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EXTENDED ABSTRACT

Simulating the Effect of River Dredging on the Extent, Depth, and Risk of Flooding Using The HEC-RAS (2D) Model in Areas with a Low Slope (Case Study: Agh-Ghala City)

Laleh Rezaei Ghaleh [a], Hossein Rezaie [a,*], Khalil Ghorbani [b]

[a] *Dept. of Science and Water Engineering, Faculty of Agriculture, Urmia University, Urmia, Iran*
[b] *Dept. of Water Engineering, Faculty of Water and Soil Engineering, Gorgan University of Agricultural Sciences and Natural Resources, Gorgan, Iran*

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1. Introduction

Throughout the world, hydraulic models are used to simulate floods. Gorgan Roud River has historically caused significant damage to Golestan province. This study aimed to investigate the impact of dredging on the 2018 flood in Golestan province. Riverbed adjustments of 0.5, 1, and 2 meters were applied to the Gorgan Roud River using GIS software and the HEC-GeoRAS plugin from the outlet of Voshamgir dam to Agh-Ghala City. The DEM of the region was corrected to account for these changes. The flood area, depth, and velocity of the 2018 flood in Golestan province were simulated using HEC-RAS (2D) software, taking into account the effects of dredging. The results indicate that dredging increased the water flow capacity of the Gorgan Roud River but did not reduce the flood extent, especially in the upstream area. However, it reduced the level of flooding in Agh-Ghala. Risk maps demonstrate that dredging to 0.5, 1, and 2 meters, reduced the depth of high-risk areas in Agh Ghala city by 1.1%, 4.7%, and 12.7%, respectively.

2. Methodology

This study utilized the HEC-geoRAS plugin in GIS software to create input DEMs for the HEC-RAS model. To begin, a TIN layer was established for the study location using a topographic contour map. Next, the center line of the river and its left and right banks were added to the TIN layer, followed by the creation of a cross-section along the river. The height information from the cross-section layer was then used to adjust the riverbed heights to depths of 0.5, 1, and 2 meters, resulting in three different rasters for the river. The DEM layer was inputted into the model with the desired geographic coordinate system defined. Additionally, a land use map of the target area and Manning coefficients for various land uses were entered. A two-dimensional flow Area was then defined as a polygonal layer for the designated area, and hourly flow hydrographs were inputted into the model as unsteady flow characteristics with the upstream and downstream boundary conditions specified. Once the model was implemented, depth and velocity maps and an orthophoto were generated as input for GIS software. This process was repeated for three DEMs resulting from changes in the riverbed height, as well as the base DEM of the area. The aforementioned procedure is depicted in Fig. 1.

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* Orcid Cod Corresponding Author: 0000-0002-1354-7385
E-mail addresses: l.rezaei@urmia.ac.ir (Laleh Rezaei Ghaleh), h.rezaie@urmia.ac.ir (Hossein Rezaie), ghorbani.khalil@gau.ac.ir (Khalil Ghorbani).

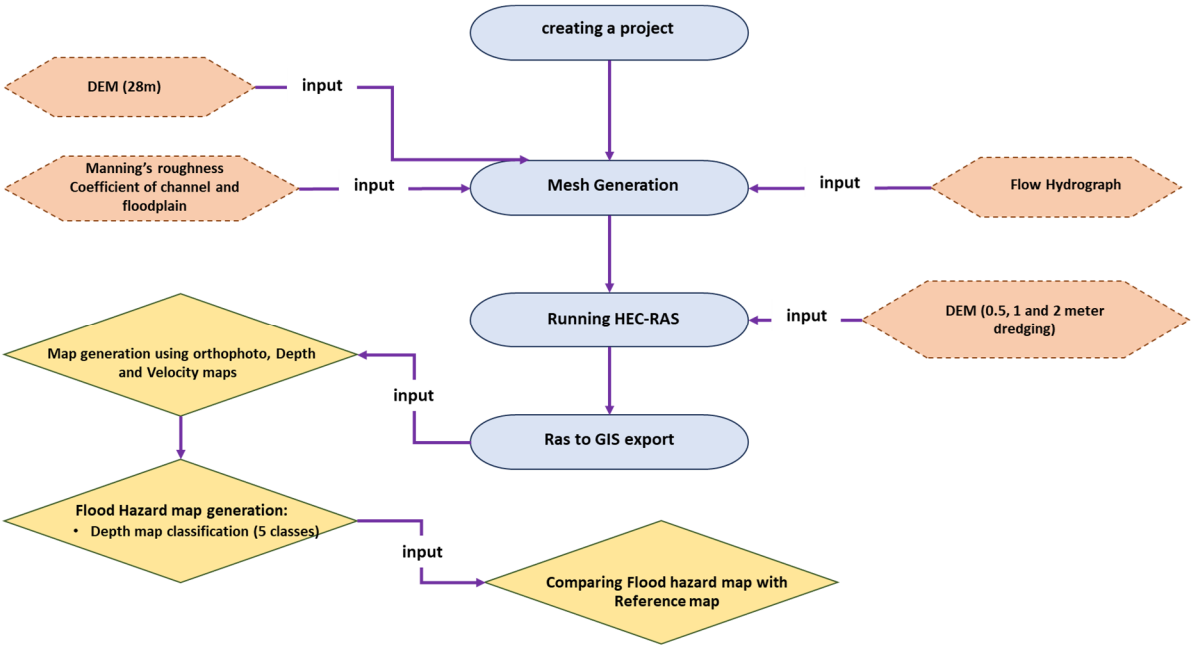

Fig. 1. Model implementation Flowchart

3. Results and discussion

Through the figures presented, it is evident that increasing dredging depth leads to the largest area of inundation being related to low to medium-risk classes. The volume of flood in this basin further extends from the flood plain to the residential areas of Agh-Ghala City, which are located in low-altitude areas. This has created dangerous areas in the north of Agh-Ghala City, as depicted in the first figure. The southern access road of Gorgan to the city of Agh-Ghala shows a high depth of flooding. However, dredging can significantly reduce the extent of high-risk areas. As per the risk class classification table, increasing dredging depth leads to a decrease in high and severe risk classes, by 6.4 and 6.3 percent, respectively. Additionally, dredging up to a height of 2 meters has reduced the flood zone by 26.7% in Agh-Ghala City, while medium-risk areas have become low-risk areas. However, it must be noted that the urban development of Agh-Ghala City in the territory of the Gorgan-Roud River has not been in accordance with the flood zones of this river, leading to significant damage in recent years. Floods of this river usually occur in the old paths towards the Etrak basin. Although dredging has reduced the flood zone, flooding is still observed in the northern and northwestern parts of the city. Therefore, it is necessary to consider the urban development of Agh-Ghala city while keeping a safe distance from these areas.

4. Conclusions

Based on the flood zone maps, it appears that the area's most susceptible to flooding are mainly used for agriculture. However, the recent flood in April 2018 in Golestan province exposed urban areas like Agh-Ghala to flood damage. The HEC-RAS model was able to accurately simulate the Gorgan-Roud River flood, highlighting its capability to produce water levels in desired locations with reasonable precision. One of the factors that can increase river flow is dredging, which has been found to reduce high-risk areas and the flood extent in the urban area of Agh-Ghala. While it doesn't significantly reduce the flood volume upstream, dredging still plays a critical role in minimizing damages in Agh-Ghala.