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Rock Fall Zonation Map of Doroud– Andimeshk Railway Track Using GIS

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ABSTRACT

Significant proportion of national and infrastructure investment devotes to construction activities in nature. These investment must be selected with sufficient confidence to ensure survival and duration of vital interest. In this study after collecting information including slope angle, lithology, fault's length, River's length, Road's length Rainfall, earthquake and vegetation in packed cell map is processed in Geographical Information System(GIS) . finally landslide hazard zonation in Doroud-Andimeshk railway is presented. Zonation map of the area is prepared using Moora-Varson method and is validated using AHP method. Slope angle is obtained from digital elevation map of the area.1/250000 topography map is used to obtain digital elevation map. Lithology map is prepared using 1/100000 geological map. Fault's length, Road's length, river's length and vegetation are obtained from Landsat satellite map. Rainfal and earthquake data are obtained from Meteorology center and Geophysical Institute of Tehran. At the end, the area with high risk of rockfall was introduced.

KEYWORDS

Zonation Map, Rock Fall, AHP Method, Geographical Information System, Dorude-Andimeshk Railway

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1- BRIEF INTRODUCTION

The landslide inventory map is the first step in any mitigation program. Less than 10 years ago in our country, GIS methods spread as a quick way to prepare landslide inventory maps. To determine the factors influencing landslide and hazard zonation maps in determining the potential areas of risk and help planners to select suitable locations for development such as roads and urban areas in the early stages of planning is very helpful (Anbalagan 1998). Ismaeili and Ahmadi (2003) study the factors affecting rockfall and hazard zonation by two methods of Analytical Hierarchy Process (AHP) and multiple regression by 7 factors, and finally they found that the AHP method is more accurate than multiple regression [1].

2- METHODOLOGY

Various factors such as topographic conditions, lithology, hydrogeology, tectonic and seismic conditions have affected the instability of soil and rock slopes and these factors may cause instabilities to increase by their manual influence on each other. In this regard, the role of human activity in the instability of slopes should also be taken into consideration. The factors affected by instability of slopes can generally be divided into two categories; first a group of organic factors and second a group of environmental factors. Organic factors include composition, texture and structure of the materials and geometry of the slope. Environmental factors include trenching and excavation, quick water loss, tectonic, rainfall, freezing, weathering and earthquake vibration [2]. In this study, all factors affecting the instability of slopes are reviewed and evaluated and finally seven factors including slope angle, lithology, length of road and river, land cover, fault length, rainfall and seismic events have been considered as affective factors in the instability of slopes [3].

-*Slope angle*

The slope angle is the main factor of slope instability, while natural and artificial are two types of slopes. For classification of slopes within the studied area, a topographic map (1:25000) was used. Assuming all other factors constant, the larger slope angles have a higher risk of rockfall.

Texture and structure of materials and slope ingredients have an important role in the stability and instability of slopes. Slopes with weak rock and low shear strength have a higher risk of rockfall.

-Road and river length

Roads and rivers with trenching and excavation build natural and artificial slopes so with an increase in roads and rivers, the risk of rockfall increases.

-Land cover

Land cover is an indirect factor on slope stability.The influence of tree roots in the soil increases slope stability, land cover absorption, soil moisture and decreases the moisture factor on slope instability.

-Fault length

Fault action can be a rockfall start point, water penetration into fault zones can cause erosion of the rocks and create discontinuity and rockfall risk increases.

-Rainfall

Soil moisture increased with increasing rainfall; heavy and intense rainfall was a rockfall starting factor.

-Earthquake

The earthquake power created rupture and initial tensile cracks in the slopes, while earthquake recurrence increased depth and crack openings. Over time, other factors such as earth gravity complete the earthquake factor in slope instability.

-Rockfall hazard zonation map (RHZ)

To determine the influence of effective factors on rockfall hazard zonation, the weighting method or rating method were usually used. During long and extensive studies on both sides in Doroud-Andimeshk railway, some old and new rockfalls and their occurrence factors have been detected. The result of this section is used as a calibration factor to recognize the weight of factors affecting the rockfall hazard zonation map.

According to factors affected by instability, the following equation can be considered for the studied area:

$$RHZ = (C_L \times F_L) + (C_I \times F_I) + (C_F \times F_F) + (C_D \times F_D) + (C_R \times F_R) + (C_S \times F_S) + (C_{LC} \times F_{LC})$$

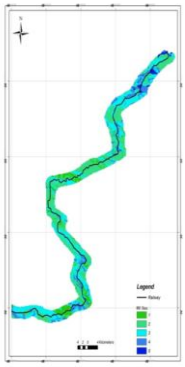
In this equation, F_L= lithology factor, F_I= Slope angle factor, F_F= Fault length factor, F_D= Road and river length factor, F_R= Rainfall factor F_S= Earthquake factor, F_{LC}= Land cover factor.

Coefficients represent the weight of each factor on instability, coefficient values determined by studies and engineering judgment and are given in the following table.

3- MAIN CONTRIBUTIONS

coefficient	C_L	C_I	C_F	C_D	C_R	C_S	C_{LC}
value	1.5	1	1.2	0.75	1	1.6	0.75

Rockfall hazard zonation in Doroud-Andimeshk railway is presented. The zonation map of the area is prepared using the Mora-Varson method and is validated using the AHP method. The AHP method was suggested with Thomas Saaty in 1970. The AHP method enables decision makers to determine mutual and simultaneous effects in uncertain and complex situations.



-RHZ map of Doroud-Andimeshk

The cell classification map of each factor affecting rockfall was prepared with ArcGIS software, and all map layers combine after processing and finally RHZ map of Doroud-Andimeshk railway classified by RHZ values in 5 zones of, very high (critical), high, medium, low and very low is obtained (safe)(Fig. 1)

Fig. 1- RHZ map of Doroud-Andimeshk railway

4- SIMULATION RESULT

The rockfall hazard zonation map of the Doroud-Andimeshk railway project was applied as a research and development project. Rockfall is the resultant performance set of the main and subsidiary factors and rarely one factor can create rockfall. In this study, by Mora and Varson zonation method with 7 factors including slope angle, lithology, length of road and river, land cover, fault length, rainfall and seismic events case study classified into 5 zones, and 43 areas with medium, high and very high risk are identified.

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