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ORIGINAL ARTICLES

Effects of Environmental Land Slide of Malayer Kalan dam using GIS sofware

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ABSTRACT

The natural environments usually are affected by one of the the natural hazards mass movement that causes huge damages as direct consequences: destroying of roads, residential areas and service installations and indirect consequences same as environmental unpleasant effects, soil loss and decreasing the capacity of dams. The LNRF Potential and present research carried out on Kalan dam watershed in Malayer to recognize prepared areas for mass movement. In this research, some factors such as lithology, slope, altitudinal surfaces and rainfall are chosen as the most effective factor in the mass movement occurrence. By using geological and topography maps and aerial photos in from of geographical information system (GIS) and Arc GIS softwares, they used the LNRF model in the maps of the research in the numerical and stratum from for analyzing the obtained data through studying the effective variances as the research conceptive tools. At the end, the zoning map of the mass movement dang are prepared by overlaying the various layers through weighting to the effective factors and their algebraic conclusion. According to the results, the watershed divided to 5 zones as very high, high, medium,low unstable and stable. The field survey also showed that the LNRF model is a good competence to study the data and zoning the mass movement in the basin of Kalan dam.

Key words: mass movement, Kalan dam, zoning, Model, LNRF

Introduction

Natural environment always keep on changing and these changes are normally caused by human activities.The problems to achieve solutions and methods appropriate to inhibit and control and reduce risks and damages caused by the planning principles of the natural environment will be glaring as a serious problem (Servati, 1991).

Mass movements studies are used to identify susceptible areas and factors in the occurrence of recognition for proper management of the land in order to prevent the occurrence of damages. Stoping of instability of the mass movements of natural hazards are abundant that cause financial damages, injuries and destruction of natural resources in the region. Apart from these, soil erosion, threatening residential areas, farm and roads, dam and fill reservoir dams will occure, including cases where the result of mass movements occurring types (Khezri, 1995). Why study a mass movement in the world is important, Ramakarishnan and Dai (2002), method of study for recognition in a landslide area in a small area in Nilgiris Kothajiri based GIS (DEM). Ortophoto maps were prepared by means of aerial ortophoto regional 1:8000. Layers of information and maps were ortophoto, topography, land use, slope, soil, lithology, topography and drainage network. These layers were divided by a combined GIS and finally to 4 regional studies areas (areas with very high landslide risk, high, medium and low).

Tangestani (2003) in the area in Fars province prepared, PKK landslide prone areas map using the gamma operator fuzzy point. Petrology studied angle of slope, slope, land cover, weathering depth, near the road, topographic height and depth as the soil factors. The results showed that the study area is landslide areas with high stability. Hengxing et al., (2003) investigated landslide stability in Hong Kong in response of pore pressure induced by the modeling influence Barandgy temporary and unsaturated rainfall using technology GIS,. They reported that different reactions in different landslide slope stability with different hydraulic properties, rainfall former landslide stability and nature of pore pressure reaction. Sharma (2004) landslide risk assessment using GIS in the Himalayan mountains in Nepal in the area of East Garjuwa reaching out to the landslide surface are very sensitive to rainfall. Increase in rainfall increases in areas prone to slippage rate. The rainfall is a very important factor in the occurrence of topographic surface landslide to sue. Chance occurrence of slope landslide is increased with increasing intensity. Finally, the results showed that 6/64 percent of the actual landslide with high-risk areas are consistent over the 6/64 of a shallow will happen landslide surface or in the future high-risk areas. Baldieviezo (2004) applied El Triunfo in the field using four-variable models based on slope, direction, drainage patterns and land cover using remote sensing of topography and the reported a severe impact by the landslide slope.

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Seczuk and Gardner (2004) in India, introduced a systematic method for unstable slopes provided prone to slip. Parameters studied were the slope, drainage, slope gradient, direction and land use / vegetation.

Wang and colleagues (2005) slip Yudonghe investigated in West Hubei Province in China. Weak zones, growth failure, slope downward geological layer and water penetration were considered as the most important factors in the landslide. Slope instability was analyzed by the method of Back Propagation Neural Networks (BPNN). The results of this analysis showed that the estimated slip Yudonghe currently is in a stable condition. Pierluigi & Brandolini (2007) evaluated and monitored the landslide activity in the West Portofino Promontory Geological by, morphological and hydraulic methods. Their results indicated geomorphologic studies enabled a series of landslide rate of several centimeters a year.

Materials and Methods

The study area location:

Dam basin is located in South-Eastern of Malayer city in Hamedan province in longitude 53' 48º to 04' 49º and latitude 52' 33º to 4' 33º is located (Figure 1). Average height of the field 4/2178mm. Region are formed in terms of geological zone of Sanandaj - Sirjan location. There are differences for petrography of different units regional metamorphic rock, granite mass inters ion Borujerd Quaternary alluvial deposits(Geological Report Malayer 1990).

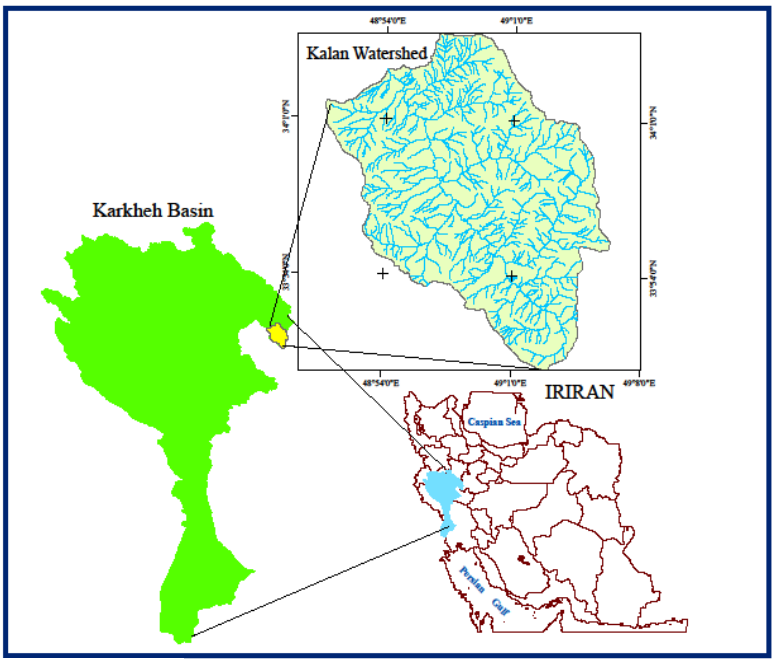

Fig. 1: Geographical location of basin

Browse Ambergeh climatic type climatic zone, semi-arid and cold and Mediterranean rainfall regime that is ruling, the average annual precipitation stations Malayer 3/320 m.m. belonging to the highest rainfall in the spring season with 1' 36° percent. Descending atmosphere late in the Persian month November(Aban Persian month),March(Esfand Persian month) the late snow and frost days Total 3' 870 Day of year. The average annual temperature of 7' 11 °C is. Dam Report Kalan Malayer (1993).

Methodology:

Zone classification to a mass movement of all available reports and maps required including: 50000:1 scale topographic map, geological scale: 1:100000 and 1:50000 scale aerial photo of the relevant were obtained organs. Using aerial photos, mass movements occurred in the region and identify their positions were determined on the topographic map. Distribution map, then as a mass movement and been prepared as a digital base map, was used Yaghoobi (1995). For ease of analysis between the factors affecting mass movements Litho logy variables, distance from the fault, slope, altitude and rainfall levels. Maps and geographic information system was digital in the form factor (GIS) using ArcGIS 9.3 software (2007). (Haeri, 1995). Distance to fault

mapping, fault region Buffering distance was 1000 meters. Hypsometry map Plan height divided into areas with a class height was 9. Isohyt for mapping levels, rainfall stations available through pluviometry Kriging model method and Spherical, within the ArcGIS software were finding Isohyt was divided into six levels. Then obtain homogeneous units, each prepared with maps and distribution maps were overlapping mass movements. Mosapoor (1996).

Results and Discussion

Data analysis factors in a digital mass movement's field study method in LNRF took ArcGIS software environment. This method of operating the credit risk of landslides is the use of landslide surface occurred in a unit of the average landslide occurred in the whole (year 1) action is occurring to prepare a risk index value of this phenomenon.

Relationship (1):
LNRF:
landslide area occurrence in uniteaverage area movement occurrence in total unites
Area of mass movement occurred in a unit average area in the whole movementreagon

$$1\text{-}\mathrm{LNRF} < 0.67 \rightarrow Weight = 0$$
$$2\text{-}\mathrm{LNRF} < 1.33 \rightarrow Weight = 1$$
$$3\text{-}\mathrm{LNRF} > 1.33 \rightarrow Weight = 2$$

Stable-1-
2-Unstable medium
3-Unstable

Later in second year, weight each homogeneous units estimated by weight and maps and tables prepared and studied factors determined in each index LNRF homogeneous units.
Finally, the total weight of map data were prepared, maps, area classification based on risk areas.

Results:

The procedures mentioned study results and analysis of data format maps and tables are given in:

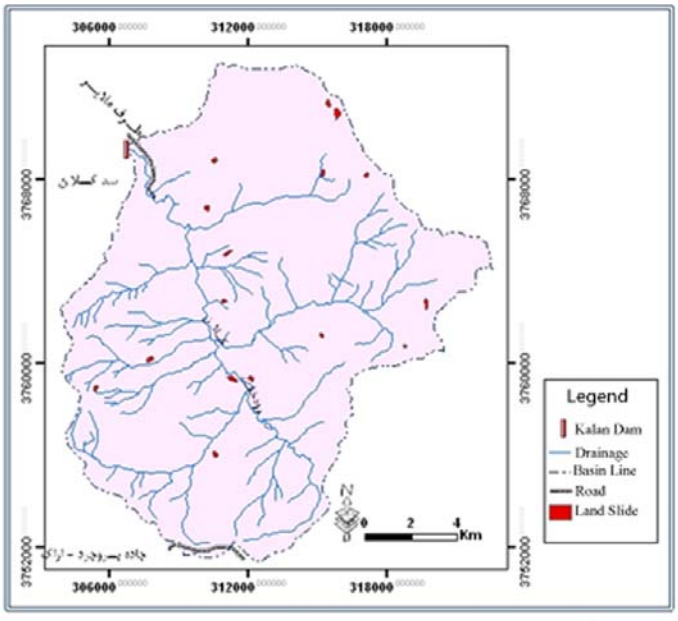

Fig. 2: Map Distribution mass movements in the dam basin Kalan Malayer

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Distribution of mass movements in the field of study With studies done about 17 mass movements, mainly of sliding type, in the field identify and map their distribution (Figure 2) in the field, respectively. Profile The landscape also is given in Table 1.

Table 1: Profile mass movements Malayer Kalane dam basin

Occurrence	mass movements rows Location Area	Area (ha)	Area (percent)	Occurrence	mass movements rows Location Area	Area (ha)	Area (percent)
1	hafttappeh	6.12	8.4	10	Emamzedeh abbas	8.66	11.9
2	kalleh	3.07	4.2	11	gootestan	1.44	2.0
3	Around kalleh	2.67	3.7	12	Around gootestan	0.77	1.1
4	Around kalleh	4.59	6.3	3	Emamzadeh khatoon	4.00	5.5
5	biatoon	4.19	5.7	14	Kooh gardal	10.01	13.7
6	dodangeh	4.73	6.3	5	koohagardal	4.21	5.8
7	Kooh sardeh	3.37	6.5	6	Koohgis	3.30	4.5
8	ǵoppanoori	5.44	7.5	17	Darreh morad	2.33	3.2
9	Darreh rast	4.00	5. 5	18	total	72.96	100

Characteristics of the study area Petrology:

As in Figure 3 are all geological map showed areas of diversity Petrography region. Petrography and percentage of units and their area and percent area of mass movements occurred in them are given in Table 2. As can be observed, and Fylyt Aslyt unit with 9 / 32 percent and granite with 6 / 4 percent, respectively the highest and lowest incidence of mass movements are in them.

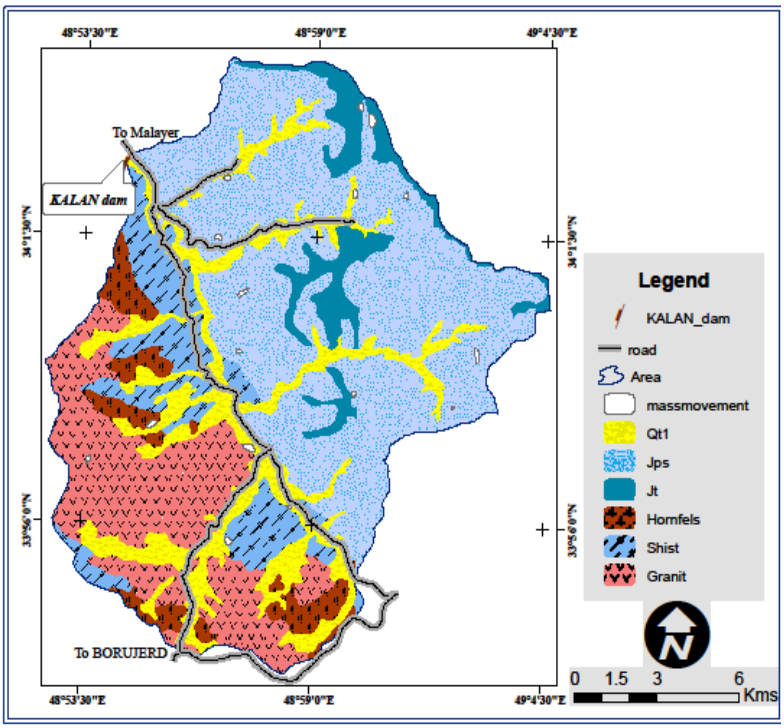

Fig. 3: lithology map of Kalan malayer dam basin

Table 2: Area units Lithology and mass movements in the

	The area units Petrology		mass movement area	
	ha	Percent	ha	Percent
Granite	4697.1	18. 0	3. 38	4. 6
Hornfels	1275.8	5.3	5.44	7.5
Mottled schist	2319.4	9.5	4.74	6.5
Aslyt, Fylyt	10751.9	44.3	23.99	32.9
Sandstone	1525.4	6.3	14.23	19.5
Alluvial sediments	4020.1	16.6	21.18	29.0
Total	24290.0	100	72.96	100

Profile faults the study area:

As the methodology described area faults map (Figure 4) with a distance of 1000 meters buffering and distribution map was overlapping mass movements. Results (Table 3) shows that a significant percentage of the mass movements of less than 1000 meters distance occurred and more than 3000 meters away any mass movement is not all.

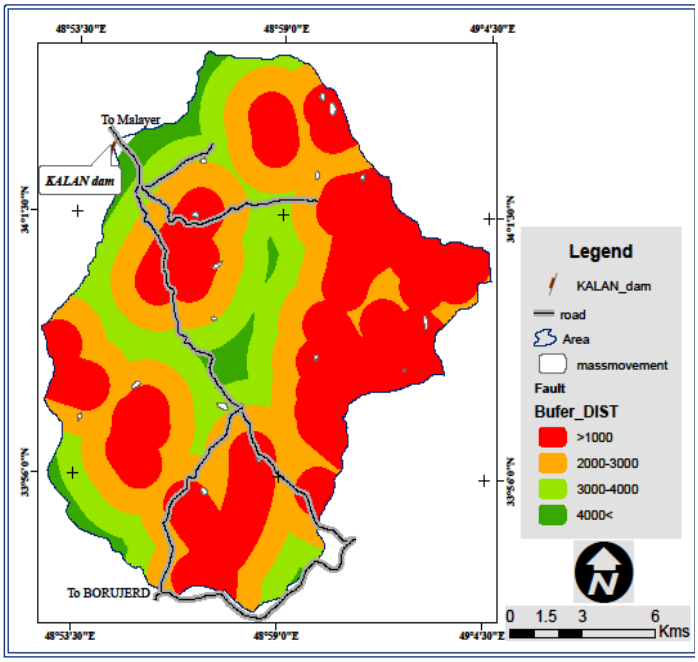

Fig. 4: Fault distance map Kalan Malayer dam basin

Table 3: Classes' area and distance from fault and landslide occurred in the unit

unit	Distance from the fault	area per unit		area of mass movements	
	ha	Percent		ha	Percent
1	>1000	10475.2	43.04	41.73	57.2
2	1000- 2000	7790.5	32	20.21	27.7
3	2000-3000	4775.9	19.6	11.01	15.1
4	3000>	1248.4	5	0	0
Total	24290.0	100	72.96	100	

Slope of the study area:

Based on the results obtained from the slope map (Figure 5) in the field of large-scale dam area 50 percent of the field concordance. Less than 15 percent and the rest of concordance have between 15 to 70 percent. As the results overlap map slope and mass movements (Table 4) shows, most mass movements in the field range from 20 to 30 percent slope has happened.

Profile height field study:

Based on the results, the maximum height of 2678 meters altitude areas of North-East to the output field

with at least 1890 meters above sea level is variable, so the 9th floor area studied height (Figure 6) and then divided into map obtained Map a mass movement that was overlapping the results are in table 5. As consideration class is the highest altitude 2100-2000 are having mass

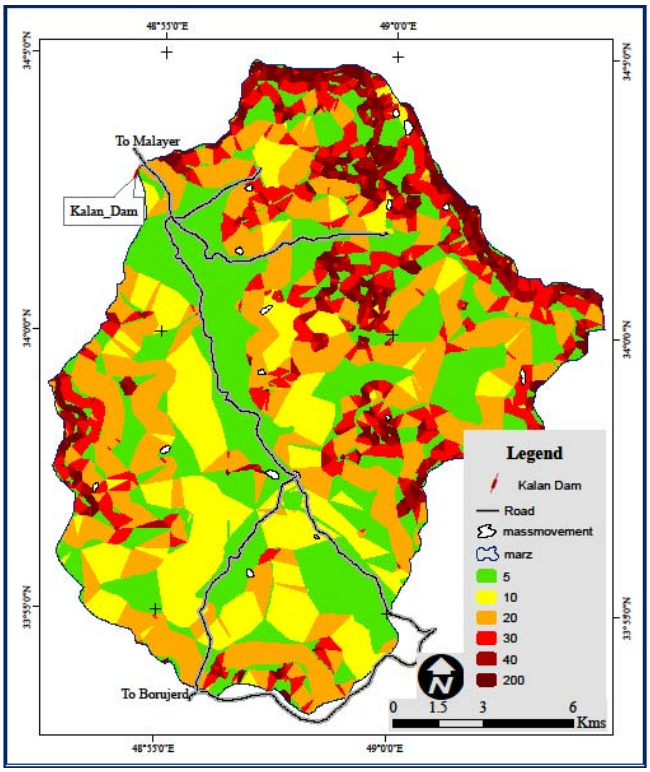

Fig. 5: Slope map Kalan Malayer dam basin

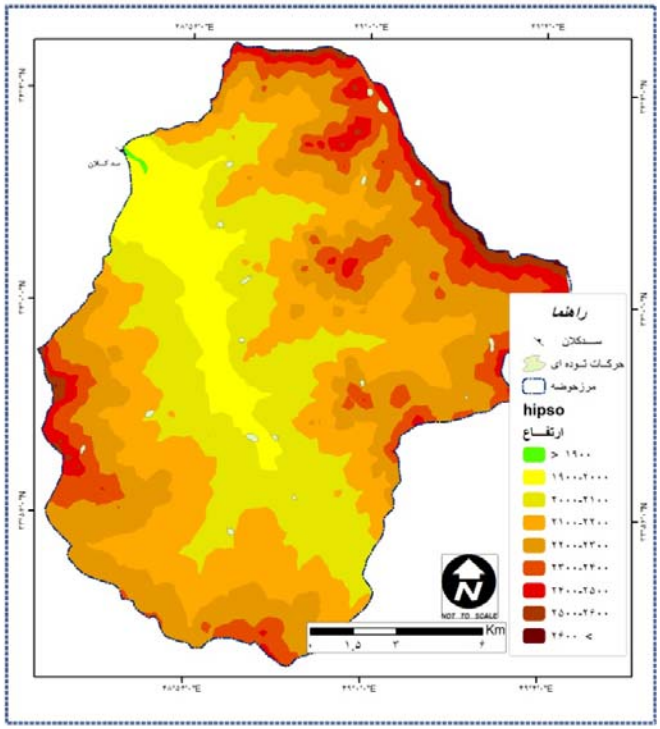

Fig. 6: Hypsometric map Kalan Malayer dam basin

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Table 4: Area classes slope and mass movements occurred in each class

Percent	area of each floor	area of slope mass	movements	Floor slope	
	ha	Percent		ha	Percent
A	40<	547.5	2.3	0	0
B	30-40	940.0	3.9	0	0
C	20-30	3652.5	15	25.3	34.7
D	10-20	7297.5	30.0	18.7	25.6
E	5-10	7372.5	30.4	15.96	21.9
F	0-5	4480.0	18.4	13.03	17.8
Total	24290	100	72.96	100	

Table 5: surface area, altitude and mass movements has been happened per unit

Class height	area per Class		area of mass movements	
	ha	percent	ha	percent
1890-1900	17. 5	0.07	0	0
1900-2000	1845.0	7.6	8.66	11.9
2000-2100	5200.0	21.42	24.70	33. 9
2100-2200	6477.5	26.6	9.44	12. 9
2200-2300	5720.0	23.5	3.11	¾
2300-2400	3305.0	13.61	22.82	31.3
2400-2500	1260.0	5.2	4.21	5.8
2500-2600	397.5	1.7	0	0
2600-2678	67.5	0.3	0	0
Total	24290	100	72.96	100

Precipitation characteristics of the study area:

In the field study the average annual rainfall 1/320mm and maximum rainfall in the spring with 36 percent total annual rainfall. Descending atmospheric field late in the Persian calendar month Aban (November) late as the snow falling in the Persian month Esfand (March) will. Relationship to mass movements with the rainfall map Isohyt (Figure 7) that the method was mentioned map overlap region were mass movements. The results (Table 7) showrd that 23/61 percent of the mass movements in the rate of rainfall occurred from 390 to 348 mm.

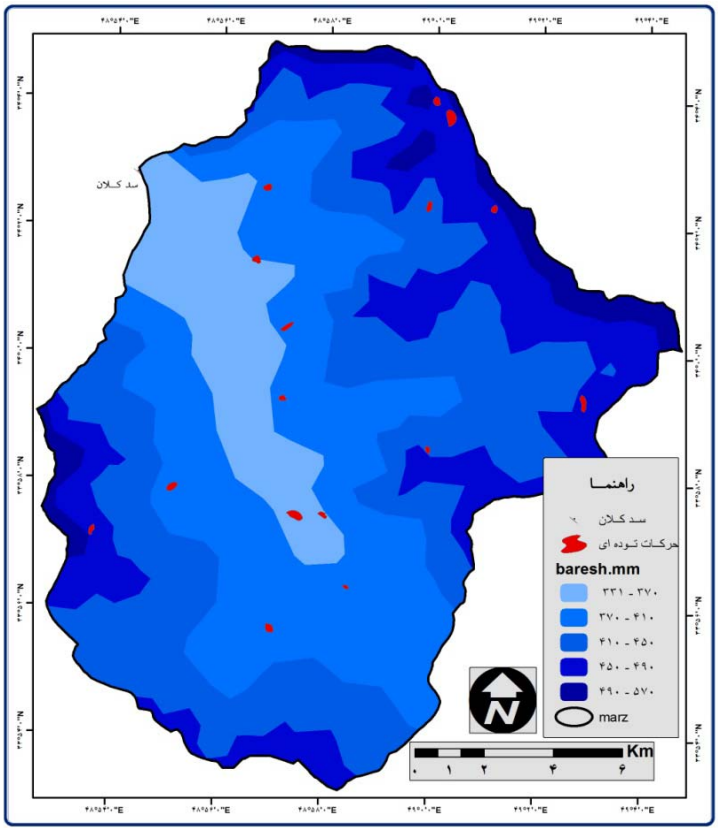

Fig. 7: Isohyt map Kalan Malayer dam basin

Table 6: rate rainfall and mass movements has been happened in each level

Row	Rainfall (mm)	Area per unit		area of mass movements	
		ha	percent	ha	percent
1	267-300	261. 7	1.1	0	0
2	300- 324	5519. 0	22.7	12.79	17. 53
3	324- 348	6959.0	28.6	15.50	21. 24
4	348-369	6048.3	24. 9	33. 04	45. 28
5	369-390	4093.0	16. 9	11. 64	15.95
6	390-423	1408.9	5.8	0	0
Total	24290	100	72. 96	100	

The results of implementing the model LNRF:

The results of implementing the model for the study variables (Petrology, distance from the fault, slope, altitude and rainfall classes) in tables 8 to 12 are given:

Table 7: Results of model performance units LNRF Lythology

	Petrology unit	area mass movements	LNRF	weight
1	Granite	3.38	0.28	0
2	Hornfles	5.44	0. 44	0
3	Stone	4.74	0. 39	0
4	Aslyt	23. 99	1. 97	2
5	sandstone	14.23	1.17	1
6	alluvial sediments	21.18	1. 74	2
Total	72.96			

Table 8: Results of model performance within the fault LNRF Game

distance from the fault	area of mass movements	LNRF	weight	
1	> 1000	41.73	1.72	2
2	1000-2000	20.21	0. 83	1
3	2000-3000	11. 01	0. 45	0
4	3000<	0	0	0
Total	72.96			

Finally, weight maps overlap with each other zone classification map area (Figure 9) based on mass movements was achieved stability that the 5class area: very high instability, high instability, instability moderate, low and stable stability and areas divided prone to mass movements were determined, the area of each class are given in Table 9.

Table 9: Results of model performance in classes LNRF slope

Floor area of slope	percent slope	mass movements	LNRF	weight
A	40<	0	0	0
B	30-40	0	0	0
C	20-30	25. 3	2. 08	2
D	10-20	18.7	1.54	2
E	5-10	15. 96	1. 31	1
F	0-5	13. 03	1. 07	1
Total	72.96			

Table 10: Results of model performance in classes LNRF altitude

row	floor area altitude	mass movements	LNR	Fweight
1	1890-1900	0	0	0
2	1900-2000	8. 66	1.07	1
3	2000-2100	24.70	3. 05	2
4	2100-2200	9.4	1. 17	1
5	2200-2300	3. 11	0. 39	0
6	2300-2400	22. 82	2. 81	2
7	2400-2500	4.21	0. 52	0
8	2500-2600	0	0	0
9	2600-2678	0	0	0
Total	72. 96			

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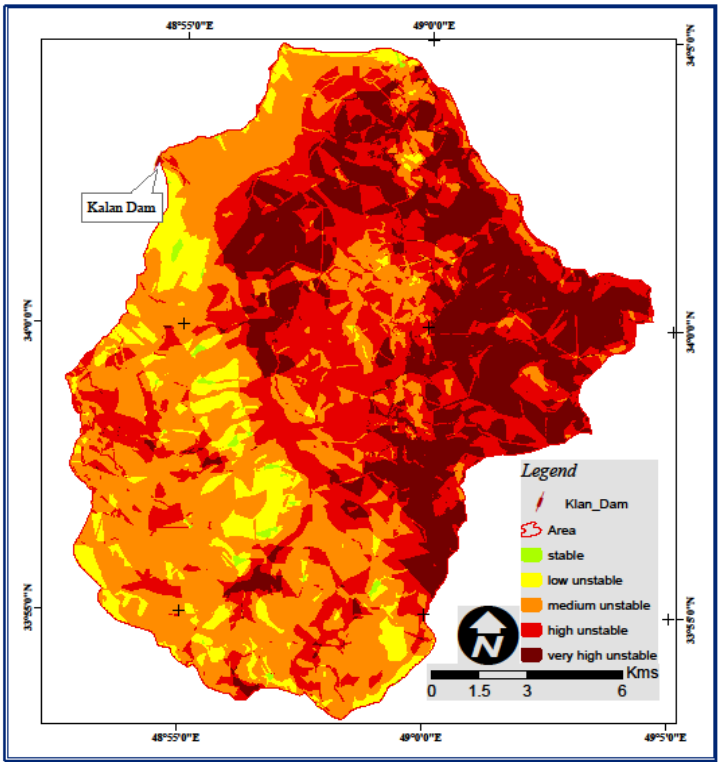

Fig. 8: zonation map with the stability slope movement in Kalan dam basin

Table 11: Results of model performance LNRF in surface isohyt

Row	rainfall (mm)	area of mass movements	LNRF	weight
1	267-300	0	0	0
2	300-324	12.79	1.05	1
3	324-348	15.50	1.27	1
4	348-369	33.04	2.72	2
5	369-390	11.64	0.96	1
6	390-423	0	0	0
Total	72. 96			

Table 12: Area of stability classes' slope processes area of stability status

row	stability situation	ha	percent
1	stable	647	2.7
2	low unstable	3656	15
3	moderate unstable	9397	38.7
4	high unstable	8983	34.9
5	very high unstable	106	8.7
Total	24290	100	

As is noted in the table above, the region at risk is a mass movement and instability status to take over.

Conclusion:

Figure 8 shows the risk of instability in the area are moderate to high, and the total area are having, eastern and south eastern most area of instability. Factors which have been evaluated in this area, the risk of occurrence of regional mass movements are more cases studied separately the tables and maps presented in this case is that, this part of the geological formation of the region with Aslyt units and Fylyt are occurring, sand and alluvial sediments were prone to high susceptibility due to erosion or mass movements. Also close this section of the fault zone (less than 1000 meters) is accelerating, the effect of severeshaking, the occurrence of mass movement. Major slope has been it about 10 to 30 percent for the conditions disrupt the balance status to provide slope material and cause higher shear stresses in the slope. High rate of rainfall (rainfall more than 325 mm) is a favorable factor to provide the necessary moisture for a mass movement in this part of the operation

area is. High-altitude has increased 2000 meters in the area and despite other favorable conditions, the range of instability. Instability in the area led to severe soil erosion and transport of materials by surface flow to the reservoir dam to dam useful survival reduced and significantly. Importance of this issue and identify landslide risk zone classification for special attention to the matter of prevention and land area the size of the potential power and makes them widely.

Finally, field studies and field observations and comparison with the results of the model LNRF and efficiency model used confirmedthat the results can be trusted to be an acceptable limitation withing the studied reagon.

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