Landslide hazard Zoning with Using Combination Methods of Hot Spot, ANP and WlC (Case Study: Khalkhal County)

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1. Introduction

One of the most important hazards that has always changed the natural environment is landslides. Landslides are catastrophic and widespread, causing significant damage in many parts of the world. Landslide is the movement of downward or integrated bulky loose weathered material and sediments which always quickly occurs across slopes. Landslides are very important natural hazards that exert high damages to human and economic property every year especially in mountainous area. According to this reason, in recent years, evaluation of landslide in terms of regional and small scale has been under attention of experts. Therefore, landslides are among the disasters that can be predicted and prevented. To study the risk of landslide, there are several ways in which zoning is one of the most important methods. Landslide hazard zoning is the mapping of areas with the same probability of occurrence at a given time. Identifying sensitive and endangered areas and preparing a landslide hazard zoning map is an important step in preventing and reducing landslide damage.
Khalkhal County with an area of 2688 square kilometers is located in the south of Ardebil province. The study area in view of specifically regional situation such as topography (mountainous area), high slope, the existence of soft surface formation, non-resistant material above the resistant layers, and condition of dominate climatic has high potential for mass movement occurrence. It results in enormous and irreversible damage if no action is taken. Therefore, zonation of township area in view of sensibility to landslide is very necessary.

2. Materials and Methods

In this study, firstly, the factors affecting landslide occurrence (including slope, aspect, lithology, land use, soil, precipitation, distance from the road, distance from the river and distance from fault), according to the natural and human conditions of the area were identified. In the next stage, maps of effective factors in landslides of study area by Geographical Information System (GIS) were produced. Data set layers of access roads, stream network, elevation classes, slope and aspect were derived from digitizing topography map at 1:50000 scale. Layers related to fault and litology were derived from

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digitizing of 1:100000 Khalkhal geological map. In order to obtain the land use layer, land use map of Khalkhal township and satellite image were used. In so doing, soil map of area and soil of Ardabil Province were inserted. We exerted climatology station data and gradient equation to obtain precipitation map.
Criteria weighing using the ANP method, which is a developed form of the AHP method is able to model the correlation and feedback between the elements in a decision making and to integrate all the internal effects of the components involved in the decision making process into computations. The final analysis and modeling was done by using Hot Spot Analysis as a method of spatial statistics as well as WLC method as one of the multi-criteria decision-making methods.

3. Results and Discussion

According to the results of the study, areas with a hot spot of 99%, mainly involved the slopes of 20 to 35% are investigated. It can also be said that the high-risk areas are located in areas with high rainfall (400-650 mm), and the landslides of the Khalkhal County are formed after heavy rainfall or after the melting of the snow in the spring.
Investigating the lithology factor also shows that non-nominal and semi-resistant formations, which are mostly Quaternary loose formations, have a high sensitivity to landslides. Hot spot spots are also found in soils with high clay, silt and marl, and on the northern and northwestern slopes. The survey of land use criteria also showed that the agriculture area has the highest percentage of the area of high risk areas. In addition, the high risk areas (hot spots), introduced by the research method, show that high risk areas are located relatively close to roads, rivers, and faults.
Also, the results of the overlap of the study with the distribution of landslides, showed that 74.80 from the landslide distribution points in the Khalkhal county are in high risk classes (hot spots 99% to 90%) and 9.93% slip dispersion points are in low risk classes (cool spot is 99% to 90%). The lack of a meaningful model accounted for 15.27% of the slip dispersal points.

4. Conclusion

The study results showed that the slope, land use, precipitation, and lithology factors were 0.663, 0.646, 0.639, and 0/379, respectively, with the highest weight coefficient . Also, the results of this study indicate that 9.28, 14.33, 15.89% of the study area in the classes with 99%, 95% and 90% stain is analyzed. It can also be said that according to the results of the study, Khalkhal County has a high potential for landslide risk and management measures should be taken in it.
According to the zoning map of the study, the study of high risk pixels resulting from the research method and its comparison with the distribution map of field surveys as well as climatic conditions, topography, geology, hydrology, and human governing the region can be the result of using the combination of Hot Spot, ANP, and WlC methods having a high degree of relative landslide study. It is expected that this study and the results of this research will pave the way for better and more knowledgeable management and planners in this field.

Keywords: Khalkhal, Landslide, Hot Spot, ANP, WLC

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