Applying Independent Component Analysis and Wavelets Analysis to Explore the Response of Groundwater Level to Surface Hydrology

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The groundwater is a component of the global hydrology cycle. For an aquifer system, the responses of the external forces such as rainfall, river flow, groundwater pumping and earth tide etc. were mixed in the groundwater level. This study applies the Independent Component Analysis (ICA) and the Wavelets Analysis to decompose the signals of groundwater level, rainfall and river water-level in time and frequency domain. The decomposition facilitates exploring the response of groundwater level to the surface hydrology. The independent components (ICs) of groundwater level and external forces are examined by their cross-correlations and the associated wavlets transform. The proposed method was applied to the Taichung Basin based on the data collected during 2009-2017. The study identified a pair of groundwater level ICs to rainfall ICs with a high correlation coefficient value (0.85) and a similar pattern of wavelets transform. A river water-level ICs with correlation coefficient 0.69 to groundwater level ICs was also identified. The result demonstrates that the rainfall has a significant influence on the groundwater level, and the river water-level has a moderate impact on the groundwater system in Taichung Basin. Besides examing the impact of surface hydrology to groundwater level, the proposed methodology can obtain a clean signal pair of impact-to-response and that is valuable to more advanced study.

Keywords: Fourier Transform, Groundwater, Independent Component Analysis, Wavelet Transform

