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Investigation of runoff generation processes at the headwater scale: a multidisciplinary comparative approach

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The understanding of runoff generation processes at the headwater scale is still one of the main goals in experimental hydrology. Its investigation is essential for efficient water resources management and protection of water quality. To identify the major controls of runoff generation in two headwater catchments in the Grand Duchy of Luxembourg a multidisciplinary approach combining traditional hydrological methods (i.e. hydrometry, geochemical and isotopic tracers), hydrogeophysics (electrical resistivity tomography (ERT)) and pedological methods (soil drillings and sampling) was applied. The two basins were considered as being relatively simple structured and representative for the Devonian schist and Jurassic sandstone lithology in Luxembourg.

The combination of investigation methods revealed more complex runoff generation processes than originally expected based on traditional hydrological methods. The analysis of hydrometric and hydrochemical data allowed to identify different runoff components and pointed out the different hydrological responses. The application of the ERT method further revealed the variable and complex subsurface configurations and their importance for runoff generation in the basins. These techniques helped in combination with drillings and soil sampling to better understand the origin and flow

pathways in the catchment. While the sandstone basin is mainly characterised by a constant groundwater component occurring at the sandstone-marls interface and a fast rainfall-runoff reaction due to the presence of saturated surface flow on marly substratum, the hydrological response in the schist basin strongly differs. Here, the runoff generation is controlled by the impermeable bedrock topography and the depth of the saprolitic zone that supplies a dynamic and delayed shallow groundwater component.

The application of methods and perspectives from different disciplines proofed to be a valuable approach to gain a better insight into the catchment functioning and revealed the differences in hydrological and hydrochemical responses as a consequence of their geology.