Combining the ANP Model and Shannon Entropy Index to Assess the Effective Factors in the Occurrence and Zonation of Landslide Hazard (Case study: Farob Roman basin in Neyshabur)

Ali Shekari Badi
MS Student of hydrogeomorphology in environmental planning, Hakim Sabzevari University, Sabzevar, Iran.

Mohammad Motamedi Rad
PhD Student, Geomorphology, Hakim Sabzevari University, Sabzevar, Iran.

Malihe Mohamadnia
PhD student of geomorphology, Hakim Sabzevari University, Sabzevar, Iran.

Extended Abstract

Introduction
Geomorphological hazards posed as a potentially harmful phenomenon that most important ones are mass movements and landslides. The occurrence of natural hazards (including landslide) has imposed the serious impact on countries’ economic development, especially the third world countries. One of the most important tasks of applied Geomorphology, is to check the position and value of vulnerable human environment to a variety of geomorphic hazards. The risk assessment is the first step of management and reducing the risk and also assesses the possibility of occurrence of landslide in a place with a return period. Therefore, given to the potential of occurrence of landslide in the study area and the presence of traces and evidence of frequent landslide in this area, it seems essential that to provide the landslide hazard zonation and guidelines for risk management. Accordingly, the effective factors of the occurrence of landslide in Farob Roman basin were identified and their impact is determined using ANP method and the hazard zonation map was prepared based on entropy model for this basin.

Methodology
In this study, at first the information layers of ten effective parameters including altitude, rainfall, slope, slope orientation, geology, land use, vegetation density and distance from the river, faults, and roads were provided. In order to provide these layers, the topographic maps of 1:50000, geological map of 1:100000, land set satellite images and synoptic and rain-gauge stations’ data of this area and its surrounding were used. Also in order to evaluate the results of research, information and data related to 96 landslide point (based on the Department of Watershed and natural resources of Khorasan Razavi’s data) were used to prepare the landslide zonation map. Qualitative information layers have been converted to the quantitative raster files using Arc GIS 10.1 and then given to the features taken from region landslides and based on the ANP, each layer has been weighting and finally, after the classification of layers, entropy matrix was formed for them.

Results and discussion
At first the target information layers have been converted to the raster files and then given to the landslide occurred and based on the ANP, weighted sub-criteria assigned to each layer. One of the most important features of this model is composed of super weight matrix at the later stage. In this super matrix, the set of assigned weights based on expert opinion extended to which their convergence matrix elements and row value being equal. Based on the obtained matrix, general weight vector is determined. Using this model, expert opinion and commends, that has always been associated with
the error, is adjusted and is prepared to apply in entropy model. Indeed, entropy suggest that how we can estimate the most important factor among the effective factors of an objective or in other hand, those variables that have the greatest impact on the occurrence of an event is determined in this way. In the next stage, using 1-5 equations, the final weights are calculated based on entropy model and then the landslide hazard map is prepared in GIS environment for Farob basin and finally based on the natural breaks is divided into five class and group named very low, low, medium (normal), high and very high risk. Due to the natural and geographical characteristics of study basic and entropy model that has been used for weighting, the impact of the ten effective factors is different. The factors of distance from the river with 20%, precipitation 18%, and slope with 16% have the greatest impact on the occurrence of the landslides in this region. Lithology and height with 11.1%, slope orientation with 8%, vegetation and land use by 5%, distance from fault with 2% and distance from the road with 0.07% are other effective factors on the occurrence of landslide in this basin. Finally, the landslide zonation map was tested using SCAI index. This index provides the level of accuracy in qualitative manner and represents the verifying of landslide zonation map based on the SCAI value of the accuracy of zonation map evaluation in the study basin (By accuracy we mean the reduction of SCAI value from the class of very low to very high one) which, therefore, showed a reduction of SCAI index value from the very low class toward the very high class.

Conclusion

The result of this study indicate that the most important factor on occurrence of landslide in this basin and based on the entropy model is distance from river that assigned the effect of 20%. Given that the total number of landslide that have occurred in this study area is 96 landslides, 49 landslides occurred in 0-50 meter and 40 landslides occurred in 50-150-meter distance from the river that indicate the important direct effect of erosion and river laundering. Precipitation also showed the effect of 18% that is the great impact after the distance from river and in a way that 50 percent of the basin has the precipitation about 460-500 mm and I should mention that 47 landslide occurred in this situation. Based on the entropy model, the third effective factor is slope that has the effect of 16% and 60 landslides have occurred in the slope of 20-35 percent. After these two, lithology and height were other effective factors in landslide that the highest landslides were occurred in metamorphic and changing formations (CTRS-sh) and Delijay and Shemshak formations (Jd-Jsh s) with the number of 63 and 26, respectively. Slope orientation with 8%, vegetation and land use with 5%, distance from fault with 2%, and distance from the road with 0.07% are other effective factor on occurrence of landslides in this region. About 41 percent of basin area is in the range of high and very high risk that in this area, about 73 percent of landslides occurred. This suggests that how this area is risk taking to landslides. Assessment of landslide hazard map using SCAI index revealed the high correlation of prepared risk map and the landslides points.

**Key words:** landslide, hazard (risk) zonation, The ANP model, Shannon entropy index, Farob Roman basin.
References

1. Abedini, Mousa, Beheshti Javid, Ebrahim, Fathi, Mohammad Hossein (1394). Landslide susceptibility zoning using two-parameter statistic models and fuzzy logic (case study: Bakhluo river catchment basin), geography and environmental planning, twenty-sixth year, consecutive 59, number 3, pp. 43-60.


3. Abedini, Mousa, Setayshi Nasaz, Hassan (1393). The landslide hazard zoning using analytical hierarchy process (AHP), Case study: Golje catchment basin, Geography and planning, eighteenth year, number 49, pp. 139-165.


13. Hejazi. Seyed Asadallah, Shadbash, Ranj bariyan, Maryam (1393). Identifying the effective factors and landslide hazard zonation in the western part of Sarandchay catchment area and basin, Quantitative geomorphology research, third year, number 3, pp. 114-129.


23. Pourghasemi, Hamid reza, Moradi, Hamidreza Seyyed Fatemi Oqda, Mahmoud (1393) prioritizing the effective factors on the occurrence of landslides and zoning its sensitivity using the Shannon entropy index, the journal of science and technology of Agriculture and water and soil natural resources, eighteenth year, number 70, pp 181-191.


34. Zarabi, Asghar, Divilsalar, Asadallah, Kanani, Mohamadreza (1391). Spatial analysis of urban settlements based on environmental capabilities (case study: Mazandaran), Spatial planning, Volume XVI, number 2, pp 78-100.
