The third largest earthquake in Oklahoma’s history, registering a 5.1 magnitude on the Richter scale, happened last year outside of Fairview, which is just east of Enid in the heart of the state’s oil and gas country. “At first it was unnerving,” said Roger Knak, chief executive officer of Fairview Regional Medical Center. “Now the earthquakes have just become normal.”

On the U.S. Geological Survey’s (USGS) website, www.usgs.gov, an animated map of Oklahoma illustrates the increase in seismic activity by placing a dot where an earthquake occurs. From June 9, 2008, to April 2013, 300 earthquakes were recorded—the dots appear as if tiny drops of rain are falling softly east of Oklahoma City. But from 2013 until two months ago, the northwest and north central section of the map explodes with dots of activity like a torrential downpour hitting a windshield.

“The rate of earthquakes has increased sharply since 2009 in the central and eastern United States, with growing evidence confirming that these earthquakes are primarily caused by human activity, namely the injection of wastewater in deep disposal wells,” the USGS said in a statement.

According to the USGS, advances in extraction technology have recovered oil and natural gas once thought unattainable with previous extraction methods. But the wells also extract a large amount of salt water left over from ancient oceans. The wastewater is pumped back in the ground below oil and gas extraction levels into the Arbuckle zone. This bed of limestone and dolomite, 7,000 feet below the surface, absorbs wastewater; however, it also places pressure on the Crystalline Basement—a dense layer of volcanic rock 13,000 feet below the surface that contains fissures and faults. Scientists say that friction keeps the faults from moving; water pressure reduces the friction and causes a fault to slip, producing energy in the form of an earthquake.

**The economic impact**

Chad Wilkerson, branch executive and economist at the Kansas City Fed’s Oklahoma City office, says the USGS estimates that the likelihood of a damaging earthquake has increased in parts of Oklahoma.

In 2015, the USGS reported more than 60 percent of earthquakes in the continental United States of magnitude 3 or greater occurred in Oklahoma. Specifically, there were 908 such earthquakes in the state last year, including 29 of magnitude 4 or greater.

“This compares to 558 earthquakes of 3.0 or greater in all other states, including 44 quakes of magnitude 4.0 or greater and three of magnitude 5.0 or greater—one each in California, Nevada and Idaho,” Wilkerson said.

The National Oceanic and Atmospheric Administration (NOAA) reported there were 195 earthquakes of magnitude 5.5 or greater in developed countries from 1985 to 2015. This includes the earthquake near Prague, Okla., in November 2011, which was a magnitude 5.7. The earthquake injured people, destroyed six houses and damaged 20 others.

The magnitude or size of earthquakes is measured through the Richter scale, which measures the total amount of energy released by an earthquake, as conveyed on a seismograph from the amount of ground movement produced by seismic waves. The intensity of an earthquake is measured through the Modified Mercalli Intensity Scale, which is divided into 12 degrees by Roman numerals. A 3 magnitude earthquake, or intensity level II to III, is the weakest tremor that people can feel.

Damage estimates for earthquakes, such as the ones listed in the NOAA reports, are more available for occurrences in highly populated areas.

Damage estimates also can vary even if two individual places experience similar-size earthquakes. Local geology, population density, construction practices and epicenter location all can affect damage outcomes.

For example, the 2010 magnitude 7 earthquake in Christchurch, New Zealand, with a population size of 376,700, caused an estimated $7 billion in damage, while a 1992 7.6 magnitude earthquake in Landers, Yucca Valley, Calif., with a population of 17,000, caused an estimated $155 million in damage. The location of the epicenter and population density played a key role in these damage estimates.

“These large differences in economic damages across even similar-sized large earthquakes, combined with their relative..."
in frequency and differing characteristics, make it impossible to provide close estimates of the likely economic consequences of any potential future quakes,” Wilkerson said.

Yet, Wilkerson added, magnitude and intensity play a key role.

“Looking just at magnitudes, the median economic damage of earthquakes of magnitudes greater than 6.5 since 1985 ($628 million) is about 3.5 times higher than the median for earthquakes of magnitude 5.5 to 6.5 ($178 million). And the median damage of large earthquakes in areas with populations greater than 250,000 (nearly $2 billion) is nearly 75 times greater than for those in areas with populations below 250,000 ($28 million).”

And most economic damages include only direct costs, not near-term additional costs to other industries resulting from less money being spent in local areas due to the disaster, Wilkerson said. The estimates also do not include the long-term economic benefits of rebuilding.

To get a better sense for the scale of damages from large earthquakes, Wilkerson said, someone could compare them with the economic damage caused by other types of disasters. Of the top 10 costliest U.S. natural disasters from 1985 to 2015, six were hurricanes, two were droughts and one was a flood. Hurricane Katrina tops the chart with an estimated $152.5 billion in damages in 2005. The 1994 magnitude 6.7 Northridge, Calif., earthquake came in at No. 3 and was the only earthquake in the top 10, with an estimated cost of $64 billion in damages. Although not as intense as other U.S. earthquakes, the Northridge earthquake’s epicenter was in a densely populated area—a 1.4 million people.

Wilkerson says that perhaps the most relevant and familiar disaster comparison for Oklahomans is tornadoes. The two tornadoes since 1985 that have caused the most economic damage in the United States occurred in 2011—one in Joplin, Mo., and the other in Tuscaloosa, Ala. Each caused between $2.5 billion and $3.0 billion in damages (2015 dollars). But the third and fourth most-damaging tornadoes in recent U.S. history both occurred in the southern part of the Oklahoma City metropolitan area, in or near Moore. The most recent one, in 2013, caused about $2.1 billion in damage, while a previous large tornado in 1999 caused $1.4 billion.

“Many also think that the economic impact of earthquake damage is something new to Oklahomans,” he said.

Although the state has not experienced a catastrophic earthquake, Oklahomans are dealing with how to pay for the current damage from the multitude of tremors.

“Adding the costs of earthquake insurance was something we would have never even thought of doing two years ago,” Knak said. But as residents and business owners think about the possibility that a more intense earthquake could occur, earthquake insurance seems like a reasonable choice.

“If Oklahoma was to have a 7-point or 7.5 earthquake, you could well be looking at a catastrophic loss and we could also be looking at a concentration of carriers,” Oklahoma Insurance Commissioner John Doak said during a state Insurance Department hearing in May.

Oklahoma insurance regulators have been concerned about the condition of the state’s market for earthquake insurance, especially after receiving reports of some insurance providers raising rates by up to 300 percent. And in some cases, insurers were unwilling to pay benefits to homeowners, saying the damage was not a “natural” disaster but the result of human activity.

That’s why in June, Doak formally declared the state’s market for earthquake insurance as “uncompetitive.” The regulator says Oklahomans are unfairly limited when shopping for quake insurance. Most earthquake coverage in Oklahoma is written as an endorsement or rider on the homeowners’ policy. Of the 119 companies that sell earthquake insurance in the state, Doak said four companies control more than half the market. The commissioner’s order requires companies to submit rate increases before they can take effect, which makes it easier for Doak’s office to challenge any increase it deems unfair.

Like many Oklahomans, Knak wants to see a permanent solution to decrease the amount of earthquakes in the state.

“I think what a lot of people want is for the Oklahoma Corporation Commission to look at a catastrophic loss and we could also be looking at a concentration of carriers,” Oklahoma Insurance Commissioner John Doak said during a state Insurance Department hearing in May.

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Finding a solution

The Oklahoma Corporation Commission has been implementing directives for wastewater disposal operators, known as the traffic light system. The system allows staff to review disposal well permits for proximity to faults, seismicity in the area and other issues. All proposed disposal wells, regardless of location, now undergo a seismicity review. This has allowed the state to regulate the disposal of wastewater, sometimes through shutting down wells or regulating operations.

The new safety implementations, along with the drop in oil prices, have curbed production in the state—ultimately decreasing the amount of seismic activity.

The Oklahoma Geological Survey recently reported that the number of earthquakes in Oklahoma fell by 52 percent between January and April of this year. The data also show the number of monthly earthquakes has fallen by 55 percent since an activity peak in June 2015. Oklahomans, however, know there is a fine line in the regulation of oil and gas wells. Oklahoma and energy have ties going back to the state’s founding. Energy makes up five percent of the state’s labor force, but other business sectors also rely upon it. The recent drop in oil prices has already had devastating affects on the labor market and government budgets.

“I don’t want my house falling down, but we don’t want to hurt the source,” Knak said. “The local economic impact of over-restricting oil and gas would be more devastating than the earthquakes.”

KEVIN WRIGHT, EDITOR

FURTHER RESOURCES

“How Much Economic Damage do Large Earthquakes Cause?” By Chad Wilkerson


COMMENTS/QUESTIONS are welcome and should be sent to tendators@kc.frb.org