EGU2020-10981, updated on 16 Oct 2021
https://doi.org/10.5194/egusphere-egu2020-10981
EGU General Assembly 2020

Effects of biotic and abiotic indices on soil water content in a decade-long grassland biodiversity experiment

Christine Fischer[1,2], Sophia Leimer[3], Christiane Roscher[4,5], Janneke Ravenek[6], Hans de Kroon[6], Yvonne Kreutziger[7], Jussi Baade[8], Holger Beßler[9], Nico Eisenhauer[5,10], Alexandra Weigelt[5,11], Liesje Mommer[12], Markus Lange[13], Gerd Gleixner[13], Wolfgang Wilcke[3], Boris Schröder[14,15], and Anke Hildebrandt[1,5,16]

[1]Institute of Geosciences, Friedrich Schiller University Jena, Jena, Germany
[2]Department of Conservation Biology, UFZ, Helmholtz Centre for Environmental Research, Leipzig, Germany
[3]Institute of Geography and Geoecology, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
[4]Department of Physiological Diversity, UFZ, Helmholtz Centre for Environmental Research, Leipzig, Germany
[5]German Centre for Integrative Biodiversity Research (iDiv) Halle Jena Leipzig, Leipzig, Germany
[6]Experimental Plant Ecology, Institute for Water and Wetland Research, Radboud University Nijmegen, Nijmegen, The Netherlands
[7]Institut für Wasser und Boden Dr. Uhlmann, Dresden, Germany
[8]Institute of Geography, Friedrich Schiller University Jena, Jena, Germany
[9]Department of Plant Nutrition, Humboldt-Universität zu Berlin, Berlin, Germany
[10]Institute of Biology, Leipzig University, Leipzig, Germany
[11]Department of Systematic Botany and Functional Biodiversity, Institute of Biology, University of Leipzig, Leipzig, Germany
[12]Plant Ecology and Nature Conservation Group, Wageningen University, Wageningen, The Netherlands
[13]Max Planck Institute for Biogeochemistry, PO Box 100164, 07701 Jena, Germany
[14]Landscape Ecology and Environmental Systems Analysis, Institute of Geoecology, Technische Universität Braunschweig, Braunschweig, Germany
[15]Berlin-Brandenburg Institute of Advanced Biodiversity Research (BBIB), German
[16]Department of Computational Hydrosystems, UFZ, Helmholtz-Centre for Environmental Research, Leipzig, Germany

Soil moisture is the dynamic link between climate, soil and vegetation and the dynamics and variation are affected by several often interrelated factors such as soil texture, soil structural parameters (soil organic carbon) and vegetation parameters (e.g. belowground- and aboveground biomass). For the characterization of soil moisture, including its variability and the resulting water and matter fluxes, the knowledge of the relative importance of these factors is of major challenge. Because of the spatial heterogeneity of its drivers soil moisture varies strongly over time and space. Our objective was to assess the spatio-temporal variability of soil moisture and factors which could explain that variability, like soil properties and vegetation cover, in in a long term biodiversity experiment (Jena Experiment).

The Jena Experiment consist 86 plots on which plant species richness (0, 1, 2, 4, 8, 16, and 60) and functional groups (legumes, grasses, tall herbs, and small herbs) were manipulated in a factorial design Soil moisture measurements were performed weekly April to September 2003-2005 and

2008-2013 in 0.1, 0.2, 0.3, 0.4, and 0.6 m soil depth using Delta T theta probe.

The analysis showed that both plant species richness and the presence of particular functional groups affected soil water content, while functional group richness per se played no role. Plots containing grasses was consistently drier than average at the soil surface in all observed years while plots containing legumes comparatively moister, but only up to the year 2008.

Interestingly, plant species richness led to moister than average subsoil at the beginning of the experiment (2003 and 2004), which changed to lower than average up to the year 2010 in all depths.Shortly after establishment, increased topsoil water content was related to higher leaf area index in species‐rich plots, which enhanced shading. In later years, higher species richness increased topsoil organic carbon, likely improving soil aggregation. Improved aggregation, in turn, dried topsoils in species‐rich plots due to faster drainage of rainwater.

Our decade‐long experiment shows that besides abiotic factors like texture, soil water patterns are consistently affected by biotic factors such as species diversity and plant functional types, but also properties that originate from biotic-abiotic interactions such as soil structure. Especially the effect of plant species richness propagated to deeper soil layers 8 years after the establishment of the experiment, and while originally caused by shading it was later related to altered soil physical characteristics in addition to modification of water uptake depth. Functional groups affected soil water distribution, likely due to plant traits affecting root water uptake depths, shading, or water‐use efficiency. Our results highlight the role of vegetation composition for soil processes and emphasize the need for long-term experiments to discover diversity effects in slow reacting systems like soil.