A Study on the Reasons of Land Slide in the West of Mazandaran Province

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Abstract
The slope instability is a prevalent phenomenon in Iran which creates heavy financial damages and sometimes hurts and kills people. Generally, the land slides are more predictable and manageable comparing other natural disasters in a way that by knowing the landslides potential, in the country, a proper strategy can be formulated based on preventing them, coexistence or confronting this phenomena in various regions. In this regard, in this essay, the attempts are done to study and specify the factors of landslides by scope inferences and using aerial photos and topographic maps in the west of Mazandaran province. The results show that 98% of recorded mass wasting is in the category of landslides. (Rotational and annual motion) which accompanies with heavy damage. Only 2% of land slides are because of creep or Sulyfelection motions. 71% of landslides occurs in the areas having usage changes (forest to a grass land, a farm or residential land). The main reason for 38% of small occurred landslides are because of the road construction on the inclined regions. 18% of occurred landslides are mainly large and covers the several ten hectares. The change in usage is mostly the main reason of landslides. 27% of recorded landslides are occurred exclusively on Shemshak formation having shale, silt, stone, marl and clay lithology. Other cases happened on other formations with similar lithology or the fourth era sediments.

Key words: landslides, mass movements, landslide zones, aerial photos, use changing.

Introduction
Iran has the main natural conditions for creating a wide range of landslides by having mostly mountainous topography, tectonic activities, high seismicity and various geological and climate conditions. In Iran, the land slide as a natural phenomenon make high fatality and property damage. 38 dangers are identified among natural dangers in Iran (about 43 natural dangers threaten human life and natural resources). The position of landslide is in the 3rd grade based on global estimate, the possibility of danger occurrence and the prediction of possible damage resulted from it after earthquake and mineral resources wasting. Other dangers such as flood, erosion volcano, tsunami are on the next position. Based on an initial estimate, 500 billion Rs. property damage is imposed by landslides per year in Iran. Of course in a case that we don’t count the loss of natural resources that are irreparable.

The definition of landslide:
Despite of more than 100 years study record there are obvious problems and disagreement on the definition wordage and classifying the landslide or mass movements because of the type multiplicity and behavior diversity. But the proper word in foreign resources is landslide and its Persian equivalent is "Laghzesh" which is generally used for a special type of mass movement and in the plural state, it is landslides which its Persian equivalent is sleep mass movements. It covers all types of shapes for range or mass movements such as slide including rotary, transitive, creep (cumbersome (slow) and one movement of ingredient in a range, Sulyfelection, mad flows (cumbersome and pasty movement of clay materials), soil loss (the sudden fall of a mass on a slope or steep). But what is important and considerable is that the landslide has a specific concept which is famous as "Ranesh" in the public literature wrongly. It can be defined as the movement of weathered material on the slope (it is made of quaternary sediments (fourth era), residual soils, fine-grained formations with shale and marl lithology, clay layers and los deposits by the water.
and gravity force. This issue occurs in mountainous regions with steep, damp and having cute use changing slopes imposing fatality or property damage. In fact, the land slide is a natural tax and a natural reflection against the changes on the face of natural resources by human being. Based on an initial estimate, 500 billion Rls. property damage is imposing per year in Iran. Of course in the case that we don’t count the loss of non-reversible natural resources (Nasiry, 2004, p 1). The recorded statistics by the ministry of agriculture jihad shows that till early 1999 the occurrence of about 2590 mass and slide movement killed 162 people, destroyed 176 houses, imposed 1866 billion Rls. property damages, destroyed 676 hectares of the woods and 170 kilometers connection roads (Salehi pour, 2001, p4). A lot of works and studies are done about the mapping of landslides worldwide and different researches presented various classifications by different types of methods, including Saroli (2001) which has mapped the landslide in Korea using linear regression method. Using information layers in this research include slope, slope direction, soil thickness, the distance from stream lands usage and vegetation. After comparing the results of mapping by distribution map, it has been specified that this method has a rather suitable results. The researches on modeling and mapping of land slide risk is very young in Iran and mainly it is related to the early of previous decade. One of the researches is a study which has been done by Esmaeili and Ahmadi (2003) on analyzing the effective elements in making landslide and mapping of its resulted dangers. It is done through two methods of multiple regression and hierarchical analysis. Seven parameters are used in this study. Finally it is determined that the hierarchical analysis method has a higher accuracy than multiple regression. Mohammad khan (2001) also did the mapping of risk for mass movements for drainage basin of Taleghan considering 6 elements named slope, height, lithology, rainfall, slope direction, the land usage and using hierarchical method. Sadat Feiz Nia, Kelarestagh, Ahmadi and Safaei (2004) performed the mapping of landslide by 4 methods of information value of area density, overlap index, and hierarchical analysis method for systems (AHP) in the GIS environment to analyze the effective factors in creating landslides and mapping of risk for drainage basin of Shirin rood. Finally, it was found that areas having widely changes in land usage are high risk areas.

The necessity of studying landslide
Landslides are very important in terms of frequency, the severity of occurrence and direct and indirect damages. Therefore, quantifying all elements and estimating all damages and side effects for mass movements are rather impossible but doing it is a scientific, economical and social necessity. Estimating the damages, recording the occurrences and determining the importance of mass movements are difficult among natural risks.

1- landslides have complex compounds and various types, but generally, the most important risks are because of the earth quake, flood and torrential rains so its results and damages are considered because landslides of the earth quake and other elements (like consequential landslides of the earthquake in 1990 in Gilan province, Roodbar or mass fall of stones and the slope materials in the edge of Kandevan road in the earth quake on the 8th of June, 2003, Baladeh, Mazandaran. The landslide is a depth phenomena in a narrow area which occurs in the outside of human environments and out back; therefore impresses society and the officials less. Single landslides seldom impose remarkable damages for managerial and political reactions. The fright of people is much less from earth quake and recently the danger of ozone layer. The officials have not yet understood the problem of landslide and the benefits of preventing the risks results from it. According to global statistics the per capita share for per 14 people is one landslide in the humid and semi humid areas. The lack of statistics and necessary data for evaluating exactly the proper damage and fatality of mass movements in the worldwide, specially Iran has developed the fatalistic thoughts about the landslides in some cultures and nations. Therefore, the emergence of teaching how to confront the risks of landslide is more important than developing scientific knowledge and its technology. When people speak about landslides, they pay attention more to its direct and instant damages and forget its indirect damages and environmental results and effects. Analyzing the landslides in the west of Mazandaran province, the west of Mazandaran having the 6400 square kilometer is located in northern slope of central Alborz with particular conditions of geology and stratigraphy. The existence of formations with fine-grained lithology always provide favorable grounds for moving mass.
According to collected statistics during recent 10 years (source :Department of natural resources of Mazandaran) 105 landslide occurrences are recorded in this scope which have demolished area equal to 470/3 hectares of natural resources, agriculture, infrastructures and so on, and always damages equal to 5836 Rls. (without counting inflation from occurrence year up to now). The environmental value of demolished factors and spiritual, psychological and social problems are not also considered.

**The region geology**
The area of west of province is covered by seven sheet of geology map( Nowshahr, Baladeh, Chalus, Marzan Abad, Ramsar, Shokaran and Javaerdeh ) having the scale of 1/100/000 under coverage. The most of spread is related to formations of second era of geology (Mesozoic) which includes Shemshak formation with grey shale, silt stone, sand stone and conglomerate lithology, Chalus formation with tuff, marl, calcareous sandstone, and site litho logy, Tizkooh formation with dolomite limestone litho logy and Elika formation with limestone, dolomite lime stone and mass dolomite, litho logy. In the next pace, the maximum spread is related to formations of third era including green tuff, shale, lime stone, conglomerate and quartz sediment – destruct.

**The region Pedology**
The soil of this area are generally in the category of Mollisols and Entisols soils which covers a wide surface and the category of Inceptisols and Alfisols are also in less quantity.
Materials and methods:

For doing this research, aerial photos, topography maps and field operations plan questionnaire are used. (20 sheets of topography map having scale of 1:50000 and 64 sheets of topography map having scale of 1:50000 and 54 sheets of topography map having scale of 1:25000 are related to the study area. The number of using sheets are in the appendix. All photos are studied based on flight lines from up to down and left to right of the map. The land slides are specified on the map and the area of the map is closed. It is obvious that if their size on the aerial photos are in 1:20000 and at least 5*5 scale, all types of land slides are recognizable such as falling, slide, stream, creep, etc. In a case that it is smaller than this size, it will be marked as a land slide without recognizing its type.

In order to recognize a land slide on an aerial photo, there are evidences as following:

- The change in the water way which is created by mass movement in a way that there is a convexity or concavity in the moved part of the water way.
- Disorder on the slope which has a regular shape in a way that it differs completely with other parts of slope.
- The headland above the moved area and also in some cases lateral head lands which shows the movement in the area.
- The cracks in the moved slope which is observable in the photo.
- The light crescent above the slide area, that shows the change in the shape and entity of the slope.
- The spoon shape that can be seen at the bottom of material aggregation.
- In some cases, by watching the areas that have layering, one can see that the layers are erased in on area but they are layers in the lateral part of this region.
- Sometime, there is a lake landslide mass in lower parts because of materials blocking the water way or the river.
- After falling, there is a depression inside the showing the change in the slope.
- The existence of frictional state in lower parts of falling region that can be seen as the repetition of dark and light color tone in the photos.
- The stone blocks aggregation in lower parts of disordered slope.
- The spread of stone blocks in the under studies slope.

![Figure 3: A sample for determining the slide on aerial photos in the region.](image)

After completing the questionnaires, the results related to the land slide are as follows:
A – The table of flight lines and the number of aerial photos related to each of them.
B – The table of number distribution for each type of landslide movements.
C – The table of the landslides number in each part in topography map.
D – The table of landslides number in each of octet directions.
E – The table for the type of landslides activities.
F – The table for distributing the landslides number based on the type of materials (stone, soil, and the combination of stone and soil).
G – The table for the number of landslides which threat different elements.
H – The table for the number of the landslides based on each of effective factors in creating landslide.
The results for studying the landslide in the west of Mazandaran province:

- 98% of recorded mass, movements from landslide type (rotary and transitive movement) are always accompanied by heavy damage and only 2% is related to creep or Sulyfection movement.
- 71% of landslides are happened in the areas with change usage (forest to grassland, farm and residential areas).
- 38% of small landslides are mainly because of constructing road on the steep areas.
- 18% of small landslides are big and covers multi ten hectares which its main reason is change in the usage.
- 27% of recorded landslides are exclusively on Shemshak formation with shale, silt stone, marl and clay litho logy. Other cases happened on other formations with similar litho logy or the sediments of fourth era. The important thing is that the landslides happened because of two or more stimulating factors. According to the priority for the effective factors on the landslides:

  In 25% of landslides, the water way or river, the slide in the slope, the increase in the lateral erosion and following wash of slide slope is the first priority of the landslide. In 4% of landslides, the earth quake shock is the first priority. Considering that this factor has a low frequency, its possibility percentage is always high in the risk of subsequent landslide of the earth quake. A notable point is that only in the earthquake on 8th of June, 2004 in Kojoor, Balade, the falling of weathered stones in steep slopes of Kandevan road edge caused the fatality and property damage which is generally attributed to the earthquake. If such an earth quake happened on damper slopes with northern direction having usage change or after heavy snowfall and snow melting, the possibility of wide landslides would increase. Other elements such as surface water, slopes steep and shape, the lack of vegetation and so on are the first priority of the landslides. Also, 91% of landslides happened in the previous slide locations.

![Figure 4: The transmittal map of landslides in the west of Mazandaran state.](image)

In studying the reasons for landslide in the intended range, it has been determined after studies that:

- Slope (gravity power) and the form of the slope, the type of formation of the area geology are the main factors preparing the landslides and these are out of human management. Some elements like water (flooding rains, snow melt, surface waters), the earth quake shock and human elements are intensifying elements.
- Human factors are among availability elements and in human management. Some factors like usage changing (forest to grass land and farm, grass land having trees to the agricultural and residential areas) decreases the soil consistency, causes the water penetration, increases the water because of the porous soil and finally prepare the ground for the rapture of lower layers.
- Building roads and the river under the slide slope causes the cut and instability of the slope.
- The lack of management for controlling the water for the agriculture on the steep slopes increases the water in the porous soil.

Unprincipled construction on steep slope that has an usage change intensifies the vertical loading and the slide.
Conclusion
The researches show that the land slide happens in the slopes with the steep more than 33%. So, considering this issue that this area is in the mountainous region, more than 82% of the surface has a steep more than 33%. Additionally, more than 76% of the northern slopes are made of fine-grained formations and sensitive to the land slide with clay, marl, silt, shale and so on. With regard to human factor intensifying the landslide (rods, change in the usage and so on, beside the natural factors intensifying the landslides like torrential rainfall, snow melting, earth quake shock, etc and also considering the synergetic effect (super math), these elements increases the potential of landslide in west of Mazandaran province, when some of them or all elements happen simultaneously, and are a serious threat for natural resources and the era of human environment.

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