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Analysis of the Effect of Factors Affecting Flooding in Hamadan Province Using Shannon Entropy Model and GIS

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Abstract

1- Introduction

Natural hazards cause enormous damages every year. Among the natural hazards, floods, earthquakes, and droughts have special importance in financial and human losses. Meanwhile, according to the available statistics and information, floods in some parts of the world, especially in Asia and Oceania, have the highest damage. Iran is one of the arid and semi-arid regions of the world with particular climatic conditions. Inappropriate spatiotemporal distribution of rainfall in such regions has caused devastating floods. In this study, flood vulnerable areas are identified by determining the effective parameters of flood using Shannon entropy model. The results of this study can be used in flood zoning and forecasting and planning and management of water resources in the region.

2- Materials & Methods

In multi-criteria decision-making problems having and knowing the relative weights of the existing indicators is a significant step in the problem-solving process. (Relations 1 to 6).

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$$A_{ij}=\begin{bmatrix} a_{11} & a_{12} & a_{1n} \\ a_{21} & a_{22} & a_{2n} \\ a_{31} & a_{32} & a_{3n} \\ \dots & \dots & \dots \\ a_{m1} & a_{m2} & a_{m3} \end{bmatrix} \quad (1)$$

$$n_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} X_{ij}} \quad (2)$$

$$nij = \begin{bmatrix} x_{11} & x_{12} & x_{1n} \\ x_{21} & x_{22} & x_{2n} \\ x_{31} & x_{32} & x_{3n} \\ \dots & \dots & \dots \\ x_{m1} & x_{m2} & x_{m3} \end{bmatrix} \quad (3)$$

$$Ej=-k\sum_{i=1}^{m} P_{ij} \times lnp_{ij} \quad i=1,2\dots,m \quad (4)$$

$$wj=dj/\sum dj \quad (5)$$

$$w_j=\begin{bmatrix} w_1x_{11} & w_2x_{12} & w_nx_{1n} \\ w_2x_{21} & w_2x_{22} & w_nx_{2n} \\ w_3x_{31} & w_3x_{32} & w_nx_{3n} \\ \dots & \dots & \dots \\ w_mx_{m1} & w_mx_{m2} & w_mx_{mn} \end{bmatrix} \quad (6)$$

Entropy method is one of the multi-criteria decision-making methods for calculating the weight of criteria. This method requires a criterion-option matrix. The steps of Shannon entropy method consist of five steps of the decision matrix, normalization of the decision matrix, calculation of the entropy of each index, the calculation of deviation, and calculation of weight value Wj.

In the Shannon method using the experience and knowledge of experts appropriate factors are determined and weighed. After collecting the questionnaire data and considering the geography of the study area, the scores of each factor are adjusted.

3- Results & Discussion

Natural parameters of flood occurrence in Hamadan province include: climate, snowmelt, slope, soil type, Gravilius coefficient, and vegetation. Due to the climatic characteristics of the province, most of the province's rainfall is due to the Mediterranean systems. In winter, the rains are in the form of snow, and in the early spring the melting of snows is accompanied by spring rains which most of the time causes the rivers to overflow. Due to the severe destruction of vegetation in the province, the potential of the region in flooding has been increased. In general, it can be said that the occurrence of floods in any region is due to the confrontation and alignment of human and natural factors. This study only examines the natural causes of flood. The study of the effect of each parameter in the occurrence of floods based on the data-expert method showed that the six factors studied in these studies do not have the same effect on reducing or increasing floods in the basins.

4- Conclusion

Based on scoring the natural factors that cause floods, according to the intensity of their impact, the flood-prone areas of the province have been identified. Based on the combined data model and Shannon entropy, the highest weighting was given to the maximum 24-hour precipitation. Vegetation factors, snow melting time, basin slope, soil type and Gravilius coefficient were identified as the most effective natural factors in causing floods in Hamadan province, respectively. Based on the final weights, a hazard map was drawn using the GIS. According to the hazard map, the very high risk regions are located in the central and southern parts of the province. Also, the northern areas including the cities of Razan, Kaboudar Ahang and Dargazin are located in high risk area.

Using the results of this study, it is possible to identify the approximate time of flood occurrence and flood-prone areas in Hamedan province.

Keywords: Shannon entropy model, GIS, Flood, Hamadan province.