The importance of *in-situ* soil moisture observations to evaluate the main drivers of event runoff characteristics in small-scale catchments

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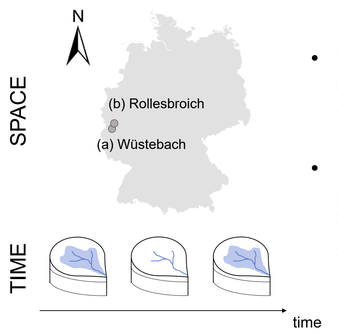
Relevance and research gap

- Enhanced hydrological process-understanding at the catchment scale is critical for a **sustainable management of water resources.**
- **Runoff responses vary in space and time** due to complex interactions of e.g., topography, land use, soil properties, geology, and climatic conditions.



- Variability makes fundamental understanding of catchment processes difficult.
- Search for **repeating temporal patterns** in hydrological variables can improve understanding of event runoff characteristics.

Figure 1. Spatiotemporal variability of runoff (schematic) with study catchments of (a) Wüstebach, and (b) Rollesbroich in Germany.

Objectives

i. Quantify **the influence of hydro-meteorological variables on event runoff characteristics** under similar soil moisture conditions using a time series-based pattern search.

ii. Assess the **importance of** *in-situ* **soil moisture observations** at different depths on event runoff characteristics compared to previous surrogate measures.

Study area

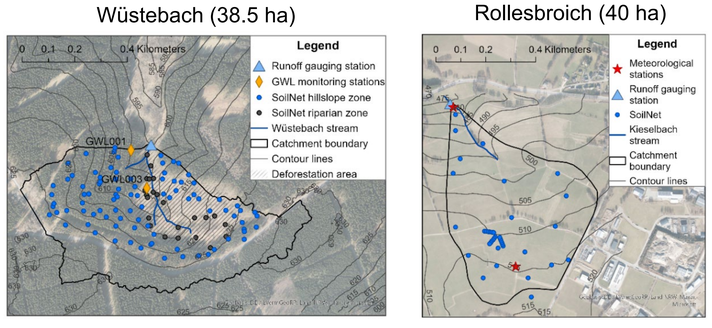


Figure 2. Study catchments of Wüstebach (Eifel National Park, Germany, partly forested), and Rollesbroich (Eifel region, Germany, grassland).

Data

Long-term time series of hydro-meteorological variables (Fig. 3):

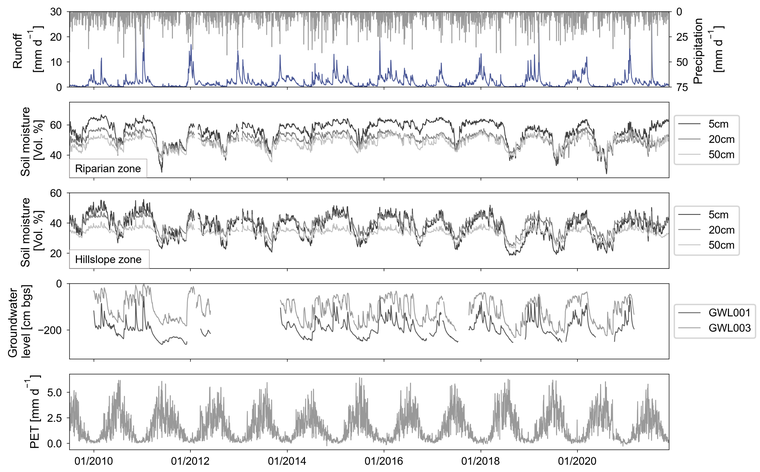
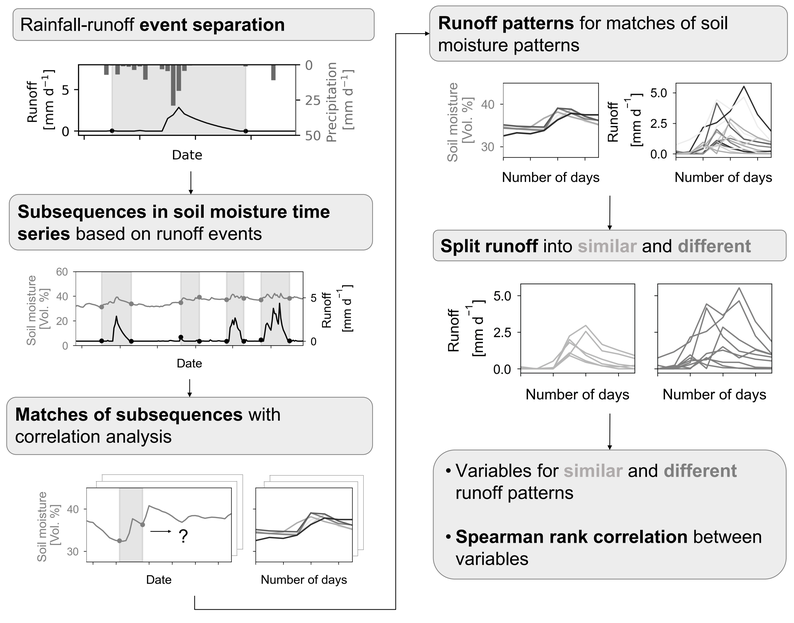


Figure 3. Example of observation data including precipitation, runoff, soil moisture, groundwater level, and potential evapotranspiration (PET) shown for the Wüstebach catchment.

Methods



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Results

Impact of antecedent wetness conditions on event runoff coefficients (ERC):

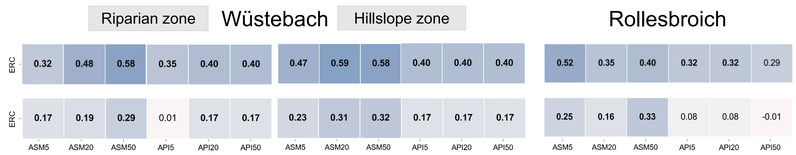

Figure 4. Spearman rank correlation coefficients between event runoff coefficient (ERC) and antecedent soil moisture (ASM) as well as antecedent precipitation index (API) for similar (top row) and different (bottom row) runoff patterns.

- Correlation coefficients between ERC and antecedent wetness conditions are generally **higher in case of a similar runoff pattern** compared to a different one (Fig. 4).

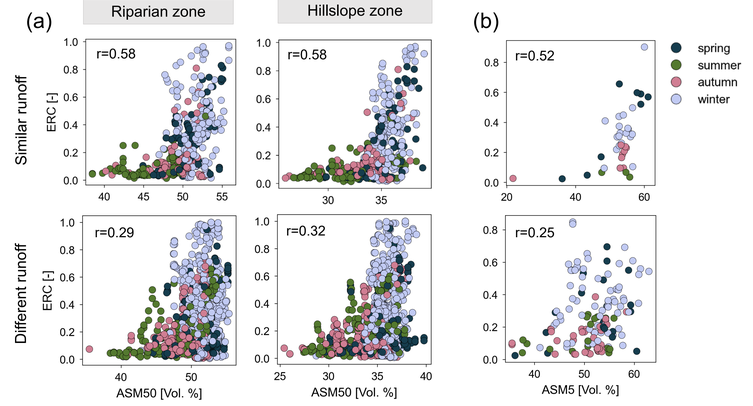

Figure 5. Scatterplots of event runoff coefficients (ERC) and antecedent soil moisture in 5 and 50 cm depth (ASM5 and ASM50, resp.) in (a) Wüstebach and (b) Rollesbroich, separated between similar and different runoff.

- ERC increases after **ASM threshold** for similar runoff patterns (Fig. 5).

Conclusions

- **Temporal patterns of similar soil moisture conditions** were detected in the two catchments.
- **Splitting runoff** into similar and different patterns **under similar soil moisture conditions** can provide further insight into the hydro-meteorological drivers of runoff characteristics.
- Antecedent precipitation index as proxy for soil moisture conditions could not reflect the relationship between runoff characteristics and wetness conditions.