# Effects of drought on forest soil structure and hydrological soil functions

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*HYDROLOGY*

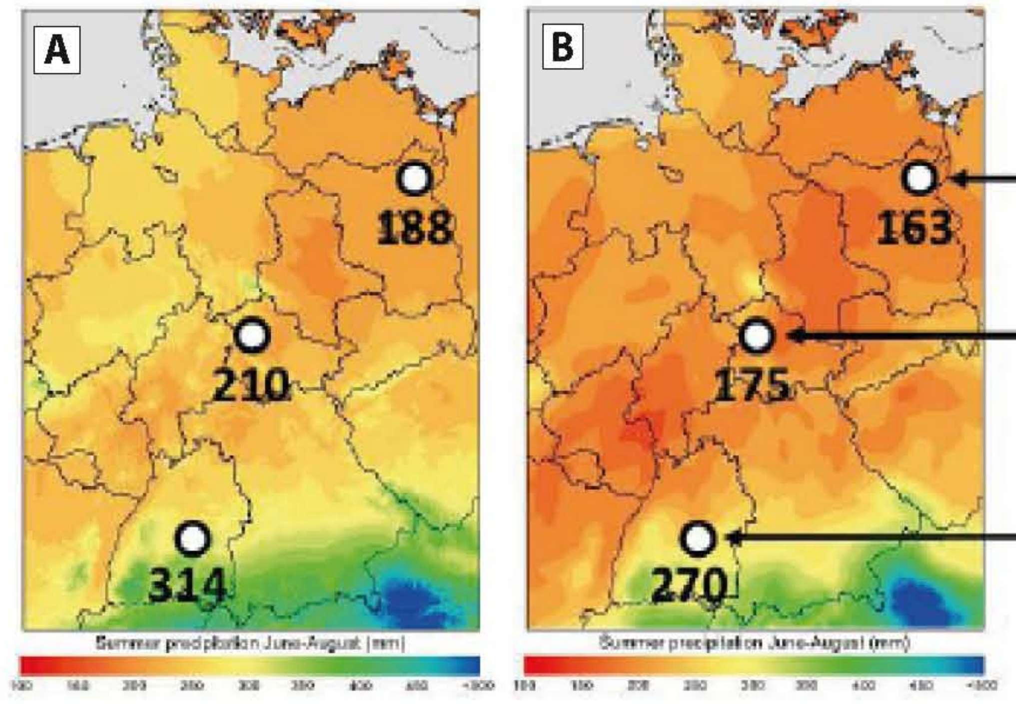
## Introduction

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.

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.

**According to the A1F1-scenario, summer precipitation will decrease within the next fifty years**

To investigate the effects of drought on forest soils, we have choosen three different areas across Germany:




| Area | prognosted depletion year 2050 |
|---|---|
| Schorfheide (Brandenburg | 25 mm |
| Hainich (Thüringen) | 35 mm |
| Schwäbische Alb (Baden-Württemberg) | 44 mm |

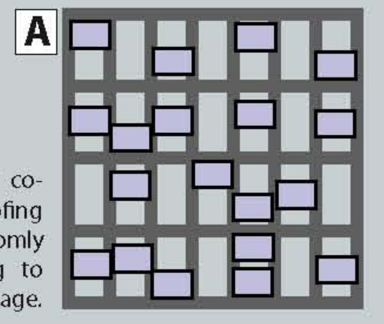
A) Mean summer precipitation (June - August) for Germany from 1930 - 1990

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

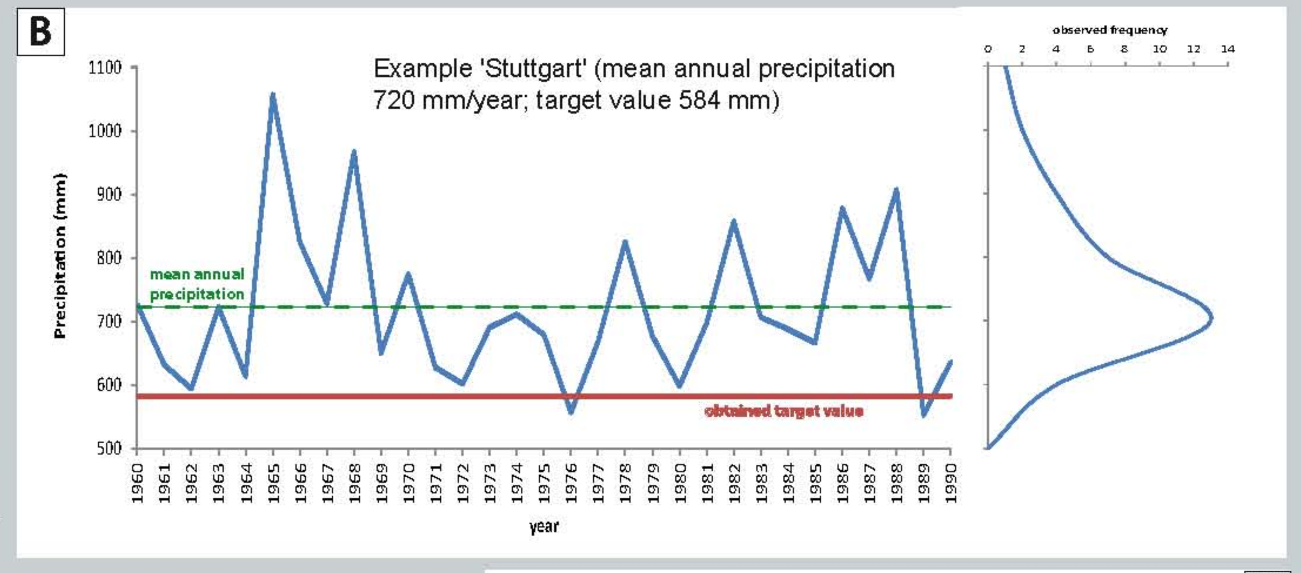
## Reduction of Precipitation

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'.

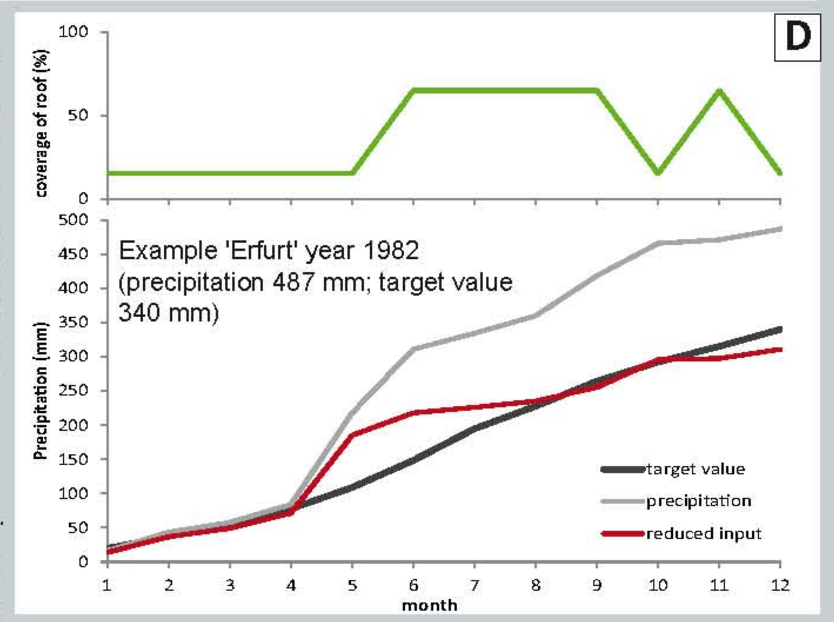



**A)** An example for roof coverage of 45 %. The roofing elements are moved randomly every month according to needed coverage.




**B)** 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).


**C)** Roofing construction with cenral tree.




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

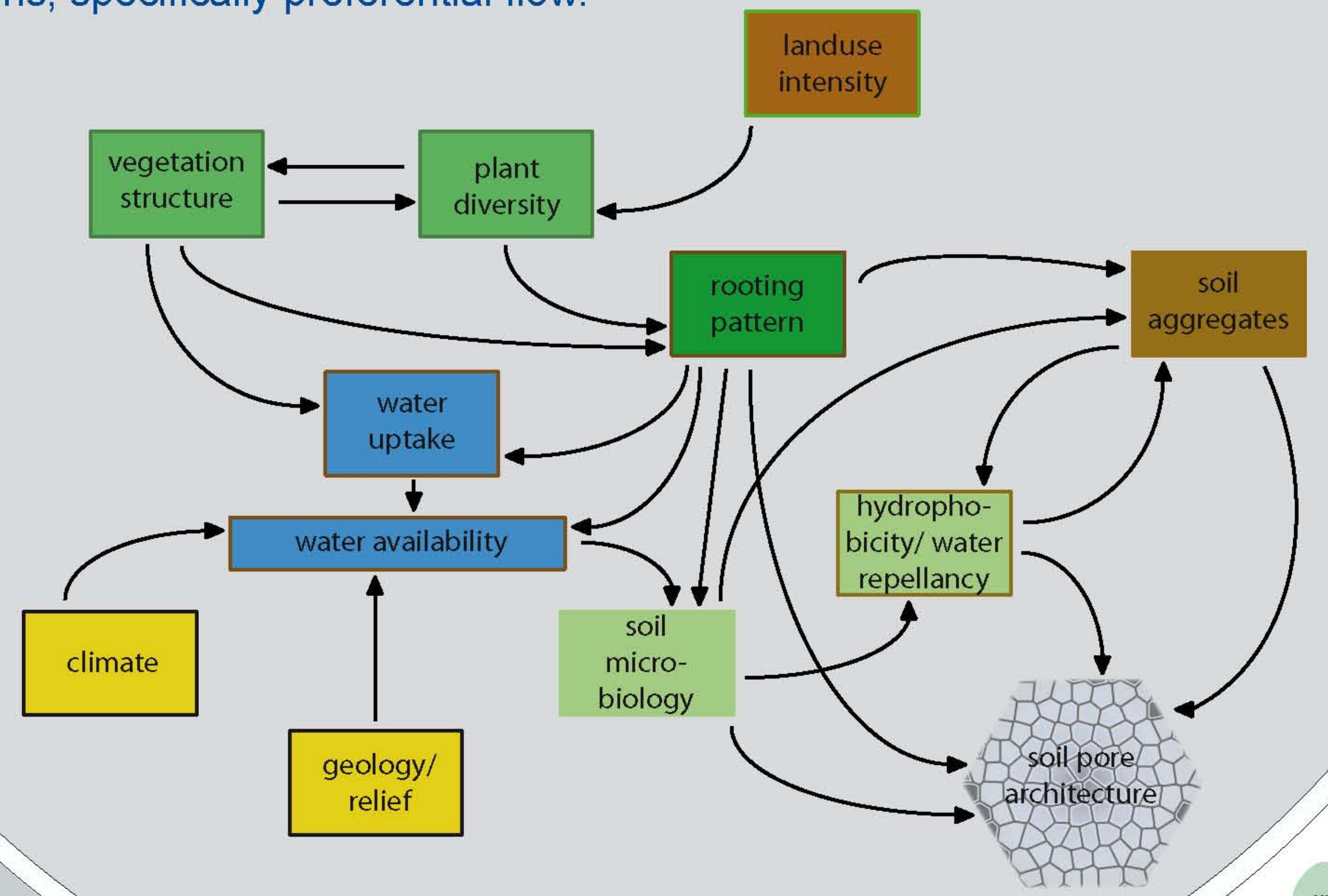
## Hypotheses

### 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 aggre-gates. This will affect hydrological soil functions, specifically preferential flow.

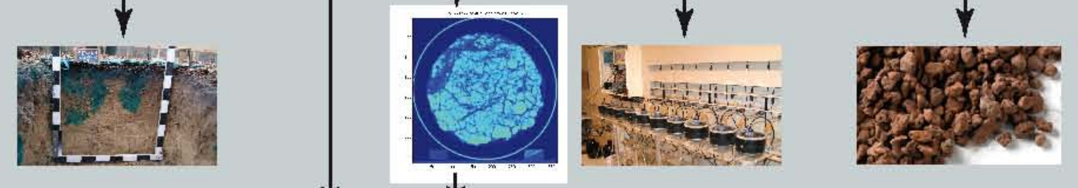
c: Ecosystem responses to drought, in particular changes in rooting patterns and microbial community composition will influence and possibly enhance bypass flow, water uptake and water redistribution in soils.




## Laboratory experiments

**field campains**: 2011 (Baseline), 2012 (Spring, Fall), 2013 (Spring, Fall), 2014 (Spring)

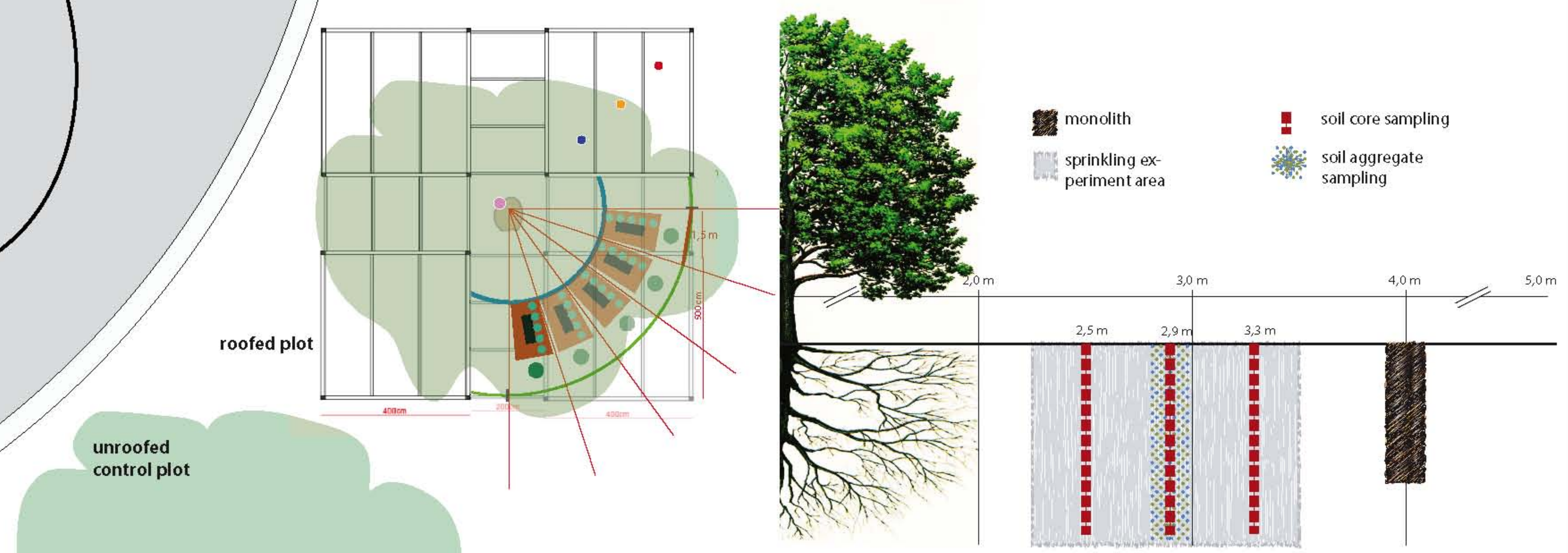
| | | | | |
|---|---|---|---|---|
| | spring + fall | fall | spring + fall | spring + fall |
| **sample type** | Field Experiments | Monoliths | Soil Cores | Disturbed soil samples |
| **laboratory experiment** | Sprinkling Experiment | Inflow-Outflow; CT | Multi-Step-Outflow | Sieving & Photometrie |
| **obtained data** | - infiltration pattern | - breakthrough curves - tracer distribution within monoliths; - size distribution of solids and pores | - retention conduction curves - micro-/mesopore architecture | - size distribution of aggregates |
| **objective** | Characterisation of hydrological soil functions | Characterisation of pore architecture | | Characterisation of soil texture & soil aggregates |



## 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.

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