Monitoring drought effects on soil structure and hydrological soil functions

Katharina Gimbel, Heike Puhlmann, Markus Weiler

HYDROLOGY

Introduction

Climate change is predicted to severely affect precipitation patterns across central Europe. Soil structure is closely linked to the activity of soil microbiota and plant roots, which modify flow pathways along roots, organic matter and water repellence of soils.

Study sites: prograted depletion

- Schorfheide (Brandenburg) - 25 mm
- Hanitzsch (Thuringia) - 35 mm
- Schwäbische Alb (Baden-Württemberg) - 44 mm

Through shrinkage and fracturing of soil aggregates, soil structure is also responding to changing climate (in particular drought conditions).

The ecosystem response to reduced water supply will depend on the system’s stability. Soil hydrological properties not only affect plant functioning but, in turn, are strongly influenced by the vegetation.

Our research is focused on the direct and indirect effects of drought on different parts of the forest-understory-soil system.

Hypotheses

Drought will change the hydraulic functions of the soil via alteration of the soil structure.

- a: Soil structure is site-specific and depends on the management intensity and the diversity of plant and soil-microbial communities.
- b: Drought will cause a change in soil structure, due to shrinkage and fracturing of soil aggregates. This will affect hydrological soil functions, specifically preferential flow.
- c: Ecosystem responses to drought, in particular changes in rooting patterns and microbial community composition will influence and possibly enhance bypass flow, water uptake and water redistribution in soils.

Laboratory experiments

In order to test hypotheses a) and to characterize the architecture of macro-, meso-, and micro-pores, undisturbed soil samples are analyzed by imaging techniques, computed tomography and hydraulic flow experiments. Temporal dynamics of the soil structure are monitored through repeated soil sampling at a profile wall. Rooting density and patterns are also monitored continuously. Effects of soil-structural changes on the hydrological soil functions are assessed by continuous soil water and soil matrix potential monitoring, infiltrometer and dye-pulse experiments. Observed soil-structural changes are linked to changes in rooting patterns and changes in hydrophobicity.

Monitoring and Sampling

The effects of the imposed precipitation reduction are continuously monitored on the roofed and in parts on the control plots (soil moisture, soil temperature, electric conductivity, air temperature, and humidity, roof runoff and sapflow).

The effects of the imposed drought on soil structure and hydrological soil functions are monitored in repeated measuring/sampling campaigns in spring and fall. In addition, experiments for hydrophobicity and aggregate structure are conducted on site.

Institute of Hydrology, Albert-Ludwigs-University of Freiburg
katharina.gimbel@hydrology.uni-freiburg.de  www.hydro.uni-freiburg.de