

# Prioritization of areas for controlling erosion and sediment production due to landslides using the Analytic Hierarchy Process (AHP) method (Case study: Oghan watershed, Golestan Province)

H. Musavi khosravi<sup>1</sup>, A. Peshgaae<sup>\*2</sup>, A. Uromeie<sup>3</sup>

## Abstract

Investigating the effective factors in the occurrence of landslides in an area and zoning the hazard resulting from them can have a positive impact on the management of damage caused by this phenomenon. In this study, with the aim of prioritizing areas for controlling erosion and sediment production due to landslides, using the Analytic Hierarchy Process (AHP) method, the landslide hazard zoning map was prepared in the Oghan watershed. First, the effect of influencing factors on the occurrence of landslides was identified by relating them to the landslide Dispersion layer, and after preparing all the information layers, all these layers were overlapped using Arc GIS software and finally, the landslide hazard zoning map was drawn. Also, the extent of different danger zones and the number of landslides occurred in them and on that based, it was found that landslide hazard zoning in this Watershed with AHP method has a high accuracy and complies with existing conditions. Topographic profile A-A ' showed that the areas very high hazard, which are mainly related to loess deposits, are located in valleys with an average slope of 6 to 11 degrees and at an altitude of less than 1100 meters.

**Keywords:** *Erosion, Zoning, Landslide, AHP Model, Oghan Watershed*

<sup>1</sup> Graduated with a master's degree in engineering geology, Boali Sina University, Hamadan

<sup>2</sup> Graduated with a master's degree in engineering geology, Tarbiat Modares University, Tehran Atefe473P@gmail.com

<sup>3</sup> Member of the Faculty of Geology Department, Tarbiat Modares University, Tehran

\* **Corresponding Author**

## Extended Abstract:

### 1. Introduction

Landslide is one of the natural hazards that make the land vulnerable. Landslides intensify erosion, forests destruction, agricultural lands, blocking rivers and form natural dams, and Destruction of construction projects. In the northern regions of Iran, due to special climatic conditions, geology, topography, as well as some human factors such as land use change and the construction of communication routes, the percentage of landslides is higher than in other parts of the country. In recent years, extensive studies have been conducted on the causes, degree and hazard zoning, stabilization method and how to prevent landslides in the world and in Iran. For example, Yalcin, 2008 prepared a landslide susceptibility map in the Ardis basin of Turkey with three methods of analytical hierarchy process (AHP), weighting factor ( $W_f$ ) and statistical index ( $W_i$ ), and concluded that the AHP method can identify areas with landslides compared to the other two methods in the area. The study shows better.

### 2. Materials and methods

The method is used for landslide hazard zoning in the Oghan's watershed is Analytical Hierarchy Method (AHP). This method is based on the pairwise comparison of the effective factors in the occurrence of landslides and the sub-factors related to the main factors. This method first by weighting of effective factors considered for zoning, then scoring each of the classes related to each of the factors, coefficients will be obtained based on which the final model will be presented. In this study, after preparing the required raster maps, including the soil map, altitude levels, distance from the waterway, slope, distance from the road and climate, their weighting was done based on the Analytical Hierarchy Model (AHP) and using ArcGIS software. Then the layers were overlapped in this software and finally a landslide hazard map of the studied area was prepared.

### 3. Tests results

After drawing the landslide hazard zoning map using the AHP method in the study area, it was found that the instabilities occurred in this watershed are in good agreement with the prepared map (Table 1).

**Table 1.** The percentage of landslides that occurred at different levels of hazard in the Oghan watershed

Degree of hazard	Safe	Low hazard	High hazard	Very high hazard
Number	0	5	151	<b>393</b>
Percent	0.0	0.9	27.4	<b>71.7</b>

### 4. Conclusion

The largest volume of areas with a high hazard of landslides is related to loess deposits. After examining the position of the topographic profile A-A' in the drawn zoning map, it was found that the high hazard areas, which are mainly related to loess deposits, are located in valleys with an average slope of 6 to 11 degrees and at an altitude level of less than 1100 meters. These conditions can be related to the sedimentation mechanism of loess; Because these silty drifts need a bed with a gentle slope to be deposited, and on the other hand, according to the available evidence, it seems

that the system carrying these sediments was not able to bring them to an altitude level higher than 1100 meters.

## References:

- Amir Ahmadi, A., 1389. Landslide hazard zoning using the Analytic Hierarchy Process, case study: Chelav Amol watershed, scientific-research journal of the Iranian Geographical Society, 8th year.
- Ong, M., 1370. Investigating the geomorphological evolution of the Qarasu watershed (Gorgan), Ph.D. course in natural geography, Islamic Azad University, Science and Research Unit, page 115.
- Ahmadi, A., 2016. Investigating the role of climate in range movement in mountain areas of North Khorasan using geographic information system (GIS) to control natural disasters and strategies to deal with them, PhD thesis, Tarbiat Moalem University, Tehran.
- Bednarik, M., Magulova, B., Matys, M., Marschalko, M., 2010. Landslide susceptibility Assessment of the Kral'ovany–Liptovský Mikuláš Railways case study, *Physics and Chemistry of the Earth*, 35 (3-5): 162 – 171.
- Bilali, F., Vahab-zadeh, Qurban., Pourqasmi, Hamidreza., Forozanfar, Milad., 2015. Landslide susceptibility zoning using fuzzy logic method (case study: a part of the Nekarood watershed): *Journal of the Engineering Geological Society of Iran*, Volume 9, numbers 3 and 4, pages 19 to 30.
- Biswajeet, P., 2010. Landslide Susceptibility Assessment and Factor Effect Analysis: Back Propagation Artificial Neural Networks and Their Comparison With Frequency Ratio and Bivariate Logistic Regression Modeling Original Research Article, *Environmental Modeling & Software*, 25(6): 747-759.
- Fardad, M., Al-Sheikh, A., Hakimpour, F., Vafainejad, A., 1390. Landslide hazard sensitivity zoning with neural network fuzzy logic methods, a case study of Mal Khalifa area, 15th conference of Geological Society of Iran.
- Ghafouri, M., Lashkaripour, G., Dehban Ivan Astakhri, M., Zare Sefat, M., Siar, A., 2014. Assessment of landslide potential in Pelroud earthen dam reservoir with fuzzy multi-criteria approach: *Journal of Iranian Engineering Geological Society*, The seventh volume, numbers 1 and 2, page 1 to 14.
- Hijazi, A., Javadi, M., Mousavi Kojabad, N., 1401. Landslide hazard assessment and zoning using fuzzy logic (case study: Sarajo river catchment): *Scientific-Research Quarterly of Geography and Regional Planning*, Year 12, No. 4, pp. 178-191.
- Hijazi, A., Ranjbarian Shadbad, M., 2014. Identification of effective factors and landslide hazard zoning in the western part of Serand Chai watershed, *Quantitative Geomorphology Research*, third year, number 3, winter 2014, page 114 - 129.
- Khullar, V. K., Sharam, R. P., & Paramanik, K. 2000. A GIS approach in the landslide zone of Lawngthlia in southern Mizoran. In *Landslide, proceeding of the 8th international symposium on landslides*, Vol. 3: 1461-1472.
- Komac, M., 2006. A landslide susceptibility model using the Analytical Hierarchy process method and multivariate statistic in per alpine Slovenia, *Geomorphology*, 74(1-4): 17 – 28.
- Lizarralde, G., 2008. The challenge of low-cost housing for disaster prevention in small municipalities. In 4th International i-Rec Conference 2008. Building resilience: achieving effective post-disaster reconstruction.
- Mousavi Harami, R., 1391. *Sedimentology*, Behnasher Publications, p. 289.
- Nikodel, M., Orumieh, A., Satayishi Rad, Mohammad Rasoul., 2018. Landslide hazard assessment by AHP method in the Caspian Sea coast, Nowshahr to Ramsar area: *Journal of the Iranian Engineering Geology Society*, Volume 3, No. 1 and 2, page 1 to 14.
- Organization of Geology and Mineral Explorations of the country, geological map of Dozin, sheet 1:100000.
- Panahande, M., Behrouz, A., Aryaman, Q., Ghanbari, F., 2018. Application of Analytical Hierarchy process (AHP) in locating waste disposal site in Semnan city, *Health and Environment Magazine*, Scientific and

- Research Quarterly of Health Science Association Environment of Iran, second period, fourth issue, winter 2018.
- Pirmoradi, A., 2016. Second International Conference on Electronic Municipality, Ministry of Interior, Organization of Municipalities of the country.
- Rezaei, Hamed., 2014. Identification of land hazards in loess deposits and methods to deal with it: Golestan University Research and Technology Vice-Chancellor, final report and research plan.
- Shariat Jafari, M., 1387. Landslide special hazard assessment in a part of South Alborz: Iran Engineering Geological Society Journal, Volume 1, No. 3 and 4, Pages 1 to 14.
- Shivani, C., 2010. Landslide Susceptibility Zonation Through Ratings Derived From Artificial Neural Network Original Research Article. International Journal of Applied Earth Observation and Geo information, 12 (5): 340-350.
- Strokova, L., 2022. Landslide susceptibility zoning in surface coal mining areas: a case study Elga field in Russia. Arabian Journal of Geosciences, 15(2), pp.1-17.
- Wan, S., 2009. A spatial decision support system for extracting the core factors and thresholds for landslide susceptibility map, Engineering Geology, 108 (3-4): 237 – 251.
- Yalcin, A., 2008. GIS-based landslide susceptibility mapping using analytical hierarchy process and bivariate statistics in Ardesen (Turkey): comparisons of results and confirmations. CATENA, 72 (1): 1-12.
- Zhang, W., Wang, W., Xia, Q., 2012. Landslide hazard Zoning Based on contribution of rate stack Method, Energy Procedia, vol. 16: 178 – 183.