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Water repellency in an Alpine forest soil and its impact on hydraulic characteristics under simulated climate change

Andreas Schwen (1), Michael Zimmermann (2), Axel Lamparter (3), Susanne Woche (4), and Jörg Bachmann (4)

(1) Institute of Hydraulics and Rural Water Management, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria (andreas.schwen@boku.ac.at), (2) Institute of Soil Research, University of Natural Resources and Life Sciences (BOKU), Vienna, Austria, (3) Federal Institute for Geosciences and Natural Resources, Hannover, Germany, (4) Institute of Soil Science, Leibniz University of Hannover, Hannover, Germany

The climate of Alpine environments is expected to change dramatically as a consequence of global climate change. In this ecologically sensitive environment, prolonged dry periods and an increased occurence of extreme rainfall events is forecasted by many climate change models. On the other hand, soil water repellency (SWR) is known to affect hydraulic processes in soils, particularly in acidic forest soils and as a consequence of prolonged dry periods. By changing the soil surface properties, SWR also changes the hydraulically effective properties of soils. The quantification of the spatial occurence and degree of hydrophobicity is a crucial prerequirement for ecological and hydrological impact assessment and developing new models. Therefore, the objective of the present study was to quantify soil water repellency in an Alpine forest with respect to its spatial variability and affected by different simulated climatic regimes. The study was accomplished in the Rosalian mountains, some 60 km south of Vienna, Austria. The vegetation was a mature beech forest and the soil was a Podsolic Cambisol over weathered granitic rock debris. As parts of the experimental plot were covered by plastic roofs and artificially irrigated, three different treatments were tested: Compared to the natural precipitation (control), the irrigation amount was reduced with two drought degrees (moderate and extreme). Within a small grid, 9 samples were taken per treatment in two depths (surface and 0.10 m). The contact angle was determined with the modified sessile drop method. Additionally, total and organic carbon contents and the hydraulic soil properties were quantified. Infiltration experiments were performed with a tension infiltrometer using water and ethanol. The results showed considerable water repellency with at least subcritical contact angles for all treatments. Contact angles increased to above 90 degree at the moderate and extreme drought treatments. Differences between intrinsic and apparent hydraulic properties as reflected by the ethanol and water infiltration, respectively, increased with increasing drought degree.