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Does drought alter hydrological functions in forest soils?

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Climate change will probably alter precipitation patterns across central Europe, and (summer) droughts are expected to be more frequent and severe in future. Droughts may modify soil properties, such as the pore volume distribution, soil aggregation, water repellency and rooting patterns. These changes in soil properties affect the hydrological functioning of the soil like water retention, infiltration and percolation and thereby the site conditions for plants. The aim of this research is to investigate the effect of droughts on the hydrological functioning of forest soils. We conducted rainfall-reduction experiments in three woodlands (nine investigation sites) across Germany. We established adaptive roofing systems which allow a flexible reduction of the precipitation between 15 % and 65 % of the incoming precipitation depending on the actual precipitation. The impact of the imposed droughts on the soil properties was assessed by repeated analyses of soil aggregation, hydrophobicity and pore volume distribution. Hydrological functioning of the soil was assessed by means of repeated dye tracer sprinkling experiments. Comparing dye tracer images of 2011 with images taken after two years of imposed drought, we found a general shift in infiltration processes depending on the soil type. Sandy soils showed a shift from front-like infiltration towards a more fingered and scattered infiltration. Soils rich in clay tend to develop unstained (= not wetted) areas in the top layer, which might hint to evolving hydrophobicity. This was confirmed by field and laboratory hydrophobicity tests. Further, the same profiles were showing signs of lower permeability in the bottom layers. Similar to hydrophobicity, we want to link the results of soil aggregation and pore volume distribution to the changes in the infiltration pattern. Our study shows that changes in precipitation pattern can severely affect forest soil properties and their hydrological functions. The results of this study may help to assess future behavior of the plant-soil-water-system and may help to adjust models or include relevant processes into existing models to predict future response to different precipitation patterns as well as help coping with existing and future emerging challenges in forest management.