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ORIGINAL ARTICLE

Deep learning-based streamflow prediction for western Himalayan river basins

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Abstract Accurate streamflow (Qflow) forecasting plays a pivotal role in water resource monitoring and management, presenting a complex challenge for water managers and engineers. Effective streamflow prediction enables the optimized operation of water resource systems in alignment with technological, financial, ethical, and political objectives. Traditional data-driven models like the Autoregressive model and Autoregressive Moving Average model are widely used for water resource management. However, these models show limitations in handling intricate nonlinear hydrological phenomena. To address these limitations, Deep Learning models emerge as promising alternatives, given their inherent ability to handle nonlinearity. Nonlinearity in time series modeling is formidable due to factors like long-term trends, seasonal variations, cyclical oscillations, and external disturbances. This study proposes a deep neural network architecture based on Neural Basis Expansion Analysis for Time Series (N-BEATS) to predict the daily Qflow of western Himalayan river basins. The study employs datasets collected from the Rampur station of the Satluj basin and the Pandoh and Manali stations of the Beas basin. The experimental results unequivocally demonstrate the superiority of the proposed deep neural network model over benchmarked conventional deep learning models such as Long Short-Term Memory, Feedforward Neural Network, Gated Recurrent Unit, and Recurrent Neural Network. The proposed deep neural network model achieves remarkable accuracy, exhibiting a root mean square error below 0.05 m^3/s when comparing actual and predicted Qflow values across all datasets. Consequently, the proposed deep neural network model based on N-BEATS emerges as an efficient and invaluable solution for precise Qflow prediction, empowering efficient water resource management and control. The results suggest that the proposed model can serve for streamflow prediction and water management in Himalayan river basins.

Keywords Streamflow · Prediction · Deep learning · N-BEATS · Western Himalayan · River basins

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1 Introduction

Accurate streamflow forecasting is essential for effective water management tasks such as improving the efficiency of hydroelectricity generation, agricultural management, and flood protection. Forecasts, with lead times of hours

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