Western agricultural communities need water conservation strategies to adapt to future shortages

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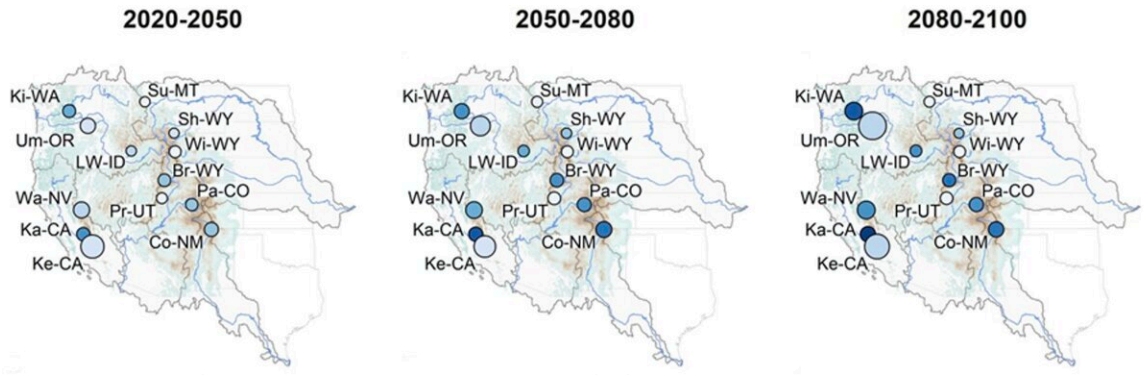

Graphic displaying vulnerability to future changes in snowpack depth and snowmelt timing for each of 13 agricultural communities examined in the study. Darker circles indicate higher vulnerability, while larger circles indicate greater declines in snow. Ki-WA refers to Kittitas in Washington, Um-OR to Umatilla in Oregon, LW-ID to Little Wood in Idaho, Wa-NV to Walker in Nevada, Ka-CA to Kaweah in California, Ke-CA to Kern in California, Co-NM to Costilla in New Mexico, Pa-CO to Paonia in Colorado, Pr-UT to Price in Utah, Br-WY to Bridger in Wyoming, Wi-WY to Wind in Wyoming, Sh-WY to Shohone in Wyoming, and Su-MT to Sun in Montana. Credit: *Earth's Future* (2024). DOI: 10.1029/2024EF004577

The Western U.S. is heavily reliant on mountain snowpacks and their gradual melt for water storage and supply, and climate change is

expected to upend the reliability of this natural process. Many agricultural communities in this part of the country are examining ways to adapt to a future with less water, and new research shows that a focus on supplementing water supply by expanding reservoir capacity won't be enough to avert future water crises.

Led by scientists at the Desert Research Institute (DRI), the study is published in *Earth's Future*. By identifying agricultural communities considered at-risk from looming changes in snowfall and snowmelt patterns, the researchers found that water conservation measures like changes in crop type and extent were more stable adaptive strategies than changes to reservoir capacity.

By the end of the century, many areas could have less than half the water they have historically relied on to refill their reservoirs, but changing the types and extent of their crops could help by restoring an average of about 20% of reservoir capacity.

The research team included scientists with the diversity of expertise needed to capture the complexities of water systems while balancing concerns for locally focused adaptation. Beatrice Gordon, lead author of the study and sociohydrologist and postdoctoral researcher at DRI, says the research is needed to inform water management at the local level, where most decisions are made. Gordon herself grew up on a ranch in Wyoming, where she learned firsthand the challenges that face water-insecure communities—an experience that helped lead to her research focus on agriculture and water in the Western U.S.

"A lot of decisions about water are made at the local level, but there's this big disconnect between that reality and the macro-scale level of most research on this topic," Gordon says. "We really wanted to understand what the future could look like at the scale that most communities manage their water resources. What are the levers that folks in these

communities have when it comes to a future with less snow?"

Mountain snowpacks have historically acted as nature's water towers across much of the region by storing winter precipitation and releasing it downstream during drier months. Water management systems were designed with this process in mind, but climate change is altering snowmelt patterns in ways that will make it difficult for existing systems to meet the needs of downstream water users. As the world's largest user of freshwater, irrigated agriculture is at particularly high risk from these changes.

Strategies for addressing water shortages that focus on augmenting supply include expanding reservoirs and replenishing groundwater with surplus water, but these approaches become less effective as the timing and availability of precipitation become more unpredictable. In contrast, water conservation strategies such as reducing total crop acreage, periodic crop fallowing, and shifting toward higher value crops can help manage these risks.

To find out how risk management practices could work on a community-level scale, the researchers built a comprehensive risk assessment framework based on guidance from the Intergovernmental Panel on Climate Change (IPCC). For each of 13 communities, they gathered historical data on irrigation water supply, agricultural water demand, snow storage and snowmelt patterns, and more. They then used projections for the future climate through 2100 to understand how supply and demand dynamics may change in the near future.

"We gathered all these data together and looked at the picture of risk, and then also the ways that adaptation could reduce risk," Gordon says. "Our goal was really to make this as relevant as possible for the people who are actually making decisions on the ground."

"Dr. Gordon assembled a very impressive and unprecedented dataset for this paper linking agricultural water supply and demand across the Western United States," says study co-author Gabrielle Boisramé, assistant research professor at DRI.

The Western agricultural communities the researchers selected are located in headwaters areas, making them both subject to significant changes in future climate and sentinels for the future of the West. Several of them are located in the Upper Colorado River Basin, which feeds into the main stem of the river—a water system that supports more than 40 million people.

"A lot of these areas are providing downstream water to other communities," Gordon says. "So, if they have an increase in demand and a decrease in supply, it impacts not only that area, but also the areas that rely on that water downstream."

The study results show that there will be a stark decline in how much many of these communities will be able to refill their reservoirs in just a few decades, with some seeing declines to about half of the water they were historically able to store. A drop that significant is particularly acute in many of the smaller reservoirs that can only hold about a year's worth of water.

"It shows how important it is to dedicate effort—now, not in 20 to 50 years—to figuring out how we, as scientists, can provide better information about water conservation," Gordon says. "And I think that there's an opportunity to really think about how we support communities in these efforts, especially small communities in headwaters regions that might be fully dependent on agriculture."

"Our results indicate the importance of water conservation as an adaptive strategy in a warmer future with less snow," she continues. "And that's

broadly true across a lot of different places in the Western U.S."

More information: Beatrice L. Gordon et al, The Essential Role of Local Context in Shaping Risk and Risk Reduction Strategies for Snowmelt-Dependent Irrigated Agriculture, *Earth's Future* (2024). DOI: 10.1029/2024EF004577

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