Experiments on forest soil structure, hydrological soil function and drought conditions

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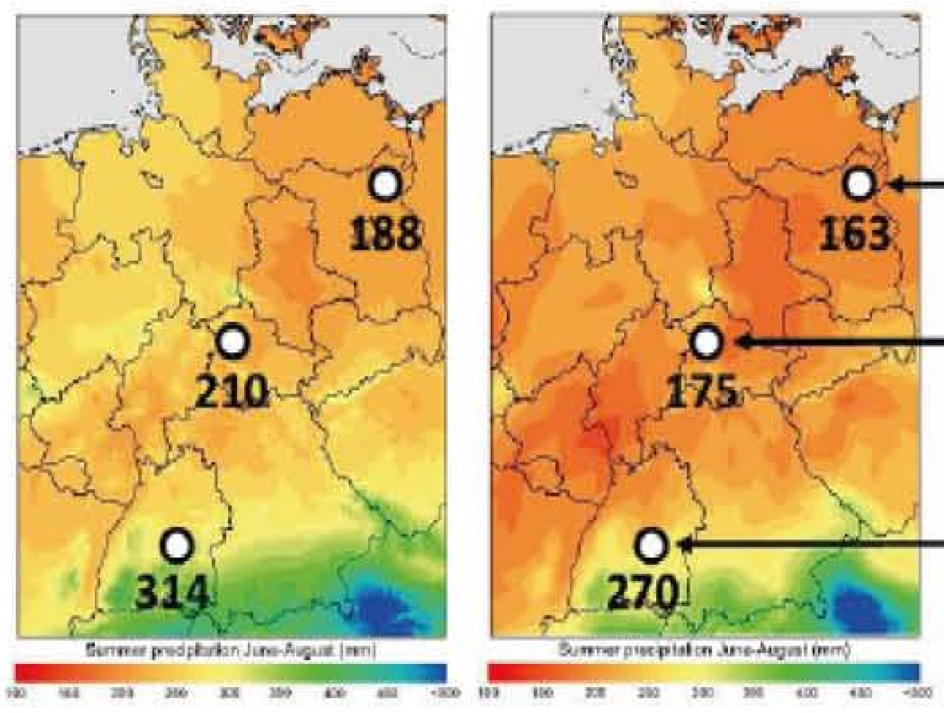
Introduction



A) Mean summer precipitation (June - August) for Germany from 1930 - 1990

B) Mean summer precipitation (June - August) predicted for 2021 - 2050 according to the A1F1-scenario

Study site	prognosted depletion
Schorfheide (Brandenburg)	25 mm
Hainich (Thüringen)	35 mm
Schwäbische Alb (Baden-Württemberg)	44 mm

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.

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.

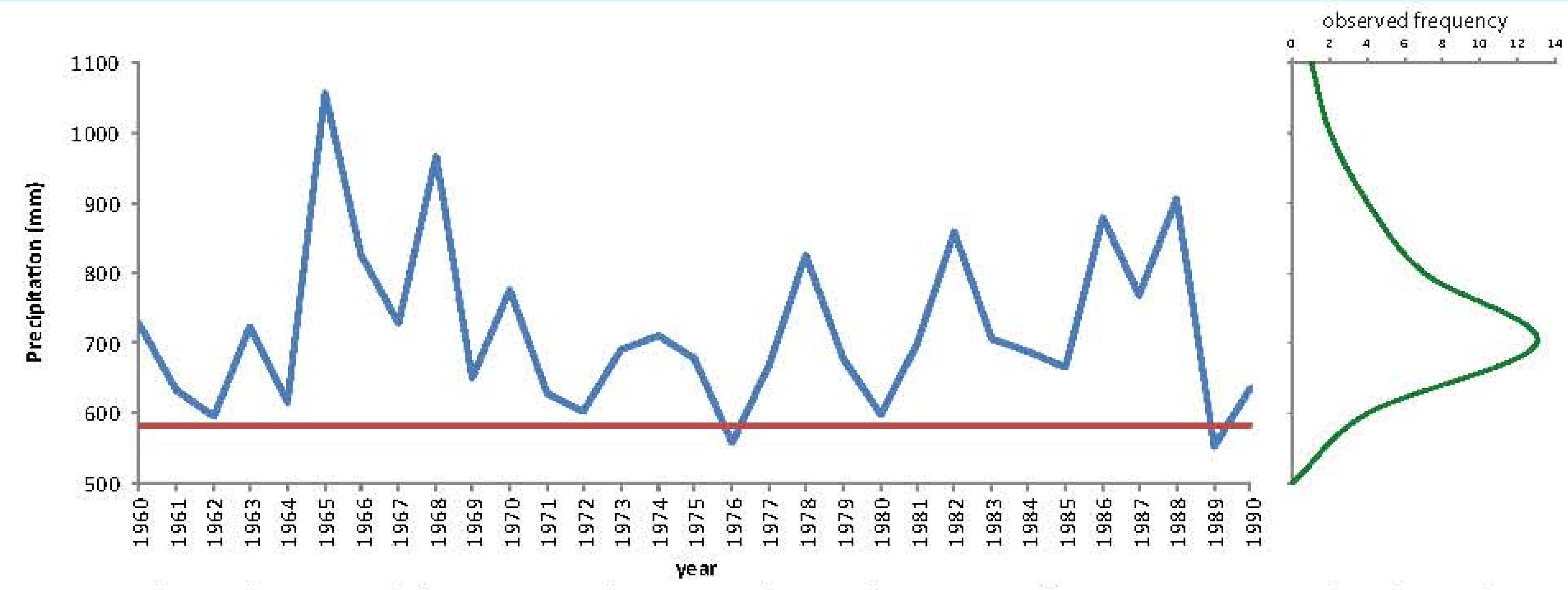
a: Soil structure is site-specific and depends on the management intensity and the diversity of plant and soil-microbial communities.

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 and infiltration.

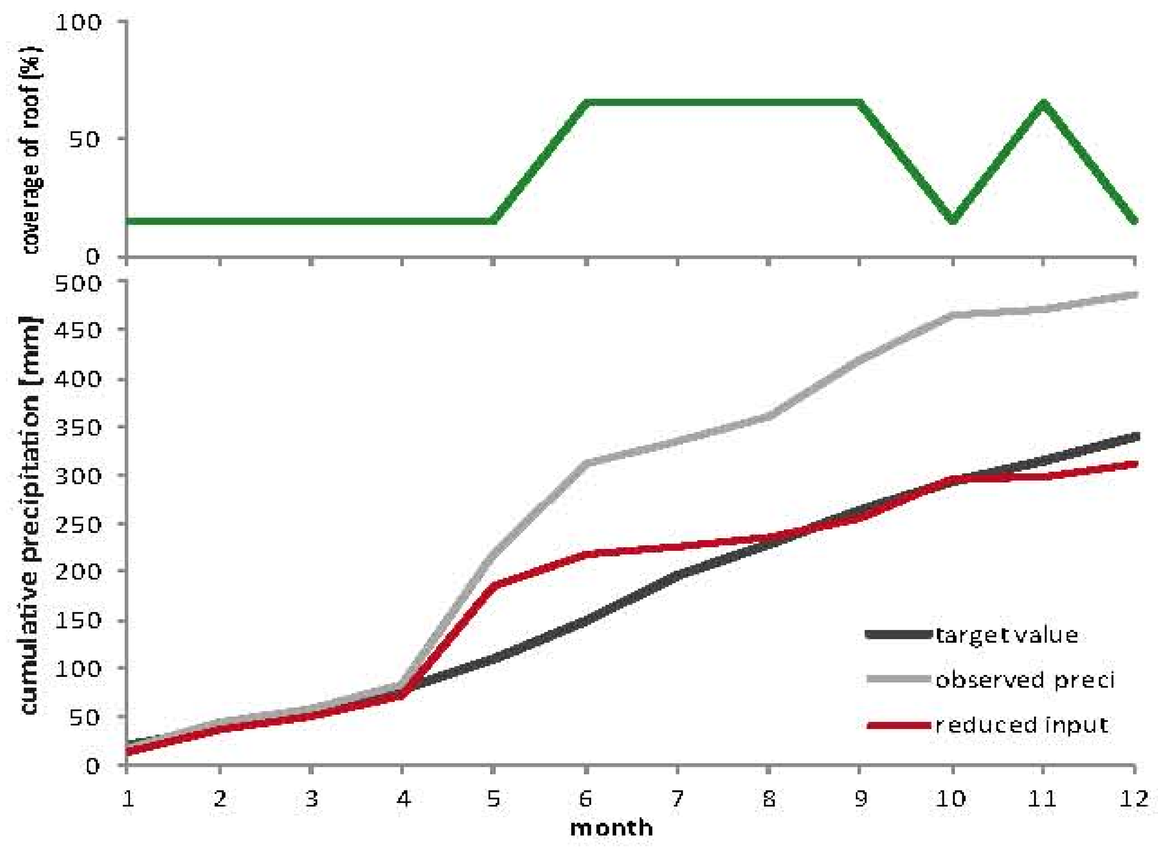
c: Ecosystem responses to drought, in particular changes in rooting patterns and microbial community composition will influence and possibly enhance bypass flow, water uptake and water redistribution in soils.

Drought = Reduction of Precipitation

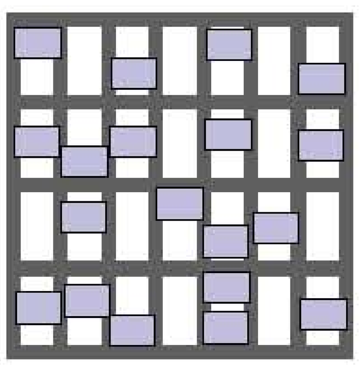
We established adaptive roofing systems which allow a flexible reduction of the precipitation in order to achieve the longterm minimum precipitation of a site. The 2.5-percentile of annual precipitation sums obtained from climate data of the years 1960 - 2010 was used as targed value. To reproduce the natural variation within the annual precipitation cycle, we used a 'seasonal factor'.



Climate data (example from area in Baden-Württemberg) with mean annual precipitation, target value obtained from this data, and observed frequency of occurance (annual precipitation).



Reduction of precipitation to achieve the target value. Roof coverage (B) between 15 % and 65 %. (Example calculated for the year 1982 to test the feasibility)



An example for roof coverage of 45 %. The roofing elements are moved randomly every month according to needed coverage.

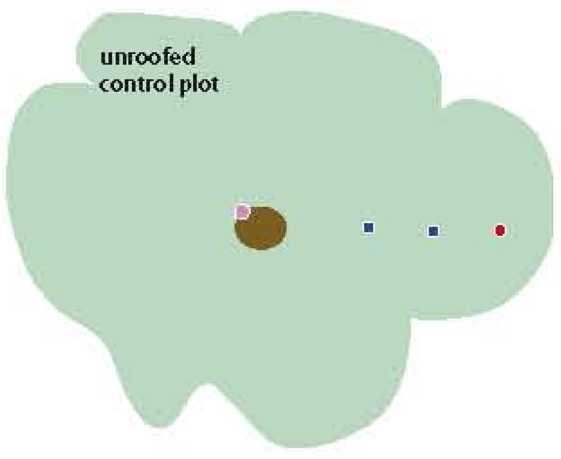
Roofing construction (10 x 10 m) with cenral tree.

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

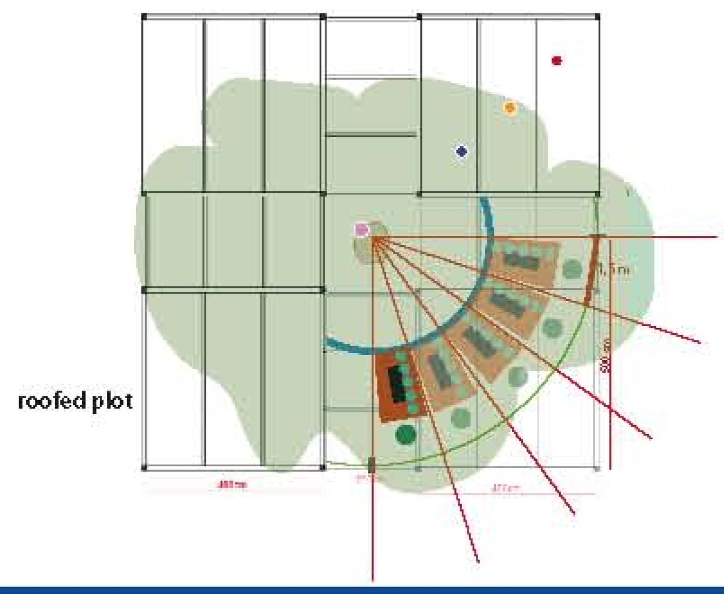


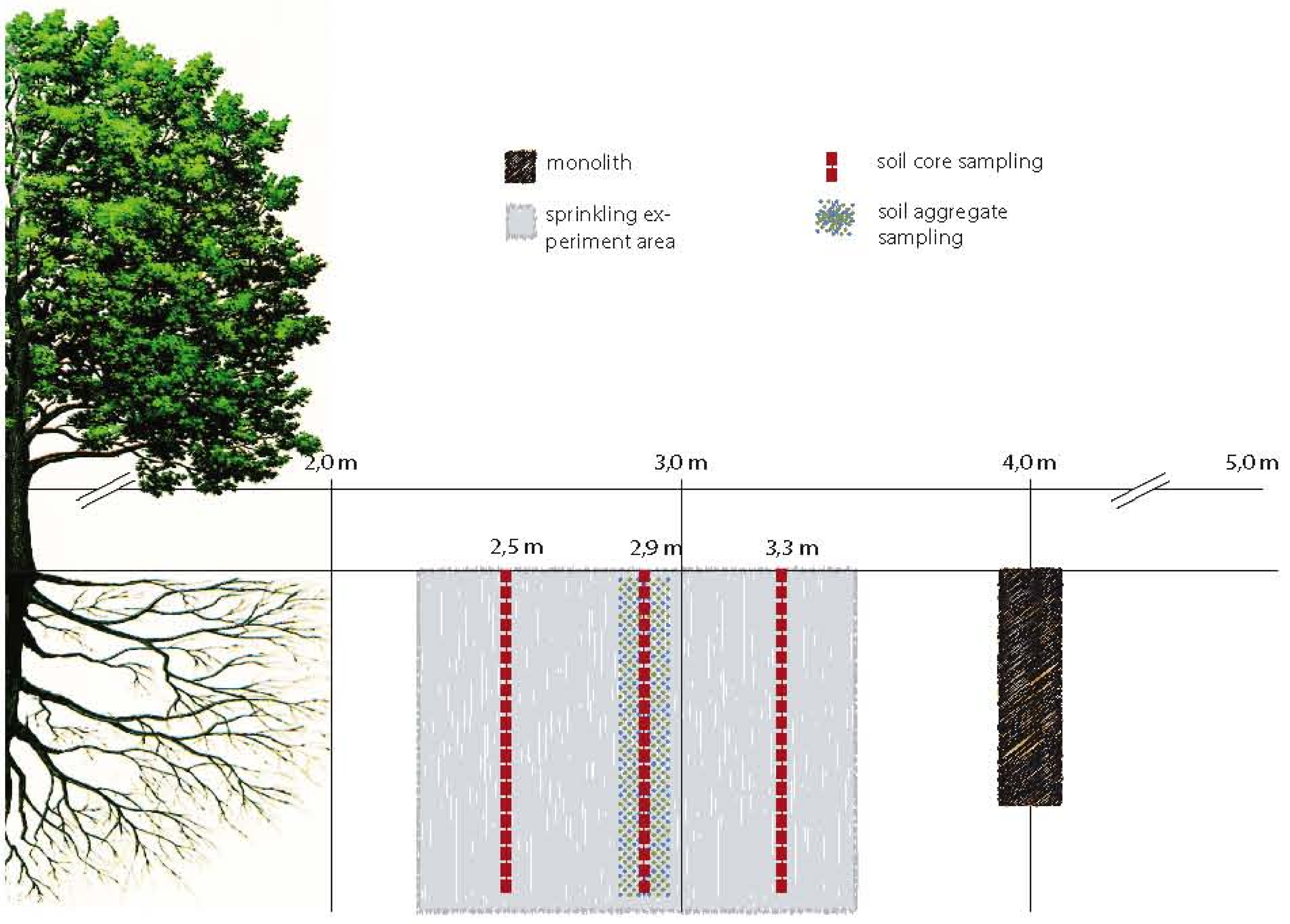
Continuous Monitoring:

- Soil moisture, soil temperature (5TM probe)
- Soil moisture, soil temperature, electric conductivity (5TE probe)
- Soil moisture, soil temperature, electric conductivity (5TE probe) and matrix potential (MPS-2 probe)
- sap flow

Sampling Campaigns:

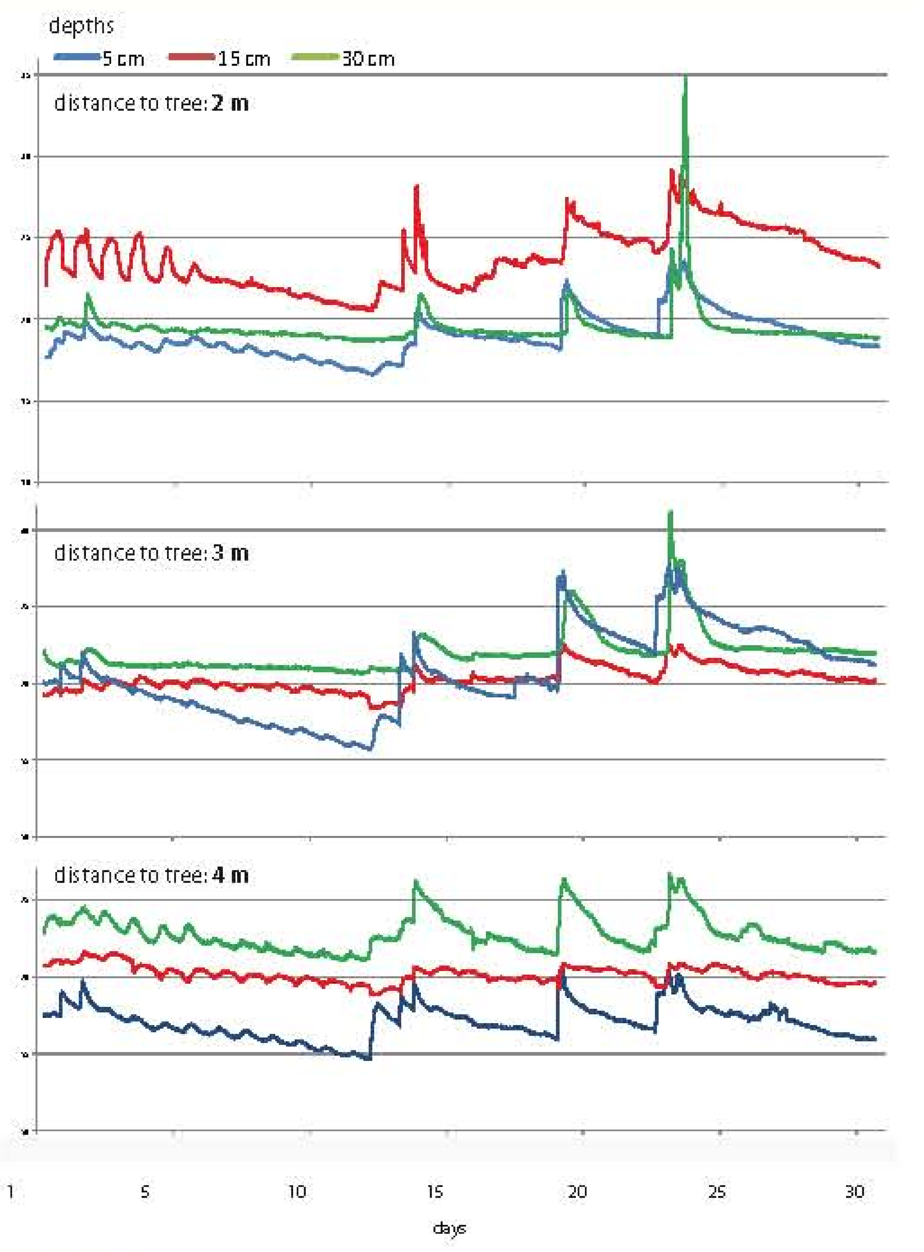
- Soil cores (100ml)
- Soil monolith (up to 70 litres)
- Area for sprinkling experiments (red) with excavated area (black)



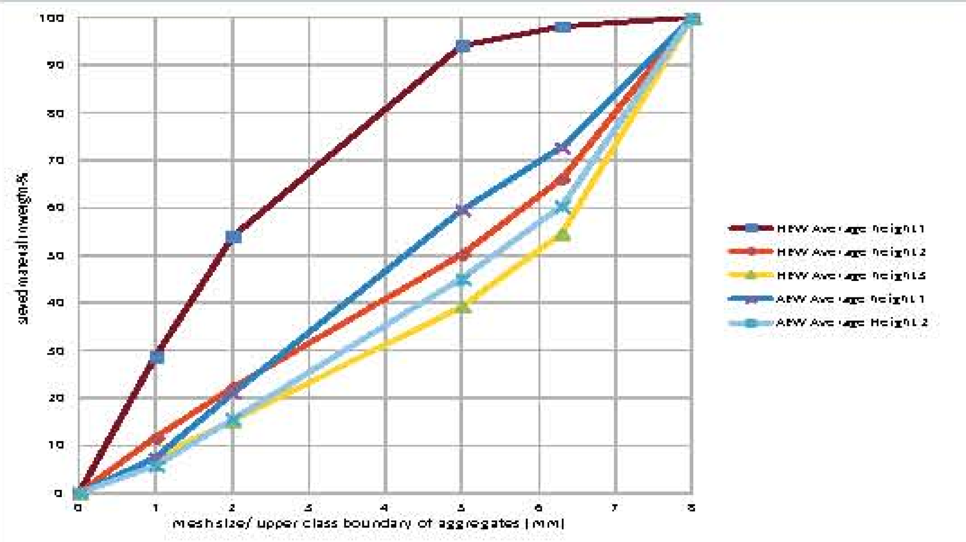


First Results

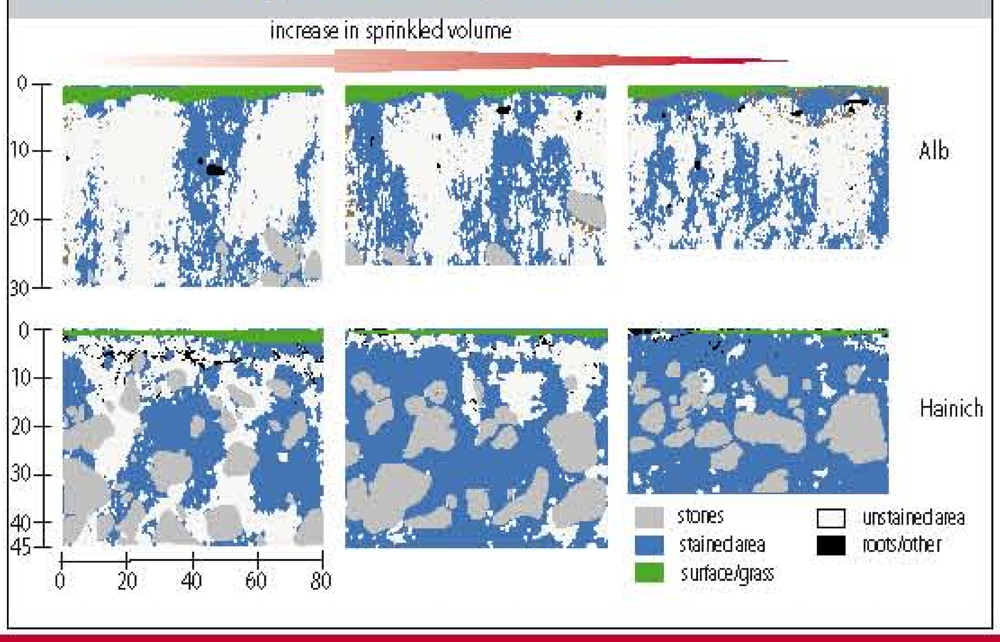
Soil moisture - probe data



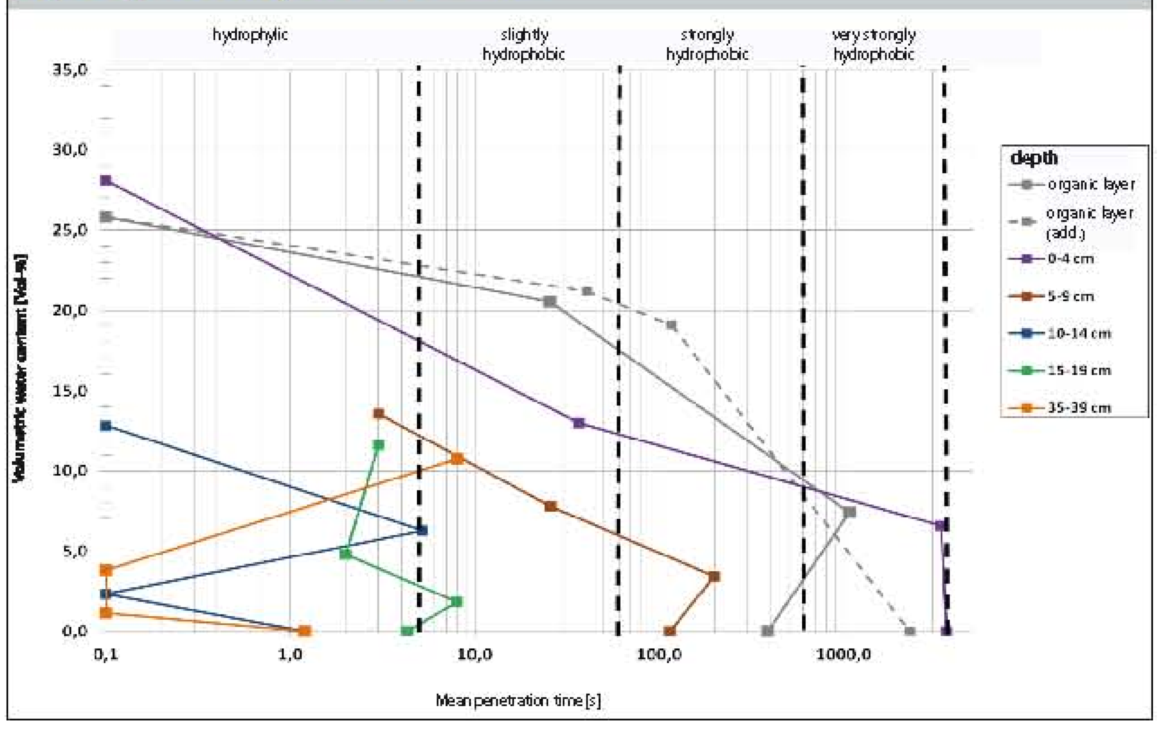
Aggregates - sieving



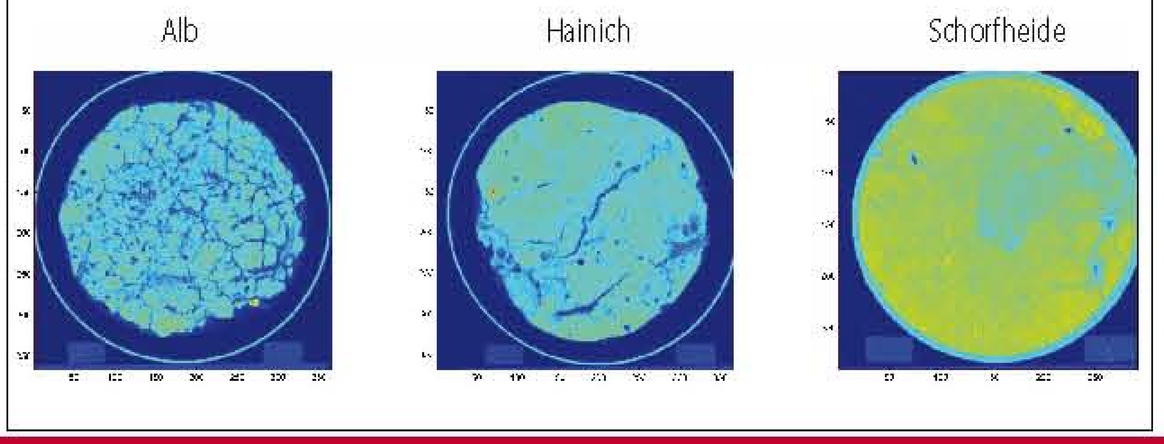
Infiltration - dye tracer experiments



Hydrophobicity - WDPT tests



Macropore distribution - CT scans



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