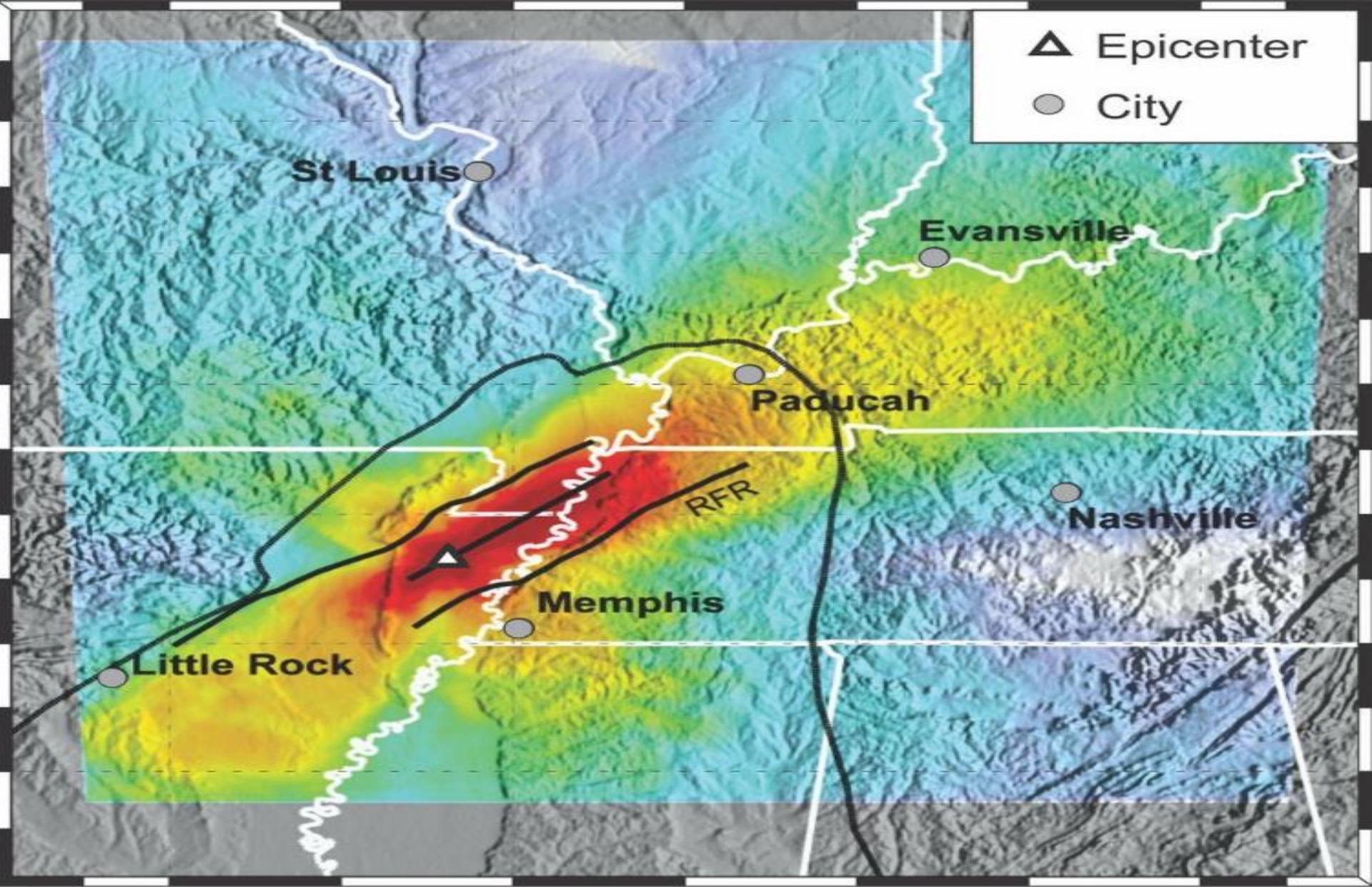

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Exercise Scenario

At **0700 a.m. (CST)** on February 6, a magnitude 7.7 earthquake was recorded in the central U.S. region near the southern section of the New Madrid Seismic Zone. The United States Geological Survey (USGS) is reporting the epicenter just southwest of Blytheville, Arkansas and seismic waves traveled outward in all directions. This earthquake produced successive waves of strong ground shaking that began moving along the Reelfoot rift and appeared to be focused northeast toward Paducah, Kentucky and southwest toward Little Rock, Arkansas. The USGS has also reported that the earthquake produced long-period shaking that lasted up to 45 seconds in some areas, including Memphis and Dyersburg, TN, Little Rock, AR, Cape Girardeau, MO and Paducah, KY.

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Situational Assessment:
Information for Decision Making

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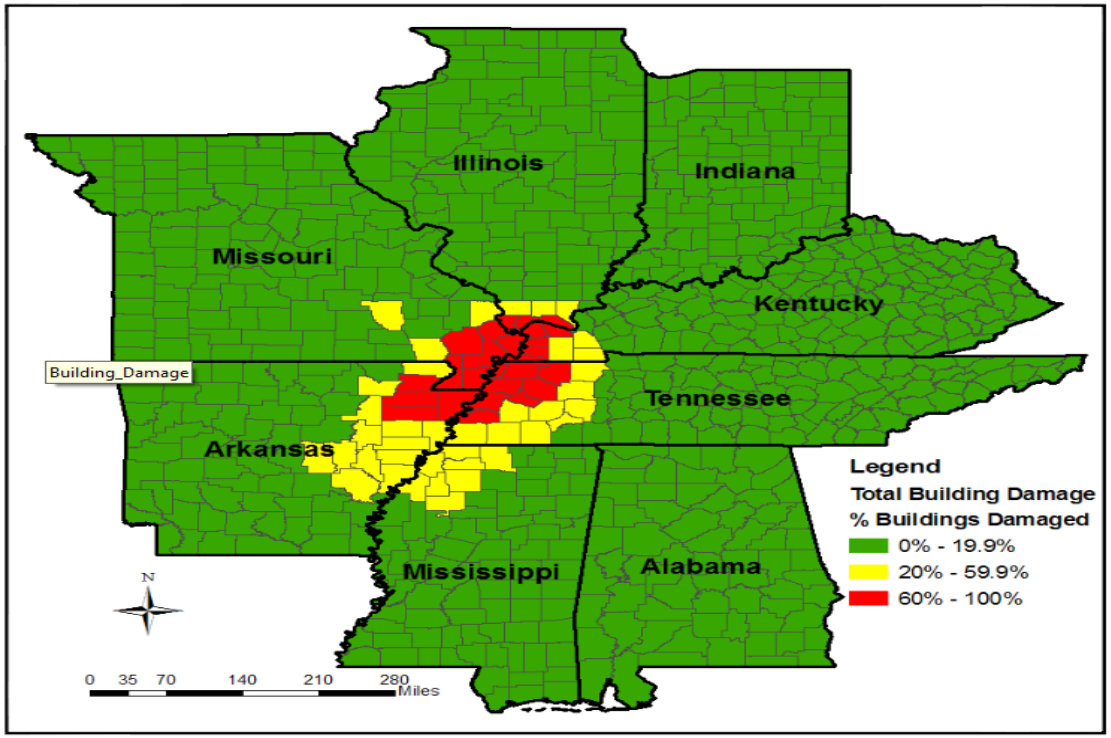
Initial Estimated Impact and Damages

General Buildings

10/1/2009

	Total Buildings	Buildings Damaged	URM Damage	Wood Damage
Alabama	1,758,300	15,382	372	3,009
Arkansas	1,325,400	162,235	29,134	68,763
Illinois	3,655,800	44,464	10,120	17,712
Indiana	2,202,000	14,215	2,564	4,796
Kentucky	1,543,900	68,400	9,413	36,116
Mississippi	1,064,000	57,442	4,995	19,856
Missouri	2,101,900	86,838	26,772	40,185
Tennessee	2,126,600	264,198	48,880	163,577
TOTAL	15,777,900	713,174	132,250	354,014

- *Though buildings are damaged throughout the entire 8-state region, the most severe damage occurs in western TN, northeastern AR, western KY, the Boot Heel of MO, and southern IL*
- *Roughly 25 counties are catastrophically damaged, meaning more than 60% of all buildings are damaged (colored red)*
- *Additionally, almost 40 counties incur substantial damage with 20% to 60% of all buildings damaged (colored yellow)*



Building damage is illustrated by the percent of buildings damaged in each county. Counties with more than 60% of buildings damage are critically impacted.

Mid-America Earthquake Center | Virginia Tech Invent the Future | Institute for Crisis, Disaster and Risk Management, The George Washington University

NOTE: URM: Indicated Unreinforced Masonry structures

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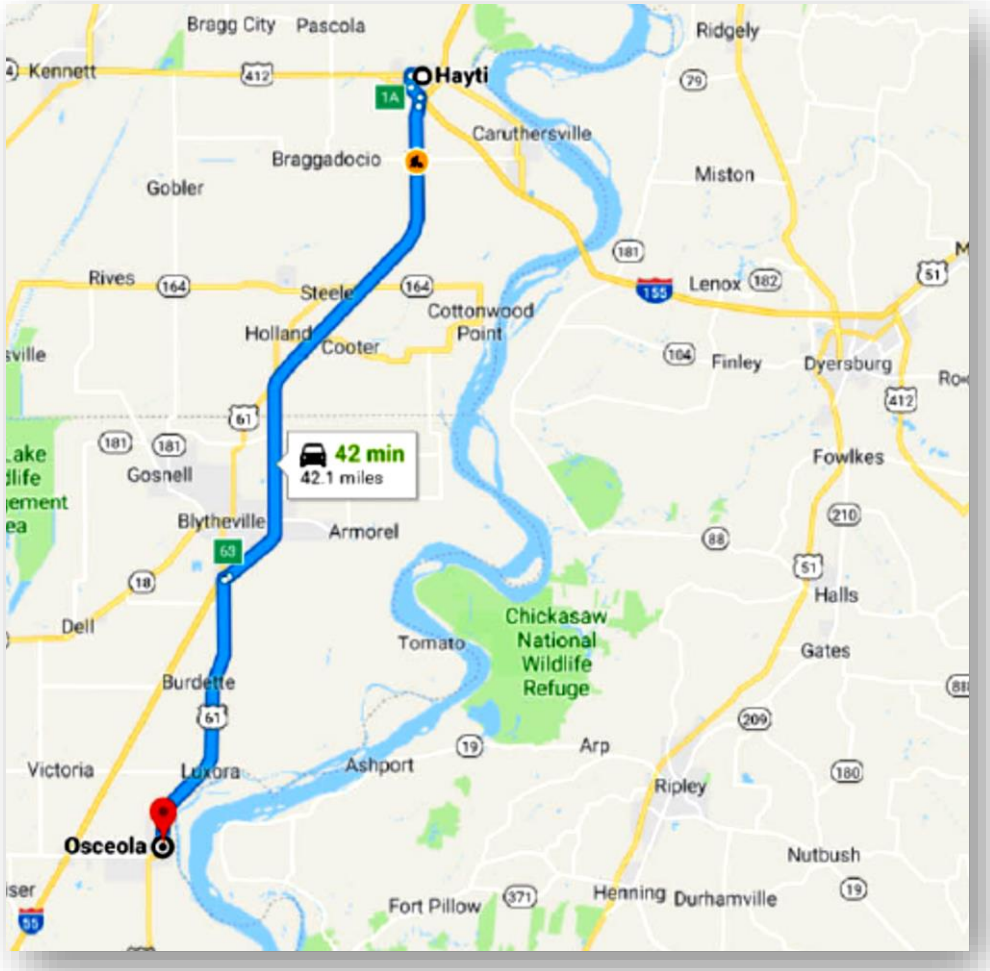
Damage to Transportation Networks

Most roadways within a 35 mile radius northeast and southwest of Blytheville, Arkansas have sustained moderate to severe damage.

NATIONAL EXERCISE PROGRAM

Damage to Transportation Networks

Interstate 55 North and South in Missouri sustained heavy damage and is impassable in areas from Hayti, Missouri to just south of Osceola, Arkansas.



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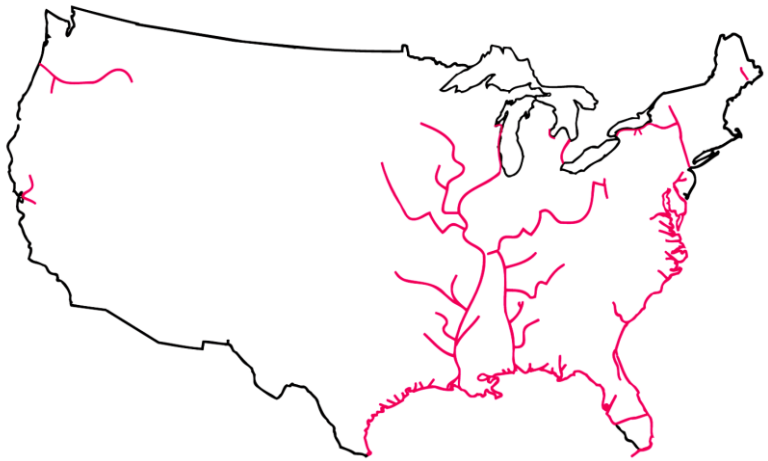
Damage to Intracoastal Waterways

The Mississippi River, its tributaries, and the Gulf Intracoastal Waterway, are an interconnected network that accounts for 86 percent of the route length of the U.S. water traffic system. Initial assessments indicate the earthquake in the New Madrid Seismic Zone have seriously impeded the navigability of the rivers and canals as well as caused serious damages to port facilities.

- Landslides, collapsed bridges and bank failures have blocked channels.
- Debris from fallen trees and other materials is hindering navigation.
- Uplift and subsidence is expected to have caused changes in channel depth in certain waterway areas.
- Liquefaction have resulted in large lateral flows that could leave to block channels.



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Damage to Airports

- Arkansas-International Airport (Blytheville, AR) Closed – Significant infrastructure and runway damage
- Jonesboro Municipal Airport (Nettleton Township, AR) Closed – Significant infrastructure and runway damage
- Manila Municipal Airport (Manila, AR) Closed – Significant infrastructure and runway damage
- Covington Municipal Airport (Covington, TN) Closed – Significant infrastructure and runway damage
- Fayette County Airport (Somerville, TN) Closed – Significant infrastructure and runway damage
- Memphis International Airport (Memphis, TN) Closed – Significant infrastructure and runway damage
- Charles W. Baker Airport (Memphis, TN) Closed – Significant infrastructure and runway damage
- West Memphis Municipal Airport (West Memphis Township, Mississippi Township, AR) Closed – Significant Infrastructure and runway damage
- Tunica Airport (Tunica, MS) Open – Minor damage, full operations
- University Oxford Airport (Oxford, MS) Limited Operations – Mild infrastructure damage, no damage to runway. Open to disaster response flight operations only

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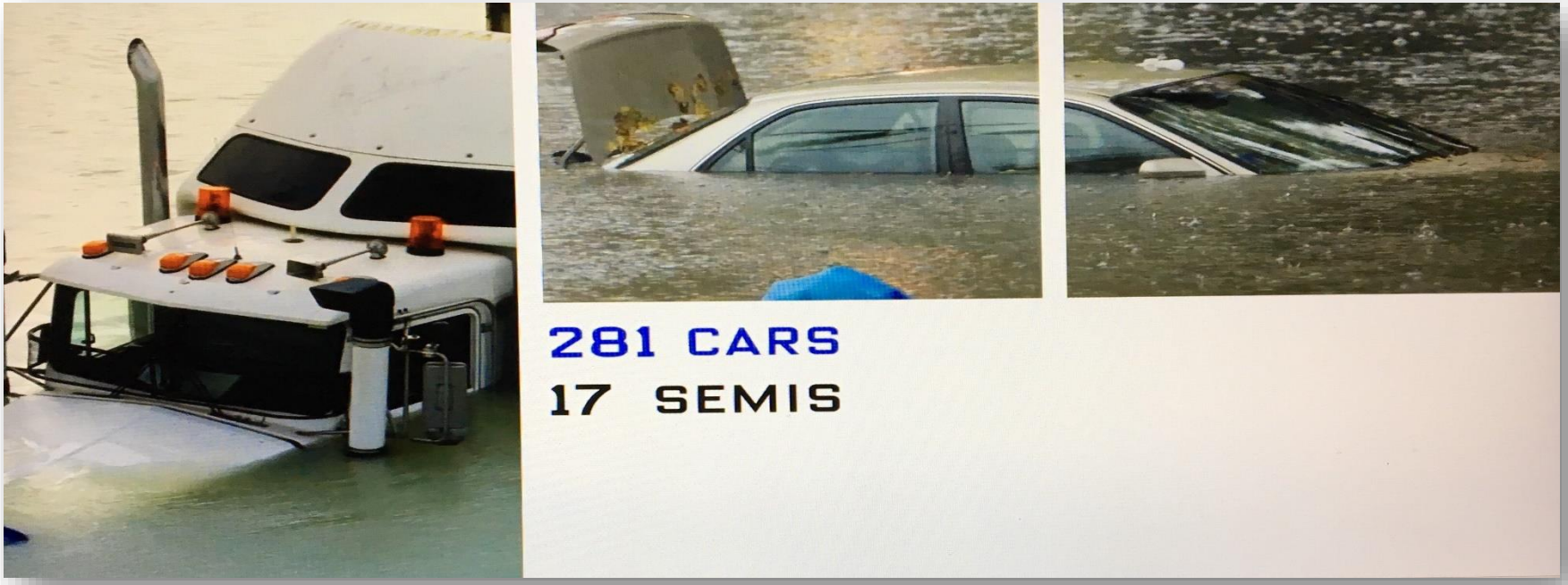
Damage to Bridge Networks

The **Memphis-Arkansas Memorial Bridge**, that carries Interstate 55 across the Mississippi River between West Memphis, Arkansas and Memphis, Tennessee was heavily damaged and has collapsed. Vehicle traffic carrying morning commuters plunged into the Mississippi River during the earthquake. The bridge also carries U.S. Highways 61, 64, 70 and 79 from Memphis to West Memphis.



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Damage to Bridge Networks

The **Harahan Bridge** that carries two rail lines and a pedestrian bridge across the Mississippi River between West Memphis, Arkansas and Memphis, Tennessee experienced a catastrophic fail and collapsed into the Mississippi River. The bridge is owned by Union Pacific Railroad. A BNSF train was approaching the bridge when the earthquake began and 21 cars plunged into the river.

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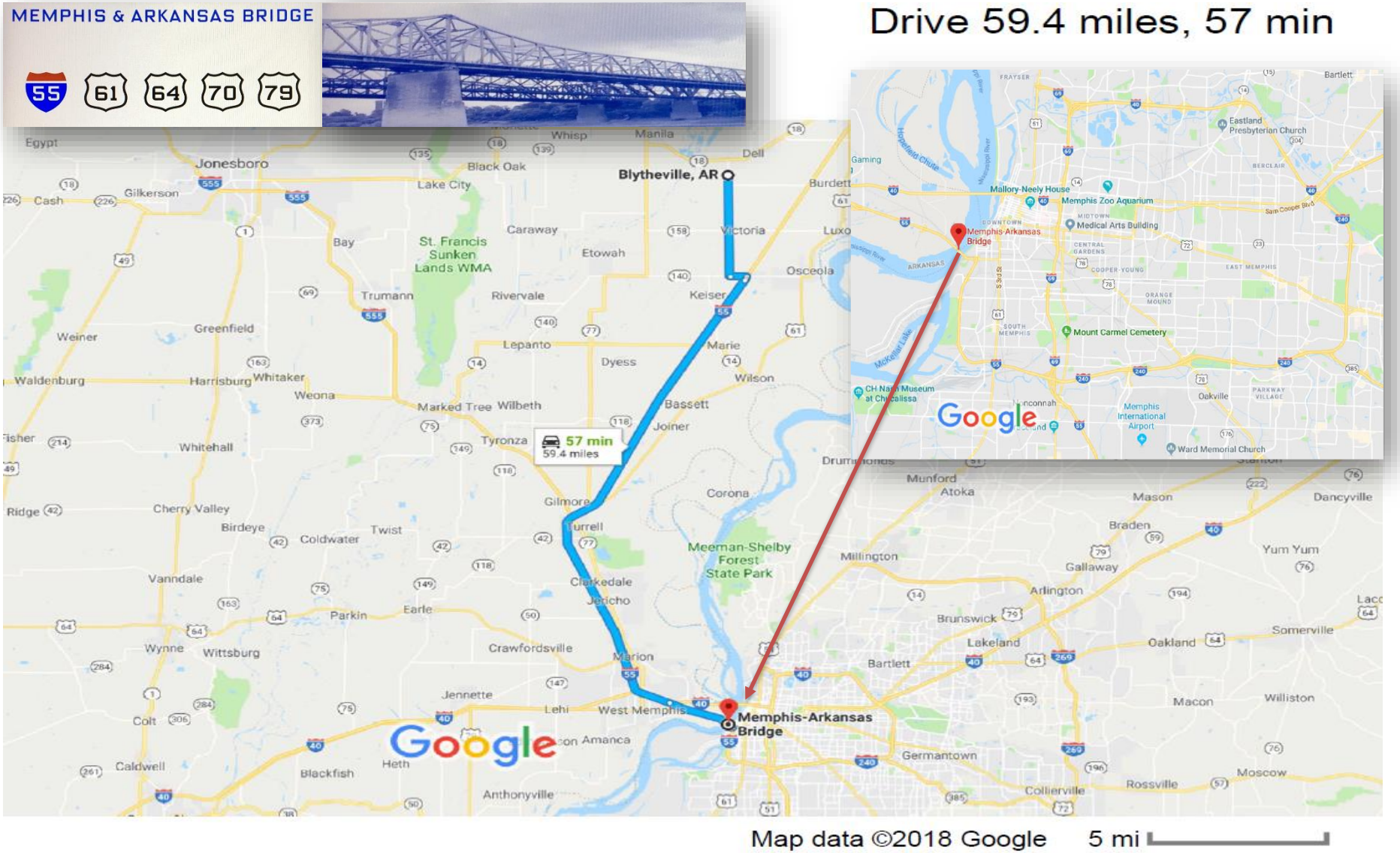
Damage to Bridge Networks



Damage to Bridge Networks

I-40 Mississippi River Bridge Seismic Retrofit Project

Also known as the **Hernando de Soto Bridge**, is a steel tied arch bridge carrying **Interstate 40 across the Mississippi River between West Memphis, Arkansas and Memphis, Tennessee.** This bridge is **one of only two crossings** of the Mississippi River in the Memphis area. It carries **approximately 60,000 vehicles daily** and is situated at the southeastern edge of the New Madrid Seismic Zone,

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Damage to Bridge Networks

I-40 Mississippi River Bridge Seismic Retrofit Project

- In 1992, the Tennessee Department of Transportation (TDOT) and the Arkansas Highway and Transportation Department (AHTD) contracted with TRC to conduct seismic evaluation and prepare retrofit design for the I-40 Bridge. In 2000 the project was expanded when TRC began overseeing the retrofit construction.

Figure 7. Friction Pendulum Bearing at Pier B

Figure 8. Modular Expansion Joint at Pier C

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Damage to Bridge Networks

I-40 Mississippi River Bridge Seismic Retrofit Project

Figure 10a. Pier E8 – Footing Retrofit

Figure 10b. Pier E8 – Footing Retrofit (cont.)

Figure 11. Pier E8 – Foundation Demolition and Pipe Piles

Figure 12. Pier E8 –Column Strengthening

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Damage to Bridge Networks

I-40 Mississippi River Bridge Seismic Retrofit Project

SEISMIC PERFORMANCE CRITERIA

Seismic performance goals, developed in conjunction with TDOT and AHTD, required that the bridge be designed to remain **"operational / serviceable"** following the maximum probable "Contingency Level Earthquake". The seismic criteria performance may be summarized as follows:

- Serviceable following contingency level earthquake
- 2-3 day closure for inspection
- Repairs to secondary components performed under traffic
- Structure functional for emergency vehicles immediately after the earthquake
- Structure operational for general public following inspection

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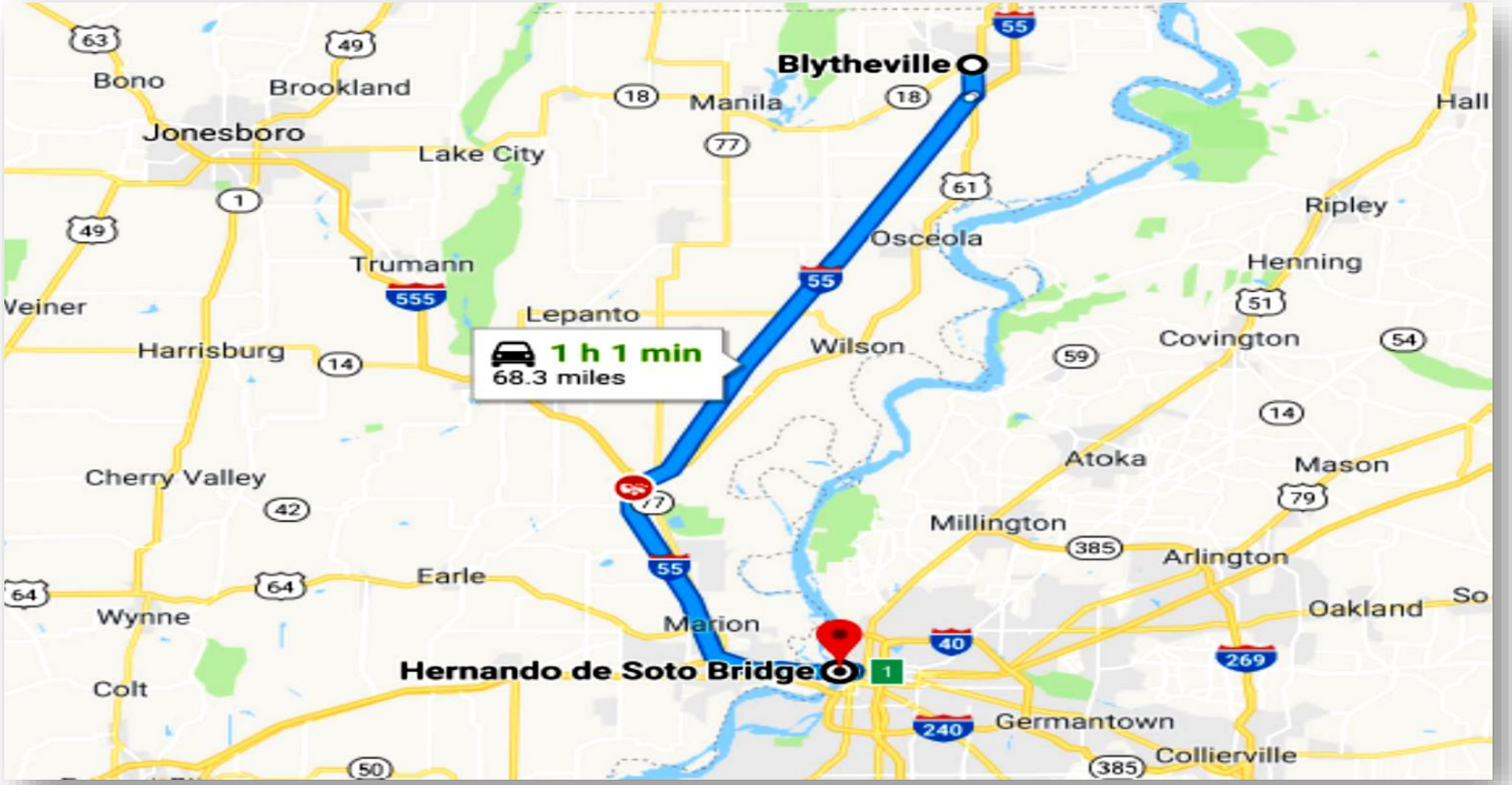
Damage to Bridge Networks

The I-40 (Hernando DeSoto) Bridge to Blytheville, AR is 68 miles



Damage to Bridge Networks

The **Caruthersville Bridge** on Interstate 155 and Route 412 that spans the Mississippi and connects Dyersburg, Tennessee to the east with Caruthersville and Hayti, Missouri to the west has sustained significant damage to pylon support. State highway crews have closed the bridge and are conducting further inspections and earthquake damage assessments.

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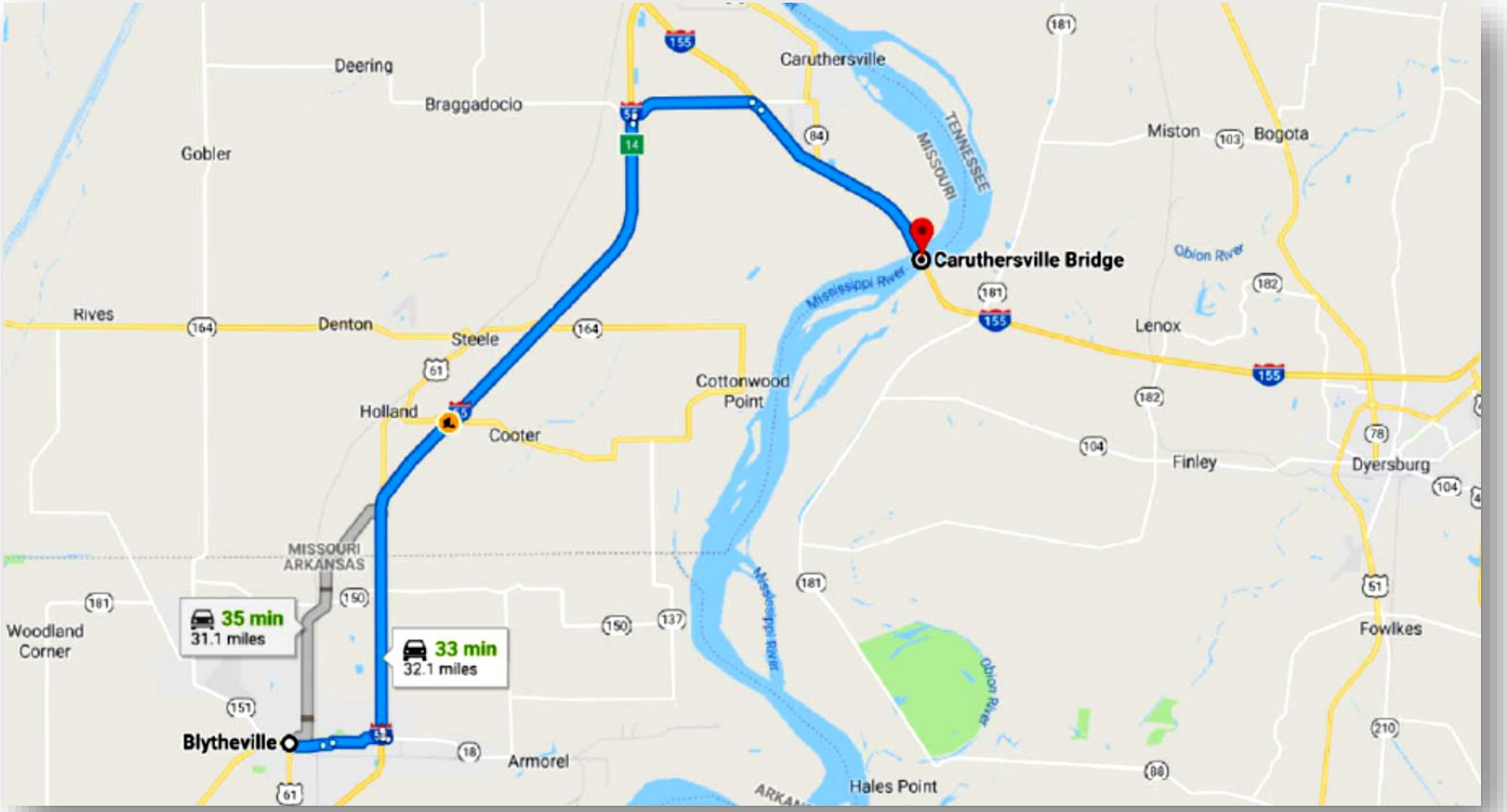
Damage to Bridge Networks

The **Caruthersville Bridge** to Blytheville, AR is 32 miles



Damage to Buildings

State	No. of Damaged Buildings
Alabama	15,382
Arkansas	162,235
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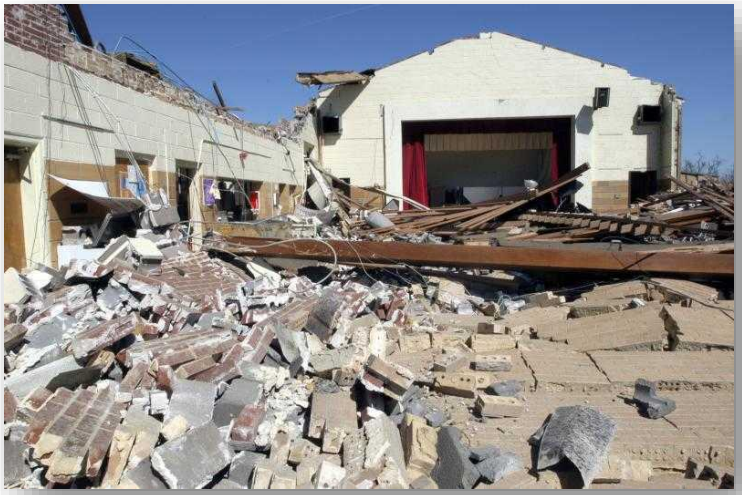
Indiana	14,215
Kentucky	68,400
Mississippi	57,442
Missouri	86,838
Tennessee	264,198



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Damage to Buildings

General Buildings

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Tennessee	2,126,600	264,198	48,880	163,577
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- *Additionally, almost 40 counties incur substantial damage with 20% to 60% of all buildings damaged*

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Damage to Medical Care Network (AR and TN)

- Great River Medical Center (Chickasawba Township, Blytheville, AR) – Significant damage, partial roof collapse, transferring patients
- SMC Regional Medical Center (Monroe Township, AR) – Significant damage, transferring patients
- Lauderdale Community Hospital (Ripley, TN) – Significant damage, transferring patients
- Baptist Memorial Hospital (Covington, TN) – Moderate damage, 60% operational, cannot accept patients
- Tennova Healthcare – Dyersburg Regional (Dyersburg, TN) – Significant damage, transferring patients
- Arkansas Methodist Medical Center (Spring Grove Township, AR) – Moderate damage, not accepting additional patients
- Lawrence Memorial Hospital (Campbell Township, AR) – Minor damage, accepting additional patients
- NEA Baptist Memorial Hospital (Nettleton Township, AR) – Moderate damage, not accepting additional patients
- St. Bernards Medical Center (Nettleton Township, AR) – Moderate damage, not accepting additional patients
- Methodist North Hospital (Memphis, TN) - Moderate damage, not accepting additional patients
- Methodist University Hospital (Memphis, TN) - Moderate damage, not accepting additional patients
- Baptist Memorial Hospital (Memphis, TN) – Minor damage, accepting additional patients
- Arkansas Continued Care Hospital (Nettleton Township, AR) - Moderate damage, not accepting additional patients

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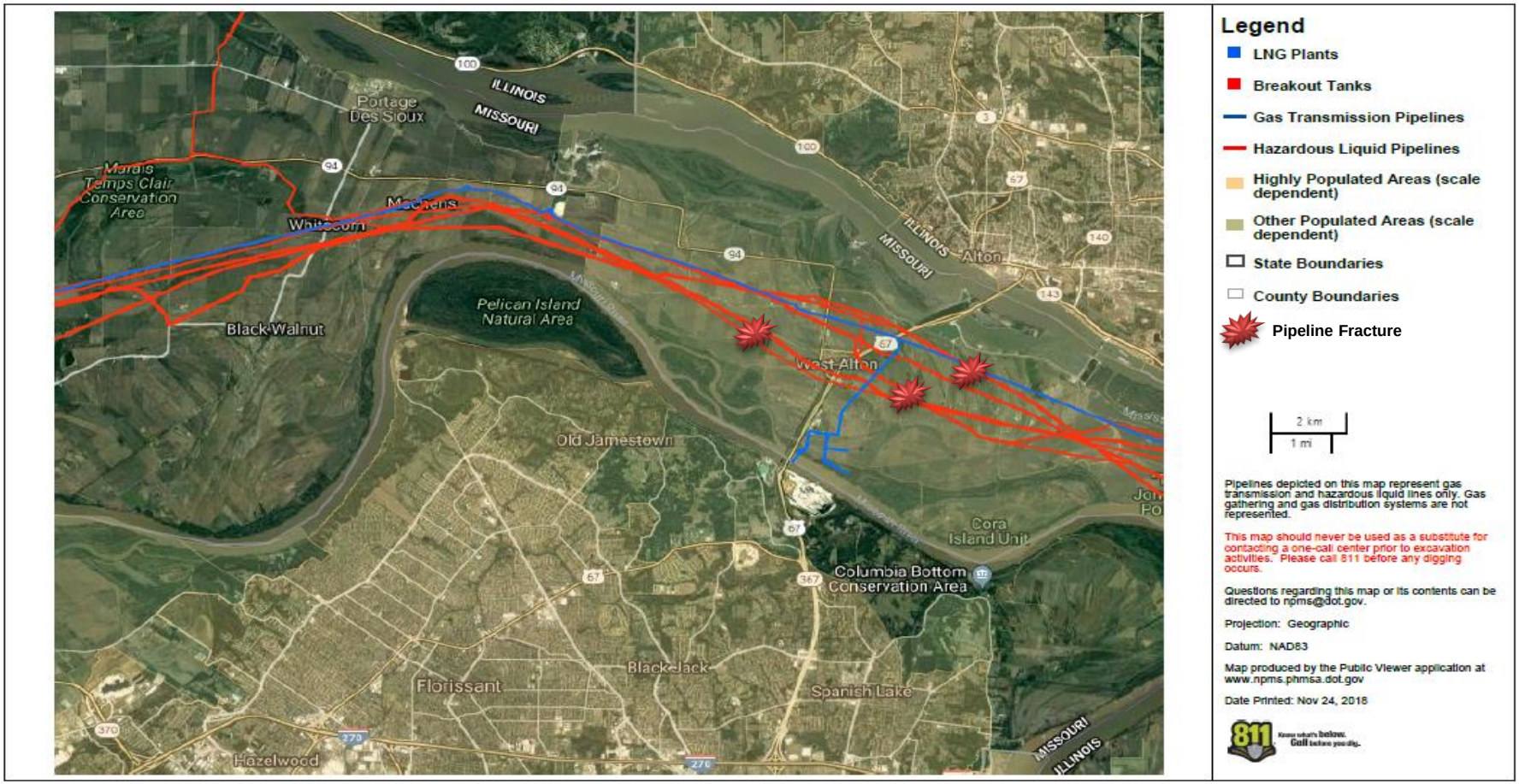
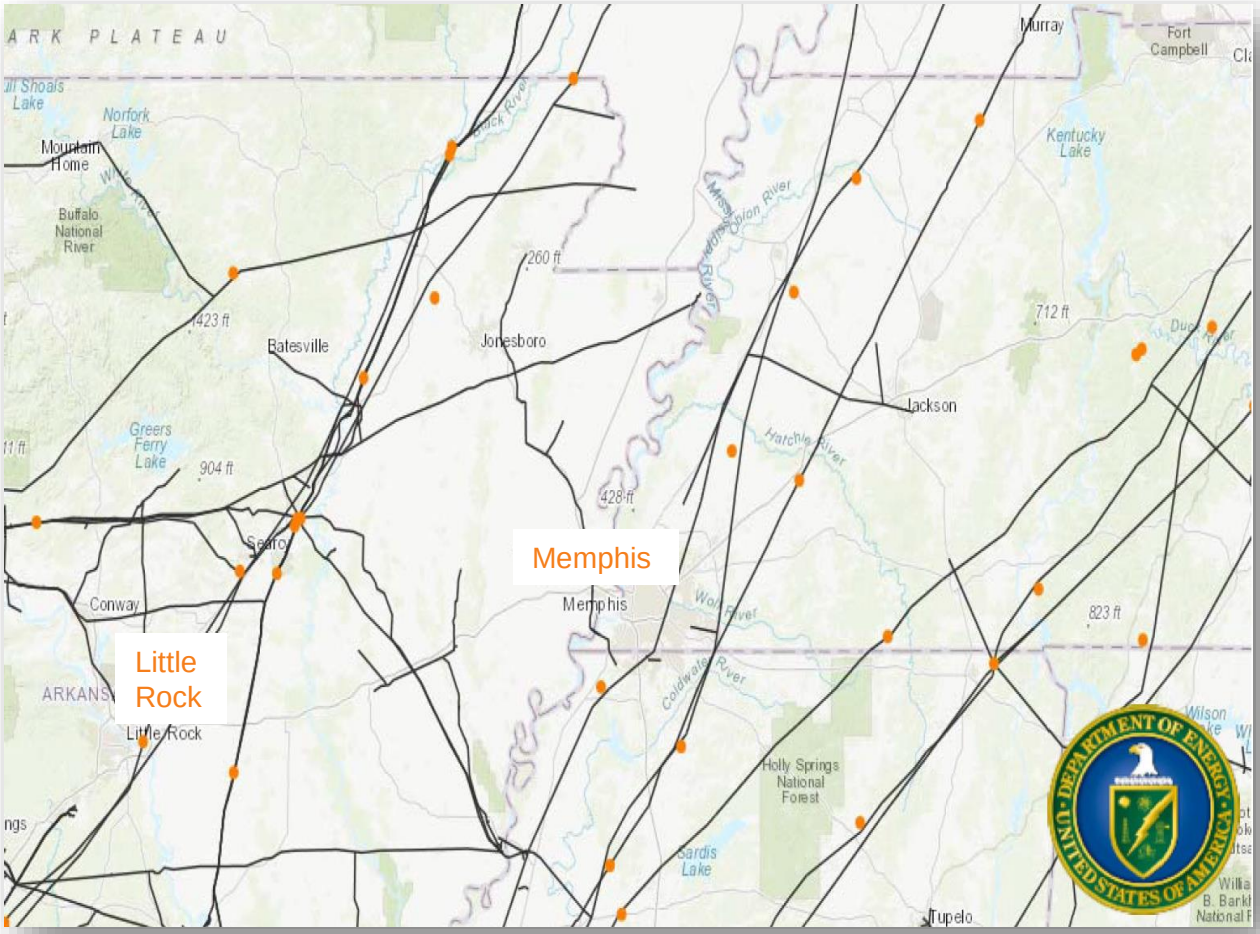
Damage to Petroleum & Water Treatment



There are seven major pipelines crossing the Mississippi River in eastern St. Charles County, Missouri. All seven are buried in loose unconsolidated sediments of the Missouri-Mississippi River flood plain. Spillage has occurred due to multiple fractures in the pipeline system causing contamination to the municipal water supply to the city of St. Louis.

Damage to Natural Gas Transmission Pipelines



This graphic, referenced from the U.S. Department of Energy's EAGLE-I software database, indicates the location of major oil refineries and power plants in the New Madrid Seismic Zone region.

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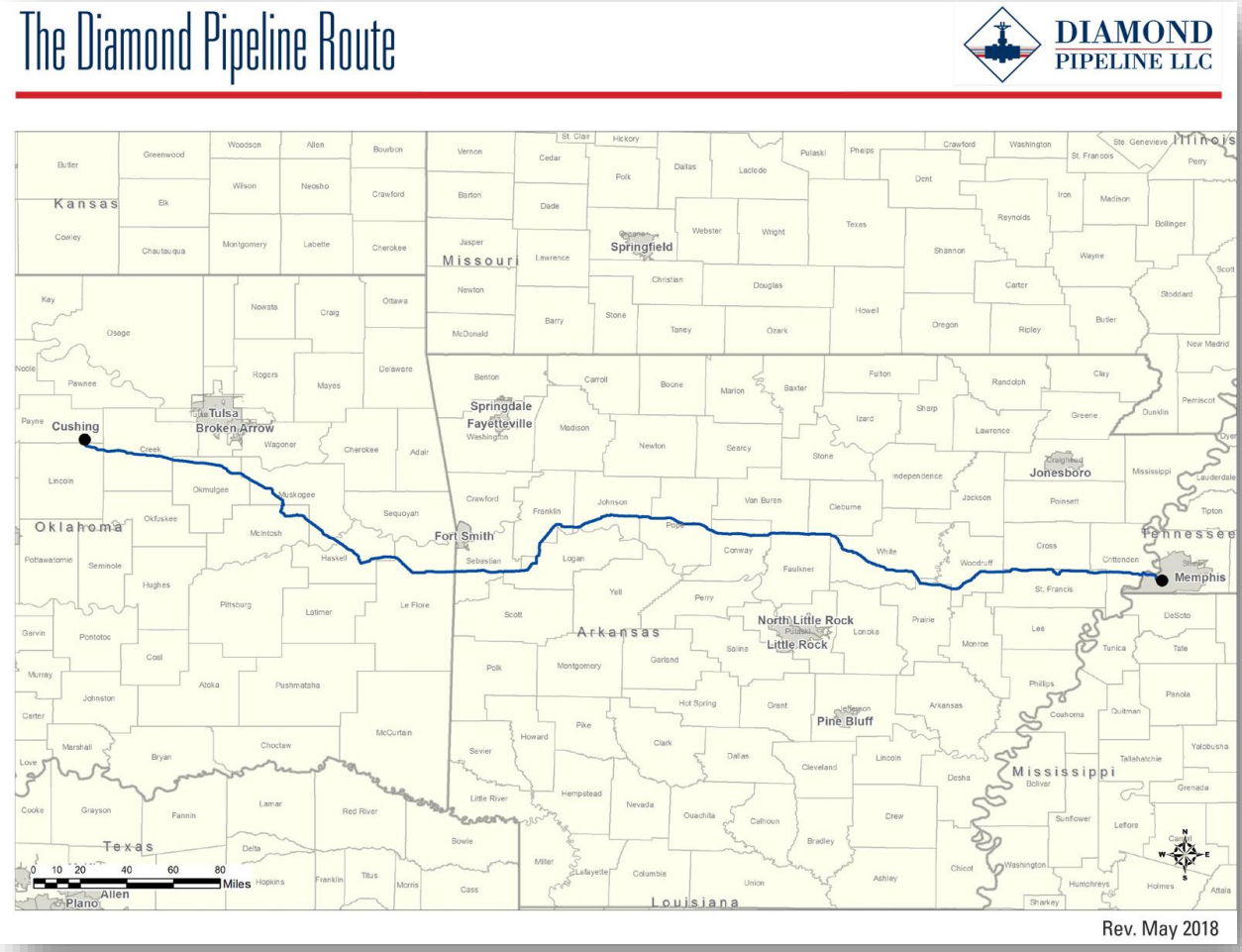
Damage to Natural Gas Transmission Pipelines



The Diamond Pipeline is an important crude oil pipeline running under the Mississippi River at Memphis. The Diamond Pipeline is a 440-mile, 20 inch pipeline capable of transporting up to 200,000 barrels per day of domestic sweet crude from Cushing, OK, to Memphis, TN. Surveys and inspections are on-going to determine a damage assessment and possible impacts.

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Damage to Natural Gas Transmission Pipelines

Note: Information from Argonne National Laboratory, "New Madrid and Wabash Valley Seismic Study, 2009"

- A pipeline segment break triggered by the earthquakes implies 100% flow reduction along the pipeline
- Transmission pipelines through the seismic zones are generally ductile, made of steel, are arc welded, and are buried at an average of 4 to 6 ft below ground surface.
- Order of load shedding:
  - gas-fired power plants
  - industrial
  - commercial
  - residential

NATIONAL EXERCISE PROGRAM

Damage to Natural Gas Transmission Pipelines

Note: Information from Argonne National Laboratory, "New Madrid and Wabash Valley Seismic Study, 2009"

Natural Gas Study: Conclusions and Summary of Key Findings

- Key Finding 1: Ten interstate pipelines would be at risk of damage due to the events
- Key Finding 2: All ten pipelines would experience at least one break and several leaks due to PGA, PGV, and liquefaction
- Key Finding 3: Even with implementation of emergency remedial measures, all FEMA Region V states (except Minnesota) and other nearby states would experience a substantial reduction in delivery, ranging from 2% to 27%

Indiana	~ 18%	Michigan	~ 18%	Illinois	~13%
Ohio	~12%	Wisconsin	~2%		

- Key Finding 4: Even with emergency remedial actions, the seismic events would impact:
  - 20,000–30,000 households (or 60,000–100,000 people)
  - 50,000–140,000 Industrial and commercial customers or units
- Key Finding 5: A well-orchestrated implementation of remediation measures would limit impact on natural gas-fired power to insignificant levels (less than 2% of installed capacity)
- Key Finding 6: In general, all underground storage facilities (except for 2) would not experience any serious damage so as to make them dysfunctional
- Key Finding 7: Restoring damaged pipelines to full functionality would take about 1–3 months depending on how the pipeline companies subdivide and "phase" the work, the availability of crews, conditions of access roads, and resolved target completion times; restoration for residential and industrial customers would take 2–4 and 4–8 weeks, respectively

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Damage to Electrical Grid

Electricity infrastructure systems appear to have been impacted well beyond the NMSZ Region. The impacts have affected 100-150 million people, especially those in the states nearest the epicenter experiencing the majority of the power outages. Many areas within the Eastern Interconnection could potentially face downtimes ranging from a minimum of 14 hours to as much as up to 5 days.

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Damage to Electrical Grid

Voltage Category (kV)	No. of Transmission Lines	No. of Substations
230	40	37
345	20	18
500	28	19
Sub-total	**88**	**74**

Estimated Impact to Electric Grid within the New Madrid Area, Argonne National Lab

Typical Component Damages to Towers and Distribution Systems Due to Seismic Events

- Buckling or collapse tower frame due to ground liquefaction, deformation and landslides.
- Insulator damages due to PGA ground motion.
- For distribution systems, there are two major types: burn-down of feeder and service lines and failure of concrete distribution poles.
- Downed lines can remain energized and cause fires. Assess, prioritize, and implement temporary quick work-around.
- In the U.S. wood poles are typically used for distribution and their performance in general has been very good.

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BREAK

STARTEX

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Module 1 Group Discussion:

Information Sharing and Integration, Energy/Fuel Prioritization, Main Supply Route Command and Control, Evacuation Routes, and State Geologist resources.

Module Overview

Two Modules with each module consisting of three activities

1. Scenario Ground Truth Update
   - Facilitator provides a scenario update and discussion questions
2. Table Group Discussion
   - Table discussion of scenario and response to discussion questions
3. Plenary Discussion
   - Group Review of Discussion Questions

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Module 1 Scenario Update

It has been 24 hours since a magnitude 7.7 earthquake rocked the area within the New Madrid Seismic Zone. Significant damage has been reported within a 420 mile area from Little Rock, Arkansas north to Evansville, Indiana.

Initial priority focus is on life-saving measures, search and rescue, medical evacuation, ruptured gas lines, down live power lines, fire suppression, hazardous materials and chemicals, etc.

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Module 1 Scenario Update

ASSUMPTIONS TO CONSIDER: (1 of 2)

- The magnitude of the earthquake has created geographic competition for resources. Regional mutual aid fire, EMS, and law enforcement resources are limited as other jurisdictions face similar circumstances.
- Federal mobilization of resources may take 24 to 48 hours to arrive in the affected areas, and there may not be enough resources to service all affected areas initially.
- Disrupted communications systems, overwhelmed first responders, and the overall magnitude of the situation may slow the collection and sharing of the initial situation assessment.

Module 1 Scenario Update

ASSUMPTIONS TO CONSIDER: (2 of 2)

- Damage to critical City facilities (EOC, DOCs, and fire stations) may require alternative arrangements to manage response services.
- Damage to water and communications systems may challenge EMS operations.
- The number of people trapped in buildings may initially exceed capacity to respond.
- Local medical facilities are damaged. Surviving hospital capacity may be inadequate to treat casualties and other medical emergencies
- All EOCs have operational communication capability

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Module 1 Scenario Update

ASSUMPTIONS TO CONSIDER: (2 of 2)

- Damage to critical City facilities (EOC, DOCs, and fire stations) may require alternative arrangements to manage response services.
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Module 1 Discussion Questions (1 of 2)

1. During the first 24 hours following the earthquake, what are your agency's role, immediate concerns and priorities?

2. Discuss what systems/platforms your agency use to collect Essential Elements of Information to support decision-making? Does a need exist for interoperability with other systems, WebEOC, ArcGIS-based, etc.?

3. Discuss what specific critical information/data elements for transportation related Essential Elements of Information will your organization need in order to drive response efforts following a catastrophic earthquake event? (Air, Rail, Roads, Waterways, Fuel)

4. What partnerships currently exist to establish and manage a fuel supply chain? How will fuel be sourced to support initial response efforts? What is the private sectors role?

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Module 1 Discussion Questions (2 of 2)

5. If key bridges, highways and rail leading into the area near the epicenter received moderate to severe damage, how would resources be transported?

6. How will the operational status of main supply routes be determined? How will this information be shared? How might reoccurring aftershocks affect on-going operations?

7. In addition to distributing fuel at PODs (Fuel Points of Distribution), what other methods are in place to support distribution efforts. What is the private sector's role?

8. What state geology resources are available to support response efforts? Discuss authorities and the responsibility for coordination and management of the state level U.S. Geological Survey (USGS) Geospatial Data Clearinghouse? Discuss how this information is shared with Emergency Management Agencies and other partners.

9. Discuss fuel-related waivers that might be available in the first 24 to 48 hours after the earthquake?

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Lunch

12:30 PM – 1:25 PM

Module 2 Group Discussion:
Information Sharing, Operational Reporting, Tracking and EMAC Resource Management

Module 2 Scenario Update

It has been 72 hours since the magnitude 7.7 earthquake occurred in the area within the New Madrid Seismic Zone. Urban Search and Rescue Teams and other resources have arrived and continue to deploy throughout the impacted areas. Missouri, Arkansas, Tennessee, and Kentucky have requested EMAC A-Teams be deployed to their states. FEMA/DHS has requested a National EMAC Liaison Team (NELT). FEMA/DHS has also requested a Regional EMAC Liaison Team (RELT) in Region IV. A number of main supply routes and evacuation routes have been cleared. Air transport of resources to established staging areas are also underway.

State disaster response resources in Missouri, Arkansas, Tennessee, and Kentucky are exhausted due to the widespread geographic impact of the earthquake and are not available to support EMAC requests outside of their state.

EMAC®
Emergency Management Assistance Compact

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Module 2 Discussion Questions

1. Discuss how resources are requested through the EMAC? What processes exist to reduce the time between resource requests to deployment?

2. How are resources tracked once request have been filled and assets deployed?

3. How will an event that causes geographically dispersed damage across neighboring states affect resource requests and sourcing? Discuss the challenges of moving personnel vs equipment in this environment.

4. Who manages the command and control of EMAC resources once they receive an EMAC Mission Order Authorization and arrive in the deployment area?

5. Discuss EMAC reimbursement process. Discuss the use of federal reimbursed funds to cover EMAC reimbursement?

ENDEX

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Hotwash – Summary of Outcomes

1. Did the exercise achieve the elements of Objective 1 by facilitating for the discussion of:
   - Information sharing and integration
   - Relationships to address Energy/Fuel prioritization
   - Main Supply Route
   - Command and Control
   - Evacuation Routes
   - State Geologist Resources

2. Did the exercise achieve the elements of Objective 2 by facilitating for the discussion of EMAC resources:
   - Operational Reporting
   - Tracking
   - Management

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Thank You on Behalf of the NED

Chad Gorman
Director
National Exercise Division

Ted Robinson
Exercise Program Manager
National Exercise Division

- **Exercise Starter Kits** please contact the NED at: HSEEP@fema.dhs.gov
- **Exercise nomination** for support from NED: at: NEP@fema.dhs.gov

NATIONAL EXERCISE PROGRAM

Closing Remarks

Jim Wilkinson

Executive Director

Central United States Earthquake Consortium

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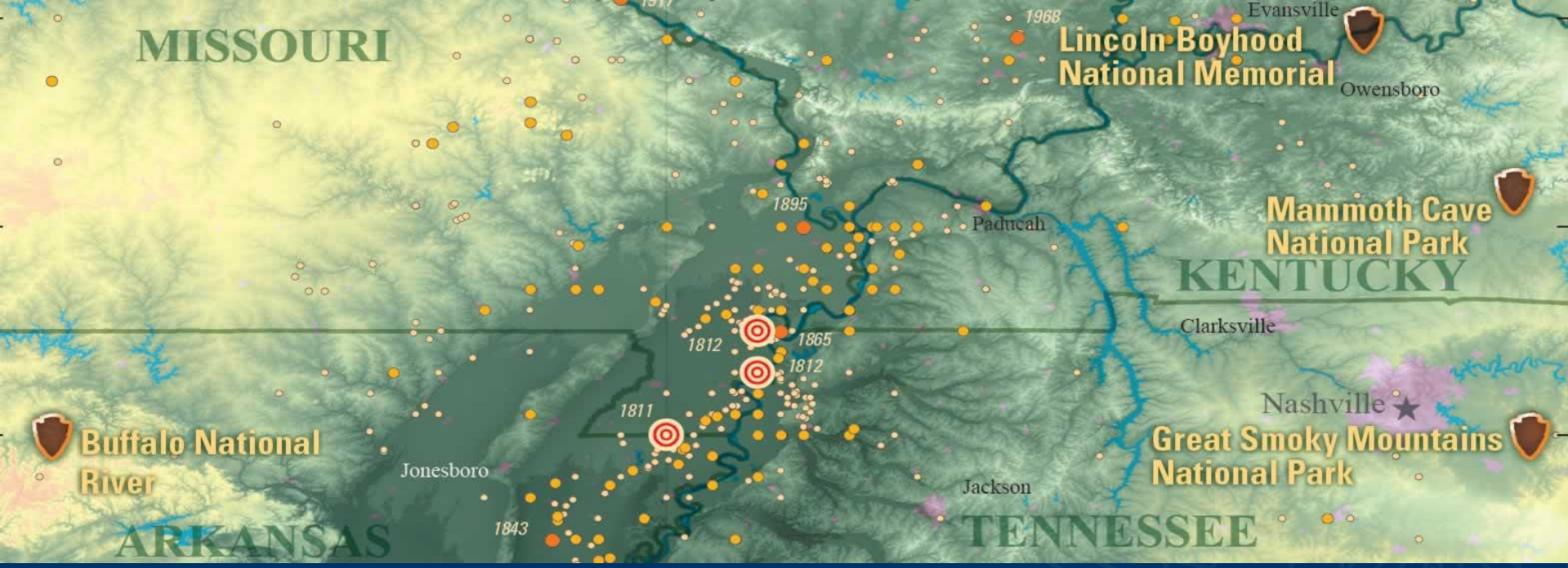

Central United States Earthquake Consortium

New Madrid Seismic Zone Earthquake Tabletop Exercise

Thanks for your participation

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