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Experimental study on the dynamics of water repellency on temperate forest soils

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Water repellency is widely associated with dry soils and has important hydrological implications including an increase in runoff and erosion risk. It has been widely studied under Mediterranean conditions and after disturbances, e.g. wildfires, but there is still a lack of knowledge on the water repellency within temperate forests. As the occurrence of extreme summer droughts is expected to increase significantly in Central Europe, combined with an increase of high intensity, low frequency rainfall events, water repellency becomes an issue necessary to understand due to its consequences facing runoff generation and erosion.
This study examined the occurrence and dynamics of water repellency, with respect to soil moisture content, temperature, and the soil and forest type, in the upper Holzbach catchment, within the Hunsrück low mountain range, Germany.
The topsoil (0-10 cm) was sampled in duplicates at 19 sites, under different forestry types including Spruce, Birch and Beech forest, mixed forest, Christmas trees and within a harvesting track. To investigate the effect of the soil moisture content, water repellency was measured with the water drop penetration time method (WDPT) at different soil moisture contents. Two experiments were conducted; (1) after drying out starting at field moisture content and (2) after artificial wetting and subsequent drying. After additional oven-drying at 50°C and 105°C water repellency was measured again.
Water repellency was observed under both coniferous and deciduous forest, but was significantly lower at the harvesting track which is characterized with a compacted Ah- and destroyed Oh-layer. Other samples with Ah-layers also exhibited significantly lower water repellency relative to other topsoil layers. This trend confirms that soil organic matter is likely to be an important factor for water repellency. Water repellency was lower under artificial drying conditions for 81% of the observations, but non-linear behaviour of water repellency with respect to soil moisture content was observed under both experimental conditions. After additional oven-drying at 50°C, no significant changes where observed but a markedly increase was recorded after oven-drying at 105°C.
It is very likely that a time-dependant factor rather than the soil moisture content affects the occurrence of water repellency.