Comparative Study of Information Value, Density Area, LNRF, Frequency Ratio Mmethods in Landslide Zoning at Poshtdarband Region, Kermanshah Province

Mohammad Hosein Ghobadi[1*], Seyed Hosein Jalali[1], Bahman Saedi[1], Noshin Pirouzinajad[2]

1. Professor, Department of Geology, Faculty of Sciences, Bu-Ali Sina University, Hamedan, Iran

2. Department of Geomorphology, Faculty of Geography and Planning, Tabriz University, Tabriz, Iran

Extended Abstract

(Paper pages 91-114)

Introduction

Due to possibility of occurrence in various natural environments and the variety of natural and artificial factors that affect landslides, landslide has special importance in natural hazards. Depending on the landform, several factors can cause or accelerate the landslide. According to previous researches, Human activities, land morphology, geological setting, slope, aspect, climate conditions, proximity to some watershed features such as rivers and faults are the most important parameters. Landslides occur frequently each year and they can cause heavy losses which compensating some of them requires a lot of money and time.

Assessing landslide related hazards with only limited background information and data is a constant challenge for engineers, geologists, planners, landowners, developers, insurance companies, and government entities.

The landslide occurrence in terms of time and place are not easily predictable, for this reason, Landslide Hazard Zonation (LHZ) or Landslide Susceptibility Zonation (LSZ) maps are used to predict the happening of landslides. A landslide susceptibility map depicts areas likely to have landslides in the future by correlating some of the principal factors that contribute to landslides with the past distribution of slope failures. These maps are basic tools for land-use planning, especially in mountain areas. Landslide susceptibility mapping relies on a rather complex knowledge of slope movements and their controlling factors. The reliability of landslide susceptibility maps mostly depends on the amount and quality of available data, the working scale and the selection of the appropriate methodology of analysis and modeling.

Such maps are obtained by dividing of a region into near-homogeneous domains and weighting them according to the degree of possible hazard of a landslide. There are two ways to do landslide hazard zonation: (i) a qualitative approach that is based on expert knowledge of the target area and portrays susceptibility zoning in descriptive terms; and, (ii) a quantitative approach based on statistical algorithms. In the present study of landslide susceptibility zonation, bivariate statistical methods (information value, density area, LNRF, frequency ratio) were used. In bivariate statistical analysis, each factor map is combined with the landslide distribution map and weighting values based on landslide densities are calculated for each parameter class.

Materials and Methods

The best method for studying landslides, which has long been of interest to researchers, is hazard zonation. In this method due to the affecting factors in landslide occurrence, the study area is classified into areas with low to very high risk. Such zonation could be of great help in regional planning. Different methods have been developed for this purpose. In this research four bivariate statistical methods namely information value, density area, LNRF, and frequency ratio are used to investigate the hazard zonation in Poshtdarband region, Kermanshah province. The study began with the preparation of a landslide inventory map. The instability factors used in this study included geology, land use, normalized difference moisture index (NDMI), slope gradient, aspect, distance from faults, distance from surface water, distance from roads, profile curvature and plan curvature. Landslide area ratio was calculated in classes of effective factors maps and weighted by four bivariate statistical methods. In addition, landslide hazard zonation maps were obtained from algebraic sum of weighted maps with regard to breakpoints of frequency curve. Finally, by using density ratio (D_r) Index through all four methods hazard classes were compared and with the help of quality sum (Q_s) and precision (P) indexes these four methods were compared and evaluated.

Results and Discussion

If the landslide susceptibility analyses are performed effectively, they can help engineers, contractors, land use planners, etc. minimize landslide. In this study, bivariate statistical methods were applied to generate landslide susceptibility maps using the instability factors. The bivariate approach computes the frequency of landslides with respect to each input factor separately, and the final susceptibility map is a simple combination of all the factors irrespective of their relative significance in causing landslides in a particular region.

In table 1 subclasses of instability factors which had the highest value in different methods, are summarized.

The density ratio indexes (D_r), quality sum indices (Q_s) and precision indices (P) were used to compare the methods. By overlaying the landslide inventory map of the study area and landslide hazard zonation maps, quality sum (Q_s) and precision (P) indices introduce a suitable model for the studied region, and density ratio index (D_r) introduces division precision among the zones or hazard classes in each zonation model.

Table1. subclasses of instability factors in different methods which had the highest value

factor / methods	aspect	Slope	distance from surface water	land use	plan curvature	profile curvature	distance from fault	distance from the roads	NDMI
information value	N, NE	>40	>1000	forest	concave	concave	<500	>1000	-0.17_ -0.408
density area	N, NE	>40	>1000	forest	concave	concave	<500	>1000	-0.17_ -0.408
LNRF	SW, S	10-20	>1000	pasture	Convex	convex	<500	>1000	-0.17_ -0.408
frequency ratio	N, NE	>40	>1000	forest	concave	concave	<500	>1000	-0.17_ -0.408

The density ratio for information value method in the very high hazard class is accounted 1.700495. These values for density area, frequency ratio, and LNRF methods are, 3.407827, 3.402257, and 1.694628 respectively.

Method precision (P) values for information value, density area, frequency ratio, and LNRF methods are 0.160826, 0.241024, 0.240672 and 0.16942 respectively.

Conclusion

- Frequency ratio, density area and information value methods showed that forest land use, slope and slope shape factors have the highest impacts on a landslide occurrence.
- The LNRF method showed that geology factors, pasture land use and distance from surface water had the greatest role in landslide making.
- For frequency ratio, information value, and density area methods, the effective factors in landslide are the same, however through the LNRF method, the three factors which have the greatest impact on landslide happening, are generally different from the three other methods.
- The density ratio values show that density area and frequency ratio methods respectively have more accuracy and applicability within all used methods for separating hazard classes in the study area.
- The quality sum (Q_s) results indicate that although there are minor differences, the frequency ratio compared to the density area method was more accurate and more applicable for separating landslide hazard in the Poshtdarband region.
- The calculated results of P index indicated that among the used methods, the density area method with a nuance of the frequency ratio method is the most suitable method for the study area.

Keywords: Landslide zonation, Information value, Density area, LNRF, Frequency ratio, Bivariate statistical methods, Poshtdarband area.

*Corresponding Author: amirghobadi@yahoo.com