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Landslide Hazard Zoning Using Artificial Neural Network and TOPSIS Models Downstream of Sanandaj Dam

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1-Introduction

The purpose of this study is to select the best model and identify landslide risk areas in the downstream basins of Sanandaj Dam. Every year, mass movements in the region cause damage to roads, natural resources, farms and residential areas, and increase soil erosion. Kurdistan province, with its mostly mountainous topography, high tectonic activity, diverse geological and climatic conditions, has the most natural conditions for mass movements. According to the available statistics, this province is the third province in terms of landslides after Mazandaran and Golestan. (Naeri & Karami, 2018). The Gheshlagh River Basin is a mountainous region with a north-south trend. In terms of construction land, it is located on the structural zone of Sanandaj-Sirjan. The study area with an area of 970.7 square kilometers is located downstream of Sanandaj Dam. The city of Sanandaj is located within the basin. Effective parameters for landslides according to the type of climate and morphological processes are provide in the geography of the region.

2-Methodology

The present study includes five stages of research background and data collection, preparation of information layers, implementation of artificial neural network and TOPSIS models, preparation of landslide Hazard zoning map in gheshlagh basin with the mentioned models and validation test of the models. In this study, nine effective factors for landslides, including slope, slope direction, fault distance, road distance, waterway distance, lithology, land use and precipitation were used. Using Google Landsat 8 ETM satellite imagery, Google Earth software identified 237 slip points. Then, the coordinates of the slip points transferred to the Arc GIS software and a map of the landslide distribution area in this environment was prepared. In addition, in this

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study, 89 non-slip points were prepared for use in the training and testing stages of Persephone neural network inside slopes less than 5 degrees. Artificial neural networks are made of a large number of interconnected processing elements called neurons that act to solve a coordinated problem and transmit information through synapses. Neural networks begin to learn using the pattern of data entered into them. Learning models, which is actually determining their internal parameters, based on the law of error correction. In this method, by correcting the error regularly, the best weights that create the most correct output for the network identified. The neurons are in the form of an input layer, an output layer, and an intermediate layer. TOPSIS is a very technical and powerful decision-making model for prioritizing options by simulating the ideal answer. In this method, the selected option should be the shortest distance from the ideal answer and the farthest distance from the most inefficient answer,(Dong, 2016). In the artificial neural network model, the middle layer selected by default. Percentage70 of the landslides occurred for neural network training and the remaining 30% as reference data used to test and calibrate the model. Data trained using a multilayer perceptron network with Adam learning algorithm. The final structure of the network has nine neurons in the input layer, 30 neurons in the middle layer and 1 neuron in the output layer. In the TOPSIS model, after scaling the decision matrix, Shannon entropy method used to weight the criteria and to determine the relative distance between the positive and negative ideals of the Euclidean distance.

3-Results and Discussion

The final structure of the network has nine neurons in the input layer, 30 neurons in the middle layer and 1 neuron in the output layer. In the TOPSIS model, after scaling the decision matrix, Shannon entropy method used to weight the criteria and to determine the relative distance between the positive and negative ideals of the Euclidean distance. After creating the raster layers of each index in the TOPSIS model, a vector-point layer created that has one row per pixel and one column per index, thus creating a matrix with dimensions of 9 by 1078555. The operation of Salavatabad fault in the east of the basin has caused Horst and Graben in the region. The significant difference between the height of the mountain unit and the riverbed has caused hazards and the transformation of landforms in the region .In both models, the western part of the basin is in a very high-risk zone, and housing and mass movements threaten agricultural land in these areas. The western outskirts of Sanandaj, which is located in the center of the basin, also affected by numerous landslides and classified in the high and very high danger zone.

4- Conclusion

The downstream area of Sanandaj Dam is one of the most active areas of Kurdistan province and the west of the country in terms of human activities. Out of a total of 970 square kilometers, the area under study, according to the neural network model, is about 31 percent and the TOPSIS model is 30 percent of the area within the optimal areas for human activities. In addition, according to the neural network model, about 39% and the TOPSIS model 42% of the region are in the range of undesirable and very undesirable areas. The results show that the study area in general has a high potential for landslides. Dangerous areas are located mainly in the west and southwest of the constituency. These areas correspond to the mountain unit, rainfall of more than 385 mm and high slope. Rainfed agriculture and rangeland with medium-sized canopy are widespread in this area. These areas are also located on the k8, kp1 and PE geological units. Comparison of the results of risk zoning validation in the model shows that in this area, the perceptron neural network model has a better accuracy than the TOPSIS model.

Keywords: Hazard zoning, Landslide, Neural network, TOPSIS, Sanandaj Gheshlagh Watershed

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