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Analysis of short- and long-term controls on the variability of event-based runoff coefficient

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Introduction: Runoff coefficient (RC) is a key hydrologic parameter representing the ratio of rainfall that becomes surface runoff, crucial for flood prediction, urban drainage, and water resource management. While widely used, RC's variability across different temporal and spatial scales remains insufficiently understood. Previous studies have explored factors influencing short-term RC variability, including rainfall intensity, antecedent moisture, and catchment characteristics like land use and soil type. However, less attention has been given to watershed shape and drainage density. Understanding these influences is critical for predicting RC under changing climate and urbanization conditions. This study focuses on event-based RC, investigating the role of temporal and spatial controls. Our findings contribute to better management strategies for runoff in varying environments, providing insights into long-term trends influenced by climate and land use changes.

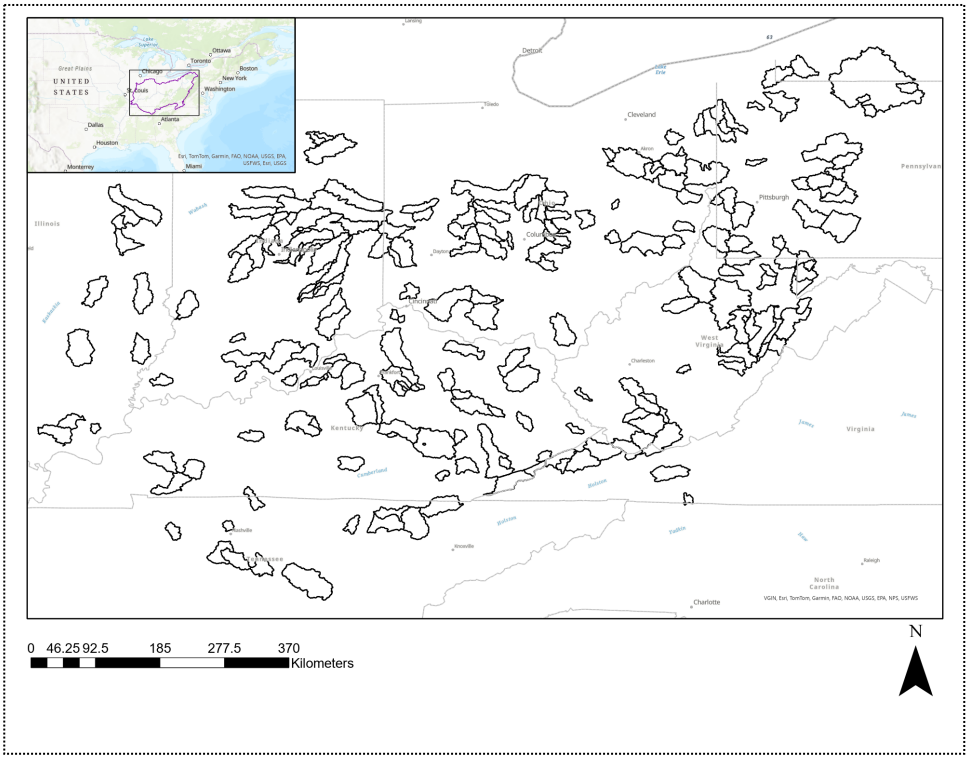

Figure 1. Location of all the watersheds analyzed in the Ohio region.

Methodology: This study identifies rainfall-runoff events using a streamflow-based method, detecting local minima in hourly data. Events are filtered by two criteria: peak discharge must exceed 1.5 times the initial discharge, and rainfall occurring 10 hours after a previous event is considered separate. Rainfall amount, duration, and intensity for each event are calculated, while watershed characteristics like drainage density, elevation, and slope are derived from DEM data. Runoff coefficient variability is explored by grouping events based on climatic factors and antecedent soil moisture, with violin plots and ANOVA used for analysis. Long-term trends are assessed using the Mann-Kendall trend test.

Results: The study found that runoff coefficients increase with higher rainfall intensity and antecedent soil moisture, while rainfall amount and duration had minimal impact. Notably, the SCS curve number method showed no strong correlation with runoff coefficients. Larger watersheds had lower runoff during low-intensity storms, but higher runoff during intense rainfall. Elevation and slope also influenced runoff, with higher elevation and steeper slopes leading to lower coefficients. Long-term trends in runoff coefficients were mainly driven by antecedent soil moisture changes, with cultivated area increases also affecting runoff in certain regions. Minimal trends were observed in the northwestern Ohio region.

Conclusion:

- Antecedent soil moisture is a key factor influencing short- and long-term runoff coefficients.
- Rainfall intensity and watershed characteristics, such as drainage area and elevation, also affect runoff.
- Future research should explore the impact of land cover changes and the effects of urbanization and reservoir construction.

FOR FURTHER READING:

Beven, K. (2019). Towards a methodology for testing models as hypotheses in the inexact sciences. Proceedings of the Royal Society A, 475(2224), 20180862.

Tarasova, L., Basso, S., Zink, M., & Merz, R. (2018). Exploring controls on rainfall-runoff events: 1. Time series-based event separation and temporal dynamics of event runoff response in Germany. Water Resources Research, 54(10), 7711-7732.