Estimation of natural and anthropogenic impacts on groundwater resources of Pintung delta plain using numerical spatiotemporal modeling

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This study applies a numerical spatiotemporal dynamic model to estimate the natural and anthropogenic impacts on groundwater resources, and to identify the unstably vulnerable areas which need intensively monitor. The methodology of this study can be divided to six parts: (1) estimate temporal-spatial pattern of pumpage and recharge using coupled analysis of groundwater hydrograph fluctuation and isotope; (2) simulate spatiotemporal groundwater level using numerical model and regard that as actual observed data; (3) compute groundwater storage hydrograph according to observed groundwater level for inverse evaluating the temporal distribution of pumpage and recharge under multiple irrigation practices; (4) apply principle component analysis with observed groundwater level for inverse evaluating the spatial distribution of pumpage and recharge; (5) compute the spatiotemporal distribution of pumpage and recharge and simulate the corresponding groundwater level; and (6) assess the insufficient monitoring areas determined by higher evaluated error of pumpage and recharge. This study applies the established method on the groundwater system of Pintung delta plain. Results show that, the weighted average precise percentage of inverse evaluated temporal-spatial distribution of pumpage and recharge using PCA reaches 95.24%. The spatiotemporal distribution of pumpage and recharge is extremely non-uniform in Pintung plain that annual over-exploitation of shallow groundwater aquifer in tail fan reach 2.89×10^8 m^3. Furthermore, the assessing outcome show that, the area with higher differential value of harmonic mean pattern of leakage rate and with higher groundwater fluctuation amplitude has higher spatial evaluated error. These unstably vulnerable areas are mostly located at the intersection of upstream river and delta boundary and the intersection of downstream river and geological non-homogeneous demarcation.

Keywords: principle component analysis, estimation of pumpage and recharge, numerical groundwater modeling, hydrograph analysis, isotope, vulnerability assessment

