The role of Spatial Analysis and Zonation of Landslide Vulnerability in Urban Planning: A Case Study of North West Slopes of Tehran Metropolitan

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Extended Abstract

1. Introduction

Today, urban planning, including detailed plans, unfortunately landslide hazard zones are not well recognized. Despite the occurrence of several landslides in the north west of Tehran, a comprehensive and transparent study has not been yet done on zonation and identification of landslide-prone areas. However, the role of the geomorphological studies and zonation of landslide is considered especially during the last three decades. Landslide hazard zonation map for the North West of Tehran metropolis has not been identified separately and has not been updated. Zonation of environmental hazards is one of the ways that can identify critical zones and in various urban development plans, the necessary measures for these areas should be considered. This study analyzes the spatial distribution of landslide prone zones in the North West slopes of Tehran.

2. Theoretical Framework

The theoretical framework is spatial analysis. Spatial analysis analyzes the spatial patterns, spatial geographic phenomena, and the study of the formation, dispersion, interrelations, differences and similarities, the evolution of patterns, and how they are planned. The spatial schools is one of the main schools in geographic studies. The spatial analysis includes two important stages of the study, which include knowing how to explain the causes of dispersion, and identifying spatial patterns or zones and spatial relationships between them that lead to the theory's discovery or confirmation of a theory based on existing data.

3. Methodology

The following data is used in this research:

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1. Library documents,
2. Digital elevation model,
3. Digital geological map of Tehran Province,
4. Digital landuse map of Tehran Province,
5. Climatic and synoptic statistics of Tehran Province stations.

According to the field study, 9 critical criteria were identified in the occurrence of landslides in the study area. These criteria are slope, distance from the faults, geological formations, land use, distance from the rivers, precipitation, elevation, aspect and distance from the roads.

Fuzzy logic is based on the concept of partial truth. In the classical set theory, membership is defined as 1 = true or 0 = false. The classical set theory does not allow thresholds. Thus slope is susceptible for landslides (1) or not (0). In a fuzzy set, membership is expressed on a continuous scale from 1 full to 0 full Non-membership. In landslide susceptibility mapping, fuzzy logic defines the instability factors as members of a set reaching from 1, expressing the highest susceptibility, to 0, expressing no susceptibility of landsliding, allowing different degrees of membership.

4. Findings

Using the above mentioned methods, the results showed that landslide hazard zones in North West of Tehran are about 14 percent of the area studied, and are high and very high. About 12 percent of the study area is in moderate risk zone, too, and the rest of the region that includes about 72 percent is in low and very low risk zone. Effective factors in the occurrence of landslides in the study area are: 1. Slope: Forty three percent of landslide movements have occurred on 30 to 50 degrees which may be due to the relatively steep slopes at the height of 1800 meters to 2000 meters. Which it facilitates the movement of the landslide mass? 2. Distance from the faults: The result of map intersection of classes distance from the faults in the study area and sliding movements suggests that 62.88% of the landslides have occurred less than 500 meters from the faults. The presence of active faults in the study area indicates tectonic activities. Therefore, there is a possibility of landslides if faults are active during an earthquake. 3. Geological formations: Most of the landslides have occurred in Karaj Formation, which can be due to the loosening of deposits under the influence of weathering. Due to the topography of the study area and the destruction of its vegetation, it is likely that these sediments are exposed to weather, and may be weathered. The least landslides have occurred in volcanic formations such as Andesitic and Basaltic volcanic rocks. These formations are resistant against erosion and degradation. 4. Land use: Studying the map of land use and survey in relation to land cover map showed that about 96.8 percent of the sliding movements have occurred in medium and poor pastures vegetation. Destruction of vegetation and its lack not only causes leaching the slopes during precipitation, but also the soil on the slopes is exposed directly to the air, they easily weathered, which causes the soil instability in the study area. Field surveys taken from the watershed suggest that the soil instability as a result of the native vegetation degradation5. Distance from the rivers: 72.46 percent of landslides have been observed in less than 500 meters distance from the

rivers. The river flow and its drainage networks can cause leaching the soil-foot slopes and it causes unstable soil. 6. Precipitation: About 48 percent of landslides have occurred in precipitation greater than 300 mm. The high and excessive precipitation can cause leaching the soil-foot slopes especially for those slopes that have been cleared of vegetation. Given the fact that the vegetation has been destroyed in much of the study area, and the fact that the relatively high precipitation occurs in the mountainous area, precipitation via rapture in the slopes can lead to the occurrence of landslides in the area under study. 7. Elevation: Most of landslides have occurred in the range of 1600 to 2500 meters elevation. An increase in precipitation with elevation may be a risk factor for the occurrence of landslides in the zones. The high and the excessive precipitation causes leaching the slopes and its instability. Moreover, in the highland and mountainous areas, rocks and soil weathering is easy, which causes soil instability in these areas. 8. Aspect: Most landslides have occurred in southern directions (south, southwest and south east). Due to the mountainous nature and the thin air in the high elevation, especially in late winter and early spring, the sun will melt the snow in these areas which causes soil become moist in these parts of directions. The expansion of the soil during the day and its contraction during the night provide unstable slopes and loosen the soil in these directions, too. 9. Distance from the roads: most landslides have occurred in the distance of 1000 meters to 5000 meters from the main roads. Therefore, the impact of the roads on the landslides will be determined significantly.

5. Discussion and Conclusion

The result of the present study showed that about 14 percent of the studied area is high and very high. About 12 percent of the studied area is in moderate risk zone, and the rest of the region that includes about 72 percent is in low and very low risk zone. Spatial analysis of landslide hazard zones shows that the morphology of these zones follows the morphology of topographical and hydrological factors. The analytical results show that due to the topography, tectonic activities and geology, heavy precipitation and the lack of observance distance from drainage networks including valleys and inappropriate land uses, especially tower construction in the hot spots, the risk of landslides is very high. Therefore, reformation and stabilization of slopes is proposed.

Key Words: Spatial analysis, Mapping vulnerability, Landslide, Tehran Metropolitan

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