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Effects of a layer of vegetative ash layer on wettable and water repellent soil hydrology

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Following a wildfire, a layer of vegetative ash often covers the ground until it is dissolved or redistributed by wind and water erosion. Much of the existing literature suggests that the ash layer temporally reduces infiltration by clogging soil pores or by forming a surface crust (Mallik et al., 1984; Onda et al., 2008). However, an increasing number of field-based studies have found that, at least in the short term, ash increases infiltration by storing rainfall and protecting the underlying soil from sealing (Cerdà and Doerr, 2008; Woods and Balfour, 2008). On the other hand, after a fire the soil may have produced, enhanced or reduced its water repellency (Doerr et al., 2000). Very few studies have been taken into account the interaction of the ash and the repellent soil. The layer of ash may have similar role as a litter layer in delaying runoff and reducing erosion by storing water. In order to examine this interaction, it was been made a series of experiments using a laboratory rainfall simulation. It has been assessed the effects of an ash layer i) on a wettable and water repellent soil (WDPT > 7200s), ii) with different ash thicknesses (bare soil and 5 mm, 15 mm and 30 mm of ash), iii) preceding and following the first rain after a fire when the ground is still wetted and after being partially dried. Three replicates were done, being a total of 40 simulations. The ash used was collected from a Wildfire in Teruel (Spain) during summer of 2009. The simulations were conducted in metal boxes of 30x30 cm and filled with 3 cm of soil. The slope of the box was set at 10° (17%) and the intensity applied was 78-84 mm h-1during 40 minutes. The splash detachment was determined also using four splash cups. Overland flow and subsurface drainage was collected at 1-minute intervals and the former stored every 5 min to allow determination of sediment concentrations, yield and erosion rates. Each sample was examined at the end in terms of water repellency, infiltration pattern and ash incorporation into the soil. The results show that when ash covers the wettable soil, runoff occur for a short period of time in the middle of the event. It occurred latter on time but larger in quantity as the ash thickness increases (from 0% to 2% of runoff coefficient) and at the same time drainage is reduced (from 57 to 24%). This suggests that the ash layer became saturated and produce runoff until the water is able to drain into the soil. Oppositely, in water repellent soil as ash thickness increases both runoff is reduced (from 78% to 26%) and drainage is increased (from 0 to 16%). That fact indicates a modification in the hydraulic conductivity of the repellent soil due to the pressure of the ash layer. Splash and erosion rates are bigger in water repellent soils yet erosion rates never exceed 2.5 g m-2 h-1. The fact of wetting increases the runoff and drainage rates in wettable but reduce them in the water repellent soil. An irregular infiltration pattern is observed afterwards. After drying the soil, the increase in runoff indicates a crust formation. Moreover, in water repellent soils part of the repellency is reestablished. These findings demonstrate that the interaction of the soil-ash layer should be considered and better studied in the immediate hydrological response after wildfire due to its particular behavior.

References

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