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A framework for quantification of groundwater dynamics – concepts and hydro(geo-)logical metrics

Ezra Haaf (1), Benedikt Heudorfer (2), Kerstin Stahl (2), and Roland Barthel (1)

(1) Department of Earth Sciences, University of Gothenburg, Sweden (ezra.haaf@gu.se), (2) Faculty of Environment and Natural Resources, University of Freiburg, Germany

Fluctuation patterns in groundwater hydrographs are generally assumed to contain information on aquifer characteristics, climate and environmental controls. However, attempts to disentangle this information and map the dominant controls have been few. This is due to the substantial heterogeneity and complexity of groundwater systems, which is reflected in the abundance of morphologies of groundwater time series. To describe the structure and shape of hydrographs, descriptive terms like “slow”/ “fast” or “flashy”/ “inert” are frequently used, which are subjective, irreproducible and limited. This lack of objective and refined concepts limit approaches for regionalization of hydrogeological characteristics as well as our understanding of dominant processes controlling groundwater dynamics. Therefore, we propose a novel framework for groundwater hydrograph characterization in an attempt to categorize morphologies explicitly and quantitatively based on perceptual concepts of aspects of the dynamics. This quantitative framework is inspired by the existing and operational eco-hydrological classification frameworks for streamflow. The need for a new framework for groundwater systems is justified by the fundamental differences between the state variable groundwater head and the flow variable streamflow. Conceptually, we extracted exemplars of specific dynamic patterns, attributing descriptive terms for means of systematisation. Metrics, primarily taken from streamflow literature, were subsequently adapted to groundwater and assigned to the described patterns for means of quantification. In this study, we focused on the particularities of groundwater as a state variable. Furthermore, we investigated the descriptive skill of individual metrics as well as their usefulness for groundwater hydrographs. The ensemble of categorized metrics result in a framework, which can be used to describe and quantify groundwater dynamics. It is a promising tool for the setup of a successful similarity classification framework for groundwater hydrographs. However, the overabundance of metrics available calls for a systematic redundancy analysis of the metrics, which we describe in a second study (Heudorfer et al., 2017).

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