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Natural ’background’ soil water repellency in conifer forests: its prediction and relationship to wildfire occurrence

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Soils under a wide range of vegetation types exhibit water repellency following the passage of a fire. This is viewed by many as one of the main causes for accelerated post-fire runoff and soil erosion and it has often been assumed that strong soil water repellency present after wildfire is fire-induced. However, high levels of repellency have also been reported under vegetation types not affected by fire, and the question arises to what degree the water repellency observed at burnt sites actually results from fire.

This study aimed at determining ‘natural background’ water repellency in common coniferous forest types in the north-western USA. Mature or semi-mature coniferous forest sites (n = 81), which showed no evidence of recent fires and had at least some needle cast cover, were sampled across six states. After careful removal of litter and duff at each site, soil water repellency was examined in situ at the mineral soil surface using the Water Drop Penetration Time (WDPT) method for three sub-sites, followed by col- lecting near-surface mineral soil layer samples (0–3 cm depth). Following air-drying, samples were fur- ther analyzed for repellency using WDPT and contact angle (hsl) measurements. Amongst other variables examined were dominant tree type, ground vegetation, litter and duff layer depth, slope angle and aspect, elevation, geology, and soil texture, organic carbon content and pH.

‘Natural background’ water repellency (WDPT > 5 s) was detected in situ and on air-dry samples at 75% of all sites examined irrespective of dominant tree species (Pinus ponderosa, Pinus contorta, Picea engelmanii and Pseudotsuga menziesii). These findings demonstrate that the soil water repellency commonly observed in these forest types following burning is not necessarily the result of recent fire but can instead be a natural characteristic. The notion of a low background water repellency being typical for long- unburnt conifer forest soils of the north-western USA is therefore incorrect. It follows that, where pre-fire water repellency levels are not known or highly variable, post-fire soil water repellency conditions are an unreliable indicator in classifying soil burn severity.
The terrain and soil variables examined showed, overall, no convincing relationship with the repellency levels observed ($R2 < 0.15$) except that repellency was limited in soils (i) developed over meta-sedimen- tary lithology and (ii) with clay contents >4%. This suggests that water repellency levels cannot be pre- dicted with confidence from common terrain or soil variables.

This work is presented in the memory of the late Scott Woods, who was instrumental in the success of this study and an inspiration to us all.