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Effects of biogenic hydrophobicity on soil water movement - a review

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Soil hydrophobicity (water repellency) can reduce the affinity for soils to water such that infiltration or wetting may be delayed for periods ranging from as little as a few seconds to in excess of weeks. This behaviour is thought to be caused primarily by a coating of long-chained hydrophobic organic molecules on individual soil particles. These substances may be released from a range of plants, decaying organic matter, soil fauna and micro-organisms either naturally or during burning. Hydrophobicity tends to be spatially and temporally highly variable, which makes its effects difficult to observe and predict. It is often most prominent after prolonged dry spells and can disappear entirely after prolonged contact with water. Owing to the cultivation of certain, sometimes introduced, plant species and the increase in wildfires in some regions, hydrophobicity has developed in previously unaffected areas. It affects, for example plant growth, soil hydrology and soil erosion processes. This contributions aims to provide a critical review of the current knowledge on the effects of moderate to severe hydrophobicity (i.e. where infiltration is markedly reduced) on soil water movement at centimetre to catchment scales. The main hydrological impacts of hydrophobicity at these scales are: (a) reduced infiltration; (b) increased overland flow; (c) spatially localized infiltration and/or percolation, often with fingered flow development; (d) modifications of the three-dimensional distribution and dynamics of soil moisture; (e) enhanced streamflow responses to rainstorms; and (f) enhanced total streamflow. Major advances have been made during the last two decades in measuring and understanding the smaller-scale (cm-m) hydrological effects of hydrophobicity for texturally relatively homogeneous soils, but our knowledge of effects at larger scales and for texturally heterogeneous soils has remained scant. The main challenges that

have affected progress are the both spatially and temporally highly variable nature of soil hydrophobicity, which is coupled with an increasing complexity of other interacting hydrological variables at larger scales. Accordingly, recent modelling approaches have been successful in predicting the effects of hydrophobicity on soil water movement at plot or small-field scales, but approaches to predict in detail its hydrological effects at larger scales have yet to be developed.