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Near-infrared (NIR) spectroscopy for the estimation of properties of burned soils and the assessment of fire severity

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It is well recognized that the effects of fire on soil properties are largely dependent by the temperature reached. Recently, near-infrared (NIR) spectroscopy has been pointed as a powerful tool to asses the temperature reached on the soil, and thus allowing a certain measurement of the fire severity.

But some changes on soil properties don't follow a linear relationship with the temperature of heating (such as soil respiration and soluble organic carbon). Moreover the degree of changes in some soil properties at different temperatures could be different depending of soil type. According to this, specific parameters should be analysed for a complete characterization of the effects of fire on soils. In this sense, NIR have been also used as an accurate method for the estimation of some properties in agricultural and forest soils. But less information is available about the use of NIR for the analysis of parameters in burned soils.

The first objective of this work was to check the ability of NIR to estimate the basal respiration (BR) and the soluble organic carbon (SLBOC) content in burned soils. Samples of six different soils were heated in a furnace-oven at different temperatures (from 70 to 700ºC), simulating wildfires of different intensities. As expected,

changes in BR and SLBOC changed drastically as consequence of heating, but these changes didn't followed a lineal correlation with the temperature of heating. Some of these samples were incubated during one month, and the BR and SLBOC were measured again. All the samples were scanned in a Fourier-Transform near-infrared spectrophotometer (MPA, Bruker Optik GmbH). Models relating NIR spectra with BR and SLBOC were obtained using OPUS 5.5. Accurate models were obtained for the BR and SLBOC using NIR ($r^2 > 0.90$).

The second objective of this study was to compare different methods to asses the fire severity using NIR. For this, the maximum temperatures reached (MTR) on each of the heated samples were recorded (using thermocouples) as a measure of the fire severity. We compared the results obtained using a quantitative approach (partial-least squares regressions) with other typical methods of qualitative classification and ordination (such as discriminant analysis and clusters).