Floods linked to San Andreas quakes

Historical record underscores connections between reservoirs and seismic activity.

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Geophysicists have linked historical earthquakes on the southern section of California's famed San Andreas fault to ancient floods from the nearby Colorado River.

The work has broad implications for understanding how floods or reservoirs relate to quakes — a topic that gained new relevance in 2008, after a massive earthquake in China's Sichuan province killed more than 80,000 people. Some geologists have proposed that impounding water behind a newly built dam there helped hasten the quake.

Now, new work in southern California suggests that at least three times in the past 2,000 years, the weight of river water spreading across floodplains seems to have helped trigger earthquakes in the region.

The findings could also be significant for the future of the Salton Sea, a lake about 200 kilometres east of San Diego that is the dwindling relic of a flood from a century ago. Various groups have long proposed pumping water back into the lake, from conservationists who want to restore wildlife habitat, to developers wanting to take advantage of the region's mild climate and scenic setting.

The latest study, presented last month in San Francisco at a meeting of the American Geophysical Union, suggests that water-management plans should take the potential earthquake risk into consideration.

Between 2006 and 2008, a team led by geophysicist Daniel Brothers of the US Geological Survey's Woods Hole Science Center in Massachusetts conducted the first detailed seismic survey of the Salton Sea, uncovering a previously unknown fault system running beneath the lake (D. S. Brothers *et al. Nature Geosci.* **2,** 581–584; 2009). The team subsequently analysed data from 20-metre-deep cores pulled from the lake bed in 2003 during earlier work for the US Bureau of Reclamation. The cores showed layers of coarse sandy material laid down during floods — at the same time that seismic activity was known to have occurred.

"We found quakes happened about every 100 to 200 years and were correlated with floods," says Brothers. "The Colorado River spills, loads the crust and then there is a rupture." He says the team is "very confident" in its evidence for the existence of three flood-derived quakes, of roughly magnitude 6, which happened about 600 years ago, 1,100 years ago and 1,200–1,900 years ago. "Sediments don't lie," he says.

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A network of faults runs under California's shrinking Salton Sea, which was created in a flood a century ago.

The team has other, scant evidence for a quake that may have occurred soon after the 1905 flood that created the sea. Patrick Williams, an earthquake geologist at San Diego State University, says the group's work is "really smart", and calls out for more follow-up studies to be done on the causes of flood-induced quakes.

A quake of about magnitude 7 struck the southern San Andreas fault about 300 years ago; the next is a century overdue. One possible reason is the Hoover Dam: since its completion in 1936, the lower Colorado no longer floods.

A new scheme, however, could bring a further influx of water to the Salton Sea region. Developers are eyeing a route to pump water through low basins and river channels that link the Salton Sea to the Gulf of California (see map). The idea is being pushed by consultant Gary Jennings, whose Utility Solutions Group in South Lake Tahoe, Nevada, hopes to be involved in the project. In about a month, the Salton Sea Authority, a regional restoration agency, will consider a planning agreement to move forward with Jennings's 'sea-to-sea' plan.

Jennings, who had not heard of the seismic work when asked by *Nature*, calls the new findings "very insightful". "If anyone raises an earthquake flag," he says, "we would say don't increase the size of the sea."

"The new studies may cause some serious problems" for the project, adds Douglas Barnum, science coordinator for the Salton Sea at the US Geological Survey in La Quinta, California. Yet even if some form of water management goes ahead, he says, the new geophysical data gathered on the sea will still be important for understanding the region. ■

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