CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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What's Exacerbating California Fires?

Baltar, M., J.E. Keely, and F.P. Schoenberg. 2014. County-level analysis of the impact of temperature and population increases on California wildfire data. Environmetrics 25: 397-405. DOI: 10.1002/env.2257

In recent decades fires in the western USA have become more frequent and burned more area. This study uses California to assess the relative importance of climate change and human population growth as two potential causes of increased fire activity. Climate change is causing increases in average monthly temperatures that may dry-out vegetation and make ignitions more likely, while increasing human populations may increase the number of human caused ignitions, which already make up 84% of California's fire ignitions. Specifically, these authors want to understand the "extent to which *changes* in *population* and *temperature*, within a given county, appear to influence burn area and number of wildfires."

Sorted by 58 California counties to better discern spatial heterogeneity, 17 years of CalFire wildfire data (January 1, 1990, to December 31, 2006), mean temperature data (www.almanac.com), and human population data (California Department of Finance) were compared via generalized linear models (GLMs). Nine of the counties were discarded from the analyses due to a lack of fire data or because records were maintained by other independent fire agencies. This left the study with 49 counties and 9996 county months for analysis.

Management Implications:

- For the period 1990-2006 increases in temperature had a much stronger effect on total area burned and number of fires in California counties than did increases in population.
- During this same time span the number of fires declined with population growth.
- The effects of temperature and population change show distinct differences in fire activity among seasons and geographic regions; temperature effects are strongest in the interior region while population effects are seen only in southern California for number of fires.
- These results should not be generalized too broadly based on the limited time span and data missing from non-CalFire jurisdictions.

Random effects Poisson regression models were used to model number of fires and area burned as response variables to increases in 1) temperature and 2) population. To avoid masking of seasonal temperature variation with annual means, the data were split into three fire seasons: summer, fall and winter. Data were also subdivided spatially into coastal, interior, and southern California. Results were based on fourteen fitted models using combinations of all of the data and subsets of the seasonal and spatial data.

When all counties are included, the models showed increasing fire numbers (146% ± 4.8%) and fire size (31% ± 1.3%) as temperature increased +4.31^{0}C (1 RMS (A standardized unit referring to the Root Mean Square of temperature increase used in these models). Population growth was much more weakly related, with a small increase in area burned (.09% ± 0.1%) and a decline in the number of fires (-0.15% ± 0.05%) for every 3,813 people added. One hypothesis for the decline in number of fires with increasing population is that as counties urbanize, there is less burnable vegetation and decreased potential for wildfire ignitions.

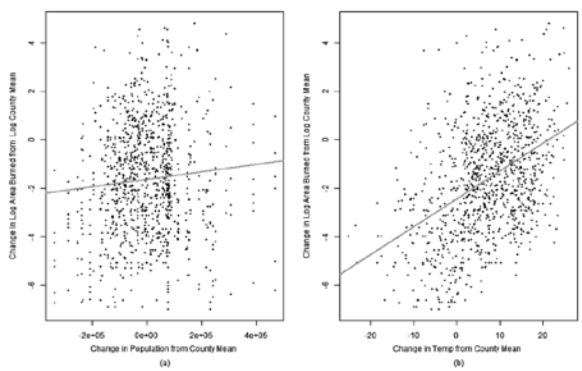

Figure 1. (a) Change in population from county-mean population versus change in log burn area minus log county-mean burn area; (b) Change in temperature from county-mean temperature versus change in log burn area minus log county-mean burn area. Least squares lines overlaid.

When fire season is considered, summer shows much less increase (37.6%) in burned area than similar temperature increases (1.52^{0}C, 1RMS) in winter (54.4%) and fall (89.2%). The same pattern holds for number of fires with the lowest number in summer (7.5%) and higher in fall (20%) and winter (23.9%). The authors note that fall has the highest variability in temperature of the three seasons (1 RMS is 2.82 ^{0}C). If the increase in temperature is set to 1 ^{0}C instead of 1 RMS, then winter would have a 44% increase in area burned while fall and summer would only increase about 25%.

The seasonal effect on fire activity related to population change follows the same general pattern as for the whole year. The increase in burned area is strongest in summer and the number of fires decreases most in winter.

When the data for temperature increase is considered across the three geographic regions (coastal, interior and southern California), temperature effects are significant for burn area and number of fires in all regions. The temperature effect is strongest in the interior region where predicted increases in the number of fires is about twice that of the coast and southern regions (111% vs 54% and 48% for 1 RMS). The effect on area burned is even stronger, with approximately four times as much area burned as coastal or southern California.

The regional effect of population increase is significant only in the southern California region and only for the number of fires, which marginally decline.

How well did the models fit the actual data? The model for number of fires across all county-years explained 40% of the observed variance. The model for total area burned is only 0.3% of the variance unless the outlier for the 2003 San Diego fires is removed; the variance explained in that case is 14%.

In conclusion, the authors caution against widespread generalization from these results due to the short time span (just 17 years) and missing data sets from non-CalFire jurisdictions. They note important covariates that may confound their results and others that might be further analyzed and they recommend that the result be further tested with additional data sets from other spatial-temporal regions.