Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 4, p. 353-360, 2015
http://www.innspub.net

INNSPUB

RESEARCH PAPER

OPEN ACCESS

Drought changes trend in Khuzestan Province, Iran

Ali Asareh[1*], Ebrahim Amiri[2]

[1]*Department of Water Science and Engineering Ahvaz branch, Islamic Azad university, Ahvaz, Iran*

[2]*Department of Water Science and Engineering , Lahijan branch, Islamic Azad university, Lahijan, Iran*

Article published on April 30, 2015

Key words: drought, standardized precipitation index (SPI), Khuzestan, 5-year moving mean.

Abstract

Iran is a dry country suffering from water crisis. With respect to the role of surface waters in the region ecosystem and the effect of drought on quantity and quality of waters, the present study was carried out to investigate drought changes trend in Khuzestan Province. Therefore, the annual rainfall statistics of synoptic stations in Dezful, Shooshtar,Behbahan, Abadan, MasjedSoleiman, Ahvaz, and Izeh were used for a period of 20 months. The accuracy and of the dataand homogeneity were tested through the run test and double mass analysis. Then, the frequency and severity of drought were studied based on the implementation of standardized precipitation index (SPI). In order to investigate drought changes trend in selected stations, 5-year moving mean was used. The obtained results showed that 10 cases of drought in Ahvaz station, 11 ones in Dezful station, 12 ones in Abadan station, 10 ones in MasjedSoleiman station, 10 ones in Behbahan station, 11 ones in Izeh station, and 8 ones in Shooshtar station had occurred. The results of the research showed that in all stations except Shooshtar station more than 50% of drought period had occurred and the trend is quite evident in the 5-year moving mean of the data. The results also indicated that in all stations the changes of 5-year moving mean had a decreasing trend and the reduction was equal to 54.55% in Abadan station, 45.58% in Ahvaz station, 49.20% in Behbahan station, 41.53% in Izeh station, 51.09% in MasjedSoleiman station, 42.20% in Dezful station, and 41.64% in Shooshtar station.

***Corresponding Author:** Ali Asareh ✉ ali_assareh_2003@yahoo.com

Introduction

Iran is a dry countrywith water crisis and drought is a weather phenomenon and a catastrophic event that causes a lot of damage. This phenomenon damages crops and leads to the decrease of yield, rapid decrease of surface flows and the loss of underground reservoirs, and changes in aquatic ecosystems such as rivers, wetlands, and or lack of rainfall compared to the long term average. Drought is different from other natural disasters because this phenomenon occurs slowly and in a relatively long period of time and sometimes it continues over several years (Shahian *et. al.*, 2011). There is not an accepted definition of drought yet. Wilhite and Glantz (1985) classified drought into four categories including meteorological drought, agricultural drought, hydrological drought, and socioeconomic drought.In all these definitions, drought isexpressed as a continuous and sustainable period when the water content in a region reduces to a considerable extent. Meteorological drought refers to a kind of drought that results from the lack of rain and it is the first sign of drought. Meteorological drought continuation results in hydrologic drought when the level of surface and groundwater supplies is lower than the normal. As the water table lowers the soil moisture reduces and causes agricultural drought. From the social-economic point of view, drought means the time when the shortage of water for human needs causes social and economic disorders. These various definitions have led to definition of different indices. Precipitation is the most important parameter which has been used in the definition of indices.Some drought definitions have focused on daily, weekly, or periodic precipitations and it seems like that such definitions do not fit the climatic conditions in Iran because in most regions of Iran wherethere is no rainfall for one or even two seasons it is not possible to determine drought as short periods of a few days and has no meaning.The research conducted by Palmer (1965) on drought is one of the first researches that consider drought as the ongoing and abnormal lack of moisture (deviation from natural conditions with long-term mean of meteorological parameters).Hong and *et. al.* (2001) evaluated three indices, Standardized Precipitation Index (SPI), Z Score Index of Annual Precipitation (ZSIAP) and China-Z Index (CZI) and expressed the advantages and disadvantages of each one. The results showed that calculating ZSIAP and CZI was easier than SPI. Moreover, when the rainfall is below the average precipitation for a period, CZI method works better than the other two ones. Pashiardis and Michaelides (2008) used SPI and RDI in order to determine arid areas in the case study of Cyprus. The results of their research indicated that both indices would effectively analyze drought. SarySarraf *et al.* (2011) investigated Aras basin drought and wet periods using dependable rainfall index (DRI), Nietzsche method, and the percent of normal precipitation index (PNPI). The results showed that in most stations the precipitation status was normal and among the applied methods, the dependable rainfall index (DRI) was better than the other ones for determining drought and wet periods by having fewer restrictions and more capabilities. Hashemi Devin and AhangarZade (2013) used the precipitation data of 17 weather stationrain gauge and synoptic stations in North Khorasan Province within the 22-year statistical period in order to monitor the meteorological drought in North Khorasan Province in GIS environment. The results of their calculations showed that Di and SPI coincided with the year of minimal rainfall showed severe and very severe drought in all the stations under study. Since Iran is located in the belt of arid and semiarid regions of the world, the drought has traditionally been proposed a problem in this area and yet it is. Statistics show that per capita of renewable water in Iran has reached from 4000 to 5000 cubic meters in decade 1950 to about 2000 cubic meters in the present condition and if the current trend is continued, it will reach to less than 1000 cubic meters in 2020. So the drought is considered as an objective reality in Iran. This leads to water resources crisis, which consequence is the socio-economic crises. Thus, identification and prediction of drought in Iran is of utmost importance so in this way, we can be aware of the occurrence of the phenomena and do proper conservation and

management measures to reduce losses and damages caused by it.Due to several droughts in recent years, studies have increased in this field and many researchers have used different methods for monitoring the drought. In this context, a relatively new index is standardized precipitation index (SPI), which several uses of it have been seen in different countries, especially the United States.Because of the importance and the role of surface streams and wetlands of Khuzestan Province in the life cycle of country, and since a remarkable volume of water flows in the rivers every year, it is very important to care for the rives and their watersheds. As precipitation is the most unstable climatic variable in arid and semiarid areas whose changes are reflected is soil moisture, surface and groundwater flows, this research aims to investigate drought changes trend within the annual scale in Khuzestan in a period of 20 years.

Materials and methods

Khuzestan Province with an area of 64,057 km² is located in the southwestern part of Iran in the bank of Arvand Rood and the Persian Gulf which has allocated about one-third of surface waters of the country to itself as well as the oil and gas reserves. Five major and huge rivers of Iran including Karun, Dez, Karkhe, Jarahi, and Hendijan are flowing into it and with respect to climatic conditions and the possibility of agricultural activities during the year and connecting to the sea and easy access to domestic and foreign markets due to owning all air, sea, rail, and land communication facilities,it is globally distinctive and unique.This is while in spite of benefiting from the most important water resources development projects and their application, the province is unfortunately open to the various and the most widespread pollutants of water resources and due to many industrial, municipal, agricultural polluting factors and also natural sources of salt, the scientific and administrative concerns on the quality and contamination of water resources have a special stand in the province.

Precipitation in upstream basin of Karun varies from 250 mm to 1700 mm particularly in the high altitudes. The average rainfall in this area is 650 mm. Rainfall in Bazaft basin is generally more than 1500 mm per year and as we move towards the southeastern part of the basin the rainfall decreases. The highest rainfall occurs since November to April and torrential rains often pour down in the region from December to February.Mountainous areas with an altitude of more than 2000 m above the sea level are covered with snow every year. In the upper basin, the hottest month of the year is June and the coldest month is January and the maximum monthly temperature is 40°c and the minimum temperature recorded is -14°c. The mean annual evapotrans-piration fluctuates between 1000 to 3000 mm.

In this research, I order to investigate drought in Khuzestan province the standardized precipitation index (SPI) for a period of 20 years (1992-2012) was analyzed. The selected synoptic stations include Dezful, Shooshtar, Behbahan, Abadan, MasjedSoleiman, Ahvaz, and Izeh stations. The random data were analyzed by Spearman Test of sequences and the accuracy and homogeneity were controlled by run test and the incomplete data were replaced by regression method.Furthermore, SPSS software was used to determine correlation coefficient. In order to examine drought changes trend the five-year moving mean in various stations was used. A view of stations in Khuzestan is displayed in Fig. (1).

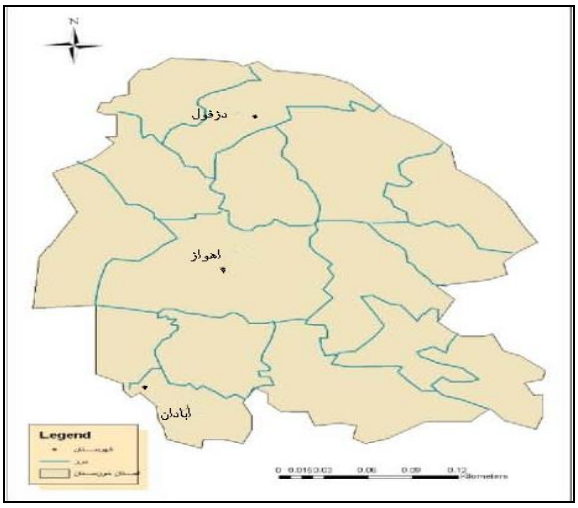

Fig. 1. Location of selected stations in the basin.

Calculating Standardized Precipitation Index (SPI)

According to the above points, the monthly precipitation data of the specific stations were reconstructed and the annual precipitation data for each station was obtained. After calculating the mean and standard deviation of 20-yerar period, SPI values were calculated via the Equation (1):

$$(1)\quad spi = \frac{x - \bar{x}}{sd}$$

Where, SPI is standardized precipitation index, X is total precipitation in a given year, $\overline{x}$ is the mean of total precipitation in a given year, and SD is standard deviation of data.

According to this method drought occurs when SPI is continuously negative and reaches -1 or less and it ends when SPI is positive. The cumulative amounts of SPI show the magnitude and the severity of drought (Hays, 2006). Table (1) shows drought classification according to this index.

Table 1. Drought classification according to Standardized Precipitation Index (SPI).

Drought Category	SPI
Very severe wet period	More than 2
Severe wet period	1.5 to 1.99
Mild wet period	1 to 1.49
Normal	0 to 0.99
Mild drought period	0 to -0.99
Moderate drought period	-1 to -1.49
Severe drought period	-1.5 to -1.99
Very severe drought period	-2 and less

Results and discussion

As mentioned before, according to this method drought occurs when SPI is continuously negative and reaches -1 or less and it ends when SPI is positive.The cumulative amounts of SPI show the magnitude and the severity of drought. Table (2) displays the results of calculations. According to the obtained results for SPI in Table (2) and with respect to the limits specified in Table (1), 10 examples of drought have occurred in Ahvaz station among which 5 ones are mild drought, 3 ones are moderate and 2 ones are severe drought. 11 cases of drought have occurred in Dezful station among which 6 ones are mild drought, 4 ones are moderate and one is severe drought. 11 examples of drought have also occurred in Abadan station among which 7 ones are mild drought, 2 ones are moderate and 2 ones are severe drought. The results of the other stations are displayed in Table (3).

The results of the research indicate that the most severe drought period in Ahvaz station is related to 2011-2012 when the average annual rainfall is 83.2 mm and in Abadan and Izeh stations the most severe drought periods are related to the same year by the average annual rainfall of 53.2 mm and 352.5 mm, respectively.

On the other hand, the most severe drought period in Behbahan and MasjedSoleiman stations are related to 2008-2009 by 130.9 mm and 176 mm, respectively; the most severe drought period in Dezful is related to 2007-2008 by 132 mm and in Shooshtar is related to 1999-2000 by 131.8 mm.

Table 2. The obtained results for SPI in different stations during the statistical period (1993 to 2013).

Station	Ahvaz		Dezful		Abadan	
year	mean annual precipitation	SPI	mean annual precipitation	SPI	mean annual precipitation	SPI
93-94	109.2	-1.27	211.6	-0.89	117.8	-0.66
94-95	193.6	-0.24	370.8	+0.39	211.8	+1.07
95-96	285.7	+0.87	336	+0.11	243.8	+1.66
96-97	195	-0.23	276.5	-0.37	128	-0.47
97-98	337.9	+1.5	577.8	+2.07	186	+0.59
98-99	198.1	-0.19	318.6	-0.03	164.5	+0.2

Station	Ahvaz		Dezful		Abadan	
year	mean annual precipitation	SPI	mean annual precipitation	SPI	mean annual precipitation	SPI
99-2000	130.8	-1	174.1	-1.12	131.5	-0.41
2000-2001	240	+0.32	319.2	-0.02	159.6	+0.11
2001-2002	270.2	+0.68	427	+0.85	196.1	+0.78
2002-2003	165.3	-0.59	175.5	-1.19	113.1	-0.75
2003-2004	265.8	+0.63	291.1	-0.25	196.6	+0.79
2004-2005	220.5	+0.08	350.4	+0.23	145.6	-0.14
2005-2006	220	+0.07	382.4	+0.49	240	+1.59
2006-2007	225.9	+0/14	411.2	+0.72	164.8	+0.2
2007-2008	100.2	-1.38	132	-1.54	92.4	-1.13
2008-2009	85.8	-1.55	164.3	-1.28	89.3	-1.18
2009-2010	247.3	+0.4	330.2	+0.06	128.1	-0.47
2010-2011	141.8	-0.87	283.5	-0.31	61.5	-1.7
2011-2012	83.2	-1.59	176.4	-1.18	53.2	-1.85
2012-2013	332.9	+1.44	365.2	+0.35	135.9	-0.33

Table 2 (continued). The obtained results for SPI in different stations during the statistical period (1993 to 2013).

Station	MasjedSoleiman		Behbahan		Izeh		Shooshtar	
year	mean annual precipi-tation	SPI	mean annual precipi-tation	SPI	mean annual precipi-tation	SPI	mean annual precipi-tation	SPI
93-94	285.4	-0.77	175.9	-1.05	466	-0.62	176.1	-0.88
94-95	626.2	+1.24	499.1	+1.27	813.3	+0.58	429.4	+1.01
95-96	537.6	+0.72	431.3	+0.78	1000.4	+1.23	398	+0.77
96-97	356.2	-0.35	249.2	-0.5	604	-0.14	238.9	-0.42
97-98	591.9	+1.04	618.1	+2.12	830.8	+0.64	437.8	+1.07
98-99	408.3	-0.04	347.3	+0.18	489.1	-0.54	345.5	+0.38
99-2000	204.5	-1.24	157.6	-1.18	384.7	-0.90	131.8	-1.22
2000-2001	360.1	-0.33	197.8	-0.89	501.3	-0.50	328.3	+0.25
2001-2002	499.3	+0.49	530.5	+1.49	965.4	+1.10	336.9	+0.32
2002-2003	336.7	-0.47	190.1	-0.95	513.2	-0.46	166.7	-0.96
2003-2004	486.4	+0.42	425.9	+0.74	567	-0.27	417.3	+0.92
2004-2005	482.3	+0.39	359.7	+0.27	686.1	+0.14	356.2	+0.46
2005-2006	403.5	-0.07	370.8	+0.35	987.3	+1.18	317.2	+0.17
2006-2007	493.2	+0.46	382.7	+0.43	690.4	+0.16	386.6	+0.69
2007-2008	215.5	-1.17	138.6	-1.32	359.8	-1	141.9	-1.14
2008-2009	176	-1.41	130.9	-1.37	391	-0.88	223.9	-0.52
2009-2010	327.5	-0.52	314.3	-0.06	695.1	+0.17	309.2	+0.11
2010-2011	266.1	-0.88	247.5	-0.54	386.1	-0.90	225.6	-0.52
2011-2012	247.5	-0.99	256.3	-0.05	352.5	-1.01	178.8	-0.87
2012-2013	445.8	+0.17	421.7	+0.71	796	+0.52	343	+0.36

Table 3. Drought frequency in the studied stations during 20 years based on SPI.

Station	Severe drought	Moderate drought	Mild drought	Normal	Mild wet	Severe wet
Ahvaz	2	3	5	7	1	2
Dezful	1	4	6	8	-	1
Abadan	2	2	7	6	1	2
MasjedSoleiman	–	3	9	6	2	-
Behbahan	–	4	6	7	2	1
Izeh	–	2	9	6	3	-
Shooshtar	–	5	3	10	2	-

Drought Changes Trend in Different Stations

Drought changes trend in different stations is displayed in fig.s 2 to 8. In all the stations, the changes trend of 5-year moving mean shows that the rate of annual precipitation was decreasing and the reduction was 54.55% in Abadan station, 45.58% in Ahvaz station, 49.29% in Behbahan station, 41.53% in Izeh station, 51.09% in MasjedSoleiman station, 42.20% in Dezful station, and 41.64% in Shooshtar station.

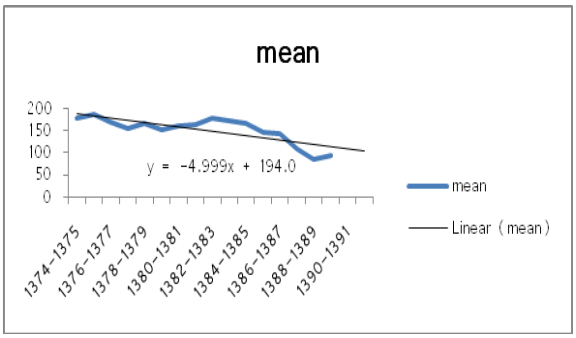

Fig. 2. 5-year moving mean of annual precipitation in Abadan station.

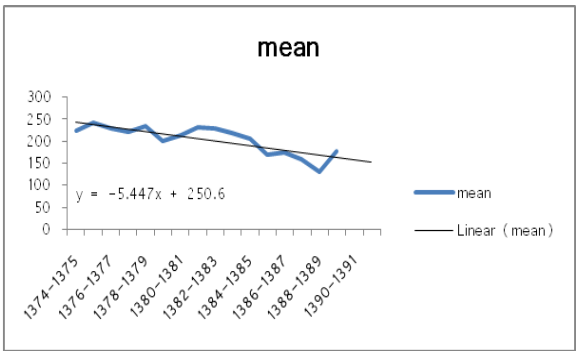

Fig. 3. 5-year moving mean of annual precipitation in Ahvazstation.

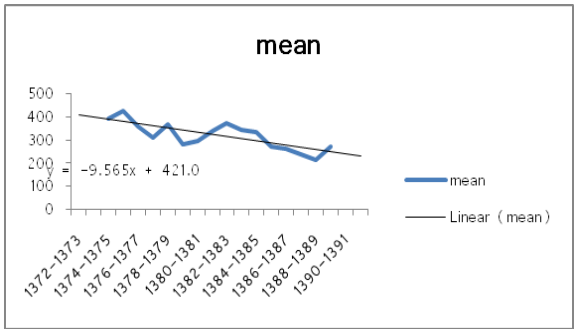

Fig. 4. 5-year moving mean of annual precipitation in Behbahanstation.

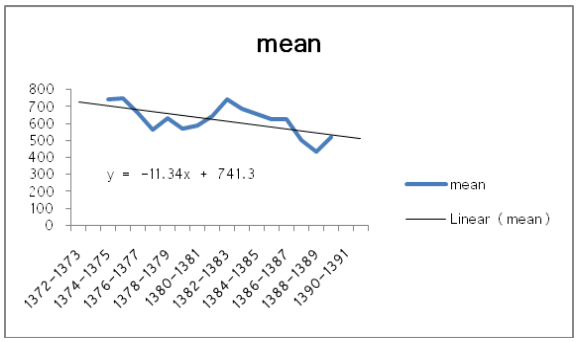

Fig. 5. 5-year moving mean of annual precipitation in Izehstation.

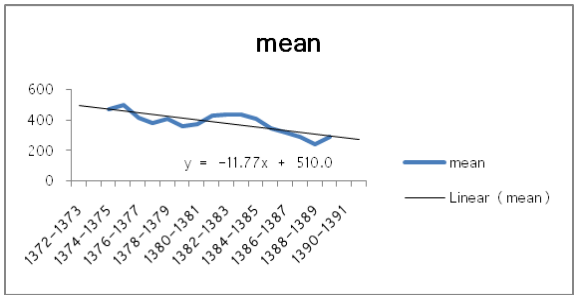

Fig. 6. 5-year moving mean of annual precipitation inMasjedSoleimanstation.

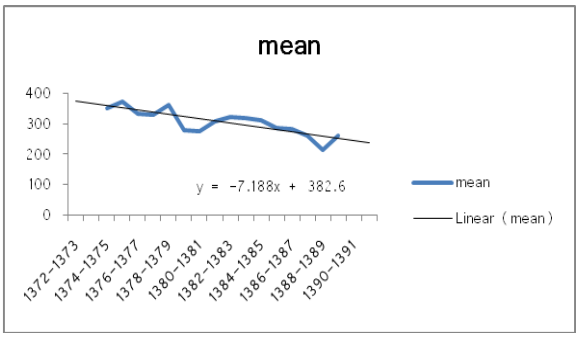

Fig. 7. 5-year moving mean of annual precipitation in Dezfulstation.

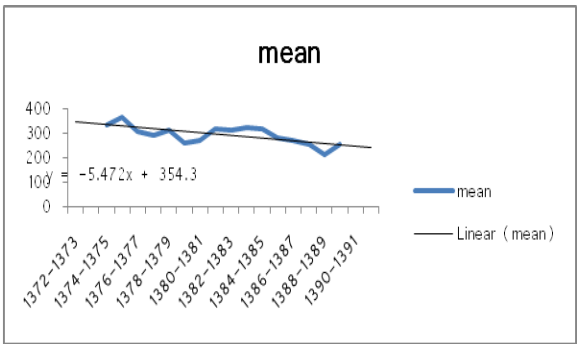

Fig. 8. 5-year moving mean of annual precipitation in Shooshtarstation.

Conclusion

Since this research aims to determine drought periods in Khuzestan province, it can be stated that investigating the other parameters and comparing them can be more useful, but it is evident that according to the studies carried out by KhaliliEghdam *et al.* (2007), Zare' Abyaneh and Mahboobi (2004) on drainage basins in Iran, SPI is a good index for evaluating different characteristics of drought and wet periods. The results of the present research showed that according to this index 10 examples of drought have occurred in Ahvaz station among which 5 ones are mild drought, 3 ones are moderate and 2 ones are severe drought; 11 cases of drought have occurred in Dezful station among which 6 ones are mild drought, 4 ones are moderate and one is severe drought; 11 examples of drought have also occurred in Abadan station among which 7 ones are mild drought, 2 ones are moderate and 2 ones are severe drought; 10 examples of drought have occurred in Behbahan station among which 6 ones are mild drought, 4ones are moderate; 11 examples of drought have occurred in Izeh station among which 9 ones are mild drought and 2 ones are moderate drought; 12 examples of drought have occurred in MasjedSoleiman station among which 9 ones are mild drought and3 ones are moderate drought; 8 examples of drought have occurred in Shooshtar station among which 3 ones are mild drought and 5 ones are moderate drought. A look at the data in this research leads to the conclusion thatin all stations except Shooshtar station more than 50% of the times during the research period, drought has occurred. Furthermore, the changes trend of 5-year moving mean in all stations shows that the rate of annual precipitation was decreasing, and the highest precipitation reduction belonged to Abadan station by 54.55% and the lowest precipitation reduction belonged to Izeh station by 41.53%.

Acknowledgements

The authors find it necessary to sincerely thank the respected authorities of the Faculty of Agriculture and Natural Resources and the Research Assistant of Ahvaz Islamic Azad University for their generous cooperation.

References

Farajzadeh M, MovahedDanesh A, Ghaemi H. 1995. Drought in Iran. Journal of Agriculture, **5(1, 2),** Tabriz University.

Hashemi Devin M, Ahangar Zadeh Z. 2013. Monitoring meteorological drought in North Khorasan Province in GIS environment. The First National Conference on Climate, Kerman.

Hong WU, Hayesi JM, Weiss A, Qihn. 2001. an evaluation of the standardized presipitationindx, The china –z index and the statitcal z-score. International journal of climatology, vol. 21, pp.745-758.

Khalili Eghdam N, Mosaedi A, Latifi N. 2007. Investigating drought and its occurrence trend in Uremia. Journal of Agriculture and Natural

Resources, 4(5): Special Issue of Crop and Plant Breeding.

Palmer WC. 1965. Meteorological drought. USWB. Res. Paper no. 45.

Pashiardis S, Michaelides S. 2008. Implementation of the standardized precipitation indx(SPI) and the reconnaissance drought indx (RDI) for regional drought assessment :A case study for cyprus . europen water . nol.23/24,pp.57-65.

SarySarraf B, GholiNejad N, Kamani A. 2011. Investigating drought and wet periods in Aras basin using precipitation-based profiles. Quarterly of Lar Natural Geography, 4 (12).

Shahian R, Jamea A, Mostamand R, Haghighat M, Dehghan H. 2011. Zoning crisis threshold of Fars Province droughts by means of standardized precipitation index (SPI) to achieve drought risk management.

Wilhite DA, Glantz MH. 1985. understanding the droght phenomenon: the role of definitions, water international,vol . **10,** pp.111-120.

Zare' Abyaneh H, Mahboobi A. 2004. Investigating drought conditions and its trend in Hamadan based on drought statistical indices. Research and productivity in agriculture and horticulture, No. **66,** fall 2004.