Analyzing and zoning of geomorphic hazards in the Northern regions of Iran using the network analysis process

Case Study: Gilan province

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Extended abstract

Introduction

Today, cities in different parts of the worldare exposed to damages from natural hazards for various reasons. These hazards which are associated with lots of financial damages, fatalities and injuries, are in need for urgent preventive measures. Based on the United Nation International Strategic Plan for disaster reduction (UNISDR), all hazards have two natural and human activities origins.The province of Gilanis one of the northern coastal provinces, whose center is the city of Rasht. The objective of the present research is, analyzing and zoning geomorphic hazards in the province of Gilan. The method of this research is descriptive – analytical, and empirical. In the descriptive section, by using documentary studies and also in the analytical section, by identifying the effective parameters in the zonation of geomorphic hazards and integratingthem with the spatial analyses in GIS, vulnerable zones were identified in the study area.

In this research, the factors effective in the zonation of hazards were identified first. Then, in order to measure the significance of each of these factors, a questionnaire was prepared to carry out this important task by the method of ANP and by collecting the opinions of the relevant experts on each of the identified factors. After obtaining the opinions and using the fuzzy logic method, evaluation of each of the criteria and determination of their importance coefficients were done and based on its results, spatial evaluation was carried out using ARC GIS and high risks zones were identified.Results have shown that the use of fuzzy logic along with spatial analysis of GIS has been able to be used as an efficient tool in zoning geomorphic hazards and to prove the capability of the analytical model of research well.

Materials & Methods

The performing method of this research is descriptive-analytical, which is compiled using documentary studies of required information and dat. In this study, it was attempted to investigate the geomorphic hazards in the province of Gilan. At first, the study area was identified. In the next stage, information layers such as slope, topography, vegetation, the elevation map of land use and… were prepared using 1: 50000 topographic maps, 1:100000 and 1: 250000 geological maps, and Digital Elevation Model (DEM), and finally, the provided effective information layers by

the experts' opinion and the obtained field and documentary studies were investigated in the form of network analysis model. Network Analysis Process (ANP) is one of the techniques for decision-making. When several indicators are considered for evaluation, the evaluation task becomes complicated, and when the criteria are of different genders, the work will become more complicated, and the evaluation and comparison go out of the analytical state which the mind is capable of performing), and a strong tool for practical analysis is needed. Therefore, the network analysis process is capable of doing this (Shadfar et al., 2007: 66). The network analysis process is one of the multi-criteria decision-making techniques. This model has been designed based on the hierarchical analysis process and replaces 'network' with 'hierarchy'. The main assumption in AHP is based on the independent function of the hierarchical upper groups from all of its lower parts and from the criteria of each level and class (Chang et al., 2005: 22 and De Seun, 2004: 636).Saatyhas proposed the use of the hierarchical analysis model (AHP) to solve problems with independent and dependent criteria and solutions, and has established and presented the network analysis model (Lee and Kim, 2001: 374). Thus, the ANP method was presented as an extension of AHP.

As the AHP provides a framework for hierarchical structures with one-way relationships, the ANP also provides the possibility of complex internal relationships between different levels of decision and criteria. The ANP feedback approach has replaced the network structure with hierarchical structure, suggesting that the relations between different levels of decision-making can't simply be imagined as up-down, dominant-recessive or direct-indirect.In general, the ANP model consists of a hierarchy of control, clusters, elements, interrelationships between clusters and elements (Sarkis, 2002; 23; Oraet et al., 2006: 247). The geomorphic hazards of Gilan province were evaluated and zoned in 6 stages (Saaty, 1392).

1- First step:At first, given the field and library studies as well as the experts of the issue, the research-related elements were defined from 4 clusters with 11 elements. The relations between the variables and clusters were determined using correlation analysis.

2- Second step: the pairwise comparison matrix and the relative weight estimation: the determination of relative weightin ANP is similar to AHP, In other words, the relative weight of the criteria and the sub-criteria can be determined throughpairwise comparison.Pairwise comparisons of the elements in each level are done similar to the AHP method because of its relative significance to the criterion of control.

3- Third step:the formation of primary super matrix. The ANP elements interact with each other. These elements can be the decision-making unit, criteria, sub-criteria, the obtained results, options, and anything else. The relative weight of each matrix is calculated based on the pairwise comparison similar to the AHP method. The resulting weights are entered in the super matrix, which indicate the mutual relationbetween the elements of the system.

4- Fourth step: the formation of a weight super matrix: super matrix columns consist of several special vectors that the sum of each vectoris equal to 1. Therefore, it is possible that the sum of each column of primary super matrixto be more than 1. In order to factorize the column elements proportional to the relative weight, and that the sum of the column be equal to 1, each column of the matrix is standardized. As a result, a new matrix is obtained, the sum of each column of which will be equal to 1. The new matrix is called the weight matrix. (FarajiShabbarbar et al., 2011: 56).

5- Fifth step:the calculation of the general weight vector: in the next step, the weight super matrix reaches to a power limit so that the matrix elements are converged and its row values are equal. The general weight vector is determined based on the matrix obtained.

6- Sixth step:the calculation of the final weight of the criteria: finally, the weight of each of the effective criteria is obtained. After determining the structure of the model and determining the weight super-matrices and the limit, the weight of each of the effective indices is obtained. After weighting the natural criteria effective in the zonation of the effective indices, using fuzzy logic technique in this stage, the maps of geomorphic hazards mapping of Gilan province are plotted

Results & Discussion

After determining the relationship between the effective criteria in geomorphic hazards, the experts' opinions, the matrix of pairwise comparison, and the relative weight estimation, the formation of primary super matrix, the formation of weight super matrix, the calculation of the general weight vector, the calculation of the final weight of the criteria was carried out, using the mathematical operations in the ArcGissoftware. Then, using fuzzy logic technique, maps of geomorphic hazards zonation in Gilan province were drawn. Given the combination of all layers and the application of the coefficients obtained from the network analysis model, the final map of geomorphic hazard zonation was plottedand three vulnerable zones were obtained.
1- First zone - Northeast of the province: This is a zonewith high risks due to its location on the way of floods and geological features.
2-Second zone: south of the province: located in the vicinity of Roodbar and Rudsar, and to some extent Amlash, is considered as a part of high risky zones of the province. Closeness to the faultand relatively high slope are among the characteristics of this zone.
3-Third zone: center of the province: in the vicinity of the city of Bandar-e Anzali, Somesara is considered as high risk zones of the province. Flooding, high erosion, and slope movements to some extent are among the features of this zone.

Conclusion

Investigating the situation and the value of vulnerable human environments against various types of geomorphological hazards seems to be very important and essential. Natural hazards, especially geomorphic hazards, have already had and have lots of financial and losses and fatalities. On this basis, natural hazards were considered as one of the basic studies in order to be able to control and reduce natural hazards. Thus, the most risky zones of Gilan province were integrated into critical centers such as mines in the province. In order to model and predict the relative risk of geomorphic hazards in the present research, an ANP network analysis model was used. For each of the different values and ranges, a weight and score were obtained, for which the fuzzy sum of these scores and the integration of each layer in the obtained weight, determined the relative risk of the occurrence of geomorphic hazards. The results showed that three vulnerable zones in the northeast, south of the province I the vicinity of the cities of Roodbar and Rudsar, and to some extent,Amlash, and the center of the province in the vicinity of the cities of Bandar-Anzali, and Somesara, are risky and hazardous areas which are affected by the risks of flood and Geological features, proximity to faults and relatively high slopes, flooding, high erosion and, to some extent, movements of the slopes. The application of fuzzy logic along with spatial analysis of GIS has been able to be used as an effective tool forgeomorphic hazards zoning. In the end, it is necessary to note that the location of some of the zones at low levels of vulnerability and risk does not represent their idealsituation and determines only the place of the aforementioned zone in relation to other zones.

Keywords: Geomorphic hazards, Safety, Spatial analysis, Fuzzy logic, Gilan.