整合校正後 NCEP GEFS v12 展期 1-30 天降雨預報與水文模式分析水庫入流量預報效能

Integration of NCEP GEFS v12 Calibrated Extended-Range Rainfall Forecasts with Hydrological Modeling to Analyze Reservoir Inflow Forecasting Accuracy

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摘　要

為考量天氣型態之快速變化並掌握預報雨量時空分布，進而提供水庫與攔河堰入流量預報資訊作為農業水資源管理決策參考，本研究整合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)之降雨預報與水文模式，進行水庫與攔河堰 1-30 天入流量預報。經由導入氣象署產出之校正後 NCEP GEFS v12 預報系統 1-30 天歷史降雨預報成果，分析農業示範灌區其主要水源(石門水庫、曾文水庫與士林攔河堰)之入流量預報效能。

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 2000/01-2019/12 歷史降雨預報產品，此校正後產品為經偏差修正與降尺度之高解析(1 km×1 km)網格預報產品，具有 20 組系集降雨預報與 1 組決定性預報。本研究採用該組決定性預報作為修正型 HBV 水文模式之輸入資料，以預報水庫與攔河堰未來 1-30 天入流量，並計算每次預報的流量預報誤差。流量預報誤差的計算方式為預報值減觀測值，預報值分旬採用第 1 旬(預報第 1-10 天)、第 2 旬(預報第 11-20 天)、第 3 旬(預報第 21-30 天)預報流量之平均值，而觀測值則採用預報同期間之第 1-3 旬觀測流量平均值。另採用氣候法(即以預報同期間之歷史流量平均值當作預報值)與採用校正後 NCEP GEFS v12 降雨預報輸入修正型 HBV 水文模式進行流量預報之結果相互比較。分析結果顯示：整體而言，第 1-3 旬流量預報優於採用歷史流量平均值之氣候法。在第 1 旬流量預報誤差整體表現最佳；然而在第 2 旬及第 3 旬，隨著預報期間的延長與預報雨量不確定性增加，流量預報效能略微下降。

關鍵詞：NCEP GEFS v12，展期雨量預報，入流量預報，HBV 水文模式

Abstract

In order to account for the rapid changes in weather patterns and to grasp the spatial and temporal distribution of forecasted rainfall, providing inflow forecasts for reservoirs and weirs as reference information for agricultural water resource management decisions is important.

This study aims at integrating the precipitation forecasts from the Global Ensemble Forecast System version 12 (GEFS v12) of the U.S. National Centers for Environmental Prediction (NCEP) with a hydrological model to conduct 1- to 30-day inflow forecasts for reservoirs and weirs. By incorporating the 1- to 30-day historical rainfall forecasts from the corrected NCEP GEFS v12 system, produced by the Central Weather Administration, the study analyzes the inflow forecasting performance for major water sources in agricultural demonstration irrigation zones, including Shihmen Reservoir, Zengwen Reservoir, and Shilin Weir.

The Central Weather Administration has produced historical rainfall forecast products from January 2000 to December 2019 in the form of 7-day accumulated daily rainfall forecasts for the next 1 to 30 days. This corrected product is a high-resolution (1 km × 1 km) gridded forecast dataset that has undergone bias correction and downscaling, and includes 20 ensemble rainfall forecasts and one deterministic forecast. This study uses the deterministic forecast as the input data for the modified HBV hydrological model to forecast inflows for reservoirs and weirs for the next 1 to 30 days, and to calculate forecast errors for each forecast.

The forecast error is calculated as the forecasted value minus the observed value. The forecasted values are averaged over three 10-day periods: the first period (days 1–10), the second period (days 11–20), and the third period (days 21–30). Correspondingly, the observed values are the average inflows over the same three forecast periods. In addition, the results obtained from using the corrected NCEP GEFS v12 rainfall forecasts as input to the modified HBV model are compared with those from the climatology method (which uses the historical average inflow during the forecast period as the forecast value). The analysis results show that the forecast performance for the first to third 10-day periods is superior to that of the climatology method. Among them, the first 10-day period yields the best overall forecast accuracy. However, in the second and third 10-day periods, the inflow forecasting performance slightly declines due to the extended forecast lead time and increased uncertainty in rainfall predictions.

Keywords: NCEP GEFS v12 extended-range rainfall forecast, inflow forecasting, HBV hydrological model