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Active Tectonics of the Saymareh-Karkheh River Basin (Northwest of Persian Gulf, Iran)

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Abstract

Active tectonics is an indicator of recent movement of mountains and landscapes evolution for regions affected by current tectonic activity. The Saymareh-Karkheh river basin is located on the Zagros Mountain in the west Iran. The Zagros Mountain is an orogenic belt that is formed by the collision between the Eurasian and Arabian plates during Cenozoic. Active tectonics has analyzed by measurement of six geomorphic indices (hypsometric integral, basin asymmetry factor, basin shape, the stream length-gradient, mountain-front sinuosity and valley floor width-height ratio) which they combined to index of active tectonics (Iat). Based on values of this index, the Saymareh-Karkheh river basin was divided into high (Class 2, 18.8%), moderate (Class 3, 70.3%), and low (Class 4, 10.9%) relative tectonic activity parts. The above results confirm the usefulness of geomorphic analyses for regional assessment of active tectonics they are compatible with differential tectonic activity in the High Zagros and Zagros fold and thrust belt. Also, it was revealed that geomorphic indices and using of GIS technics are very useful to investigation of active tectonics in the mountain areas.

Keywords

Saymareh, Geomorphic, Indices, Zagros, Iran

1. Introduction

The Saymareh River (with near to 400 km length) has been originated from the Zagros Mountains by combination of Gamasayab, Gharasu and Kashkan rivers and finally flows into the Hour-Al-Azim wetland on the Iran and Iraq border zone. The final segment of this river (with near to 200 km length) is called Karkheh River and totally, it is the third long river (about 755 km) in Iran. The structures of the Zagros Mountains on the northeast margin of the Arabian plate reflect quaternary tectonics of this region. We have used a quantitative method

to assessment of quaternary tectonics in the Saymareh-Karkheh river basin. In this paper, for the first time six geomorphic indices: hypsometric integral (Hi), the stream length-gradient (SL), asymmetry factor (Af), mountain-front sinuosity (Smf), valley floor width-valley height ratio (Vf) and basin shape (Bs) have analysed for comparison of different landforms [1]. Then, mean of above index or Iat has calculated for determination of relative active tectonics levels. Previously, this approach has been done in the USA by [2], Spain by [3].

2. Geologic Setting

The Saymareh-Karkheh river basin is located on the Zagros Mountain that is an orogenic belt in the southwest Iran. This mountain has formed due to convergent regime between the Arabian and Eurasian plates during Cenozoic. The Saymareh-Karkheh river basin (51,341 km^2) is located on the Zagros [4]. The Zagros is underlain by Phanerozoic sedimentary sequences which it has been formed hundreds anticlines and synclines (**Figure 1**).

The anticlines and synclines have got NW-SE dominant striking in the study area. The folding intensity has decreased toward the southwest. The earthquakes in the study area have got high frequency and small to moderate magnitude, thus seismic analysis of active tectonics is difficult.

The main fault zones of the Saymareh-Karkheh river basin are Kabirkoh, Khoramabad, Kerend and Sahneh faults. The rock resistances have categorized based on rock types as: low (alluvial deposits, marl and conglomerate), moderate (gypsum, dolomitic limestone and gypsums marl), and high (limestone and sandstone) based on [3]. **Figure 2** and **Figure 3** show lithology and their

Figure 1. Location of the study area (Google Earth 2016).

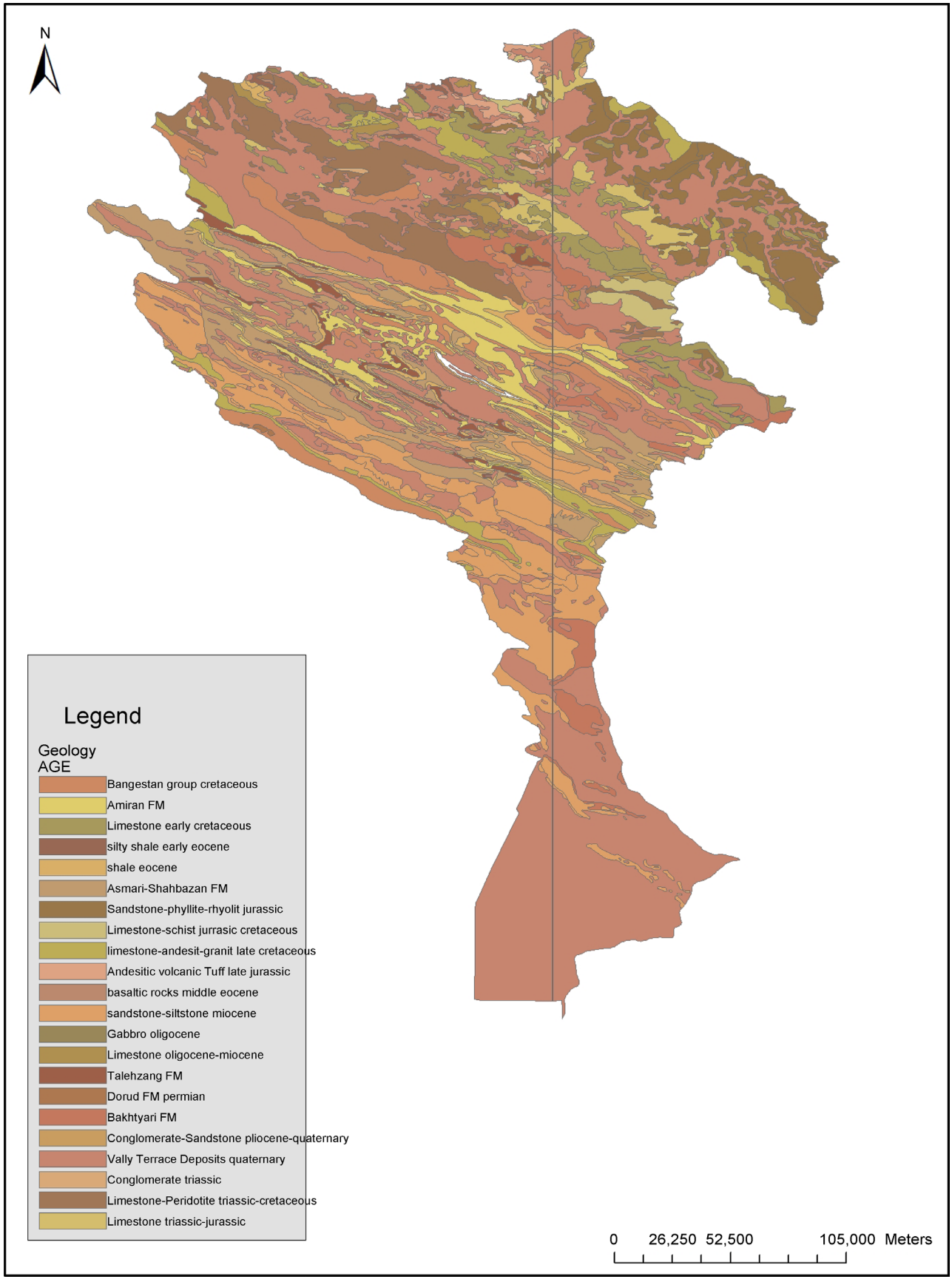


Figure 2. Geological map of the study area.

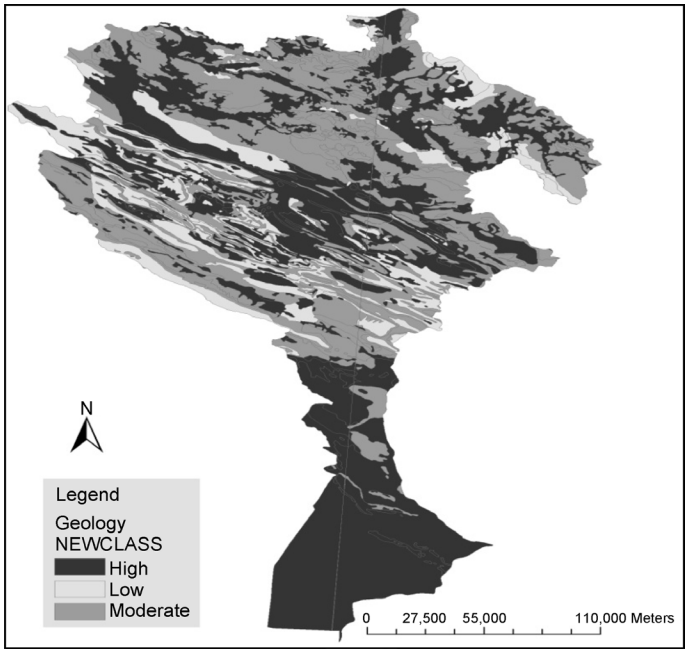


Figure 3. Distribution of rock strength levels.

resistant levels.

3. Geomorphic Analysis

Geomorphic indices are useful for quaternary tectonic investigation. We have measured six geomorphic indices mountain-front sinuosity (J), the stream-length gradient (SL), asymmetry factor (Af), hypsometric integral (Hi), basin shape (Bs), and valley floor width-valley height ratio (Vf). These indices have obtained for the Saymareh-Karkheh river basins, that flowing to the south-westward. This basin has divided into 35 sub-basins (**Figure 4**).

3.1. Stream-Length Gradient

Firstly, the stream-length gradient index has defined by [5] and it was used for many researchers such as [6].

To measure the values of this index, the drainage network and topographic maps are necessary. The contours distances are selected 20 meters.

The stream-length gradient index has calculated along all of sub-basins using a DEM based on topographic maps (for example sub-basin no.27 in **Figure 5**). Based on [3], the results are shown in **Table 1** and **Figure 6**.

3.2. Asymmetric Factor

Firstly, the asymmetric factor (Af) has defined by [7]. The asymmetric factor varies from 19.8 (sub-basin no. 23) to 86.8 (sub-basin no. 4) in the study area and results are shown in **Table 1** and **Figure 6**.

3.3. Hypsometric Integral

Firstly, the hypsometric integral (Hi) has defined by [8]. This index that shows

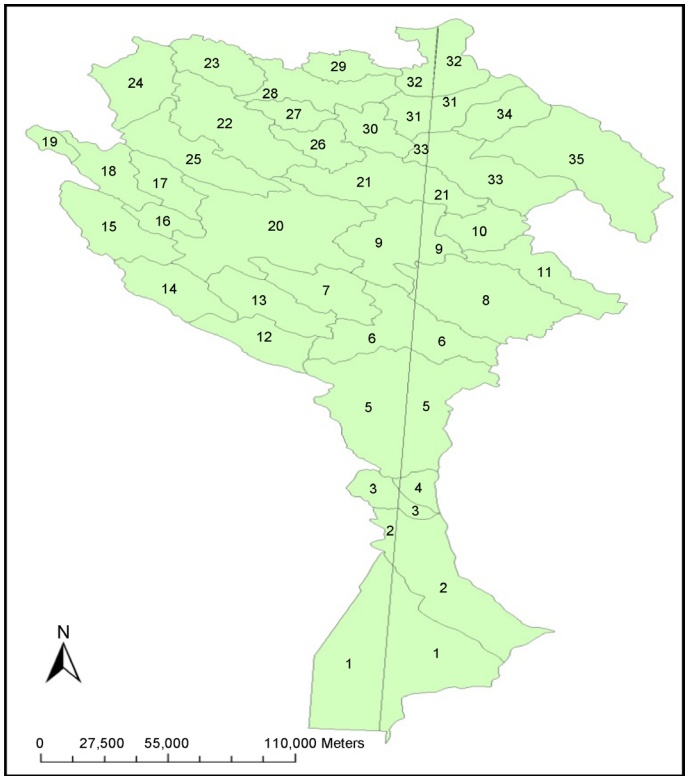


Figure 4. Thirty five sub-basins of the Saymareh-Karkheh river basin.

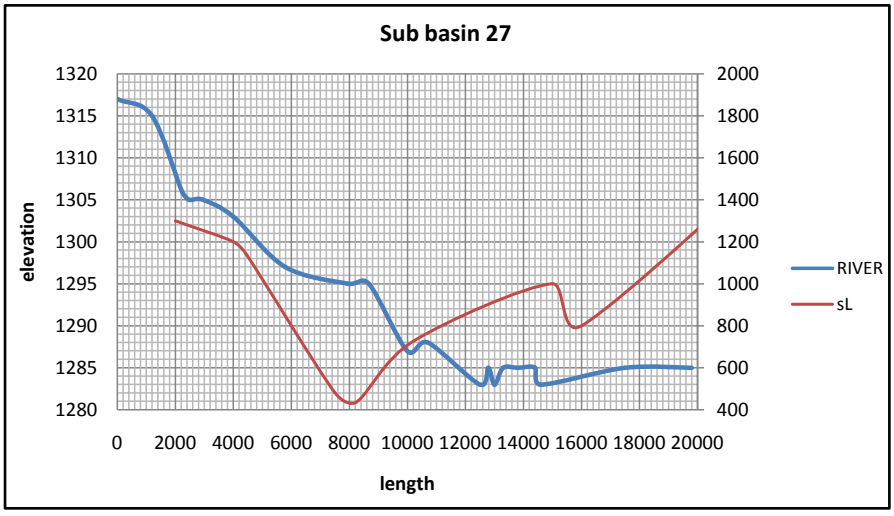


Figure 5. Longitudinal river profiles and measured SL values for three basins in the study area.

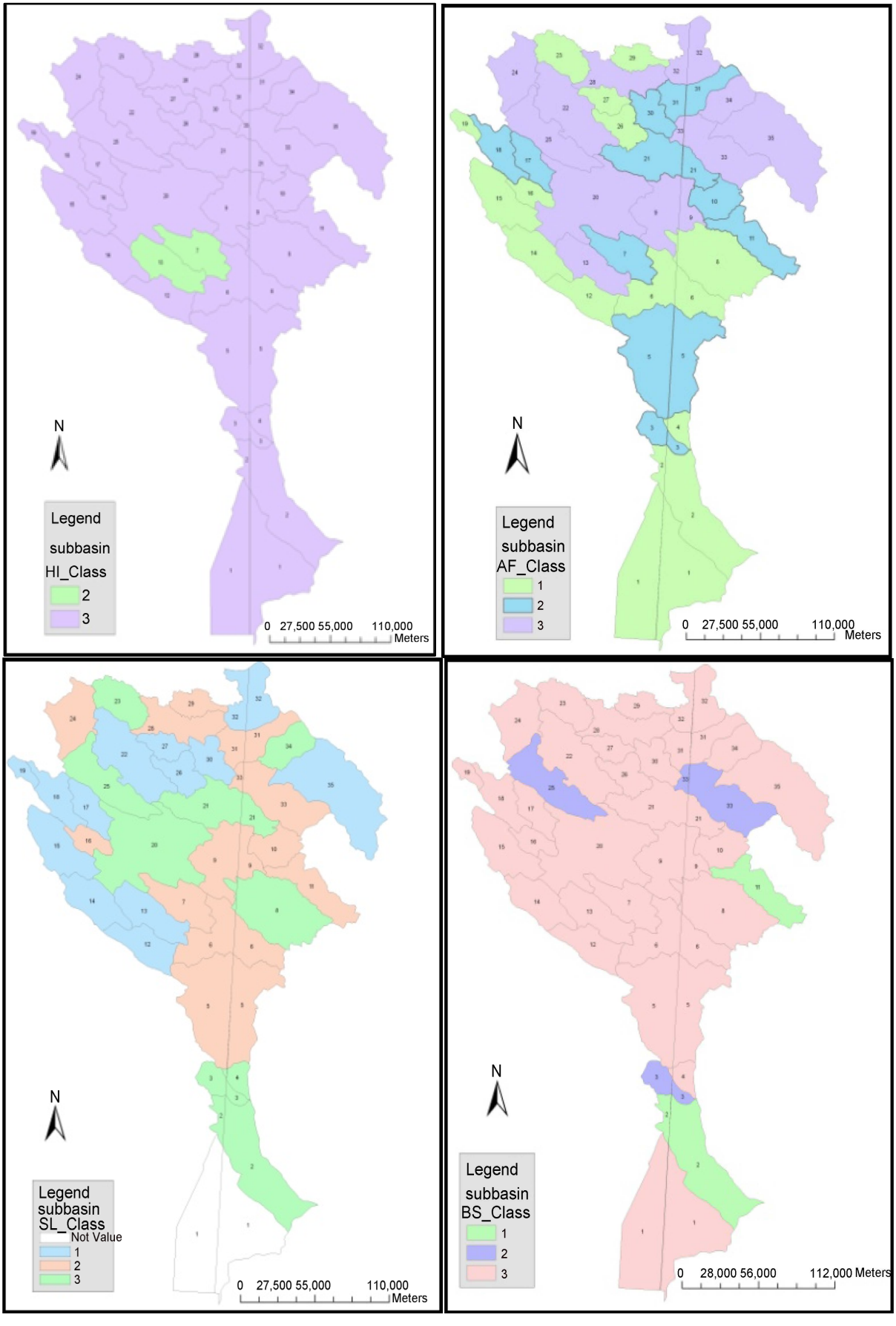
topographic maturity have calculated for all sub-basins. It ranges from 0.06 (sub-basin no. 1) to 0.47 (sub-basin no. 7). Then, the results have presented in Figure 7 and Table 1.

3.4. Valley Floor Width to Valley Height Ratio

Firstly, Valley floor width to valley height ratio (Vf) has defined by [9]. For measurement of this index, a distance varying from 2 km were set and the values

Table 1. Values of geomorphic indices.

Sub-basin	SL	Af	Bs	Smf	Vf	Hi	IAT
1	-	74.3	1.75	-	-	0.06	3
2	57.94	68.3	4.46	-	-	0.25	2
3	26.77	38.2	3.13	1.10	8.57	0.33	3
4	85.21	86.8	1.69	1.08	-	0.27	3
5	444.98	41.2	2.60	1.03 1.13	3.47 1.06 2.96 2.5	0.26	3
6	304.80	31.3	2.91	1.04	0.47	0.32	2
7	341.12	42.9	2.41	1.02	-	0.47	2
8	272.48	65.7	1.94	1.05	1.96	0.31	3
9	424.87	47.4	1.61	1.07 1.08	0.56	0.35	3
10	450.58	39.0	1.30	-	-	0.29	3
11	418.91	61.2	4.01	1.08	0.55	0.26	2
12	878.38	69.6	2.55	1.04 1.13 1.21	-	0.25	2
13	983.94	54.2	1.83	1.08	-	0.46	2
14	525.95	66.2	2.90	1.08	-	0.31	2
15	756.58	68.3	2.52	1.08	0.33	0.36	2
16	383.94	30.3	1.95	-	-	0.30	3
17	1022.7	61.1	2.00	-	30.90	0.24	3
18	604.47	39.0	2.39	1.13	-	0.20	3
19	1721.16	33.5	2.25	-	-	0.25	2
20	288.08	56.4	1.34	1.14	0.40	0.35	3
21	178.07	63.5	2.75	-	-	0.35	4
22	1193.43	54.4	2.71	1.19	2.35	0.13	3
23	289.25	19.8	1.27	1.1	-	0.28	3
24	325.89	52.1	1.12	1.13	-	0.18	4
25	165.79	46.1	3.83	1.13	2.85 1.81	0.21	4
26	742.41	27.1	1.18	1.19	8.10	0.17	3
27	1798.3	81.6	2.29	-	-	0.33	2
28	301.20	47.0	2.29	1.1 1.0	1.12 1.11	0.36	4
29	380.89	66.9	1.99	-	-	0.21	3
30	747.46	62.0	2.05	1.0 1.19	1.06	0.22	3
31	304.56	61.9	2.20	1.23	3.63	0.17	3
32	834.34	52.5	1.14	1.22	1.25	0.26	3
33	428.81	47.7	3.28	1.04 1.17 1.35	3.40 0.38 0.86	0.21	3
34	287.72	56.4	1.97	1.04	6.85 1.37	0.22	4
35	870.76	54.4	2.61	1.17	4.65 3.40	0.27	3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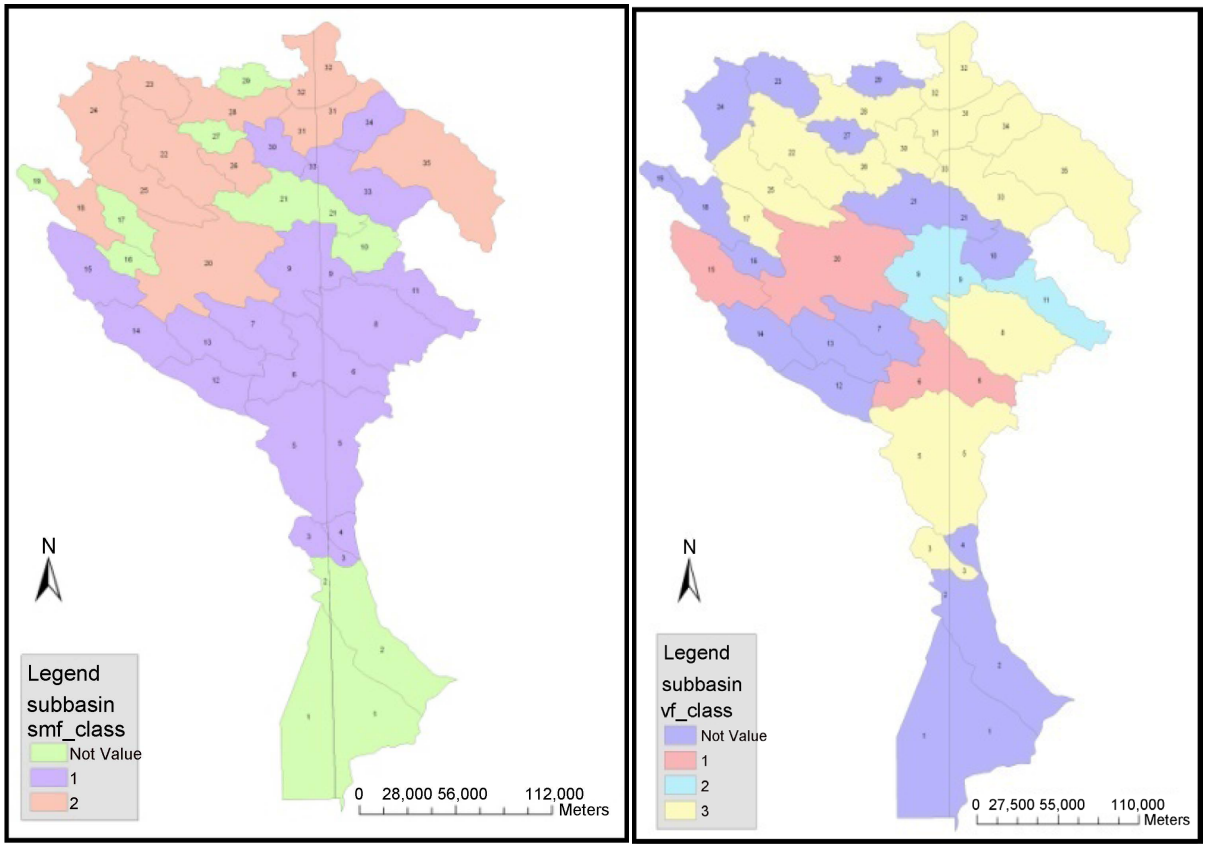

Figure 6. Distribution of six index and classification of them into three classes.

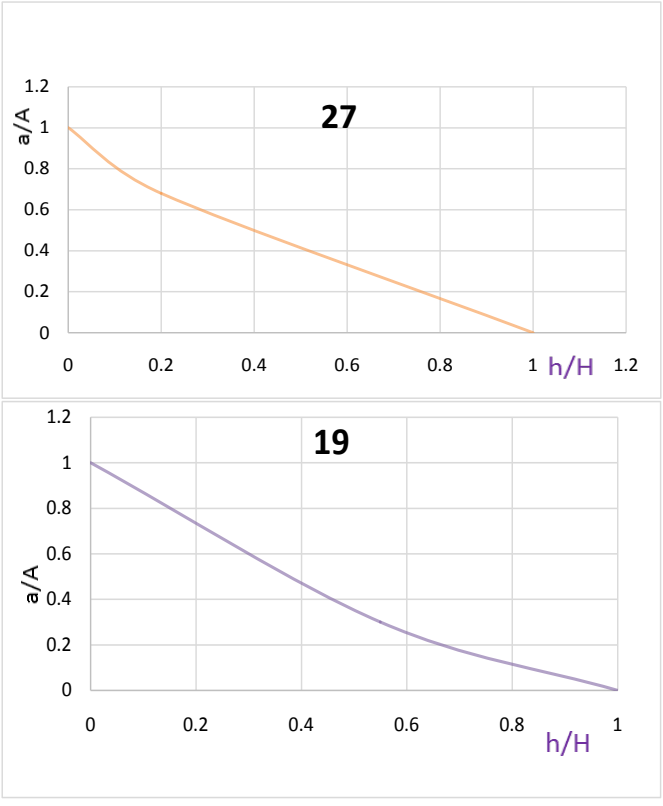

Figure 7. Hypsometry curves of two sub-basins (no. 19, 27).

have measured from topographic maps (Figure 6 and Figure 8). The results are shown in Table 1. The range of Vf is from 0.33 (sub-basin no. 15) to 30.9 (sub-basin no. 17).

3.5. Basin Shape

Firstly, the basin shape index (Bs) has defined by [10]. This index has calculated by using the topographic maps and the results are shown in Figure 6 and Table 1. The basin shape index ranges from 1.12 (sub-basin no. 24) to 4.46 (sub-basin no. 2).

3.6. Mountain Front Sinuosity

Firstly, the mountain front sinuosity index (J) has defined by [9]. We were measured the mountain front sinuosity index for 23 mountain fronts (Figure 6

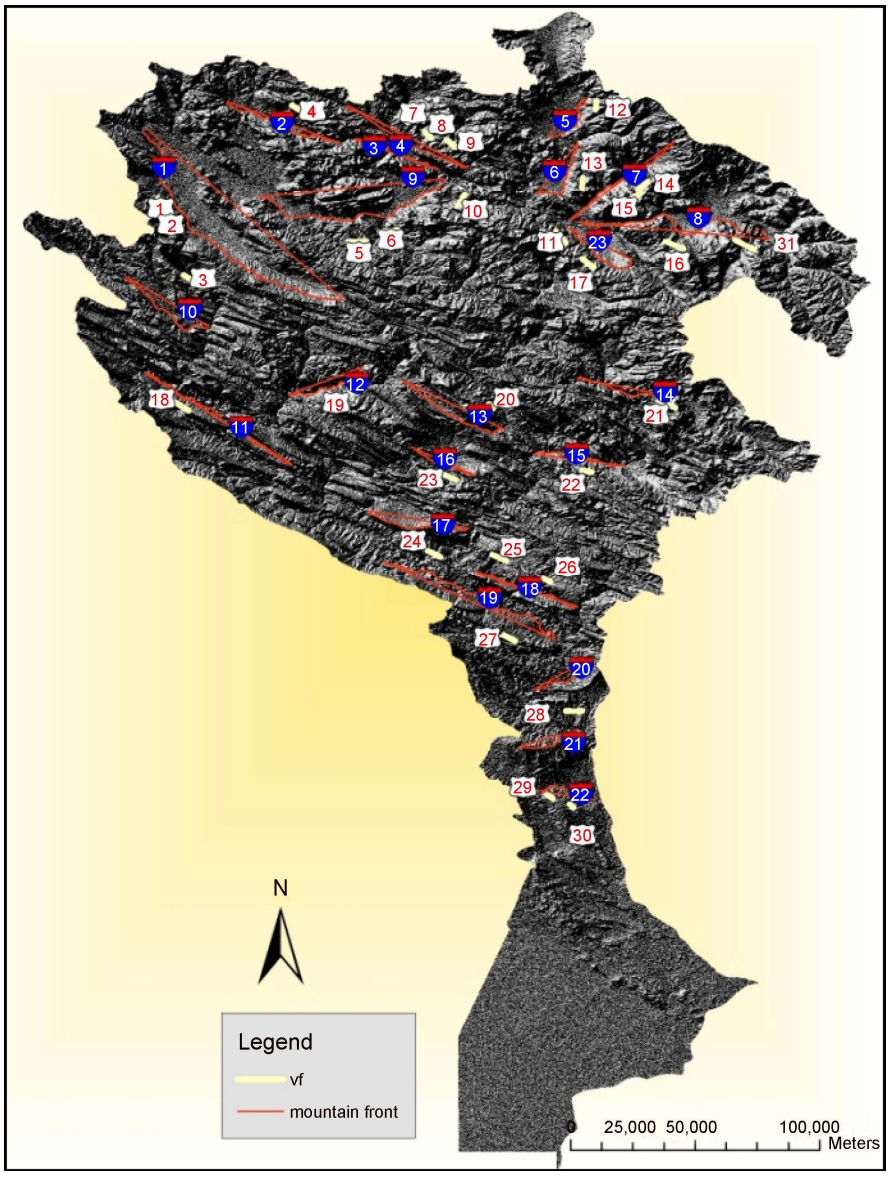

Figure 8. Location of sections for Smf and Vf calculations.

and Figure 8) by using SRTM images. Our results are shown in Table 1.

4. Results and Discussion

Based on previous work on the salt and mud diapirism [11]-[30] and neotectonic regime in Iran [31]-[36], Zagros in south Iran is the most active zone [37]-[76]. Then, Alborz [77]-[123] and Central Iran [124]-[152] have been situated in the next orders. Thus, the study area has been affected by an important regional shortening, but this research tried to evaluate levels of relative tectonic activities in a wider region by using of six geomorphic indices. The averages of these indices have used to investigation in the Saymareh-Karkheh river basin. The values have divided into very high, high, moderate and low levels and their distribution are shown in Table 1 (IAT column) and Figure 9.

Figure 9 shows the result of the classification for each basin; 23.7% (12,180 km^2) to Class 2; 62.9% (32,318 km^2) to Class 3; and 13.3% (6843 km^2) to Class 4.

The Sahneh fault zone is the most important part, based on Iat and connects the Morvarid fault in the NW to the Nahavand fault in the SE. Tectonically, the mechanism of the Sahneh fault is high angle reverse with dextral strike slip component, and is compatible with the earthquakes focal mechanism solution, movement of the Arabian plate.

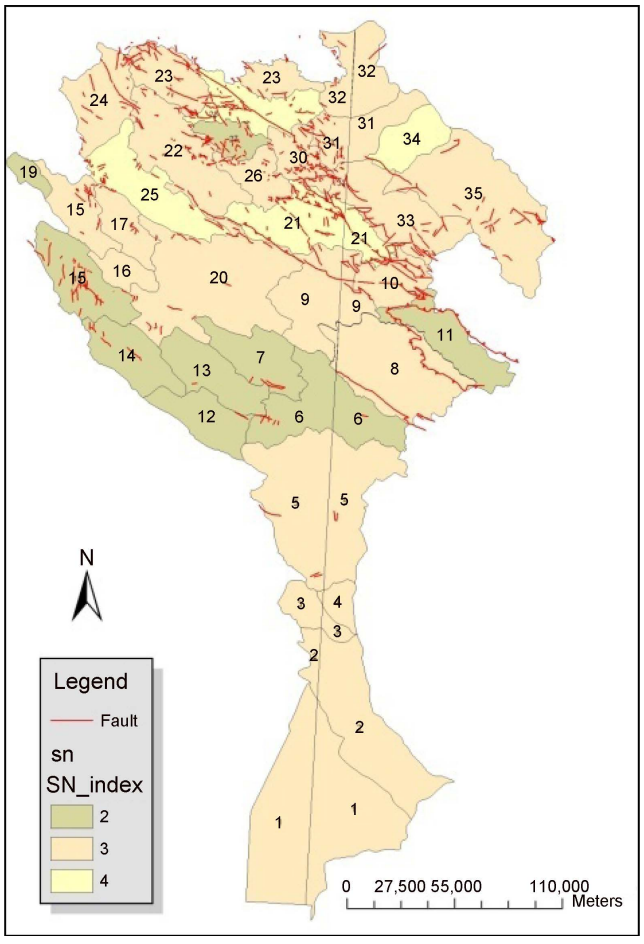

Figure 9. Distribution of Iat classes.

5. Conclusions

The Saymareh-Karkheh river basin in the southwest Iran was selected for investigation of above quantitative method. Six geomorphic indices have measured in the Saymareh-Karkheh river basin. Finally, index of active tectonics was measured by combination of the below geomorphic indices; valley floor width-valley height ratio, mountain-front sinuosity, stream-length gradient, hypsometric integral, drainage basin asymmetry factor and basin shape.

The high values of Iat were found along longitudinal fault of Zagros Mountain such as Sahneh fault zone. The most parts have got moderate levels of active tectonics, because they have shown class 3. Also, the low values of Iat have located on plains and un-faulted areas.

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