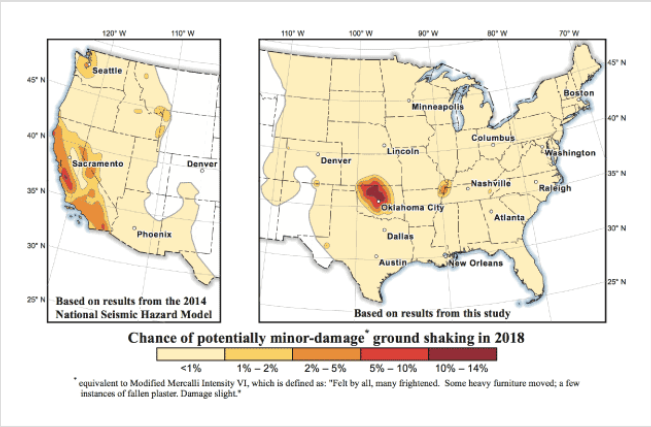
Short-term Induced Seismicity Models

2018 One-Year Model



Map showing chance of damage from an earthquake in the Central and Eastern United States during 2018. Percent chances are represented as follows: pale yellow, less than 1 percent; dark yellow, 1 to 2 percent; orange, 2 to 5 percent; red, 5 to 10 percent; dark red, 10 to 12 percent. See Hazard from the western United States from the 2014 National Seismic Hazard Maps (Petersen et al., 2014) for comparison.

The USGS has produced the 2018 one-year probabilistic seismic hazard forecast for the central and eastern United States from induced and natural earthquakes. For consistency, the updated 2018 forecast is developed using the same probabilistic seismicity-based methodology as applied in the two previous forecasts.

Rates of earthquakes across the U.S. M ≥ 3.0 grew rapidly between 2008 and 2015 but have steadily declined over the past three years, especially in areas of Oklahoma and southern Kansas where fluid injection has decreased.

Documentation

Petersen, M. et al., 2018 One-Year Seismic Hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes - Seis. Res. Lett., doi.org/10.1785/0220180005.

Maps for Media

- Forecast for Damage from Natural and Induced Earthquakes in 2018 (% Chance of Damage)

Scientific Data

- GIS Data, Catalogs, Seismic Hazard Data
- Source Code

For More Information

- Induced Seismicity Research

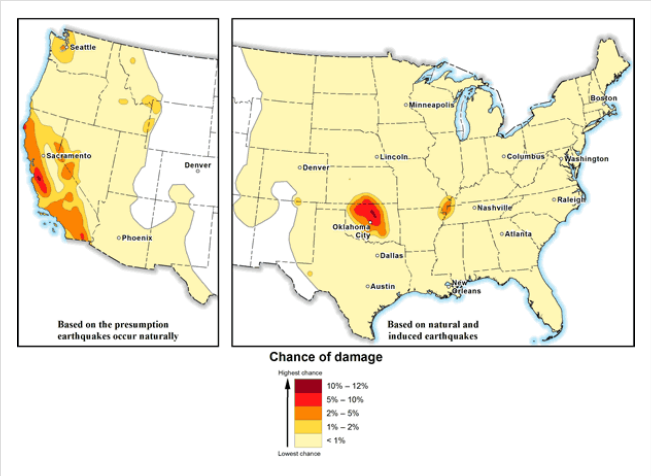
The seismicity pattern in 2017 was complex with earthquakes more spatially dispersed than in previous years. Some areas of west-central Oklahoma experienced increased activity rates where industrial activity increased. Earthquake rates in Oklahoma (429 earthquakes of M ≥ 3 and 4 M ≥ 4), Raton Basin (Colorado/New Mexico border, 6 earthquakes M ≥ 3), and the New Madrid seismic zone (11 earthquakes M ≥ 3) continue to be higher than historical levels. Almost all of these earthquakes occurred within the highest hazard regions of the 2017 forecast.

Even though rates declined over the past three years, the short-term hazard for damaging ground shaking across much of Oklahoma remains at high levels due to continuing high rates of smaller earthquakes that are still hundreds of times higher than at any time in the State's history. These short-term hazard levels are similar to active regions in California. During 2017, M ≥ 3 earthquakes also occurred in or near Ohio, West Virginia, Missouri, Kentucky, Tennessee, Arkansas, Illinois, Oklahoma, Kansas, Colorado, New Mexico, Utah, and Wyoming.

2017 One-Year Model

Documentation

2017 One-Year Seismic Hazard Forecast for the Central and Eastern United States from



Map showing chance of damage from an earthquake in the Central and Eastern United States during 2017. Percent chances are represented as follows: pale yellow, less than 1 percent; dark yellow, 1 to 2 percent; orange, 2 to 5 percent; red, 5 to 10 percent; dark red, 10 to 12 percent.

The U.S Geological Survey (USGS) has produced a one-year 2017 seismic hazard forecast for the central and eastern United States from induced and natural earthquakes that updates the 2016 one-year forecast; this map is intended to provide information to the public and to facilitate the development of induced seismicity forecasting models, methods, and data. The 2017 hazard model applies the same methodology and input logic tree as the 2016 forecast, but with an updated earthquake catalog.

The 2016 forecast indicated high seismic hazard (greater than 1% probability of potentially damaging ground shaking in one-year) in five focus areas: Oklahoma-Kansas, the Raton Basin (Colorado/New Mexico border), north Texas, north Arkansas, and the New Madrid seismic zone. During 2016, several damaging induced earthquakes

Induced and Natural Earthquakes - Seis. Res. Lett., v.88, n.3

USGS News Release

USGS Top Story: New USGS Maps Identify Potential Ground Shaking Hazards 2017

Maps for Media

- Forecast for Damage from Natural and Induced Earthquakes in 2017
  (% Chance of Damage)
- Forecast for Ground Shaking Intensity from Natural and Induced Earthquakes in 2017
  (Modified Mercalli Intensity)

Scientific Data

- Data
- Catalogs
- Source Code
- GIS Data

See also Induced Seismicity Research.

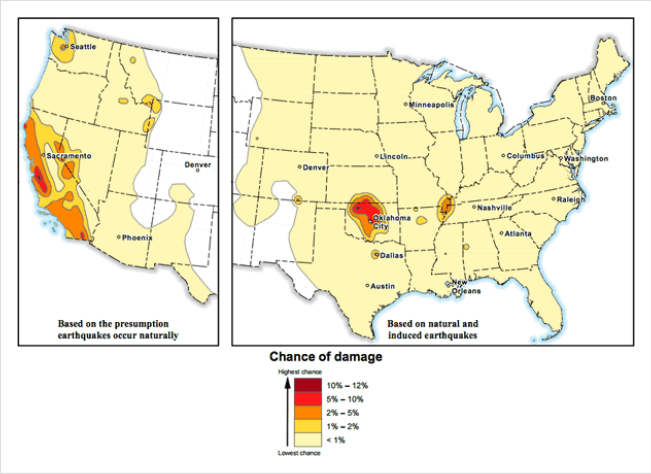
occurred in Oklahoma within the highest hazard region of the 2016 forecast; all of the 21 magnitude (M) ≥ 4 and three M ≥ 5 earthquakes occurred within the highest hazard area in the 2016 forecast. Outside the Oklahoma-Kansas focus area, two earthquakes with M ≥ 4 occurred near Trinidad, Colorado (in the Raton Basin focus area), but no earthquakes with M ≥ 2.7 were observed in the north Texas or north Arkansas focus areas. Several observations of damaging ground shaking levels were also recorded in the highest hazard region of Oklahoma. The 2017 forecasted seismic rates are lower in regions of induced activity due to lower rates of earthquakes in 2016 compared to 2015, which may be related to decreased wastewater injection, caused by regulatory actions or by a decrease in unconventional oil and gas production. Nevertheless, the 2017 forecasted hazard is still significantly elevated in Oklahoma compared to the hazard calculated from seismicity before 2009.

2016 One-Year Model

USGS Open-File Report

2016 One-Year Seismic Hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes - OFR-2016-1035

USGS News Release



Map showing chance of damage from an earthquake in the Central and Eastern United States during 2016. Percent chances are represented as follows: pale yellow, less than 1 percent; dark yellow, 1 to 2 percent; orange, 2 to 5 percent; red, 5 to 10 percent; dark red, 10 to 12 percent.

The U.S. Geological Survey (USGS) has produced a 1-year seismic hazard forecast for 2016 for the Central and Eastern United States (CEUS) that includes contributions from both induced and natural earthquakes. The model assumes that earthquake rates calculated from several different time windows will remain relatively stationary and can be used to forecast earthquake hazard and damage intensity for the year 2016. This assessment is the first step in developing an operational earthquake forecast for the CEUS, and the analysis could be revised with updated seismicity and model parameters. Consensus input models consider alternative earthquake catalog durations, smoothing parameters, maximum magnitudes, and ground motion estimates, and represent uncertainties in earthquake occurrence and diversity of opinion in the science community.

USGS Science Feature

Maps for Media

- Forecast for Damage from Natural and Induced Earthquakes in 2016
  (% Chance of Damage)
- Forecast for Ground Shaking Intensity from Natural and Induced Earthquakes in 2016
  (Modified Mercalli Intensity)
- Map of 21 Areas Impacted by Induced Earthquakes
  (Wells and Seismicity)

Scientific Data

- Data
- Catalogs
- Source Code
- GIS Data

See also Induced Seismicity Research.

Ground shaking seismic hazard for 1-percent probability of exceedance in 1 year reaches 0.6 g (as a fraction of standard gravity [g]) in northern Oklahoma and southern Kansas, and about 0.2 g in the Raton Basin of Colorado and New Mexico, in central Arkansas, and in north-central Texas near Dallas. Near some areas of active induced earthquakes, hazard is higher than in the 2014 USGS National Seismic Hazard Model (NHSM) by more than a factor of 3; the 2014 NHSM did not consider induced earthquakes. In some areas, previously observed induced earthquakes have stopped, so the seismic hazard reverts back to the 2014 NSHM. Increased seismic activity, whether defined as induced or natural, produces high hazard. Conversion of ground shaking to seismic intensity indicates that some places in Oklahoma, Kansas, Colorado, New Mexico, Texas, and Arkansas may experience damage if the induced seismicity continues unabated. The chance of having Modified Mercalli Intensity (MMI) VI or greater (damaging earthquake shaking) is 5 –12 percent per year in north-central Oklahoma and southern Kansas, similar to the chance of damage caused by natural earthquakes at sites in parts of California.