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Characterizing spatial patterns of fire regimes in Central America with the aid of geographic information systems and remote sensing data

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Vegetation fires are an important disturbance agent in the Central American isthmus that causes large ecological, economic and social impacts. The relevance of understanding the dynamics of fires in Central America is because the region has the Mesoamerican biological corridor, which has large ecological value and it is also a vulnerable region to climate change. Most ignition sources in this region come from different human-related activities especially due to agriculture, cattle grazing, and malice. In this research, we use moderate resolution imaging spectroradiometer (MODIS) datasets, to derive and represent the vegetation and climatic variations in the region. To assess vegetation conditions, we use the normalized multiband drought index (NMDI) derived from MODIS surface reflectance data, and the enhanced vegetation index (EVI) acquired from the MODIS vegetation product. We also include the MODIS land surface temperature (LST) data as a climatic variable, in addition to temperature, precipitation, wind speed and solar radiation data, acquired from the WorldClim datasets. We include elevation as a variable, acquired from the Global multiresolution terrain elevation data (GMTED) and also derive slope and aspect. Finally, we use geographical information systems data to derive some of the human imprint co-variates, such as proximity to settlements, crops, and roads. We do an exploratory analysis of all the variables within fire hotspot areas and determine their relevance. We integrate the most relevant variables identified through the exploratory analysis with the MODIS fire observations by using a robust machine learning algorithm, Random forest (RF). In addition, we analyzed two models, a model with all covariates, and a model excluding the variables related to human activities in order to assess the effect of humans on the spatial patterns of fire regimes in Central America. With the use of RF, we perform the spatial modelling and validated the results using the area under the curve of the receiver operating characteristic plot. The results acquired show that the proximity to settlements and crops, LST, temperature, NMDI, and elevation were the major drivers of fires in this region. The effect of human-related variables on fire probability varied by country but, on the whole region, given the conditions, humans enhance fire susceptibility in Central America. The estimated area with high and very high fire susceptibility was higher for the full model, compared with the model that excludes human-related variables. The high susceptibility areas are located mainly in the central-southern regions of Honduras and Guatemala, and the Pacific coast of Nicaragua. The results acquired, can lead to improved preventive measures to reduce the use of fires in vegetated areas and in this way the large negative ecological effects that are caused.