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Predicting Slide Riskswith an Emphasis on the Role of Structural and Seismic Elements (Case Study: part of Taleghan)

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ABSTRACT

In this research, beside structural and geological considerations, an exact and partial investigation is performed on side movements in some part of Taleghan. Regarding increasing damages happening due to side movements, the issue of predicting and proposing solutions and controlling methods and preventing loses and damages resulted during recent decades have been seriously discussed. The aim of this article is an exact investigation of predicting the risk of slides in future, using models which have most concordance with natural conditions of the area being studied. Seismic power dominant on each area, particularly, imposes highest influence on occurrence or intensification of slopes' breakage. Among common methods of zoning the risk of landslide, three, Kanagava, Mura & Warson and Nilsson adjusted methods, were chosen by which the area being studied was divided into areas with potential risk of slide. In all the methods mentioned, tectonic and seismic power elements are emphasized as important key elements. Elements influencing instability receive values in these methods.According to Kanagava, around 73 percent of landslides happen in predicted areas and 27 percent happen in unpredicted stable areas. Mura & Warson method didn't show appropriate results in prediction of slide risks in this area.
The ability of slide risk prediction in the area is partially good in Nilsson's adjusted method, in a way that around 60 percent of landslides happened in predicted areas and 40 percent happened in unpredicted stable areas considering drift point of view. Based on the results acquired, Kanagava is more appropriate, compared to other zoning methods, in the area being studied.
KEYWORDS: Taleghan, Seismic power, Slide

1. INTRODUCTION

In researches already done in country related to landslide, researchers have not considered the role of structural elements specifically. Argumentations and opinions in this field have been descriptive and general mostly; therefore the role of structural elements has not been analyzed well.

The speed of displacement of broken sliding materials is different based on the condition and varies from a few centimeters to meters in seconds. Dimension of sliding and instable mass is influenced by different elements and it is variable as well. Most devastating slides, according to the results from investigations around the world, due to the high speed of occurrence and amount of broken materials, relate to earthquake landslides [3]. Elements influential in instability of land slopes are various which are dividable into two inherent and environmental ones. Of course, if we ignore the speed mentioned elements influence, it can be said that many inherent elements follow the time and external elements have a major role in them.

In spite of advanced human knowledge about the mechanism of slide occurrence and their controlling elements acquired through the effort of researchers from different countries, it is expected that in result of continuation of increasing changes in nature and use of mountainous areas exposed to slide, landslides and resulting damages in future will have wider dimensions and this fact makes scientists and governmental officials from different countries pay more care and attention to consideration of different dimensions of this event and methods to predict and control it.

Importance of zoning the risk of natural slopes' instability

There is no exact data about the amount of damages caused by landslides and slope instability in many countries of the world, yet there is no doubt that this event is emerging in different mountainous areas of the earth specifically, seismic rainy areas. In the following, specific cases of these damages are noted [5]:

- Annual damages of landslide in the U.S is estimated to be thousand million dollars (Schuster, 1978) and in Italy it is 1140 million dollars (Arnold and Ferry, 1977).
- Krohn&Slossin (1976) estimated indirect damages of this event to be 20 dollar per each American annually.

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- According to UNESCO reports, 84 percent of damages caused by natural accidents relate to earthquake and 14 percent to landslides.

First step to prevent damages or deaths is to determine instable areas and predict the potential of occurrence of these events. On the other side, the most economical and fastest method to achieve this prediction in wide scale is zoning the degree of relative instability in these areas using appropriate methods and determining potential instable areas. In this sense, with the knowledge of areas with high relative risk, there is an opportunity to transfer residential areas and important vital projects and facilities or prevent direct deaths and damages by former predictions. In addition, we can stop loses in national assets or occurrence of damages by rejecting investments in risky areas and following designing principles.

Slide risk zoning, is a new empirical science with around four decades. However, due to the need of different societies, many articles and papers were published in this short period of time. Different researchers provided different methods for zoning slopes' instability. Among preferences of using these methods in development projects, is its being economical compared to methods of slope stabilization after accident happens [6].

Among common methods of landslide risk zoning, due to more concordance with conditions dominant on these methods and of the area studied, three Kanagava, Mura & Warson and Nilsson's adjusted methods were chosen as a base for providing zoning maps of slide risk of Taleghan.

The effects of tectonic elements (earthquake and structural trends) on landslides of the area

Providing that active regions are considered from seismic power in the world, it will be apparent that earthquakes are among major elements creating landslides, in a way that a good correspondence is achieved between seismic and sliding areas [3]. Because Taleghan is located along earthquake belt of Alp-Himalaya, the effect of earthquake on slides of area is distinguishable evidently. This fact is proves through considering historic earthquakes in the area in a way that as a result of earthquakes of Rey-Taleghan (958), Roodbarat- Taleghan (1608) and Taleghan (1808), lot of stone collapses and mountain slides were recorded in Taleghan [1].

Regarding the issue that most landslides happen along tectonically young ranges and active faults, a close relation between landslides and fault trends is achievable so that after some studies it was shown that around 70 percent of landslides of the area are along active faults [2].

In addition, because landslides of Taleghan follow earthquake-driven landslide characteristics, the effect of earthquake in landslide occurrence is undeniable [2].

Zoning the risk of landslides of Taleghan based on Kanagava method (1986)

As an appropriate method for seismic areas, this method was used by Kanagava's government in 1986 for slopes exposed to breakage in Japan. In this method, zones exposed to slope breakage are depicted on maps with 1/50000 scale and a network with 500 × 500 meters unit [3].

The method is based on seven elements including: amount of velocity on Gaul basis, maximum altitude difference, length of balance line, length of fault, length of made slopes, stone hardship and slope topography.

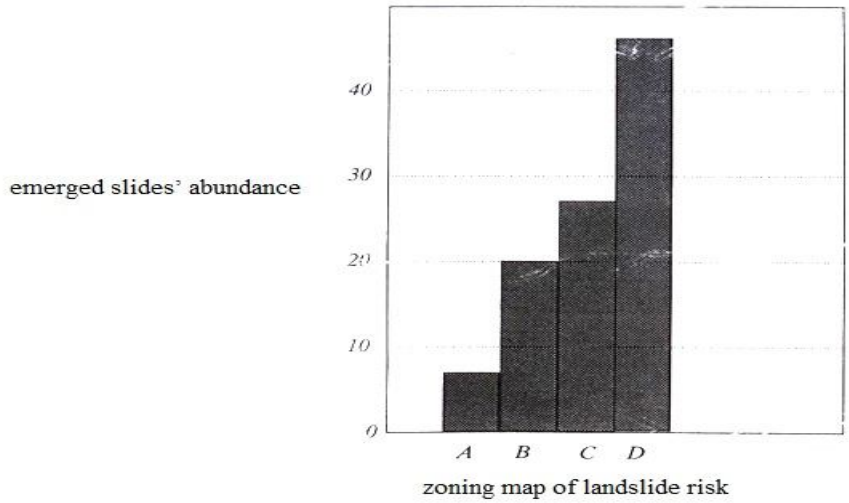


Fig. 1.histogram of emerged slides' abundance compared to zoning map of landslide risk in Kanagava method
A (the amount of emerging landslides in stable areas) B (relatively stable areas)
C (relatively instable areas) D (instable areas)

Based on this method and seven elements mentioned, Taleghan was given values. In other words, for each element noted, a data layer was achieved and a landslide risk zoning map was depicted (map 1). When evaluating the efficiency of this method it can be said that after superposing the slides on zoning map of slide risk it was recognized that around 73 percent of landslides happened correspond with predicted areas and 27 percent are in stable areas (Fig. 1). These values show a relatively good statistics for prediction of landslide risk.

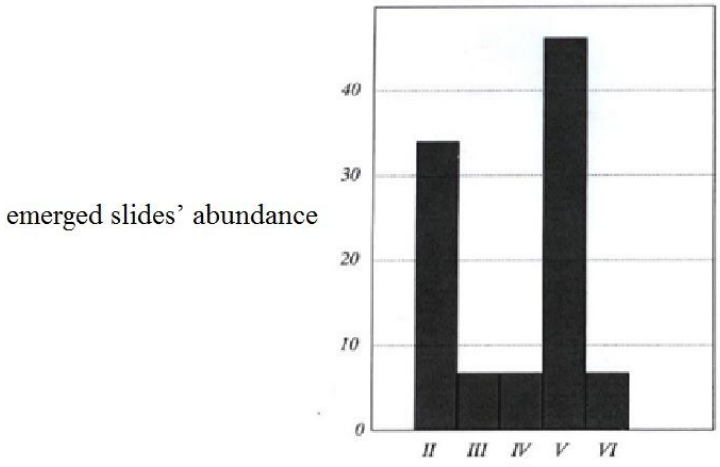
Taleghan's landslide risk zoning based on Mura & Warson method (1993)

Based on a set of studies, Mura and Warson classified slopes' breakage resulted from historic earthquakes and heavy rains in Central America and proposed this method for prediction of zones exposed to slope breakage [3]. The method is based on 5 litologic sensitivity elements i.e. natural moisture of soil, hillness, intensity of earthquake and amount of rain considered as elements influencing instability. In this method, zones exposed to breakage are depicted on 1/50000 scale maps and on network (with 1000 ×1000 meters unit). The area considered in this paper was given values based this method and 5 elements mentioned and finally, landslide risk zoning map was drawn.

Investigating Mura& Warson method it can be noted that after superposing the slides received on related zoning map, it is shown that this method couldn't predict any of emerged slides. One of the reasons for this failure is the amount of rain. Since the method is based on slopes' breakage in Kastarika with high annual and intensive rain, potential index of slide risk compared to influential elements like; amount of annual rain and influence of rain intensity, is highly sensitive. Therefore, due the low amount of annual rain (average annual rain in this area is about 442.9 millimeter) and less intensive rain (64 millimeter in a year), sensitivity of slide occurrence in the area is low and this method cannot predict happened and future slides [2].

Taleghan's landslide risk zoning based on Nilsson's adjusted method (1993)

This method is a fast method to provide slope evaluation maps using geology maps, slope maps and interpretation of air photos [3]. In fact, the method provided as Nilsson's adjusted method by HafeziMoghaddas (1993) is the same Nilsson method (1979) except that HafeziMoghaddas adjusted Nilsson's method considering characteristics of the area being studied. In order to provide landslide risk zoning map by this method, geological and topographic maps in 1/50000 scale and also a list of landslides happened in the area were applied. Figure 2 shows the abundance of the slides happened in Taleghan according to Nilsson's adjusted method [2].



II (stable areas), III (relatively stable areas), IV (relatively unstable areas), V (unstable areas) and VI (highly unstable areas)

Considering the efficiency of this method, it can be noted that with superposing slides happened in the area and zoning map provided through this method, it is clear that around 40.7 percent of landslides are correspondent with stable areas which were not predicted by this method.

CONCLUSION

The hazards and damages coming from instability of natural slopes especially in the areas exposed to earthquake are considerable, therefore in order to prevent deaths and financial losses in residential areas and protect vital projects and long term developments planning, it is recommended to investigate the risk of instability of mountainous and mountainside areas using an appropriate zoning method.

Analyzing zoning maps resulted from recommended methods (Kanagava, Mura & Warson and Nilsson's adjusted method) in some part of Taleghan shows that:

a) In Kanagava, around 73% of slides happen in instable areas and 27% of slides in stable areas

b) The reason for Mura&Warson method's failure to predict the risk of slides, is lack of concordance of environmental conditions of the area studied with the area recommended in this method, then it is required that this method is adjusted for areas like Taleghan.

c) In Nilsson's adjusted method, nearly 59.3% or landslides correspond to expected areas and 40.7% of landslides happened in stable areas.

Among methods mentioned, Kanagava, because it predicted around 73% of landslides happened, is an appropriate method for zoning of the area investigated and Nilsson's adjusted method is in next rank of importance for zoning.

d) The influence of determined role of evolutional earthquakes in project area is completely tangible. Most slides of the area, directly or indirectly, are influenced by functions of this element. The reasons to prove this fact include:

1. Evidences noted in reports existing from historic earthquakes of Taleghan
2. Characteristics of area slides (existence of landslide zones and slides with little width but considerable size) are much similar to earthquake slides remained from the earthquakes happened in recent decades (e.g. Roodbar).
3. Variance of landslides in the area follow existing fault- related trends

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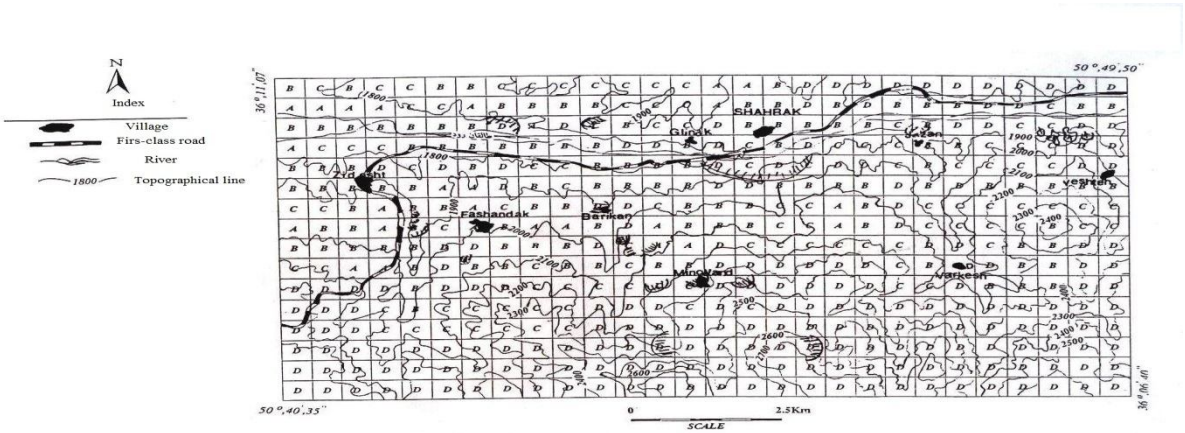

Map 1. Taleghan's landslide risk zoning map using Kanagava method (Rahmani, 1998)
A (stable areas), B (relatively stable areas), C (relatively instable areas) and D (instable areas)