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Wildfire susceptibility mapping: comparing deterministic and stochastic approaches

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Estimating the probability of wildfire-occurrence in a certain area under particular environmental conditions represents a modern tool to support forest protection plans and to reduce fires consequences. This can be performed by the implementation of wildfire susceptibility mapping, normally achieved employing more or less sophisticated models which combine the predisposing variables (as raster datasets) into a geographic information systems (GIS). The selection of the appropriate variables includes the evaluation of success and the implementation of prediction curves, as well as independent probabilistic validations for different scenarios. These methods allow to define the spatial pattern of wildfire-occurrences, characterize the susceptibility of the territory, namely for specific fire causes/types, and can also account for other factors such as human behavior and social aspects. We selected Portugal as the study region which, due to its favorable climatic, topographic and vegetation conditions, is by far the European country most affected by wildfires. In addition, Verde and Zêzere (2010) performed a first assessment and validation of wildfire susceptibility and hazard in Portugal which can be used as benchmarking.

The objectives of the present study comprise: (1) assessing the structural forest fire risk in Portugal using updated datasets, namely, with higher spatial resolution (80 m to 25 m), most recent vegetation cover (Corine Land Cover), longer fire history (1975–2013); and, (2) comparing linear vs non-linear approaches for wildfire susceptibility mapping. The data we used includes: (i) a DEM derived from the Shuttle Radar Topographic Mission in a resolution of 1 arc-seconds (DEM-SRTM 25 m) to assess elevation and slope; (ii) the Corine Land Cover inventory provided by the European Environment Agency (http://www.eea.europa.eu/pt) to produce the land use land cover map; (iii) the National Mapping Burnt Areas (NMBA) provided by the Institute for the Conservation of Nature and Forests (ICNF) (http://www.icnf.pt/portal) which provides a detailed description of the shape and the size of area burnt by each fire in each year of occurrence.

Two methodologies for susceptibility mapping were compared. First, the deterministic approach, based on the study of Verde and Zêzere (2010), which includes the computation of the favorability scores for each variable and the fire occurrence probability, as well as the validation of each model, resulting from the integration of different variables. Second, as non-linear method we selected the Random Forest algorithm (Breiman, 2001): this led us to identifying the most relevant variables conditioning the presence of wildfire and allowed us generating a map of fire susceptibility based on the resulting variable importance measures. By means of GIS techniques, we mapped the obtained predictions which represent the susceptibility of the study area to fires. Results obtained applying both the methodologies for wildfire susceptibility mapping, as well as of wildfire hazard maps for different total annual burnt area scenarios, were compared with the reference maps and allow us to assess the best approach for susceptibility mapping in Portugal.

References:
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