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A spatial-temporal stratification of drivers of recent human-caused large fires in Spain

Marcos Rodrigues (1), Sergi Costafreda-Aumedes (2), Carles Comas (3), and Cristina Vega-García (4)

(1) University of Lleida, ETSEA, Agr.&Forest Eng., Lleida, Spain (rmarcos@eagrof.udl.cat), (2) University of Florence, Department of Agri-food Production and Environmental Sciences (Department of Agri-food Production and Environmental Sciences), (3) University of Lleida, Campus Cappons, Department of Mathematics, Lleida, Spain (carles.comas@matematica.udl.cat), (4) University of Lleida, ETSEA, Agr.&Forest Eng., Lleida, Spain (cvega@eagrof.udl.cat)

The area affected by wildfires is experiencing an overall decrease in the European Mediterranean region. However, there is no clear trend associated to the incidence of large fire events, which continue to pose an important threat, the assets-at-risk. For instance, 2015 and 2017 were years with intense fall-winter fire activity tied to an extended dry period after summer. In this sense, improving wildfire season definition or understanding the underlying spatial and temporal patterns of the drivers of wildfires are key factors towards a more efficient and science-based management.

In this work we present a conceptual framework to outline homogeneous spatial-temporal regions in terms of the influence of the main drivers of large fire activity: temperature, wind speed, slope, wildland-Urban-Interface and wildland-Agricultural-Interface. To do so, we combine Geographically Weighted Logit Regression (GWLR) models to parameterize the marginal influence of the drivers, with optimized hierarchical clustering to define uniform regions in terms of the underlying driving factors. These regions were subsequently explored regarding their monthly distribution of fire occurrence and the associated fuel models.

In particular, we analyzed large fires (>100 ha) in the period 2010-2015 in Spain. A binary GWLR model was fitted using ignition coordinates as presence locations. Absence locations were randomly extracted according to the observed daily distribution of fires in the study period. Each record was assigned to its corresponding date so that weather factors (temperature and wind speed) could be extracted accordingly. Additionally we retrieved site-specific information about the slope and the distance to urban settlements (WUI) and agricultural lands (WAI). The GWLR model allowed measuring the spatial distribution of the significance of the beta coefficients. We obtained a set of p-values for the beta coefficients at each location expressed as t-values. These values were submitted to hierarchical clustering, optimizing the number of clusters according to the silhouette criteria. The resulting clusters were temporally characterized according to the monthly distribution of the fire events within, and also in terms of the fuel model on which the fire ignited.

The method was applied to fires in mainland Spain, obtaining a GWLR explaining about 32% of the variance. We obtained a set of three clusters. Two of them covered the Northwest (Atlantic) region while the third extends along the whole Mediterranean coast and most of the hinterlands. The Mediterranean cluster gathers fires occurring mostly during early summer, starting in pastures with presence of scrub, sparse trees or dense shrublands. Fires within this cluster develop under high temperature and windy situations, preferably in areas closer to urban settlements. A second cluster extends over the Northwest end. It gathers most of the large fire activity, displaying two occurrence peaks in late summer and March. Fires are linked to complex terrains and shrubland mosaics. The remaining cluster covers the northern coast. These are pasture fires, related to agricultural fires during winter , favored by complex terrains and wind speed.