S1: Examples of the specific hydrograph patterns during dry or wet conditions
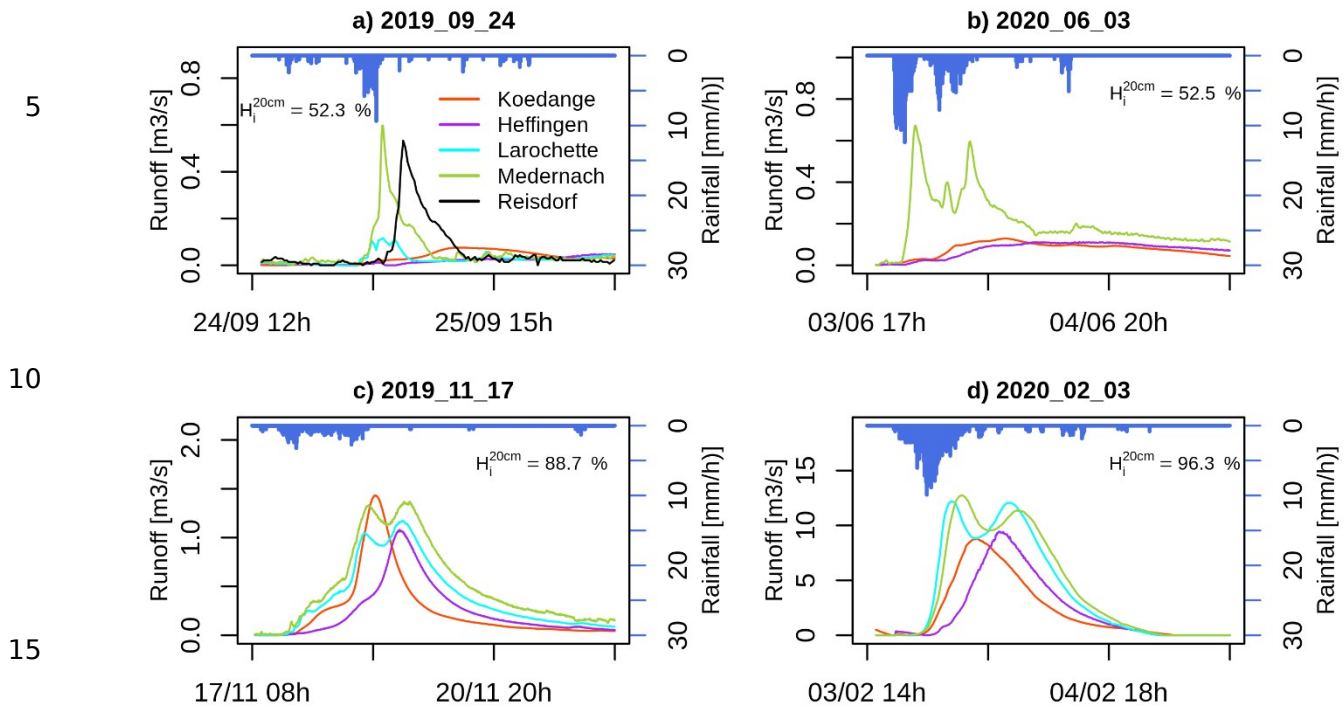

Figure S1: 4 rainfall-runoff events that have occurred on the Ernz Blanche with different soil moisture conditions. Rainfall amount are calculated on the Ernz Blanche catchment at Medernach (79 km^2). The runoff times series are observed at Koedange (31.1 km^2 orange), Heffingen (48.8 km^2, purple), Medernach (79 km^2, green) and at Larochette (69.4 km^2, cyan) and Reisdorf (100.6 km^2, black) when available. H$_i^{20cm}$ correspond to the soil moisture conditions observed at 20 cm in depth before each event.

The hydrographs show how the hydrological responses downstream to Larochette stand out during dry conditions (top panels), with erratic and quick flood peak responses. In winter (down panels), the hydrological responses downstream are more regular, although a two-peak answer occurred in contrast to the upstream part (Koedange, Heffingen).

S2: Observed response times used to define the unit hydrograph and hydraulic transfer parameter ranges (table 3).
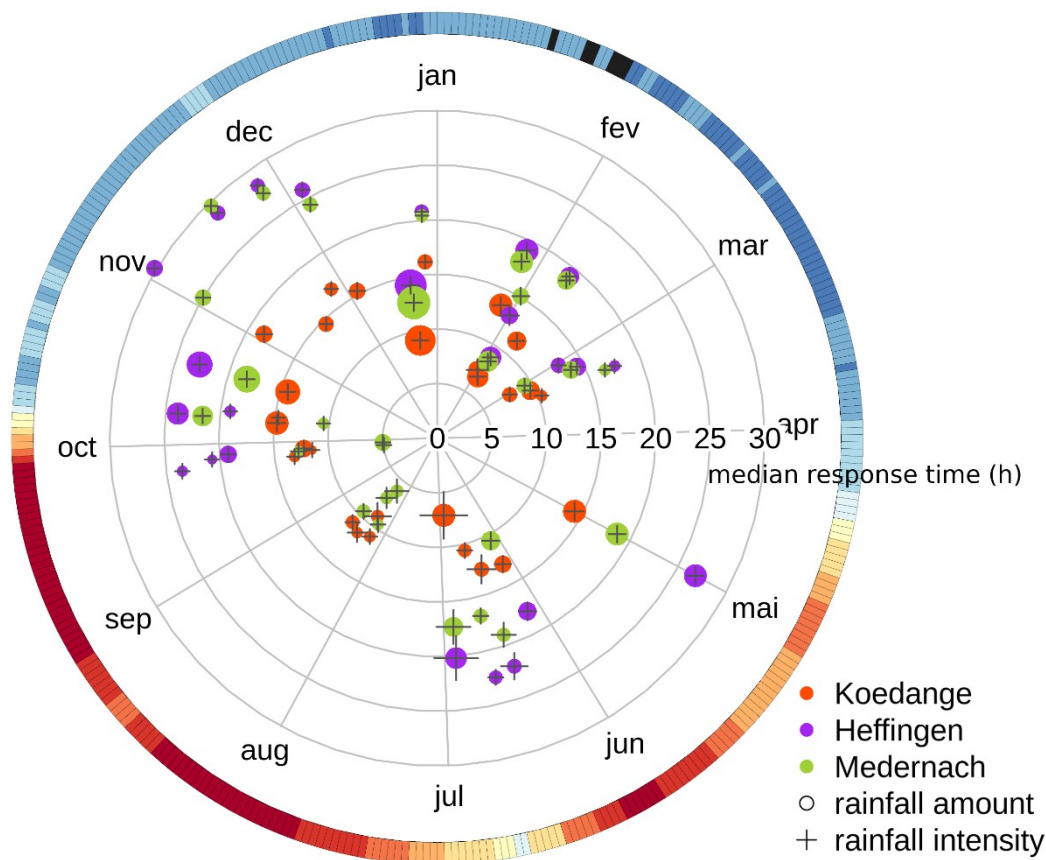
25 **Figure S2: Time offset between the median time of the rainfall distribution and the median time of the runoff response distribution at Koedange (31.1 km², orange), Heffingen (48.8 km²) and Medernach (79 km²). The colored circle corresponds to the daily average soil moisture condition at 20 cm in depth (key color scale in figure 3).**

The response times for all the events are below 20 h for the Koedange catchment and below 30 h for the Medernach catchment. This order of magnitude can be compared to the expected value of the Gamma model $E = \mu\theta$. Here we choose the

30 parameter ranges in order that E widely covers the range [5 – 30] h.

Moreover the skewness of the Gamma function is: $S_k = 2/\sqrt(\mu)$. As remember, the skewness is a measure of the distance between the mode and the expected value, standardized by the variance of the distribution. Looking at the hydrograph shapes, we choose different range of variation of μ to define the Medernach-Heffingen section and the Koedange catchment. The hydrological response of this latter shows little skewness, compared to the Medernach one. Although the assessment of

35 the skewness based on the observation is quite difficult, we assumed here that S_k is at least below 2 for Koedange, but it could significantly be higher for the Medernach catchment section.

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