



On sampling collection procedure effectiveness for forest soil characterization

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Abstract

One of the most important measures to prevent wild forest fires is the use of prescribed and controlled burning actions as it reduce the fuel mass availability. The impact of these management activities on soil physical and chemical properties varies according to the type of both soil and vegetation. Decisions in forest management plans are often based on the results obtained from soil-monitoring campaigns. Those campaigns are often man-labor intensive and expensive. In this paper we have successfully used the multivariate statistical technique Robust Principal Analysis Compounds (ROBPCA) to investigate on the sampling procedure effectiveness for two different methodologies, in order to reflect on the possibility of simplifying and reduce the sampling collection process and its auxiliary laboratory analysis work towards a cost-effective and competent forest soil characterization.

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1 INTRODUCTION

Prescribed burning actions are preventive actions used to reduce the forest fuel mass availability and therefor to reduce the number of wildfires in the summer season (Fernandes & Botelho, 2004). During a prescribed fire episode on forest area, soil temperatures are not significantly altered as this is, generally, a low intensity combustion and a relatively fast process (Rego, 1996; Rego et al., 1987). However researchers reported that soil physical and chemical properties use to experience some impact and modification (Fernandes & Botelho, 2004). Traditional soil data acquisition processes in forest field monitoring plans are well described in literature (EPA, 1989; EPA, 1996; EPA, 2006; EUFIRELAB, 2006, FAO, 2006; USDA, 2006). Generally this kind of investigation is an expensive and labor intensive process since it demands an

abundance of manpower and equipment both in field work and laboratory analysis work and in equipment.

In this paper we have used the multivariate statistical technique Robust Principal Analysis Compounds (ROBPCA) to investigate on the sampling procedure effectiveness up to 18cm layer forest soil characterization, more specifically sub-layer sampling procedure versus a single-layer sampling procedure. The data used focused on soil monitoring records of pH, soil moisture, organic matter content and iron content during a one year span (Meira-Castro et al., 2011).

2 MATERIAL AND METHODS

The study area is located in Gramelas, in NW Portugal. The soil samples were taken before the prescribed forest fire and after the prescribed forest fire. Five distinct plots for

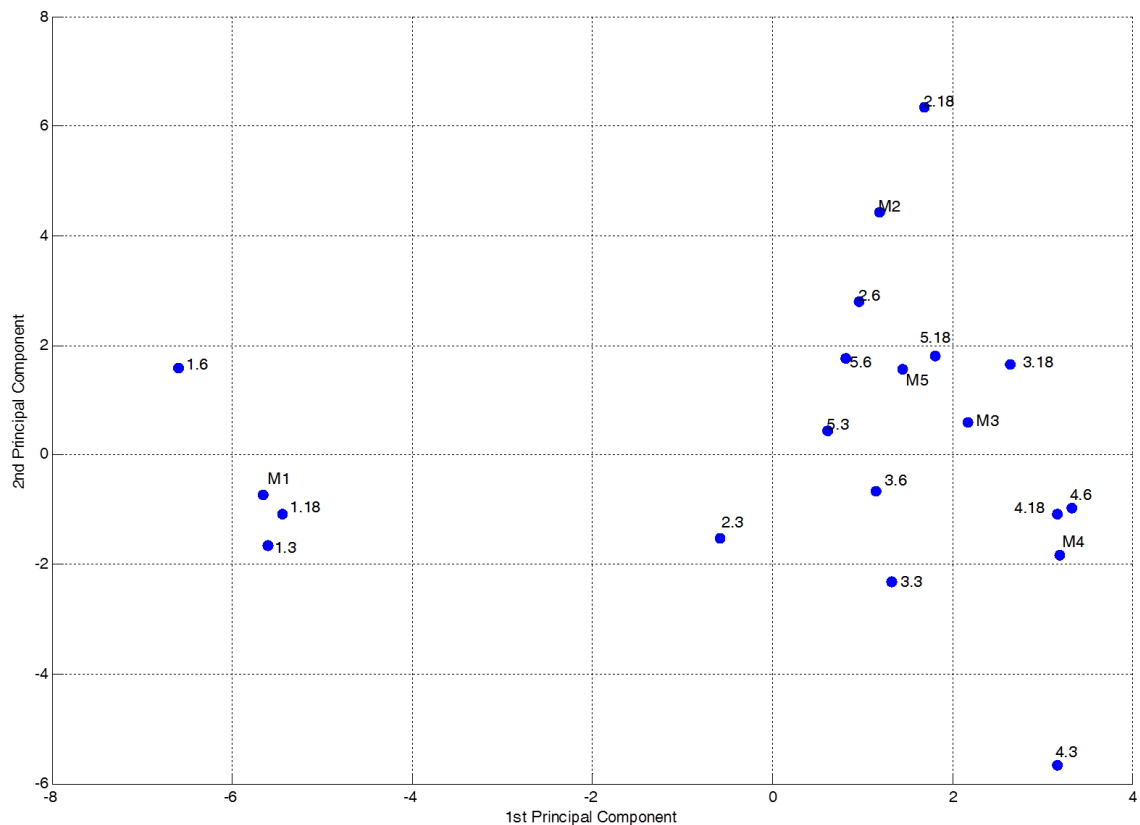


Figure 1. Representation of the ROBPCA scores in PC1-PC2 factorial plan

sampling collection were considered: point number 1 was located on a level land with low vegetation, close to a water stream; point number 2 was located in level land with lots of vegetation; point number 3 was located on a strong slope with low vegetation, point number 4 was located on a strong slope with lots of vegetation; point number 5 was located on level land with low vegetation. The sub-layers sampling collection procedure consisted in collecting, using a clean manual auger, 16 sub-samplings on a previously traced circumference with 2 meters diameter at three different depths (0 to 3cm, 3 to 6cm and 6 to 18cm). The single-layer sampling collection procedure consisted of collecting, using a shovel, at 0 to 18cm depth soil portion. The soil samples were transported to the laboratory to determine soil pH, soil moisture, organic matter and iron content.

The multivariate statistic algorithm for Robust Principal Component Analysis (Hubert et al., 2012) was used. The analyses were run in MatLab software (R2012a).

3 RESULTS AND CONCLUSIONS

Firstly, the assessment of the suitability of implementing a Principal Components Analysis procedure was done. Bartlett's sphericity test results indicated that there was statistical evidence of a significant correlation between the original variables. The application of the ROBPCA algorithm suggests that three components are retained, explaining 64% of the total variance. An analysis considering the retention of six principal components, that retained 87% of variance explained, was also carried out.

The ROBPCA appear to be a good option for statistical treatment of these particular "high dimensional" data as, in this case study, one worked with more variables than observations. In addition, ROBPCA allows simplicity to results interpretation and assures representativeness for all parameters involved, as it was possible to identify and characterize the different soil properties per se but and their correlations with sampling depth and local.

The results highlighted that samples have homogeneity in depth uniformity and heterogeneity in plot locations, that clearly identify plots near and far away from water streams and plots in horizontal plans and sloped planes. The results of this investigation indicate that, for this type of geochemical data and at a local level of Gramelas, a clear influence of the sampling area localization on the soil pH, moisture, iron and organic matter exists but the sampling procedure of low fertile soils, such as forest soils, the depth to which the sample is collected is not relevant up to 18cm.

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