Uncovering patterns in California's blazing wildfires

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The Apple Fire, seen here burning on 31 July north of Beaumont, Calif., was one of thousands of wildfires that burned across the state in 2020. Credit: Brody Hessin, CC BY 4.0

California's 2020 wildfire season was unprecedented, the latest tragedy in a decades-long trend of increasing fire. Six of the 20 largest fires in state history burned during the calendar year. In August, a 14,000-strike "lightning siege" sparked 900 fires, and by the end of the year, roughly 17,200 square kilometers had burned across the state.

In California and elsewhere, the environmental context, including topography and vegetation, combines with climate to dictate fire probabilities at any given location. Humans play a role too. Past research shows, for example, that population density and distance to the wildland-urban interface help explain fire frequency.

Chen et al. took a closer look at the variables affecting fires in California, focusing on the Sierra Nevada, the state's mountainous spine that runs more than 600 kilometers north to south. Using a fire database from state and federal natural resources agencies that spans more than 30 years, from 1984 to 2017, the researchers modeled fire probability in the Sierra Nevada.

The researchers developed a fire probability model with Maxent, a machine learning algorithm, across a 4-by-4-kilometer grid blanketing the mountain range. They evaluated three versions of the model: one considering only physical and climatic variables, one considering only anthropogenic factors like population density and human modification, and one integrating both natural and human variables.

By looking at each variable's relative contribution to model performance, the authors found that the annual mean vapor pressure deficit was the most significant predictor of fire occurrence. (Vapor pressure deficit is the difference between the air's water content and its saturation point.) This result supports the hypothesis that increasing aridity in the region, driven by human-caused climate change, will increase California's fire risk, the researchers noted.

Population density and fuel amount also play a large role in where fires erupt, according to the modeling. Less densely populated areas had a higher fire risk, as did more densely vegetated tracts. However, these trends did not hold across all elevations. For instance, population density affects low-elevation forests more than higher-elevation forests.

According to the authors, the results highlight factors shaping wildfires in California and provide region-specific guidance for forest management in the state, which could help limit risk in future years.

More information: Bin Chen et al. Climate, Fuel, and Land Use Shaped the Spatial Pattern of Wildfire in California's Sierra Nevada, *Journal of Geophysical Research: Biogeosciences* (2021). DOI: 10.1029/2020JG005786