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# *Rock Fall Hazard Zonation in the Aliabad Watershed of Horand Basin*

Sayyad Asghari Saraskanrood[3],*[1] Rasool Hasan Zadeh[2], Soheil Raufi[3]

1- Associate Professor of Department of Natural Geography, Faculty of Literature and Human Sciences, Mohaghegh Ardabili University, Ardabil.

2- Ph.D, Student of Geomorphology, Faculty of Literature and Humanities, Mohaghegh Ardabili University, Ardabil.

3- Master of GIS, Institute of Civil Engineering and Development, Hamadan

## Abstract

## 1-Introduction

Instability of natural slopes is one of the geological and morphological phenomena that has a significant role in changing the form of surface of the earth, and when it affects human activities, it can become a dangerous phenomenon (Esfandiari, 2006: 113). Landslides as geological events related to the transportation of soil / heavy rock materials and assessment of its sensitivity, is an important task for local authorities to plan and reduce the land (Xialong Deng, 2017: 2). Therefore, many attempts have been made to assess the dangers of mass movements, and it is suggested to have its reduction methods based on the key characteristics of the slip, including scope and extent, volume, startup mechanism and recurrence, and subsequently, make decisions (Kuo Jeong Chank et al., 2018: 700). (Hemati and Hejazi 2017: 24-7) evaluated the landslide hazard zonation of Lavasanat watershed using logistic regression statistical methods and the result was stated in this way that in the studied area, areas with high risk of zoning, had a large share of the area amount of the region.

Aliabad basin with the southwest - northeast trend in the geographical coordinates of $47^o13' - 47^o29'$ located in the east and $38^o42' - 38^o54'$ located in the north latitudes of the northeast of East Azarbaijan Province and southeastern part of Horand County.(Figure1)

* (Corresponding Author), **E-mail**: Sayyad Sasghari@ gmail.com

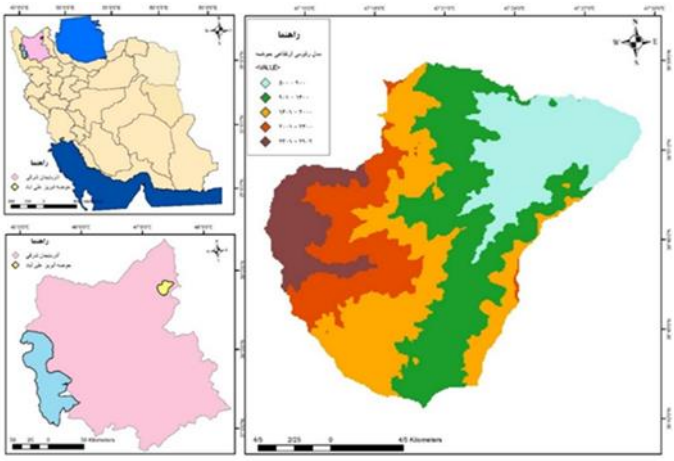

**Figure (1):** Geographic location of Aliabad watershed

## 2-Methodology

1- Topographic map (1: 50000) and geological map of Kaleybar region (1: 100000). 2- Landsat satellite images of 8 OLI sensors 3- GPS devices 4- Maps of the faults, slopes, isohyet, isotherm, evaporation, land use, elevation and hydrology 5- Envi 5.3 software 6- Statistical software of SPSS, version 16.

For zoning the risk of rock falls, nine layers of information including slope, hypsometry of the region, isohyet, isotherm, evaporation, distance from the fault, distance from the river, land use and lithology were used as independent variables and to prepare the layers in Arc GIS, 1,500,000 topographies and 1.100000 geology maps were utilized, and Landsat 8 satellite imageries were used with the OLI sensor to produce the land use layer. So, after preparing the considered data, the layers were classified as raster, and in their descriptive table, a column called the standard weight was added and the classes related to each layer were calculated using a sum ranking method. In this research, the rock fall layer was considered as the dependent variable and the 9 presented layers were considered as independent variables and all layers had been evaluated in the normalization of the weight between zero and one per pixel; based

on the proportion table method, each layer, having 500 weighted pixels that overall included 5000 pixels, was entered into the SPSS environment and regression analysis was performed thereof. Independent variables, including 9 variables, consisting of three PhDs in geomorphology and two Phd in geology were selected based on exports opinions considering their importance in creating and strengthening the dependent variable were weighted between zero and one numbers.

## 3-Results and Discussion

The Chi square test for each of the independent variables, separately, showed that there was a significant relationship between the independent variables and the dependent variable, and the effects of these variables on the dependent variable was acceptable. The numerical value of R was 0.953, and if the R value was closer to one, it would indicate the high validity of the test. The numerical value of the coefficient of determination of the independent variables relative to the dependent variable was 0.909, which indicated the high validity of the significance of the test, because it was closer to number one. Of course, it is clear that the value of the determination coefficient in Pseudo R Square was determined to be good, so the adjusted coefficient of determination was considered whose numerical value was 0.907. These findings indicated that roughly 90 percent of rock falls occurred in the Aliabad basin have been affected by these 9 estimated independent variables. Given that the statistical analyzes confirmed the validity of the effects of independent variables on the dependent variable according to the weightings of the experts in terms of zero and one for each variable as well as the importance of the variables in relation to each other as a binary comparison, the zoning of the risk of rock fall for the Aliabad watershed of the Horand basin was done using Arc Gis software, and in this zonation, five falling risk classes were used including very high, high, medium, low and very low .

## 4- Conclusion

lithology and the distance from the fault and river and foot slopes were the most important factors in the formation of rock falls since the drainage system of the basin exactly followed the fault zone. The reason for this issue can be analyzed in the way that the longitudinal distance of the highest parts of this region, from the basin to the Aliabad River was lower, which has caused the slope of the basin to perform deep slices to achieve a balance in the slopes and hydrology. The southern parts of the basin are considered as one of the most susceptible basins in the geomorphologic phenomenon of rock falls and destructive cones due to the existence of alluvial formations and the lack of proper slopes and the relative reduction of the fault to the northern and eastern parts despite having significant heights and very low and low status of zonation in the risk of rock falls, and in the southwestern part of the basin, a presence of rocky outcrops in the presence of permeable cones has been also observed. This issue should be addressed to the authorities in order to avoid serious damages to the lives of the inhabitants of the basin, so that the potential risks of this phenomenon could be controlled as much as possible including: threatening communication routes and threatening rural villages and damaging electrical and telecommunication facilities, therefore, infrastructure solutions should be applied in this regard.

**Keywords**: Landslide, Rock fall, Logistic regression, Ali Abad basin

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