Short-term impact of prescribed fire on soil pH, organic matter and hydrophobicity in a *Calluna vulgaris heathland* located in Lithuania. First results.

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Introduction

It is extensively known that fire changes soil properties, depending on fire severity and soil type. Low severity prescribed fires does not change significantly soil properties, contrary to high severity fires that can have negative impacts in soils (Certini, 2005). The vegetation removal and organic matter mineralization increase soil exposition to erosion agents (Cerdà & Doerr, 2005) and ash can change solution chemistry (Pereira et al., 2011; Pereira et al., 2012), modifying temporarily the type and amount of nutrients leached in soil surface. Normally after a fire soil pH can increase (Murphy et al., 2006). This change depends on the degree of organic matter mineralization that increases the amount of soluble cations, mainly sodium and potassium (Raison & McGarity, 1980). Also, fire changes the quantity of Soil organic matter (SOM). Fire has impacts on soil water repellency (WR) with implications on soil erosion, plant growth and surface and subsurface hydrology (Doerr et al., 2009). The aim of this work it is study the immediate effects of a prescribed fire in soil pH, SOM and soil WR in the immediate period after the fire.

Methodology

Study area, sampling and statistical analysis

The prescribed fire was carried out in Dzukija National Park, located at 53 54' N and 24 22' E (Figure 1). After the fire we selected two plots where fire had different severities, evaluated according the ash color (Úbeda et al., 2009). The fire was more severe in the plot I due the major presence of grey and white ash in the burned area. In a contiguous area we designed a control plot in order to evaluate the effects of the prescribed fire. In the studied area the soil classified according to the FAO (2006) as *Cambic arenosols* and the vegetation is composed mainly by *Calluna vulgaris*. Soils were sieved with the 2mm sieve and pH was determined with 1: 2.5 soil water ratio with distilled water. Soil organic matter was assessed using the Loss of Ignition Method (LOI). Soil WR was assessed in different soil sieve fractions (2-1, 1-0.5, 0.5-0.25 and <0.25 mm) in all soil samples (260), according to Mataix-Solera & Doerr (2004). Sieve fractions were placed separately placed in plastic dishes (50 mm in diameter). Soil WR was measured using the water drop penetration time (WDPT). Three drops of distilled water were placed on soil surface and the infiltration times were recorded according Bisdom et al. (1993). Soils were classified as hydrophilic (WDPT ≤5 s), slightly (6-180 s), strongly (181- 900 s), severely (901-3600 s) and extremely water repellent (>3600 s).

Previous to data statistical analysis, we tested data normal distribution with the Shapiro-Wilk test (Shapiro and Wilk 1965). Normal distribution was considered at a $p>0.05$. In this case, the data did not respect the Gaussian distribution, even after a neperian logarithm, box-cox, and square root transformation. Only the ranked data accomplished the normal distribution requisites. Thus statistical analyses were carried out with ranked data, however the graphics are presented with the original data. The comparison between treatments, fractions and sampling periods were carried out with an ANOVA repeated measures. In the case of significant differences, a post-hoc Tukey HSD test was applied. An ANOVA-one way test was carried out to identify differences between control and burned plots between the studied periods. Significant differences were considered at a $p<0.05$.

Results

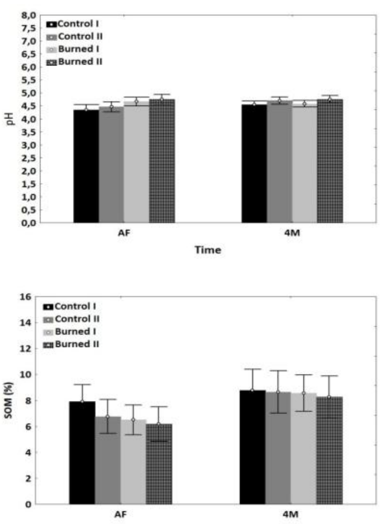

Figure 1. pH and SOM in Plot 1 and Plot 2, After and 4 months after the fire.

Figure 2. Relative frequency (%) of soil WR for different sieve fractions. a) control 1; b) burned 1, control 2; c) and burned 2; d), immediately after the fire; e) control 1; f) burned 1, control 2; g) and burned; h), four months after the fire.

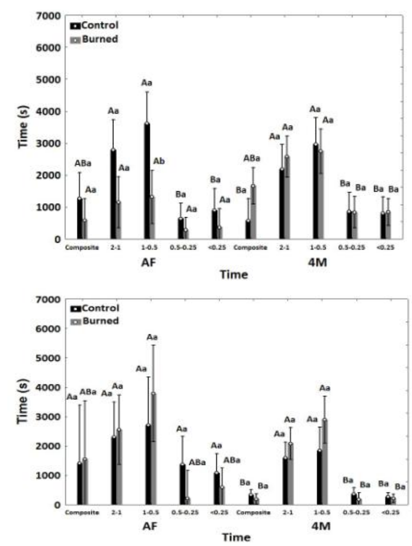

Figure 3. Mean soil WR in plot I and plot II. Error bars represent 95% of confidence. Large caps differences among fractions and small caps between burned and unburned plot in composite and burned plot. Different letters represent significant differences at a $p<0.05$. Tukey's mean separation: A>B>C.

Conclusions

The prescribed fire did not have important impacts on the studied soil properties. Considering that pH and SOM are soil properties that can be importantly changed, especially in the immediate period after the fire, that can change soil hydrological properties as water repplency, it is very likely that this fire did not change greatly soil properties. Thus the application of prescribed fire in Lithuanian *Calluna vulgaris* heathland from the soil point of view may be a good technique for landscape management..

Acknowledgments

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References

Bisdom EBA, Dekker LW, Schoute JFT. 1993. Water repellency of sieve fractions from sandy soils and relationships with organic, material and soil structure. Geoderma 56:105-118.
Cerdà A, Doerr SH. 2008. The effect of ash and needle cover on surface runoff and erosion in the immediate post-fire period. Catena 74:256-263.
Certini G. 2005. Effects of fire in soil properties: a review. Oecologia 143:1-10.
Doerr SH, Shakesby RA, MacDonald LH. 2009. Soil water repellency: a key factor in post-fire erosion? In: Cerdà A, Robichaud P. (Eds) Restoration Strategies after Forest Fire. Science Publishers: Enfield, NH, pp. 197–223.
FAO (2006) World reference base for soil resources 2006. A framework for international classification, correlation and communication. World soil resources report. 103
Mataix-Solera J, Doerr S. 2004. Hydrophobicity and aggregate stability in calcareous topsoils from fire-affected pine forests in southeasthern Spain. Geoderma 118:77-88.
Murphy JD, Johnson DW, Miller WW, Walker RF, Carroll EF, Blank RR. 2006. Wildfire effects on soil nutrients and leaching in a Tahoe basin watershed. Journal of Environmental Quality 35:479-489.
Pereira P, Úbeda X, Martin DA, Mataix-Solera J, Guerrero C. 2011. Effects of a low severity prescribed fire on water-soluble elements in ash from a cork oak (Quercus suber) forest located in the northeast of the Iberian Peninsula. Environmental Research 111:237-247.
Pereira P, Úbeda X, Martin DA. 2012. Fire severity effects on ash chemical composition and water-extractable elements. Geoderma 191:105-145.
Raison RJ, McGarity JW. 1980. Some effects of plant ash on the chemical properties of soils and aqueous suspensions. Plant Soil 55:339-352.
Shapiro S, Wilk M. 1965. An analysis of variance test for normality. Biometrika 52:591-611.
Úbeda X, Pereira P, Outeiro L, Martin D. 2009. Effects of fire temperature on physical and chemical characteristics of the ash from two plots of cork oak (Quercus suber). Land Degradation and Development 20:589-608.