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Fire-induced water repellency in conifer forest soils: a myth?

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It is commonly observed that 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. The underlying mechanisms, and the temperature ranges, under which water repellency is induced or enhanced in soils have been established through a wide range of laboratory studies, following the ground-breaking experiments by DeBano and colleagues in the 1960's. Since then, it has often been assumed that water repellency present in burnt soils is a result of the fire. More recently, however, an increasing number of studies have reported high levels of water repellency from areas not affected by fire and the question arises to what degree water repellency levels observed at burnt sites are actually a result of the fire. Here we report on a study aimed at establishing 'natural background' water repellency in common coniferous forest types in the northern Rocky Mountains (USA). These forests are, in general, not only fire-prone, but also subject to a substantial post-fire soil erosion risk associated with steep slopes, extensive areas affected by single burn events, and comparatively high rainfall intensities. Eighty mature or semi-mature coniferous forest sites, which showed no evidence of recent fires and had at least some needle cast cover, were sampled across five states in this region. After careful duff removal 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 taking near-surface mineral soil layer (0-3 cm) samples for laboratory analysis. Other variables examined were dominant tree type, ground veg-

etation, depth of litter and duff layer, slope angle and aspect, elevation, geology, soil texture and soil organic carbon content. ‘Natural’ water repellency was detected in all forest types examined irrespective of dominant species (Pinus ponderosa, P. contorta, Picea engelmanii and Pseudotsuga menziesii), slope angle, aspect, elevation and duff layer thickness. Overall, 78 % of sampled sites exhibited in-situ soil water repellency with more than half of all sites exhibiting WDPTs $>$ 60 s. These findings demonstrate unequivocally that the soil water repellency commonly observed in these forest types following burning is not necessarily the result of burning but can instead be a natural soil characteristic. Results of the more detailed laboratory analysis will also be presented, which will help to elucidate to what extent repellency, as characterized by the WDPT, of the sites examined here (i) varies with the parameters investigated, and (ii) differs from values determined in studies examining burnt forest sites in the northern Rocky Mountains.