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Modelling ash extractable Total Phosphorous and Total Sulphur distribution after a forest fire

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The ash distribution in the immediate period after the fire assumes an extreme importance and this depends especially of fire severity. Due the different conditions of combustion, the fire severity can be very heterogeneous, even in small scale distances. Different fire severities produced ash with different physical and chemical properties. One of the main effects of this is the complex and very heterogenic disposition of ash nutrients that will play an important role on plant recuperation. Spatial models help to have a better picture of ash properties distribution. However, it is important to find the best model that interpolate with best accuracy the studied the variable. In this work we test several interpolation methods, namely Inverse Distance to a Weight (IDW) (with the power of 1,2,3,4 and 5), Local Polynomial with the first and second polynomial order, Polynomial Regression (PR), Radial Basis Functions (RBF) as Multilog (MTG), Natural Cubic Spline (NCS), Multiquadratic (MTQ), Inverse Multiquadratic (IMTQ) and Thin plate Spline (TPS) and Ordinary Kriging, in order to identify the best spatial predictor for Total Phosphorous (TP) and Total Sulphur (TS) after a forest fire in Portugal. Inside the burned area we designed a small plot (27x9 m) and we collected a total of 40 samples of ash. Interpolation accuracy was observed with the cross-validation method that is achieved by taking each observation in turn out of the sample and estimating from the remaining ones. The errors produced in each interpolation allowed us to calculate the Root Mean Square Error (RMSE).
The results showed that on average ash extractable TP were 92.42 ($\pm$77.34) mg/l, with a Coefficient of variation (CV%) of 83.68. The distribution was positively skewed and non-normal distributed. This previously to modelling we transformed it with a neperian logarithm, in order to respect the normality assumptions. From all the tested methods the best predictor for TP was the IDW 1 and the less precise the NCS. This shows the heterogenic character of TP distribution, since IDW 1 is more accurate to interpolate variables with small distance variability. The distribution of TP was heterogenic and did not respond to a specific spatial pattern, with some higher values in the northwest and southwest parts of the plot. TS presented on average 1690 ($\pm$468.72), with CV% of 27.73%. In this case the variable distribution was normally distributed and no transformation was needed previous to data modelling. As TP the most precise interpolator was IDW 1 and the less accurate was also NCS. This reflects also the heterogenic distribution of TS, however small than TP, due the reduced CV%. The models presented showed important differences among interpolation tests, in both variables, and this shown that the test of interpolation methods is fundamental to have a correct evaluation of the spatial distribution of the variables.

Keywords: Ash, fire severity, interpolation methods, heterogenic distribution