Manmade earthquakes in Oklahoma on the decline

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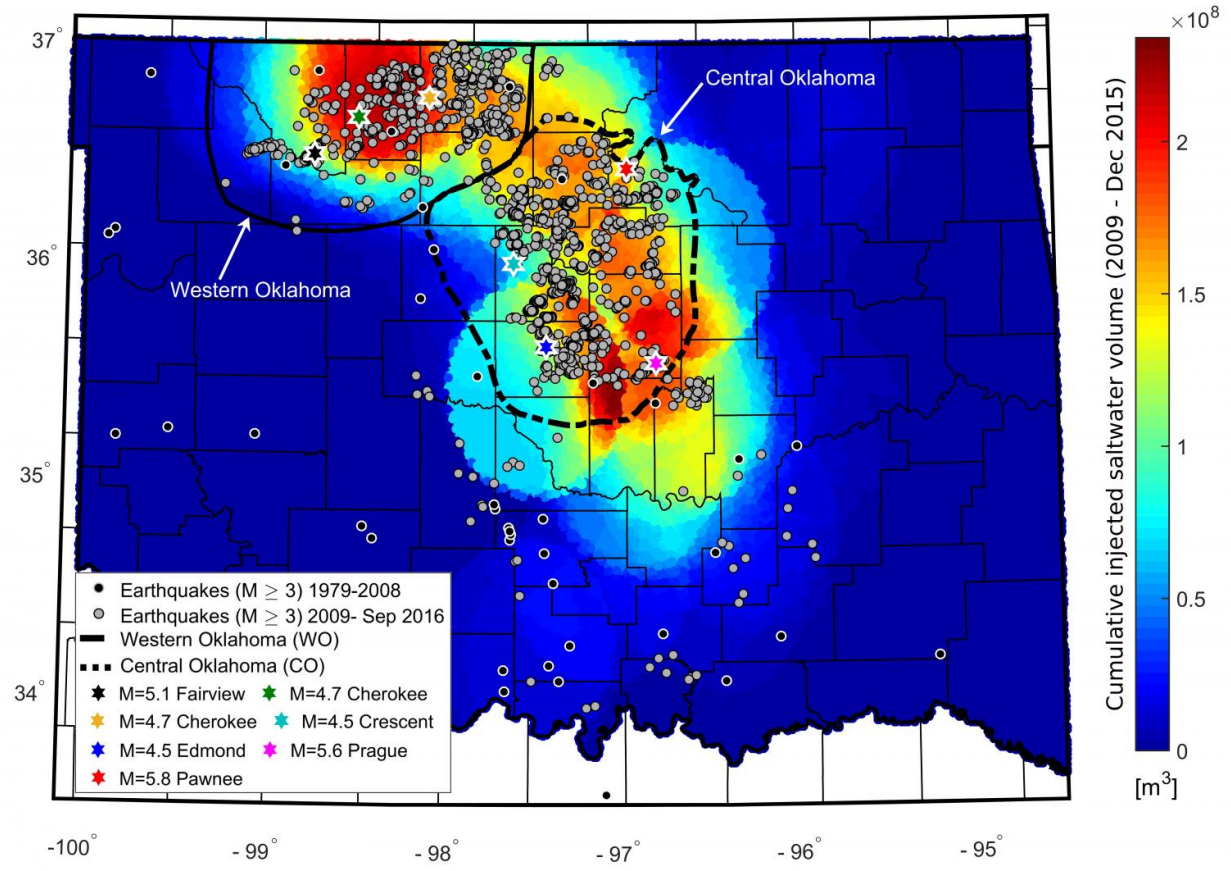

Saltwater disposal and earthquakes in Oklahoma are shown. Credit: Cornelius Langenbruch.

New regulations in Oklahoma that call for reductions in the amount of

wastewater being injected into seismically active areas should significantly decrease the rate of manmade, or "induced," earthquakes in the state, Stanford scientists say.

"Over the past few years, Oklahoma tried a number of measures aimed at reducing the rising number of induced quakes in the state, but none of those actions were effective," said Mark Zoback, the Benjamin M. Page Professor at Stanford's School of Earth, Energy & Environmental Sciences.

While wastewater from oil and gas drilling have been disposed of through underground injection in this area for many decades, induced seismicity was not a problem until the volumes being injected were massively increased, starting around 2009. In the past six years, billions of barrels of wastewater were injected into the Arbuckle formation, a highly permeable rock unit sitting directly on top of billion-year-old rocks containing numerous faults.

Research Zoback and his graduate student Rall Walsh published last year established the correlation in space and time between the areas where the massive injection was occurring and the induced earthquakes. They showed how pressure buildup resulting from the wastewater injection can spread out over large areas and trigger earthquakes tens of miles from the injection wells.

In light of these findings, the state's public utilities commission—called the Oklahoma Corporation Commission —last spring called for a 40 percent reduction in the volume of wastewater being injected. The bulk of that wastewater comes from oil production in several water-bearing rock formations that had not been extensively drilled until a few years ago.

A new physics-based statistical model developed by Stanford

postdoctoral fellow Cornelius Langenbruch and Zoback, and detailed online this week in the journal *Science Advances*, predicts that the continued reduction of injected wastewater will lead to a significant decline in the rate of widely-felt earthquakes—defined as quakes measuring magnitude 3.0 or above—and a return to the historic background level in about five years.

"When the volume of wastewater injection peaked in 2015, Oklahoma was experiencing two or more magnitude 3.0 earthquakes per day. Before 2009, when wastewater injection really started ramping up, the rate was about one per year.

"Several months after wastewater injection began decreasing in mid-2015, the earthquake rate started to decline," Langenbruch said. "There is no question that there is a significantly lower seismicity rate than there was a year ago."

Unfortunately, even though the rate of induced quakes will continue declining, the probability of potentially damaging earthquakes like the magnitude 5.8 earthquake that struck the town of Pawnee in September (the largest to have occurred in Oklahoma in historic time) will remain elevated for a number of years, the Stanford scientists say.

"As long as elevated pressure persists throughout this region," Zoback said, "there will be an increased risk of triggering damaging earthquakes."

More information: "How will induced seismicity in Oklahoma respond to decreased saltwater injection rates?" advances.sciencemag.org/content/2/11/e1601542

Provided by Stanford University