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Landslide analysis to estimate probability occurrence of earthquakes by software ArcGIS in central of Iran

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Abstract

Thepresent study area is located in the high mountains of zagros, where is the highest point of Iran. The region is a small part of the Iran extent, but more than 14% of rainfall volume is allocated. Due to many faults and heavily rainfall in there, the landslide surveying is very important. In this study, geological maps of the area were digitized by ARC GIS software and FISHNET pattern, which the scale of them is 1/100000. Also, the alluvial outcrops were separated from the rocky outcrops. After that these outcrops were separated based on the stratigraphic column and were weighted according to the age. Also, the Digital Elevation Model (DEM) of the area was provided by the topographic map which its scale was 1/25000. After that zoning of slope was performed, too. The slope interval is between 20° to 40°. Based on the geometric terms, the occurrence of landside is high in there. The fault map of area was extracted digitally from the geological map. According to meteorological data, rainfall precipitation statistics of the study area, precipitation zonation map was prepared. As for the slope, material, precipitation, fault data and weight composition, the induced landslide (based on the occurrence of earthquake) was zoned via FISHNET pattern.

Keywords: Landslide, zoning, DEM

Introduction

Landslide as one of the natural disasters in mountainous, rainy andseismic areamakes many social and economic losses every year. After the earthquake, the oscillatory motion, and in particular landslide is as the most damaging natural disasters. In the last two decades, these damages increasingly have accelerated by human manipulation in natural oscillatory systems[1]. Identify factors affecting landslide and the zoning of the hazard, is the basic tool to investigate potential areas of risk and help planners for planning and necessary actions. To prevent damage, losses or reduce the extent of slope failure, the identifying of unstable areas and predicting the probability of their occurrence are essential. Fastest method to predict in the regional scale is the determination relatively potential of slip [2]. The zoning of land slip contains: surface divided into separate areas and ranking of these areas according to the actual degree or potential risks due to the occurrence of landslides on the slope[3].

The purpose of zoning is the division of land into homogeneous areas is classified according to the degree of actual or potential landslide hazard. In other words, earth's surface is divided into specific and virtual areas of the potential risk degrees based on effective factors of creative the landslide. The factors include the parameters related to geology, soils, vegetation, climate, hydrology, physiography, and human intervention. But the effects of these factors in different parts are different[4].

Location and geographical features of the study area: The longitude of the study area is from 51° to 51° 30' 31" E and its latitude is from 31° 30' to 32° N. There are different formations such as sedimentary, igneous and metamorphic rocks. Stratigraphical formations consist of sedimentary and alluvial formations from Precambrian to the Quaternary. The study area is located in the Zagros Thrust and Sanandaj – Sirjan zone. Zagros Main Thrust Fault, its strike is North West to south East, passes from North East part of the Borojen map. This fault separates Zagros from Sanandaj-Sirjan zone.

The effective factors on landslide and the maps related to the factors: The investigation and linking the different maps show that lithology, the distance from the fault and dip of layers are the main factors which effect on the occurrence of landslide. But the precipitation, the areas with same seismic acceleration, the height differences and dip direction are less important. The DEM and slope map was plotted by the digitized topographic map which its scale is 1/25000. Faults and the alluvial strata were extracted from the 1/100000 map of the region**.**

Lithology: In the study area, the lithology is various, and it has a significant effect on zoning. Since the old layers are as to the first and second geological era, due to the high density, they have little effect on the occurrence of landslides. In the study, young layer of quaternary period has been studied. Figure 1 shows the layers of the quaternary which are weighted by age.

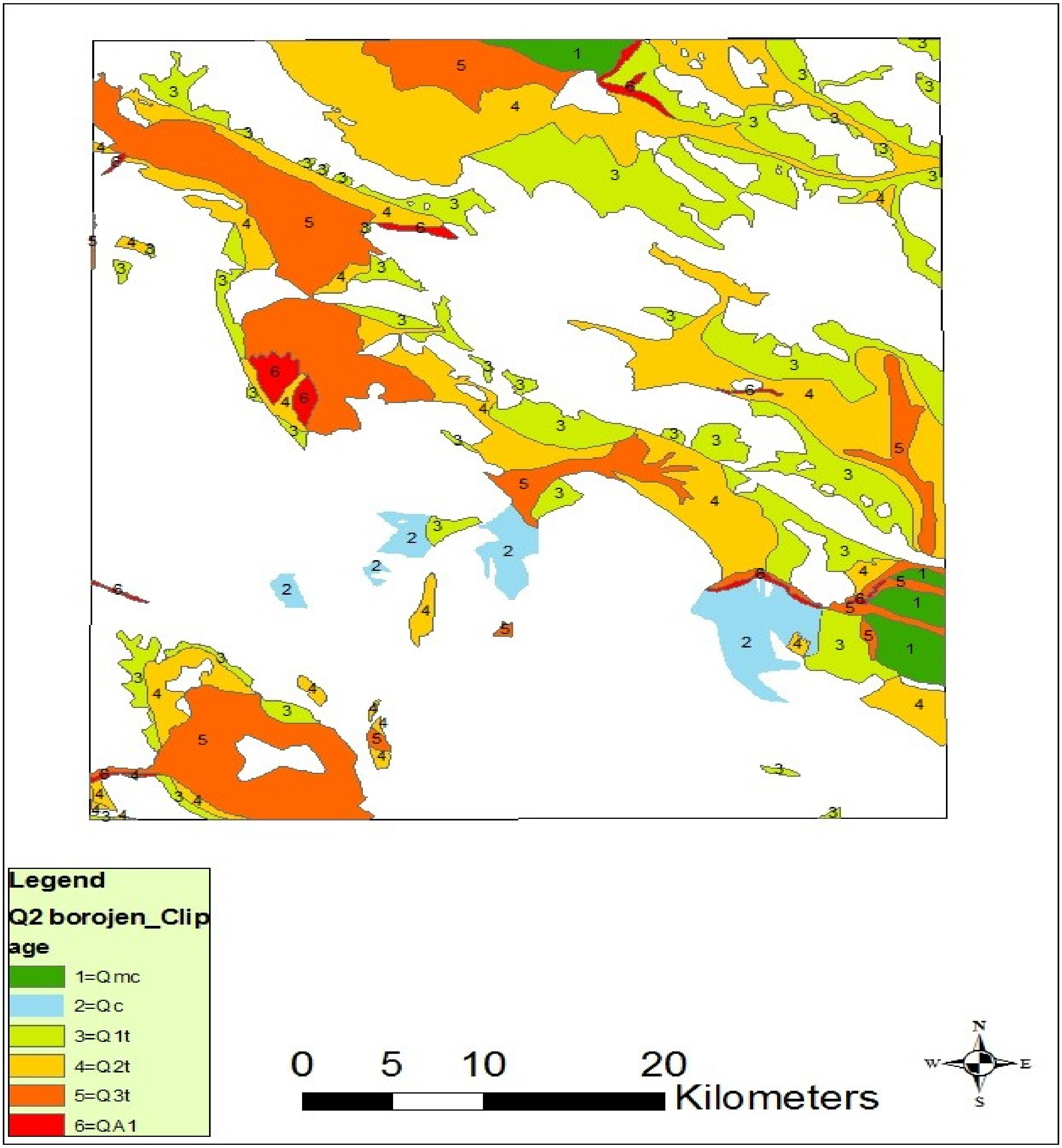

Figure-1
The despersion of digital layer of Quaternary in the study area

Distance from faults: The faults have various effects on the landslide. The crunching and shearing in the fault zone, the infiltration of water in there, discontinutiesoccures around of faults and the differences of erosion in the hillside are the effects of faults. The fault can be as start on the slopes Many landslides during an earthquake approved its role in the occurrence of landslides on the slopes and in fact, they cause to reach the thresholdin the hillsides. In figure 2, the digital fault of the area is visible.

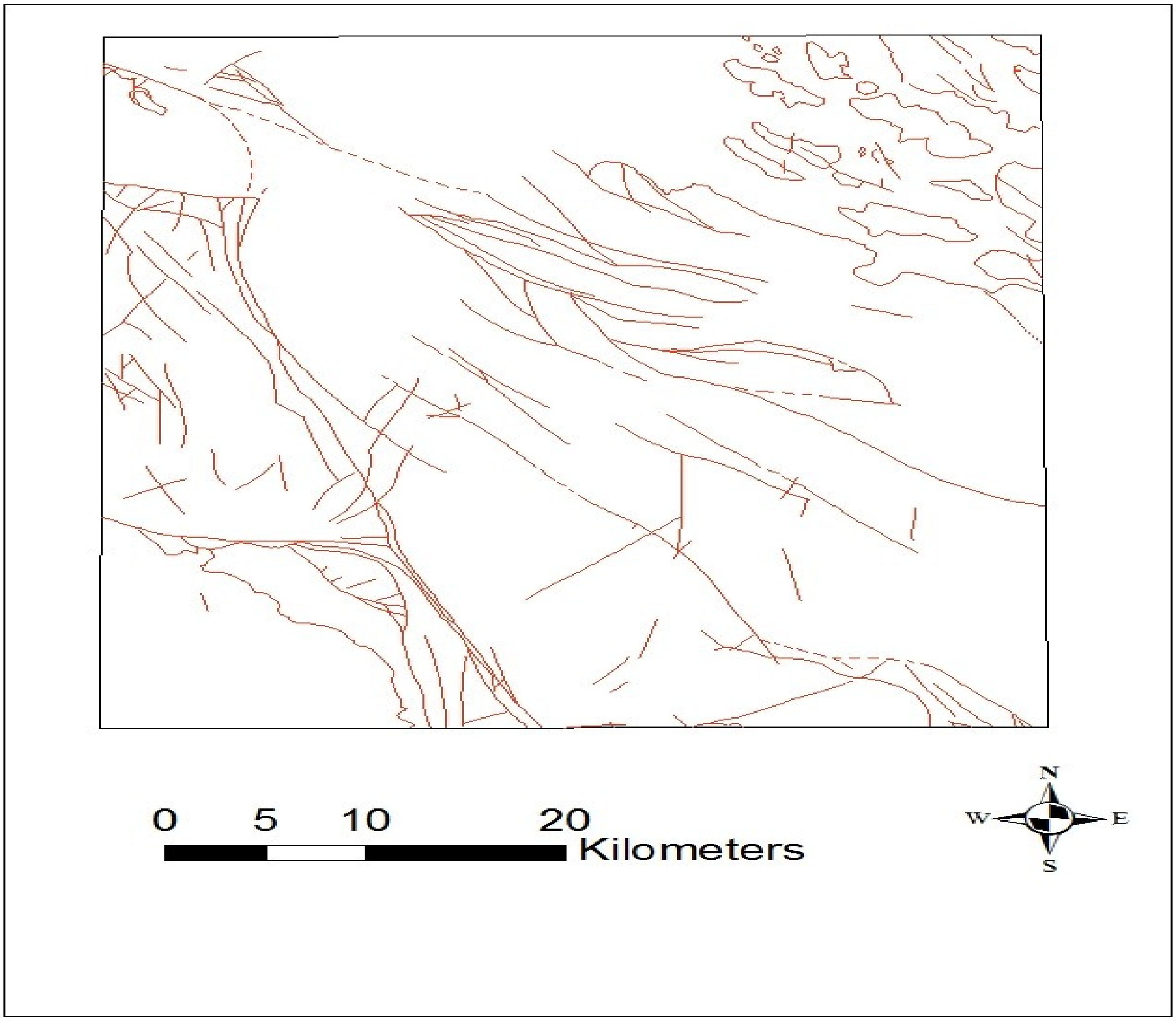

Figure-2
The digital faults of area

Topographic slope: Landslide risk in areas which has slope between 20 to 45 degrees, is higher than others. In this paper, Digital Elevation Model (DEM) was derived by using topographic maps with 1:25000 scale.

Precipitation: Precipitation leads to the rising the groundwater table, that the rising of water table, in turn increasing the hydrostatic pressure and pore water pressure in the materials of hillsides. They plays an important role in landslide. The study area has a weather station that an average annual rainfall is 32 mm.

Earthquake: An aggravating factors of landslides is earthquake. In the investigation, the earthquakes' magnitude is greater than 5 richterwere selected in Brojen.

Methodology

In this study, the alluvial layers were separated from the rock layers and were digitized at first by ARC GIS software and the map which its scale is 1/100000. After that the faults are digitized tooIn the next stepFISH mapping of the classifiedand was divided to 58 boxes which its length is 6 and its width is 5.5 km. All the factors mentioned in occurrence of landslides were jointed to the boxes. In the each FISHNET, the effect of alluvial layer was examined on there. according to the wieght of layers, the younger alluvium has a greater impact on the landslide in the final calculation. Also, the topographic slope, the distance from faults, earthquake and precipitation rate were surveyd in every box. The calculation was done by following equation (mora-varson method). The calculation was shown in the table 1. The linking landslide factor together illustrated No. 49 and No. 59 of SHIT had the greatest effect on the phenomenom.

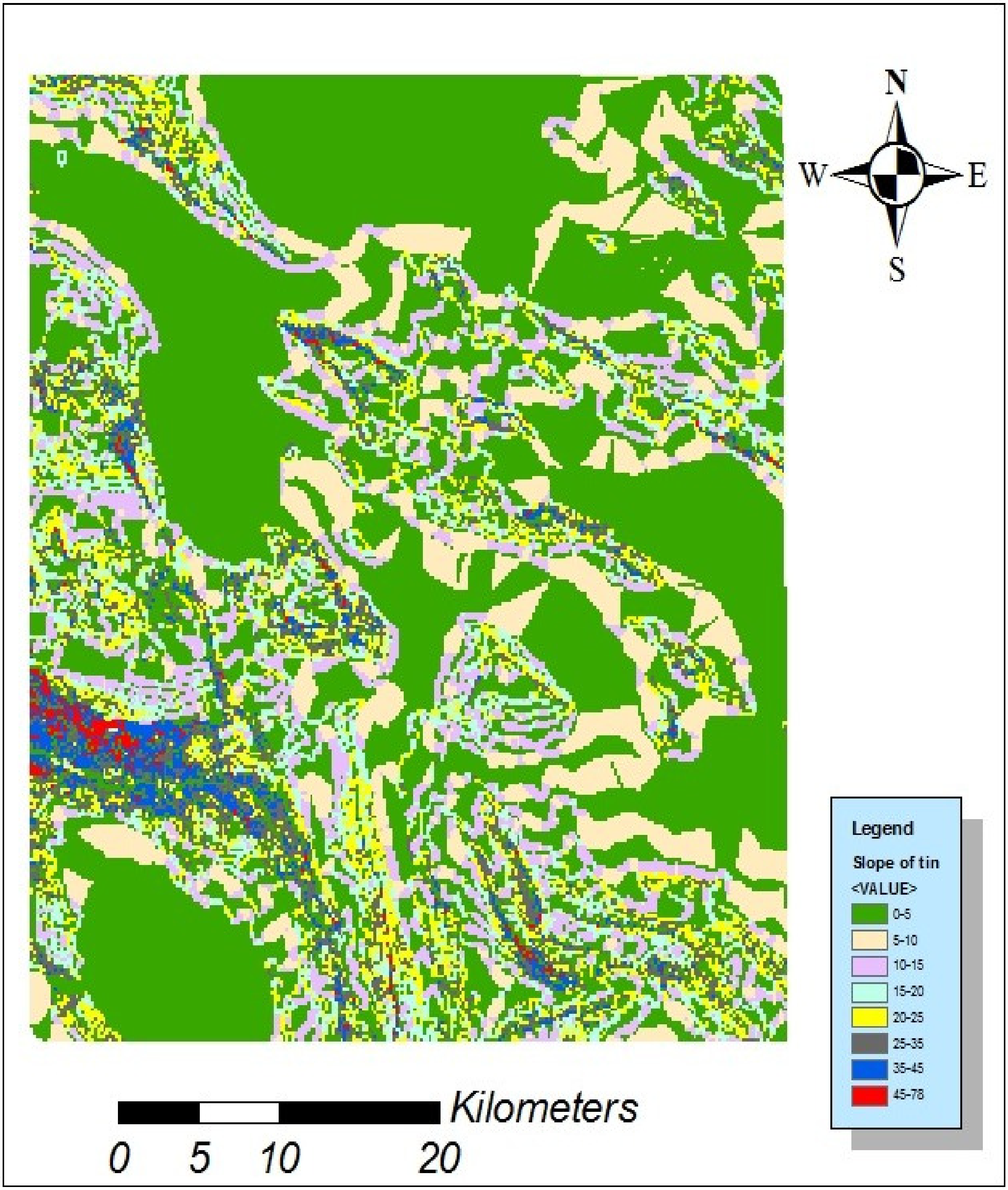

Figure-3
The topographic slope by the 1:25000 map

Table-1
Landslide index in every box

Point	Alluvium	Slope	Fault	Earthquack	Landslide index
0	.67	.33	0	.14	.78
2	.83	.45	.24	.33	.67
6	.5	.53	.14	.45	.45
8	.5	.78	.27	.44	.54
9	.83	.5	.67	.78	.35
10	.67	.5	.55	.67	.26
11	.33	.5	.78	.54	.98
12	.67	.66	.96	.34	.17
13	.5	.77	.33	.12	1.04
14	.33	.83	.24	.31	1.14
15	.87	.34	.46	.49	.33
16	.33	.97	.65	.65	.56
17	.44	.93	.76	.71	.62
18	.84	.55	.87	.26	.23
19	.93	.56	.34	.41	.51
20	.33	.34	.23	.95	.73
21	.43	.33	.54	.31	.67
22	.56	.56	.01	.49	.93
23	.32	.76	.42	.86	.61
24	.67	.89	.53	.46	.24
25	.5	.56	.54	.14	.59
28	.5	.45	.65	.37	.32
29	.83	.32	.76	.69	.67
30	.83	.78	.87	.08	.33
31	.66	.45	.67	.54	.56
32	.55	.5	.56	.34	.66
33	.95	.34	.34	.23	.79
34	.33	.54	.45	.67	.43
35	.78	.57	.53	.81	.62
36	.66	.83	.24	.28	.28
37	.56	.76	.56	.49	.89
38	.43	.96	.12	.78	.18
39	.44	.43	.18	.41	.22
40	.5	.32	.66	.55	.59
41	.5	.47	.77	.34	.68
42	.5	.33	.23	.22	.56
43	.5	.56	.66	.72	.67
44	.65	.44	.68	.69	.13
45	.77	.34	.66	.97	.61
46	.46	.89	.77	.23	.36
47	.35	.93	.33	.17	.72
48	.54	.35	.43	.33	.49
49	.84	.44	.95	.79	.44
50	.78	.5	.12	.65	.22
51	.5	.33	.23	.49	. 83

The zoning of landslide is shown in figure 4. According to the figure, the northwest and southwest of the study area have more potential landslides than other areas.

Conclusion

The main factors of landslide are lithology, topographic slope, precipitation and faults. Geological structure, topography, climate, soils, hydrology and etc, can provide the fertile field for geomorphologic phenomenomsepecially landslide. According to the weighted maps and natural features, the final map was plotted (figure 4).

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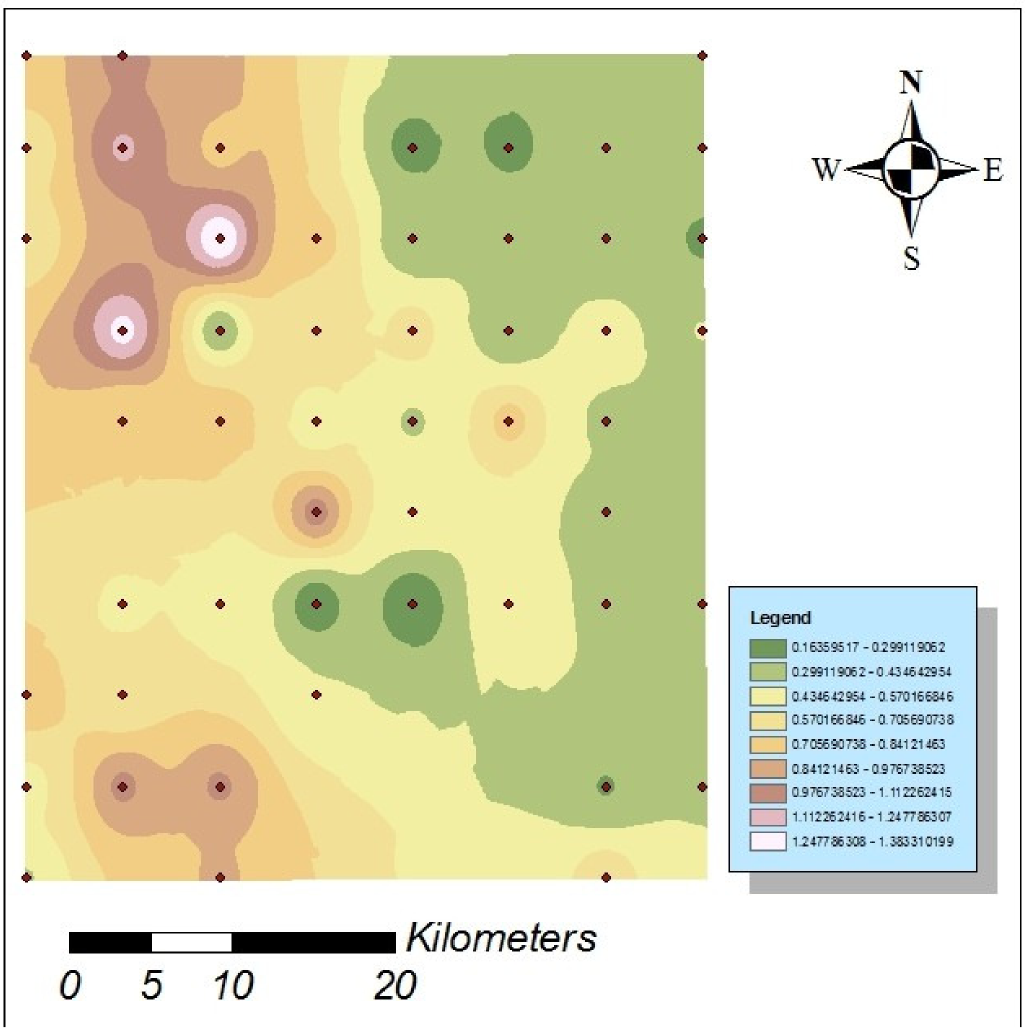

Figure-4
The zoning of the landslide potential