Zoning vulnerability of climate change in variation of amount and trend of precipitation - Case Study: Great Khorasan province

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Introduction

The Earth's climate continuously change. However, the Earth's atmosphere tries to reach a balance. In the recent decades, the intense rainfall events were observed in different parts of the world. These events caused phenomena such as severe floods and destructive waves. If such severe and stormy rains occur in areas without vegetation, it would be more threatening in these areas. The soil is less permeable in such areas, and the significant amount of the rainfalls is transformed into runoff and flood that caused damages. This feature can be clearly observed in arid regions such as East of Iran.

Iran is one of the top 10 countries of the world in the cause of disaster-prone, because of its geographical position. Due to the climate condition in North-East of Iran, This area is annually affected by heavy rainfalls that lead to floods. These floods are damaged the human life there.

Materials & Methodology

17 synoptic stations are selected in Great Khorasan province with the minimum of 21 and maximum of 62 years of statistical length. The precipitation pattern and its changes during the study period are investigated by the Mann-Kendal test.

Table 1: Specification of studied weather stations

No.	Station	Latitude	Longitude	Height (m)
1	Bojnoord	37 ° 28'	57 ° 19'	1091.0
2	Boshruyeh	33 ° 54'	57 ° 27'	885.0
3	Birjand	32 ° 52'	59 ° 12'	1491.0
4	Torbat-e Jam	35 ° 15'	60 ° 35'	950.4
5	Torbat-e Heydarieh	35 ° 16'	27 ° 12'	1450.8
6	Khoor Birjand	32 ° 56'	58 ° 26'	1117.4
7	Sabzevar	36 ° 12'	57 ° 43'	977.6
8	Sarakhs	36 ° 32'	61 ° 10'	235.0
9	Ferdows	34 ° 01'	58 ° 10'	1293.0
10	Ghaen	33 ° 43'	59 ° 10'	1432.0
11	Ghouchan	37 ° 04'	58 ° 30'	1287.0
12	Kashmar	35 ° 12'	58 ° 28'	1109.7
13	Golmakan	36 ° 29'	59 ° 17'	1176.0
14	Gonabad	34 ° 21'	58 ° 41'	1056.0
15	Mashhad	36 ° 16'	59 ° 38'	999.2
16	Nehbandan	31 ° 32'	60 ° 02'	1211.0
17	Nishabur	36 ° 16'	58 ° 48'	1213.0

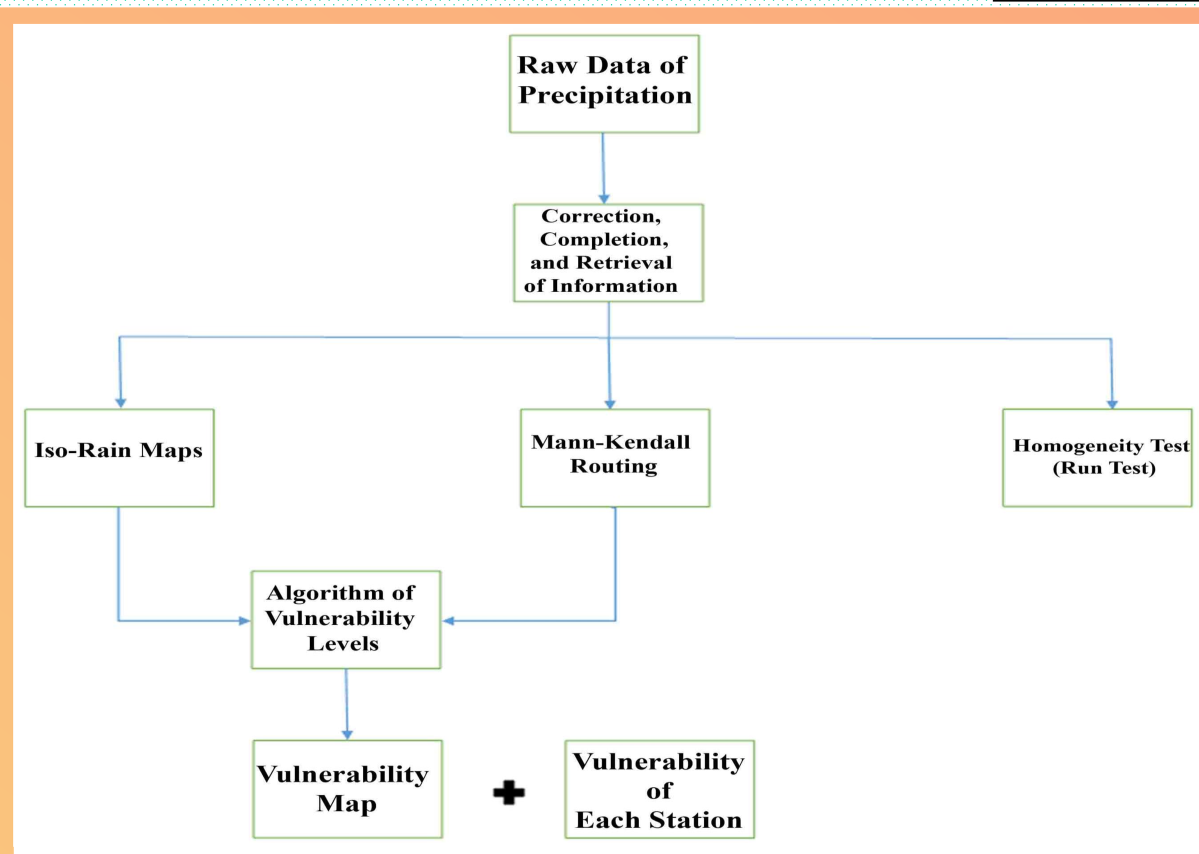

Figure 1: Executive algorithm for determination of climatic vulnerability levels.

Results

Analysis of trends in total annual precipitation and mean annual precipitation:

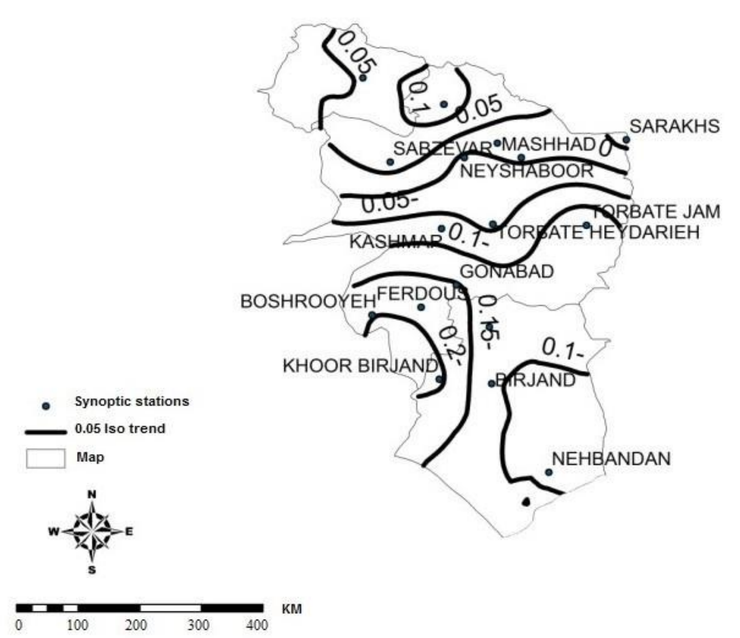

Figure 2: Iso-trend map of annual precipitation changes by Kendall method

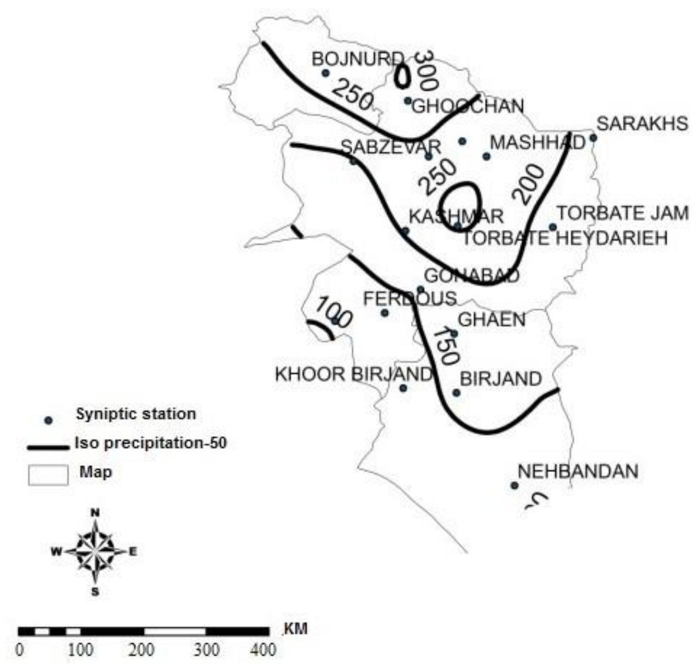

Figure 3: Iso-Precipitation map of 1951-2015

Evaluation of treats and vulnerability level:

Table 2: Annual precipitation in terms of vulnerability levels

Number	Annual precipitation [mm]	Vulnerability levels
1	$50 \leq X < 100$	Complete
2	$100 \leq X < 150$	Extensive
3	$150 \leq X < 200$	Moderate
4	$200 \leq X < 250$	Slight
5	$250 \leq$	No threat

Table 3: Climatic potential threats based on the annual precipitation

Station	Vulnerability levels	Station	Vulnerability levels
Birjand	**Moderate**	Boshruyeh	**Complete**
Torbat-e Jam			
Ghaen			
Sabzevar			
Sarakhs			
Kashmar	**Slight**	Khoor Birjand	**Extensive**
Golmakan		Nehbandan	
Nishapur		Gonabad	
Mashhad	**No threat**	Ferdows	
Bojnoord			
Torbat-e Hydarieh			
Ghouchan			

Table 4: Levels of vulnerability in Great Khorasan.

Station	Level of threat	Station	Level of threat
Birjand	**Slight**	Boshruyeh	**Complete**
Ghaen		Khoor Birjand	
Kashmar			
Nishapur		Gonabad	**Extensive**
Sabzevar		Torbat-e Jam	
Sarakhs			
Golmakan	**No threat**	Ferdows	
Bojnoord			
Torbat-e Heydarieh		Nehbandan	**Moderate**
Ghouchan			
Mashhad			

According to the classified threats to the trend of precipitation changes and annual precipitation, the status of the levels of threats in the studied region was obtained.

Table 5: Dimensionless coefficient ranges for each level in stations

Number	Ranges of coefficients	Threat
1	0.9 – 1	Complete
2	0.7 – 0.8	Extensive
3	0.6	Moderate
4	0.4 – 0.5	Slight
5	0.2 – 0.3	No threat

According to Table 5 and definitions made for different levels, the studied stations were classified by Kriging interpolation model as shown in the following figure.

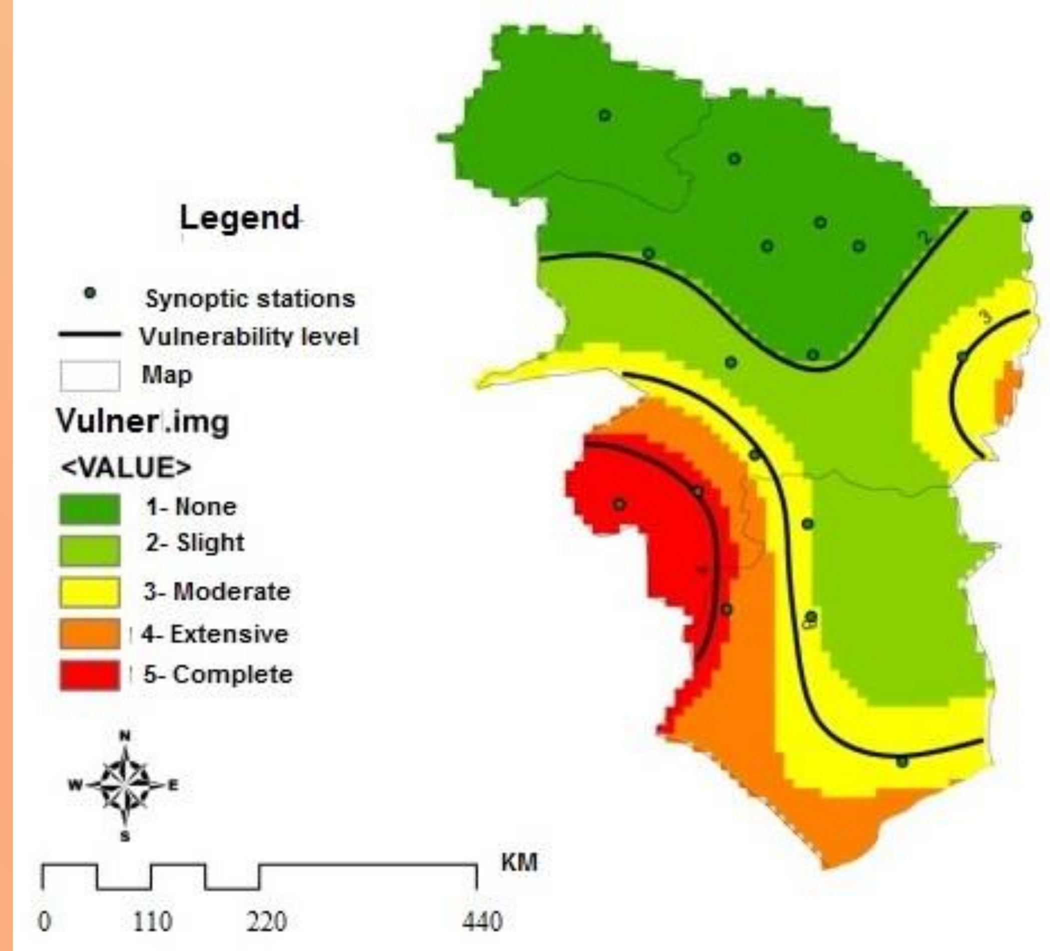

Figure 4: The map of vulnerability levels caused by climatic threats.

Conclusion

The total annual precipitation trend was positive for six stations, negative for ten stations, and zero (no trend) at only one station. In general, the northern part of the studied region showed a positive trend (Figure 4). Also, the mean annual precipitation in stations located in the eastern strip of Iran was estimated to be less than the mean annual precipitation for the whole country in most cases, indicating the arid climate of this region. More than 250 mm of rainfall per year was observed only in 4 stations. Each parameter of mean annual precipitation trend and mean annual precipitation are separately assessed at five levels of vulnerability.

Reference

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