Identification of recharge components and unknown stresses in alluvial aquifers using time series modelling

Kokimova, Ainur; Collenteur, Raoul; Birk, Steffen

Institute for Earth Sciences, University of Graz, Heinrichstraße 26, A-8010 Graz, Austria.

Alluvial aquifers provide about one half of Austria's drinking water and even larger portions in many countries around the world. To assess how climate change or direct human impacts, such as groundwater abstraction or hydraulic construction, potentially affect the storage and discharge of groundwater in these settings, sound understanding of the drivers of groundwater level changes is required. This work thus aims to (1) identify different recharge components and other hydrological stresses that affect groundwater levels at a given location and (2) assess their relative contribution to the observed groundwater level fluctuations. To this end, we employed the time series model Pastas (Collenteur et al., Groundwater, 2019), which is available as a Python package at http://www.github.com/pastas/pastas. This model uses pre-defined impulse response functions to represent the impact of individual stresses on groundwater levels. The model was applied to observation wells of the existing state hydrographic monitoring net in the Grazer Feld aquifer, an alluvial aquifer located in the Mur valley after its transition into the Styrian Basin. The northern part of the aquifer lies within the urban area of the city of Graz, while agricultural land use dominates in the southern part. The model calibration resulted in acceptable fits to the data of 128 from the 146 observation wells used for this study. The calibration results suggest that, in addition to recharge from precipitation, for most of the observation wells the river is a relevant driver of groundwater level fluctuations. The groundwater-level time series of about one third of the observation wells appear to be affected by additional stresses. In most of these cases, a good model fit is obtained by assuming a step in the groundwater levels at a distinct time, for example as a result of hydraulic constructions in the river Mur. The unacceptable model fits obtained for 18 observation wells suggest that groundwater levels at these locations are affected by additional drivers that need further investigation.