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Using the Markov Chain and Atmospheric Circulation Factors to Analyze the Precipitation and Groundwater Drought Characteristics

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In recent years, Taiwan has been facing water shortage due to the impact of the climate change, resulting in many serious drought events, especially in southern Taiwan. Long-term records from 25 rainfall stations and 17 groundwater stations in southern Taiwan basin were used in this study. We used the Standardized Precipitation Index (SPI) and Standardized Groundwater Level Index (SGI) and employed the first-order Markov chain model was used to determine the drought characteristics and propagation, including the steady-state probabilities of drought events and the mean duration for each station. This study also used the Drought Index (DI) to investigate the effects of rainfall on groundwater drought. Finally, wavelet analysis was used to investigate the periodic relationship between drought variability and atmospheric circulation factors. The results show that the steady-state probability of the meteorological drought of the Yanshui River basin in southern Taiwan is higher than other basins. The area with the longer mean duration is located in the Yanshui River basin and Erren River basin, and overall the mean duration ranges from 3 to 7 months. In addition, the result from the drought proneness analysis indicates that the longer drought duration caused by rainfall, the higher degree of drought proneness of groundwater drought occurred in the future. Finally, the results show that the mean duration of groundwater droughts are longer than those of meteorological droughts. The results of wavelet analysis show a positive correlation at long-term scales, which may be related to large-scale atmosphere circulation. The information of this research could be used as a reference for the water resource management in the future.