

The Analysis of Transverse Topographic Symmetry Factor (T Index) in the Chekene-Mazavand, North East Iran

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Received 12 September 2015; accepted 24 November 2015; published 30 November 2015

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Abstract

T index has been calculated in the Chekene-Mazavand region in the NE Iran. This index shows lateral tilting may be related to active tectonics. There are many streams and transverse topographic symmetry factor has been calculated for all streams of Kashafroud river. Firstly, based on digital elevation model, the study area was divided into 28 sub-basins. Then transverse topographic symmetry factor was calculated for each one. The values are between 0.14 and 0.57 and so, there are low, moderate and high levels of relative tectonic activities. The areas with low relative tectonic activities have found in sub-basins No. 14, 15 and 24, moderate relative tectonic activities have found in sub-basins No. 2, 5, 6, 7, 9, 10, 13, 16, 18, 19, 21, 22, 23, 25, 27 and 28 and high relative tectonic activities have found in sub-basins No. 1, 3, 4, 8, 11, 12, 17, 20 and 26. The results show that the plains have got low to moderate level of tectonic activity and faulted areas have got high tectonic activity. This matter is compatible with its tectonic setting on the Kopet Dagh belt in north east Iran.

Keywords

Transverse Topographic, Symmetry Factor, Chekene-Mazavand, Tectonic, Iran

1. Introduction

The Chekene-Mazavand area is located in the Kopet Dagh physiographic province, NE Iran (**Figure 1**). Dominant structural trend in Kopet Dagh province is NW-SE. From tectonics view, it contains the Kopet Dagh

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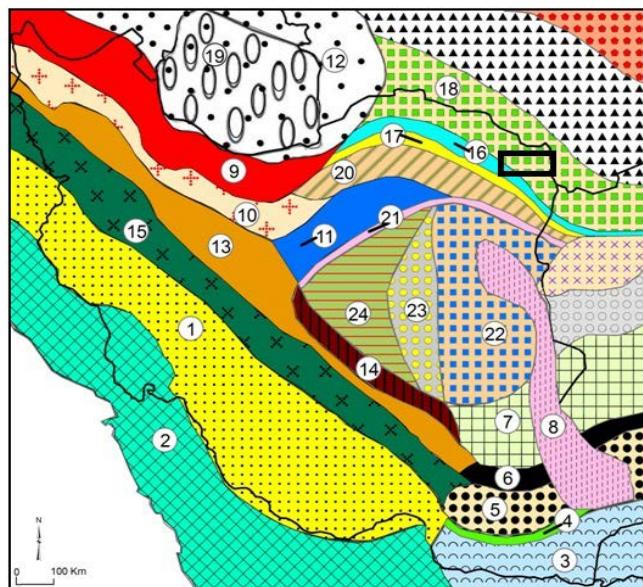


Figure 1. Physiographic-tectonic zoning map of Iran's sedimentary basins, modified from [1]. Numbers in this figure are: 1: Zagros-East Taurus hinterland, 2: Persian Gulf-Mesopotamian foreland basin, 3: Makran accretionary prism, 4: Bashagard Mountains, 5: Jazmorian-Mashkel fore arc basin, 6: Shahsavaran-Soltan magmatic arc, 7: South Lut-South Helmand back arc basin, 8: East Iran Mountain belt, 9: West-Central Alborz and lesser Caucasus hinterland, 10: Great Kavir-Northern Urmieh lake foreland basin, 11: South Great Kavirfold and thrust belt, 12: South Caspian-Black sea foreland basin, 13: Urmieh-Dokhtar Magmatic Arc, 14: Naien-Kerman retro arc foreland basin, 15: Sanandaj-Sirjan overthrust belts, 16: East Alborz or Binalod hinterland, 17: Torbat-e am-Neyshabour retro arc foreland basin, 18: Kopet Dagh hinterland, 19: South Caspian remnant basin, 20: Maiamay-Taibad Inverted back arc basin, 21: Khaf-Kavir Plain Magmatic Arc, 22: Lut Plain-Gonabad back arc basin, 23: Tabas hinterland, 24: Yazd-Khour Piggy back basin. The study area is shown in the black rectangle.

hinterland or Kopet Dagh fold and thrust belt that formed in passive margin of Eurasian plate until late Triassic and then marine sedimentation on Kopet Dagh proforeland basin has continued to Eocene. Kopet Dagh hinterland has uplifted related to Karakorum foreland basin in north east along Eshghabad fault [1]-[3].

Based on previous work on the salt and mud diapirism [4]-[15] and neotectonic regime in Iran [16]-[21], Zagros in south Iran is the most active zone [22]-[44]. Then, Alborz [45]-[84] and Central Iran [85]-[100] have been situated in the next orders. The analysis of T index that shows lateral tilting is the main goal in this paper.

2. Materials and Methods

The transverse topographic symmetry factor shows lateral tilting that it may be related to active tectonics. There are many streams and transverse topographic symmetry factor has been calculated for all streams of Kashafroud river (**Figure 2** and **Figure 3**). Kashafroud river is the main river in the Chekene-Mazavand area (**Figure 4**). Based on digital elevation model of Chekene-Mazavand area, there are 28 sub-basins. The study area is located between longitudes E58°, 30'- 61° and latitudes N35°, 30'-37° in the Khorasan province, in the NE Iran.

Transverse Topographic Symmetry Factor (T)

T index or transverse topographic symmetry factor has been calculated as $T = Da/Dd$ and it can be between 0 in the symmetric basin and 1 in the asymmetry basin.

Da is the space from the midline of the drainage basin to the midline of the active belt and Dd is the space from the midline to the basin limit [101]. In this research, we were considered class 1 for $T > 0.4$, class 2 for T between 0.2 and 0.4 and class 3 for $T < 0.2$ and so, sub-basin No. 1, 3, 4, 8, 11, 12, 17, 20 and 26 shows higher activity (**Table 1**).

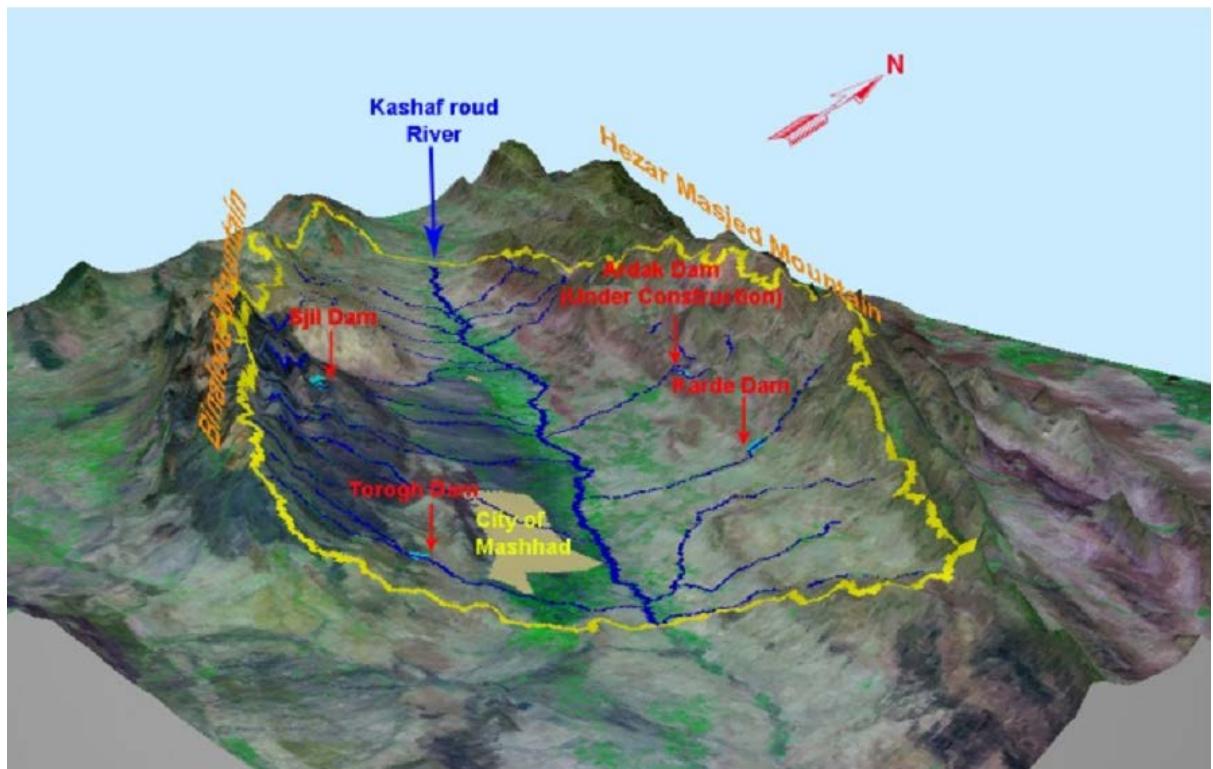


Figure 2. An oblique view on Landsat satellite image that shows some streams of the Kashafroud river.

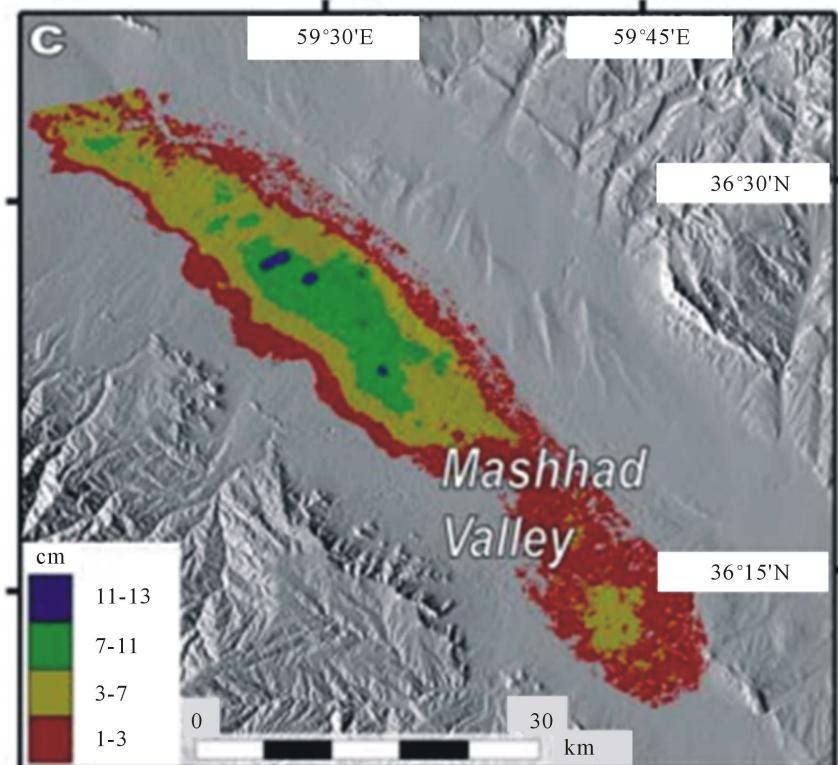


Figure 3. Land subsidence value around the middle part of Kashafroud river plain.

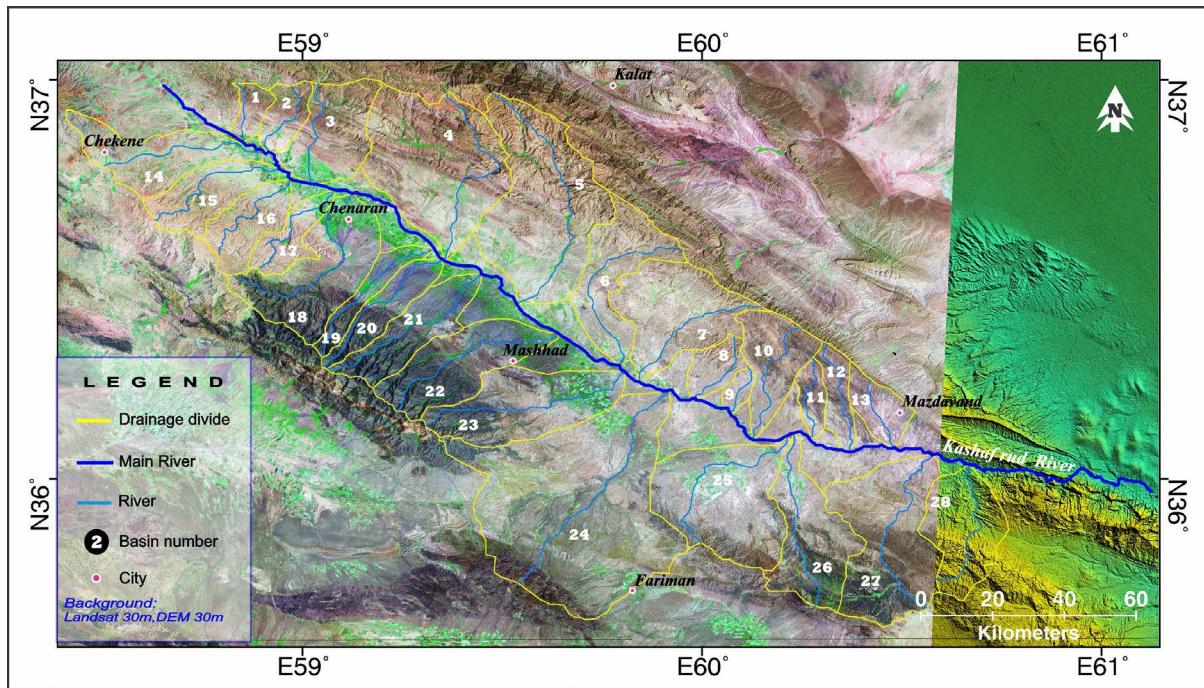


Figure 4. The sub-basins on Landsat satellite image of the Chekene-Mazavand area.

Table 1. Values of T index for sub-basins.

Sub-basin	Number	T index					Class
		Da (m)	Dd (m)	T (m)	T _{ave} (m)		
1	1	2270	3589	0.63	0.52	1	
	2	1289	3179	0.41			
2	1	299	5520	0.05	0.31	2	
	2	1172	3405	0.34			
3	3	1543	4602	0.34	0.57	1	
	4	1956	3860	0.51			
4	1	4386	7830	0.56	0.53	1	
	2	6280	7480	0.84			
5	3	2178	7200	0.30	0.34	2	
	1	8530	11010	0.77			
6	2	10920	14770	0.74	0.29	1	
	3	427	5280	0.08			
7	1	3091	11440	0.27	0.16	2	
	2	1602	10110	0.16			
8	3	3082	12290	0.25	0.34	2	
	4	5010	11210	0.45			
9	5	6810	12200	0.56	0.55	1	
	1	5850	10600	0.55			
10	2	1099	6900	0.16	0.29	2	
	3	1940	4170	0.47			
11	4	345	6200	0.06	0.20	1	
	5	1478	7240	0.20			

Continued

	1	6140	16330	0.38		
7	2	2694	10680	0.25	0.38	2
	3	2266	5680	0.40		
	4	401.6	1737	0.23		
8	1	2797	6010	0.47	0.48	1
	2	2578	5270	0.49		
	1	852.6	1939	0.44		
9	2	120.7	2851	0.04	0.34	2
	3	943.7	1771	0.53		
	1	2702	8260	0.33		
10	2	1840	9650	0.19	0.31	2
	3	1601	3840	0.42		
	1	1433	3551	0.40		
11	2	2227	3833	0.58	0.48	1
	3	1646	3238	0.51		
	4	608	1459	0.42		
	1	2822	5170	0.55		
12	2	1323	3062	0.43	0.48	1
	3	1075	2322	0.46		
	1	706	6340	0.11		
13	2	2349	5700	0.41	0.27	2
	3	1142	4077	0.28		
	1	1850	5570	0.33		
14	2	775	6600	0.12	0.19	3
	3	730	5760	0.13		
	1	512	5570	0.09		
15	2	743	6950	0.11	0.14	3
	3	1275	5940	0.21		
	1	3315	7790	0.43		
16	2	2615	6690	0.39	0.27	2
	3	417	6610	0.06		
	4	849	4575	0.19		
	1	1101	5730	0.19		
17	2	4113	7320	0.56	0.41	1
	3	2491	3564	0.70		
	4	359	1860	0.19		
	1	6620	14130	0.47		
	2	1554	7490	0.21		
18	3	1158	7120	0.16	0.25	2
	4	821	7410	0.11		
	5	1296	4619	0.28		

Continued

	1	417	2146	0.19		
	2	2165	3330	0.65		
19	3	558	2318	0.24	0.31	2
	4	227	2718	0.08		
	5	947	2493	0.38		
	1	336	2239	0.15		
20	2	2907	4464	0.65	0.45	1
	3	2094	3748	0.56		
	1	2645	5780	0.46		
21	2	1055	5930	0.18	0.25	2
	3	1957	7620	0.26		
	4	501	4000	0.13		
	1	936.7	6440	0.15		
	2	2366	6510	0.36		
22	3	1222	8630	0.14	0.20	2
	4	787	6040	0.13		
	5	1035	5060	0.20		
	1	1896	5600	0.34		
23	2	1635	11490	0.14	0.28	2
	3	2476	9070	0.27		
	4	1510	4137	0.36		
	1	2887	22910	0.13		
	2	4287	30250	0.14		
24	3	4285	30830	0.14	0.18	3
	4	2673	10240	0.26		
	5	1600	7570	0.21		
	1	7970	15910	0.50		
25	2	8440	18900	0.45	0.36	2
	3	989	6560	0.15		
	4	528	1587	0.33		
	1	2813	8350	0.34		
26	2	6900	9720	0.71	0.44	1
	3	1809	7480	0.24		
	4	1291	2660	0.49		
	1	2333	9540	0.24		
27	2	3596	10860	0.33	0.36	2
	3	6210	9830	0.63		
	4	1330	6060	0.22		
	1	3609	5470	0.66		
28	2	1082	7250	0.15	0.35	2
	3	3275	10000	0.33		
	4	1373	5510	0.25		

3. Results and Discussion

Our results show that Mashhad plain have got serious land subsidence which it was documented by field observations (**Figures 5-7**). Also, there are three levels of active tectonics. Low relative tectonic activities in sub-basins No. 14, 15 and 24, moderate relative tectonic activities in sub-basins No. 2, 5, 6, 7, 9, 10, 13, 16, 18, 19, 21, 22, 23, 25, 27 and 28 and finally high relative tectonic activities in sub-basins No. 1, 3, 4, 8, 11, 12, 17, 20 and 26. Also, the most parts of study area have shown moderate relative tectonic activities.



Figure 5. A view from cracks due to land subsidence in sub-basin No. 6.



Figure 6. A close view from a crack in **Figure 5**.



Figure 7. A view from a large crack which is related to land subsidence in sub-basin No.7.

4. Conclusions

In this research, the transverse topographic symmetry factor has been calculated in the Chekene-Mazavand area, north east Iran. Based on digital elevation model, the study area was divided into 28 sub-basins. Then transverse topographic symmetry factor was calculated for each one. The values of this index are between 0.14 and 0.57, there are low, moderate and high levels of relative tectonic activities. The most parts of study area have shown moderate relative tectonic activities.

Low relative tectonic activities level has been found in sub-basins No. 14, 15 and 24, moderate relative tectonic activities level has been found in sub-basins No. 2, 5, 6, 7, 9, 10, 13, 16, 18, 19, 21, 22, 23, 25, 27 and high relative tectonic activities level has been found in sub-basins No. 1, 3, 4, 8, 11, 12, 17, 20 and 26. The latter cases are compatible with faulted parts of study area.

Acknowledgements

This work has funded by Department of Geology, Islamic Azad University, North Tehran Branch, Iran. Also, Special thanks to Dr. Mehran Arian and Dr. Elaheh Javadi Mosavi for their supports.

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