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Exploring Subsurface Stormflow through Sprinkling Experiments at Multiple Trenchsites

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In many natural landscapes, subsurface stormflow (SSF) is a runoff-producing mechanism which can substantially contribute to the storm hydrograph of a stream. Despite its importance, there is a lack of systematic studies exploring SSF across sites with different land uses and hydrogeological characteristics. Thus, we face limitations to properly conceptualize and parametrize hydrological models.

In order to gain a better understanding of the processes governing SSF, multiple SSF-capturing trenches were excavated. The selected trench sites span over different land uses, geology, soils and climates in Germany and Austria. Depending on local boundaries, the trenches were designed with a width of 11–15 m allowing to collect water flowing laterally at depths of up to 1–3 m. Using separate drainage pipes, the trench's face is divided into an upper and lower flow-capture zone. Combining the measurements of vertically separated SSF outflow with upstream monitored groundwater levels and soil moisture dynamics, allows to estimate flow propagations along the hillslope.

Besides the continuous monitoring, these installations were used to measure SSF events triggered by artificial rainfall. In this study we investigated the SSF response at 11 different trench sites under controlled conditions using a large-scale (200 m²) experimental sprinkling system in combination with deuterated water, which served as an artificial tracer. The irrigation was applied at a rate of ca. 16 mm h^{-1} for about 3 hours. The analysis focuses on trenchflow dynamics (e.g., timing and magnitude of the peak flow, recession curve analysis) and their relationship with changes in soil moisture and groundwater level. The experiments highlighted the vastly different responses between sites; while some trenches remained dry, others were characterized by extremely high subsurface runoff coefficients and short response times.