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On the relative influence of local spatiotemporal variables on daily numbers of fires in Spain

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This paper discusses the analysis of historical daily fire occurrence data in Spain through neural networks for the characterization of spatiotemporal conditions that trigger the occurrence of multiple fires.

Abstract

Forest fires in Mediterranean countries are mainly caused by humans. Wildfires usually cluster in complex spatiotemporal patterns, depending on many geographic and temporal variables related to weather, topography, fuels and human presence and activity. Large differences in fire occurrence may take place within short distances and short spans of time, causing overload problems to fire suppression organizations (Genton et al. 2006) that are difficult to plan for.

The modeling of the daily number of fires was carried out as early as 1954 by Crosby in Clark National Forest, Missouri, USA, Later, Martell et al. (1987) also predicted the daily number of fires in Ontario, Canada, for large geographic prediction units (administrative districts), and Todd and Kourtz (1991) in Quebec, Canada, in 500 km2 cells. Other work followed, i.e. Chuvieco et al. (2009) modeled number of fires in 8-day periods from live fuel moisture content in grasses and shrubs in a Mediterranean area in Central Spain for 100 km-radius plots, and it is reviewed in this paper.

All previous work has focused on very specific factors, but no comprehensive assessment of the relationship between the main relevant fire environment variables and number of fires has ever been carried out with sufficient temporal and spatial resolution. With increased spatial resolution, fire observations become scarcer in the prediction units. With increased temporal resolution, the same can be argued for the prediction time span.

In our work we used 54,892 historical daily fire observations in Spain over a 4-year period of time, 2002-2005. A total of 58 independent variables were defined and compiled for all the 10 km x 10 km square units in the peninsular territory of Spain used by the Ministry of Environment for keeping official fire statistics. Variables included geographic risk factors such as forest land tenure or infrastructures, but also fuels, physiography, raw weather data, and 16 fire danger rating indices computed daily. Given this high spatial and temporal resolution, observations in the units were not abundant. Cases ranged from 1 to 4 fires in a single unit, any one day, for this study period.

Since high correlations between variables and observations could be reasonably expected, the models used were multilayered feed forward neural networks, more robust that statistical models that require normality assumptions and independency in the data to avoid multicollinearity.

Several classification networks were trained, tested and validated with independent data. This paper describes the model building procedures and presents the results of these analyses, discussing the impact of different geographic and temporal variables on the daily number of fires (1-4) in the prediction units of Spain through the sensitivity analysis of the inputs in the best net model.

Literature cited

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