Rainfall-Runoff Modelling Using HEC-HMS and ANN for Flood Prediction: A Study of Kolhapur Flood Event 2019

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Abstract:

Floods are one of the most common and destructive natural disasters, often caused by excessive rainfall and poor drainage management. Accurate surface runoff prediction is critical in effective flood predictions and water resource management. This study aims to develop and compare two different approaches to rainfall-runoff modelling using HEC-HMS and a data-driven Artificial Neural Network (ANN) for simulating surface runoff and flood prediction. The models are deployed for the Kolhapur region in India, which experiences intense monsoon rainfall and is prone to flash floods.

Observed rainfall and discharge data for the months of July and August 2019 were used to develop, calibrate, and validate both models. The HEC-HMS model employed the SCS Curve Number method for loss calculation, the SCS Unit Hydrograph for runoff transformation, and the Muskingum method for channel routing. On other hand, an ANN model was developed using rainfall as input and stimulated discharge as output, trained using feedforward artificial neural network.

Model performances were evaluated using statistical indicators such as the Nash-Sutcliffe Efficiency (NSE), Root Mean Square Error (RMSE), and coefficient of determination (R^2) and scenario-based analysis using return periods are evaluated. The ANN model demonstrates slightly higher accuracy as it is data driven model. However, HEC-HMS provided better physical interpretation and flexibility in scenario simulation. The study shows the significance of combining physical and data-driven models for flood forecasting.

Keywords:

ANN, HEC-HMS, Nash-Sutcliffe Efficiency (NSE), Root Mean Square Error (RMSE), SCS Curve Number, SCS Unit Hydrograph.