Warming Climate Plays Large Role in Western U.S. Wildfires, Scripps-led Study Shows

Research published in Science shows rising temperature expected in the years ahead will exacerbate the number of large and costly fires

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A new study led by scientists at Scripps Institution of Oceanography at UCSD implicates rising seasonal temperatures and the earlier arrival of spring conditions in connection with a dramatic increase of large wildfires in the western United States.

In the most systematic analysis to date of recent changes in forest fire activity, Anthony Westerling, Hugo Hidalgo and Dan Cayan of Scripps Oceanography, along with Tom Swetnam of the University of Arizona, compiled a database of recent large western wildfires since 1970 and compared it with climate and land-surface data from the region. The results show that large wildfire activity increased "suddenly and dramatically" in the 1980s with longer wildfire seasons and an increased number and more potent wildfires.

The new findings, published in the July 6 issue of Science Express (the advance online version of the printed journal *Science*), point to climate change, not fire suppression policies and forest accumulation, as the primary driver of recent increases in large forest fires.

"The increase in large wildfires appears to be another part of a chain of reactions to climate warming," said Cayan, a coauthor of the paper and director of Scripps' Climate Research Division. "The recent ramp-up is likely, in part, caused by natural fluctuations, but evidence is mounting that anthropogenic effects have been contributing to warmer winters and springs in recent decades."

Western U.S. wildfires have garnered broad public and political attention in recent years due to the severity and expanse of the areas they have consumed, including hundreds of homes burned and devastating damage to natural resources. Fire-fighting expenditures for wildfires now regularly exceed one billion dollars per year.

The scientists compiled a comprehensive time series of 1,166 forest wildfires of at least 1,000 acres that had occurred between 1970 and 2003 from wildfire data covering western U.S. Forest Service and National Park Service lands. To investigate what role climate might play, the researchers compared the time series, the timing of snowmelt and spring and summer temperatures for the same 34 years.

For the timing of peak snowmelt in the mountains for each year, they used the streamflow gauge records from 240 stations throughout western North America. The team also used other climatic data such as moisture deficit, an indicator of dryness.

Firefighter in action Photo credit FEMA

The results point to a marked increase in large wildfires in western U.S. forests beginning around 1987, when the region shifted from predominantly infrequent large wildfires of short duration (average of one week) to more frequent and longer-burning wildfires (five weeks). The authors found a jump of four times the average number of wildfires beginning in the mid-1980s compared with the 1970s and early 1980s. The comparison showed that the total area burned was six and a half times greater. Also in the mid-1980s, the length of the yearly wildfire season (March through August) extended by 78 days, a 64 percent rise when comparing 1970-1986 with 1987-2003.

The researchers determined that year-to-year changes in wildfire frequency appear "to be strongly linked to annual spring and summer" temperatures with "many more wildfires burning in hotter years than in cooler years."

They established a strong association between early arrivals of the spring snowmelt in the mountainous regions and the incidence of large forest fires. An earlier snowmelt, they said, can lead to an earlier and longer dry season, which provides greater opportunities for large fires. Overall, 56 percent of the wildfires and 72 percent of the total area burned occurred in early snowmelt years. By contrast, years when snowmelt happened much later than average had only 11 percent of the wildfires and 4 percent of the total area burned.

"At higher elevations what really drives the fire season is the temperature. When you have a warm spring and early summer, you get earlier snowmelt," said Westerling. "With the snowmelt coming out a month earlier, areas then get drier earlier overall and there is a longer season in which a fire can be started-there's more opportunity for ignition."

The greatest wildfire increases occurred in the Northern Rockies, where forest ecosystems in middle elevations were found to be highly susceptible to temperature increases. Other significant wildfire increases were found in the Sierra Nevada, the southern Cascades and the Coast Ranges of northern California and southern Oregon.

"I see this as one of the first big indicators of climate change impacts in the continental United States," said research team member Thomas Swetnam, director of the Laboratory of Tree-Ring Research at The University of Arizona in Tucson. "We're showing warming and earlier springs tying in with large forest fire frequencies. Lots of people think climate change and the ecological responses are 50 to 100 years away. But it's not 50 to 100 years away-it's happening now in forest ecosystems through fire."

The authors state that climate model projections, driven by potential increases in atmospheric greenhouse gas concentrations, indicate that warmer springs and summers will likely continue and intensify in the coming decades, accentuating conditions favorable to large wildfires.

Westerling says that the paper's results indicate that measures to limit future climate change could help to curtail catastrophic increases in future summer wildfires. If climate warms markedly over today's levels, intensified fuels management and fire suppression are not likely to be effective in much of the western U.S., he said.

"The overall importance of climate in wildfire activity underscores the urgency of ecological restoration and fuels management to reduce wildfire hazards to human communities and to mitigate ecological impacts of climate change, especially in forests that have undergone substantial alterations due to past land uses," the authors note in the paper.

The authors conclude that the increased frequency of large and devastating wildfires may significantly change forest composition and reduce tree densities, transforming the western U.S. forests' role as a storage "sink" for sequestering some 20 to 40 percent of all U.S. carbon to a source for increasing carbon dioxide in the atmosphere.

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