Organic carbon fluxes in intermittent springs

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Introduction

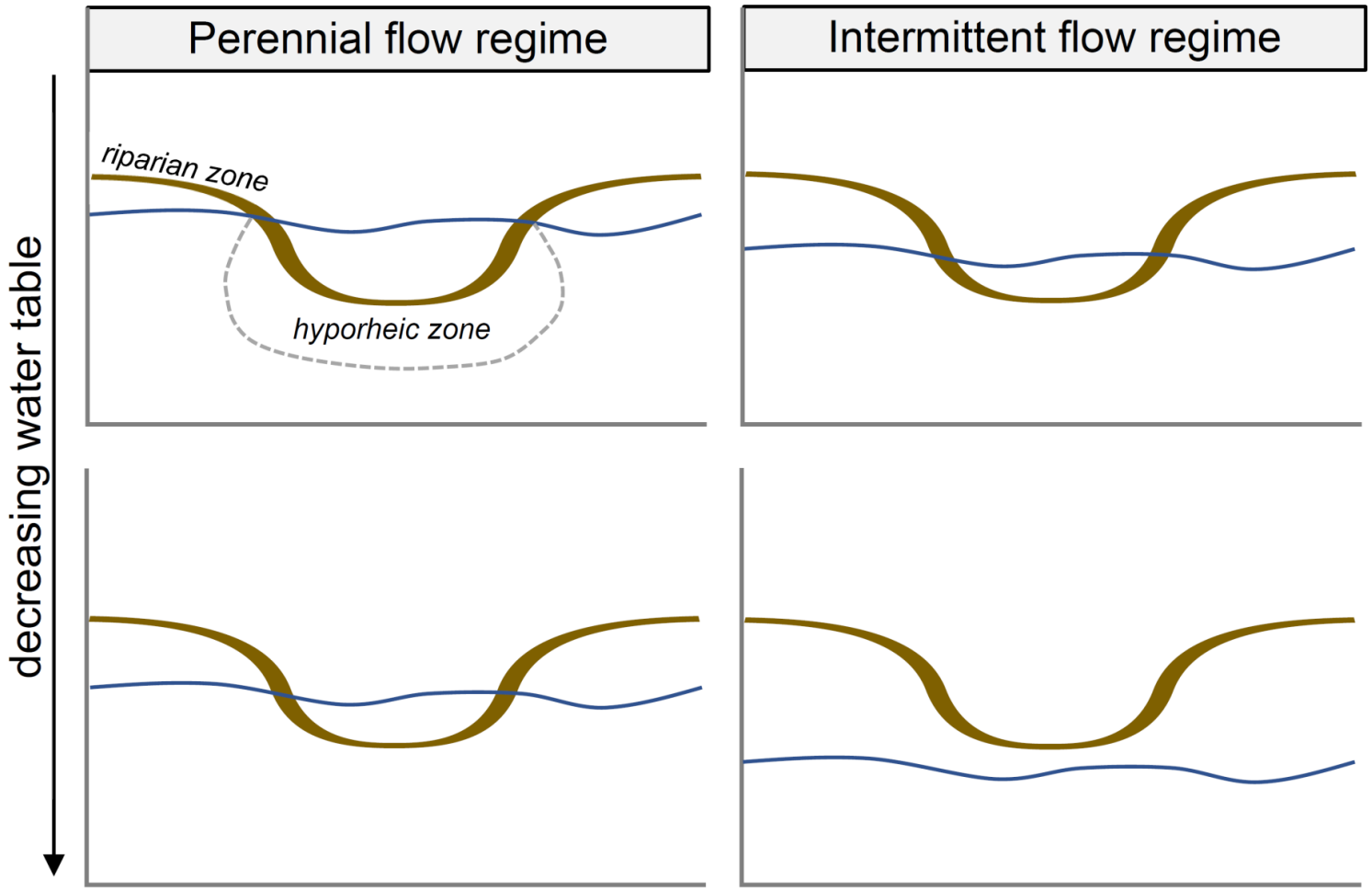

Fig.1:
Dependence of an intermittent flow regime on the water level, shown by a stream bed cross section; adapted from McDonough et al. 2011

Introduction

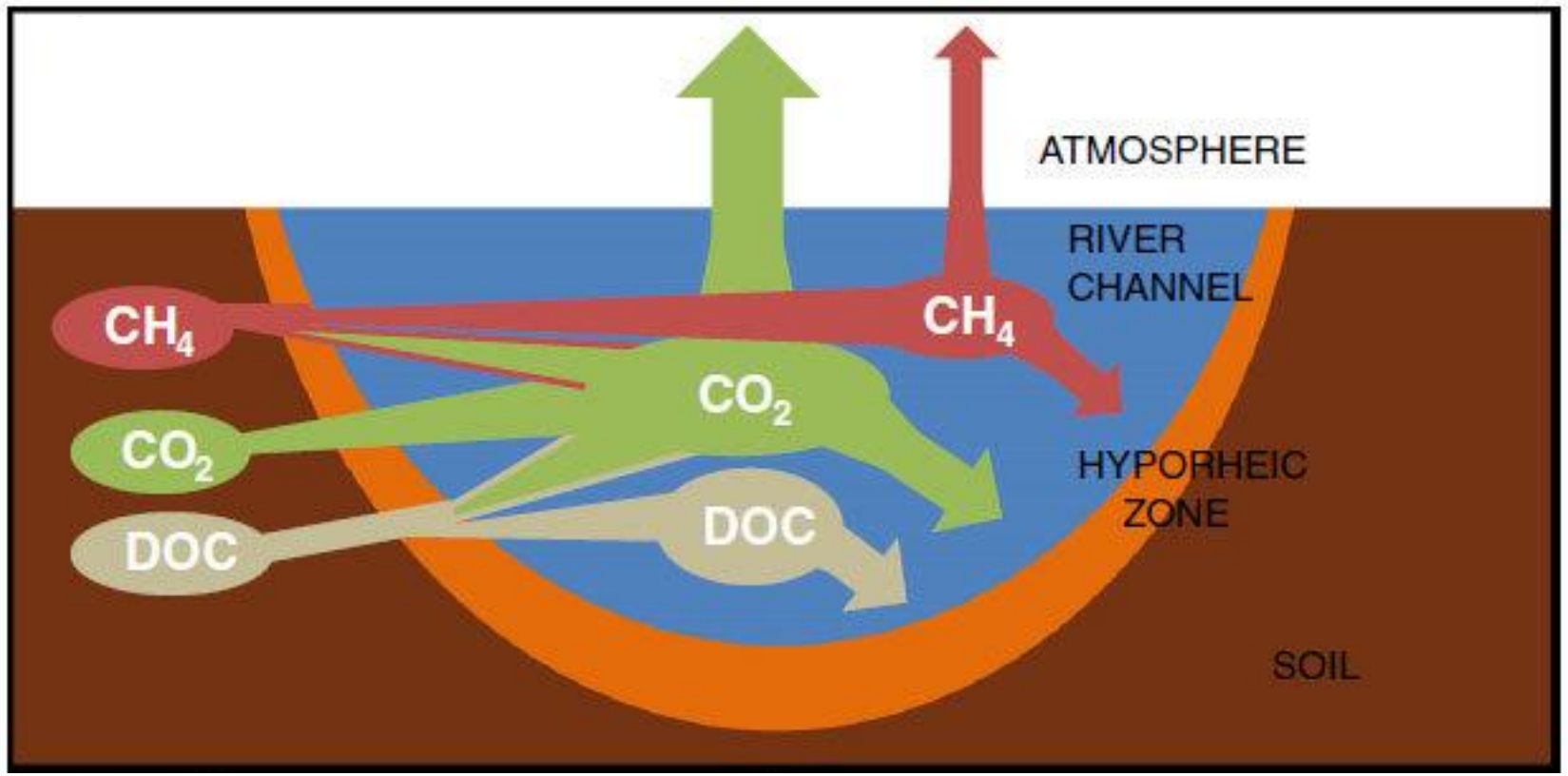

Fig.2:
Cross section of the interaction between a river channel and the adjacent soil; adapted from RASILO et al. 2017

Research Question

- Springs are known as stable habitats with low dissolved organic carbon (DOC) contents [5, 10]
- Previous investigation focused on: riparian zone, hyporheic zone and hillslopes [1, 2, 4]

- Along with climate change, intermittent springs will gain in importance and will be more frequent
- Temporarily interrupted flow regimes of springs may cause higher DOC concentrations [7]

Aims of the study:

- Investigation of spatio-temporal organic carbon (OC) dynamics of intermittent springs
- Analysis of the composition and origin of OC in intermittent springs
- Understanding the influence of special/extreme weather events on the OC fluxes
- Quantification of the OC transports from springs to the headwater streams
- Understanding the influence of DOM composition on downstream processes

Study Sites

Study sites located in four different low mountain regions in Germany:

- Sauerland
- Hesse Mountains
- Black Forest
- Ore Mountains

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covers sites with different:

- geology
- mean annual precipitation
- mean annual temperature
- land use / vegetation type

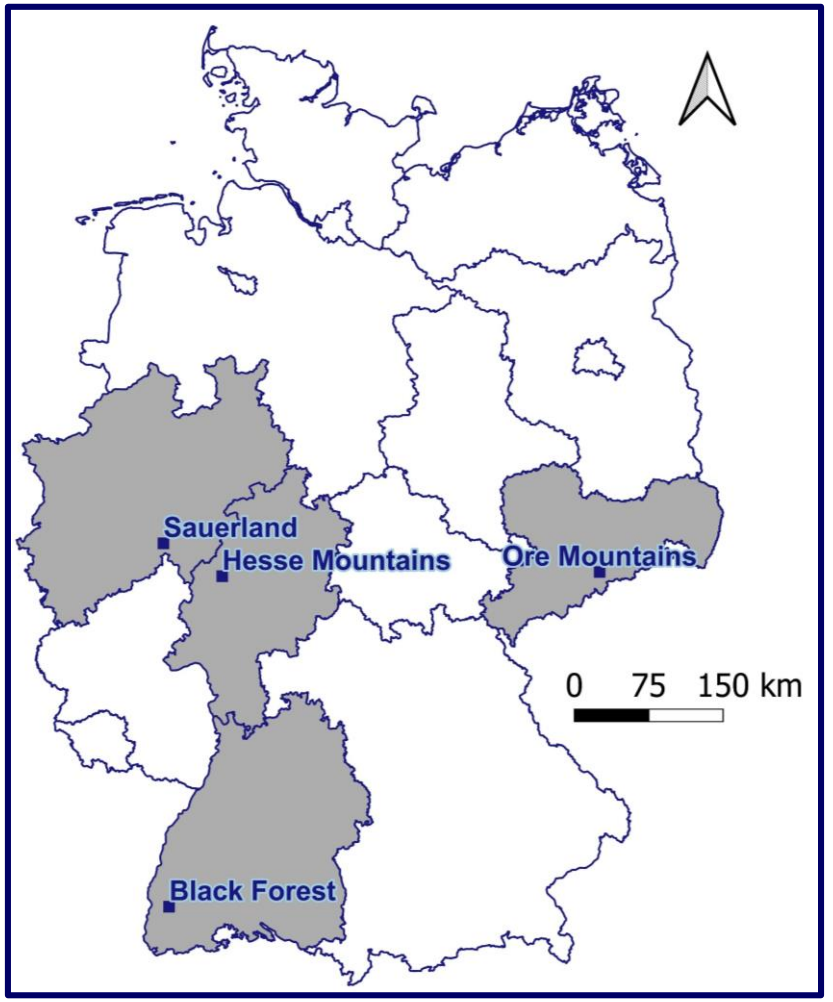
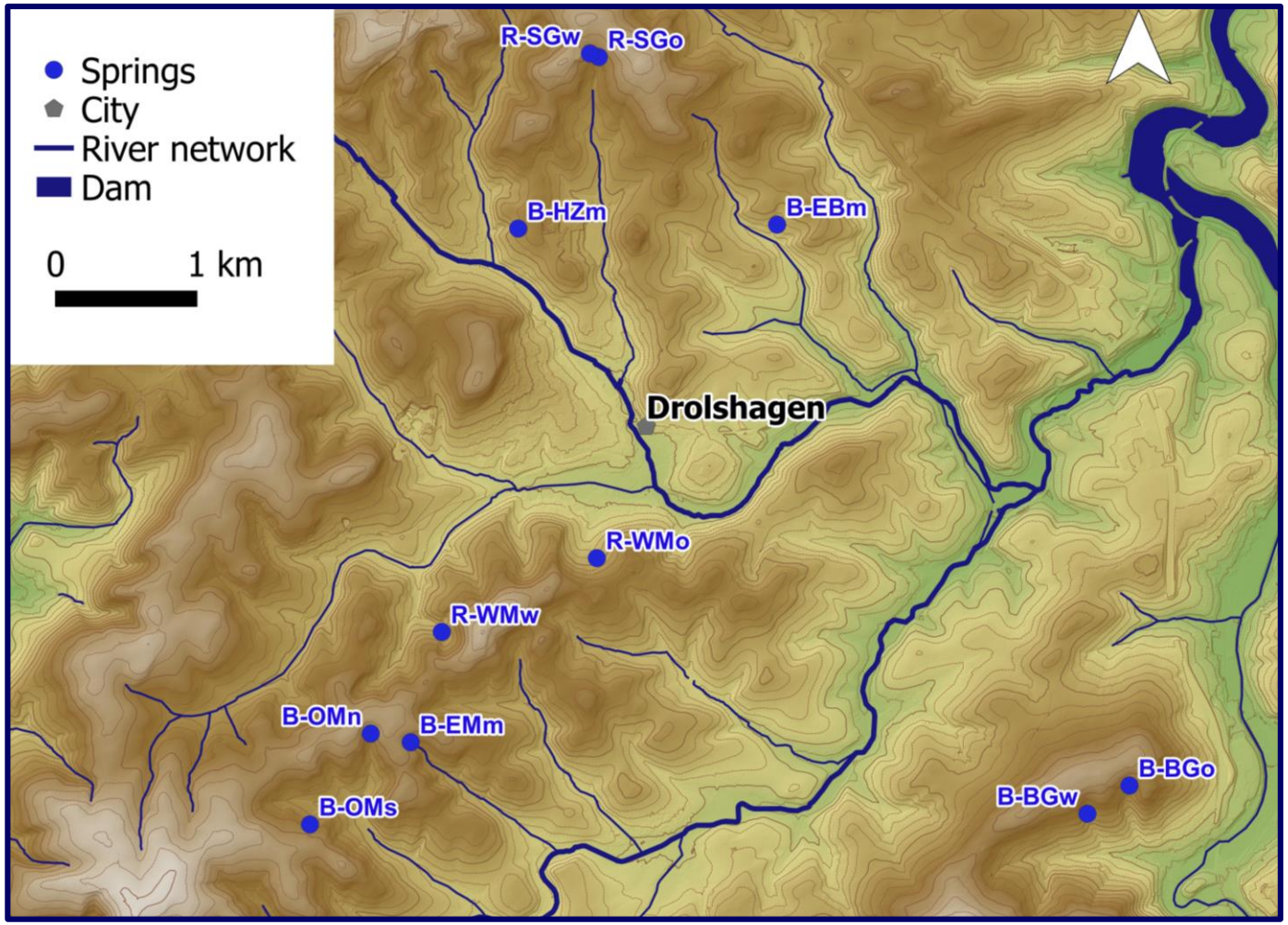


Fig.3: The four different study sites in Germany; boundary data from ESRI DEUTSCHLAND GMBH (2022)

Study Sites



- Instrumentation of 44 springs, differing in terms of:
  - spring size
  - spring type
  - discharge

Fig.4: Spring sites in Sauerland; database MWIDE NRW (2022)

Study Sites

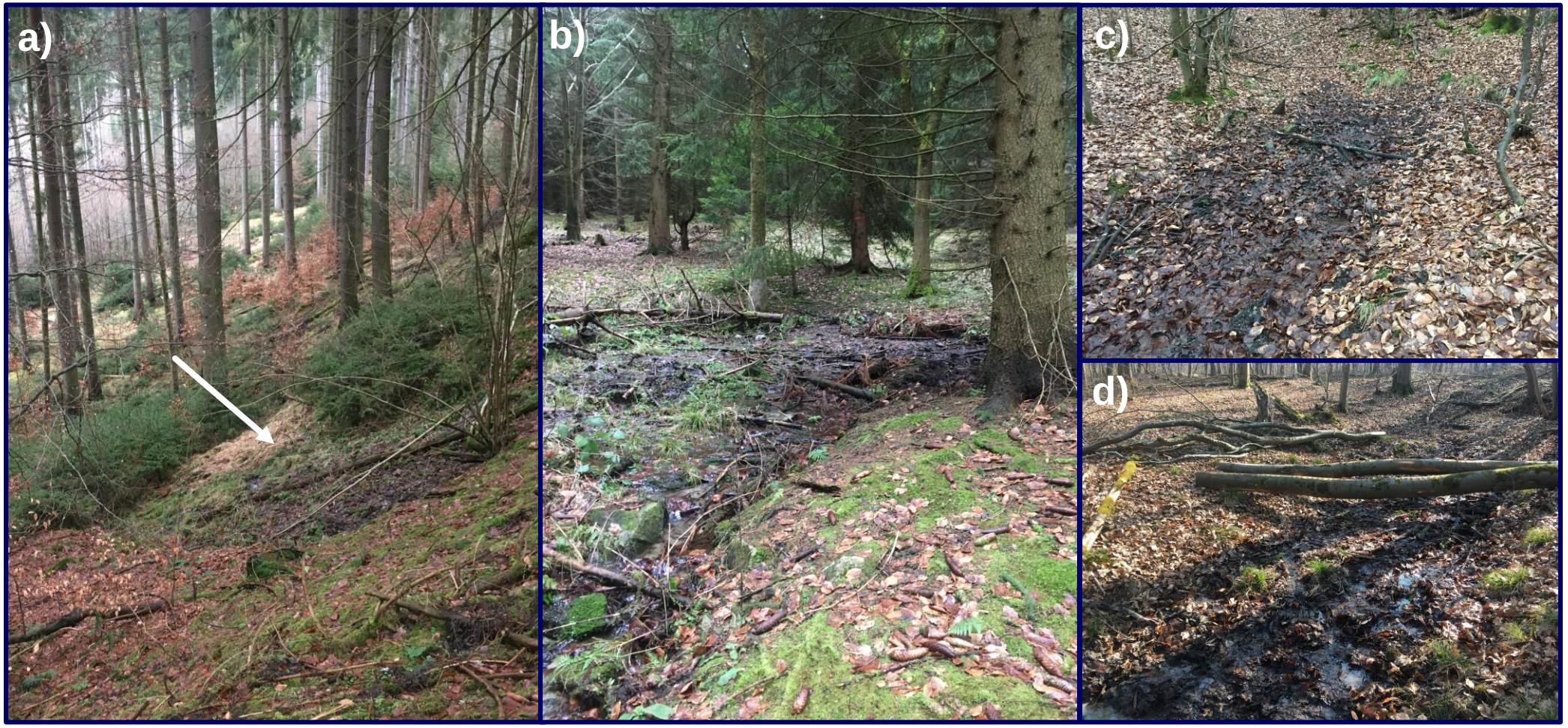


Fig.5: Exemplary spring sites within the catchment area of Freiberger Mulde (a, b) and Salzböde (c, d)

Methods

Seasonal dynamics	Permanent hydrological in-situ-measurements Continuous biogeochemical sampling campaigns
Event-based changes	Taking water samples at 4 springs using automatic water samplers
Connect spring with headwater stream	Taking water samples of headwater streams as well as groundwater and soil water samples in the riparian zone and CO_2 measurements ***- Using stable isotopes and EC measurements -***
Characterize DOC sources and composition	Excitation emission matrix (EEM) and parallel factor analysis
Quantification of OC export	Quantification based on OC concentration and spring discharge
Spatial-temporal variability and drivers	Statistically evaluation: Using multi-variate statistical techniques Modelling carbon fluxes: Using GAM and machine learning

Methods

Fig.6: Instrumentation of spring site with a weir for discharge measurements

First Results

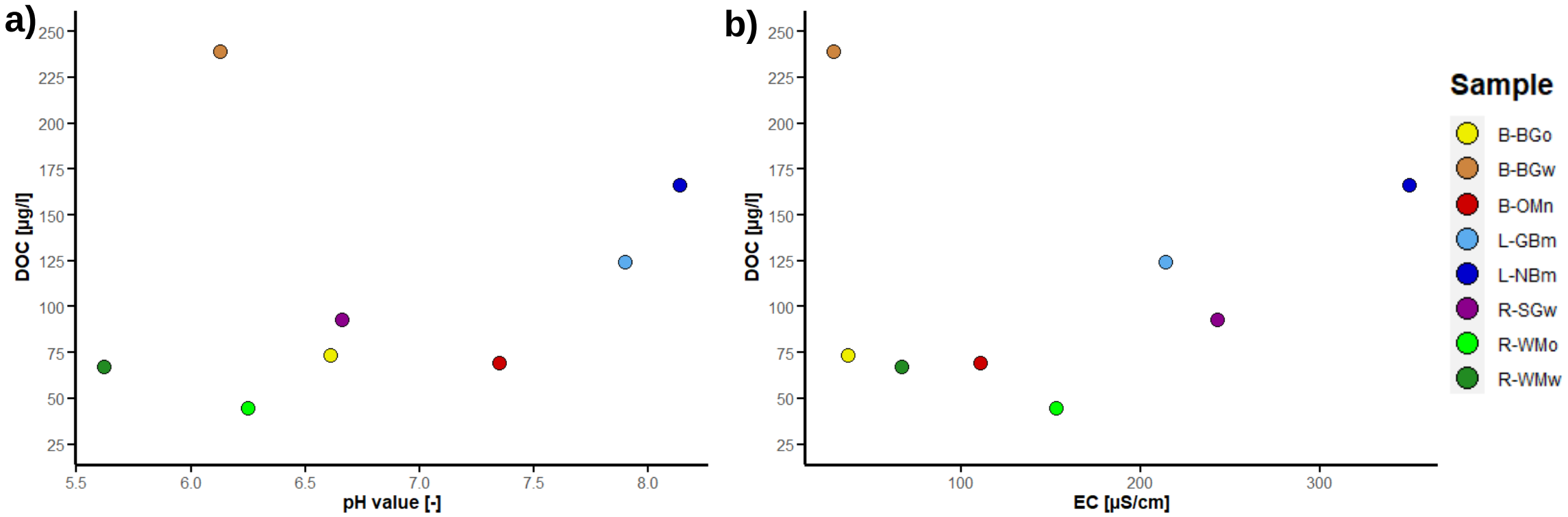
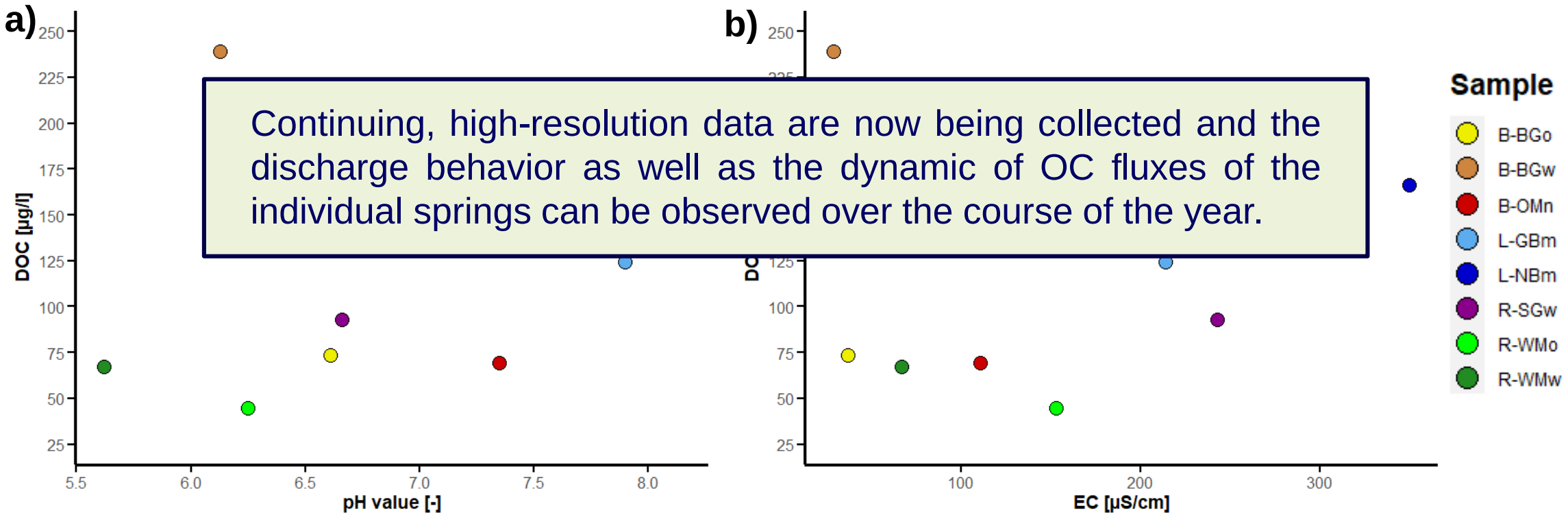


Fig.7: DOC concentrations of water samples of springs sites of the catchments Brachtpe, Rose and Lahn in relation to a) pH value and b) electrical conductivity

First Results



Continuing, high-resolution data are now being collected and the discharge behavior as well as the dynamic of OC fluxes of the individual springs can be observed over the course of the year.

Fig.7: DOC concentrations of water samples of springs sites of the catchments Brachtpe, Rose and Lahn in relation to a) pH value and b) electrical conductivity

Thank you for your attention!

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DFG Deutsche Forschungsgemeinschaft

References

[1] Blume, T., Van Meerveld, H. (2015). From hillslope to stream: methods to investigate subsurface connectivity. Wiley Interdisciplinary Reviews: Water 2 (3), 177-198.

[2] Broder, T., Knorr, K.-H., Biester, H. (2017). Changes in dissolved organic matter quality in a peatland and forest headwater stream as a function of seasonality and hydrologic conditions. Hydrology and Earth System Sciences 21 (4), 2035-2051.

[3] Esri Deutschland GmbH (2022). Open Data Portal. Kranzberg.

[4] Fasching, C., Ulseth, A. J., Schelker, J., Steniczka, G., Battin, T. J. (2016). Hydrology controls dissolved organic matter export and composition in an Alpine stream and its hyporheic zone. Limnology and Oceanography 61 (2), 558-571.

[5] Lehosmaa, K., JyvÄsjärvi, J., Virtanen, R., Rossi, P. M., Rados, D., Chuzhekova, T., et al. (2017). Does habitat restoration enhance spring biodiversity and ecosystem functions? Hydrobiologia 793 (1), 161-173.

[6] McDonough, O. T., Hosen, J. D., Palmer, M. A. (2011). Temporary streams: the hydrology, geography, and ecology of non-perennially flowing waters. River Ecosystems: Dynamics, management and conservation, 259-290.

[7] Merk, M., Goeppert, N., Goldscheider, N. (2020). Processes controlling spatial and temporal dynamics of spring water chemistry in the Black Forest National Park. Science of The Total Environment 723, 137742.

[8] Ministerium für Wirtschaft, Innovation, Digitalisierung und Energie des Landes Nordrhein-Westfalen (MWIDE) (2022). OpenNRW. Düsseldorf.

[9] Rasilo, T., Hutchins, R. H. S., Ruiz-Gonzàlez, C., del Giorgio, P. A. (2017). Transport and transformation of soil-derived CO2, CH4 and DOC sustain CO2 supersaturation in small boreal streams. Science of the Total Environment 579, 902-912.

[10] Regan, S., Hynds, P., Flynn, R. (2017). An overview of dissolved organic carbon in groundwater and implications for drinking water safety. Hydrogeological Journal 25 (4), 959-967.