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Spatial Variation of ash extractable Potassium after a wildfire

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Fire effects on landscape are very heterogeneous, even in small distances. This variability has impacts in the ash produced and as consequence in the type and amount of nutrients released in soil solution. Potassium (K) is one of the main components of wood ash. It is also widely accepted in the literature that K is extremely soluble, having important effects in soil in the immediate period after the fire. This element is very important to plant growth and photosynthesis, thus it is of major importance study the ash extractable K and their spatial distribution, because is in the ash were remains great part of the nutrients available to plant recover after fire. The aim of this work is study the spatial distribution of ash after a wildfire occurred in Portugal. In the burned area we designed a plot with 35x15 m and samples were taken every 5 m, in a total of 32. Ash was stored in plastic bags and taken to laboratory for extractable K analysis. Previously to statistical analysis and data modelling, data normality was tested with the Shapiro wilk test. Since data did not respect Gaussian distribution a neperian logarithm (ln) was applied. To observe the effects of fire severity (assessed by ash colour) we performed an ANOVA one way analysis, using ash colour as grouping variable and extractable K as dependent variable. Subsequently to identify differences among ash colours, we applied a post-hoc Fisher LSD test. Significant differences were considered at a $p<0.05$. In order to get an accurate prediction of extractable K distribution, we tested several interpolated methods, namely, Inverse Distance to a Power (IDP), with the power of 1, 2, 3, 4 and 5, Local Polynomial (LP) with the power of 1, 2 and 3, Spline with tension (SPT), Completely Regularized Spline (CRS), Multiquadratic (MTQ), Inverse Multiquadratic (IMQ) and Thin Plate Spline (TPS), Ordinary Kriging (OK) and Simple Kriging (SK). In every interpolation method we include a total of 15 neighbours and we applied a smooth factor of 0.5. Interpolation methods precision was carried out with the analysis of the errors obtained from the cross validation procedure, especially the Mean Error (ME) and the Root Mean Square Error (RMSE), the most precise method is the one with lower RMSE. The ash samples colour were in their majority very dark grey (37.50%), followed by dark grey (25.00%), light grey (18.75%), black (15.62%) and very dark brown (3.13%). On average ash extractable K was of 1712.83 parts per millon (ppm) and ranged from a minimum of 311.39 ppm to a maximum of 4102.73 mg/l. The coefficient of variation was of 63.85%, confirming the idea that fire effects on ash extractable nutrients (in this case extractable K) that spatial variation is very high even in small distances. Ash extractable elements depend among other factors ash pH and $CaCO_3$. We identified a negative correlation between extractable K and pH (-0.30, $p=0.09$) and $CaCO_3$ (-0.38, $p=0.03$) which means that this two parameters have a negative effect on K content in the measured solutions. This is very likely to be due the mechanisms of sorption and adsorbtion of ions onto $CaCO_3$ surfaces that increases with pH values, as referred elsewhere (Brady et al., 1999, Okumura and Kitano, 2003). We identified a significant positive relation between ash extractable K and Electrical Conductivity (EC) (0.70, $p=0.0001$) which shows that the salinity is importantly influenced by the present of extractable K. The ANOVA test showed significant differences at a $p<0.05$, of extractable K among ash colour. The Fisher LSD test shown that, the extractable K was significantly higher in black and very dark grey ash than in remain colours. Among all interpolation methods, SK was the most precise to predict extractable K (RMSE: 0.5242) and the less was LP3 (RMSE: 0.6996). The ash extractable K was higher in the Southeast part of the plot and the lower in the North and Northwest part of the area of interest. The findings observed in this study, showed that ash extractable K is dependent on ash colour, and that black and very dark grey ash extracts contain significant higher amounts of K in solution. In addition, spatial variability (assessed by the coefficient o variation) is very high which implies that the amount of K for vegetation recover is heterogeneous across the landscape.

References:

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