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Flood patterns in a catchment with mixed bedrock geology: characterization of diverging flood shape responses using longitudinal discharge monitoring

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In 2016 and 2018, severe convective rainfall events caused several flash floods in small mesoscale catchments in eastern Luxembourg. While the runoff coefficients of these events remained rather common, the high proportion of the generated flood peaks was very unusual - requiring further research into the dominating runoff generating processes (e.g. flow paths type, activation/connectivity, antecedent conditions).

Here we to intend to explore and quantify, based on a longitudinal monitoring of discharge, the contrasted hydrological responses of nested catchments having multiple geological and pedological discrepancies. Our study area is the elongated Ernz Blanche catchment (102 km^2, approximatively 22.5 km long, 4.5 km wide), located in eastern Luxembourg (Europe). This mesoscale catchment is representative of the physiographic diversity of the country. Its upstream part is almost equally split between marly terrain (middle Keuper) and Luxembourg sandstone outcrops. The downstream part of the catchment mainly consists of deeply cut Luxembourg sandstone, alternating with marly plateaus (Lias). We have installed in early 2019 six stream-gauges along the 27.5 km long Ernz Blanche River. In addition, we have dispatched four rain-gauges and soil moisture sensors across the catchment to measure precipitations and soil water content, respectively.

Our first year of observations shows a spatially homogeneous response of the catchment during the winter period, with the specific discharge values observed at the six stream-gauges being highly correlated. During the summer flood events, the hydrological responses between the upper and downstream parts of the catchment are clearly distinct. More specifically, the downstream part generates two-peaked flood hydrographs – the first peak consisting of a flashy and non-attenuated response to precipitation, while the second peak clearly relates to the total precipitation amount. Interestingly, we have observed this pattern even for moderate events – 12 mm of incident rainfall and 3.2 $mm.15min^{-1}$ of rainfall intensity being sufficient to produce a double-peak hydrograph. We conjecture that this dual hydrological response of the downstream part of the catchment is caused by either (i) the very dry antecedent weather conditions during the summer 2019 impacting soil hydraulic properties or (ii) the generally lower rainfall intensities observed in winter (< 1.8 $mm.15min^{-1}$), causing the initial flashy response to be either limited or

totally insignificant.

Our preliminary conclusion on the hydrological behavior of the Ernz Blanche catchment (based on response times, runoff coefficients and hydrograph separations) suggests a clear distinction in hydrological response between the upstream luxembourg sandstone outcrops and marly terrain and the downstream marly plateaus and deeply cut sandstone valleys. Hydrological responses differ between the upstream part of the catchment, where homogeneous and damped flood responses prevail throughout the seasons, and the downstream part, where a threshold behaviour dominates (between summer and winter). These findings will contribute to improve the design of conceptual flow processing models. This is an important milestone and prerequisite for any subsequent development and transposition of a suitable flood forecasting model, adapted to the large physiographic diversity of Luxembourg.