

Water pumping in Calif. elevates mountains, triggers earthquakes near San Andreas Fault – study

Anne C. Mulkern, Environment & Energy Publishing, 5-15-14

Pumping groundwater in California's drought-ridden San Joaquin Valley causes mountains to lift, triggers small earthquakes and could lead to more earthquakes over time, a study published yesterday said.

Water has been pulled from the ground in the San Joaquin Valley, where many crops are grown, to compensate for shortages in the state's dry years. But removing water from the earth causes the surrounding area to bulge out, like what happens when squeezing an elastic ball or a sponge, scientists said. The research, published in the journal *Nature*, used GPS to look at the California mountains west of the valley, including those that parallel the deadly San Andreas Fault. It found the Sierra Nevada and Pacific Coast ranges have lifted 1 to 3 millimeters per year for roughly the last decade.

That movement has a larger impact, the study theorizes. It relaxes the stress against faults, including the San Andreas, said Roland Bürgmann, a professor of geophysics at the University of California, Berkeley, who worked on the research.

"We're unclamping a little bit, by a small amount, the pressure against the fault, and that makes it able to slip just a little bit more," Bürgmann said. "That produces the increase in the number of very small earthquakes."

The quakes have been mostly in the magnitude of 1 and 2, too small for humans to feel, he said. At the same time, Bürgmann said, "ultimately, that should translate into probabilities of all sizes of earthquakes being sensitive to these changing force conditions. Anything that we or nature does that changes the stresses in the earth can have the ultimate consequence in changing the conditions of earthquakes, as well."

The study, which involved scientists in California, Nevada, Washington state and Ontario, Canada, said that climate change likely will exacerbate stress on water "through altered precipitation patterns, more frequent droughts, earlier snowmelt, larger floods, and increasing temperatures."

"Human activity may give rise to an increased rate of earthquake occurrence," the study said.

The study arrived at the same time that Golden State officials are calling for a closer look at groundwater pumping. A report released in late April by the California Department of Water Resources found that groundwater levels have fallen in nearly all areas of the state since last year and more than 60 feet in some southern Central Valley regions. It also identified significant gaps in groundwater monitoring.

State Department of Water Resources officials did not immediately respond to requests for comment on the study in *Nature*.

Larger study planned

Scientists are working on a comprehensive study across the state, Bürgmann said. It will look at all earthquakes large enough to be measured, going back 30 years, and will also examine changes in water loads to see if there's a correlation.

"We really want to know what are the differences in probabilities" of earthquakes, he said. That would allow scientists "to be more specific about how strong that effect is" from pumping and other water changes.

The research just published made use of an earlier study that the U.S. Geological Survey did in 2007, looking at small quakes in the California's Parkfield area in Monterey County. The 2007 study looked at the seasonal variations in earthquakes, which tend to happen there more in summer. It hypothesized that was due to the hydrologic cycle, where water is evaporated from the earth and then returned as precipitation.

The new study infers that instead, the quakes are caused by changing stresses on the earth from groundwater pumping.

"Whenever we're removing water, during the summer, or during the recent drought condition, essentially what we're doing is we're reducing the stress across the San Andreas Fault, which makes it easier to slip," Bürgmann said.

The new research notes that in the winter, when there is more rain and snow, the mountains lower. The net change in each year has been an uplift up to 3 millimeters.

Earthquake connection questioned

Another scientist, however, said that it's conjecture to say that water pumping is triggering earthquakes. Removing water does cause mountains to rise up, said Thomas Holzer, a geologist with USGS in California's Menlo Park. Forty years ago, he said, he found the same connection with pumping and the mountains in Arizona. When California's Hoover Dam was built in the early 1930s and Lake Mead created as a result, that caused the Earth's crust to go down, he said.

Donald Argus, a geophysicist at the Jet Propulsion Laboratory in Pasadena, Calif., earlier this year did a study that said water and snow caused mountains to lower in the winter, followed by an uplift in the summer when it melted.

The study appearing yesterday in *Nature* -- through its use of GPS data -- makes the observation that mountains have lifted, Holzer said. Groundwater pumping does affect the Earth's crust, he said, but that's not the same thing as knowing that it's triggering quakes.

"As the earth bows up beneath the [San Joaquin] Valley, it reduces the crust across the San Andreas Fault, which would reduce the friction on the fault, which would increase the likelihood it might move," Holzer said.

"It's a little more speculative to go all the way to causing earthquakes," he added.

The water pumping and mountains lifting "potentially could be the explanation" for the seasonal pattern of earthquakes in Parkfield that USGS looked at earlier, Holzer said. But that connection hasn't been proved, he said.

No increase in temblor rate over time

Groundwater pumping in the San Joaquin Valley has been taking place for at least 80 years, he said. If that were triggering a change in the rate of earthquakes, that would have been seen by now.

"We haven't seen a big change in earthquakes along the San Andreas Fault," Holzer said.

Bürgmann said that it's correct "that no significant increase in seismicity over that time scale has been documented.

"It's much harder to show changes over long time spans than to show that small earthquakes show periodic behavior due to the seasonal changes," he said in an email. "Also, the change to the longer-term tectonic stressing rate is unlikely to be very big."

The 2007 USGS research "did note increasing seismicity rates with time in their data ... but that could relate to many other things," Bürgmann said. "So the lack of a well-documented increase in seismicity is not surprising to me."

The more comprehensive study underway is aimed at more conclusive answers, he said.