Combining groundwater quality analysis and a numerical flow simulation for spatially establishing utilization strategies for groundwater and surface water in the Pingtung plain

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Abstract

The limitation in surface water made groundwater in Pingtung Plain the critical water resource. Besides, since the groundwater in this area is abundant and inexpensive, this area has the lowest ratio of tap water use in Taiwan. Result in a drawdown in overall groundwater levels, seawater intrusion, and land subsidence. Therefore, it's necessary to plan to establish manmade lakes and reservoirs to increase the supply of surface water. The study combined groundwater quality analysis with numerical flow simulation to determine the most suitable location for surface water for drinking, irrigation, and aquaculture purposes in Pingtung Plain and then ranked the townships have poorest groundwater quality and high ability of groundwater recovery for planning groundwater conservation. The multivariate indicator kriging (MVIK) method is applied for analyzing the spatial variability of groundwater quality based on different thresholds of hydro-chemical parameters for various water usage purposes. MODFLOW is used to simulate a numerical model of groundwater flow and then determine the response of groundwater quantity for each water usage purpose in each township. Then combination together to plan the essential regional need to development water resources. Results in six southeastern townships with poor groundwater quality and fast recovery effects are the most suitable for locating surface water.

Keyword: Groundwater, multivariate indicator kriging, MODFLOW, drinking, irrigation, aquaculture.

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SUMMARY

Overexploitation of groundwater is a common problem in the Pingtung Plain area of Taiwan, resulting in substantial drawdown of groundwater levels as well as the occurrence of severe seawater intrusion and land subsidence. Measures need to be taken to preserve these valuable groundwater resources. This study seeks to spatially determine the most suitable locations for the use of surface water on this plain instead of extracting groundwater for drinking, irrigation, and aquaculture purposes based on information obtained by combining groundwater quality analysis and a numerical flow simulation assuming the planning of manmade lakes and reservoirs to the increase of water supply. The multivariate indicator kriging method is first used to estimate occurrence probabilities, and to rank townships as suitable or unsuitable for groundwater utilization according to water quality standards for drinking, irrigation, and aquaculture. A numerical model of groundwater flow (MODFLOW) is adopted to quantify the recovery of groundwater levels in townships after model calibration when groundwater for drinking and agricultural demands has been replaced by surface water. Finally, townships with poor groundwater quality and significant increases in groundwater levels in the Pingtung Plain are prioritized for the groundwater conservation planning based on the combined assessment of groundwater quality and quantity. The results of this study indicate that the integration of groundwater quality analysis and the numerical flow simulation is capable of establishing sound strategies for joint groundwater and surface water use. Six southeastern townships are found to be suitable locations for replacing groundwater with surface water from manmade lakes or reservoirs to meet drinking, irrigation, and aquaculture demands.