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Temporal variability and switching dynamics of soil hydrophobicity: fire impacts

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Soil hydrophobicity is differently affected by fire depending on the degree and duration of soil heating (e.g. Dekker and Ritsema, 1994; Shakesby and Doerr, 2006; Ferreira, 2008). It is also known that hydrophobicity is seasonally variable, affected by soil moisture content and that it is generally (but not invariably) confined to the organically-enriched uppermost few centimetres of the soil (Doerr and Shakesby, 2009). Hydrophobicity behaviour is viewed as an important factor affecting hydrological and erosional soil processes, reducing infiltration capacities and soil moisture content and enhancing overland flow and slopewash (Shakesby and Doerr, 2006).
Despite extensive research on patterns and impacts repellency over the past 15 years, however, there remains a lack of knowledge and understanding on the three-dimensional temporal dynamics and controls of switching of soils between hydrophobic and hydrophilic states. This poor understanding is largely related to the destructive nature of hydrophobicity measurement methods and the problems associated with reliable and three-dimensionally meaningful soil moisture content measurements.
This poster presents the research design and results of a field and laboratory investigation to assess these switching patterns in burned and unburned areas. The study has been carried out in central Portugal, on schist bedrock with a thin (<10cm) and stony soil, covered by shrubland, mainly Erica scoparia and Gaccharis articulata.
Field data are derived from two grids, one installed in an area subject to an experimental fire, and the other one in the immediately adjacent unburned area. Each grid comprises 54 points (with 6 points located along 9 lines, spaced 1-2m apart). Each point was marked with a nail and the monitoring programme used a different 'clock' position around each point for each survey, to minimize human disturbance caused by excavation and measurement. The grids were monitored twice before the fire and 6 times after, to assess temporal and spatial hydrophobicity variability at different soil depths (0-2 cm and 2-5 cm) and in a surface ash layer where present. The monitoring programme involved hydrophobicity measurement using the Molarity of an Ethanol Droplet (MED) technique and soil moisture content assessment using time domain reflectrometry equipment.
During the sixth monitoring survey, soil samples were collected and taken to the laboratory to test their potential water repellency. The experiments involved heating of subsamples to different temperatures (35, 45, 55, 65 and 105ºC) and subsequent cooling in desiccators. After each temperature treatment, hydrophobicity (again using the MED method) and soil moisture (using the gravimetric method) were assessed.
The results revealed that during pre-fire wet periods the soil was wettable in both grids. Immediately after the fire, the burned soil was of moderate to severe hydrophobicity, much higher than in the unburned area (wettable or of low hydrophobicity). Two weeks after the fire, the burned area was still more repellent, than in the unburned area, but, one month later, the results showed a different tendency, with lower values in the burned area. This may be related to a reduction in the input of repellent compounds in the burnt area compared with the vegetated unburned area. This was confirmed by the laboratory experiments, which also revealed higher soil water repellency for samples from the unburned area collected one month after the fire, than for samples from the burned area.