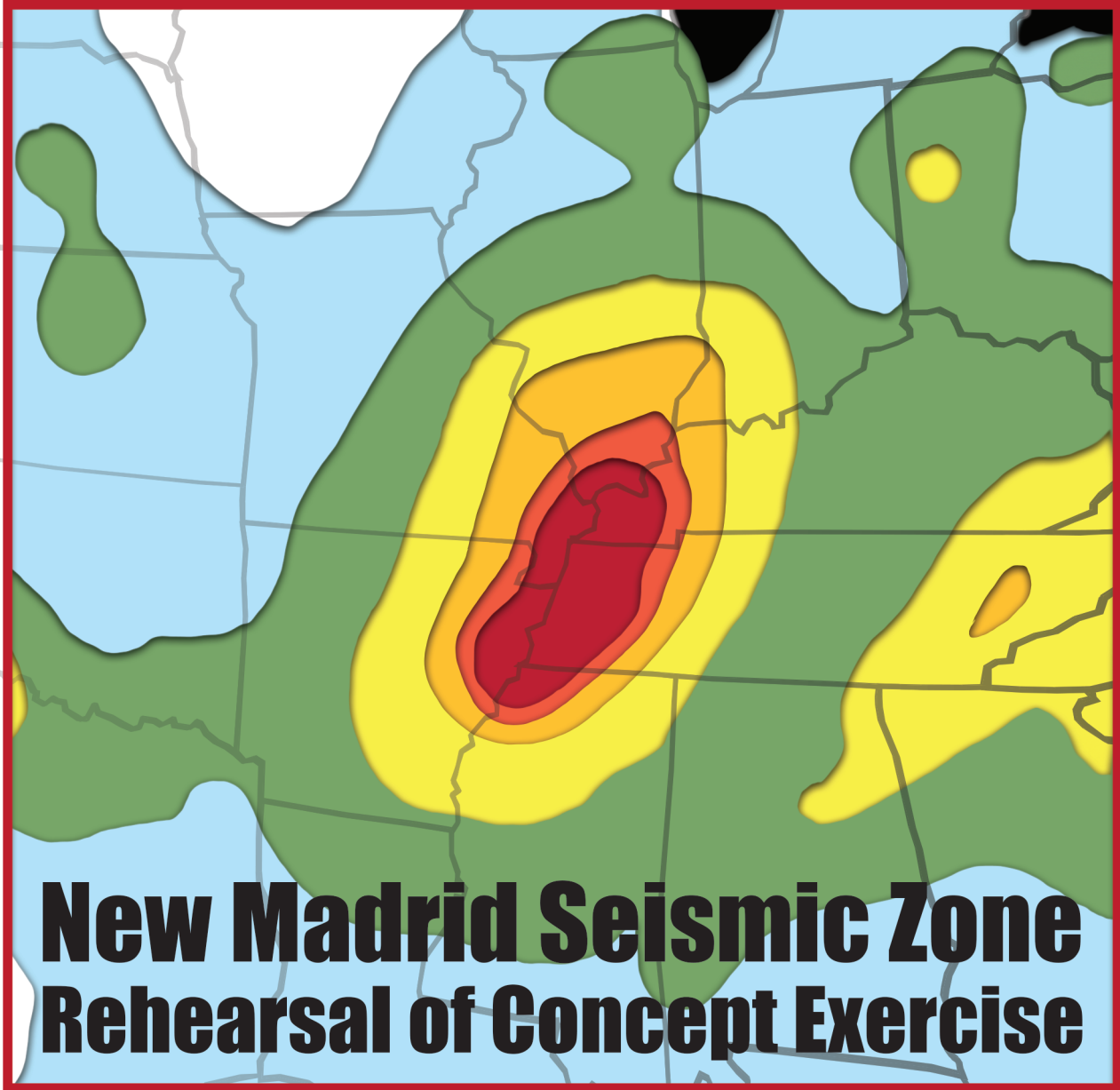
2014 Great Lakes & Ohio River Division



New Madrid Seismic Zone
Rehearsal of Concept Exercise

Frankland and Taylor National Guard Armory, Jackson, TN

US Army Corps
of Engineers

8 May 2014

Welcome to the USACE Great Lakes & Ohio River Division's (LRD) New Madrid Seismic Zone Rehearsal of Concept (ROC) Exercise.

This exercise aims to build cooperative relationships with Federal, state, and local emergency response partners in order to continue improving disaster preparedness and response. The exercise is designed to bring together the principal partners in response to a major earthquake event in the New Madrid Seismic Zone (NMSZ). By discussing the various issues raised during earthquake preparedness and response, this exercise is intended to develop a common understanding of the capabilities, expectations, and functions of participating organizations. Working together in this manner has resulted and will continue to result in more effective and successful responses in the future.

Each participant is encouraged to take full advantage of this opportunity to share ideas and identify and tackle the tough issues. The goal of the exercise is to seek solutions that will lead to mutual success in future responses.

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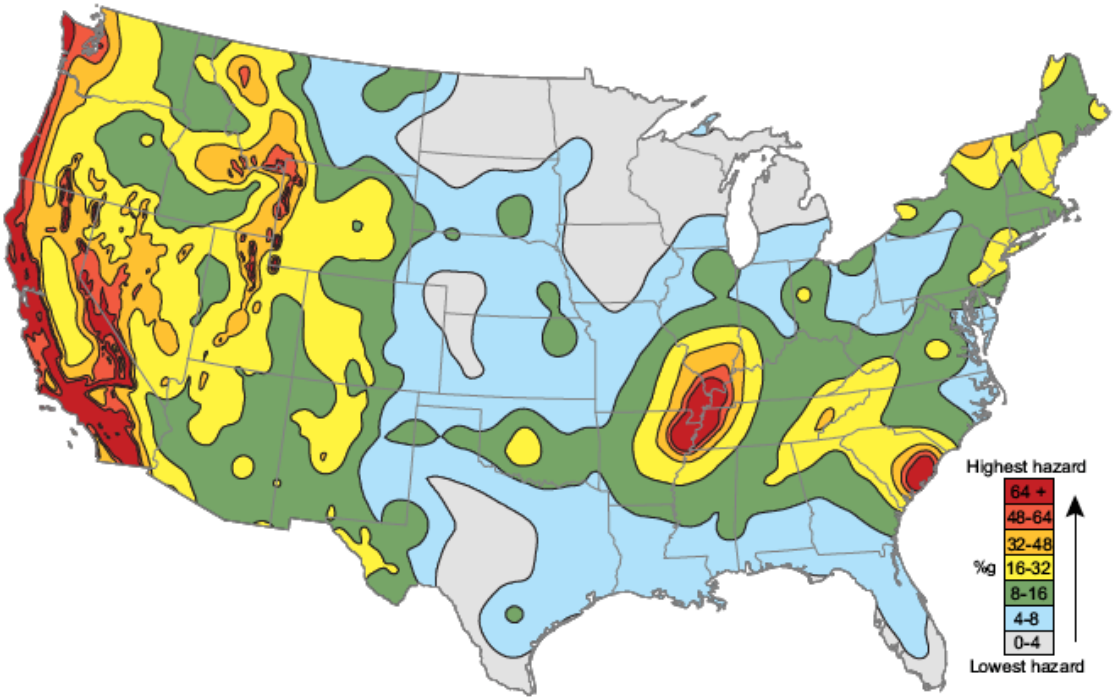


U.S. Geological Survey Shaking-Hazard Map for the United States

The goal of this exercise is to improve overall preparedness to respond to a catastrophic earthquake occurring in the central United States through candid, solution-focused discussion among intergovernmental agencies at the Federal, state, and local government levels. The workshop is hosted by the United States Army Corps of Engineers' Great Lakes and Ohio River Division (LRD), in cooperation with the Federal Emergency Management Agency (FEMA) and the state of Tennessee. Earthquake preparedness, response and recovery issues will be discussed utilizing a scenario backdrop of a catastrophic earthquake with a focus on the State of Tennessee and the City of Memphis.

Objectives

The following objectives have been selected as achievable and measurable within the allotted timeframe:

- Review the principles, concepts and plans for the intergovernmental response to a catastrophic earthquake, focusing on USACE roles and responsibilities.
- Test current USACE plans and procedures against a scenario which provides context for stakeholder discussions concerning the clarity of respective roles and responsibilities over time.
- Identify gaps/shortfalls in strategy, plans and procedures as a means of improving current guidance and doctrine for specific USACE mission areas.
- Discuss tactical aspects of USACE plans and procedures where known gaps/shortfalls exist.

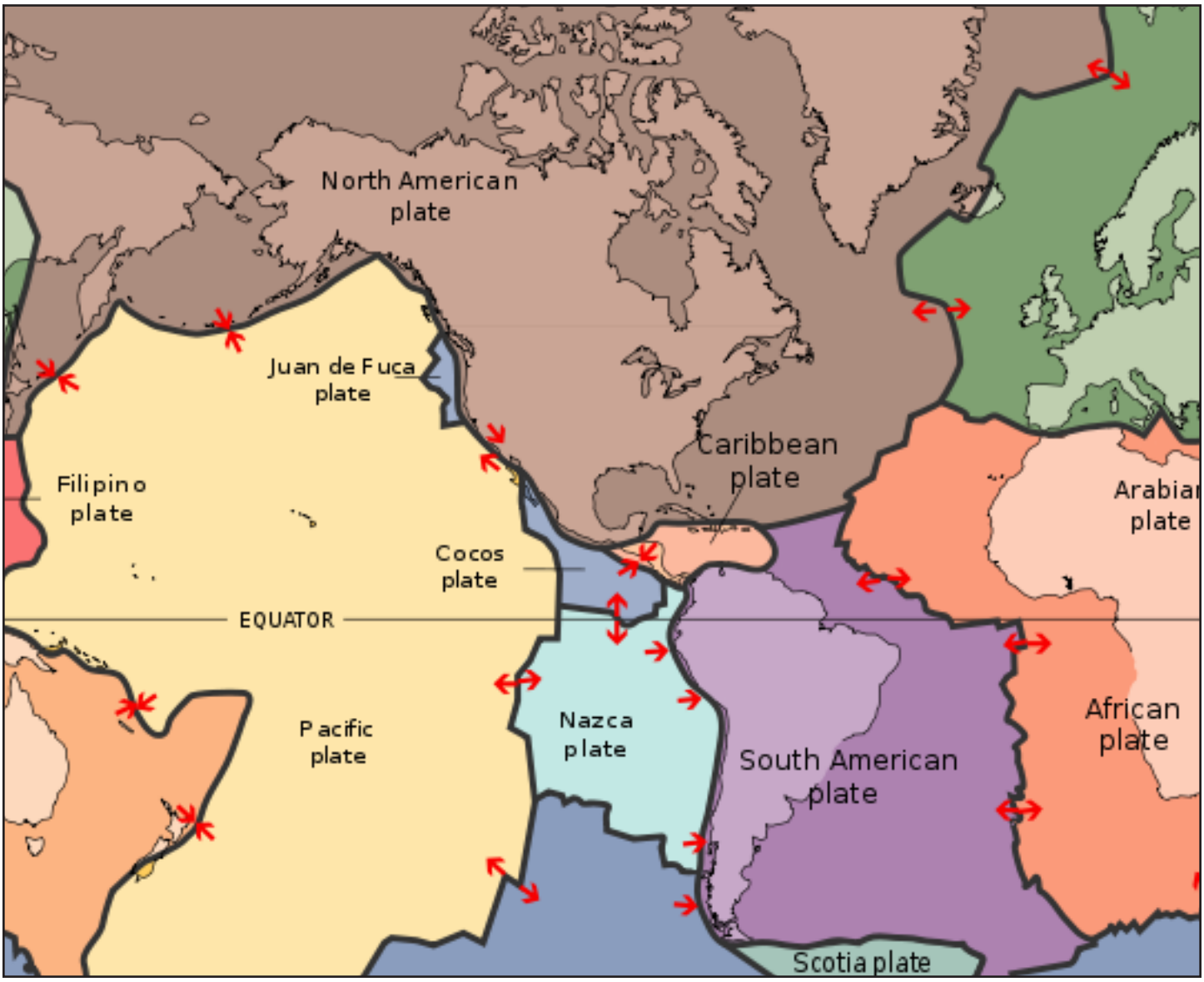
Participants

Senior decision makers and staff level representatives from key organizations associated with earthquake planning and response for the central United States, and supporting regional and national level headquarters, are invited to attend. Participation by key policy and decision makers is necessary in order to gain commitment and direction for future actions arising from the facilitated discussions. Invited organizations include: USACE representatives from Districts, Divisions and Headquarters, FEMA Regions and Headquarters, other Federal agencies, state and local governments, and appropriate private sector representatives.

Location

Frankland and Taylor National Guard Armory
1510 Highway 70 Bypass
Jackson TN, 38302

Intraplate Earthquakes



An earthquake occurs when two plates or pieces of earth slip on a fault, releasing stored energy in the form of radiating seismic waves, cracking rock, and heat produced from friction. The seismic waves travel through the earth's crust, causing tremors and often shifting the landscape.

Unlike interplate earthquakes, such as those common to the North American west coast, an intraplate earthquake is created along the interior of a tectonic plate. While most notable earthquakes occur near volatile plate boundaries, intraplate quakes can strike in usually stable regions, making them difficult to predict. Many large metropolitan areas in the central United States lie within reach of unpredictable and potentially disastrous intraplate seismic activity.

NMSZ Historical Timeline

December 25, 1699
The first known written record of an earthquake felt in the NMSZ was from a French missionary traveling up the Mississippi. At 1 PM, on Christmas Day, 1699, at a site near the present-day location of Memphis, the party was startled by a short period of ground shaking.

January 23, 1812
1500 UTC (9 a.m.); (MMS=8.1) moment magnitude scale; epicenter in the Missouri Bootheel. The meizoseismal area was characterized by general ground warping, ejections, fissuring, severe landslides, and caving of stream banks. Johnston and Schweig attributed this earthquake to a rupture on the New Madrid North Fault. This may have placed strain on the Reelfoot Fault.

October 31, 1895
The biggest quake since 1811-1812 was a 6.6-magnitude quake on October 31, 1895, with an epicenter at Charleston, Missouri. The quake damaged virtually all buildings in Charleston, creating sand volcanoes by the city, cracked a pier on the Cairo Rail Bridge and toppled chimneys in St. Louis, Missouri, Memphis, Tennessee, Gadsden, Alabama and Evansville, Indiana.

1700 1800 1900

December 16, 1811
0815 UTC (2:15 p.m.); (MMS=8.2) moment magnitude scale; epicenter in northeast Arkansas; it caused only slight damage to man-made structures, mainly because of the sparse population in the epicentral area. The future location of Memphis, Tennessee was shaken at Mercalli level nine intensity. A seismic seiche propagated upriver and Little Prairie was destroyed by liquefaction.

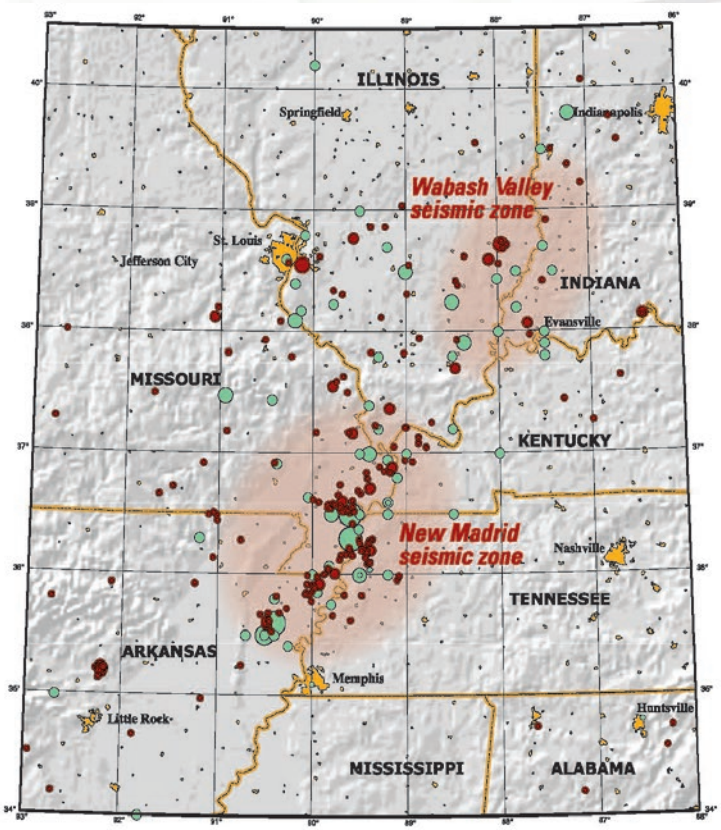
February 7, 1812
0945 UTC (4:45 a.m.); (MMS=8.3) moment magnitude scale; epicenter near New Madrid, Missouri. New Madrid was destroyed. At St. Louis, Missouri, many houses were severely damaged, and their chimneys were toppled. This shock was definitively attributed to the Reelfoot Fault by Johnston and Schweig. It was uplift along this reverse fault segment, in this event, that created waterfalls on the Mississippi River, disrupted the Mississippi River at Kentucky Bend, created a wave that propagated upstream and caused the formation of Reelfoot Lake. The earthquake's uplift and shift also created the basin that formed Caddo Lake, in Northeast Texas and Southwestern Louisiana.

NMSZ Historical Timeline

1974
Instruments were installed in and around the area in 1974 to closely monitor seismic activity. Since then, more than 4,000 earthquakes have been recorded, most of which were too small to be felt. On average, one earthquake per year is large enough to be felt in the area.

1900

November 9, 1968
The next big quake was a 5.4-magnitude quake (although it was reported as a 5.5 at the time) on November 9, 1968 near Dale, Illinois. The quake damaged the civic building at Henderson, Kentucky and was felt in 23 states. People in Boston said their building swayed. It is the biggest recorded quake with an epicenter in that state's recorded history.



This map of the New Madrid and Wabash Valley seismic zones shows earthquakes as circles. Red circles indicate earthquakes that occurred from 1974 to 2002 with magnitudes larger than 2.5 located using modern instruments (University of Memphis). Green circles denote earthquakes that occurred prior to 1974 (USGS Professional Paper 1527). Larger earthquakes are represented by larger circles.

New Madrid Seismic Zone

The New Madrid Seismic Zone (NMSZ) is an area of intense intraplate seismic activity located in the deep interior of the North American tectonic plate. Stretching across the southern and Midwestern United States, the NMSZ area covers eight states: Illinois, Arkansas, Missouri, Kentucky, Tennessee, Alabama, Indiana, and Mississippi. This region has generated some of the most powerful and geologically disruptive earthquakes in U.S. history. A series of three major earthquakes (magnitude 8 or larger) which struck the NMSZ area during the winter of 1811 and 1812 sent waves of destruction across the region and left the surrounding area in turmoil for months to come.

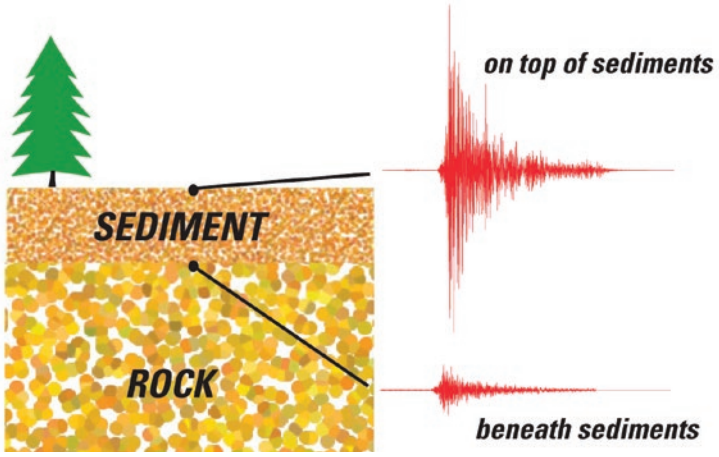
The active faults in the NMSZ are poorly understood because they are not expressed at the ground surface where they can be easily studied. The faults are hidden beneath 100- to 200-foot thick layers of soft river deposited soils called alluvium. Fault scarps and traces in the soft alluvium erode in a very short time or may be rapidly covered by new deposits thereby quickly hiding evidence of earthquake fault lines.

Due to the harder, colder, drier and less fractured nature of the rocks in the earth's crust in the central United States, earthquakes in this region shake and damage an area approximately 20 times larger than earthquakes in California and most other active seismic areas.

Even though large earthquakes occur much less frequently in the NMSZ than in California, the long term average quake threat, in terms of square miles affected per century, is about the same.

The first in these series occurred on December 16, 1811, as heavy tremors and a thunderous roar swept through the town of New Madrid, Missouri, a sparsely populated, but thriving community on the coast of the Mississippi River. Residents reported seeing bizarre flashing lights, geysers of sand, and clouds of sulfur escaping from the ground. Portions of the earth's surface lifted so high that they blocked the passage of the Mississippi River, causing the waters to flow backwards towards Illinois. The seismic shock waves were so powerful they spread for hundreds of miles across the country. Tremors were felt as far away as New York City. This first earthquake alone released energy greater than that of 1,000 atom bombs.

Over the next few months, two more catastrophic earthquakes and thousands of smaller aftershocks struck the region (including 15 quakes of estimated magnitude 6.5 to 8 and 189 quakes of estimated magnitude 5 to 6.5), causing widespread destruction and creating several lakes from the waters of the Mississippi River.



When waves of a small earthquake impinge on the boundary between hard rock and overlying sediments from below (lower seismogram), they become amplified as they travel through the sediments to the surface (upper seismogram). A seismogram records the wave motion over time. The amplifying effects of thick sediments above the New Madrid seismic zone results in motions at the surface that are many times larger than below. (Courtesy of C. Langston, The University of Memphis.)

USACE Commander's Intent From OPLAN 2010-70, New Madrid Earthquake Response Plan

Purpose:
USACE immediately begins response activities under its own authorities in order to fully support Local, State, Tribal and Federal response efforts in order to sustain lives, reestablish public works and essential services and restore critical infrastructure after a catastrophic earthquake and tsunami impact the Central United States.

Key Tasks:
- Conduct immediate personnel accountability and conduct COOP or Devolution for impacted USACE elements.
- Rapidly assess and repair damaged USACE Civil Works infrastructure.
- Deploy and conduct ESF #3 missions under the NRF and provide supported MSCs with additional staffing.
- Restore navigable waterways and essential ports in coordination with the USCG.
- Deploy a USACE TF-Forward to each state and coordination cells to key nodes (ISBs, JFOs, etc.) as appropriate.
- Perform work for others as directed to assess and repair critical infrastructure.

End State:
- Impacted Divisions and Districts are sufficiently recovered to resume and sustain mission essential operations.
- Damaged USACE civil works infrastructure is restored to its authorized operational condition.
- Critical ports and navigable waterways are re-opened and functional.
- Essential public services are re-established.

Concept of Operations

- MSCs and Districts responsibilities aligned by state
- Support FEMA/DHS through traditional ESF #3 mission assignments as well as nontraditional missions
- Worst case scenario assumes Memphis and St. Louis will be impacted districts (their PRTs will not be available)
- Support to USACE Civil Works Projects will be within current civil works boundaries

USACE Phases

- Phase 1 – Steady State (Prior to NMSZ event)
- Phase 2a – Immediate Response, Restoration of Navigation (0-24 hours after NMSZ event)
- Phase 2b – Deployment (24-72 hours after NMSZ event)
- Phase 2c – Employment and Sustained Response (72 hours – 30 days after NMSZ event)
- Phase 3a – Short-Term Recovery (30 – 60 days following NMSZ event)

USACE Challenges

- Transportation system
- Communications limitations
- Weather and seasonal factors
- Displaced civilians
- Security and sustainment of responders
- Non-functional local governments
- Loss of pipelines

Scenario

At 0900 hours (CDT), on May 8, a major earthquake occurred along the New Madrid Seismic Zone (NMSZ), north of Memphis. This fault rupture registered a moment magnitude (M) of 7.7. Ground shaking occurred for approximately 34 seconds. The shaking from the main shock was the result of a rupture of the southern (SW) arm of the New Madrid seismic zone at a depth of 6.1 miles below the earth's surface. The endpoints of the line of rupture are near Marked Tree, AR to near Dyersburg, TN.

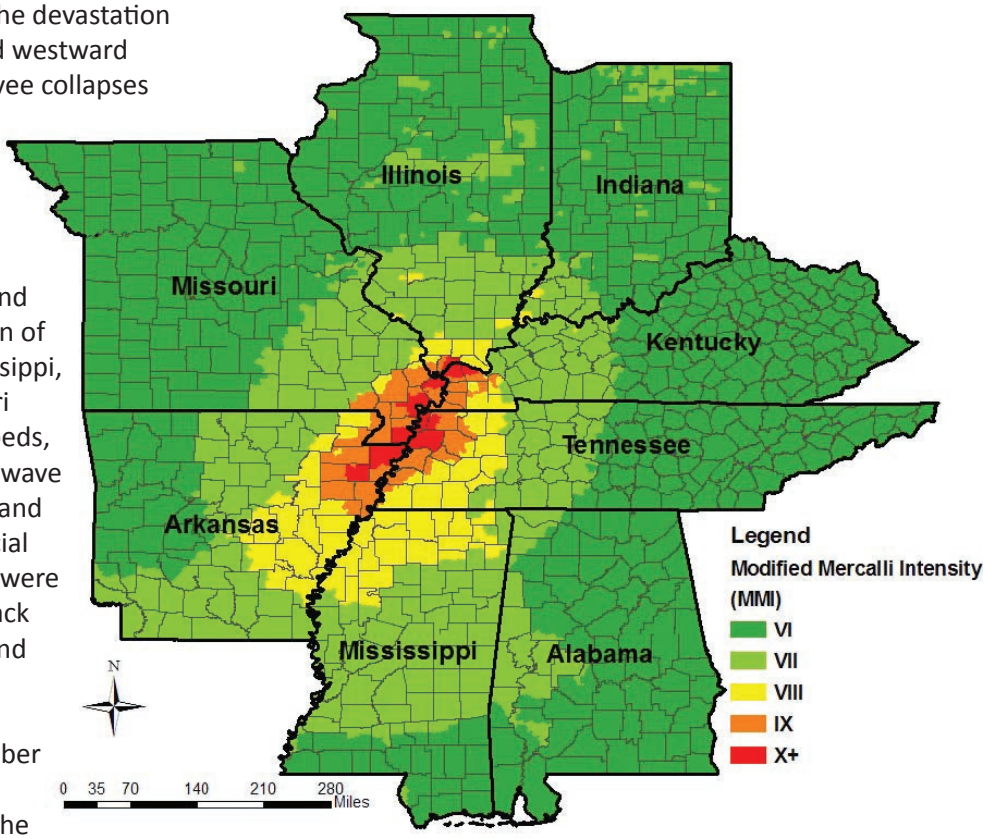
A series of aftershocks of varying intensity were felt throughout the region over the course of the next few days. The first major aftershock occurred at 0800 (CDT) on May 11 with a M 6.3 in the central segment near Reelfoot Lake in Dyersburg, TN. A second major aftershock measuring M 4.5 occurred at 1400 (CDT) and was felt throughout the region.

High winter and spring rainfall has left the ground, including levees, 60-80% saturated, and stages on many of the primary rivers and tributaries are at, or near, flood stage.

Area of Impact

The devastation ranged across an area that extended from north of St. Louis, MO, to south of Jackson, MS, well into the State of Alabama, and included most of the entire State of Arkansas. The eastern border of the devastation was marked by Louisville, KY, and extended westward to within 50 miles of Joplin, MO. Major levee collapses and high water conditions due to heavy rain have resulted in extensive flooding on both banks of the Mississippi and Ohio Rivers and many of their tributaries. Collapsed bridges and roadways and sunken vessels have caused extensive oil and hazardous material (hazmat) contamination of the cities, towns, and farmland. The Mississippi, Ohio, Cumberland, Tennessee and Missouri Rivers experienced uplifting of their river beds, which caused temporary reverse-flow and wave surges resulting in breakaway barge fleets and swamping and capsizing of some commercial and recreational vessels where the effects were most pronounced. A levee breach along Jack Carley Causeway leading to Presidents Island (near Memphis) caused the river to surge through McKellar Lake, which resulted in a large-scale breakaway of an unknown number of barges; these breakaway barges either grounded or sank. The industrial area on the west side of McKellar Lake was isolated by the levee break. Many landslides of high, undercut banks (including wooded banks) have choked the rivers, further disrupting flows.

Timeframe: May 8 - May 15, 2010 (E+0 through E+7 days)



Infrastructure Damage

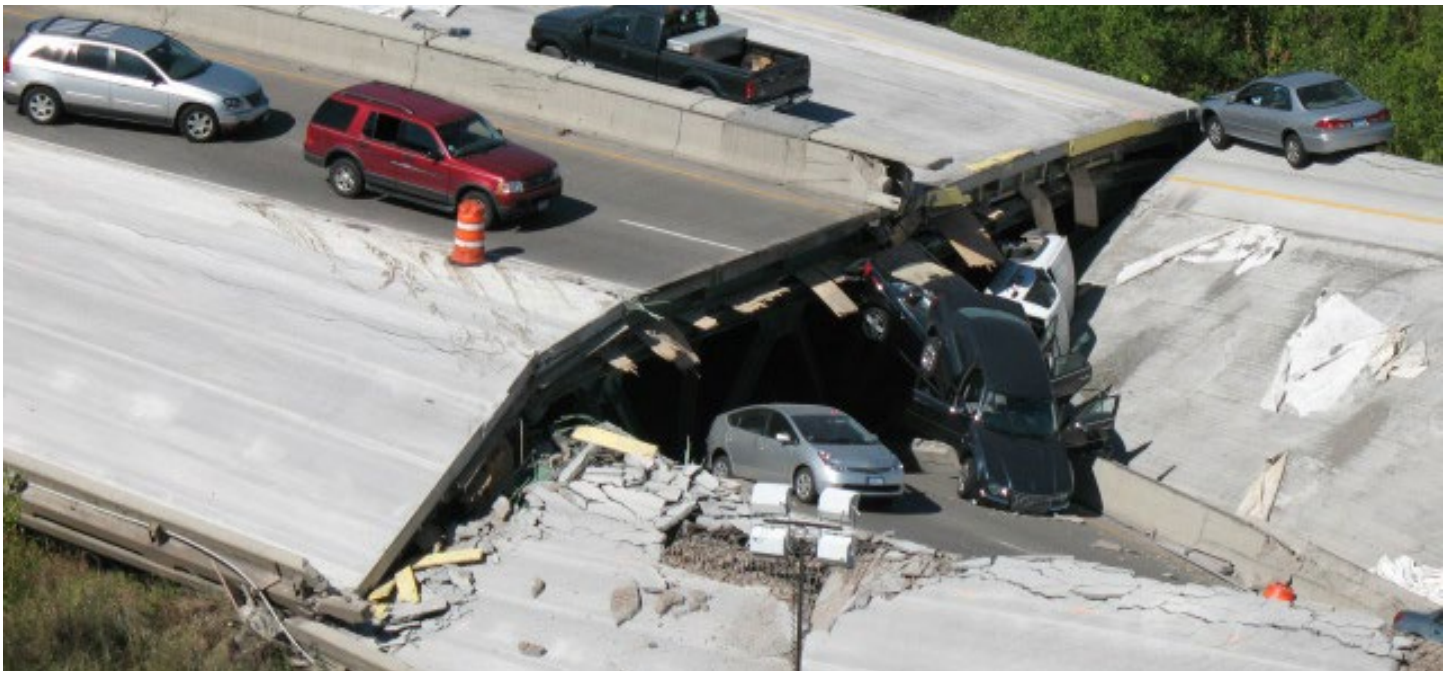
Many areas of major cities continue to be completely inaccessible due to debris and damaged roads. Railroads were seriously impacted as a result of collapsed bridges and significant damage to tracks. “East-west” rail service was completely disrupted within the affected area. Many small communities were unable to access distribution centers. Additional landslides of high, undercut banks (including wooded banks) have resulted in large amounts of marine debris being discharged into the water. Local building inspectors expressed concern that asbestos contamination was likely in older buildings suffering the brunt of the direct seismic damage. Disposal sites for contaminated waste are needed but appropriate locations have not been identified.

Facilities handling non-hazardous and hazardous cargoes, such as fertilizers, phosphates, and petroleum, collapsed along the banks of the Missouri, Cumberland, lower Ohio and Mississippi Rivers and then entered the rivers as run-off. Conflicting information on the severity of spills caused prioritization issues. There was significant concern for spilled hazmat from storage tanks, overturned railcars, and chemical stockpiles.

Two-thirds of the cities of Saint Louis and Memphis are without power. Utility companies are working to restore service, but efforts are hampered by damaged roadways. Many wireless communications towers are damaged. Wired communications are virtually unavailable due to major damage to the lines.

Impacts at a Glance

- 715,000 buildings are damaged in eight states
- 42,000 search and rescue personnel working in 1,500 teams are required for response
- 3,500 bridges are damaged
- 140 counties have significant damage to critical infrastructure
- 425,000 breaks and leaks to local and interstate pipelines
- 2.6 million households are without power
- 86,000 injuries and fatalities result from damage to infrastructure
- 130 hospitals are damaged
- 15 major bridges are unstable
- 7.2 million people are displaced
- 2 million people are seeking temporary shelter
- $300 billion in direct economic losses in eight states, may be double that in indirect losses



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