水文模式導入展期與長期降雨預報產品進行農業示範灌區水源集水區流量預報

Inflow Forecasting for Agricultural Demonstration Irrigation Districts Using Extended to Long-Range Rainfall Forecasts and Hydrological Models

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摘　要

本研究採用中央氣象署產製之 NCEP GEFS v12 展期(1-30 天)降雨預報產品，以及利用全球多模式預報資料(CWACFSv2, NCEPCFSv2, ECMWF SEAS5)產製之貝氏模型平均(Bayesian Model Averaging, BMA)長期(1-6 個月)降雨預報產品，進行農業示範灌區主要水源(石門水庫、曾文水庫、士林攔河堰與卑南溪流量站)之作業化流量預報。前述展期與長期降雨預報均經偏差修正後之高解析(1km×1km)降雨預報產品，其中 NCEP GEFS v12 為美國國家環境預報中心(National Centers for Environmental Prediction, NCEP)第 12 版全球系集預報系統(Global Ensemble Forecast System version 12, GEFS v12)；CWACFSv2 為氣象署(Central Weather Agency, CWA)氣候預報系統第二版(Climate Forecast System v2, CFSv2)；NCEPCFSv2 為美國國家環境預報中心(NCEP)氣候預報系統第二版(CFSv2)；以及 ECMWF SEAS5 為歐洲中期天氣預報中心(European Centre for Medium-Range Weather Forecasts, ECMWF)季節預報系統第 5 版(SEAS5)。

氣象署以未來 1-30 天逐日之 7 日累積雨量預報值方式產出作業化校正後展期降雨預報產品，本研究以簡易平均方式分配 7 日累積量至每天，作為修正型 HBV 水文模式之輸入資料，以預報水庫、攔河堰與流量站位址之未來 1-30 天入流量。另外前述採用全球多模式資料產製之 BMA 長期降雨預報產品，其預報雨量以月總雨量輸出，本研究則採用 K 近鄰法(K Nearest Neighbors, KNN)進一步將雨量預報值由月時間尺度轉換為日時間尺度，作為修正型 HBV 水文模式之輸入資料，以預報未來 1-180 天入流量。作業化流量預報資訊可進一步提供各示範灌區之灌溉水文分析與供灌風險評估，以掌握未來期作在不同時間、區位之各種農業水資源可運用水量，以及抗旱行動啟動時機與相關供

灌風險等決策輔助資訊。

關鍵詞：展期雨量預報，長期雨量預報，貝氏模型平均，入流量預報，HBV 水文模式

Abstract

This study utilizes two types of rainfall forecast products for operational inflow forecasting at major water sources in agricultural demonstration irrigation areas—namely Shimen Reservoir, Zengwen Reservoir, Shilin Weir, and Beinan River flow station. The first is the extended-range (1–30 days) rainfall forecast produced by the Central Weather Administration (CWA) using the NCEP GEFS v12. The second is the long-range (1–6 months) rainfall forecast product based on Bayesian Model Averaging (BMA), derived from global multi-model forecast data (CWACFSv2, NCEPCFSv2, and ECMWF SEAS5). Both the extended-range and long-range rainfall forecasts are bias-corrected and presented at high spatial resolution (1 km × 1 km). The NCEP GEFS v12 refers to version 12 of the Global Ensemble Forecast System developed by the U.S. National Centers for Environmental Prediction (NCEP). CWACFSv2 is the second version of the Climate Forecast System (CFSv2) operated by the Central Weather Administration. NCEPCFSv2 refers to the same system operated by NCEP. ECMWF SEAS5 is the fifth version of the seasonal forecasting system developed by the European Centre for Medium-Range Weather Forecasts (ECMWF).

For the extended-range forecast, the CWA produces operationally bias-corrected products in the form of 7-day accumulated rainfall forecasts on a daily basis for the next 1–30 days. In this study, the 7-day accumulated values are evenly distributed across each day using a simple averaging method, which serves as input data for a modified HBV hydrological model to forecast the inflow to reservoirs, weirs, and flow stations for the next 1–30 days. As for the long-range BMA rainfall forecasts derived from global multi-model data, the outputs are in the form of monthly total rainfall. To convert these into daily values for hydrological modeling, the K-Nearest Neighbors (KNN) method is applied. These daily-scale rainfall forecasts are then used as input to the modified HBV model to predict inflow for the next 1–180 days. The resulting operational inflow forecast information can support irrigation hydrological analysis and water supply risk assessment in each demonstration irrigation area. This allows for better understanding and planning of agricultural water availability across different periods and regions, as well as providing decision support for drought response actions and related irrigation risk management.

Keywords: extended-range rainfall forecast, long-range rainfall forecast, Bayesian Model Averaging, inflow forecasting, HBV hydrological model