

智慧季節時序診斷於水資源管理與旱災預警的應用

Application of Intelligent Seasonal Progression Diagnostics in Water Resources Management and Drought Early Warning

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摘 要

臺灣年雨量雖豐，但受限於地形陡峭降雨不易留存，常面臨乾旱的衝擊，建立乾旱預警能力與工具已是當務之急。以近期旱象為例，旱象自2025年年末開始出現，直至2026年6月上旬的梅雨季降雨才告結束，顯見乾旱是具有持續性且跨季節尺度特性的議題。此外，臺灣降雨乾、濕季差異分明，且降雨區域性差異大，大幅增加水資源管理的難度。

為因應區域水情特性，本研究結合歷史氣象資料與機器學習智慧技術，根據歷史年份的季節判釋，重新對齊與合成全年 73 個候的逐候氣象變化。以這項技術建立了一個不依賴預報輔助的氣候指引，用以描述正常季節演進下的降雨多寡變化。

在建立指引時，除了全台平均外，更涵蓋全島的重要水庫，可視為全台重要水庫降雨多寡的「農民曆」，我們稱之為「水庫乾溼季節曆」。執行時針對個別水庫，區分乾、濕季，並分別將降雨多寡區分為 4 個階層來著色，以燈號等級方式呈現，方便水資源管理者操作應用。文中並以石門和曾文水庫為範例說明初步的應用。

關鍵字：季節時序、機器學習、水資源管理、旱災預警

Abstract

Although Taiwan receives abundant annual rainfall, its steep topography makes it difficult to retain rainwater, leaving the island frequently vulnerable to the impacts of drought. Developing drought early warning capabilities and tools has become an urgent priority. Taking the recent drought as an example, the dry spell began to emerge at the end of 2025 and did not conclude until the arrival of the Meiyu seasonal rainfall in early June 2026. This clearly demonstrates that drought is a persistent issue with cross-seasonal scale characteristics. Furthermore, Taiwan's rainfall is distinctly divided into dry and wet seasons, and exhibits significant regional variability, which drastically increases the difficulty of water resources management.

To address these regional hydrological characteristics, this study integrates historical meteorological data with AI intelligent technology. Based on seasonal progression identification from historical years, we realigned and composited the pentad-by-pentad meteorological variations across all 73 pentads of the year. Through this technology, a climatological guidance independent of forecast assistance has been established to describe the variations in rainfall amounts under normal seasonal progression.

In developing this guidance, it covers key reservoir in addition to the all-Taiwan average, and can be envisioned as an "almanac" for the precipitation variations across Taiwan's reservoirs—which we call the "Reservoir Dry/Wet Seasonal Calendar." For individual reservoir, the calendar clearly separates the dry and wet seasons, dividing rainfall amounts into four easy-to-read, color-coded levels. This is presented as an operational warning-light rating system to facilitate practical application and operation for water resources managers. Finally, this paper uses the Shimen and Zengwen reservoir as case studies to illustrate the preliminary applications of this system.

Key words: seasonal progression, machine learning, water resources management, drought early warning