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High-resolution monitoring across the soil-groundwater interface – Revealing small-scale hydrochemical patterns with a novel multi-level well

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Biogeochemical turnover processes in the subsurface are highly variable both in time and space. In order to capture this variability, high resolution monitoring systems are required. Particular in riparian zones the understanding of small-scale biogeochemical processes is of interest, as they are regarded as important buffer zones for nutrients and contaminants with high turnover rates. To date, riparian research has focused on influences of groundwater-surface water interactions on element cycling, but little is known about processes occurring at the interface between the saturated and the unsaturated zone during dynamic flow conditions. Therefore, we developed a new type of high resolution multi-level well (HR-MLW) that has been installed in the riparian zone of the Selke river. This HR-MLW for the first time enables to derive water samples both from the unsaturated and the saturated zone across one vertical profile with a spatial vertical resolution of 0.05 to 0.5 m to a depth of 4 m b.l.s. Water samples from the unsaturated zone are extracted via suction cup sampling. Samples from the saturated zone are withdrawn through glass filters and steel capillaries. Both, ceramic cups and glass filters, are installed along a 1” HDPE piezometer tube. First high resolution hydrochemical profiles revealed a distinct depth-zonation in the riparian alluvial aquifer. A shallow zone beneath the water table carried a signature isotopically and hydrochemically similar to the nearby river, while layers below 1.5 m were influenced by regional groundwater. This zonation showed temporal dynamics related to groundwater table fluctuations and microbial turnover processes. The HR-MLW delivered new insight into mixing and turnover processes between riverwater and groundwater in riparian zones, both in a temporal and spatial dimension. With these new insights, we are able to improve our understanding of dynamic turnover processes at the soil – groundwater interface and of surface –groundwater interactions in riparian zones. In the future, a better prediction and targeted management of buffer mechanisms in riparian zones will be possible.