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Exploring the Relationship between Groundwater Resources and Hydrogeology in Wet and Dry Seasons by using Self-Organizing Maps

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Groundwater is abundant and widely distributed in Taiwan, and therefore becomes an important water resource. The Pingtung Plain is one of the most important areas with groundwater resource in Taiwan. The permeability of aquifers is good, but the variation of rainfall characteristics and the limitation of terrains has indirectly affected groundwater recharge. However, local residents have long-term extracted groundwater for various purposes such as irrigation and industrial uses. Therefore, in order to solve the problem of water resources scarcity in Taiwan, it is necessary to understand the variations of groundwater levels. This study used Pingtung Plain as the study area. Data consisting of precipitation, hydrogeology and groundwater level collected from 1999 to 2015 were used to investigate the relationship between groundwater and different hydrological factor. Then this study applied two Self-Organizing Maps (SOMs), an artificial intelligence (AI) algorithm, to categorize a large number of groundwater monitoring wells in wet and dry seasons for exploring the patterns of groundwater variation in each cluster through analyzing the relationship and similarity of neighboring neurons in the SOM. Analysis results indicated that: (1) according to the spatial distribution obtained from the SOMs, we found that groundwater recharge was highly influenced by the permeability of the geology in both the wet and the dry seasons. Nonetheless, severe seawater intrusion problems occurred in certain clusters with groundwater monitoring wells located along the coastal area during dry seasons; and (2) according to the temporal distribution obtained from the SOMs, rainfall was one of the main sources for groundwater recharge in wet seasons. Moreover, for clusters with aquifers of low permeability, higher correlation occurred between the average variations of groundwater levels in each ten-day period and the trends of rainfall in the previous two ten-day periods. In contrast, for clusters with aquifers of high permeability, the average variations of groundwater levels had similar trends with those of rainfall in each ten-day period, where the groundwater level rose rapidly at the initial stage. Due to less rainfall occurs in dry seasons, groundwater became the main water resource and thus groundwater levels would be affected easily by water demands in the western plain. In the aquifers of high permeability, the outflow rate of groundwater was high due to its high water level but became smooth due to a decrease in groundwater level. This study assessed the variations of groundwater levels in wet and dry seasons, which could be used to provide important information as a guiding reference for groundwater resources planning and management in the Pingtung Plain.