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New Tools Indicate How Thinning and Fire Affect Forest Water Use and Boost Runoff

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Forest-management actions such as mechanical thinning and prescribed burns do not just reduce the risk of severe wildfire and promote forest health — these practices can also contribute to significant increases in downstream water availability.

New research from UC Merced's Sierra Nevada Research Institute (SNRI) provides the tools to help estimate and verify those changes.

The study titled "Evapotranspiration Mapping for Forest Management in California's Sierra Nevada" was recently published in the journal Frontiers in Forests and Global Change. The researchers aim was to assess change in evapotranspiration, or water mainly used by vegetation, after wildfires. Looking specifically at the Yuba and American watersheds between 1985 and 2015, they used a combination of multi-year measurements of evapotranspiration, satellite imagery and precipitation data.

Notably, the study also found only limited evidence of moisture stress on the trees within the northern-Sierra watersheds studied, even during dry years, thanks to minimal reliance on subsurface water stores. Treatments that reduce forest density, then, also have the potential to increase subsurface water storage in dry years with less demand on water for evapotranspiration.

The research team, which included Professor Roger Bales and SNRI affiliates James Roche, Qin Ma and Joseph Rungee, found that evapotranspiration in these forested areas decreased for at least five years after wildfire events during the study period. In some cases, reductions in evapotranspiration lasted more than 20 years.

Less water transferred to the atmosphere from vegetation, soil, and other land surfaces through evapotranspiration means more water is available to flow downstream as runoff and be used by communities.

"Understanding the effect of wildfire on evapotranspiration provides a guide for how other reductions in forest density will impact our watersheds," Bales said. "Our analysis shows that it's possible to achieve comparable effects on evapotranspiration through management practices such as mechanical thinning or prescribed fire, across much broader areas and without some of the negative consequences associated with large-scale wildfires."

Forest-management strategies could enhance runoff in the Yuba and American basins by 4 percent to 10 percent — or 160,000 to 400,000-acre feet per year — depending on the extent of the treatments applied, the study indicates. This amount of water would provide residential use for 2-4 million people for a year, significantly bolstering California's water supply. More than 60 percent of the state's water supply originates in the Sierra Nevada.

"This new approach of using remote sensing tools to evaluate the potential for water supply impacts from forest management, and then monitoring those impacts over time, is critical for our state agency and utility partners to better quantify the value of investing in forest restoration," said Phil Saksa, a UC Merced alumni and the chief scientist at Blue Forest Conservation, which provided support for this research through a USDA Small Business Innovation Research grant.

Other organizations funding the study include the National Science Foundation through the Southern Sierra Critical Zone Observatory; the Nature Conservancy; and the California Strategic Growth Council through the Innovation Center for Ecosystem Climate Solutions.

The team's method of using satellite remote sensing data calibrated by on-the-ground measurements will be a valuable way to plan for and verify the impacts of forest management strategies into the future, ultimately increasing water availability to downstream water users.

"Understanding the co-benefits of forest management for our watersheds, in addition to the fuels-reduction and forest-health goals, can be crucial for the implementation of future forest-restoration projects," said UC Irvine Professor Mike Goulden, principal investigator of the Innovation Center for Ecosystem Climate Solutions, a multi-institution research center. "The metrics provided by this study show us a credible, accessible way to value and monetize the water-related benefits of forest management."