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Using time series correlation matrixes to identify factors driving water-table fluctuations in an aquifer system.

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In order to monitor, analyze and classify extreme events, such as droughts, various standardizations such as the Standard Precipitation Index SPI and the Standardized Groundwater level Index SGI have been developed. But besides the analysis of a single time series or a single type of time series, a changing climate necessitates a sound understanding of all of the processes and factors involved in the aquifers response to extreme events – such as droughts and floods.
In order to facilitate this sound understanding, we employ a correlation matrix that allows one to quickly identify the main (hydro/geo/meteorological) factor(s) governing the hydrologic system. Further, this matrix view allows for the identification of outliers, or sub systems within the area in question, that can then be studied in detail via other means.
To illustrate the applicability of this approach, long term groundwater, surface water and precipitation time series have been analyzed for an aquifer system and river catchment ranging from alpine climate to mediterrean/pannonian climate (River Mur, Austria). The catchment has been split up into three distinctive subregions, deemed to differ in their hydrological and hydrogeological situation. The time series have been standardized to allow for easy comparison and correlation and split up into different epochs, in order to visualize changes in the system over time.
It is shown that the subregions do show different behavior and are governed by different processes. For example it is shown that groundwater level fluctuations within different areas can either be predominantly driven by surface water or by precipitation. For example an inner alpine basin in the upper reaches of the river Mur shows a high river-groundwater correlation in the vicinity of the river, whereas distant wells show some correlation with the 3 - 9 month SPI. In a shallow, foreland aquifer, the system is mostly correlated with the 3 - 12 month SPI, with no clear surface water influence. In the case of surface water influence, the matrix view allows a quick overview of distance dependency. Furthermore, it can also be seen that there are some areas where the hydrological behavior appears to be susceptible to changes over time .
In summary, the results demonstrate that the visualization of hydrologic indices such as the SPI and the SGI provides a useful tool for the assessment of correlations of between various components of a hydrologic system and, in the given case, particularly the identification of factors driving water-table fluctuations in aquifers.