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Research Paper

Study Landslide Distribution With Using of Morphotectonic Indices in izeh-behbahan Catchment

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Abstract: Landslide Most often to depends on Morphotectonic indices.they are applicable tools to find out seimotectonic, probability estimation, and seismic planning of an area. Landslides events are the most common natural threats that have been recorded in the Iran. landslide hazard zonation planning is required for the sustainable management plan. Therefore, application of morphotectonic indices to estimate landslide risk in the selected area was the aim of this research. The selected area comprises seven sub catchments at the south west of Iran which historically has experienced several earthquakes ranging between 2.5 to 6.5 magnitudes in the Richter scale. Morphological indices such as river length–gradient index (SL), the catchment, drainage basin asymmetry (AF), transverse topographic symmetry (TP), factor hypsometric integral (HI) and index of drainage basin shape (BS) were applied for seismic planning of study area. As a result, different index was converted to the tectonic activity index (IAT) in the three categories. Besides, the resultant morph tectonic zoning map was compared with landslide risk event , and calculated showed that A good correlation between morphotectonic indices and landslide risk event map was demonstrated in this study.

Keywords: Morphotectonic, landslide , izeh-behbahan , correlation

Introduction

Earthquake is one of the most dangerous geo-induced events in Iran which leaves destructive features and large number victims. Iran's seismic zonation (IIEES 1995) includes 20 seismic provinces which mostly known neotectonic areas. Such areas identified by clear correlation between morphological features and tectonic activities. There is the long history in application of geomorphic indexes to evaluate tectonic activities around the world (Azor et al., 2002; Bull and McFadden, 1977; Keller and Pinter, 2002a, b; Silva et al., 2003; Molin et al., 2004). Neotectonic areas can be recognized by the Holocene and the Late Pleistocene tectonic features (Keller and Pinter, 2002 a, b). Besides, basin drainage pattern partially represents geometry, types and recent activity of local faults (Maroukian et al., 2008). Della-Seta et al. (2008) has stated role of morphotectonic features and landforms in interpretation of IAT. In addition, Bull and McFadden (1977) have used valley width to valley height ratio (VF) and index of mountain sinuosity (SMF) to evaluate IAT. Similarly, Silva et al., (2003) has interpreted tectonic activity of southern Spin based on the VF, SMF, and basin shape (BS) indices. Recently, Hamdouni et al (2008) has developed an applied model that includes hypsometric integral (Hi), stream length–gradient index (SL), and relative active tectonics (IAT) indexes as well as previous indices. Iranian researchers have widely used geomorphic indices to identify tectonic activity of different areas (Negaresh, 2003; Yamani. et al., 2011; Madadi.et al., 2003; Goorabi, 2007; Habibollah, 2007; Mokhtari, 2005; Khosravi, 2007; Khatib et al., 2008; Karami, 2009; Zarehmehrjadi, 2012).

Karimi et al., (2007), in Golestan province, proposed using two important factors on the landslide include geology and tectonics using GIS and Survey field.

Sari Sarraf et al., (2007), in this reserch declare that Ahar township is located on the north east of Tabriz. This township is placed within two mountain ranges of Arasbaran and Gharehdagh. Due to the intensity of geomorphic activities, the occurrence of slope mass movements, and river flooding are of the most important geomorphic features and hazards. Because of the existence of different faults in the southern parts of the city, there is the possibility of occurrence of hazards such as earthquakes. In this research, authors have used the township maps as the study area boundaries. The results would orientate the policy makers and planners toward appropriate urban and township management and planning.In the present article, the natural and geomorphic hazards have been drawn including the risks of slope movements, the effects of earthquakes, and finally, the floods after the identification of study area by applying topographic data, satellite pictures (ETM+), and the use of Geographic Information System (GIS) techniques.

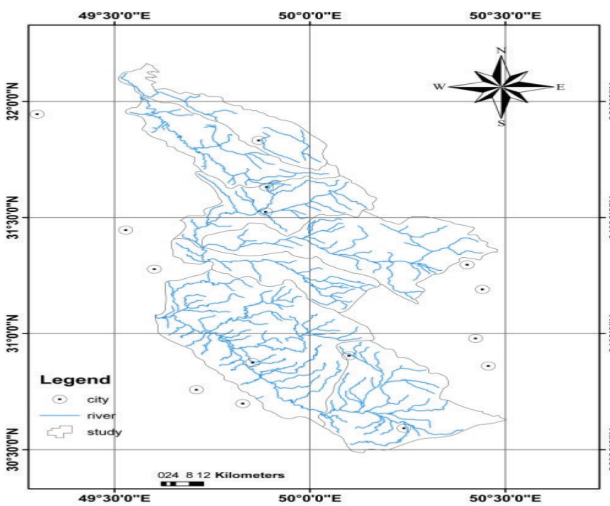
Sharifi et al.,(2013), in this reserch, investigated the relationship between active tectonic zone, and landslide and declare that Active tectonic region based on by active tectonic factors for example stream length-gradient(Sl),mountain front sinuosity(Smf), drainage basin shape(Bs), drainage basin asymmetry(Af), hypsometric integral(Hi) and ratio of valley-floor width to valley height(Vf) related to zones of landslide hazard zonation map a region .in research is noticeable comparison,determination trend and amount Vf and Smf indexes under title important active tectonic factors to zones of landslide hazard zonation.determination landforms of geometry or morphometry factors is the one of best method for study and evaluation.the first provided dem maps in GIS software by topography ,geology,tectonic maps assosiate with field geology.then provided active tectonic map by Vf and Smf indexes into three class (I)high active tectonic zone ,(II)middle active tectonic zone,(III)unactive tectonic zone and landslie hazard zonation map into five class (I) very low sensitivity class ,(II)low sensitivity class ,(III)middle sensitivity class ,(IV) high sensitivity class and (V) very high sensitivity class.comparison and conformity active tectonic hazard zonation map into Vf and Smf indexes showed about percent 68 and 53 sequential settled in the high sensitivity and very high sensitivity zone of landslide hazard zonation map . Then active tectonic hazard zonation map into Vf and Smf related to zones of landslide hazard zonation map . This relation in Vf index is more than Smf index.

Literature review has highlighted the gap which geomorphic indices need to verify by landslide risk event. The main aim of this research was testify landslide risk event in confirmation of geomorphic indices. Hence, application of an integrated method to evaluate IAT was priority and recommend of the present research.

Martial mad Methods

The study area is part of the crashed Zagros zone and the neotectonic area. The total catchment area of the Khuzestan catchment is 7886.7 km2 and is located between 49˚, 30' and 50˚, 31' longitude and between 30˚, 32́ and 32˚, 10' latitude. The study area is comprised seven sub-catchments of Izeh, Morgab, Bagh- Malak, Sydon, Dallon-mydawod, Jayzan, and Behbahan in the Khuzestan province (Fig, 1). This area is located at the south west of Iran which historically has experienced several earthquakes around two main faults which exposed at N-S and NW-SE trends.

Destructive earthquakes has happened due to mountain front fault zone (Seismic faults Izeh, Bagh-malak, Behbahan and Andica), points out high risk of seismicity in this study area. Masjed-Soleiman and Izeh are two cities which have experienced intense earthquake in 1979, where 76 people were killed.



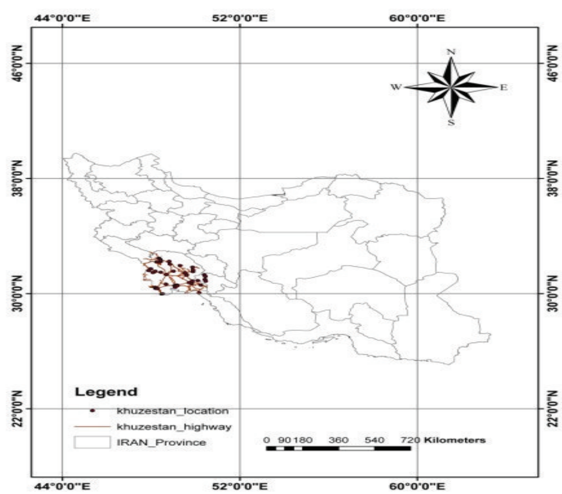


Figure 1: Geographical position of Izeh-Behban Catchment.

Geomorphic indices :

Stream length gradient index (SL)

A river system can be used as an indicator of basin topography and geology. In addition, the drainage pattern and from of a river reveals the structural evolution of a basin. Therefore, Hack (1973) proposed using the stream length gradient (SL) to evaluate the effects of tectonics on river form and drainage patterns. Variations in the SL index (Troiani and Della-Seta, 2008) depend on local uplift and the incipient local response of the index to regional tectonic events. This index was formulated by Hack (1973) as follows:

$$SL = (\frac{\Delta H}{\Delta L}) \times L \quad (1),$$

Where $\Delta H/\Delta L$ is the local slope of the evaluated channel segment and L is the channel length from the divide to the midpoint of the channel reach. The SL classification (El-Hamdooni et al., 2008) includes the following: Class (1), high tectonic activity with SL>500; Class (2), moderate tectonic activity with 300≤SL<500; and Class (3), minor tectonic activity with SL<300. This index was calculated by using equation (1) (with the ArcGIS 9.3 software) and data extracted from a topographic map (1:25,000 scales).

Asymmetric factor (AF)

The asymmetric factor (AF) can be used to evaluate the existence of tectonics at a drainage basin scale. This method can be applied over a relatively large area (Hare and Gardner, 1985; Keller and Pinter, 2002). The AF index is formulated as follows:

$$AF = 100 \times (\frac{Ar}{At}) \quad (2),$$

Where Ar is the area on the right side of the trunk stream and At is the total area of the drainage basin. The AF classification includes the following two classes: Class (1), little or no basin tilting with AF≤50; and Class (2), tilting or the effects of other tectonic events with AF≥50.

Hypsometric integral (Hi)

The Hi index was initially introduced by Strahler (1952) to indicate the elevation of a special area or landscape. The given area beneath the hypsometric curve represents the portion of a basin that has not eroded. The following equations used to calculate the Hi index (Pike and Wilson, 1971; Mayer, 1990):

$$Hi = (H_{Ave} - H_{\min}) / (H_{\max} - H_{\min}) \quad (3),$$

Where Have, Hmin and Hmax represent the average, minimum and maximum elevations, respectively. A digital elevation model (DEM) was used to calculate the required values. The Hi index classes include the following: Class (1) with Hi>0.5m; Class (2) with 0.4<Hi<0.5; and Class (3) with<0.4.

Transverse topographic symmetry factor (Tp)

The Tp index was introduced to evaluate the extent of tilting due to active tectonics (Alipoor et al., 2011). This index is represented as follows:

$$Tp = Da / Dd \quad (4),$$

Where Da shows the distance from the midline of a basin to the main river axes and Dd is the distance between the mid-line and the boundary of the drainage basin. The Tp value ranges between zero (minimum) and one (maximum).

Drainage basin shape index (Bs)

Active tectonic areas are recognized (Bull and McFadden, 1997) according to their Bs index. Higher Bs indices represent a stretched basin. Conversely, a circular basin presents few reactive tectonic effects or a more mature basin. Cannon (1976) and Ramirez-Herrera (1998) proposed using the Bs index for the horizontal projection of basin shape. The Bs index is expressed by the following equation:

$$Bs = Bl / Bw \quad (5),$$

Where Bl represents the basin length from the headwaters to the mouth and BW is the width at its widest point. The following classes are included in the Bs groups (El-Hamdouni et al., 2008): Class (1), elongate basin with Bs>4; Class (2), semi-elongate basin with 3≤Bs<4; and Class (3), circular basin with Bs<3.

Relative active tectonics index (IRAT):

In previous research, the most important and widely used geomorphic index is that of relative active tectonics (IRAT) (El-Hamdooni et al., 2008; Alipoor et al., 2011; Mahmood and Gloaguen, 2012). This index represents a summary and average of the given geomorphic indices that are used in a study as follows:

$$IRAT = S / N \quad (6),$$

Where S is the sum of the previous indices and N is the number of selected indices. The IRAT index was developed by El-Hamdooni et al. (2008) for different studies based on the topographic conditions of a basin. The following classes are used in the IRAT index: Class (1), very high with 1.0≤IRAT<1.5; Class (2), high with 1.5≤IRAT<2.0; Class (3), moderate with 2.0≤IRAT<2.5; and Class (4), low with IRAT<2.5.

Results:

The SL index was ranged between 290.53 and 590.12 which the highest value remarked at the North of catchment. This index was properly correlated with geological strength values in the study area. For instance, the SL index value was Izeh and Margab (Fig, 2), their SL index was classified in the class 3 (SL<300).

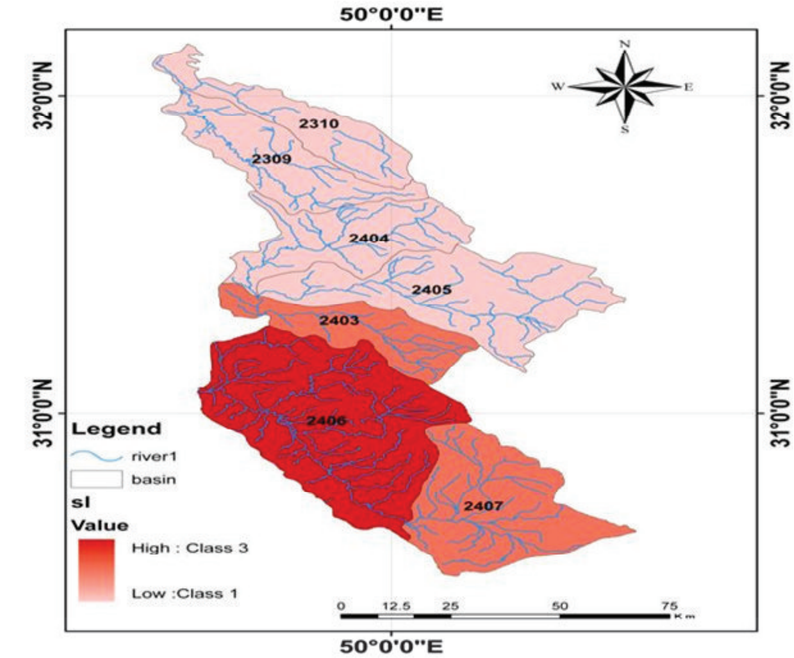


Figure 2: Stream length gradient index for study basin

The Bs index was ranging from 0.73 to 4.67 in the study area (Fig, 3). The class 1 (Bs>4) includes the Izeh and Bagh-malek sub-catchments showed the Bs index value of 4.53 and 4.67, respectively. These sub catchments remarkably point out the elongate shape and crossed by the longest fault. However, the Jayzan, Morgab and Behbahan sub catchment was classified in the class 3 (Bs<3).

The index of transverse topographic symmetry (Tp) was representing the maximum and minimum values of 0.66 and 0.15, respectively. According to Alipoor et al., (2011), the Tp indexes show that high distance between the stream centerline and the main axes of basin obtained at the Jayzan, Morgab and Izeh sub catchments which have the highest Tp values.

The asymmetric factor (AF) was ranged between 47.13 and 55.02 in the study area (Fig, 5). Maximum AF values found at the Izeh and Margab sub catchments where the frequency of Ar/At ratio were. These areas, therefore, have experienced more tectonic movements, On the other hand, the class 3 (AF<7).

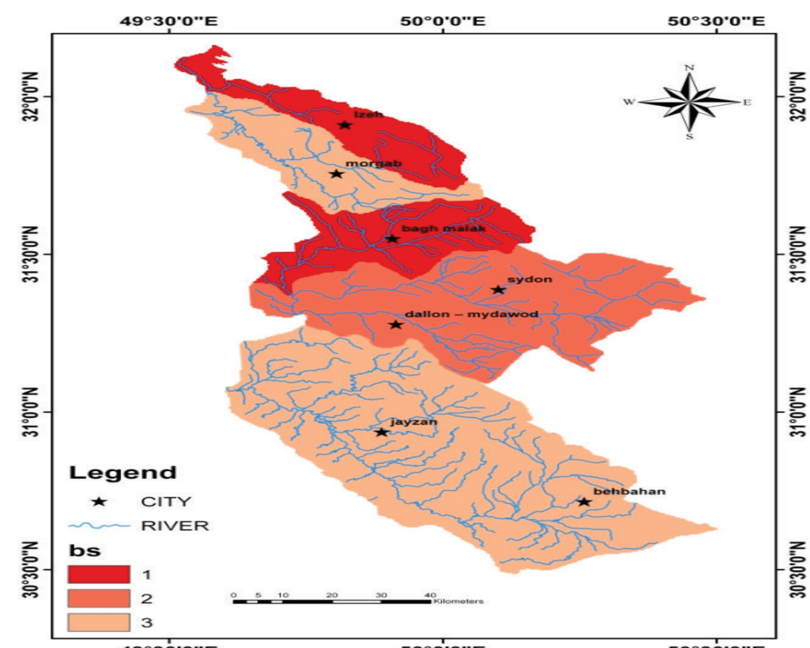


Figure 3: Variation of the Bs index in the study area

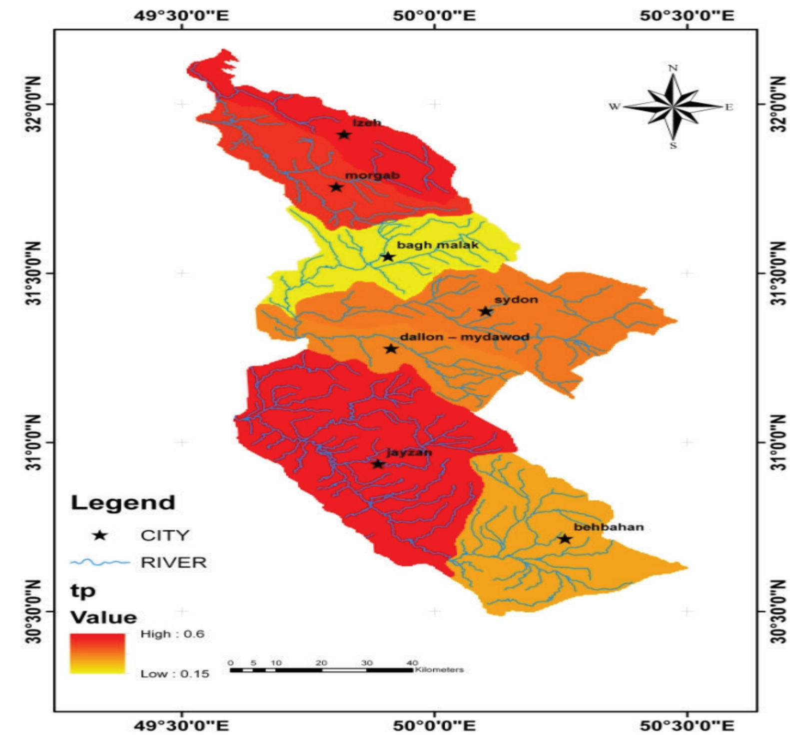


Figure 4: The Tp map of study catchment.

There is correlation between the hypsometric index (Hi) and tectonic activity in the uplifted area. This index was 0.57, 0.54, and 0.52 in the Izeh, Baghmalk, and Behbahan subcatchment, respectively. These values are in agreement with topographic catchment (Fig, 6).

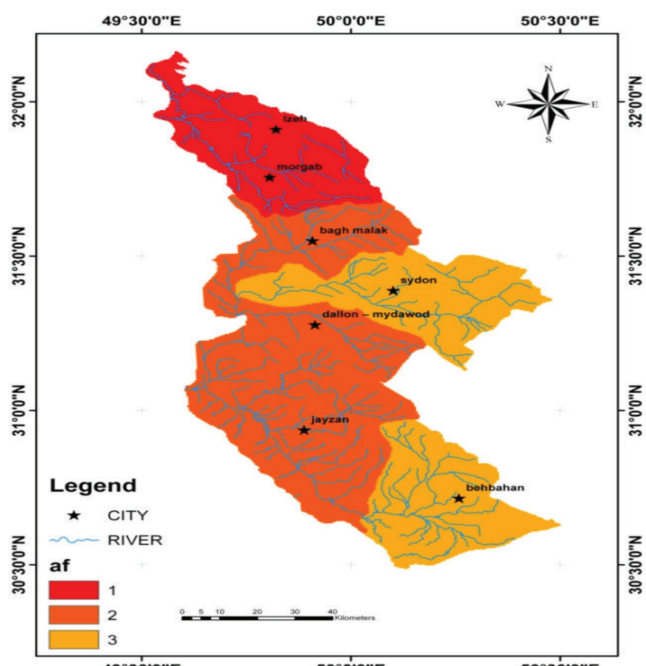


Figure 5: Showing distribution of the asymmetric factor map of study catchment.

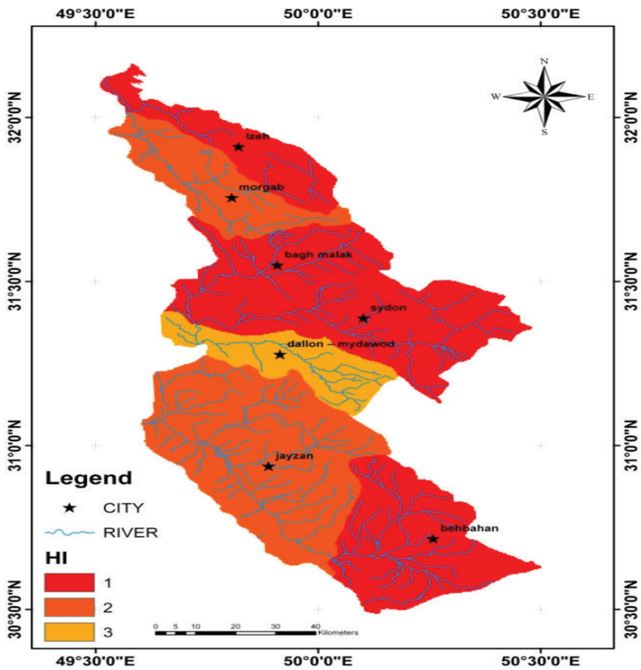


Figure 6: Showing Hypsometric integral index of the study area

The relative tectonic activity (IRAT) :

The IRAT groups (Fig, 7) at the Khuzestan catchment involves three classes. Results was not includes the class 1 (1<IRAT<1.5) or very high activity tectonics in the study area 597 km2 7.7 %. In contrast, class 2 (1.5<IRAT<2) spread at the 2828.15km2 area and occupied 36.57 % of the study area. Therefore, the Khuzestan basin was identified the tectonically active basin. Furthermore, class 3 (2<IRAT<2.5) which points to the moderate tectonic risk at the 4322 km2 55.7 % of the catchment area. Classification of IAT index at the 7 sub catchments of the study area presented in the Table 1.

Table 1: Classification of IRAT in the Khuzestan catchment

No	Sub Catchments	Geomorphic indices					IRAT	Classification
		HI	BS	TP	AF	SL		
1	Izeh	0.57	4.52	0.48	55.02	516.24	1.2	Very High
2	Morgab	0.48	2.93	0.41	54.27	590.12	1.8	High
3	Bagh-malak	0.52	4.67	0.15	52.12	559.58	1.8	High
4	Sydon	0.51	3.59	0.38	50.74	563.35	1.8	High
5	Dallon–mydawod	0.29	3.98	0.36	51.76	470.25	2.4	Moderate
6	Jayzan	0.47	0.73	0.66	52.45	290.53	2.4	Moderate
7	Behbahan	0.54	1.68	0.30	47.13	343.69	2.2	Moderate

Table 2. Amount over lap layers relative tectonic activity index with field observations land slid

classify	Area (km2)	Number of land slide	Percent of total
Very high	630	22	34.9
high	2900	34	53.9
moderate	4300	7	11.1

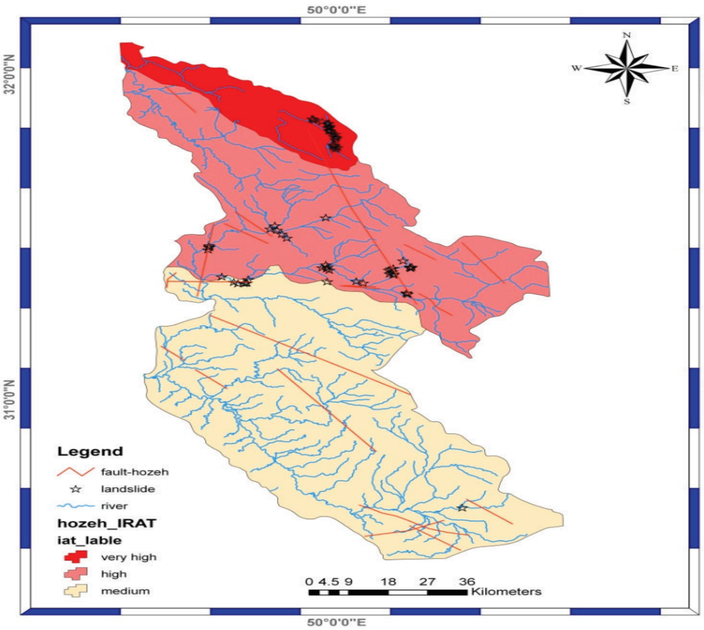


Figure 7: Distribution classes of relative tectonic activity index (IRAT) *with landslide Occurance*

Conclusion

The result showed that area majority landslide was classifying very high and high risk morpho tectonic idices ,and 11.2% area of the occurrence of land slide is Moderate.Also result showed that overlap field observations land slid 56 point (63 point land slides) adaptation to classifying very high and high risk is Good accurate.density fault show that mean about 0.045 km/km2 also range between 0.2 to 0.5 km/km2.lenght fault is 357.5 kilometer. Great relationship (0.451 pearson Correlation, sig 0.000 is significant at the 0.01 level (2-tailed). is between Euclidean distance faults and landslide occurred. The results showed that the most landslides is located in areas with high tectonic activity and indicate that there is adapt 88.8%. It can be concluded that in areas have morphotectonic indices very high and high expected that there is more landslide activity. According to Eskandari (2008), probabilistic assessment procedure(PGA) is performed for seismic hazard in Khuzestan province, Iran. The study area is located between seismic sources which were detected and modeled as volume sources. Seismic parameters, a, b values and max were estimated for each source. Results showed that some cities such as Andimeshk, Dezful, Masjed-Soleiman and Baghmalk are located in an area with high risk levels. . In addition, both models(IAT,PGA) are showed similar distribution of very high risk class in the study area. This research confidently recommends application of morphotectonic indices for evaluation of Landslide to approach to sustainable watershed management plan.

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