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Comparative hydrogeology – application of quantitative descriptors to groundwater time series with spatial proximity

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High frequency as well as long-term fluctuations of groundwater levels are consequences of many different processes within the aquifer system. Groundwater levels are influenced both by natural processes (e.g. groundwater recharge, interaction with river systems) and anthropogenic influences (e.g. water abstraction, artificial recharge and piling). Spatial and temporal superposition of these processes cause fluctuations of groundwater levels, referred to as groundwater dynamics, at the position of the well's screen. Due to superposition, the differentiation between multiple driving forces (input signals) is difficult and requires knowledge of hydro(geo)logical properties of the system, such as characteristics of the surface, vadose and phreatic zone on different scales. The exploration of those characteristics is complex and time-consuming and, therefore, normally not available on a regional scale. In contrast to the low availability of data on system characteristics, high-resolution records of groundwater hydrographs are available. Analysis of high-resolution hydrographs is a frequently applied tool for the prediction of ungauged (surface water) basins (PUB, e.g. Blöschl et al., 2013; Hrachowitz et al., 2013). The PUB community introduced a number of different quantitative indices to characterize different parts of river flow dynamics. Based on similarities of these indices, river catchments are clustered in groups of similar dynamics and subsequently linked to system characteristics. Due to various differences between surface and sub-surface catchments, unrestricted transferability of river flow indices on groundwater time series is disputable.
This study is focused on the question of how transferable these river flow indices are to groundwater time series measured in alluvial aquifers in Bavaria (Southern Germany). More than 50 indices are calculated from sub-monthly groundwater level time series from different regions, with the purpose of covering various hydro(geo)logical settings. The result of hierarchical clustering (Ward Linkage algorithm) of these 50 groundwater hydrographs serves as a baseline. The ability of each index to express hydrograph similarity is quantified by comparing indices' values from observation wells with high spatial proximity and congruent hydrographs. The alikeness of index values is quantified by measuring the Euclidean distance between the values. Additionally, the study also analyses the ability of different indices to express similarities of groundwater hydrographs from different regions but with similar hydro(geo)logical settings.

References:
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Hrachowitz, M. et al. (2013): A decade of Predictions in Ungauged Basins (PUB) - a review, Hydrol. Sci. J. 58 (6), 1198–1255, doi:10.1080/02626667.2013.803183.