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Research Article

Risk of Massive Movements in the Central Alborz Mountain Range by the LNRF Method-Case Study: Along of Haraz Freeway, Iran

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Abstract

The study area is located in the central Alborz zone, which is located in the provinces of Tehran and Mazandaran in terms of divisions. The purpose of this study was to determine the status of mass movements in the slopes and in the along Haraz freeway. Surveying satellite images and aerial photos and determining the landslide points of the old landscapes were also carried out. Then, by collecting information layers in the environment of the GIS, you considered all the effective parameters. Using LNRF method different variable analysis led to the creation of landslide zonation map. The results of the analysis and on the collation of information layers led to the preparation of a zonation map of landslide risk and finally determined that the high risk areas had a Dr (compression ratio) of 3.47 and Qs (quality) of 1.01. This situation indicates the high sensitivity of the route to the mass movement phenomenon in the mountainous axes and in loose and fracturing formations and its frequency in the south western and mostly free-run parts of the road is greater than the risk and the necessity of forecasting methods it requires stabilization and implementation of consolidation measures.

Keywords: Central alborz; Mass movements; LNRF method; Haraz freeway

Introduction

One of the natural events that we are facing today is the volatility of the area where excessive use of natural resources has exacerbated it. Investigating the phenomenon of instability of domains to produce landslide hazard zoning maps is, on the one hand, important for identifying landslide environments within the scope of human activities and, on the other hand, identifying safe areas for the development of new habitats or other future uses. Human beings, such as roads, the transmission path of power and energy, etc., are on the scale of the planners' attention. Iran is a land that is considered to be very tectonic in terms of being in the Alpine-Himalayan orogeny belt. There are mountains with high altitudes and abundant fossils. There are many faults and stratigraphic variations and formations of the genus various and other factors involved in landslide have made Iran a point in the world where the risk of landslide phenomenon is abundant. In the meantime, some similar scientists have studied mass movements. Yilmaz [1], worked about Landslide Susceptibility Mapping Using Frequency Ratio, Logistic Regression, Artificial Neural Networks and their Comparison in the Kat Landslides of Tokat-Turkey. Khanlari et al. [2] studied about Landslide hazards zonation using GIS in Khoramabad region in Iran. Ali & Hasan [3] determined characterize of Rock mass to indicate slope instability in Bandarban for a rock engineering systems approach. Landslide susceptibility assessment is an approach for estimating the likelihood in landslide occurrence considering spatial correlations between important terrain characteristics and the past landslide distribution [4]. Only few recent disaster management studies were conducted in Rwanda with main focus on hazard description, risk and vulnerability analysis, awareness and capacity building, early alert and warning. All these were done by applying descriptive, secondary data sources and social approaches limited to the district levels and also without focusing on one single hazard by considering as many causal factors as possible [5-9], The study of this area in the central Alborz zone and the presence of important faults such as North Tehran fault and Mosha-Fasham fault in this area, can increase the mass and landslide movement.

Method and Materials

Various methods can be used to assess landslide hazard, though very few are dedicated to rock falls on a regional scale many methods for the assessment of landslide hazard are based on data processing linked to Geographical Information Systems (GIS). In addition, landslide susceptibility mapping which is sensitive to selected method [10] is divided into four classes such as: i) heuristic, ii) deterministic, iii) statistical, iv) landslide inventory based probability [11,12] However, there is not a general agreement on which method is the best. But in terms of procedure in susceptibility mapping, certain steps are used: i) mapping past landslide in the relevant region, ii) selecting and mapping a set of conditioning (e.g. geological and geo morphological) factors that are supposed to be directly or indirectly correlated with landslide occurrence, iii) estimating the correlations of selected factors with landslide occurrence, and IV) determination of different landslide susceptibilities for the resulting mapping. Three types of approaches can be distinguished [13]. Methods comparing the distribution of observed landslides (by means of an inventory) with the distribution of physical factors thought to cause landslides either directly or indirectly. These methods use statistical techniques [14,15].

a. Heuristic or multi-criterion methods [16] associating weights to various instability factors, based on expert experience [17-19].

b. Physically-based approaches that evaluate stability using physical laws [20].

In this research, the most appropriate and precise method for the 100000 scale is the natural or combined unitary method for determining the zoning conditions and the methods used for zoning. This unit is the result of the layering of factors and the development of homogeneous units for all factors. In this method, for weighting and scoring, the factors mentioned above were used based on the statistical models and the combination of Dr ratio and total Qs quality were used jointly. The compression ratio:

$$Dr = \%L * \% A \qquad (1)$$

L=Percentage of total land area available in the target area, and %A=Percentage of area occupied by any zone of danger.

Thus, Dr is equal to the one in which the density of mass movements in the desired zone is equal to the density of the median masses of the region, and the larger or smaller Dr represents, respectively, the densities of more or less mass movements in the area in question relative to the average density of movements is. Total Quality;

$$\sum\infty=1(-1)^2*\% \qquad (2)$$

Where n is the number of zones in the map. Thus, the Qs parameter, the sum of the squared differences, calculates the compression ratio of each zone relative to their average (average density of the region). Model LNRF: In order to analyze the data obtained from field studies and to study the effective variables, the LNRF (Landslide numerical risk factor) model has been used as the most important conceptual tool of the research. The method of work, digitizing, and layering variables has been in the form of GIS. LNRF Is equal to Slip occurred in a unit of the operating map than average slip occurring in the entire unit of the map occurred.

Result and Discussion

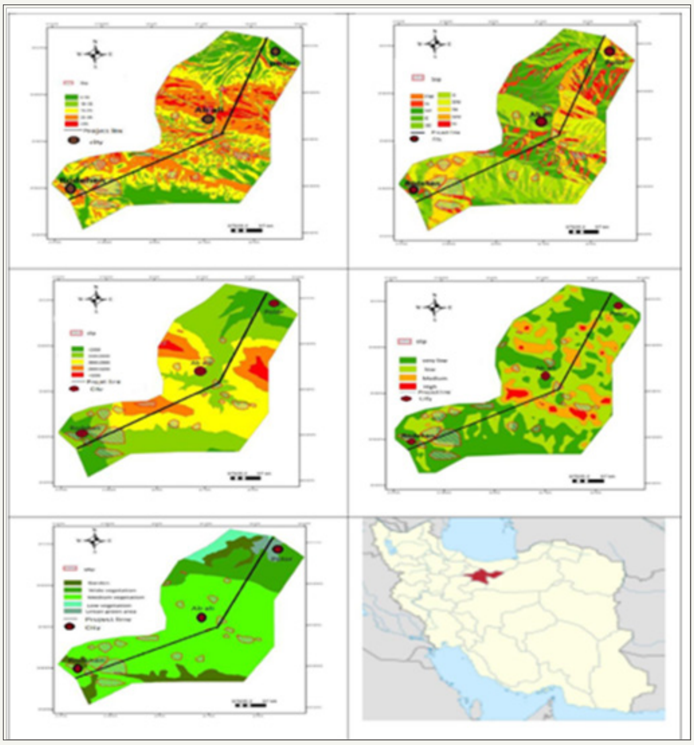

Figure 1: Categorized Maps of Effective Factors and Distribution Map of landslide.

The landslide susceptibility classes for each method were also evaluated by field surveys. After obtaining the prediction maps, the most essential component is to carry out a validation analysis. Without any validation process, the prediction models and the maps obtained are totally useless and have hardly any scientific significance. Thus, for validation of the models, the past landslides were partitioned into two subsets. The first subset of data was used for obtaining the prediction maps by using the models; the

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second subset was used as the test data and compared with the prediction results for validation and to interpret the differences in the performance. The analysis of instability factors related to topographic, geo morphological and geological settings shows that the Haraz Road area was highly sensitive to rock instability. Different measurement methods such as Global Navigation Satellite System (GNSS) measurements, remote sensing etc. are used for monitoring movements in landslide areas and revealing surface deformations. Co-registration of optically Sensed images and correlation (Cosi-Corr) method (Remote sensing method) is one of these methods. On the other hand, Tatar et al. [21] state that the landslides that occur in the vicinity of Koyulhisar are in the form of circular rotation and they still continue their activity. However, they have emphasized that these activities are not massive and are usually local landslides that are formed on the main mass. The results obtained within the scope of this study confirm almost all of these interpretations. The application of this method to the entire length of the road reveals two other unstable areas. One of those has been monitored recent years. A field survey showed that a slope of instability was present at the other location. After the above mentioned data, each of the five criteria listed below are weighted according to the following tables, Table 1 for slope of layers, Table 2, Layer direction, Table 3, Vegetation, Table 4 Status of the drainage network and drainage Table 5 refers to the relative height of the trench and after weighing tables of each of the factors in the GIS environment, Figure 1 shows the shape a) the direction of the layers b) The slope of the layer c) the relative height of the trench d) the status of the waterway and e) relative density is obtained. Then, all maps after the overlap in the GIS environment lead to Map 2 and (Table 6) of the zoning.

Table 1: Slope of the Layers.

Slip Area			Area of Degree		Slope
LNRF	Percent	(km^2)	Percent	S(km^2)	
0.25	5.08	0.22	17.55	11.09	0-10
0.44	8.76	0.38	12.52	7.91	Oct-15
2.13	42.68	1.86	34.31	21.68	15-25
1.92	38.48	1.68	30.29	19.14	25-35
0.25	5.01	0.22	5.32	3.36	>35

Table 2: Layer Direction.

LNRF	Slip Area		Tilt Area		Steep Direction
	Percent	S(km^2)	Percent	S(km^2)	
0.02	0.19	0.01	0.36	0.23	flat
1.34	15.01	0.66	10.97	6.93	N
1.45	16.28	0.71	14.04	8.87	NE
0.72	8.05	0.35	8.73	5.51	E
0.56	6.31	0.28	13.06	8.25	SE
1.52	17.05	0.75	19.75	12.47	S
1.25	14.04	0.61	13.69	8.65	SW
1.2	13.4	0.59	11.07	7	W
0.86	9.67	0.42	8.34	5.27	NW

Table 3: Vegetation.

Weight Method	Slip Area		Coverage Area		Vegetation Rates
LNRF	Percent	S(km^2)	Percent	S(km^2)	
0.3	6.03	0.26	10.11	6.39	Garden
0	0	0	2.21	1.39	Urban green area
0	0	0	3.21	2.03	Low vegetation
4.61	92.11	4	69	43.61	Medium vegetation
0.09	1.87	0.08	15.48	9.79	Wide vegetation

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Table 4: Status of the network of drains.

LNRF	Slip Area		Drainage Area		Waterways Network
	Percent	S(km^2)	Percent	S(km^2)	
1.13	28.27	1.24	42.86	26.98	very low
1.69	42.18	1.84	42.71	26.89	Low
1.18	29.43	1.29	12.54	7.89	medium
0	0.12	0.01	1.89	1.19	high

Table 5: Relative height role.

LNRF	Slip Area		Area		Relative Height
	Percent	S(km^2)	Percent	S(km^2)	
0.583	11.61	0.51	14.09	8.9	<2300
2.08	41.43	1.81	41.51	26.23	2300-2600
1.613	32.13	1.4	31.64	19.99	2600-2900
0.622	12.38	0.54	10.85	6.86	2900-3200
0.123	2.47	0.11	1.91	1.2	>3200

Table 6: Final zoning by LNRF method.

Qs	Dr	Level Slip in Category		Floor Area		Hazard Category	Zonation Method
		Percent	S(KM^2)	Percent	S(KM^2)		
1.01	0	0.02	0	6.99	4.41	Low	LNRF
	0.26	9.31	0.41	36.38	22.94	medium	
	1.1	49.15	2.17	44.66	28.17	high	
	3.47	41.53	1.18	11.97	7.55	Very high	

Conclusion

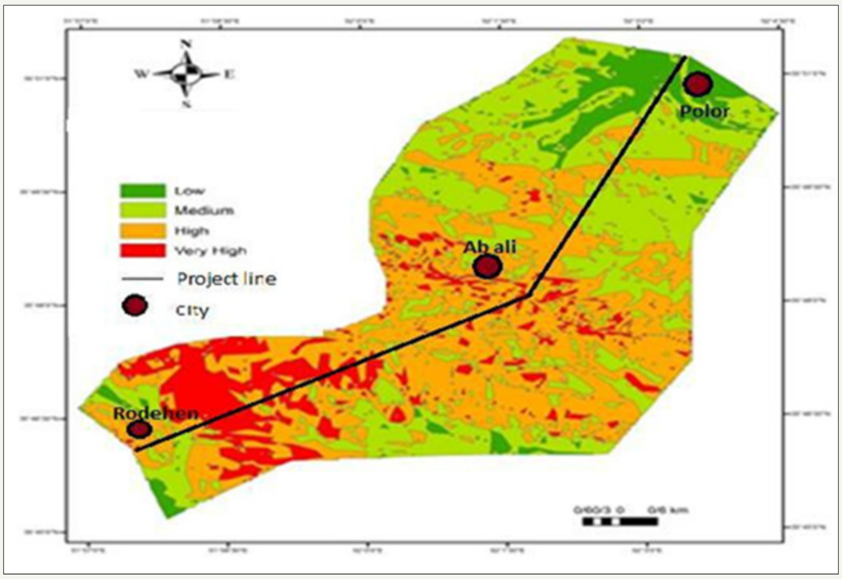

Figure 2: Landslide hazard zonation by LNRF method.

The study of mass movements in the study area and its zonation regarding landslide potential showed that certain points of the route length have a high potential for landslide occurrence, which according to the results shown in the zonation map Many have a dangerous range (Figure 2). Therefore, due to field studies, all important and effective factors in the emergence of instability are identified and the map of each of these factors is provided in the GIS environment. Finally, using the existing mathematical relations in each method, it is attempted to combine the above layers and to prepare the risk map of the failure the rock is on the way. As

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it is known, in the first 3km, a landslide risk is low to moderate, and from 3 to 15km of landslides are very high and from 15 to 23, there are dangerous mass movements and from 23 to free end, medium to low risk routes is the vast majority of these landslides develop as a circular-rotational motion. The front of this mass of old landslides is open and poses a danger for the future. Moreover, the Haraz hill, located on the flow route of mass, acts as a natural barrier that reduces a potential great danger. GIS is efficiently used for different stages of risk mapping but is insufficient for modelling susceptibility. The data set created for modelling susceptibility is transmitted into other software apart from GIS for statistical treatment of data, which may take time. Therefore, for future studies certain modelling approaches may also be adopted by the GIS environment and risk assessment processes may be automated in a single environment.

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