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# Switching between hydrophobic and wettable conditions in soil: experiments to assess the influence of cracks, roots and subsurface drainage impedance

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Although much is known about soil hydrophobicity, assessments of the overall hydrological and erosional significance of the soil property in areas affected by it are greatly hampered by a lack of knowledge on switching between hydrophobic and hydrophilic states. This arises mainly because of (1) the destructive nature of methods of assessing hydrophobicity, (2) its often high local spatial variability and (3) difficulties of relating hydrophobicity results to meaningful soil moisture values. Also, very little is known about the influence which cracks and holes through hydrophobic soil and the presence or absence of subsurface impeding layers have on the 3D pattern and speed of hydrophobicity change during wetting and drying cycles. These issues form the focus of the present paper, which was carried out as part of the EU DESIRE Project. A laboratory experimental approach was adopted. Three different soils of equal initial hydrophibicity class when dry (18 % MED), but of contrasting texture and total carbon content, were investigated: (1) from the scrub-covered (dominated by Erica umbellata, Calluna vulgaris and Pterospartum tridentatum) Vale Torto catchment in Gois municipality, central Portugal (an area where the impacts of prescribed fire were being assessed); (2) soil around a Chamaecyparis lawsonia tree in South Wales; and (3) a vegetated coastal sand-dune location at Nicholaston, Gower Peninsula, South Wales. For the experiments, 106 samples of sieved (< 2 mm), dried soil were placed to a depth of 10 cm in standardized transparent pots (16.5 cm high, top diameter 16 cm, basal diameter 11 cm). Equal numbers of samples were prepared with either (i) five simulated holes, (ii) two simulated linear cracks (in both cases extending downwards to the sample base) and (iii) control soil samples without cracks or holes). Samples were also either (i) sealed at the base to create subsurface impeded drainage or (ii) provided with unimpeded basal drainage by insertion of holes in the container base. All samples were subjected to wetting (100 ml delivered evenly to the surface) and then subsets of samples were oven-dried over different durations (0, 9, 24, 48 and 80 hours) before being assessed (destructively using the MED test) for their 3-dimensional (3D) distribution of hydrophobicity and soil moisture. Photography was also used to show wetting patterns visually.

In the wetting experiments, 3D patterns of hydrophobicity varied significantly between the samples with cracks and holes, where zones of wettable soil developed around the preferential routeways with hydrophobic soil between, and the control soil samples, where wetting patterns were more random. Samples with impeded basal drainage promoted basal wetting between cracks and holes, whe reas large expanses of unaltered hydrophobic soil persisted in samples with unimpeded basal drainages. During the drying phase, the degree, 3D-pattern and speed of redevelopment of hydrophobicity also varied greatly between samples with versus without cracks and holes and with versus without impeded basal drainage. In some cases peak hydrophibicities achieved locally within samples after 48 hours of drying were of greater severity than those recorded for the same soil in its original dry state. Important differences in both wetting and drying patterns between the three soil types were recorded and are discussed. Some implications of the results for runoff generation in soils affected by transient hydrophobicity but differing in their frequencies of cracks and holes are explored.