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ORIGINAL ARTICLE

Assessment of the combined effects of Manning roughness and DEM resolution for the water surface elevation prediction using the HEC-RAS model: a case study of Moudjar River in the Northeast of Algeria

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Abstract

Knowledge of variation of the water surface elevation in a river is very important for developing hydraulic models able to predict flooding and flood hazard mapping. The roughness and DEMs resolution are factors that can affect the flow characteristics in a river. Manning's roughness plays a significant role because it is not a constant parameter and varies depending on the length of the river. DEM resolution is potentially the crucial element to give better flood estimations. The objective of the present study is to assess the combined effects of Manning roughness and DEMs resolution to predict water surface elevation of the Moudjar River by using HEC-RAS 1D model. In this study, different results were obtained from various combinations of DEM resolution, and Manning roughness coefficients by applying the unsteady HEC-RAS (Hydrologic Engineering Centers- River Analysis System) 1D model on the Moudjar River in Algeria, to predict and quantify the performance regarding actual water surface elevation extent and the generated water surface limits. Data from February 02, 2019, to February 07, 2019, were used to determine predictive accuracy. The simulation results of the stage level of the river flow for different combinations of Manning's roughness coefficient and DEM's resolution show the closer values between the observed and simulated stage hydrograph, only in the case of the coarser DEM resolution (50 m) where the results are very distant and unacceptable. Statistical parameters such as Root Mean Square Error (*RMSE*), Mean Absolute Error (*MAE*), and Nash Sutcliff (*NSE*) were used to verify the model's accuracy and predictive ability. The results obtained and the methodology applied to the Moudjar River can be used as a useful reference for HEC-RAS modelling and flood predicting in Algerian rivers.

Keywords DEM resolution · Flooding · HEC-RAS · Moudjar River · Roughness · Water surface

Introduction

Floods are natural hazards caused by climate change and human activities that can inundate agricultural areas and urban areas, causing human casualties, economic loss, and environmental issues (Hartnett and Nash 2017; Najibi and Devineni 2018; Poff 2018; Mahmood et al. 2019; Manopiniwes and Irohara 2021), In order to minimize economic losses and the negative effects of flooding, flood modelling should be used to identify water depths and flood-prone areas (Mojaddadi et al. 2017; Apollonio et al. 2021; Komolafe 2022). Flooding modelling in rivers and floodplains requires the hydraulic model accuracy to delineate flood inundation which depends on the accuracy of the hydraulic parameters (roughness coefficients), geometric data, DEMs resolution (Sharma and Regonda 2021) and flood prediction measures (Tamiru and Wagari 2022). Several researchers have used hydraulic models with different capacities and accuracy to model rivers and floodplains using one-dimensional (1D), and two-dimensional (2D) approaches. One-dimensional hydraulic models (1D) are an easy application that can simulate large surfaces with high precision (HEC-RAS, Mike11), and it has several

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