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Groundwater dynamic during drought: decrease and recovery of streamflow and hyporheic zone groundwater

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Climate change and water scarcity critically impact on ecosystems and societal needs which requires a better understanding of droughts, their spatial and temporal evolution and effects on streamflow and groundwater dynamics. Only few studies have investigated the temporal changes of near-stream groundwater flowpaths and their evolution during droughts.

This paper addresses the following questions:

1. Is there a specific groundwater level threshold below which the near-stream flowpaths will no longer be controlled by the hillslope topographic gradient towards the stream and follow solely the down-valley topographic gradient?

2. Is the groundwater recovery from a hydrological drought driven by streamflow or recharge?

3. How do the decrease of the groundwater table and the cessation of streamflow affect the hyporheic zone during the evolution of the drought?

In this study we investigate how a meteorological drought (Summer-Autumn 2018) has impacted streamflow and groundwater dynamics in a forested catchment in the north-west of Luxembourg. The near-stream groundwater dynamic have been continuously monitored through a set of 36 groundwater wells and 7 in-stream piezometers from May 2018 to February 2019. The topography has been mapped by LIDAR and Theodolite surveys and the subsurface structure by small-scale ERT studies.

Our preliminary results indicate that streamflow and the hyporheic zone have disappeared as the drought evolved. Groundwater levels continuously decreased eventually reaching a stable minimum level corresponding to the fractured bedrock layer. Furthermore, lateral groundwater contributions to the stream channel gradually decreased and the flowpaths started to follow the longitudinal gradient of the valley. The cessation of the streamflow and the low groundwater level result in the cessation of water fluxes in the hyporheic zone. The recovery of the hyporheic zone is then driven by lateral groundwater inflow and the following onset of surface flow.