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The Precipitation Changes on the Western and Eastern Aspects of Zagros Mountains

Mehrdad Kiani[a], * Daryoush Abolfathei [b]

*a . PHD of Synoptic Climatology,Shahid Beheshti University Faculty of Earth Sciences,Iran

b . Assistant Professor of Geomorfology,Paymnoor University,Iran

*Email Address : mhrdkiani@yahoo.com

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Abstract

Zagros is one of the few Mountain ranges in western Asia. The amounts of precipitation are different in the eastern and western aspects of Zagros. Precipitation annual average is 396 mm on Western aspect. The precipitation average on the eastern slopes (310 mm) is lower than the western slopes The purpose of this study is to investigate the precipitation changes on the western and eastern aspects of the Zagros Mountains using orographic due to data from 1996-2017. The study area consists of 11 meteorological stations at an altitude of 232 to 1906 m. The results is represents that, that on the west aspects of Zagros there is an increasing trend in precipitation from 1200 to 1567 m. The amounts of precipitation are decreases to Mountain ridge. Towards the eastern slopes due to the decrease in humidity contents the precipitation is lesser than Western aspects.This study is show that the monthly precipitation averages on eastern aspects stations have been a decreasing trend has been decreasing at some of the locations since 2012-2017. The precipitation annual average of stations have been analyzed scince 1996-2017. According to this analysis, the precipitation on Western aspects has been increasing from Kouhdasht (379 mm) up to Alshtar (462mm) but then decreased gradually from Boroujerd (447mm) toward Kaboudarahang (300 mm) on Eastern aspects. This study demonstrated that precipitation changes on the Zagros aspects are related to the westerlies,moisture sources location and movement Paths of precipitation systems.

Keywords: Mountain;Zagros; aspect;Synoptic;Precipitation.

Introduction

There is a relationship between precipitation and topography in mountainous regions. The humid air masses are forced to move up the mountain when faced with a mountains. Then the air temperature decreases with increasing altitude and the air humidity is condenses.High humidity condensation turns into cloudiness and heavy precipitation on the Mountatins. After the air masses pass through the mountain, air humidity and intensity of precipitation decreases. Precipitation on the Zagros Mountains has such a mechanism. The Zagros Mountains is part of the Alpian-Himalayan orogenic belt [1].The Zagros ranges cross from northwest to southeast of Iran. These ranges play an influential role in determining the amount and distribution of precipitation on the topography of western Iran [2]. The topography of Zagros is effects the Mediterranean and Sudanese rainfall systems. So it makes that the maximum of precipitation to be observed on the windward aspects in the western Zagros Mountains. In some of scientific studies has

been mentioned to Zagros influence on Climate and synoptic patterns changes.Bart and Steinkohl [3] due to the results of theirs study determined a higher increase of the annual precipitation, especially in the western aspect of the Zagros Mountains. Low-pressure systems, which establish themselves in front of the Zagros Mountains, remain there for a significantly longer time than Mediterranean low-pressure cells, which increases the probability of rainfall in the Persian Gulf area. The Zagros Mountains have an important effect on the formation and maintenance of the low-level cyclonic circulation and mid-level anticyclonic circulation in summer [4],[5]. When westerly winds are sufficiently weak, air subsidence develops on the western slopes of the Zagros [6].But in the cold period ,Zagros Mountains produce a low-level anticyclonic circulation to the east of the range a cyclonic circulation to the west [7] The Zagros Mountains intensify the cold period frontal rains especially over the west slope and block the moist air masses from entering the interior parts of the country. Moreover, these mountains play a secondary role in creating rain days. But they are very important in the production of precipitation in the area[8]. The precipitation intensifies over the Zagros mountains due to orographic effects [9], [10], [11], [12]. The intensity and spatial extent of the rainfall differs significantly between the windward side and leeward side.In the present study, the changes of precipitation parameter are studied using the annual and monthly precipitation average values, on stations located west and east of the Zagros Mountains. The results of this study can indicate that the Zagros meridian or northwest - southeast position of Zagros is the most important factor in precipitation changes in western Iran. Because, this mountains is a natural barrier when western winds and precipitation systems are facing with it. But, this Mountain is changes the amount of precipitation to a certain altitude.

2. Materials and Methods

The Zagros Mountains located in the west of Iran with many peaks. The Oshtorankoh (4151 m) and Garin (3623m) are highest peaks in western Iran. The Zagros topography consist of mountain ranges, valleys, plains and slopes. October to April are the wet months of year in western Iran. The 11 stations in this area have been selected for the study. Daily rainfall data of the stations are related to the period 1996-2017. Daily precipitation data for the period 1996 - 2017 have been averaged to obtain the Annual and Monthly (October to April) values. In this study, a cross section is selected from the western part toward eastern part of Zagros topography in western Iran(Figure.1). This section starts from Dehloran in the west and extends to the Kaboodarahang in eastern part of Zagros.

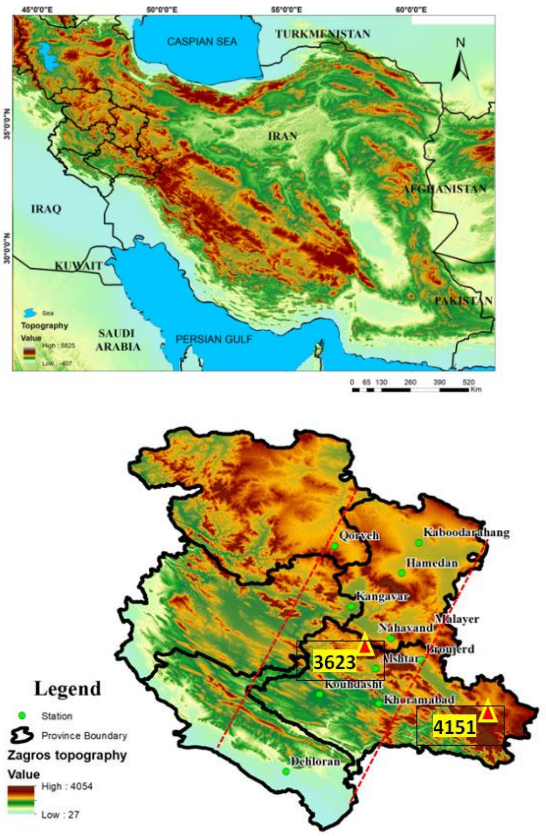

Figure 1. the scattering of study stations on the Zagros topography

In this study, the stations selected have located on western aspect and eastern aspect. The stations situated on the western aspect (8stations) are more than eastern stations (Table.1).Dehloran,Kouhdasht,Khoramabad,Alshtar,Boroujerd,Nahavand,Kangavar,Malyaer

have located on western Zagros and Qorveh,Hamedan, Kaboodarahang are eatsern stations.The precipitation Monthly averages(October to April) on the western stations in general are more than the eastern stations.The most of precipitation Monthly average has calculated for the Alshtar station on western Zagros(Table 1).

Table 1. Precipitation monthly average on the western-eastern cross section of Zagros

Station	province	Aspect	Altitude (m)	precipitation Monthly average (mm)
Dehloran	Ilam	Western	232	34.46
Kouhdasht	Lorestan	Western	1199.8	50.85
Khoramabad	Lorestan	Western	1147.8	61.15
Alshtar	Lorestan	Western	1567.2	62.31
Boroujerd	Lorestan	Western	1629	59.79
Nahavand	Hamedan	Western	1680.9	52.15
Kangavar	Kermanshah	Western	1468	49.51
Malayer	Hamedan	Eastern	1777.8	41.03
Qorveh	Kordestan	Eastern	1906	40.06
Hamedan	Hamedan	Eastern	1741.5	37.82
Kaboodarahang	Hamedan	Eastern	1679.7	37.11

3.RESULTS AND DISCUSSION

On the Zagros western aspect the precipitation Monthly averages increases with altitude from 1200 -1567 m and then decreases (Figure.2). The eastern aspects receives less precipitation. Because, humidity density and cloud thickness is lesser than the western aspects (Figure.3). The Mediterranean and Sudanese air masses have deposited most of its humidity on the western aspects of the Zagros Mountains. Therefore the eastern stations have located on rain shadow slopes of the Zagros. The precipitation on the eastern aspects decreases continuously from about 1900 to 1700 meters.

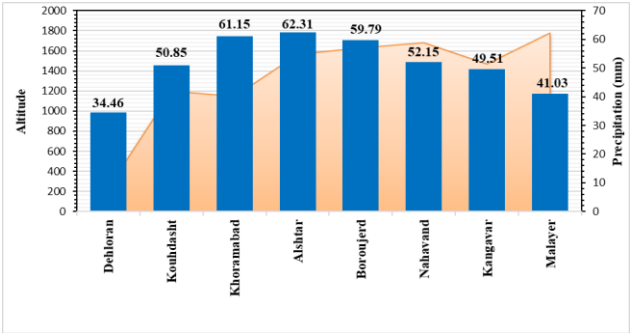

Figure 2: Relationship between precipitation monthly average(1996-2017) and altitude on the western aspects of Zagros.

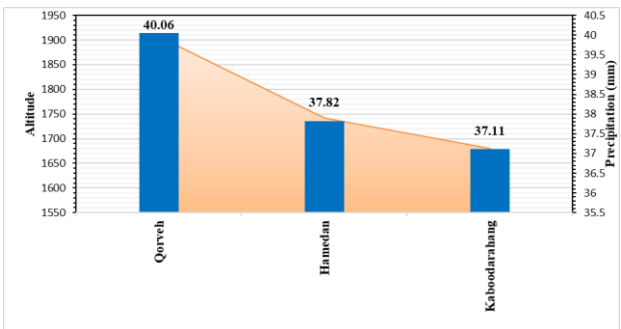

Figure 3. Relationship between precipitation monthly average (1996-2017) and altitude on the eastern aspects of Zagros.

The study also represented that the monthly precipitation of the western stations has been decreasing since 2008-2011 (Table 2). Table 3 is represents monthly precipitation of eastern stations of the zagros has declined in recent years (2012-2017) compared to the previous periods(1996-2011). Monthly precipitation on eastern aspects in Qorveh, Hamedan and Kaboodarahang has been decreasing significantly 1996 to 2017.

Table 2. precipitation Monthly Average on the western stations of Zagros (1996-2017)

Year	Dehloran	Kouhdasht	Khoramabad	Alshtar	Boroujerd	Nahavand	Kangavar	Malayer
1996-99	52/24	48/38	66/50	58/06	59/77	48/65	49/11	36/87
2000-03	33/43	55/64	60/01	70/33	61/85	51/81	53/21	41/07
2004-07	36/33	58/93	72/14	70/75	66/44	55/61	52/70	44/14
2008-11	23/67	40/59	50/05	50/52	48/96	46/63	44/08	39/33
2012-15	36/83	48/20	58/99	57/44	59/29	49/14	45/39	42/73
2016-17	36/08	53/40	57/28	66/96	65/06	69/96	55/66	43/07
Average	36/42	50/86	60/83	62/34	60/23	53/63	50/02	41/20

Table 3. precipitation Monthly Average on the eastern stations of Zagros (1996-2017)

Year	Qorveh	Hamedan	Kaboodarahang
1996-99	43/01	34/86	35/13
2000-03	39/02	42/51	42/33
2004-07	41/63	39/09	37/57
2008-11	44/85	41/03	36/91
2012-15	35/16	33/66	30/14
2016-17	33/32	33/69	29/40
Average	39/50	37/47	36/42

4. Conclusions

The bar chart of the precipitation monthly average along the western aspects of the Zagros is confirmed that the precipitation is gradually increasing with altitude from Dehloran toward Alshtar .But, The decreasing trend is initialize gradually from Broujerd toward Malayer. Alashtar station is situated at the elevation of 1567 m and the Nahavand is situated at the elevations of 1680m but the rainfall of Nahavand is less compared to Alashtar (Figure 4).

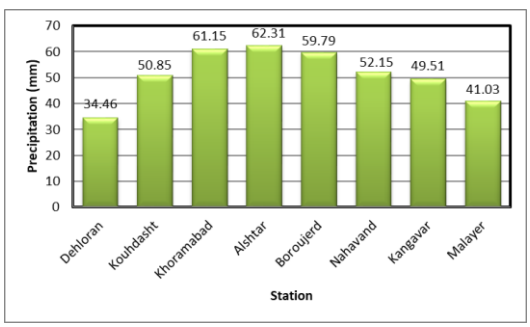

Figure 4: The chart of precipitation Monthly average (1996-2017)for western stations of zagros

The precipitation annual total average (1996-2016) has been 396 mm on the western stations. But ,it has been less than 310 mm. Because, during the November until the end of April, the heavily rain on western Iran due to westerlies and Mediterranean and Sudanese systems that comes from of west. The eastern synoptic systems such as easterlies and Siberian high pressure system are dry and not enough humidity.

The precipitation annual total average has been calculated from 1996-2017 for all the selected stations (Figure 5). The precipitation annual total average has been increasing from Kouhdasht (379 mm) up to Alashtar (462 mm) but then again from Boroujerd (447 mm) in western aspects toward Kaboudarahang (300 mm) it has been decreased rapidly. It is also determined that the eastern stations (Qurveh,Hamedan, Kaboodarahang) receives less precipitation (310 mm) .

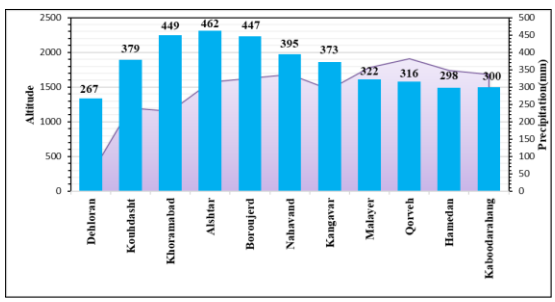

Figure 5: Relationship between precipitation annual totals average(1996-2017) and altitude on the all the stations from west toward east aspects of Zagros.

Figure 6 represents the precipitation changes on Zagros topography in western Iran (1996-2017). The annual precipitation average on the western aspects is larger than the eastern aspects.

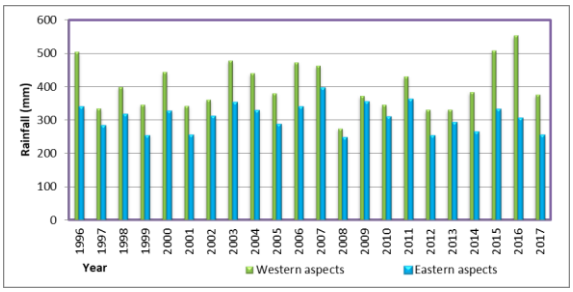

Figure 6: precipitation changes on western and eastern aspects of Zagros Mountains (1996-2017)

4. Conclusions

In This study investigated precipitation changes on western and eastern aspects of the Zagros Mountains. The precipitation on the western aspects of Zagros is more than its eastern aspects. On the western slopes, precipitation is increasing from 1200 m to 1600 m and then decreases. This decreasing trend continues toward the eastern stations. The reason for the decrease in precipitation on the eastern slopes is the decrease in humidity and cloudiness. The westerlies and the Sudanese and Mediterranean precipitation systems that come from of the west facing to the Zagros Mountains and are forced to ascending movements. Most of the humidity of these synoptic systems on the western aspects turns into rain. The annual precipitation of the western aspects is higher than the eastern aspects. Easterlies winds and synoptic systems such as the Siberian high pressure system not enough humidity and are dry. Therefore, the eastern stations are located on the shadow-rain slopes of Zagros Mountains. Also, the precipitation monthly average of the eastern stations has declined in recent years compared to previous years.

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