Optimizing the location of the standard flood map in flood zoning using geomorphological characteristics

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Abstract:

One of the new methods for flood zoning is Geomorphological Indexes (GI), which requires little hydraulic-hydrological data. In this method, the standard flood map for a small part of the studied basin is used to increase the accuracy. The flood peak flows are different due to different standard flood map locations. Thus, the flood zoning results will be different. For this reason, it is necessary to select the best location for the standard flood map. In this research, the standard flood maps were used in the Kashafroud sub-basins including Radkan, Jaghargh, and Agh-Darband. The results showed that the Agh-Darband sub-basin located at the end of this basin had the best results for the standard flood map. The flood zoning results in the sub-basins showed flood zoning high accuracy based on the true positive rate (RTP), and the area under Curve (AUC) values. The flood risk maps results showed that 12.62, 16.30 and 24.64% of urban and rural regions will be exposed to flood risk for 25, 50, and 100-year return periods. The results of this study pointed out that the GI method can be used as an alternative to hydraulic and hydrological modeling for flood modeling due to its proper accuracy and low requirement for much hydraulic and hydrological data.

Keywords: flood zoning, geomorphological index, digital elevation map, land use, standard flood map.

Introduction:

Flood zoning with high accuracy using hydraulic and hydrological methods requires much hydraulic and hydrological data. Hydraulic and hydrological data collection at the macro scale is time-consuming, much costly, and insufficient statistical length. Hence, it is necessary using models with low such data requirements. Manfreda et al., [1] results showed that there is a significant relationship between flood and Topographic Index (TI) in a basin. Samela et al., [2] stated GI can be used as alternative hydraulic and hydrological methods for flood modeling due to their high effects on floods. Based on this, Samela et al., [3] designed the (Geomorphic Flood Area) GFA plugin in QGIS software. Albano et al., [4] results showed that using GI is a cost-effective method to create flood hazard maps on national and large scales.

Material and methods:

The study area in this research is the Kashafroud basin. The main goal of this research is to optimize the standard flood map location using the GFA plugin for flood zoning in the Kashafroud basin. The Radkan, Jaghargh, and Agh-Darband sub-basins located at the beginning, middle, and end of the Kashafroud basin, respectively, were selected. In the first step, the best statistical distribution was selected using EasyFit software to obtain the flood peak flows with different return periods. Next, flood zoning maps were created using HECRAS software as standard flood maps for these sub-basins. Then, flood zoning maps were created using the GFA plugin based on the standard flood maps. In the next step, flood modeling maps accuracy was investigated based on standard flood maps. After selecting the best location for standard flood maps, flood zoning maps with mentioned return periods were created using the GFA plugin for the Kashafroud basin. Finally, flood risk maps were obtained for the Kashafroud basin.

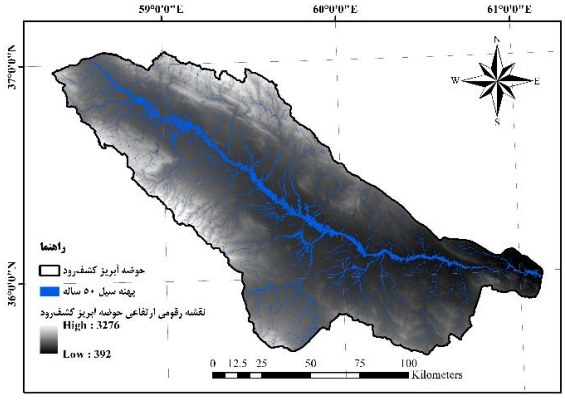
Result and Discussion:

Table 1 shows the performance of flood zoning in the Kashafruod basin using the standard flood maps in the studied sub-basins. RFP, RTP, and AUC values show false positive ratio, true positive ratio, and area under curve values, respectively. Since RFP value is less than 10% and RTP value is more than 90%, the model used has good performance. According to the AUC values presented in Table 1, a supervised and accurate classification has been done for flood zoning in the Kashafroud basin.

Table 1. The performance of the GFA plugin for flood zoning in the sub-basins of Kashafroud

Sub-basin	Flood Return Period	τ_{opt}	R_{TP}	R_{FP}	AUC
Radkan	25	-0.334	0.937	0.086	0.973
	50	-0.335	0.938	0.085	0.974
	100	-0.347	0.936	0.097	0.969
Jaghargh	25	-0.325	0.985	0.071	0.981
	50	-0.329	0.98	0.053	0.988
	100	-0.33	0.963	0.087	0.979
Agh-Darband	25	-0.335	0.983	0.044	0.994
	50	-0.363	0.98	0.041	0.994
	100	-0.412	0.968	0.042	0.992

Agh-Darband sub-basin with R_{TP} more than 96%, R_{FP} less than 5%, and AUC values greater than 0.99 for studied return periods show better performance in comparison another sub-basin. It can be concluded that the closer the standard flood map location is to the end parts of the studied basin, the flood zoning using the GFA has better performance. Figure 1 shows flood zoning results in the Kashafroud basin based on the standard flood map in the Agh-Darband sub basin.



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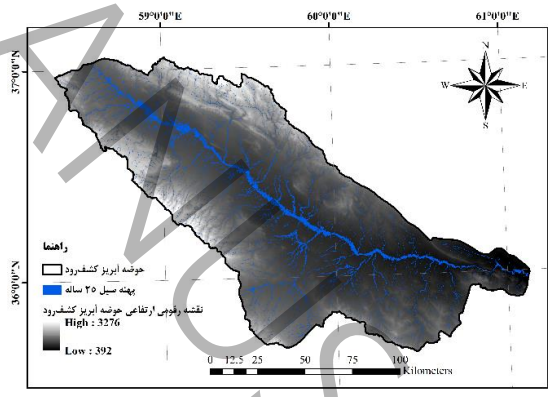

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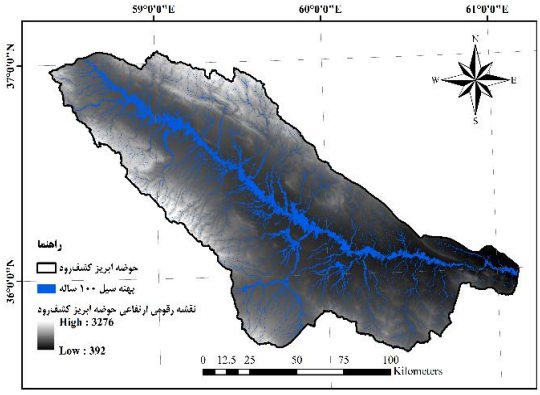

c

Figure 1. a) 25-, b) 50-, c) 100-year flood zone map in the Kashafroud basin.

Conclusion:

The highest R_{TP} value was obtained from the standard flood map in the Agh-Darband sub-basin for flood zoning. Considering that these values are higher than 0.96, it shows the high accuracy of this method for flood zoning in the Kashafroud basin. The AUC value was more than 0.99, which points out the effective zoning in the Kashafroud basin. According to AUC in different sub-basins, the Agh-Darband sub-basin located at the end of this basin had the best results for flood zoning using GI. Hence, it can be stated that the best performance of the GFA plugin is obtained from the standard flood map located at the end parts of a studied area.

References:

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