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Which catchment properties determine runoff behavior in small catchments?

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The complexity of Pleistocene landscape and various anthropogenic influences complicate the classification of runoff characteristics of small catchments in northeast Germany. Such a classification would be of use for scientists and water managers in order to estimate the catchments' vulnerability regarding floods and low flows, transfer results to ungauged catchments as well as planning of measures to adapt to climate change. The objective of our study is the use of dimensional reduction technique solely on discharge time series in order to classify runoff behavior of small catchments (< 500 km^2) of Brandenburg, Germany.

The study is based on data of daily discharge at 40 gauges from 1991 to 2006. Data was provided by the State Office of Environment, Health and Consumer Protection of the Federal State of Brandenburg. Principal Component Analysis was applied to reduce dimensionality to as few principal components as possible explaining still most of the variance in the data. Additionally, meteorological data and catchment properties derived from hydrogeologic, soil and land use maps were included to better understand the results and to check hypotheses about underlying processes and driving forces.

The first six components exhibited an eigenvalue exceeding one and explained 73% of the total variance. Analysis of the loadings and comparison with meteorological and catchment properties allowed assigning runoff generating processes to the principal components. The first principal component represented the mean runoff behavior of the time series from all catchments. Further components could be related to precipitation patterns that exhibited a northwest-southeast and southwest-northeast gradient, a higher evapotranspiration by wetlands and river lakes, water management activities and specific behavior or measurement errors at single gauges. Despite our hypothesis that soil, groundwater and land use properties are crucial to understand discharge patterns at small catchments the results show that precipitation patterns and the area of river lakes and wetlands explain most of the variance in our data set. Our method was suited to extract common patterns in catchment runoff. We show challenges in defining catchment similarity arising from runoff generating processes which are correlated. Additionally, similarity in water management and other anthropogenic influences had to be included in this research area. Further, we used this classification to estimate catchments' vulnerability to extremes, especially low flows, and formulate key concerns for water managers.