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Soil water repellency distribution and persistence in burned and unburned calcareous forest soils, eastern Spain

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Alkaline soils are considered to be less prone to water repellency (hydrophobicity) development compared to acidic soils. This is speculated to be due to an, under alkaline conditions (i) enhanced solubility of the humic acid fraction (implied in water repellency development) and (ii) reduced fungal activity of fungi releasing hydrophobic compounds. Cases of water repellency, however, have been reported from alkaline calcareous soils under grass, shrub and tree cover. Here we summarise key findings from recent work carried out in eastern Spain to provide insight into the occurrence, distribution and persistence of water repellency in calcareous forest soil in relation to vegetation type, wildfire history and soil characteristics.

In an unburned calcareous forest, 160 soil samples were taken at sites under different dominant species (*Pinus halepensis*, *Quercus coccifera*, *Juniperus oxycedrus* and *Rosmarinus officinalis*). Soil water repellency (WR) was present in 20% of samples, with its persistence levels being mainly in the region of 10-30 seconds Water Drop Penetration Time (WDPT). Under *P. halepensis* and *Q. coccifera*, water repellency was more frequent (40% and 30% respectively) compared to *J. oxycedrus* and *R. officinalis* (5% in both cases). The highest WR levels were normally observed in presence of fungal hyphae in the rhizosphere. Further work, however, needs to be carried out to

fully clarify whether the spatial distribution of WR is determined primarily by organic matter quantity, its quality or the presence of fungi because associated with the soil conditions under different plant species.

To examine the effect of fire on WR, burnt and adjacent unburnt soils were sampled after seven forest fires in the summers 2003 and 2004 (n=145) within 5 days of each respective fire and before any rainfall. Burning increased the frequency of WR occurrence amongst samples, on average from 32% to 76%. In comparison, after a prescribed fire in *P. halepensis* forest on calcareous soils conduced in Catalonia, where the mean maximum temperature at the soil surface was between 94º and 598ºC (n=30), WR frequency increased from 38% to 98% (n=84). It is speculated that in the prescribed fire, which was aimed at sustaining a low fire severity, temperatures within the top few cm of soil had remained below the critical temperature for WR destruction (300-500ºC, depending on duration and oxygen availability) leading to an almost ubiquitous WR distribution. In contrast, in the wildfires examined here, temperature variations may have been greater, leading to WR destruction in some places, but little or no enhancement in some others, such that WR was present in only ca 3/4 of the soils examined.

WR distribution amongst different soil aggregate sizes (2-1, 1-0.5, 0.5-0.25, <0.25 mm) was also examined. In all cases (soil samples: n=240), the same pattern occurred, with the finer fractions (0.5-0.25 and < 0.25 mm) exhibiting the highest degrees of WR. This apparent distribution may have repercussions for soil functioning in this semiarid environment as the smallest aggregates are often a key source of plant nutrients. For example, we found that under controlled irrigation experiments under unsaturated soil water conditions, seed germination rate for a primary post-fire succession herb (*Brachypodium phoenicoides*) was lower for the WR compared to the wettable samples.

Our studies suggests that degree of WR found in calcareous forest soils is lower than that normally reported from acidic soils in Mediterranean regions and elsewhere, but that the implications of these WR levels may still be significant for vegetation growth, particularly in relation to post-fire regeneration. In order to prevent or mitigate soil degradation processes associated with the recent trend of increased fire occurrence and severity, more research is required to achieve a better understanding of the causes of the difference in WR within aggregates sizes, the cause of its spatial distribution, and the temporal evolution of WR in fire-affected areas.