On the Water-Starved Colorado River, Drought Is the New Normal

With the Southwest locked in a 19-year drought and climate change making the region increasingly drier, water managers and users along the Colorado River are facing a troubling question: Are we in a new, more arid era when there will never be enough water? Second in a series.

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After two decades of drought, Lake Mead in Nevada is just 40 percent full.

Ted Wood

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In the basement of the University of Arizona's Laboratory of Tree-Ring Research, the fragrant smell of pine hangs in the air as researchers comb through the stacks of tree slabs to find a round, 2-inch-thick piece of Douglas fir.

They point out an anomaly in the slab — an unusually wide set of rings that represent the years 1905 to 1922. Those rings mean it was a pluvial period — precipitation was well above average — and so the trees grew far more than other years.

"In 1905, the gates opened and it was very wet and stayed very wet until the 1920s," said David Meko, a hydrologist at the lab who studies past climate and stream flow based on tree rings. "It guided their planning and how much water they thought was available."

The planning was that of the states that share the water of the Colorado River. Worried that a burgeoning California would take most of the water before it was fairly divvied up, representatives from the other Colorado River Basin states, presided over by U.S. Secretary of Commerce Herbert Hoover, came together in 1922 to develop an equitable apportionment. They looked at flow measurements and figured that the river contained an average of 15 million acre-feet. They divided the Colorado River states into two divisions – the upper basin and the lower basin, with the dividing line in northern Arizona near the Utah border. The upper basin states — Utah, Wyoming, Colorado, and New Mexico — agreed not to take more than a total of 7.5 million acre-feet and to allow the other half to flow south to the lower basin. The agreement they signed was called the 1922 Colorado River Compact, also known as the Law of the River.

Scientists at the University of Arizona are using tree rings to study centuries of drought conditions in the Colorado River Basin.

The 1922 compact, though, is based on a premise that the tree rings in the University of Arizona lab now show is false. The river's long-term average flow is about 12 to 15 million acre-feet, in a good year. Meanwhile, the lower basin states — Arizona, California, and Nevada — use 7.5 million acre-feet, and in 1922 no one factored in evaporative losses from the desert sun at the yet-unbuilt Lake Mead reservoir, which amount to another 1.2 million acre-feet, or the water taken up by plants. Nor did anyone factor in a subsequent 1944 treaty that requires the United States to provide 1.5 million acre-feet to Mexico. A conservative estimate on how much Colorado River water is actually used is 20 million acre-feet.

This over-appropriation is problem enough, but in recent years the river's flow has been dwindling. The region is locked in a 19-year-long drought, the

most severe in 1,250 years. And it may continue much longer. The tree ring data shows that there have been numerous multi-decadal or mega-droughts in the basin in the last 1,000 years. The prospect that drought could be the new normal for the region is creating a good deal of anxiety along the Colorado.

"Many water managers like me are struggling at not panicking," said Mark Harris, general manager of the Grand Valley Water User's Association in Grand Junction, Colorado. In his farm cap and jeans, Harris is a no-nonsense type, not given to hyperbole. This year, though, some "junior" water users on the Yampa River, a tributary to the Colorado, were told they would not get their water because others had priority, the first time that has ever happened, and late-season water flows near Grand Junction were near crisis levels. "The crunch is here," Harris said. "It's here, and it will stay here. We will never be out of the woods, we are in the woods forever."

> *Another low-snow winter would trigger the first emergency declaration in the basin, forcing states to deal with water cutbacks.*

Never has the question of "what will the winter be like?" loomed larger than it does this year in the Colorado River Basin. If it is anything like last year (when about two-thirds of the usual snow fell) and many other low snow years since 2000, it will trigger the first emergency declaration in the basin, which could force states to deal with cutbacks in the water they are appropriated. And even if it is a big snow year, it will likely only delay what now seems inevitable.

The last time Lake Mead was full was 1983. Since then it has slowly declined. It is now 40 percent full: 1,082 feet above sea level. It may never be full again, experts say. If it drops 7 feet, to 1,075 feet, it will trigger the first Tier 1 water cutbacks. A flyover reveals a giant white ring all the way around the lake's

112-mile-long perimeter, dramatically showing how far water levels have dropped.

Mark Harris, a water manager in Grand Junction, Colorado.

There are three levels of cutbacks. When Lake Mead falls to 1,050 feet, a Tier 2 crisis occurs, and Tier 3 at 1,025. At each level, states in the lower basin have to give up more of their water. Lake Mead would have already hit 1,075 feet and a First Tier declaration if it weren't for the fact that farmers, ranchers, and many others have been working to avoid an emergency by keeping more water in the river through conservation efforts. For example, in 2017, state, federal, municipal, and private entities funded the purchase of 40,000 acre-feet from the Gila River Indian Community to be left in Lake Mead in perpetuity as part of a system conservation agreement.

Last August, the U.S. Bureau of Reclamation issued a report on the water future of the region. The agency's predictions were sobering. By May of this year, the bureau forecast the level will dip just below 1,075 feet, and at the beginning of 2020, the level is expected to drop to 1,070. By the summer of 2020, the prediction is 1,050 feet, almost Tier 2. If these predictions come true, users will have to begin giving up their water allotments, starting with the most junior.

If water levels continue to drop, sinking below 1,050 feet, Hoover Dam — which impounds Lake Mead and provides power to millions of people in Southern California, Nevada, and Arizona — will stop generating electricity,

as water levels will be too low to flow through it. And should Lake Mead keep dropping all the way to 895 feet, it will fall below the level at which water can be piped out — the dreaded "dead pool." Moreover, because Lake Mead is funnel-shaped, the lower it gets the faster it drops. At some point there is the likelihood that the lower basin will force the upper basin to send water to meet its obligations — a compact call — something that's never happened before.

> *A few wet years in a long dry spell would be critical these days to keep the Colorado from completely drying up.*

All of this is uncharted crisis terrain. "If the drought is multi-decadal the system will fail," said Jack Schmidt, a professor of watershed science at Utah State University. "But nobody knows what failure means."

Arizona officials have a sense of it and are coming to grips with the reality. They are the most junior users in the Lower Basin and a Tier 1 shortage would mean Arizona would have to start cutting allocations to users. "If the current climate trend continues," said Kathryn Sorensen, director of the Phoenix Water Services Department, "you could have 'dead pool' in four years. That's worst case." Should that happen, the whole region, she says, would be thrown into crisis.

If these were normal times, past droughts might give us a sense of what might be in store. The climate information stored in tree rings show that the longest drought in this region occurred in medieval times and lasted for 62 years — with no very wet years in between the dry ones. A few very wet years in a long dry spell would be critical on the Colorado these days to keep it from completely drying up.

But it may be even worse than that. This drought is unusually hot.

“Temperatures keep going up,” said Meko, of the University of Arizona tree ring lab. “We keep breaking records year after year. It’s additional stress on the water system.” Meanwhile, the two driest years all the way back to the 1200s occurred in 1996 and 2002. “It’s a little worrisome to see the most extreme years right near the present,” he said.

Water levels on the Yampa River near Steamboat Springs, Colorado dropped so far in 2018 that the river was closed to recreation.

“Droughts impacted by warmer temperatures will be more severe,” says Connie Woodhouse, who also studies climate at the tree ring lab. “A lack of precipitation is one thing. But when a drought happens and temperatures are warmer, the precipitation deficits are exacerbated. You have more evaporation, more ground heating, and it impacts the snowpack.”

From 2000 to 2014, flows in the river were 19 percent below the averages in the previous years, and a third of that loss was caused by high temperatures, according to researchers Jonathan Overpeck of the University of Michigan and and Brad Udall at the Colorado Water Insitute at Colorado State University, in an often-cited paper about the unprecedented nature of this

drought and what it means for the future.

The biggest impact of high temperatures is something called runoff efficiency — the amount of stream flow that results from precipitation. Right now about 15 percent of the water in the snow in the watershed makes it into the river. The other 85 percent soaks into the ground, evaporates, or is taken up by plants. As it gets warmer, runoff efficiency is decreasing. Shorter winters mean the ground has less snow cover and is darker, so it warms up more and sooner, which means snow melts faster and more water evaporates and is taken up by plants in a longer growing season. The Colorado River Research Group, 10 veteran academics who study the Colorado, call this most alarming change to the physical environment.

> *The alarm is palpable among water managers throughout the Southwest. They see the writing on the wall.*

Warmer temperatures also mean that of the precipation that does come, more of it will fall as rain instead of snow. The Colorado's engineering infrastructure was built around the natural long-term storage that snowpack provides, but rain pulses quickly through the system.

Meanwhile, the rapid development of everything from housing developments to solar installations in the Southwest has created more dust particles which go airborne and settle on to the snow fields of the Rockies, five to seven times as much dust as was seen a century ago. The darker snow melts sooner and faster, a phenomenon that costs the river about 5 percent of its flow. And as the drought continues, there's more dust from more dry ground and that creates more dust.

As the flow of the Colorado diminishes, more water users will be forced to turn to groundwater pumping.The news on that front, though, is also

problematic. In a 2014 paper, researchers at the Global Institute for Water Security, which uses a satellite to measure large-scale changes in groundwater by measuring changes in gravitational pull, found that from 2004 to 2013, the loss of groundwater from pumping was 6.5 times greater than the total loss of water from Lake Powell and Lake Mead. “Everybody knows that groundwater will become progressively more important,” said Jay Famiglietti, the institute’s director. “The problem is groundwater is rapidly disappearing so we shouldn’t depend on it being there.”

However the biggest cloud looming over the Colorado River Basin is whether the region is entering a completely new era, a permanent change as opposed to a temporary one, caused by a planet being rapidly warmed by human activity. “Is this a drought or is this aridification of the Southwest and Colorado River Basin?” asked the University of Michigan’s Overpeck, who has long studied the Colorado.

Like Overpeck, many experts believe the drying up of the Colorado is being driven by a changing climate. “It’s going to get drier and drier,” he said. “It could mean a hell of a lot less water in the river. We’ve seen declines of 20 percent, but it could get up to 50 percent or worse later in this century.”

The Green Mountain Reservoir in Summit County, Colorado reached critically low levels in 2018.

If climate change is locked in, he said, what is going on now is not a new normal, but a stop along the way to a yet-drier new normal somewhere in the distant future. “In that case, every year will be a new reality,” he said. “The

aridification of the Southwest will continue as long as we put greenhouse gases into the atmosphere. We need to stop burning fossil fuels and that will help stop the decline in the river flow.

“And even if we did that, there’s warming baked in,” he said. “It would continue for another decade and then stabilize. Then we will get the new normal. And it will be at that level of warmth for centuries.”

That’s why the alarm is palpable among water managers in the Southwest. They see the writing on the wall, and there are few skeptics about climate change among them. The plight of Cape Town, South Africa, which came to the brink of a water system crash last year, is on many people’s minds along the Colorado River.

This era of drying is especially serious because so much — some 40 million people and an economy that includes the world’s fifth largest, in California — is riding on the flow of the Colorado. The specter of a region facing an existential crisis because of a warming climate becomes more real every day. “If you can see it, you should plan for it,” Phoenix’s Sorensen said. “And I can see it.”

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