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Mapping and quantification of groundwater–surface water exchange along a headwater stream using Distributed Temperature Sensing: First findings from the Wüstebach Catchment, Germany

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Groundwater-Dependent Ecosystems (GDEs) are valuable as they support ecosystem services at local and regional scales. Although they are closely related, surface- and groundwater bodies have traditionally been studied and managed separately. Since local hydrogeology and climate conditions affect GDEs, detailed spatial and temporal studies on their chemical and quantitative interactions are required.

A multi-disciplinary approach was used to investigate the interactions between surface- and groundwater in the Wüstebach test site, a 38.5 ha headwater catchment located in the Eifel National Park, Germany. This catchment is operated by the Forschungszentrum Jülich and is part of the TERENO Eifel Lower Rhine Valley Observatory. Along the streambed, a Fibre Optic Distributed Temperature Sensing (FO-DTS) experiment was set up in October 2022 to monitor the temperature changes of surface water along a 293 m long transect. The FO cable was connected to a Silixa XT-DTS instrument and temperature measurements were collected at 25 cm and 15 min sampling intervals. Moreover, a series of conservative tracer measurements were carried out using slug and continuous injection tests along the stream to quantify the amounts of groundwater exfiltration. In addition, spatially detailed electrical conductivity readings along the stream together with groundwater level measurements were carried out and water samples were collected for chemical determinations. Results of the salt dilution injections revealed that the headwater stream receives a significant contribution from groundwater along the transect, while the initial DTS recordings pinpointed several distinct locations where groundwater inputs occur along the stream; which were also identified on the field. An improved understanding of the catchment's quantitative and qualitative water flows is anticipated as a result of the mapping and subsequent quantification of the groundwater input.