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Understanding similarity of groundwater systems with empirical copulas

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Within the classification framework for groundwater systems that aims for identifying similarity of hydrogeological systems and transferring information from a well-observed to an ungauged system (Haaf and Barthel, 2015; Haaf and Barthel, 2016), we propose a copula-based method for describing groundwater-systems similarity. Copulas are an emerging method in hydrological sciences that make it possible to model the dependence structure of two groundwater level time series, independently of the effects of their marginal distributions. This study is based on Samaniego et al. (2010), which described an approach calculating dissimilarity measures from bivariate empirical copula densities of streamflow time series. Subsequently, streamflow is predicted in ungauged basins by transferring properties from similar catchments. The proposed approach is innovative because copula-based similarity has not yet been applied to groundwater systems.

Here we estimate the pairwise dependence structure of 600 wells in Southern Germany using 10 years of weekly groundwater level observations. Based on these empirical copulas, dissimilarity measures are estimated, such as the copula's lower- and upper corner cumulated probability, copula-based Spearman's rank correlation - as proposed by Samaniego et al. (2010). For the characterization of groundwater systems, copula-based metrics are compared with dissimilarities obtained from precipitation signals corresponding to the presumed area of influence of each groundwater well. This promising approach provides a new tool for advancing similarity-based classification of groundwater system dynamics.

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