

應用 Mann-Kendall 及創新趨勢檢定法分析屏東平原降雨及地下水位變化趨勢

Application of Mann-Kendall and Innovative trend test methods to analyze rainfall and groundwater level variation trends in the Pingtung Plain

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摘 要

屏東平原為我國重要農業區，地下水則為該區重要灌溉水替代來源，了解氣候變遷下該區之降雨量及地下水位時空變化趨勢，有助於擬定完善之地下水經營管理策略。本研究以屏東平原 2000~2023 年期間之 9 處雨量站和地下水觀測井 96 口(第一含水層 34 口、第二含水層 27 口、第三之一含水層 26 口及第三之二含水層 9 口)觀測資料，使用兩種非參數之趨勢檢定法，包括近年來新提出之創新趨勢法(Innovative trend analysis, ITA)，及廣泛應用之 Mann-Kendall test 趨勢檢定法(MK test)應用於降雨量與地下水位之趨勢分析，並由檢定結果比較兩者之差異及適用性。研究顯示，對降雨而言，MK test 在年及各月尺度上之檢定結果皆為無顯著趨勢；ITA 在年尺度上主要呈現顯著下降，而在各月份趨勢上則呈現差異，顯著上升主要出現於枯水期，顯著下降則發生於豐水期。就地下水位趨勢而言，兩種年尺度趨勢分析結果均顯示屏東平原各含水層，包含第一、第二及第三之一含水層呈現顯著下降趨勢之觀測井數高於上升趨勢者，且扇頂區以下降趨勢為主導，扇尾區域以上升趨勢為主導，扇央區則屬於過渡帶。就各月份之地下水位趨勢而言，前述各含水層各月份下降趨勢比例絕大多數高於上升趨勢，除第一含水層可發現部分豐水期月份上升趨勢比例較其他月份提高外；其他含水層較不受豐、枯水期影響。研究亦顯示部分觀測井位所處之各含水層均同時出現明顯之水位下降趨勢，是否與各標的競用地下水資源有關，值得進一步追蹤並加以控制，整體而言，ITA 相較於 MK test 在趨勢檢定之結果擁有較高之顯著趨勢偵測率，也能透過圖形化散佈點分佈情形，獲取細部低、中、高各級距趨勢變化資訊，提供更為全面分析結果。本研究結果除能作為其他相關水文趨勢研究之參考外，亦可提供水利單位在擬定水資源永續經營管理相關策略上之依據。

關鍵詞：地下水，屏東平原，創新趨勢法，Mann-Kendall test

Abstract

The Pingtung Plain is an important agricultural area in Taiwan, and groundwater is an important alternative source of irrigation water in the area. Understanding the spatiotemporal trends of rainfall and groundwater in this area under climate change will help to formulate a complete groundwater management strategy. According to the observation data obtained from 9 rain gauges and 96 groundwater observation wells (34 in the first aquifer, 27 in the second aquifer, 26 in the third aquifer layer I, and 9 in the third aquifer layer II) in the Pingtung Plain from 2000 to 2023, two non-parametric trend detection methods, including the recently proposed Innovative Trend Analysis (ITA) and the widely used Mann-Kendall (MK) test, was applied to the trend analysis of rainfall and groundwater level, and the differences and applicability between the two methods are compared based on the verification results. For rainfall, the MK test results show no significant trends at on the annual and monthly scales. ITA mainly shows a significant decrease on the annual scale, while there are differences on the monthly trends. The significant increase mainly occurs in the dry season, a significant decrease occurs during the wet season. As for the trend of groundwater levels, both annual scale trend analyzes reveal that the number of observation wells showing a significant downward trend in each aquifer, including the first, second and third-I aquifers, is higher than that of the upward trend, and the Proximal-fan area is dominated by a downward trend, the Distal-fan tail area is dominated by an upward trend, and the Mid-fan area is a transition zone. In terms of groundwater level trends in each month, the proportion of downward trends in each of the aforementioned aquifers in each month is overwhelmingly higher than the upward trend. Except for the first aquifer, it can be found that the proportion of upward trend in some wet season months is higher than that in other months, other aquifers are less affected by the wet and dry seasons. The insufficient rainfall in recent years has led to the need for increased groundwater extraction to supplement the irrigation water shortage. This study also indicates that some observation wells show significant declining trends in multiple aquifer layers simultaneously, which may be related to the competition for groundwater resources among different water users and deserves further tracking and control. Furthermore, compared with MK test, ITA has a higher significant trend test detection rate, and it can also obtain detailed trend change information at low, medium and high levels through graphical scatter point distribution, providing a more comprehensive analysis result. The results of this study can serve as a reference for other related hydrological trend studies, and can also provide a basis for water authorities to formulate sustainable water resource management strategies.

Keywords: Groundwater , Pingtung Plain , Innovative trend analysis , Mann-Kendall test