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A new metric for better identifying and understanding rainfall-runoff events

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Accurate identification and characterization of rainfall–runoff events is necessary for analysing hydrologic extremes, understanding their drivers, and assessing their long-term trends. The process of rainfall-runoff event identification usually includes rainfall event detection, runoff event detection, and finally, rainfall-runoff pairing. Although rainfall event detection is usually performed by Peak Over Threshold (POT), to detect runoff events, several methodologies have been developed using different definitions of runoff events, frameworks, and statistical rules. For example, some methods define runoff events as an upward and then a downward movement from a baseline. Upon the definition of a runoff event, runoff event detection methods must define parameters to represent runoff events. For example, a threshold may be considered as a baseline above which movements are detected as an event. On the other hand, rainfall-runoff event pairing is also often performed subjectively. Rainfall-runoff event pairing is usually performed by applying a search window with parameters like the length of search window, the direction of pairing (from rainfall to runoff or vice versa), and the start of searching (i.e. peak of rainfall, start of runoff, etc.). Consequently, the rainfall-runoff event pairing adds further uncertainty to rainfall-runoff event identification process.

Different ways of identifying a rainfall-runoff event can lead to uncertainties in the resulted event statistics. Meanwhile there is no specific rule to select the statistical rules to detect and pair rainfall-runoff events method. The uncertainty in runoff event identification can introduce further uncertainty impacting the interpretation of rainfall-runoff relationships in a catchment. For example, the Runoff Coefficient estimates the proportion of rainfall in a runoff event and is an important signature of the rainfall-runoff relationship and hydrologic regime of the catchment. Our ability to understand rainfall-runoff event characteristics is largely hindered by the uncertainty in identifying those events. There is a lack of understanding about uncertainty in rainfall-runoff identification process and the selection of parameter values which is usually performed by visual inspection.

In this study, we have assessed the uncertainty of rainfall-runoff event identification using several rainfall-runoff event identification methods and a wide valid parameters' range. Using random sampling, we performed rainfall-runoff event identification with various rules in 467 unimpaired catchments in different climates, and then, analysed the characteristics of identified rainfall-runoff events. Results showed that the changes in rainfall-runoff identification rules, causes a notable change in rainfall-runoff event characteristics, and under some rules, rainfall-runoff event identification methods tend to bias towards specific events (for example, larger rainfall-runoff events). Under some rules, identified rainfall-runoff events obtained RCs greater than 1 which are physically implausible. Results demonstrated that moving towards wetter catchments increases the uncertainty of rainfall-runoff event identification as well as the percentage of RCs greater than 1. To assists users in rule selection, we developed a new metric which aids rainfall-runoff event identification process. The metric works based on two criteria of: 1- proportion of paired runoff events to total rainfall events, and 2- percentage of valid RCs (RC<1). Results showed that the metric leads to more consistent results among different rainfall-runoff event identification rules (lower uncertainty), capturing a wider range of events magnitudes, and lower percentage of implausible rainfall-runoff events (RCs>1) (Mohammadpour Khoie et al., 2025). Results of the developed metric will provide researchers with more confident results enhancing our understanding of hydrologic processes in a catchment.

REFERENCES

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