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The relative importance of hydrophobicity in determining runoff-infiltration processes in burned forest soils

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Wildfires induce fundamental changes to vegetation and soil structure/texture which conseqeuntly have major impacts on infiltration capacity, overland flow generation, runoff and sediment yields. The relative importance, however, of fire-induced soil water repellency (WR) on hydrological and erosional processes is somewhat controversial, partially, as the direct effects of soil WR in-situ field conditions have been difficult to isolate. It is generally accepted that hydrophobicity is caused by the formation of organic substances in forest soils, while burning is considered to enhance this process. Given the complex response of the soil-vegetation system to burning, soil WR is only one of several affecting soil hydrology. Other factors include the physical sealing of soils triggered by rain drops energy, the increase in soil erodibility due to changes in soil aggregates, and the role of the ash in sealing the burned surface. The degree and spatial distribution of WR burned varies considerably with fire severity, soil and vegetation type, soil moisture content and time since burning. Nevertheless, given the inverse relationship between soil moisture and hydrophobicity, the role of the latter in determining overland flow during wet winters when the soil is mostly inundated, is marginal.

Following a 60 ha wildfire, which took place at the Pe'eram catchment during July 2009, we assessed the spatio-temporal distribution of WR in a burned *Pinus halepensis* forest. The site, located in the Upper Galille, Israel, was severely burned; the combustion removed all understory vegetation and burned down some of the trunks, leaving a thick layer of ash. The soils composed of reddish-brown clay loam forest soil and terra rossa on limestone bedrock, greyish light rendzina characterises the marl and chalk exposures. To consider the effect of distance from trees, in-situ hydrophobicity was assessed within a week, month and five months after the fire, using the WDPT test. Measurements were taken in concentric circles around the burned trees at two soil depths.

We complemented this investigation by conducting a series of laboratory simulations. Non-burned soil was taken for laboratory analysis and rainfall simulations. Four treatment types were conducted: non-burned soil, non-burned soil + pine needles, burned soil without ash (300°C/15 min. after adding pine needles) and burned soil with the residue ash (300°C/15 min. after adding pine needles). Hydrophobicity was measured in all trays. Constant rainfall intensity of 30 mm/hr was simulated until terminal infiltration rates were reached. The experimental trays were oven dried and simulated again to imitate the effect of second rainstorm.

Preliminary results indicate strong surface WR (60% >180s) at a distance of 1m and at the subsurface (50% >180s) directly by the trunk. In the control non-burned site stronger WR was found in proximity to the trunks. While in the burned sites extreme values (>300s) were apparent (15-35%) and correlated with distance from the trunk, no corresponding patterns were noticed in the control trees. The attempt to create homogeneous layer of WR under controlled laboratory conditions yielded a scattered pattern of repellency, similar to the field conditions. In contrast to expected, the bare soil and bare soil covered by needles exhibited the highest and lowest infiltration rates, respectively, while the burned hydrophobic soils demonstrated intermediate rates. It is thus suggested that in some soils, WR might enhance infiltration capacity by creating a complex mosaic of runoff-generating and runoff-absorbing micro-patches. In the experimental non-burned soil a rapid crusting of the surface provided lateral connectivity whilst the accumulation of litter and organic matter blanket the surface and enhance the vertical conductivity. To better understand the role of WR in generating hydrological response, it is required to consider the 3D "sponge like" properties of the WR soils.