(9)

Application of HEC-HMS Model on Event-Based Simulation in Kalu Ganga for Flood Prediction

Kamburugamuwa, S.W.*, Netthikumara, N.K.Y., Nandalal, H.K.

Department of Civil Engineering, University of Peradeniya, Peradeniya, Sri Lanka
**sachiniswk97@gmail.com*

Abstract

Rainfall-runoff modeling is crucial for managing flood risks, particularly in rivers like the Kalu Ganga in Sri Lanka, which frequently experiences flooding. The Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS 4.10) provides an effective tool for simulating and analyzing rainfall-runoff dynamics. Event-based modeling is vital for understanding how a basin responds to specific rainfall events, aiding in accurate flood prediction and water resource management. This study tested six rainfall-runoff model combinations to determine the most effective configuration for the Kalu Ganga Upper catchment up to Ellagawa, focusing on simulating and predicting runoff accurately for flood events. Criteria such as rainfall type (event-based), spatial process (semi-lumped), model type (empirical), and fitted parameters were considered to select the best model combinations. Rainfall data from four gauging stations in the Ratnapura district and discharge data from the Ellagawa station (2018–2021) were used for calibration and validation, providing real-world input for the model. GIS tools were employed to delineate sub-basins and calculate catchment rainfall using Thiessen polygons, ensuring precise spatial representation of rainfall across the watershed. Calibration involved optimizing model parameters, and the results showed variation in performance across different events, highlighting the model's sensitivity to rainfall intensity and distribution. Among the six tested combinations, the Initial Constant method paired with the Clark Unit Hydrograph, the Recession base flow method, and the Muskingum routing method performed best, achieving a Nash-Sutcliffe Efficiency (NSE) of 0.98, Root Mean Square Error (RMSE) of 0.1, and Percent Bias (PBIAS) of 0.16. These results demonstrate the model's high accuracy in simulating runoff and replicating observed discharge hydrographs. The findings emphasize the effectiveness of semi-lumped hydrological modeling in tropical basins influenced by varying rainfall patterns, forest cover, and land use. The SCS Unit Hydrograph transformation method was particularly suited for the study area's tropical characteristics. However, the model's performance was affected by the quality of input data and the relatively short study period. Future studies should incorporate continuous rainfall simulations, additional gauging stations, and advanced methods like Green-Ampt and Mod Clark to further refine model accuracy. Integrating land-use changes, expanding the dataset, and considering longer simulation periods would enhance the model's utility for water resource management and flood forecasting. This study demonstrates the potential of HEC-HMS as a reliable tool for event-based flood prediction in the Kalu Ganga basin, providing accurate forecasts of flood peaks and timing, and offering broader applications for similar tropical river basins.

Keywords: *HEC-HMS, Rainfall-runoff model, Event-based rainfall, Calibration and Validation.*