AERI

Irrigation and Drainage Structures Engineering Research/Vol.21/No.78/ Spring 2020/P: 79-98

Flood Hydrograph Routing using Mike11 Numerical Model and Artificial Intelligence System (Case Study: Seymareh River)

S. Malekzadeh, A. Arman* and A. Azari

* Corresponding Author: Assistant Professor, Campus of Agriculture and Natural Resources, Razi University, Kermanshah. Email: a.arman@razi.ac.ir
Received: 6 February 2019, Accepted: 28 May 2019

Extended Abstract

Introduction

Using hydrological information and physical and hydraulic characteristics of the river route for flood routing in different cross sections of the river, impact of forecasting on the occurrence and flow peak flow and successful implementation of flood alarm systems and forecasting flood volume downstream of the river. Given the importance of predicting flood hydrographs, especially in flood plain rivers, and the lack of sufficient information and statistics at some river basins, this may result in hydraulic methods in such rivers. This study aimed to compare the results of flood routing using the numerical model MIKE11 and the support vector machine method. This comparison was based on three parts: peak discharge, flood volume and baseline hydrograph time.

Methodology

In this study, based on physical and hydraulic information of the route, hydraulic routing of flood hydrographs between two hydrometric stations of Holeilan and Sazebon was conducted in a distance of 67 km from Semareh River in Ilam province, Iran. For this purpose, 365 cross-sections with an approximate distance of 200 m were considered for flow routing. The geometrical data of these sections and their physical characteristics in terms of their distance (in kilometers) were entered in the MIKE11 upstream interval. River bed gradiation curves were used to estimate the roughness coefficient in each section. These coefficients were optimized during model calibration and validation. In addition to the main river, discharge included two major sub-branches located along the river. The flow rate of these branches was defined as sub-flow of internal boundaries in the model. For upstream boundary conditions, hourly hydrograph data of Holeilan station and for downstream boundary conditions, flood hydrograph data and discharge values of rating-curve station at the last river crossing were entered. The SVM model was then used to predict the flood hydrograph at the output of the interval based on the input flood hydrograph data. Based on the delay time of flood passage between Holeilan and Sazebon stations, flood hydrograph data at Holeilan station located upstream of 0, 2, 4, 6, 8, 10, 12 and 14 hours delays as input layers and hydrograph discharge values at the location of the Sazebon station was considered as the output layer and the model was calibrated and validated using recorded hydrographs. Finally, the results of these two models were compared. Flood hydrographs were also upstream with different return periods and flood hydrographs were predicted at interval outflows with different return periods.

Results and Discussion

Based on the results of both calibration and validation, it was found that the support vector machine method predicted the peak discharge relatively better than that of the MIKE11 method, but with considering statistical indices, such as RMSE which calculated all hydrograph discharges, the results of the flood hydrograph prediction in MIKE11 model had relative advantages over the support vector machine model. This model also simulated the volume of floods more accurate. However, in order to compare the behavioral pattern of predicted flood hydrographs with different return periods, especially floods with the peak discharge more than the peak discharge hydrographs used in the calibration and validation phase, flood hydrograph values with period various returns as inputs to the study area were entered into each model at Holeilan station and flood hydrographs were predicted at the output of the interval and at the corresponding station location with the corresponding return period. Because the classification of data in the training phase is adjusted to discharges less than 25 years, the SVM model was able to predict only hydrographs with 2, 5 and 10 year return periods. But after the calibration and validation, the Mike11 model was able to predict the hydrograph well with the return periods of 2, 5, 10, 25, 50 and 100 years.

Conclusions

The results showed that the SVM model was somewhat better than the Mike11 model if the only criterion was to predict peak flow within the range of historical discharges. But this model was not accurate for predicting partial events with a return period of more than ten years. Given the statistical indices of RMSE, NRMSE, and NASH, which use all hydrograph discharges to evaluate results rather than using peak discharge, the Mike11 model provided better results than the SVM model. The Mike11 model performed better than the SVM model in predicting partial event hydrographs with different return periods.

Acknowledgment

The authors of the article extend their thanks reviewers for reviewing and improving the structure of the article, and also to the National Surveying Agency for providing the maps of the Seymareh River.

Keywords

Artificial Intelligence, Flood Rivers, Flood Routing, Numerical Methods, River Cross Sections