# Modified Mercalli Intensity for Scenario Earthquakes in Evansville, Indiana

By Chris Cramer, Jennifer Haase, and Oliver Boyd

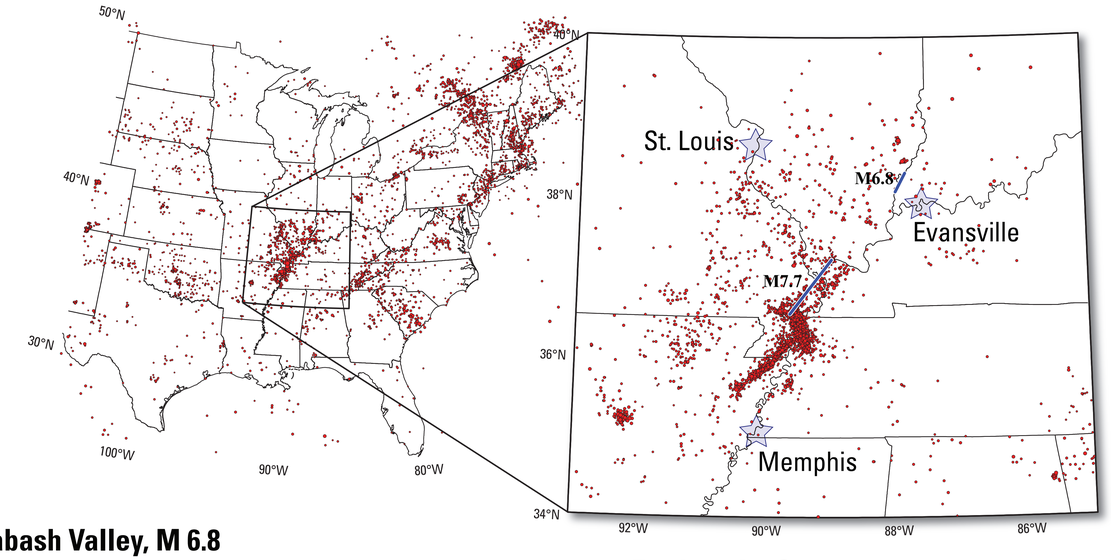
Evansville has experienced minor damage from earthquakes several times in the past 200 years. Because of this history and the fact that Evansville is close to the Wabash Valley and New Madrid seismic zones, there is concern about the hazards from earthquakes. Earthquakes currently cannot be predicted, but scientists can estimate how strongly the ground is likely to shake as a result of an earthquake. Earthquake-hazard maps provide one way of conveying such estimates of strong ground shaking and will help the region prepare for future earthquakes and reduce earthquake-caused losses.

The Evansville Area Earthquake Hazards Mapping Project has produced a series of maps that show the hazards from earthquakes in the region. Included in this array of products are scenario-hazard maps, which predict ground shaking from two hypothetical earthquakes: (1) a magnitude 7.7 earthquake in the New Madrid seismic zone, and (2) a magnitude 6.8 earthquake in the Wabash Valley seismic zone. These earthquakes are believed to be the largest probable earthquakes that could impact the Evansville region.

The results from the scenario ground-motion modeling are displayed below in terms of Modified Mercalli Intensities (MMI); the translation from ground-motion measurement to a description of earthquake intensity allows for an analysis of likely damage. Modeled intensities range from MMI V (moderate shaking with light levels of expected damage) to MMI IX (violent shaking with heavy damage). For both scenarios, the strongest shaking is expected along the Ohio River valley, where thick, soft sediments amplify earthquake waves.

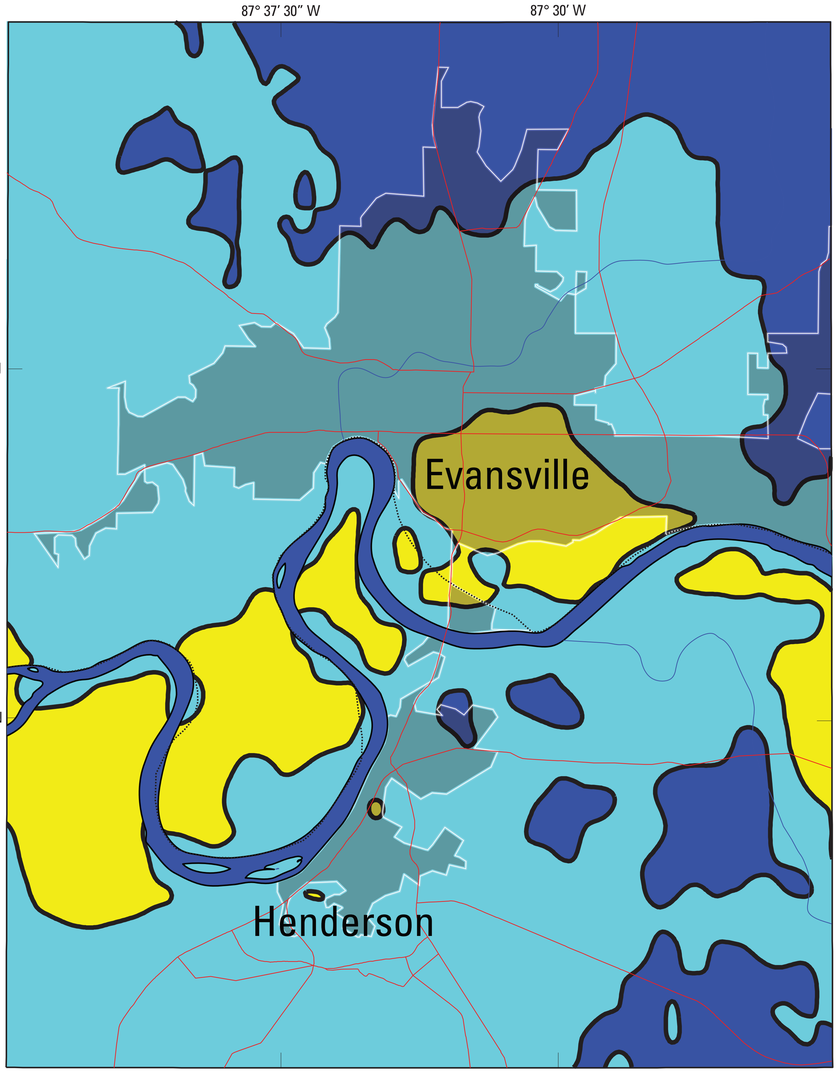
While both scenarios predict at least some damage across the broader Evansville region, the level of damage is greater for the magnitude 6.8 Wabash Valley earthquake due to the proximity of Evansville to the earthquake source (25 miles versus 100 miles for New Madrid). For the Wabash Valley scenario, the type of predicted damage ranges from collapse of poorly built masonry structures along the Ohio River Valley to broken windows, dislodged brick work, and cracks to poorly designed or older structures outside of the river valley. For the New Madrid magnitude 7.7 scenario, light damage is expected outside of the river valley, including broken windows and glassware and cracked plaster. Within the Ohio River valley, poorly designed masonry structures and adobe houses could be cracked and damaged, and weak chimneys may be broken.

These scenario ground-shaking maps complement probabilistic seismic-hazard maps produced by the Evansville Area Earthquake Hazard Mapping Group and provide government officials, city planners, and emergency response personnel with the information they need to prepare for possible future earthquake-caused ground shaking in the Evansville area.



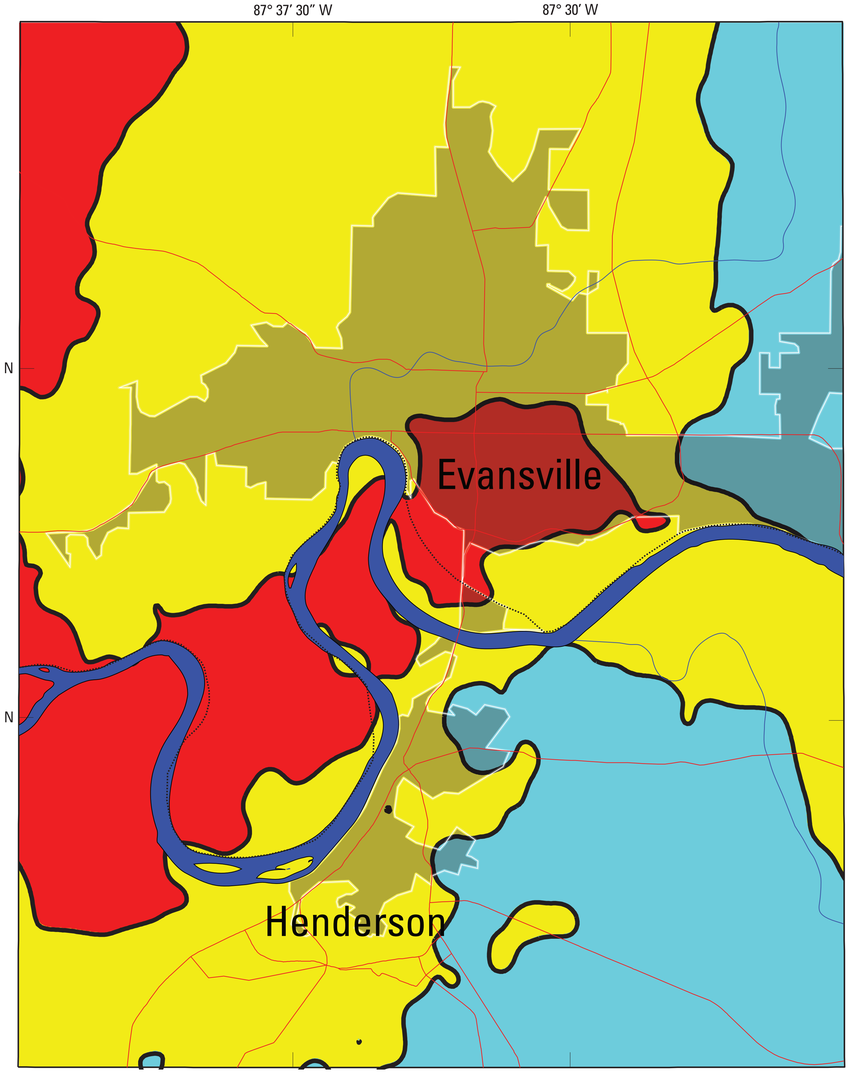

## Modified Mercalli Intensities

### New Madrid, M 7.7




The darker areas superimposed on the MMI maps correspond to the metropolitan areas of Evansville, Indiana and Henderson, Kentucky. Red lines are major roads and blue lines are rivers. Cartographic data were obtained from the U.S. Census Bureau, http://www.census.gov/geo/www/cob/bdy_files.html

### Wabash Valley, M 6.8

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SCALE 1:84 480

1 0 1 2 3 4 5 6 MILES

1 0 1 2 3 4 5 6 7 8 KILOMETERS

## Earthquake Sources

Earthquakes in the image on the left are taken from the USGS earthquake catalog for the National Maps, which has data concerning earthquakes that have occurred from from 1534 to 2006. Earthquakes in the image on the right are obtained from the catalog produced by the Center for Earthquake Research and Information at the University of Memphis. It contains instrumentally observed earthquakes from 1974 to 2009. The blue lines are the locations of the scenario earthquakes.

### EXPLANATION

**Modified Mercalli Intensity Scale**




| MMI | Description |
|---|---|
| I | Not felt. Long-period effects of large earthquakes, sometimes experienced near or beyond the margin of the area of perceptible shaking, such as dizziness, nausea, slow swaying of structures, liquids, bodies of water (seiches), chandeliers, doors. |
| II | Felt indoors by a few persons at rest, especially on upper floors of buildings. |
| III | Felt indoors by several people. Hanging objects swing. Vibration like passing of light trucks. |
| IV | Felt indoors by many people, outdoors by few. Windows, doors, dishes rattle. Vibration like passing of heavy trucks or sensation like a heavy body striking building or heavy objects falling inside. |
| V | Felt by most people; frightened a few; a few run outdoors. Vases and small unstable objects are overturned, fallen, some broken. Small furnishings and objects displaced. Hanging pictures, shutters, doors swing; pendulum clocks stop, start, change rate. |
| VI | Poorly built masonry structures or weak materials such as adobe are cracked. Plaster is cracked. Some windows and much glassware are broken. Many knickknacks, books are knocked off shelves. Moderately heavy furniture is displaced or overturned. |
| VII | Poorly designed or built masonry structures, adobe houses, old walls (especially those without mortar) are cracked and damaged. Ordinary masonry structures are somewhat cracked. Weak chimneys are broken at roof line; many chimneys cracked. Loosened brickwork, stones, tiles, plaster, cornices, unbraced parapets are shaken down. Many windows are broken. Heavy furniture is overturned. Concrete irrigation ditches damaged. |
| VIII | Ordinary masonry structures are considerably damaged, partially collapsed. Well-built masonry structures are somewhat damaged. Frame buildings are somewhat damaged, and moved on foundations if not bolted down. Some masonry walls are fallen, many seriously cracked. Chimneys, monuments, towers, elevated tanks are twisted or fallen. Branches are broken from trees. Very heavy furniture is overturned. |
| IX | Poorly built masonry structures, adobe houses are destroyed. Ordinary masonry structures are heavily damaged, sometimes with complete collapse. Well-built masonry structures are seriously damaged. Frame structures are fallen off foundations if not bolted down. Frames are racked. Reservoirs are seriously damaged. |
| X | Most masonry and frame structures are destroyed with their foundations. Some well-built wooden structures and bridges are destroyed. Dams, dikes, embankments are seriously damaged. Railroad rails are bent slightly. |
| XI | Few, if any, masonry structures remain standing. Wood-frame structures severely damaged. Dams, dikes, embankments greatly damaged. Well built bridges destroyed. Railroad rails bent greatly. |
| XII | Damage nearly total. Practically all works of construction greatly damaged or destroyed. |

**Acknowledgments**

The U.S. Geological Survey (USGS), which produces earthquake hazard maps for the Nation, collaborates with local partners to develop detailed maps for urban areas such as Evansville that are vulnerable to strong ground shaking. The Kentucky and Indiana Geological Surveys worked with the USGS to produce surficial geologic maps of the Evansville area. These partners also worked with Purdue University; the Center for Earthquake Research and Information (CERI) at the University of Memphis; and the Illinois State Geologic Surveys to decide on parameters for the scenario earthquakes. Purdue University in collaboration with CERI performed the liquefaction, scenario and probabilistic seismic hazard calculations and produced the final maps. Additional partners are the Southwest Indiana Disaster Resistant Community Corporation and the Central U.S. Earthquake Consortium State Geologists.

### Partners

PURDUE UNIVERSITY

THE UNIVERSITY OF MEMPHIS
Center for Earthquake Research and Information

INDIANA GEOLOGICAL SURVEY INDIANA UNIVERSITY

Southwest Indiana DRC Disaster Resistant Community Corporation

KGS

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
Institute of Natural Resource Sustainability
ILLINOIS STATE GEOLOGICAL SURVEY

Association of CUSEC State Geologists

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