



Towards an improved synthesis of experimental fieldwork and mathematical modelling in hydrology: An application of the flexible model approach at the catchment scale

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This study investigates the connection between catchment properties and catchment response using a multi-disciplinary approach. Here, we contrast and synthesise perspectives from the experimentalist and the modeller. The former provides fieldwork-derived evidence and understanding of topography, geology and soils as well as a qualitative perception of “how the catchment works”, whilst the latter focuses more directly on the catchment response expressed through a flexible mathematical model enabling an exploration of perceived responses and a quantification of predictive capability. We show that despite considerable research in either direction, much remains unexplored in how catchment characteristics influence catchment response. This leads to major research questions such as what is the dominant correspondence between catchment “form” and “function” and how to best evaluate fieldwork evidence often deployed at the slope scale for predictions over much larger catchment scale domains.

The case study considers 3 headwater catchments in Luxembourg, with contrasting geological and hydrological characteristics. Previous fieldwork has suggested the 3 catchments are characterized by different flow-generating mechanisms, and exhibit distinctly different hydrological responses. The experimental insights available in these catchments are exploited to generate a set of alternative model hypotheses, which are implemented using the flexible modelling framework SUPERFLEX and scrutinized using several diagnostic measures. We examine and discuss the correspondence between catchment structure and model structure, and how contrasting catchment characteristics can explain differences in catchment response. We also discuss how fieldwork-derived understanding and the mathematical modelling perspective can enrich each other, contributing to an improved understanding of catchment behaviour.