整合衛星遙測與水文氣象數據之乾旱監測模型

A Drought Monitoring Model Integrating Satellite Remote Sensing and Hydro-meteorological Data

逢甲大學營建及防災研究中心

助理教授	專案經理	資料工程師	組長
何智超	王鈺超	張智雄	李承家
Chih-Chao Ho	Yu-Chao Wang	Chih Hsiung Chang	Cheng-Jia Li

經濟部水利署水利規劃分署

分署長	科長	正工程司	助理研究員
張廣智	葛武松	趙永楠	許家銓
Kuang-Chih Chang	Wu-Sung Ke	Yeong-Nan Chao	Chia-Chuan Hsu

摘　要

乾旱是一種無法避免的自然現象，對環境、經濟和社會產生廣泛而深遠的影響。由於乾旱的起始和結束時間難以確定，乾旱的嚴重程度往往用來判斷其影響範圍。輕微乾旱會影響農業生計和民生用水，而嚴重乾旱則威脅社會經濟發展和公共衛生安全。在過去的 50 年中，台灣發生了 18 次嚴重乾旱，導致農業休耕停灌。109 年更是創下 56 年來首次颱風季無颱風登陸的紀錄，並且是 50 多年來降雨量最低的一年，導致全台各區供水吃緊，不得不實施減供甚至停供的限水措施。隨著氣候變異加劇，乾旱事件發生越趨頻繁，但其發生或結束往往沒有明確特徵可供定義和預警。因此，如何有效預測乾旱並提出適當因應措施，成為水資源管理的重要議題。本研究提出一套結合衛星影像進行乾旱監測的方法，採用雨量、流量、水庫蓄水量(標準化、百分位數)及溫度植生乾燥指標 Temperature-Vegetation Dryness Index,TVDI)等五項因子建立乾旱監測，其中水庫蓄水量及流量兩項因子會依據各水庫對於供水範圍的比例做分配，此外，為提供一致性的乾旱程度判定，本計畫引入不確定性決策分析之等可能性法，對於空間網格乾旱程度進行判定，為進一步掌握縣市及鄉鎮市區範圍之乾旱程度，參考美國乾旱監測網站(U.S. Drought Monitor)的乾旱程度及覆蓋率指數(Drought Severity and Coverage Index,DSCI)估計區域水文乾旱程度，並設定情境決定 DSCI 歷時之標準，比對水利署發布之實際燈號進行驗證。

關鍵詞：遙測、乾旱監測、水資源管理、乾旱程度及覆蓋率指數、區域水文乾旱程度

Abstract

Drought is an inevitable natural phenomenon that has extensive and profound impacts on the environment, economy, and society. Due to the difficulty in determining the onset and end of droughts, their severity is often used to gauge their impacts. Mild droughts affect agricultural livelihoods and household water use, while severe droughts threaten socio-economic development and public health safety. In the past 50 years, Taiwan has experienced 18 severe droughts, leading to agricultural fallow and irrigation suspension. In 2020, Taiwan recorded the first typhoon season in 56 years without a single typhoon making landfall, and it was also the driest year in over 50 years, causing water supply shortages across the island and necessitating water rationing and suspension measures. With the intensification of climate variability, drought events are becoming more frequent, but their occurrence or cessation often lacks clear characteristics for definition and warning. Therefore, effectively predicting droughts and proposing appropriate response measures have become important issues in water resource management. This study proposes a method for drought monitoring that integrates satellite imagery, utilizing five factors: precipitation, streamflow, reservoir storage (standardized and percentile), and the Temperature-Vegetation Dryness Index (TVDI). The factors of reservoir storage and streamflow are allocated based on the proportion of water supply coverage of each reservoir. Additionally, to provide consistent drought severity determination, this study introduces the equiprobability method of uncertainty decision analysis to determine drought severity in spatial grids. To further understand the drought severity at county and township levels, the study references the Drought Severity and Coverage Index (DSCI) from the U.S. Drought Monitor to estimate regional hydrological drought severity and sets scenarios to determine the DSCI duration standards, verifying them against the actual signals released by the Water Resources Agency.

Keywords: Remote Sensing，Drought Monitoring，Water Resources Management，TVDI，Regional Hydrological Drought Severity