EGU-EUROPEAN GEOSCIENCES UNION

EFFECTS OF BIOTIC AND ABIOTIC INDICES ON LONG TERM SOIL MOISTURE DATA IN A GRASSLAND BIODIVERSITY EXPERIMENT

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THE JENA EXPERIMENT
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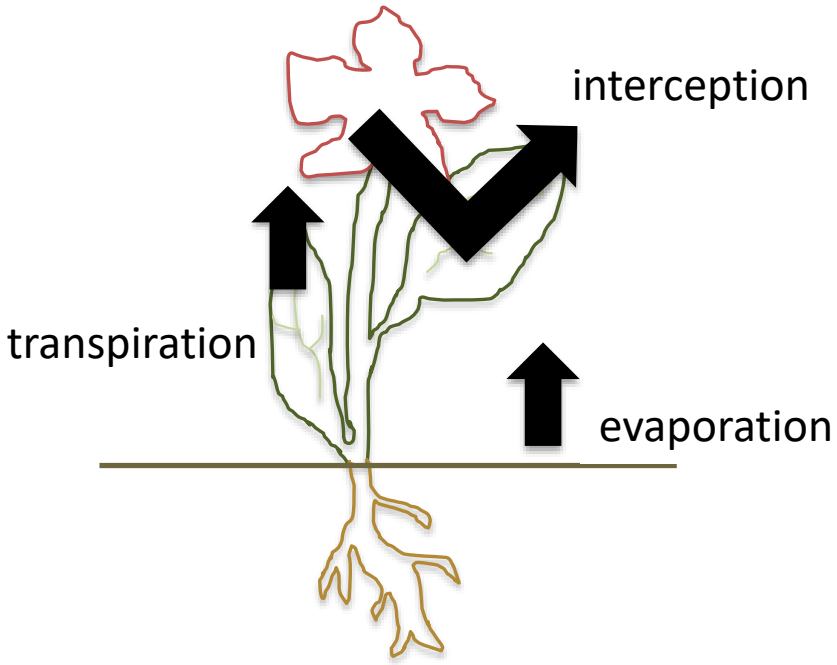
Motivation

Plant canopies effects soil water in several ways



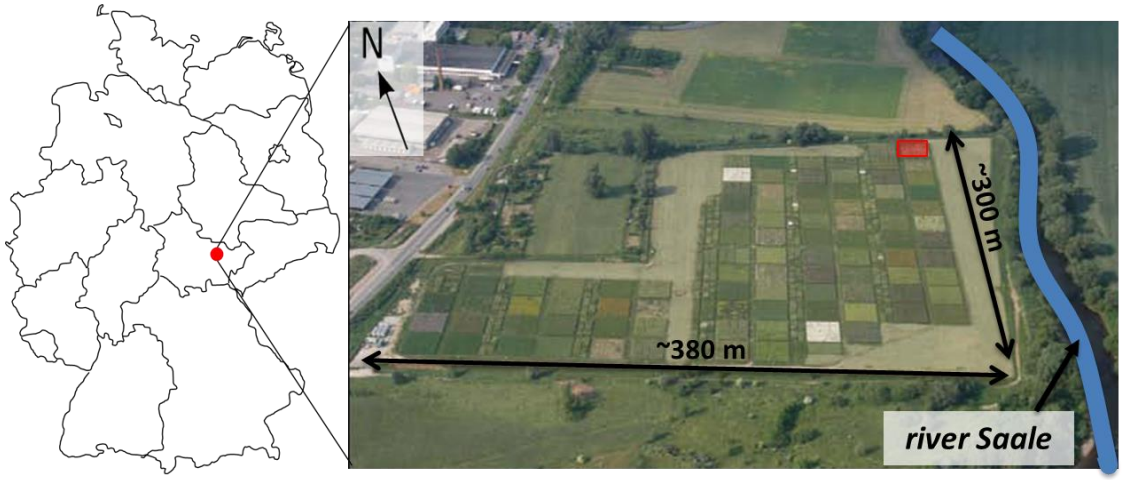
- Soil moisture variability is affected by several processes, many are related to vegetation activity
- Root water uptake and transpiration by plants → soil water content decreases
- Canopy cover increases the shading of the soil surface and can decrease evaporation →soil water content increases
- Plant community influences soil organic matter dynamics → unknown effects on soil water content

Investigate how plant community affects soil water content and assess the underlying mechanisms for plant–soil interactions

The Jena Experiment

Statistical design that allows for testing influence plant community biomass on soil water content

- Plant diversity experiments manipulate plant cover by loss of plant species richness
  → above- and belowground productivity increases with diversity
- Before establishment in 2002, field site was arable land
- Variation of plant species mixtures (1-60 species from Central European grasslands) on 82 plots of 20 × 20 m
- Categorized in plant functional groups (grasses, legumes, small and tall herbs)
- Covers a gradient of both plant species richness (1,2, 4, 8, 16, and 60 species) and functional group richness (1, 2, 3, and 4 groups) in a nearly orthogonal design
- Soil moisture was measured in 0.1, 0.2, 0.3, 0.4, and 0.6 m soil depth from 2003 until 2013 (May to September; excepted 2006 and 2007)



Photograph by J. Baade

Results

Effect of Plant species richness on soil water content

Year	2003	2004	2005	2008	2009	2010	2011	2012	2013
0.1 m	↑*	↑*				↓*		↓*	
0.2 m							↓*	↓***	↓*
0.3 m			↓*				↓***	↓***	
0.4 m							↓*	↓**	
0.6 m							↓**	↓*	

Year	2004	2010	2011
0.1 m	Leaf area index↑***	rootbiomass↓** Leaf area index↓	-
0.2 m	-	-	Soil orgnaic carbon↓**
0.3 m	-	-	Leaf area index↓*** Soil organic carbon↓**
0.4 m	-	-	Leaf area index↓**
0.6 m	-	-	Leaf area index↓***

modfied from Fischer et al., 2019

Arrows indicate significant increase (↑) or decrease (↓) for the relative differences of soil water content with increasing species richness:

- 2003 / 2004 shallow soil, shading by leaves → decreases soil evaporation → higher soil moisture
- 2010, shallow soil, increased LAI and root BM → increased transpiration → lower soil moisture
- From 2011, shallow soil, higher SOC and decreased bulk density → decrease soil moisture
- From 2011, deeper soil, greater evaporative demand → decrease in soil moisture

Legend

Grey fields:	No relation between species richness and soil water content
Text:	Variables, which **improved** the same model, when replacing species richness with this variable -> underlying effects
Arrows:	Direction of the relation
Color:	**yellow** mainly soil effect, **green** mainly ecosystem effect

Effect of plant functional groups on soil water content

Topsoil

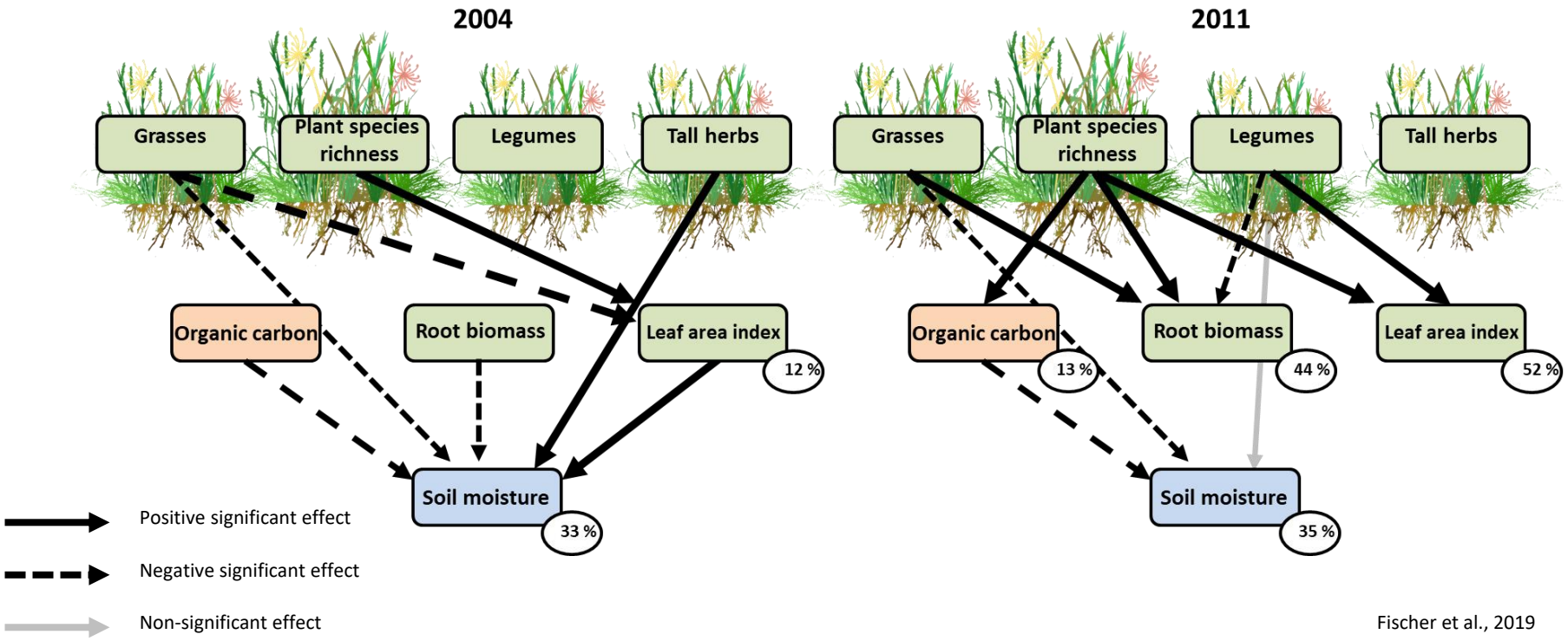
- Grasses: drier in all observed years
- Legumes: moister, but only up to the year 2008

Bottom

- Small herbs: moister in all years
- Tall herbs: drier in all years

Summary

Effects of species diversity are both from enhanced transpiration but with establishment increasingly also soil feedbacks



Fischer et al., 2019

Functional groups affected the soil water distribution by characteristic shifts of root water uptake depth, but did not enhance exploitation of the overall soil water storage

Thank you for your attention

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RESEARCH ARTICLE

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Plant species richness and functional groups have different effects on soil water content in a decade-long grassland experiment

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Abstract

1. The temporal and spatial dynamics of soil water are closely interlinked with terrestrial ecosystems functioning. The interaction between plant community properties such as species composition and richness and soil water mirrors fundamental ecological processes determining above-ground–below-ground feedbacks. Plant-water relations and water stress have attracted considerable attention in biodiversity experiments. Yet, although soil scientific research suggests an influence of ecosystem productivity on soil hydraulic properties, temporal changes of the soil water content and soil hydraulic properties remain largely understudied in biodiversity experiments. Thus, insights on how plant diversity—productivity relationships affect soil water are lacking.
2. Here, we determine which factors related to plant community composition (species and functional group richness, presence of plant functional groups) and soil (organic carbon concentration) affect soil water in a long-term grassland biodiversity experiment (The Jena Experiment).
3. Both plant species richness and the presence of particular functional groups affected soil water content, while functional group richness played no role. The effect of species richness changed from positive to negative and expanded to deeper soil with time. Shortly after establishment, increased topsoil water content was related to higher leaf area index in species-rich plots, which enhanced

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