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Investigating climatic and geologic controls on local groundwater dynamics

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Characterization of groundwater resources for e.g. vulnerability analysis of climate change or abstraction schemes is often severely limited by the lack of data describing the hydrogeological conditions and the dynamic processes. Currently, very few general methods are available to describe the change of hydraulic head as the primary source of information on groundwater resources. Within surface hydrology, comparative hydrology and classification based on system characteristics has been successfully used to generalize the response of catchments. Here, we propose an analogous approach of comparative hydrogeology, using a large dataset of well-described groundwater observation wells, to understand the relationship between climatic as well as geologic controls and groundwater dynamics. A large dataset of 350 groundwater head time series with a daily measurement interval from Bavaria in Southern Germany was compiled. From these, a number of non-redundant time series indices were calculated to numerically express the dynamic features within the time series (Heudorfer et al., 2017). Subsequently, a large set of candidate controls was established. Aquifer characteristics were compiled from bore logs (e.g. aquifer material, aquifer condition, dominant overburden material). Additionally, a set of characteristic climatic descriptors and surface properties (e.g. land use, soil type) was derived, as well as a set of topography-based descriptors for groundwater flow conditions in the surrounding of near-surface wells (e.g. boundary effects, aquifer convexity and slope). These candidate controls were investigated by applying k-means cluster analysis to the time series indices. Subsequently, within-cluster homogeneity for growing cluster numbers and with regard to each candidate control was calculated. The usefulness of a control was assessed by checking growth of within-cluster homogeneity with cluster number. Further, possible granularity was checked by identifying the cluster number, where within cluster homogeneity converges to the maximum. The proposed evaluation method is a first step toward a groundwater systems classification as well as a subsequent regionalization of groundwater dynamics.

Heudorfer, B., Haaf, E., Barthel, R., Stahl, K., 2017. A framework for quantification of groundwater dynamics - redundancy and transferability of hydro(geo-)logical metrics, EGU General Assembly Conference Abstracts, pp. 1434.