High severity wildfire effects in ash thickness and immediate post-fire evolution in a Portuguese *Pinus pinaster* forest.

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I. Introduction

High severity wildfires devour great amounts of combustible, inducing tremendous impacts on the landscape. One of the most visible impacts of these fires is the great destruction of soil cover and the consequent exposure to the erosion agents. After the fire, especially in crown fires, the ash distribute on soil surface is the unique and valuable protection, especially important in high severity wildfires, where the soil is affected with more intensity and the nutrient depletion is higher. Thus, the thin ash layer has a key role on soil protection after the fire. There is a great lack of studies about the effects of wildfires in ash thickness. The aim of this work is study the effects of a highseverity wildfire on ash thickness and their immediate evolution in a *Pinus pinaster* forest.

Figure 1. Studied area

Figure 2. Foto of the burned area 1 day after

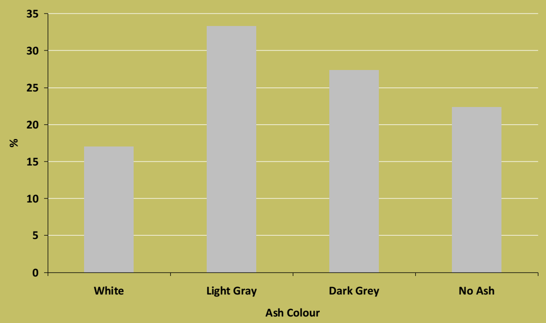

Figure 3. % of Ash color in the burned area (*N*=300).

II. Materials and Methods

The fire occurred in July 26, of 2010, near an urban area and affected 79 ha of forest near the Portuguese coast (Figure 1 and 2). One day after the fire, it was designed one transect in a south faced slope with 27% of inclination. Ash thickness measurements were taken every 10 centimetres, in a total of 300 measuring points. Simultaneously to ash thickness measurements, we observe visually the ash colour, in order to classify fire severity. Eighteen days after the fire we the second measurement was taken in the same area. In order to observe the relation between Distance to the Slope Top (DST) and the ash thickness and within measurements we applied a Pearson correlation coefficient, significant at a p<0.05. Data normality was tested with the Shapiro wilk test. Any of the ash thickness distributions followed the normal distribution. Therefore we applied a non parametric Factorial ANOVA's on rank transformed data, considering as predictors time and ash colour and ash thickness as dependent variable were performed. If differences were significant at a p<0.05, a Tukey HSD post-hoc test was used to identify differences among sampling periods and ash colour. Data is presented in original values. All analysis were carried out with Statistica 7.0.

III. Results and conclusions

The results shown that ash was White (17%), Light Gray (33.33%) and Dark Gray (27.33%) and in some points no ash was covering the soil surface (22.33%) (Figure 3), perhaps due the inexistence of vegetation previously to fire occurrence or due the high temperatures produced, that consumed all the available biomass. The correlation between ash thickness and the Distance to the Slope Top (DST) is of 0.27, p <0.001, which means that in general after fire, the ash layer is more thick in the bottom of the slope. Eighteen days after the fire, the correlation between ash thickness and DST is of 0.18 p>0.05, which means that in relation to the previous period important changes occurred in ash thickness and the difference between the accumulation in the top and bottom of the slope is lower (Figure 3). This shows that ash was (re)distributed between the studied periods. In addition, the correlation between ash thickness measurements (one day and eighteen days after) is of 0.05, p>0.05, and this strength the idea that immediately after the fire ash (re)distribution changes significantly, and the respective impacts (Figure 3). Between the measurements, no rainfall occurred, thus the wind might be the driver of these changes, especially if we consider that the ash was mainly composed by fine particles (due the high severity of combustion). During the summer time in Portuguese coast, strong winds blow in the late afternoon from North (called "Nortada"), and in the present case they were the major drive of these changes. The ANOVA results identified significant differences between ash thickness x time x ash colour at a p<0.01 (Figure 4). The TUKEY HSD post-hoc test shows that one day after the fire, ash with dark gray and light gray colour were significantly thicker than the white ash. Eighteen days after the fire, we identified a significant decrease in ash thickness (in all the colours) in comparison with the previous measurement. Nevertheless, no differences between ash thicknesses among the different colours were identified. One important founding of this study is that in the sampling points measured one day after the fire where we did not identify ash layer, in the second measurement they were cover by (re)distributed ash (Figure 4). In addition, the ash cover increased significantly. This is a strong evidence of ash (re)distribution after the fire, especially after wildland fires where ash is majority composed by fine dust and easily transported. The findings of this work showed that the ash distribution after fire is high and the ash produced at higher severity is very likely to influence other areas burned with less severity and vice versa. This study also advocates that rain could not be the major driver of ash redistribution and that wind ash (re)distribution can induce extremely complex impacts on soil properties.

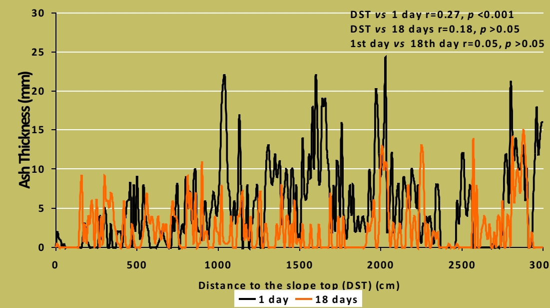

Figure 3. Ash thickness one day and 18 days after the fire (*N*=300).

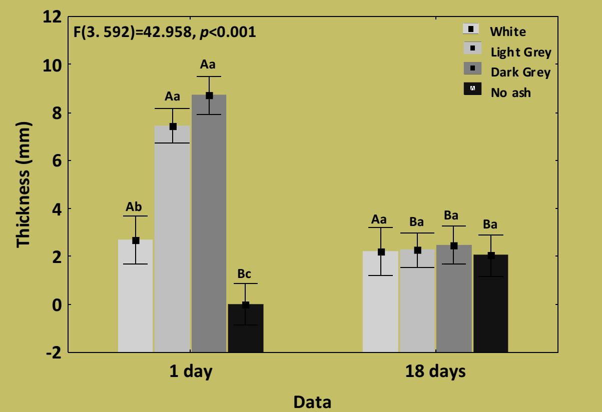

Figure 4. Summary of ANOVA results and Fisher LSD test for ash thickness in flat area, between measurement periods (in capital letters) and within ash colours (in small letters). Different letters mean significant differences at a p<0.05. Hanging bars represent ± 95%. (*N*=300).