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Rock fragments induce patchy distribution of soil water repellency in burned soils

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INTRODUCTION

Forest fires are recurrent phenomena in the Mediterranean area and are one of the main causes of changes in the Mediterranean ecosystems, increasing the risk of soil erosion and desertification. Fire is an important agent which can induce important changes in the chemical and physical characteristics of soils. During wildfires, only a small part of the heat generated is transmitted to the first centimetres of the soil profile. The intensity of the changes produced in the physical and chemical characteristics of the soil depends on the temperatures reached at different soil depths, the time of residence of temperature peaks, and the stability of the different soil components. One of the soil physical properties strongly affected by fire is soil water repellency (WR). Depending on temperature, time of heating, type of soil and fuel, fire can induce, enhance or destroy soil WR. Soil WR is a key factor in controlling soil hydrology and water availability in burnt soils together with other factors as texture or aggregation. Although the occurrence and consequences of fire-induced soil WR have been deeply studied, some gaps still exist, as the influence of rock fragment cover during burning. During combustion of litter and aerial biomass, the soil surface under rock fragments is heated and reachs temperature peaks after a certain delay respect to exposed areas. In contrast, temperature peaks are longer, increasing the time of residence of high temperature. In consequence, rock fragments may change the expected spatial distribution of soil WR. Up to date, very scarce research concerns the effect of rock fragments at the soil surface on the fire-induced pattern of soil water repellency.

METHODS

Two experiments were carried out in this research. In the first case, an experiment was conducted in an experimental farm in Sevilla (southern Spain). The effect of a low severity prescribed fire was studied in soil plots under different rock fragment covers (0, 15, 30, 45 and 60%). Soil WR was assessed in soil samples (0-10 cm) collected monthly during 6 monhts after burning.

In the second case, a fire-affected forest soil from Calañas (Huelva, southweastern Spain) was studied. Soil plots under different fire severities (low, medium and high severity burning) and rock fragment cover classes (20-40 and 60-80%) were analyzed. Soil WR was assessed in the soil surface immediately under the vertical projection of randomly selected stones and in the middle point between these and the nearest stones. Unburned adjacent soils under similar rock fragment cover classes were used as control.

All soil WR assessments were carried out using the WDPT method.

RESULTS

In both cases, soil WR was induced in the soil surface contacting rock fragments after burning. Severity of WR ranged between subcritical or slight (low severity burning) and strong (high severity burning). Soil WR was also found to increase with rock fragment cover, especially after moderate or high severity burning, both under and between rock fragments. It is suggested that high density of rock fragments on the soil surface create a continuous surface of high residence of temperature peaks (in agreement with García-Moreno et al., 2013). Combustion of plant residues in oxygen depletion conditions between adjacent nearby rock fragments contributes to heat transfer to the soil surface and consequent enhanced soil WR.

REFERENCES

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