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Parameter estimation of heterogeneous field in basin scale based on signal analysis and river stage tomography

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Understanding the spatial distribution of the aquifer parameters is crucial to evaluating the groundwater resources on a basin scale. River stage tomography (RST) is one of the potential methods to estimate the aquifer parameter fields. Utilizing the head variations caused by the river stage to conduct RST is essential to delineate the regional aquifer's spatial features successfully. However, the two external stimuli of the aquifer system, rainfall and river stage, are usually highly correlated, resulting in mixed features in the head observations, which may cause unreasonable estimates of parameter fields. Thus, separating the head variations sourced from rainfall and river stage is essential to developing the reference heads for RST. To solve this issue, we propose a systematic approach to extracting and reconstructing the head variations of river features from the original head observations during the flood periods and conducting RST. We utilized a real case study to examine the developed method. This study used the groundwater level data, rainfall data, and river stage data in the Zhuoshui River alluvial fan in 2006. The hydraulic diffusivity (D) values of five observation wells were used as the reference for parameter estimation. The results show that the RMSE of the D value is 0.027 (m2/s). The other three observation wells were selected for validation purposes, and the derived RMSE is 0.85(m2/s). The low RMSE reveals that the estimated D field can capture the characteristics of the regional aquifer. The results also indicate that the estimated D values derived from the developed method are consistent with the sampled D values from the pumping tests in the calibration and validation processes in the real case study. The results demonstrate that the proposed method can successfully extract and reconstruct the head variations of river features from the original head observations and can delineate the features of the regional parameter field. The proposed method can benefit RST studies and provide an alternative mixed-feature signal decomposition and reconstruction method.