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# Continental spatial non-stationarity of fire-human relationship using GWR

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Considering the MODIS fire counts and GFED burnt areas products for the period 2001-2009, the purpose of this study was to analyze the spatial stationarity of the relathioship between these response variables and population density (2005) .

The two relationships were modelled using a Geographically Weighted Regression (GWR) at a continental scale in half degree cell, and compared with Ordinary Least Squares (OLS), to evaluate the existence of non-stationarity of the estimated slope coefficient of the relationships. The GWR models were compared with the corresponding OLS models for each continent, testing the null hypothesis that local modelling represents no improvement over global modelling. The results showed non-stationarity in the regression coefficients of the studied relationships. Statistically significant local estimates of the coefficients were mapped in order to evaluate their spatial variation in magnitude and sign. The relationships of fire counts and burnt area with population density were found to vary spatially not only in magnitude but also in sign in every continent, which indicates how global models miss these local spatial relationships by considering a solely unique global estimate for modelling those relationships.

The spatial autocorrelation of local models residuals were reduced when compared with the OLS residuals. In the case of the modelled relationship between fire counts and population density, the proportion of fire variability that is explained increased in the local model approach, spatially varying from 61% (Asia and South America) to 80% (Africa) comparing with 13% and 9%, respectively, given by the OLS model. When considering the proportion of the burned area, the local spatial approach produced results for the R2 ranging from 21% in Asia to 61% in North America continents, significantly improved when compared with the 0.25% and 2.7%, respectively, obtained in the OLS model.

The F tests suggest that the GWR models are a significant improvement over the global models, even accounting for differences in degrees of freedom, therefore rejecting the stated null hypothesis. This analysis reveals that GWR is an important tool for assessing local variations in sign and magnitude of the relationship between fire and population density, thus how this factor may influence the continental fire patterns and the burned area extent, that otherwise would be missed if an OLS global model would be used to explore these relationships. Furthermore, the spatial patterns and the signs of the two compared relationships are similar and are compared at a regional level. Some case studies found in the literature were used for comparison and further interpretation, supporting that human population through land practices and land use changes may affect the spatial distribution of fires and burnt areas.

As GWR is an improvement over OLS analysis and a complement to global statistical methods, it also contributes towards improving parameterization of process based models dealing with continental and global vegetation fire activity.