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Study finds surprising source of Colorado River water supply

More than half of the rivers in the Upper Colorado Basin originate as groundwater, USGS says.

Sarah Tory | June 20, 2016 | *Web Exclusive*

Every spring, snow begins to melt throughout the Rocky Mountains, flowing down from high peaks and into the streams and rivers that form the mighty Colorado River Basin, sustaining entire cities and ecosystems from Wyoming to Arizona. But as spring becomes summer, the melting snow slows to a trickle and, as summer turns to fall, all but stops.

Scientists have known for a long time that flow in rivers is sustained by contributions from both snowmelt runoff and groundwater. The groundwater is composed of rivulets of water hidden below ground —some thousands of years old — that are particularly important for sustaining a river's flow after the spring snowmelt has subsided. Less clear, however, was exactly how much of the flow in rivers came from groundwater, a critical source of much of the West's water supply. Now, a new study, (http://onlinelibrary.wiley.com/doi/10.1002/2015WR017963/abstract) released last month by the U.S. Geological Survey (USGS), helps quantify just how much: more than half the flow of rivers in the upper part of the Colorado River Basin is sustained by groundwater. That finding, say experts, highlights the need to better protect a resource threatened by overuse and climate change.

"Because we now have numbers on this connection, we have a better understanding of the importance of groundwater as a contributor to our surface water supply, and anything impacting the groundwater system will also impact flow in rivers." says Matthew Miller, a USGS scientist and the lead author of the study.

An aerial shot of Utah's Uinta Mountains shows how the winter snow lingering on high peaks feeds the rivers flowing through the valleys below. Those rivers are also fed by groundwater, which accounts for over half the streamflow in the Upper Colorado River Basin.

NASA/Flickr

To determine how much of the flow in rivers came from groundwater, scientists examined streamflow data at 146 sites in Colorado, Utah, Wyoming, New Mexico, and Arizona, measuring the electrical conductivity of the water. Low conductivity meant the water had not had time to pick up ions from the ground, indicating it came from recent snowmelt. Meanwhile, higher conductivity signified the water had picked up ions as it trickled through soil and rocks below ground. Researchers then used the information to determine the percentage of water originating from snowmelt runoff and the percentage originating from groundwater and created a model that predicts where streamflow originates in the Upper Colorado River basin. On average, Miller and his team found that 56 percent of that flow comes from groundwater.

Though water managers recognized the link between groundwater and surface water back in 1877, for the better part of the last century, state laws allocating water to various users through a system of water rights dealt only with surface water. But when heavy pumping systems were developed after WWII, groundwater levels throughout the West plummeted.

In some places, over-pumping has caused the water table to drop hundreds of feet, creating giant cracks in the land as it sinks and drying up streams. In 2015, a team of NASA scientists determined that some 13 trillion gallons of groundwater had been lost from the Colorado River Basin (http://www.nasa.gov/jpl/grace/study-third-of-big-

groundwater-basins-in-distress) since the NASA satellites began collecting data in late 2004 — equivalent to roughly one and a half times the total capacity of Lake Mead and as much water as the state of Arizona uses in six years.

In the past several decades, Western states have passed laws to better regulate groundwater and curb over-pumping. California became the last to do so with the 2014 Sustainable Groundwater Management Act (https://www.hcn.org/issues/46.19/californias-sweeping-new-groundwater-regulations). Still, when it comes to incorporating groundwater into states' byzantine water laws, big challenges remain, says Malcolm Wilson, the head of the Water Resources Group for the Bureau of Reclamation's Upper Colorado Region. How much, for instance, does pumping groundwater affect a user with rights to a nearby river?

The new study, says Wilson, offers a reminder both for the Bureau of Reclamation and for states that managing surface water and groundwater as two interconnected parts of a system is essential, particularly as the climate changes. Thanks to warmer temperatures, in the future, more streamflow in the West will likely come from rainfall instead of from snowmelt. Since rain tends to run quickly off the surface more quickly than melting snow, that means less water will be percolating into the ground to replenish the aquifers that sustain rivers late into the dry months of the year. And the shifting climate also promises to increase events like major forest fires that can turn the soil hydrophobic and prevent water from seeping into the ground.

For Wilson, the study's finding reinforces the idea that we need to take a more holistic approach to resource management. Sustaining the West's groundwater, means not only allocating supplies properly, he says, but protecting the watersheds that produce groundwater.

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