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Integrating a Linear Signal Model with Groundwater and Rainfall time-series on the Characteristic Identification of Groundwater Systems

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Groundwater resources play a vital role on regional supply. To avoid irreversible environmental impact such as land subsidence, the characteristic identification of groundwater system is crucial before sustainable management of groundwater resource. This study proposes a signal process approach to identify the character of groundwater systems based on long-time hydrologic observations include groundwater level and rainfall. The study process contains two steps. First, a linear signal model (LSM) is constructed and calibrated to simulate the variation of underground hydrology based on the time series of groundwater levels and rainfall. The mass balance equation of the proposed LSM contains three major terms contain net rate of horizontal exchange, rate of rainfall recharge and rate of pumpage and four parameters are required to calibrate. Because reliable records of pumpage is rare, the time-variant groundwater amplitudes of daily frequency (P) calculated by STFT are assumed as linear indicators of puamage instead of pumpage records. Time series obtained from 39 observation wells and 50 rainfall stations in and around the study area, Pintung Plain, are paired for model construction. Second, the well-calibrated parameters of the linear signal model can be used to interpret the characteristic of groundwater system. For example, the rainfall recharge coefficient (γ) means the transform ratio between rainfall intention and groundwater level raise. The area around the observation well with higher γ means that the saturated zone here is easily affected by rainfall events and the material of unsaturated zone might be gravel or coarse sand with high infiltration ratio. Considering the spatial distribution of γ, the values of γ decrease from the upstream to the downstream of major rivers and also are correlated to the spatial distribution of grain size of surface soil. Via the time-series of groundwater levels and rainfall, the well-calibrated parameters of LSM have ability to identify the characteristic of aquifer.