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Investigation of relationship between sediment yield and landslide in Iran

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Abstract

Landslides have been made irreversible damage to urban areas and economic in Iran. In this research, at first, for Investigation of relationship between landslide and sediment yield was recognized some of effective factors on Landslide. These Factors were processed with use of ILWIS and Arc GIS software's. Landslide hazard zonation was done using Density Area and Index Overlay methods in GIS and evaluated them using Quality Sum index. In after phase, were determined sediment yield in each of them. Finally, occurrence rate landslide investigated in sediment yield zones. The results indicated that, slope, lithology and distance from the hydrographic network have the greatest impact on landslides. Most of the landslides have occurred in the 15-40% slope class, units of conglomerate and marl, and within one km of drainage network. On the other hand, the relationship between landslide frequency and distance of the fault was not a linear relationship and Almost 60 %of landslides have occurred distance of one km of the faults. Evaluation using Quality Sum index showed that the density Area has a more logical answer and as Appropriate method will be introduced in the basin. Investigation of deposition potential in sub-basins showed that Javaherdeh sub basin with 92.74 deposition potential is the first priority. Nedasht and latmohalleh sub basins, each with a deposition potential of 20.08 are the next priorities. Relationship between landslide area and deposition potential were identified as 8/91% of the landslides in the area of low And about 79 percent of landslides are located in high and very high deposition potentials.

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Introduction

Landslides are significant natural hazards in many areas of the world. Globally, they cause hundreds of billions of dollars in damage, and hundreds of thousands of deaths and injuries each year (Aleotti and Chowdhury, 1999) According to Schuster (1996), in the next decades, landslide prone areas are increasing due to urbanization, developmental activities, deforestation, changing climatic patterns. With regard to the importance of landslides in soil Erosion and destructive results for watershed residants, Investigation of effective factors on Landslides is of high significance. Landslides are considered as a major source of sediment. on the other hand, landslides are complex phenomena which depend on multiple factors and are created in different times and places under certain conditions (Nickandish, 2000) in Iran, removal of the natural vegetation and deforestation contribute to slope instability with a very high landslide activity (Shadfar, 2005). One of the most important factors affecting soil erosion is landslide phenomenon which have caused various irreversible damages. Some of the most important factors in triggering the landslide are

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geology, faults, drainage networks, elevation, slope, aspect, soil, Geomorphology, landuse and precipitation van Westen et al. 2008, Yilmaz, 2009, Nandi and Shakoor, 2010, Pradhan, 2010) . The application of GIS to landslide analysis is a useful and efficient tool. There have been many recent studies of landslide using GIS such as Clerici and others, 2002; Donati and Turrini, 2002;, Mandy and others, 2001). The watershed in this study is frequently subjected to heavy precipitation and exhibits mountainous topographical features, dense forest, which makes it prone to extensive landslides.

Materials and Method

Safarood drainage basin has been located in north of Iran, Mazandaran Province. It runs from 36°0'30" To 36°22'20" northern latitude and from 53°27'25" To 53°3'18" eastern longitude. The area of drainage basin is 13995.65 (ha). The most of drainage basin area has been covered from forested lands. The annual mean temperature of the terrain in 12.5 °C and the annual mean precipitation is estimated 696.7 (mm). The area climate from Dommartan method is humid. From geological point of view, the most of geologic formation are related to Shemshakn, Elika and Roteh formations (Fig1).

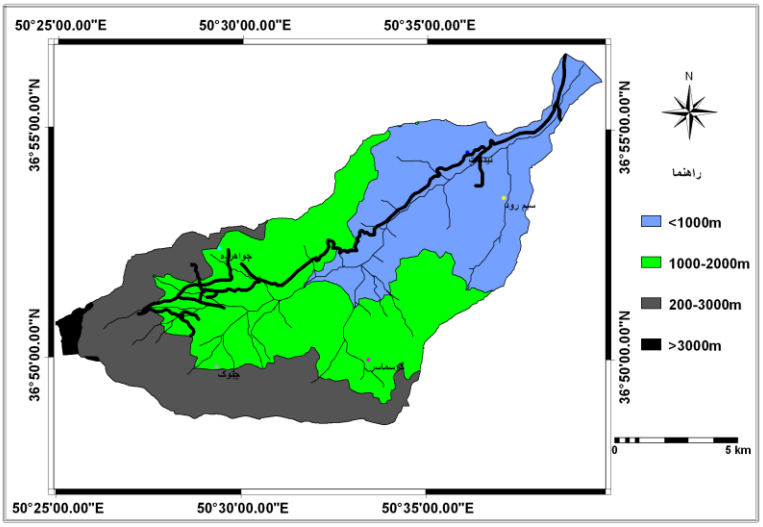

Fig. 1. Location map of the study area, safarood basin, Iran

In this research, At first, for Investigation of relationship between landslide and sediment yield with use of Field survey, Local interview and Review ending studies, was recognized some of effective factors on Landslide in watershed. These Factors are Lithology, Slope, Aspect, Distance from Fault and distance from Drainage Network. After recognition, were processed factors with use of ILWIS and Arc GIS software's. Weighting parameters and classes of agents was done according to the Density Area and Index Overlay methods. In after phase, catchment divided to different sub catchments. Hydrophisical Factors , such as Hydrological variables (P), Area , Topography (R), capability of Erosion (E), Vegetation cover (V) were evaluated in each subcatchments.And Then, were determined sediment yield in each of them. After completing the calculation factors, was done Deposition potential of basin and sub-basins according to following model.

$$CSY = AS * R * V * E * P$$

Finally was determined sediment yield and Landslides occurred in each of the sub basins.

Results and Discussion

The concentrations of soil EC (dS m^{-1}) and ESP showed a wide range and a skewed distribution (Figure 2). Indicator variograms were calculated seperately for each soil salinity classes; nonsaline, saline, saline-sodic and sodic. The indicator variogram parameters and fitted variograms were given in Table 1 and Figure 3, respectivelly. Variograms were fitted using either spherical or exponential models (Table 1). The range values showing the distance over which samples in different salinity groups are spatially dependent ranged from 493 to 2387 m. The values for nugget to sill ratio showing the quality of spatial distribution changed from 0.11 to 0.36.

Table 1. Slope classes Area and Landslides

Landslides Area (ha)		Slope classes Area		Slope%
percent	ha	percent	ha	
2.43	33.35	2.99	417.88	0-15
60.50	830.17	53.19	7444.34	15-40
29.72	407.87	31.75	4443.78	40-60
7.35	100.85	12.07	1689.65	>60
100	1372.25	100	13995.65	total

Table 2. Landuse classes Area and Landslides

Landslide Area		Landuse Classes Area		Landuse
Percent	ha	Percent	ha	
1.51	20.75	1.01	141.04	Farming
62.62	859.25	64.16	8980	Dense Forest
10.13	139	8.01	1120.56	Medium Forest
23.57	323.50	22.71	3178.89	Rangeland
2.15	29.50	3.16	441.87	Settlement
0	0	0.95	133.29	Orchard
100	1372.25	100	13995.65	Total

Table 3. Distance from hydrographic network classes area and landslides

Landslide Area(ha)		distance from hydrographic network Classes Area(ha)		Distance from hydrographic network
Percent	ha	Percent	ha	
64.89	890.50	49.62	6944.31	0-500
25.58	351	32.65	4570.10	500-1000
9.05	124.25	14.31	2003.34	1000-1500
0.47	6.50	3.41	477.89	>1500
100	1372.25	100	13995.65	Total

Table 4. Distance from fault classes Area and Landslides

Landslide Area		distance from fault Classes Area		Distance from fault Classes
Percent	ha	Percent	ha	
39.88	547.25	51.25	7172.13	0-1000
16.49	226.25	25.59	3581.56	1000-2000
38.62	530	16.73	2341.69	2000-3000
5.01	68.75	6.43	900.27	>3000
100	1372.25	100	13995.65	Total

Table 5. Lithology classes Area and Landslides

Landslide Area		Lithology Classes Area		Lithology Classes
Percent	ha	Percent	ha	
11.11	152.50	5.57	780.72	Q1a1,Q2d,QIm
0.040	0.50	12.12	1694.88	Re,bg
46.88	643.25	40.05	5606.21	Pr,Js
0	0	1.45	203.43	K2v,Kii
41.97	576	40.81	5710.42	C
100	1372.25	100	13995.65	Total

Landslide Inventory Map

Investigation of landslides started with the preparation of a landslide inventory map based on extensive field works (GPS) and Interpretation of aerial photographs. Landslide Inventory Map has shown in fig 2.

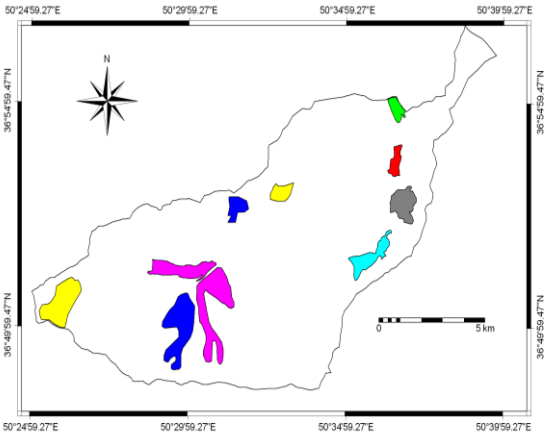

Fig. 2. Landslide Inventory Map

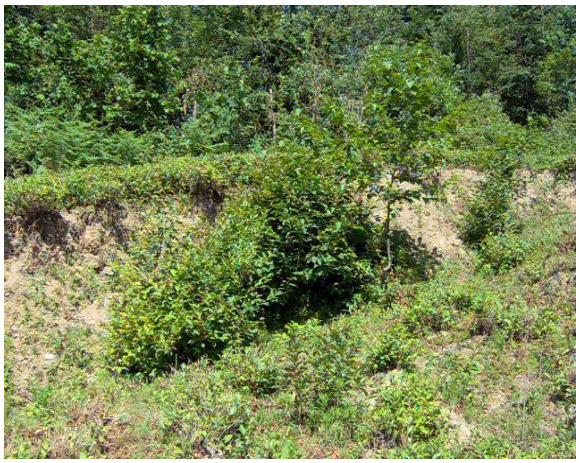

Fig. 3. Destroying tea gardens

Conclusion

The results of a number of factors indicated that the most landslides in the watershed occurred in the 15-40 percent slope class, shemshak formation, one km of drainage network. The results of Landslide hazard zonation showed that Density Area model is more suitable in this watershed. Javaherdeh sub basin with regard to deposition potential is the critical sub basin in the watershed. On the other hand about 79 percent of landslides are located in high and very high deposition potentials (Table 6).

Table 6. Deposition potential in subbasins

Prioritization of sub basins	Deposition Potential in each ha	Landslide %	Deposition Potential %	Deposition potential	Area(ha)	Sub basins
2	60/2	23/60	16/91	91499	1519/90	chetok
1	92/74	22/95	37/56	203122	2190/07	javaherdeh
3	28/6	24/37	13/71	74180	2593/68	kenarrod
4	26/16	0/13	12/02	65016	2485/15	garesbasar
6	20/08	11/15	12/48	67501	3361/38	Nedasht
5	21/99	17/81	5/33	28833	1310/84	simrood
6	20/08	0	1/98	10736	534/64	latmohaleh

Table7. Relationship between landslide with Sediment yield zones

Landslide%	Landslide Area (ha)	Zone area%	Sediment yield zone Area (ha)	Sediment yield zone
8.91	122.30	46.40	6494.38	low
12.39	170.04	25.91	3626.61	medium
57.41	787.82	22.84	3196.86	high
21.29	292.09	4.84	677.74	Very high

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