# GIS-based Analysis of Relative Tectonic Activity in Southeast of Iran with a focus on Taftan volcano

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*Taftan volcano has been located in southeastern of Iran and zone of Nehbandan-Khash (Iran Eastern Mountains). It seems that both the young volcano and active tectonic have played an important role in morphometry in this area. Geomorphic indices have been used to study tectonics in this area. These Indices include Drainage Basin Asymmetry (AF), Transverse Topography Symmetry (T), Mountain Front Sinuosity (Smf), River Slope Length (SL), Floor Width to Valley Height (VF), Hypsometric Integral (Hi), and Drainage Basin Shape (BS). These Indices have been used to evaluate Relative Active Tectonic (IAT) of basins and sub-basins of the area. Recently, it is found that Neo - Tectonic has played an important role in geomorphic evolution. On the basis of this model, three tectonic zones are recognizable in that area: (Zone with High Relative Tectonic) that found in sub-basins of 4-B and 9-C. (Zone with moderate Relative Tectonic) that found in the wide-area (northeast) including Dargiyaban and Sadabad Faults. (Zone with Low Relative Tectonic) that only found in sub-basins 5-C and 8.*

***Keywords:*** *Active Tectonic, Tectonic, Volcano, Morphometric, Taftan Volcano, Iran.*

## Introduction

Taftan volcano aged Pliocene-Quaternary has a young and semi-active volcanic system that located at a distance of 50km from north of Khash city. This volcano has been considered by geologists. Effects of tectonics are different in various area of the volcano. Regarding the northern part of Saravan Fault which has been located near this area, it is important to calculate the level of Relative tectonic activity in that area. It seems that both young volcano and active tectonics have played an important role in morphometry of this area (Aghanabati, 2004).

Quantitative methods have been used to study rates of relative tectonic in Taftan volcano and around it (Keller and Pinter, 2002), as well as geomorphic indices have been used to study tectonics. These indices include Drainage Basin Asymmetry (AF), Sinuosity Mountain Front (Smf), River Slope Length (SL), Floor Width to Valley Height (VF), Hypsometric Integral (Hi) and Drainage Basin (BS). They are determined on the basis of a single useful index to study relative active tectonic (Keller and Pinter, 2002; Azor et al., 2002; Silva et al., 2003; Molin et al., 2004). The investigations of tectonic geomorphology is important because the results of regional studies on neotectonics are significant for evaluating natural hazards as well as land-use development and management in the crowd areas (Cloetingh et al., 2006; Pedrera et al., 2009; Pérez-Peña et al., 2010; Mahmood and Gloaguen, 2012; Faghih et al., 2015). In addition to the role of tectonic action of the area, it can be considered as the effect of quaternary actions of Taftan volcano in changing morphotectonic parameters can be considered.

These indices have been used to evaluate Relative Active Tectonic (IAT), basins and sub-basins of that area. This method has been used to calculate rate of tectonic activities in the areas such as southeastern of USA (Rockwell et al., 1985), Pacific Coast in Costa Rica (Wells et al., 1988), North China Plain (Han et al., 2003), Mediterranean Beach in Spain (El-Hamdouni et al., 2008), Sarvestan in the central Zagros (Dehbozorgi et al., 2010), Rudbar Lorestan dam site (Alipoor et al., 2011) and Tehran in the central Alborz (Bagha et al., 2014). Relative Category of active tectonics has been performed on the basis of studies done a basin of Taftan volcano and Surrounding areas (El-Hamdouni et al., 2008). The results gained from analyzing the indices have been compared with field observations. This research can be helpful to solve the problems of tectonics in this area. In an area surrounding the young volcano(s), structures such as Saravan and Mirjaveh faults, Khan Mohammad Chah, Sa'ad Abad, Dar Giaban, etc., are visible. By reason of the activity of these faults, the morphometric parameters will be changed. Due to the existence of active structures, such as the above mentioned faults and the history of the tectonic activities in this region, the probability of the occurrence of natural disasters (such as earthquakes, landslides and …) associated with the tectonic processes is inevitable. Therefore, any developmental activities such as dams' construction for developing the villages and the cities, the road-

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construction, mining, surface water's management in this area should be done based on the tectonic activity levels in order to prevent the financial damages and the rate of deaths in the near future.

### Geological overview

Taftan volcano aged Pliocene-Quaternary (Aghanabati, 2004) has a young and semi-active volcanic system that located at a distance of 50 km from northeast of Khash city (Biabangard, 2009) (Fig. 1). This volcano, 1300 sq. $m^2$, has been acted last time since 1970-71. Taftan volcano is located at an altitude of 4050 meters above the sea level and 2000m, from the surrounding plains (Ganser, 1971).

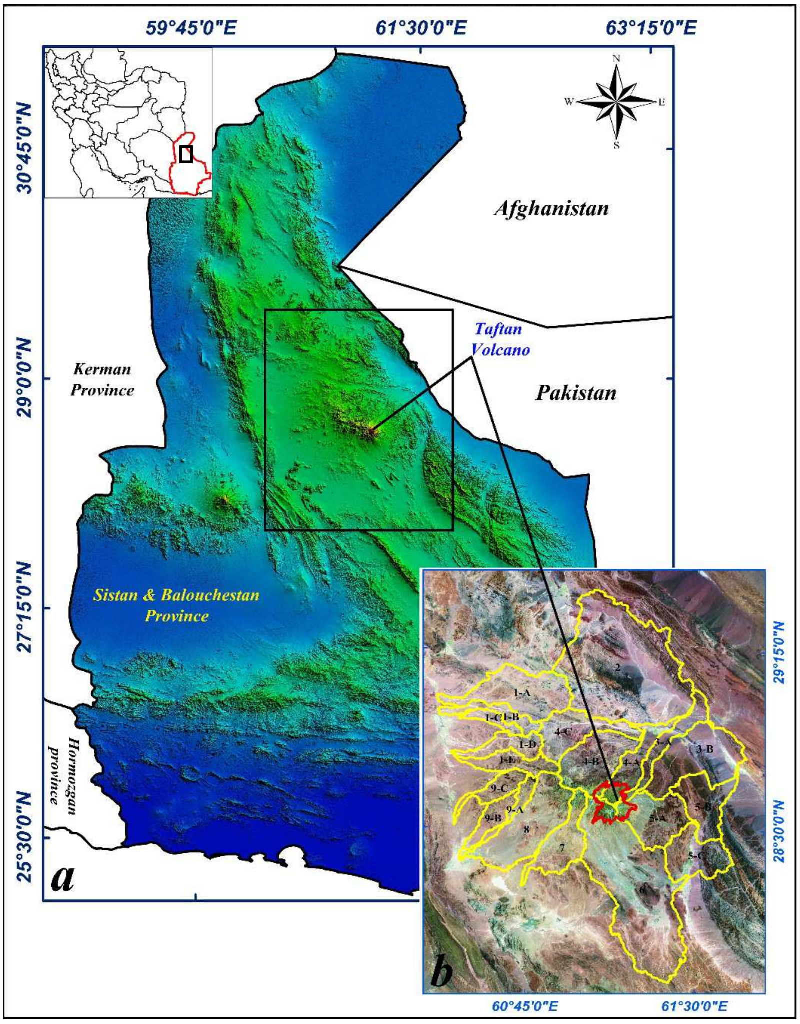



*Fig. 1. Position of the area, Position of Volcanic Cone, Position of basins and sub-basins. a) SRTM data from Sistan and Balouchestan provinces, b) Satellite Image of the study area and Position of Volcanic Cone.*

It is noted that Taftan volcano is one of the volcanic centres of the magmatic arc that originated from subduction of Oman Oceanic Crust under the Continental Accretion Prism of Makran (Aghanabati, 2004). In addition to acidic magmatisms to the moderate level of middle oligocene (granodiorite and quartzdiorite), the frequent dykes and sills as their combination is hornblind diorite to quartzdiorite (which has been attributed to the magmatism after the middle oligocene), have been cut the middle oligocene in different directions in many points such as the Eocene flaccid sediments and the intrusive igneous rocks (Aghanabati, 2004).

Quaternary Units include old and young alluvial sediments ($Qt_1$ and $Qt_2$), alluvium that is forming in the bed of current rivers ($Qa_l$) in different levels. Taftan volcano is the major unite in quaternary that the main products are extended in the form of pyroclastic rocks, lavas and their tuff, epyclastic and ignimbrite materials (Fig. 2). (Aghanabati, 2004).

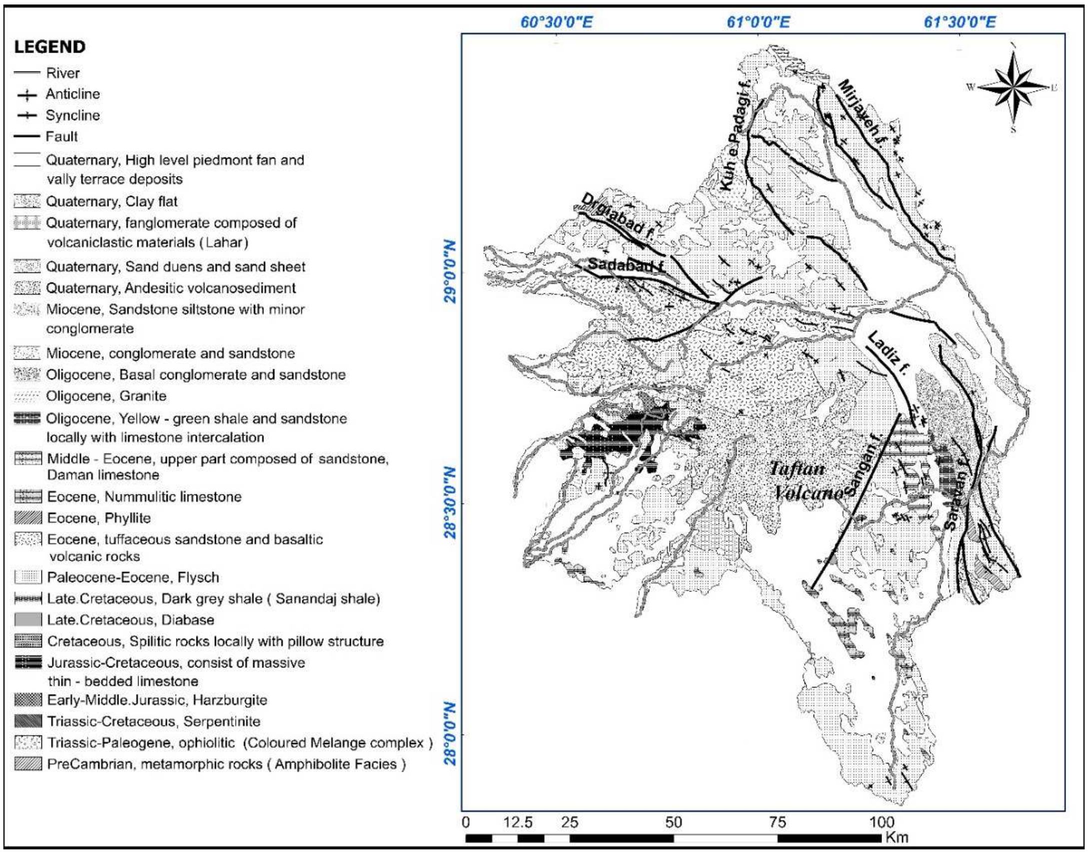



*Fig. 2. Geological Map of Taftan. Geological Map of Taftan (Modified by Authors After Eftekhar Nejad and Aghanabati 1994).*

## Morphotectonics and Active Tectonics Indices

In morphometric and morphological studies, qualitative and quantitative indices are considerable. They are effective in order to get useful information about the tectonic position (active or passive) of the area. The results of several indices can be integrated and added to the other information such as uplift rat and determined category of tectonic activities; these categories suggest a relative level of activity in an area. Developed by several authors, these indices can be considered as tools for studying active tectonics because they provide rapid insights into specific area or sites in the study area that are adjusting to relatively rapid rate of active tectonic deformation (Bull and Mcfadden, 1977; Rockwell et al., 1985; Keller, 1986; Ramirez-Herrera, 1998; Silva et al., 2003). Some indices such as Drainage Basin Asymmetry (AF), Sinuosity Mountain Front (Smf), River Slope Length (SL), Floor Width to Valley Height (VF), Hypsometric Integral (Hi) and Drainage Basin (BS) have been calculated.

In this classification, the basins are separated from the dividing line of water as each of them (basin) is composed of the independent parts that are overlapped and divided into sub-basins, accordingly.

The study area is divided into 20 basins and sub-basins on the basis of Topographic maps 1:50000, Landsat satellite images in 15m, and 30m, IRS (5.5m), SRTM (30m), Topographic Maps1:50000, Satellite Images, SRTM (30m) and Geological Maps. Their positions have been drawn and determined on the basis of the Main River, slope, and topography. In order to determine the active tectonic area in the scale of drainage basin using morphometric indices of Taftan volcano and its surroundings, first, drainage basins were extracted using Arc Hydro tool in ArcGIS software, and then the main rivers' network in the study area were constructed and, finally, the morphometric indices have been measured on the basins and sub-basins.

## Drainage Basin Asymmetries (Asymmetry Factor)

Active tectonics can cause deformations in drainage patterns, resulting in tilting of basins (Hare and Gardner, 1985; Keller and Pinter, 2002). Asymmetry Factor has been developed to show the tectonic tilting in drainage scale or large areas as follows:

$$Af = 100\ (Ar/At). \qquad (1)$$

Where, *Ar*: Area of Right Basin of River, *At*: Total Area of Drainage Basin and *Af*: Basin Asymmetry. In this area, *Af* is calculated for 20 basins and sub-basins (Table 1). Amounts of $Af < 50$ and $Af > 50$ are tilted to the west and east, respectively. Drainage Basins Asymmetry evaluated by the symmetry factor of transverse topography illustrates that there is tilting in many basins. Sub-basinn of “1-D (49.06)” is near the symmetrical position. And Sub-basins of “1-A, 1-E, 3-A, 3-B, 4-A” are associated with the have the highest slope due to the uplift resulted from the volcanic cone activity as well as the existing structures in this area. Among them, sub-basin of “4-A (92.02)” is the one which is along with tilts that can be related to the many small faults of this sub-basin (Fig. 3). Sub-basin “9-B” is the least tilting and extended from north to southwest.

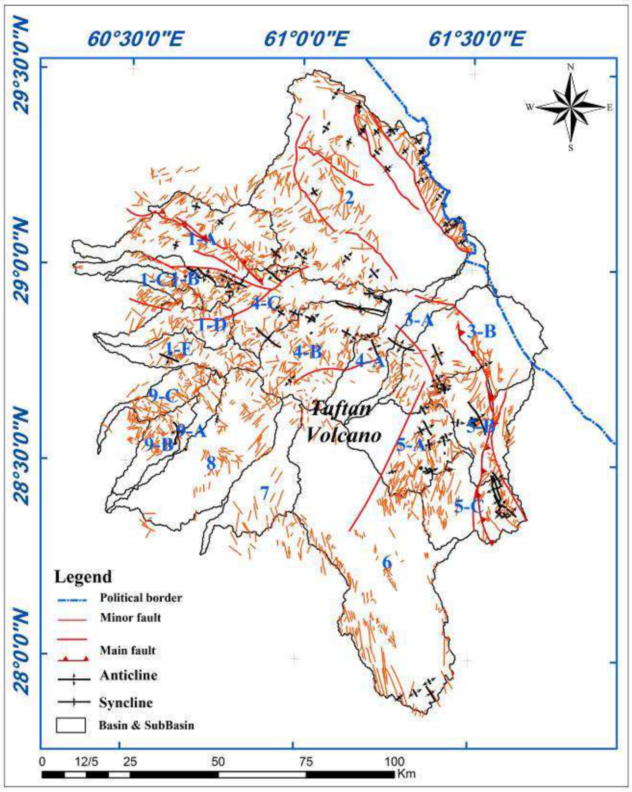



*Fig. 3. Structures Map of Taftan.*

**Transverse Topography Symmetry**

This index is used to evaluate and calculate Transverse Topography Asymmetry.

$$T = Da/Dd. \quad (2)$$

Where, *Da*: Distance from the middle line of the drainage basin to the middle line of Active Meander Belt and *Dd*: from the middle line of the basin-to-basin boundary. For a basin with complete symmetry $T = 0$, when the distance of asymmetry increases from the middle line, *T* also increases and becomes close to the amount of flow. It supposes that the slope of bedrock doesn't influence on channel movement, significantly. Then, *T* is a vector with direction and size of 0 and 1. Amounts of *T* are measurable with various parts of the valley and indicate vertical preferential movement, of the drainage basin axis.

$$Tave = T_1 + T_2 + T_3/3. \quad (3)$$

Amount of *T* is close to the *Af*, but it cannot be evaluated to determine tilting direction. While *Af* is a method that illustrates the amount and speed of tilting. For a basin with complete symmetry $T = 0$, when asymmetry increases, *T* also increases and becomes close to 1. Drainage basin symmetry evaluated by Transverse Topography Asymmetry indicates that there is tilting in many parts of the drainage basin and *T* ranges 0.16 and 8-0. 82 for basin and sub-basin "9-B", respectively. T index in the lower geographic latitudes shows a minor numerical value. But the values of this index will be increased in the geographical latitudes such as 24'280 'to 40'280 to the north (sub-basin of B-9), 36'280 to 01'290 to the north, and 38'280 to 55'280 to the north (sub-basins of A-4 and B-4), respectively, which indicates the asymmetry of a transverse topography in these sub-basins. The increase of *T* in this part of the study area was related to the existing structures in this region, such as faults and active folds.

### Sinuosity Mountain Front

Sinuosity Mountain Front is an index to reflect the between erosion forces that tend to make sinuosity and tectonics that tend to make a direct line in Sinuosity Mountain Front. Mountain Fronts related to active tectonics and uplift are direct relatives, and their *Smf* is low. The values equal to 1 (of this index) are specific to active tectonic areas. If the uplift level is decreased or stopped, the mountain front will be windswept by the erosion processes, and the value of this index (SMF)will be increased. The values of less than 1.4 indicate active tectonic fronts (Rockwell et al., 1985; Keller, 1986).

Regarding that geological maps don't outcrop any fault of mountain front in sub-basins of 1-C and 5-A sub-basins, then the index can't be calculated. All mountain fronts of this area are active, and three parts of 90, 109, and 125 are the most active of all and are related to Mirjaveh mountain front fault, a minor branch of Khan Mohammad Chah Fault and Saravan mountain front, respectively (Fig. 4). They indicate the high level of tectonic activities, and they are in one tectonic category which has been extended from the northwest of this area to the southeast one.

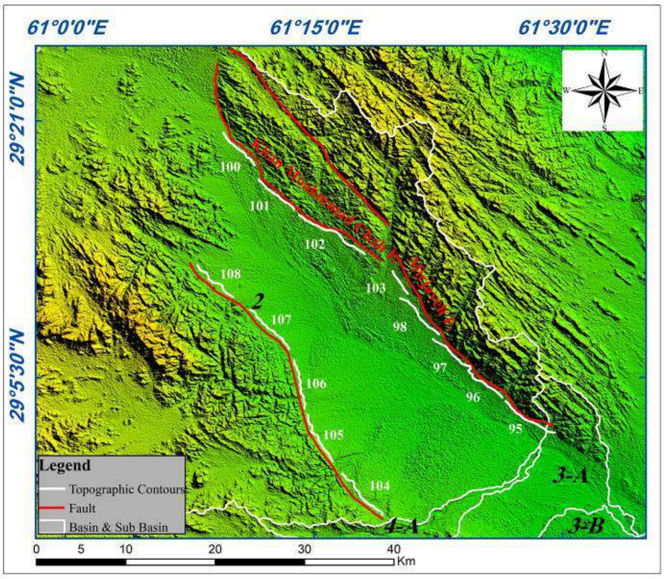



*Fig. 4. Some calculated parts of Smf in the study area.*

### Stream Gradient Index

Defined Stream Gradient Index as follows:

$$SL = (\Delta H/\Delta L) \times L. \qquad (4)$$

Where, SL: Stream Gradient Index, ($\Delta H/\Delta L$): Channel Slop or Gradient ($\Delta L$: changes of channel length, $\Delta H$: changes of channel height) and $L$: Total length of channel from the place of dividing stream to the middle area where the calculated index in it.

Slop-Length Index (*SL*) is one of the quantitative geomorphic parameters that used in morphotectonic studies. *SL* can be accounted as a useful tool to study the movements in active tectonic areas or areas in large scale (Chen et al., 2003; Zovoili et al., 2004). When streams and channels flow in the areas with a high uplift, *SL* will be increased, but when the streamflow is parallel with some structures such as valleys from right-slip faults, *SL* will be decreased (Keller and Pinter, 2002). In order to investigate the relationship between rock's strength and the aforementioned index, the rocks available in the study area have been classified based on their strength level toward various groups with very low level of strength (such as young alluvium deposits), low level of strength (such as sloping deposits), moderate level of strength (such as shale and siltstones), high level of strength (such as limestone, tuff, conglomerate, sandstone) and very high level of strength (such as andesite, granite, and basalt) (Memarian, 2001)

The most anomaly dispersion of *SL* is in the basins and sub-basins (that are in normal and resistant lithological category) located on the west and northwest of Taftan volcano. Due to anomaly areas, *SL* is only high in 4-C where its lithology is soft as young alluvial sediments and as its reason refers to the active and young tectonic structure (active fault). The remaining basins and sub-basins of the study area due to the lack of resistant lithology or the active and young structures in that area are associated with the low values of *SL*. As it can be seen, the lowest values of this index were related to the sub-basin of A-3 which mainly includes alluvial deposits of the present time, as well; the low level of strength of these rocks can be attributed to the low value of *SL* index in this sub-basin. (Fig. 5).

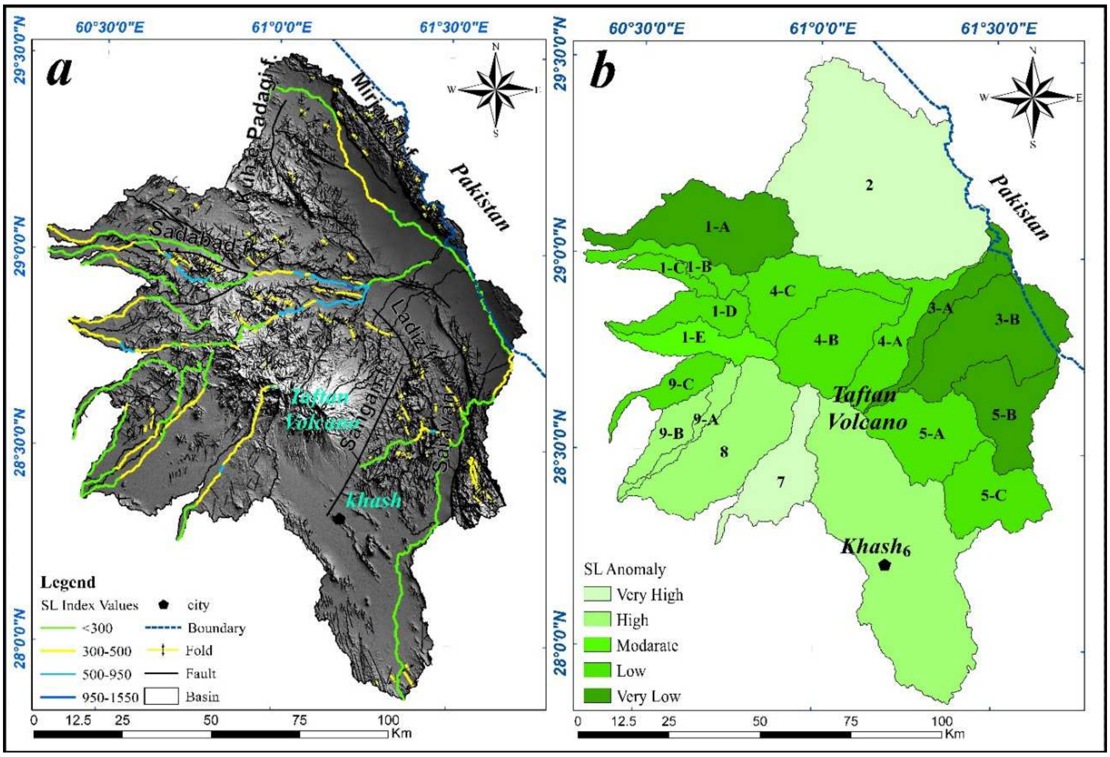



*Fig. 5. a: SL for Drainage Net of River. b: Dispersion of anomaly areas of SL with resistance categorizing of the studied basins.*

Additionally, this study area can be easily divided into several distinct sections grouped in regard to erosion. The high value of *SL* index in the sub-basin of E-1 and in the basin of 7 indicates the activity of the lower latitudes of the mentioned area; however, the highest values of *SL* due to the high level of lithologic resistance at that point are related to the basin of 7. Table 1 illustrates the category of *SL* in the area. *SL* has been considered to study the uplift effect of the main volcanic cone of Taftan; boundaries of the cone have been determined on the basis of geological maps, topography and ring structures of Taftan volcano In order to investigate the uplift – effect of the main cone of Taftan volcano, SL index has been studied. The boundaries of this cone have been determined based on the geological maps of the area, topography and catenary structure of the Taftan volcano. The measurements are carried out according to the topographic maps. Additionally, the height and the measuring intervals (regarding the cone and the plain boundaries) are considered equally for the aforementioned index to specify the uplift – effect of the cone (Relative activities of tectonics) to the surroundings. At this stage, the boundary of the cone and plane (its periphery) were studied separately in each basin. In the process, the boundaries of the cone and its plane have been considered, separately (Fig. 6).

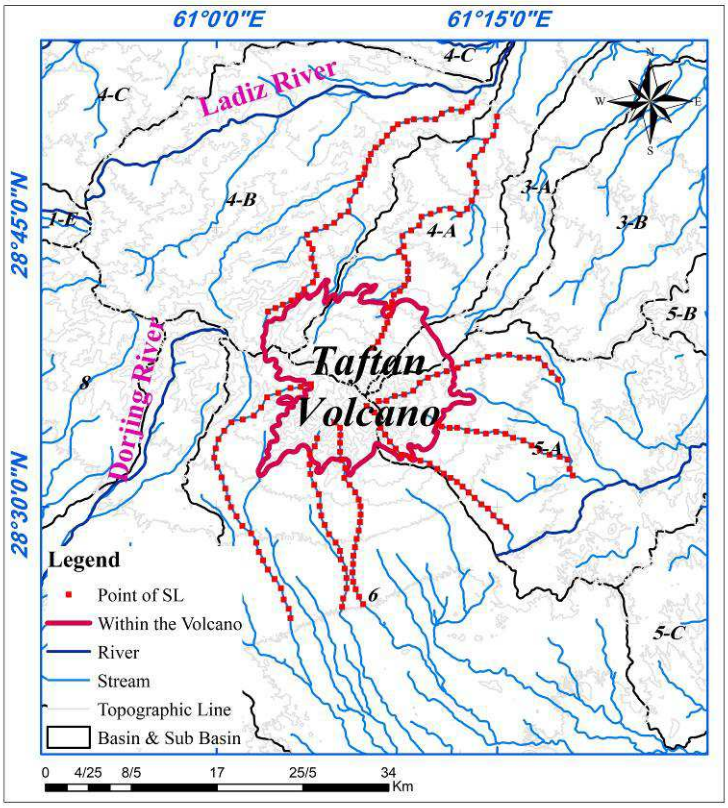



*Fig. 6. Some measured places of SL around Taftan volcano.*

These results suggest that uplift of the cone has influenced on active tectonic parameters, significantly *SL* is high around the cone. At a short distance, *SL* increases but decreases around the plane in spite of the long distance. Maximum amounts of *SL* around the cone in basins and sub-basins are 3A, 5A, 4A, 6,4B, respectively. But maximum amounts of *SL* around the plan are related to 5A, 6, 4A, 4B and 3A.

## The ratio of Floor Width to Valley Height (VF)

Floor Width to Valley Height (VF) (Bull and Mc Fadden, 1977; Bull, 2007) is defined as follows:

$$Vf = 2Vfw/ (E1d - Esc) + (Erd - Esc). \quad (5)$$

Where, *Vf*: Ratio of Floor Width to Valley Height, *Vfw*: Floor Width, *E1d* and *Erd*: height of left and right walls then each other's and Esc: height of the floor. Valleys are often narrow upper than the mountain front (Ramirez-Herrara, 1998), and then SL should be an indefinite interval upper of the mountain front. Value of *Vf* will be changed according to the size of the basin, drainage discharge and kind of rock. Then amounts of *Vf* should be compared to similar geological conditions. Silva et al. (2003) calculated this index in the Eastern Cordillera (southwestern of Spain) and showed that V-shape valleys associated with a value of *Vf* less than 1 will be evolved in response to the active uplift, while U-shape valleys associated with a value of *Vf* more than 1 show a major lateral erosion due to the stability of the base surface or lack of tectonic performance.

According to geological maps of the area, any lineaments, main channel and minor branches don't cut 5-C, 3-B and A-3; and for this reason, this index can't be calculated for them. It is noticed that *Vf* is dependent on the drainage basins extent and bedrock lithology in addition to tectonic factors. In 19 active profiles in the area (Fig. 7), the value of *Vf* is low which has been determined on the basis of V-shape valleys Due the effect of uplift and the activity of Taftan volcano as well as the value of *Vf*, west, northwest and southeast of Taftan volcano can be considered or accounted as the youngest and most active parts along with high active tectonic relatives, So uplifting Taftan volcano has been influenced on tectonic structures of these parts. Figures 8 confirms results from this index as similar *SL* in Taftan Cone and Plane.

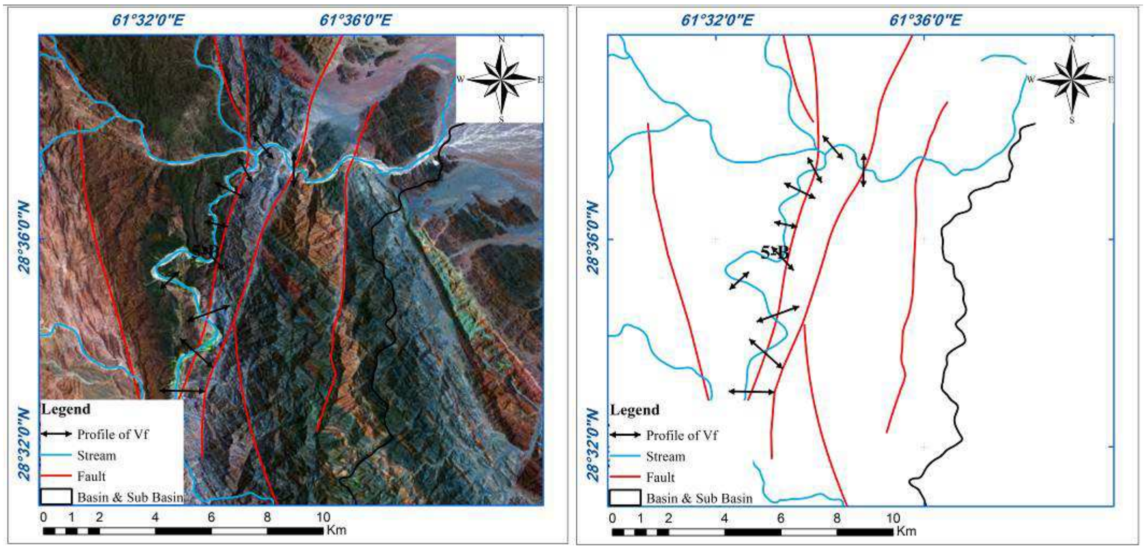



*Fig. 7. Some measured place of Vf around Taftan volcano.*

### Hypsometric Integral (Hi)

The Altimetry Curve indicates the distribution of altitude in an area, a drainage basin to a complete plant (Strahler, 1952). This curve illustrates the results or the results gained from performing ratio of total basin height (relative height) to the total basin area (relative area), and it's a hypothetical altimetry curve for a drainage basin located on a monotone slope. The drainage basin includes 8 on the same line; total area (A) is the total area between a pair of lines of the same adjacent line. Area (a) is an area of the basin up to special height line (h). Amount of relative area a/A has ranged from 0 (the lowest area in the basin) to 1 (the highest area). Calculation of altimetry integral is a simple method to determine the altimetry curve in a special drainage basin as follows (Pike and Wilson, 1971; Keller and Pinter, 2002):

$$Hi = Average\ Altitude - Minimum\ Altitude/Maximum\ Altitude - Minimum\ Altitude. \quad (6)$$

Then, three amounts are necessary to calculate the Integral; two of them (Minimum and Maximum altitudes) are accessible from the topographic map, simply. High amounts of the Integral indicate young and active tectonic areas, but low ones indicate low tectonic and erosion (El-Hamdouni et al., 2008). (Maximum and Minimum altimetry Integral ranges between 0 and 1). It is necessary to note that the convex curve indicates the high activity of the area and activity of faults and uplifting related to folds currently, but cave curve indicates low tectonic activities in the area. In except of three sub-basins of 1-A, 9-A and 9-C as Hi is 0.53, 0.53 and 0.51, respectively (it shows a semi-active tectonic or maturity stage of Davies Pattern in three basins, average amount indicates geomorphic processes is balanced in three mentioned basins), other basins and sub-basinss indicate passive or old tectonic process or old stages of Davies Pattern because the amounts of *Hi* are lower than 0.50 and indicate high erosion in the sub-basins (Fig. 8).

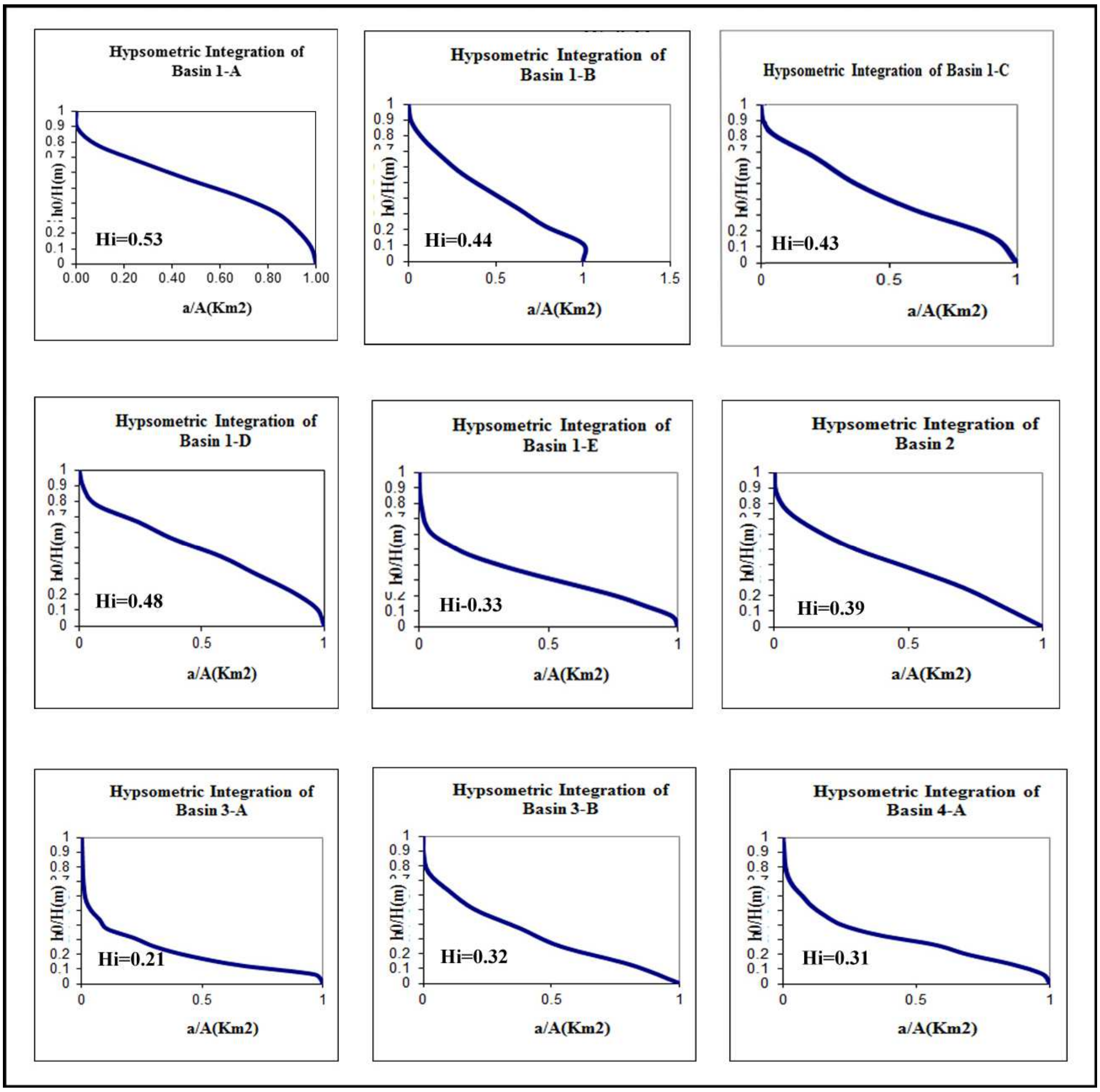
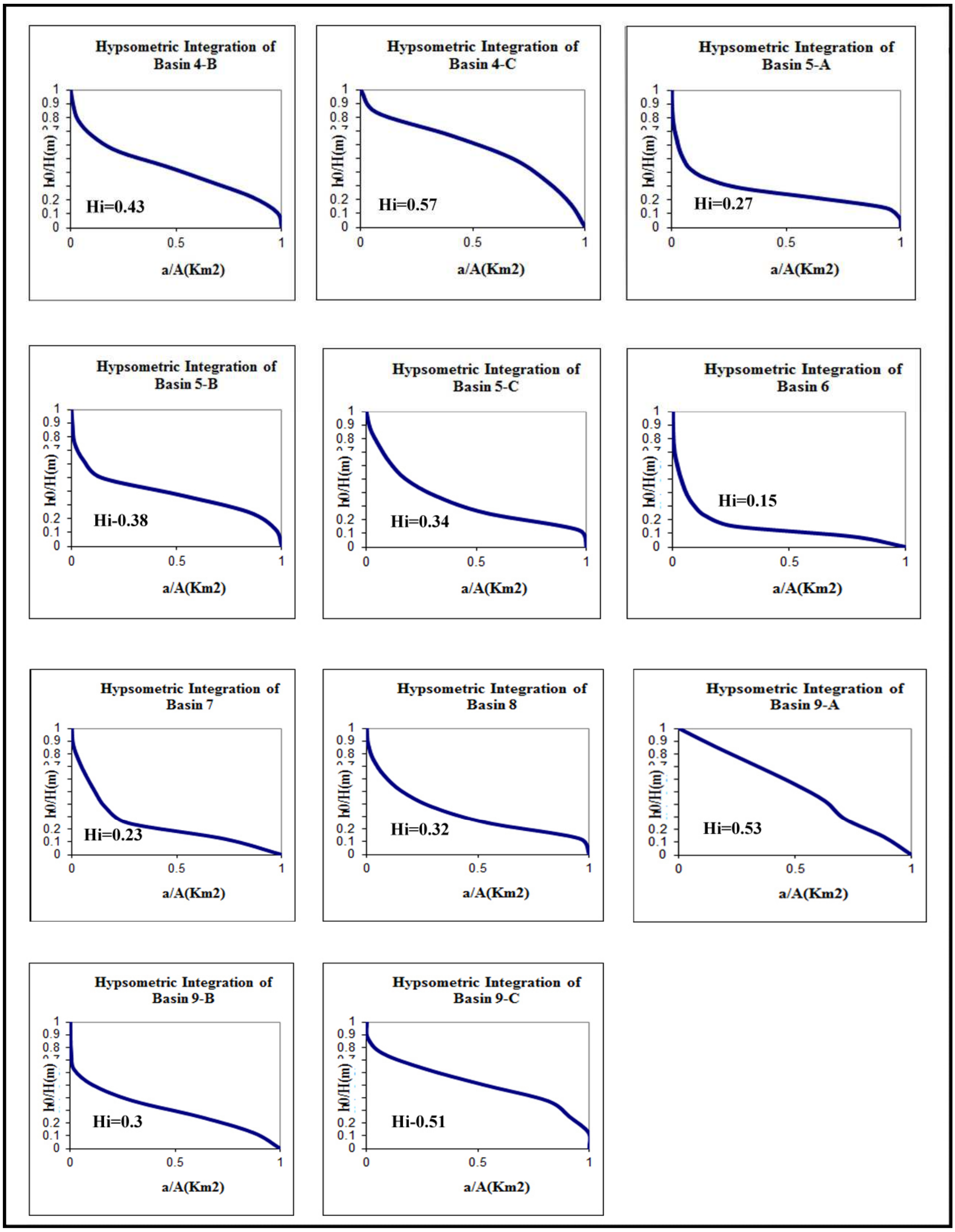



*Fig 8. Hypsometric Curve of 20 Basins and Sub-basins.*




*Continued Fig 8. Hypsometric Curve of 20 Basins and Sub-basins.*

## Index of Drainage Basin Form

It is calculated as follows (Ramirez-Herrera, 1998):

$$Bs = Bl/BW \quad (7)$$

Where, *Bs*: Drainage Basin Form, *Bl*: the length of Drainage Basin and *Bw*: the width of Drainage Basin. Young Drainage Basins in active tectonic areas tend to elongate in the direction with topographic slope. But along drainage basin evolution or decreasing the tectonic action, the basins have transformed from long to circular forms (Bull and Mc Fadden, 1977). This index illustrates the difference between long basins in high amount and circular basins in low amount. Long basins are one of the specifications of the active tectonic area that has a river in a dig towards down. Mountain Fronts due to the fast uplifting are along with the steep and long basins. By decreasing or stopping the tectonic activities, basins will be extended, which will be started from the top of the mountain front (Ramirez-Herrera, 1998). It has been studied in Drainage Basin Form in the area (Table 1 and Fig. 9).

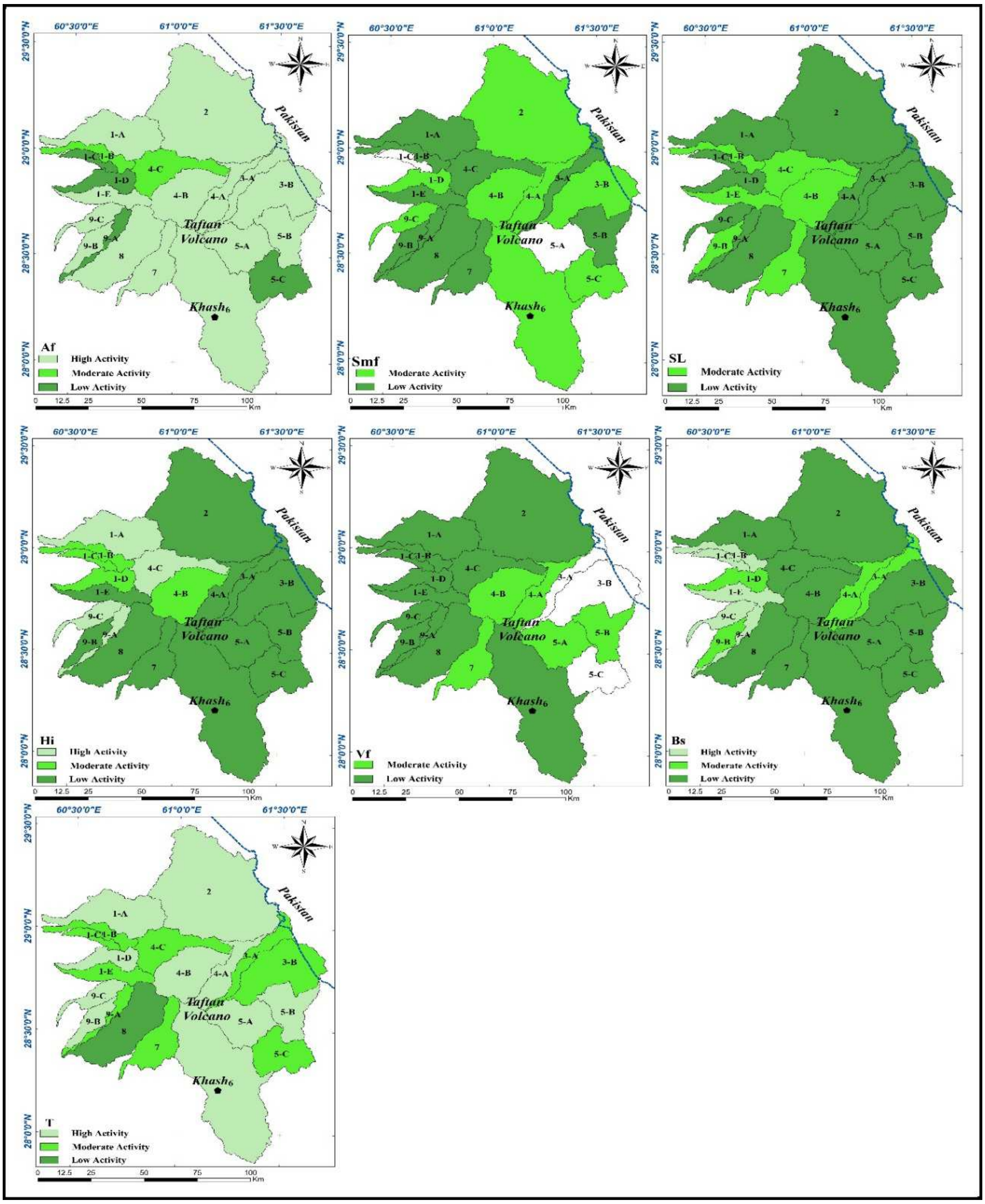



*Fig. 9. Position of basins and their categorization in three groups of all Indices.*

## Categorizing Relative Tectonic Action

In this paper, categorization of Relative Active Tectonic introduced by the El Hamdouni et al. (2008) for the first time has been used to evaluate Relative Active Tectonic (IAT) of basins and sub-basins of that area. Various tectonic indices have been calculated for each basin and sub-basin and divided into three categories - 1, 2, and 3 - that indicate a high, middle, and low level of activities, respectively. Table 1 illustrates average Tectonic Indexes (S/n) and amounts of Relative Active Tectonic (Iat) for basins and sub-basins of the area. (Fig. 10).

*Tab. 1. The categorization of Relative Active Tectonic in the area.*

| Ref.No | Basin | Class of: | | | | | | | S/n | Iat class | Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | SL | AF | Hi | VF | Smf | T | Bs | | | |
| 1 | 1a | 3 | 1 | 1 | 3 | 3 | 1 | 3 | 2.14 | 3 | Moderate |
| 2 | B1 | 2 | 2 | 2 | 3 | 3 | 2 | 1 | 2.14 | 3 | Moderate |
| 3 | 1c | 3 | 3 | 2 | 3 | - | 2 | 1 | 2.33 | 3 | Moderate |
| 4 | 1d | 3 | 3 | 2 | 3 | 2 | 1 | 2 | 2.29 | 3 | Moderate |
| 5 | 1e | 2 | 1 | 3 | 3 | 3 | 1 | 1 | 2 | 3 | Moderate |
| 6 | 2 | 3 | 1 | 3 | 3 | 2 | 1 | 3 | 2.29 | 3 | Moderate |
| 7 | 3a | 3 | 1 | 3 | - | 3 | 2 | 2 | 2.33 | 3 | Moderate |
| 8 | 3b | 3 | 1 | 3 | - | 2 | 2 | 3 | 2.33 | 3 | Moderate |
| 9 | 4a | 3 | 1 | 3 | 3 | 2 | 1 | 2 | 2.14 | 3 | Moderate |
| 10 | 4b | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 1.86 | 2 | High |
| 11 | 4c | 2 | 2 | 1 | 3 | 3 | 2 | 3 | 2.29 | 3 | Moderate |
| 12 | 5a | 3 | 1 | 3 | 2 | - | 1 | 3 | 2.17 | 3 | Moderate |
| 13 | 5b | 3 | 1 | 3 | 2 | 3 | 1 | 3 | 2.29 | 3 | Moderate |
| 14 | 5c | 3 | 3 | 3 | - | 2 | 2 | 3 | 2.67 | 4 | Low |
| 15 | 6 | 3 | 1 | 3 | 3 | 2 | 1 | 3 | 2.29 | 3 | Moderate |
| 16 | 7 | 2 | 1 | 3 | 2 | 3 | 2 | 3 | 2.29 | 3 | Moderate |
| 17 | 8 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 2.71 | 4 | Low |
| 18 | 9a | 3 | 3 | 1 | 3 | 3 | 2 | 1 | 2.29 | 3 | Moderate |
| 19 | 9b | 2 | 1 | 3 | 3 | 3 | 1 | 2 | 2.14 | 3 | Moderate |
| 20 | 9c | 3 | 1 | 1 | 3 | 2 | 1 | 1 | 1.71 | 2 | High |

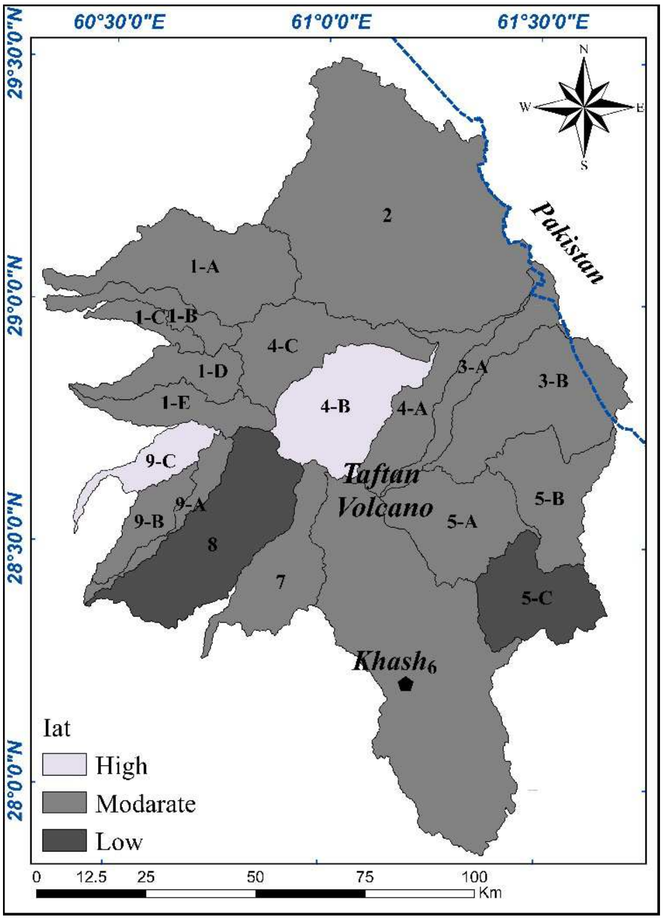



*Fig. 10. Category of Relative Active Tectonic in the study area in terms of their separation.*

1. The area in High Relative Active Tectonic: found in two sub-basins of 4-B and 9-C. Due to serious tilting of 4-B, amounts of Hi, and high extension of the drainage basin and tilting 9-C, these two sub-basins have high and young Relative Active Tectonic.

2. The area in Middle Relative Active Tectonic: It includes a large area. Important structures such as Dargiaban and Saadabad faults have been located in the area.

3. The area in Low Relative Active Tectonic: It is found in two sub-basins 5-C and 8. In terms of Lithology, there are Silt, clay, old and new alluviums in this area. Important structures include Saravan, Koohrud and Gazou faults located on the southeast of the area. Low level of activity of sub-basin 5-C is as the results of basin shape and the amount of uplifting and tilting (Fig. 8). Field studies have been considered in structures and morphologies areas located along the rivers, and some active tectonic parameters have been considered as follows (Fig. 11, 12).

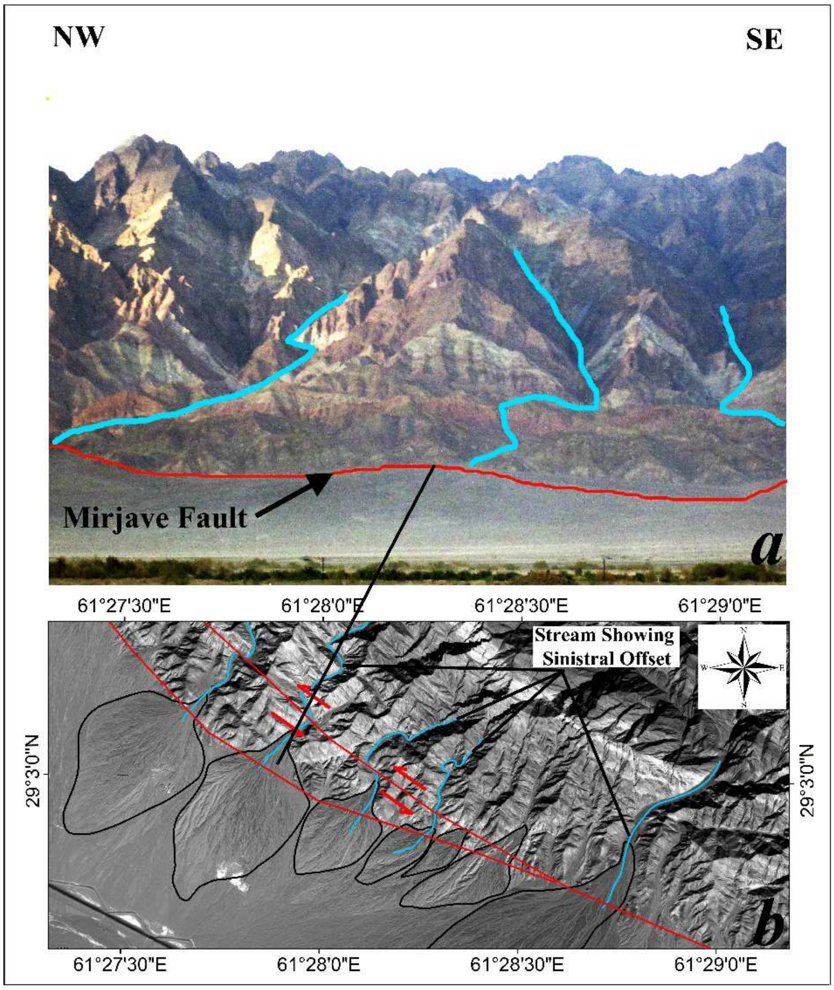



*Fig. 11. a) Landsat Satellite images. It is found some transformations along the channel as a result of moving fault. Cones, located adjacent to the mountain front indicate active uplifting, b) Field picture of the area that illustrates Mirjaveh Fault and some geomorphic effects.*

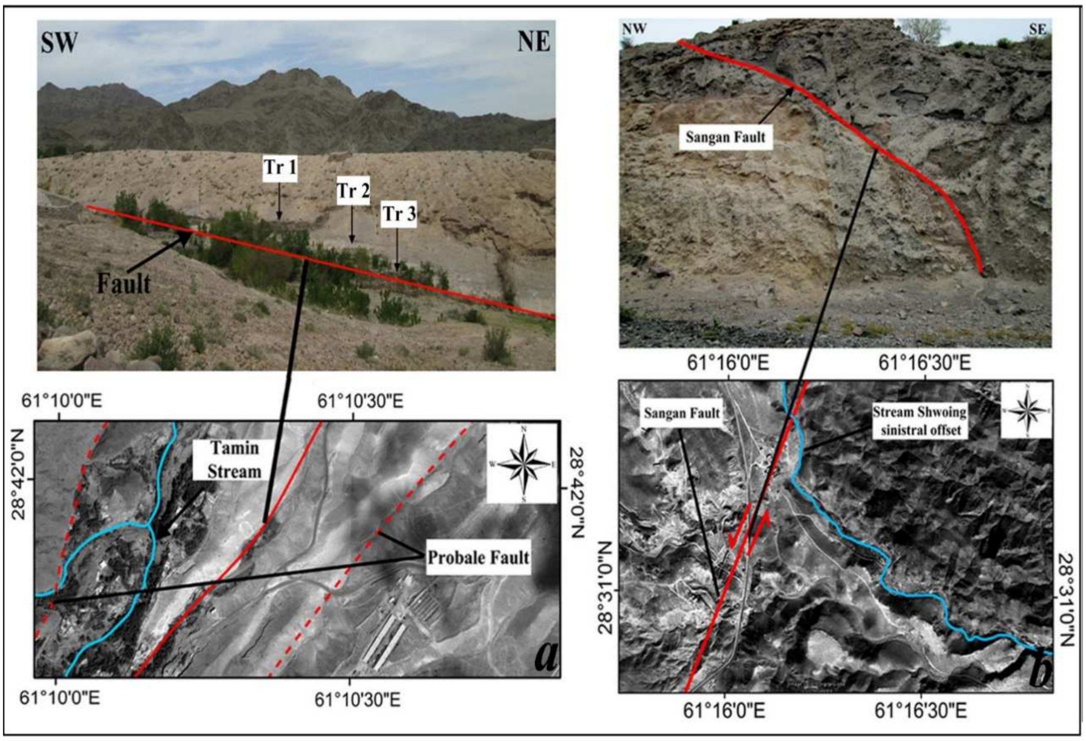



*Fig. 12. Landsat Satellite images illustrate some active tectonic evidence. a) River traces near this area Tamin Village on the northeast of Taftan volcano, b) Effect of Sangan Fault in dug tranche wall in the southeast of Taftan volcano.*

## Conclusion

The amounts gained from calculating the indices on the basis of the relative active tectonic category have been integrated and concluded that neotectonic plays an important role in evolving area tectonic. Regarding the new-tectonic insights, the presence of active structures in the study area such as folds and faults has been caused into changes in this region which (these changes) are visible as uplifts. Three tectonic areas are recognizable in the area: Area with high relative tectonic action found in sub-basins of 4-B and 9-C. An area with high relative tectonic activities has been found in sub-basins of 4-B and 9-C. An area with moderate relative tectonic activities has been found in wide areas such as Dargiaban and Sa'adabad faults located on the northwest part. An area with low relative tectonic action activities has been found in a small area. Sub-basins of 4-B and 9-C have high relative tectonic activity affected by moving young faults and active tectonic structures located on both sub-basins. Sub-basins of 1-A, 1-B, 1-C, 1-E, 2, 3-A, 4-A, 4-B, 5-A, 5-B, 6, 7, 9-A, 9-B have moderate relative tectonic activities, and 8 and 5-C have low relative tectonic activities. By calculating the tectonic indices, it was found that in the broad range of the study area, the level of tectonic activities is moderate. In the boundary of Taftan volcano cone which was the result of the accumulation of magma over the past times due to the existence of high resistance rocks, the values obtained from the calculation of tectonic indices indicate this active area. However, near the boundaries of the volcanic cone which mainly consists of flake deposits and metamorphic rocks, the tectonic activities, as well as structures such as the faults of Saravan and Mirjaveh, Khan Mohammad Chah, Sa'ad Abad, Dagiaban, and the folds resulted from these activities, can be controlled. Additionally, as the result of these tectonic movements, the morphometric parameters of this region have changed.

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