‘A hot drought’: Warming is driving much of the Colorado River’s decline, scientists say

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Since 2000, the amount of water flowing in the Colorado River has dropped 19 percent below the average of the past century, a decline that has left the Southwest on the brink of a water shortage.

Now, new research indicates that a large portion of that decline isn’t due to less rain and snow falling from the sky, but to warmer temperatures brought on by climate change.

Scientists from the University of California-Los Angeles and Colorado State University found that about half the trend of decreasing runoff from 2000-2014 in the Upper Colorado River Basin was the result of unprecedented warming across the region.

“A good chunk of the decline we’re seeing right now is temperature-related. And as the Earth continues to warm, we’re going to see less flow in the river,” said Brad Udall, a water and climate scientist at Colorado State University who co-authored the research. “We need to prepare for a river that has significantly less water in it.”

Udall, together with UCLA researchers Mu Xiao and Dennis Lettenmaier, used a hydrologic model to examine the streamflow in the Upper Colorado River Basin from 1916 through 2014. They found the flow declined by 16.5 percent over the past century.

They calculated that 53 percent of the trend was linked to warming, which has shrunk the average snowpack in the mountains, boosted the uptake of water by plants and increased the amount of water that evaporates off the

landscape.

“We separated the effect of different factors and determined the influences,” said Xiao, the study’s lead author and a doctoral student in UCLA’s Department of Geography. “Aside from warming temperature, the precipitation also contributed to the drought. This was not obvious to us as the precipitation in the Upper Basin doesn’t show a significantly decreasing trend.”

The researchers attributed the remaining 47 percent of the decrease in the river’s flow to shifts in precipitation patterns, with less rain and snow falling in four areas of Colorado that tend to be especially productive in feeding tributaries in the Rocky Mountains.

“The precipitation is falling in different places, places that aren’t nearly as effective in generating runoff,” Udall said. “It’s the heat and it’s also this changing pattern in precipitation from areas that are really productive in generating runoff, like the state of Colorado, to areas that are much less effective, like the deserts of Utah.”

Comparing two droughts

Udall and some other researchers have taken to calling the unrelenting dry spell the Millennium Drought.

The river’s reservoirs have fallen dramatically since 2000. Lake Powell is now 47 percent full, and Lake Mead is just 38 percent full.

The scientistscompared data for the Millennium Drought from 2000 to 2014 with a drought from 1953 to 1968. That earlier drought similarly shrank the flow of the river, but they found it was driven by a decrease in precipitation across the river basin, not by warming.

And when the researchers removed the influence of higher temperatures in their modeling and looked at precipitation alone, they saw that the 1953-68

drought became worse than the Millennium Drought.

“In the 1950s, there’s no warming signal there. It’s about the same as the long-term average, and so the precipitation decline fully explains that 1950s drought,” Udall said. “But to get into the 2000s drought, to explain it, you can’t just use precipitation. It’s a hot drought.”

The study, which was published Aug. 30 in the journal Water Resources Research, is part of growing body of scientific research examining how global warming is affecting the Colorado River and how rising temperatures are likely to affect water supplies in the future.

In another study last year, Udall and climate scientist Jonathan Overpeck used climate models to estimate a business-as-usual scenario of greenhouse gas emissions. They projected that without changes in precipitation, warming will likely cause the Colorado River’s flow to decrease by 35 percent or more this century.

The Colorado River and its tributaries provide water for about 40 million people and more than 5 million acres of farmland from Wyoming to Southern California.

The legal framework that divides the Colorado River among seven states and Mexico was established during much wetter times nearly a century ago, starting with the 1922 Colorado River Compact. That and subsequent agreements have allocated far more water than what flows in the river in an average year, leading to chronic overuse.

The treaties that originally divided the river allocated 7.5 million acre-feet of water per year for the four Upper Basin states; 7.5 million acre-feet for the Lower Basin states of Nevada, Arizona and California; and 1.5 million acre-feet for Mexico.

The river’s flow in recent years has been far less than the water doled out

under those agreements. Since 2000, the river's average flow has been less than 12.4 million acre-feet per year.

"It's quite possible that we could see 12 million acre-feet or even less going out into the future," Udall said.

Officials: Drought-contingency plan will be ready for Legislature's next session

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The river is managed under a system that delineates between the Upper Basin and the Lower Basin, with the dividing line running through Lees Ferry in northern Arizona, just downstream from Glen Canyon Dam and Lake Powell.

Across the Upper Basin, which produces about 90 percent of the runoff into the river, the scientists said the trend in average annual temperatures from 1916 to 2014 was an increase of 1.8 degrees Celsius, or 3.2 degrees Fahrenheit.

"The entire West has become substantially warmer over the last 50 years or so. There's no reason to think that that trend is going to reverse itself anytime soon given the continuing increase in greenhouse gas emissions. So, it seems pretty clear that that is going to be felt in the streamflows," said Lettenmaier, a UCLA professor who focuses on hydrologic prediction and water-climate interactions.

"If I was a water manager, that would be my concern," he said, "and I know that is the concern of the Bureau of Reclamation in particular."

Water crisis spurs talks

With the levels of Lake Mead near historic lows, Reclamation Commissioner Brenda Burman and other federal officials have been urging leaders of water agencies in Arizona, California and Nevada move ahead with negotiations on

a proposed drought-contingency plan under which each state would take less water from the reservoir to keep it from falling to even lower levels.

Under the current rules, if Lake Mead's water level reaches elevation 1,075 feet above sea level at the end of any year, the federal government will declare a shortage and supplies to Arizona and Nevada will be cut back. Federal officials have said the region will narrowly escape a shortage in 2019 but that a shortage may be declared in 2020.

To work toward a plan in Arizona, state Department of Water Resources Director Tom Buschatzke and Central Arizona Project General Manager Ted Cooke have been leading biweekly meetings since mid-July with a committee of stakeholders. In a joint statement this week, Buschatzke and Cooke said the goal is to have a plan in place before the end of the year representing "broad-based agreement" between parties including water districts, cities, farmers and tribes.

They said the plan, once finalized, won't prevent Lake Mead from falling into a shortage but will "keep us and the Colorado River system from being in an even worse place."

At water-starved Lake Mead and Lake Powell, 'the crisis is already real,' scientists say

'We really need to open our eyes'

Connie Woodhouse, a professor at the University of Arizona who has studied the effects of warming on the Colorado River but wasn't involved in the latest research, said the findings are interesting and informative. She said the analysis of variations in different sub-basins is new and important.

"The fact that the sub-basins have different contributions to total (Upper Colorado River Basin) flow, and that some basins have particularly large contributions, has been known, but this level of analysis hasn't been done

before," Woodhouse said in email.

She said the results underscore how critical some headwaters areas in Colorado are for the river's flow — including watersheds where runoff feeds into tributaries such as the San Juan, Gunnison and Yampa rivers — and how sensitive the flow is to conditions in those areas.

She said the new information "gives us a better understanding of what seasons and regions are the ones that might be important to keep an eye on," and might be useful for anticipating runoff in the future.

As for the finding that about half the decrease in river flow since 2000 was linked to warming, Udall said that he was initially shocked by the result but that he sees the numbers as plausible — and scary.

"The likely explanation for why they're so high is that we now have a bunch of self-reinforcing feedbacks, a self-reinforcing cycle here, that promotes dryness," Udall said. "We really need to open our eyes to the possibility for very large flow declines and how we would best manage our way through it."

To deal with the situation, Udall said, it will be important for officials to allow as much flexibility as possible in how the river system is operated, and to optimize how water is used.

With hard choices ahead, he said, it may be that what emerges looks a lot different than how the river was managed in the 20th century.

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