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Groundwater in the Colorado River basin won't run out — but eventually we won't be able to get at it, scientists warn

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The Colorado River basin has lost a Lake Mead's worth of water in the last 20 years — and scientists say we're passing a "critical point" where pumping groundwater will become too expensive.

Stark new satellite data reveal that the Colorado River basin has lost huge amounts of groundwater over the last few decades, with some research suggesting that this groundwater could run out by the end of the century.

But is that really the case? And if so, what could be done to prevent that happening?

While groundwater is being depleted, it's unlikely the water will ever run out completely. However, continued drainage of the basin could make the water table fall so far it's basically inaccessible, experts told Live Science.

Massive watershed

The Colorado River snakes through seven U.S. states (Wyoming, Colorado, Utah, New Mexico, Nevada, Arizona and California) and two Mexican states (Baja California and Sonora). Some 40 million people, including those in Phoenix and Las Vegas, depend on it for their water needs. But as supplies of this surface water have dried up over the past two decades — reaching record lows — more and more people have been pumping groundwater from far below the surface, mainly for agricultural use.

To get a better idea of how much groundwater is being extracted,Jay Famiglietti, director of science for the Arizona Water Innovation Initiative at Arizona State University, and his colleagues turned to data from NASA's Gravity Recovery and Climate Experiment (GRACE) and GRACE Follow-On satellite missions. These satellites track changes in Earth's gravity field to measure shifts in the amount of water above and below the ground, and when combined with data on snowpack, surface water and soil moisture, this information can allow scientists to estimate how much groundwater has been depleted.

The researchers estimate that since 2003, pumping from wells has drained about 28 million acre feet (34 cubic kilometers) of groundwater from the Colorado River Basin. This is akin to the capacity of Lake Mead, the largest U.S. reservoir, which sits behind the Hoover Dam on the Colorado River. The study was published May 27 in the journal Geophysical Research Letters.

About three-quarters of the groundwater depletion is happening in the river's lower basin, largely in Arizona, where water is pumped from desert aquifers to irrigate farmland, according to the study. In these largely rural areas, farms aren't usually hooked up to municipal water systems, and instead rely on water pumped from wells on the property. Because the wells are private, there is often no municipal, county- or state-level measurement of how much water they are drawing up.

Famiglietti and his colleagues estimate that annual groundwater losses in the basin averaged more than 1.2 million acre-feet (1.5 cubic kilometers) and if the trend continues, it could lead to water shortages and limit food production.

"We're passing a critical point where it is getting more and more expensive to go deeper into the aquifer, and the water quality is dropping," Famiglietti said.

Dozens of wells have dried up in the area. Collapsing aquifers have caused land subsidence, and created fissures.

Bottom of form

Ryan Mitchell, chief hydrologist at the Arizona Department of Water Resources, who was not involved in the new study, told Live Science that he welcomes the paper's findings and is concerned about the levels of estimated groundwater depletion in some areas. However, he takes issue with a sentence in the paper that suggests that an Arizona Department of Water Resources simulation indicated "complete depletion by the end of the century." He said the simulations don't indicate complete depletion of groundwater at all, let alone by the end of the century.

The groundwater won't run out, he said, but neither GRACE satellite data nor measurements of water use will tell us exactly how much water is left in aquifers.

"It's almost like it's an unknowable number in the same way that if someone said how many grains of sand are on the beach, you could make some assumptions and make some guesses but you can never actually know the exact amount of sand grains," Mitchell said.

Bridget Scanlon, a research professor in the **Bureau of Economic Geology** at the University of Texas at Austin, and her team recently used GRACE data to assess the implications of drought in the Colorado River basin. They saw similar patterns, finding that there was a period of high groundwater use as irrigation expanded between the 1940s and 1970s. Then, the amount of groundwater recovered during a wet period in the early 1980s and 1990s.

But since then, the picture has differed depending on how areas are managed. In "active management areas," or areas where water use is monitored, the levels of groundwater have stayed roughly level. In these areas, groundwater is pumped, but based on how much is drawn up, management agencies can divert more water to the depleted area to filter back down to the aquifer.

In unmanaged areas, no agency tracks how much groundwater is pumped, so agencies don't know when to replenish the aquifers. High extraction in unmanaged areas is driving the overall draining of groundwater, Scanlon told Live Science.

"We can't manage what we don't measure," he said. "It shows that if you have rules in place and you keep a close eye on water use and you actively manage it, you can kind of keep it at a sustainable level."

One thing is for sure: Waiting for precipitation to end the drought and replenish aquifers won't be enough. Studies imply that the flow of the Colorado River is expected to continue to decline thanks to climate-linked reductions in snowfall and rainfall — and that means there will be less surface water to use, less water to recharge aquifers and more reason to extract water from underground.

A shift away from water-intensive crops like alfalfa could help reduce the depletion of groundwater in the Colorado River basin. (Image credit: Morey Milbradt/Getty Images)

Drilling deeper wells is one solution, but there are problems with that, Famiglietti said. At some point, it will cost millions of dollars for a deep-enough well that will have high energy costs to pump water, he said, and that water is likely to require treatment.

"As you go deeper into the groundwater, that water has been sitting around in contact with soil and rocks for a long time, so it's dissolving solids and salts," Famiglietti said. This can lead to water that is salty, poor-tasting or that contains high levels of arsenic. "And because these are often refilled by agricultural water, they [are] collecting higher concentrations of pesticides and fertilizer," Famiglietti said.

Another option is to reduce water use, by, for example, changing what is farmed, to shift fromwater-intensive crops like alfalfa, Famiglietti said. "It can't be business as usual," he said. "We have to think about what our priorities are for water use."

"I'm as concerned about tomorrow as I am about 100 years from now," he said. “It's very clear that we need more groundwater management in the lower basin, which is mostly in Arizona. Only 18% by area is managed, and there's an awful lot of depletion happening outside of those areas."

Every expert Live Science talked with suggested that extending the area covered by active water management areas would help — first, by keeping tabs on what is being used where, and then trying to replace what is used.

As part of such schemes, water could be brought in from elsewhere, Scanlon said. For example, this already happens when San Antonio buys water and pipes it from East Texas more than 150 miles (240 kilometers) away.

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"Groundwater is a finite resource," Mitchell said. "You need to be able to let it recharge naturally or be able to replenish what you use. He said Scanlon's research shows that "we're doing OK in the active management areas, and we're not doing so hot in the areas where we don't have some kind of framework in place."

A legislative bill to extend the areas that are actively managed has been proposed in Arizona, but similar ones have stalled after facing opposition. Those opposed say restricting water doesn't protect existing agricultural use of groundwater and will stifle economic growth. Some also object to water use being decided at the state level when they would prefer smaller water districts with locally elected directors.

"We're not trying to spy on anyone; we just want to know what the water uses are," Mitchell said. "But it's hard because trust in governments is at an all-time low. We are trying to put things in place to help the mom-and-pop domestic wells — those folks who can't afford to drill 2,000-foot [600 meters] wells because it's just too deep and too expensive. We want to try to help them protect their water resources."

the colorado river basin from dead horse point: The Colorado River basin provides water to approximately 40 million people. (George Rose/Getty Images)

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