Harnessing big data and machine learning to forecast wildfires in the western U.S.

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The 2016 Roaring Lion Fire in Montana. Credit: Mike Daniels

The area burned by wildfires each year across the Western United States has increased by more than 300 percent over the past three decades, and much of this increase is due to human-caused warming. Warmer air holds more moisture, and the thirsty air sucks this from plants, trees, and soil, leaving forest vegetation and ground debris drier and easier to ignite. Future climate change, accompanied by warming temperatures and increased aridity, is expected to continue this trend, and will likely exacerbate and intensify wildfires in areas where fuel is abundant.

Park Williams, a Lamont-Doherty Earth Observatory associate research professor and a 2016 Center for Climate and Life Fellow, studies climatology, drought, and wildfires. He has received a $641,000 grant from the Zegar Family Foundation that he'll use to advance understanding of the past and future behavior of wildfires. His goal is to create a tool to help scientists understand why wildfires in Western U.S. states have changed over the last century, ways they may evolve in the future, and how humans can most effectively respond to them.

Williams will compile observations of tens of thousands of fires over the last 30 to 40 years and where they burned across the Western U.S. He'll relate these to climate data sets of where people live, and what vegetation grows where. The end product will be a computer program that can project how these variables affect the probability of large fires and that will attempt to simulate how vegetation responds to fire.

"This is important because after a fire there's less vegetation than there was before," said Williams. "This means that the probability of a subsequent fire goes down for a while. And the fire probability won't be high again until vegetation is dense in that area again. Modeling that process is very difficult but it's very important because we would like to understand why things have gone the way they have in the past, and it's likely the changes in vegetation cover have been important."

Williams believes the U.S. has pursued an unsustainable fire management policy for the last 100 years, fighting fires whenever they occur as hard as possible. This has allowed vegetation to accumulate in many places where fires might have thinned it out, leaving a greater abundance of forest cover that can potentially burn. He feels this approach persists despite the acknowledgment that it's not working because we don't have a better strategy—yet.

"This tool will allow us to explore different futures, said Williams. "In one hypothetical future, we keep fighting fires just as hard as we have in the last century. In another hypothetical future, we don't fight fires at all. Ultimately we will probably choose something between those two extremes."

By providing various scenarios for different locations at a one hundred mile-spatial scale, the new tool could show why different policy strategies based on location might result in different outcomes, enabling leaders to make more informed, sustainable fire management decisions specifically tuned for local conditions.

Creating the tool is the next logical step in research Williams did as one of the first recipients of a fellowship from the Center for Climate and Life at Columbia University. That support allowed him to research the general correlation between forest fires and climate variability across the Western U.S. He found strong relationships between temperature and the amount of forest fire area throughout the entire region.

In academia, such creative inter-disciplinary scientific projects are often less likely to obtain traditional research funding.

"Wildfire is an integration of climate science, ecosystem science, social science, and political science," said Williams. "It is very difficult to get funded through standard government grants. The Center for Climate and Life is great because it really promotes multi-disciplinary science and funds work where the more breadth there is, the better."

He expects that his new tool will eventually be able to produce seasonal forecasts of wildfire probabilities. For example, "Our model could be used in late spring to estimate the probability of a large forest fire in the eastern Cascades of Washington in the upcoming summer," said Williams.

That information could be helpful to land managers and owners who are considering preventative maintenance measures such as prescribed burns or forest thinning. It could also increase public awareness of wildfire risk and prompt people to maintain their yards or plan how to evacuate in case of a fire. "The information could be useful for guiding decision making on many different scales from the individual family to the state government," said Williams.

Ultimately, he hopes the lessons learned from his research will help build regional fire models for other parts of the world. Williams envisions a day when there will be a "jigsaw puzzle" of regional fire models for various countries that provide a better sense of how wildfires will behave in the future.

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