California wildfires have become more severe, killing more trees, UC Irvine researchers find

More state forests are vulnerable to wildfire due to climate change.
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Two natural resource specialists walk through an area of Redwood Mountain Grove burned in the KNP Complex Fire in California’s Sierra Nevada Mountains to evaluate fire effects.

Picture Credit:
Daniel Jeffcoach / National Park Service

Irvine, Calif., Nov. 18, 2024 — The severity of California's wildfires has rapidly increased over the last several decades as a result of human-driven climate change, resulting in accelerated tree losses during more intense wildfires, an *Environmental Research Letters* study from University of California, Irvine and the University of Utah scientists reveals.

"As California's climate has become warmer and drier, the severity of the average wildfire increased by 30 percent between the 1980s and 2010s," said Jon Wang, a professor at the University of Utah and former postdoctoral researcher in the UC Irvine Department of Earth System Science.

This means that for every acre of forest scorched by fire, the damages to tree canopy are considerably higher than what they were several decades ago.

"When fire moves over a forest's floor, often the tree canopy will survive and, in some situations, thrive from fire effects on nutrient cycling," said study co-author James Randerson, professor in the UC Irvine Department of Earth System Science. "The new research suggests more fire is jumping into the tree crowns, causing more damage and tree mortality."

Randerson added that wildfires have moved into new areas with denser and more vulnerable forests. Those areas include northern mountain and coastal regions that may have been protected in the past by cooler summers and higher levels of surface moisture. The authors describe this shifting vulnerability of forests as an increase in forest exposure.

"There's a pretty shocking map of just how much these fires have expanded into northern California forests," Wang said. "There's just a lot more fire in these northern forests than there used to be."

The team wanted to find out how much of the rising tree cover loss in California is due to increases in total area burned, how much of the loss is due to increasing wildfire severity and how much is due to fire moving into new areas with denser forests. Previous research led by Wang revealed that total tree cover in California has decreased by 7 percent since 1985 from the combined effects of wildfire and drought-induced die-off.

“We found that on a relative scale tree cover losses were rising faster than the fire-burned areas were,” said Wang. “That was implying to us that it’s not just that fires are getting larger, they’re also burning more intensely, and they’re affecting the forests more severely on a per-unit burned area basis.”

Using a simple model, the authors found that this increased severity and vulnerability resulted in twice as much tree cover loss as would have occurred from increases in burned area alone.

Wang explained that before California wildfires started growing in severity and size, forests usually had time to regrow and reestablish whatever tree cover was lost. “But all the new recent fires are so big and so intense that our forests can’t keep up,” said Wang. “If fires were not changing, you’d expect our ecosystems to be in a steady state. One area that’s burned is counterbalanced by an area that’s recovering.”

One of the forests in California seen as emblematic of tree cover loss are the famous groves of giant sequoia redwoods in Sequoia and Kings Canyon National Parks. Those and similar forests are getting much hotter and drier as the climate continues to warm, which means they are often more vulnerable to extreme fire behavior when a fire does eventually strike.

To do the science, the team analyzed a long-term time series of satellite imagery from the U.S. government’s Landsat Program. These data, which are available starting in 1985, allowed the team to quantify the fire-driven tree cover loss over the last several decades.

“While past studies have measured fire severity, our study is unique in allowing for a quantitative breakdown of the importance of burned area, severity and forest exposure for the loss of California’s forests,” said Randerson.

Climate change is allowing severe fires to affect forests that once tolerated milder fires, and studies like this could help land managers and stakeholders better understand the ways in which forests are changing.

“Severely burned forests could be replaced by something more adapted to the hot, dry climates of Southern California,” said Wang. “Shrub and chapparal ecosystems might end up expanding further into areas where big trees and old forests used to thrive.”

Funding for the work came from California's Strategic Growth Council Climate Change Research Program, the University of California's National Laboratories Laboratory Fees grant program, the U.S. Dept. of Energy RUBISCO Science Focus Area, and NASA's Modeling, Analysis, and Prediction, Arctic and Boreal Vulnerability Experiment, and NASA's Land Cover Land Use Change programs.

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