Meteorological drought monitoring using several drought indices (Case study: Aligudarz county)

Tahmine Dehghani[1], Hedieh Ahmadpari[2*], Fatemeh aghelmirrezaei[3], Ahmad Godarzi[4]

1-M.Sc. Graduate of Irrigation and Drainage, Department of Irrigation and Drainage, College of Aburaihan, University of Tehran, Iran.

2-M.Sc. Student of Irrigation and Drainage, Department of Irrigation and Drainage, College of Aburaihan, University of Tehran, Iran

3-M.Sc. Graduate of Hydrology and Water Resources, Shahid Chamran University of Ahvaz

4-PhD of Water Structure, Faculty of Agriculture, University of Lorestan, Khorramabad, Iran

Abstract

Drought is caused decrease by of rainfall, runoff and soil moisture and also increase of air temperature and water table compared to long time average condition. Drought can be divided into four major groups of Meteorological, Hydrological, Agricultural and Social-economical which meteorological drought will be evaluated by rainfall values comparing with its average. The application of drought indicators in summarizing many of the effective parameters in drought is useful for planners at different levels. In this research, PNI, DI, SPI, ZSI, CZI and MCZI indices have been used to monitor the drought in Aligudarz county. In this study, DIP software is used to calculate meteorological drought indicators; and the value of these indicators for the Kazemabad station of Aligudarz county in a period of 48 years (1970-2018) has been estimated and analyzed. The results show that SPI, PNI, CZI and ZSI indices have almost the same trend. And the trends of SPI, CZI and ZSI indices are almost the same. With these interpretations, it can be concluded that the three indices SPI, CZI and ZSI for determining dry periods achieve the same results. Also, the trend of PNI index is in line with the trend of these three indicators. The DI index has a trend similar to the four mentioned indices, but the intensity of fluctuations is very high. The MCZI index is quite different from the other five indices in the process and in determining drought. The MCZI index is not able to display and determine the drought and wetness of this region on an annual scale because the results are the same for all years (Moderately dry).

Keywords: DIP software, Drought indicators, CZI, MCZI, ZSI, PNI, SPI

Introduction

Drought is an inevitable phenomenon and one of the disasters that should be considered without the possibility of prevention, but it can be managed and organized. In general, from a climatic point of view, drought is a kind of deviation from the average conditions (Miryaghobzade and Khosravi, 2018). The damage and adverse effects of drought are so severe that some consider it is more damaging than other natural disasters such as floods and earthquakes. Drought management can be one of the most effective measures in reducing drought damage (Tahan and Kheiri, 2009). Runoff drought is the most important type of drought due to the high dependence of many activities on surface water resources (Nikbakht et al, 2012). As a result, develop drought response plans and its management is very important. Drought monitoring is one of the basic components of drought risk management. It is typically done using various drought indicators that are effectively continuous rainfall and other climatic variables (Ghasemi et al, 2011). Several indicators are presented to decide on the characteristics of hydrological and meteorological drought. These indicators are generally based on one or more climatic elements (Salahi et al,2018). Some drought indicators can be: precipitation deciles Index (DPI), Palmer Drought Intensity Index (PDSI), Normal Precipitation Percentage Index (PNPI), Surface Water Storage Index (SWSI), Effective Precipitation Index (SPI), Index Crop moisture (CMI), reductive drought index (RDI) and rainfall anomalies index (RAI). Nikbakht et al,(2012) Determined the severity of drought flow with normal index percentage (PNI) in the western basins of Lake Urmia located in northwestern Iran. Flow records were obtained from 14 hydrometric stations for the period October 1975 - September 2009. The worst drought of current occurred at almost all stations between 1999-2000 and 2000-2001. The severity of PNI-based stream droughts has increased over the past 34 years. Ghasemi et al (2011) Examined two indicators for monitoring drought in Hosseinabad plain (located in the Southeast of Birjand city in iran).Indicators used include deciles and standard precipitation indices. The comparison of indices is based on drought cases and classes given at 12 synoptic stations over 11 years, as well as the 1998-2001 drought. The results show that SPI responds slowly to the onset of drought. DI seems to be very responsive to the rainfall events of a particular year, But it is contradictory in terms of space and time. It was found that SPI can detect the onset of drought, its spatial and temporal changes continuously, and SPI has a greater response to emerging drought and better performance. Mashari Eshghabad et al (2014), examined the performance of meteorological drought indicators at different time scales in the Tajan(Tejen) Basin(located in the north of Iran). Indicators used in this study are: normal rainfall percentage (PNPI), Z-score index (ZSI), standard precipitation index (SPI), China Z index (CZI), modified CZI (MZCI) and decile precipitation index (DPI). Drought indices in time scales of 1, 3, 6, 9, 12, 18, 24 years of minimum rainfall with very severe drought and the method of correlation coefficients between drought index values and monthly rainfall were determined. The results showed that the best indicator on the annual time scale is DPI, while on the time scale of 1, 6, 12 and 24 months, PNPI is the best indicator. MCZI was the best indicator for the 9 and 48 month time scales and ZCI had the highest efficiency for the quarterly scale. Tavazohi and Nadoushan (2018),conducted a study to evaluate drought in Zayandehrud river basin using standard precipitation indices (SPI) and Normal- ized difference drought index (NDDI). To calculate the SPI (Standard Sediment Index), the historical daily rainfall records of seven hydrometric stations for 15 years from 2000 to 2015 were collected at intervals of three and six months as well as one year, and the SPI was calculated by DIP software. Based on the results obtained from the SPI index, the drought in Isfahan was almost normal and relatively dry. The NDDI index shows an upward trend in drought over a 15-year period. Sobhani et al (2020), evaluated and monitored the drought and its indicators in Ardabil province. Using rainfall and temperature data in the 26-year period (1993-2018), from five synoptic stations in Ardabil province, droughts in this province were calculated using four indicators CZI, SPI, ZSI and MCZI in DIP software. The results indicated that very severe droughts on the 12-month scale occurred less than the 6-month scale and moderate droughts were more than severe and very severe droughts at 5 stations. The severity of drought at 12-month scale was higher than 6-month scale in TOPSIS model, but VIKOR model indicated more severe drought at 6-month scale than 12-month scale. The purpose of this study is to investigate the drought in Aligudarz county using PNI, DI, SPI, ZSI, CZI and MCZI indicators.

2- Materials and methods

2-1-Study area

Aligudarz is located in the east of Lorestan. The population of this county is 131,534 thousand people. It is located in a mountainous area with a very cold climate in the east of Lorestan province and is also one of the high cities and cold regions of Iran. The average annual rainfall in this region is 430 mm. Kazemabad is a village in the central part of Aligudarz city in Lorestan province of Iran. Kazemabad station is located in the Dez River Basin at an altitude of 2022 meters above sea level in longitude 49° 40' 5'' and latitude 33° 9' 0'' near the village of Kazemabad. Dez is a river that originates from the middle Zagros mountain range in Lorestan province, Oshtrankooh and Qalikuh mountains, enters Karun river. The length of the Dez River from the headwaters to the end is 480 km. The following figure shows the geographical location of the Kazemabad station (Figure 1).

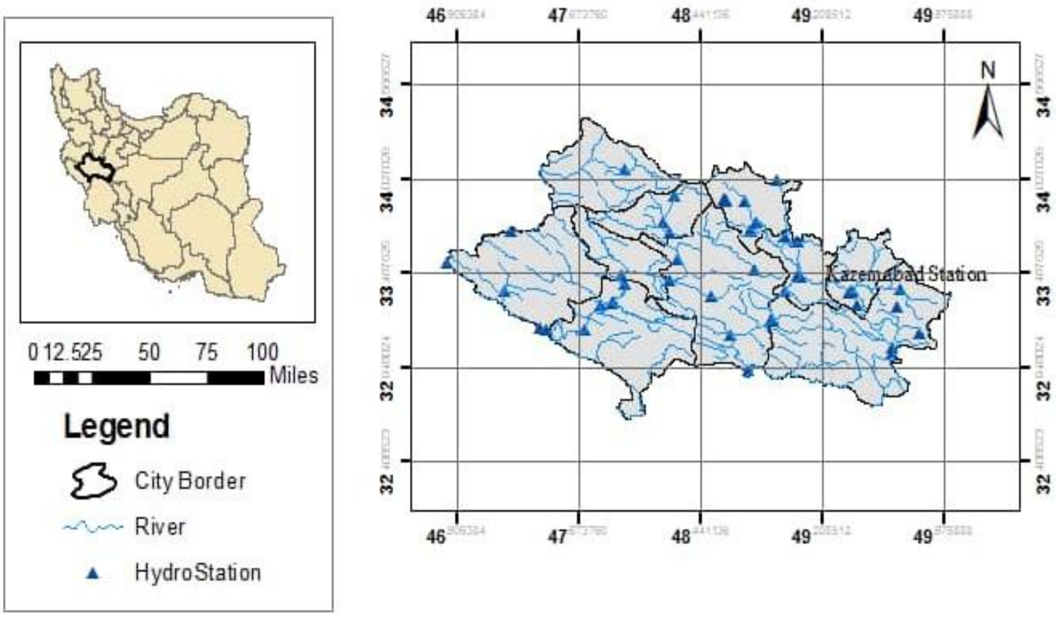

Figure 1. The geographical location of the Kazemabad station

2-2- Drought indicators

To quantitatively and qualitatively assess the phenomenon of drought, indicators such as drought indicators are used around the world (Miryaghobzade and Khosravi, 2018). In this study, rainfall data of Kazemabad synoptic stations, which are related to Lorestan water department, were used. Statistical data is from 1969 to 2018(49 years). DIP software was used to perform the calculations. With this software (determination of drought indices) which runs under Windows, drought indices can be obtained by reading meteorological information. The indicators used in this software are (SPI), (PNI), (DI), (ZSI), (CZI), (MCZI). A brief explanation of each of them is given below.

2-2-1-Standard precipitation index (SPI)

The standardized precipitation index is based on the fact that precipitation deficits have different effects on groundwater, resource storage, soil moisture, snow cover and creek flow. The standardized precipitation index calculates the precipitation deficit for multiple time scales (3,6,12,24,48 months). These time scales reflect the impact of drought on the availability of different water resources. Soil moisture conditions react twice as much to precipitation anomalies on a relatively short scale, while groundwater, river flow, and storage resources respond to precipitation anomalies over a longer period. A classification system is used to define the drought intensities resulting from the standardized precipitation index (Table 1) (Mavi and Tupper,2004).

Table 1- SPI drought index classes

Drought classes	Index%
Normal and higher	>1
Close to normal	-1 to 1
Moderate drought	-1.5 to -1
Severe drought	-2 to -1.5
Very severe drought	≤-2

Erdenetuya et al (2010), Named SPI as an effective element in drought identification and water resources management. This index is calculated from Equation 1.

$$SPI = \frac{P_i - \bar{P}}{SD} \qquad (1)$$

In this equation: P_i is annual rainfall, I is year, $\bar{P}$ is average long-term rainfall and SD is the standard deviation of precipitation in the statistical period.

2-2-2-Percentage index of normal precipitation (PNI)

Percentage index of normal precipitation is a index that is mostly used to understand the general public. This index is one of the simplest methods of measuring precipitation for a region. The use percentage index of normal precipitation index is very useful when it is used only for one region or one season. But on the other hand, it should be noted that the percentage of normal precipitation is easily misleading and unrealistic and offers different conditions depending on the region and season. One of the disadvantages of using normal precipitation is that the average precipitation is not the same as the mean and its value is 50% deviated from the precipitation that has occurred in the climate reports. The reason for this is that precipitation does not have a normal distribution on a monthly and annual scale, and the use of the percentage of normal precipitation is implicitly similar to the normal distribution where the mean and average are assumed to be the same. The PNI Index was first developed in 1998 by Wilk et al and is always positive and is limited to zero from below and theoretically not limited from above (Beroghani et al, 2015). The different classes of this index are listed in Table (2). This index is calculated from Equation (2).

$$PNI = \frac{p_i}{\bar{p}} * 100 \quad (2)$$

In this equation: P_i is annual rainfall, I is year, $\bar{P}$ is average long-term rainfall in the statistical period.

Table 2 - PNI drought index classes

Drought classes	Index%
Normal and higher	>90
Close to normal	80-90
Poor drought	70-80
Moderate drought	55-70
Severe drought	40-55
Very severe drought	<40

2-2-3-Decimal index (DI)

This method was presented based on the application of frequency distribution 1967 by Gibbs and Maher(Gibbs,1976). This index divides the occurrence of long-term rainfall into deciles of normal distribution. This method has relatively simple calculations but requires long-term statistics to use (Smakhtin and Hughes, 2007). The different classes of this index are listed in Table (3).

Table 3- Classification of DI index

Condition	Index value
Very intense wet	4
Intense wetness	3
Medium wetting	2
Poor wetness	1
normal	0
Poor drought	-1
Moderate drought	-2
Severe drought	-3
Very severe drought	-4

2-2-4-Score Index (ZSI)

The Score Index (ZSI) index was introduced by Triola in 1995 to monitor meteorological drought. Based on studies conducted in temperate regions of Europe and the United States, in this method, the total time series in the study period is considered a statistical community and the index is calculated and used to determine the dry and wet months. In arid and semi-arid climates, due to the fact that the coefficient of variation of rainfall is high and the data do not follow the normal distribution, the use of this method makes the dry months less important and instead the wet month is very exaggerated (Rezaei and Daneshkar Arasteh,2007). The classification of this index is given in Table (4). This index is calculated from Equation (4).

$$ZSI = \frac{p_i - \bar{p}}{SD} \quad (4)$$

In this equation: P_i is annual rainfall, I is year, $\bar{P}$ is average long-term rainfall and SD is the standard deviation of precipitation in the statistical period.

Table 4- Classification of ZSI index (help DIP software)

Drought class	Index value
Very intense wet	≥2
Intense wetness	1.5 to 1.99
Medium wetting	1 to 1.49
Close to normal	-0.99 to 0.99
Moderate drought	-1.49 to -1
Severe drought	-1.99 to -1.5
Very severe drought	≤-2

2-2-5- Chinese Z index(CZI) and Chinese Z index modified (MCZI)

In this index, it is assumed that rainfall data follow the Pearson ш distribution. The same SPI classification is used to classify this index. The classification of these indicators is given in Table (5). CZI is estimated according to Equation (5) (Adib and Gorjizadeh, 2016).

$$Z_{ij} = \frac{6}{C_{si}}(\frac{C_{si}}{2}\varphi_{ij} + 1)^{1/3} - \frac{6}{C_{si}} + \frac{C_{si}}{6} \quad (5)$$

Z_{ij} is CZI index, i is the time scale that can be 1, 2, ..., 24 years and j is the desired year.

$$C_{si} = \frac{\sum_{j=i}^{n}(x_{ij} - \bar{x}_i)^3}{n\sigma_i^3} \quad (6)$$

Where C_{si} the coefficient of skewness and n is the total number of years in the statistical period.

$$\varphi_{ij} = \frac{X_{ij} - \bar{X}_i}{\sigma_i} \quad (7)$$

Where $\boldsymbol{\varphi_{ij}}$ the standardized variable. $\boldsymbol{X_{ij}}$ is the rainfall of year j for period i, $\boldsymbol{\bar{X}_i}$ and $\boldsymbol{\sigma_i}$ are the mean and standard deviation of rainfall at each time scale, respectively. To calculate CZI, the middle is sometimes used instead of the average, which is called the modified CZI index or MCZI.

Table 5 - Classification of CZI index and MCZI index (DIP software help)

Condition	MCZI	CZI
Acute wetness	≥2	≥2
Intense wetness	1.5 to 1.99	1.5 to 1.99
Medium wetting	1 to 1.49	1 to 1.49
Close to normal	-0.99 to 0.99	-0.99 to 0.99
Moderate drought	-1.49 to -1	-1.49 to -1
Severe drought	-1.99 to -1.5	-1.99 to -1.5

Very severe drought	≤-2	≤-2

3-Results and discussion

Figure (2) shows the status of annual rainfall over a period of 48 years (1970-2018). According to the figure, the highest rainfall occurred in the water year of 1993 at the rate of 885 mm and the lowest rainfall occurred in the water year 1991 at the rate of 378 mm.

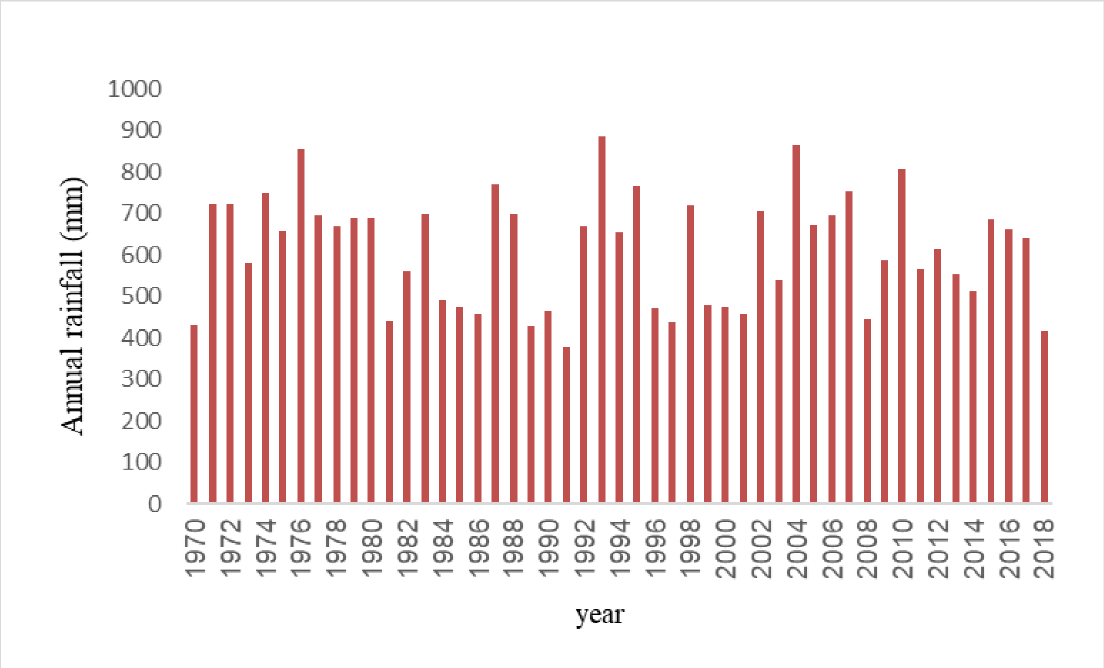

Figure 2- Rainfall of Kazemabad station

Tables (6) to (11) show the results of meteorological drought monitoring in Kazemabad station based on different indicators. The most different results were obtained first by MCZI index and then DI index. As it was said, during the statistical period of the water year 1993 are the most rainy water year and 1991 are the least rainy water year and the results of Tables (6) to (12) in these years are as follows according to the SPI index of the water year 1991 is in severe drought and 1993 in very wetness, according to PNI index of water year 1991 in moderate drought and 1993 in normal category, according to DI index of water year 1991 in very much below normal and water year 1993 in very much above normal, according to CZI index, water year 1991 in very severe drought and water year 1993 in extremely wet season, according to MCZI index, water year 1991 and water year 1993 are in moderate drought and according to The ZSI index of the water year 1991 is in severe drought and the water year 1993 in very extremely wet.

Table 6. Drought monitoring results based on SPI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	-1.46	Moderately dry	1995	1.13	Moderately wet
1971	0.85	Near normal	1996	-1.07	Moderately dry

1972	0.85	Near normal	1997	-1.39	Moderately dry
1973	-0.18	Near normal	1998	0.81	Near normal
1974	1.02	Moderately wet	1999	-1.02	Moderately dry
1975	0.39	Near normal	2000	-1.04	Moderately dry
1976	1.67	Very wet	2001	-1.19	Moderately dry
1977	0.66	Near normal	2002	0.72	Near normal
1978	0.46	Near normal	2003	-0.49	Near normal
1979	0.61	Near normal	2004	1.74	Very wet
1980	0.6	Near normal	2005	0.5	Near normal
1981	-1.34	Moderately dry	2006	0.66	Near normal
1982	-0.34	Near normal	2007	1.03	Moderately wet
1983	0.68	Near normal	2008	-1.31	Moderately dry
1984	-0.88	Near normal	2009	-0.13	Near normal
1985	-1.05	Moderately dry	2010	1.37	Moderately wet
1986	-1.19	Moderately dry	2011	-0.28	Near normal
1987	1.14	Moderately wet	2012	0.07	Near normal
1988	0.67	Near normal	2013	-0.4	Near normal
1989	-1.46	Moderately dry	2014	-0.71	Near normal
1990	-1.14	Moderately dry	2015	0.59	Near normal
1991	-1.97	Severly dry	2016	0.43	Near normal
1992	0.47	Near normal	2017	0.29	Near normal
1993	1.85	Very wet	2018	-1.58	Severly dry
1994	0.37	Near normal	-	-	-

Table 7. Drought monitoring results based on CZI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	-1.38	Moderately dry	1995	1.15	Moderately wet
1971	0.83	Near normal	1996	-1.06	Moderately dry
1972	0.82	Near normal	1997	-1.32	Moderately dry
1973	-0.24	Near normal	1998	0.78	Near normal
1974	1.02	Moderately wet	1999	-1.02	Moderately dry
1975	0.33	Near normal	2000	-1.03	Moderately dry
1976	1.78	Very wet	2001	-1.16	Moderately dry
1977	0.62	Near normal	2002	0.69	Near normal
1978	0.41	Near normal	2003	-0.54	Near normal
1979	0.57	Near normal	2004	1.87	Very wet
1980	0.56	Near normal	2005	0.45	Near normal
1981	-1.29	Moderately dry	2006	0.62	Near normal
1982	-0.4	Near normal	2007	1.03	Moderately wet
1983	0.64	Near normal	2008	-1.26	Moderately dry
1984	-0.9	Near normal	2009	-0.19	Near normal
1985	-1.04	Moderately dry	2010	1.43	Moderately wet
1986	-1.16	Moderately dry	2011	-0.34	Near normal
1987	1.16	Moderately wet	2012	0	Near normal
1988	0.63	Near normal	2013	-0.46	Near normal
1989	-1.38	Moderately dry	2014	-0.74	Near normal
1990	-1.12	Moderately dry	2015	0.55	Near normal
1991	-1.77	Severly dry	2016	0.37	Near normal
1992	0.42	Near normal	2017	0.22	Near normal
1993	2	Exteremly wet	2018	-1.48	Moderately dry
1994	0.31	Near normal	-	-	-

Table 8. Drought monitoring results based on DI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	-4	Very much below normal	1995	3	Much above normal
1971	2	Above normal	1996	-3	Much below normal
1972	2	Above normal	1997	-4	Very much below normal
1973	0	Normal	1998	2	Above normal
1974	3	Much above normal	1999	-3	Much below normal
1975	1	Slightly above normal	2000	-3	Much below normal
1976	4	Very much above normal	2001	-3	Much below normal
1977	2	Above normal	2002	2	Above normal
1978	1	Slightly above normal	2003	-2	Below normal
1979	2	Above normal	2004	4	Very much above normal
1980	2	Above normal	2005	1	Slightly above normal
1981	-4	Very much below normal	2006	2	Above normal
1982	-1	Slightly below normal	2007	3	Much above normal
1983	2	Above normal	2008	-3	Much below normal
1984	-3	Much below normal	2009	0	Normal
1985	-3	Much below normal	2010	4	Very much above normal
1986	-3	Much below normal	2011	-1	Slightly below normal
1987	3	Much above normal	2012	0	Normal
1988	2	Above normal	2013	-1	Slightly below normal
1989	-4	Very much below normal	2014	-2	Below normal
1990	-3	Much below normal	2015	2	Above normal
1991	-4	Very much below normal	2016	1	Slightly above normal
1992	1	Slightly above normal	2017	0	Normal
1993	4	Very much above normal	2018	-4	Very much below normal
1994	1	Slightly above normal	-	-	-

Table 9. Drought monitoring results based on MCZI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	-1.13	Moderately dry	1995	-1.13	Moderately dry
1971	-2.82	Exteremly dry	1996	-1.13	Moderately dry
1972	-1.13	Moderately dry	1997	-1.13	Moderately dry
1973	-1.13	Moderately dry	1998	-1.13	Moderately dry
1974	-1.13	Moderately dry	1999	-1.13	Moderately dry
1975	-1.13	Moderately dry	2000	-1.13	Moderately dry
1976	-1.13	Moderately dry	2001	-1.13	Moderately dry
1977	-1.13	Moderately dry	2002	-1.13	Moderately dry
1978	-1.13	Moderately dry	2003	-1.13	Moderately dry
1979	-1.13	Moderately dry	2004	-1.13	Moderately dry
1980	-1.13	Moderately dry	2005	-1.13	Moderately dry
1981	-1.13	Moderately dry	2006	-1.13	Moderately dry
1982	-1.13	Moderately dry	2007	-1.13	Moderately dry
1983	-1.13	Moderately dry	2008	-1.13	Moderately dry
1984	-1.13	Moderately dry	2009	-1.13	Moderately dry
1985	-1.13	Moderately dry	2010	-1.13	Moderately dry
1986	-1.13	Moderately dry	2011	-1.13	Moderately dry
1987	-1.13	Moderately dry	2012	-1.13	Moderately dry
1988	-1.13	Moderately dry	2013	-1.13	Moderately dry
1989	-1.13	Moderately dry	2014	-1.13	Moderately dry
1990	-1.13	Moderately dry	2015	-1.13	Moderately dry
1991	-1.13	Moderately dry	2016	-1.13	Moderately dry
1992	-1.13	Moderately dry	2017	-1.13	Moderately dry
1993	-1.12	Moderately dry	2018	-1.13	Moderately dry
1994	-1.13	Moderately dry			

Table 10. Drought monitoring results based on PNI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	69.96	Moderate drought	1995	125.12	Normal
1971	117.99	Normal	1996	76.9	Slight drought
1972	117.96	Normal	1997	71.2	Slight drought
1973	94.51	Normal	1998	116.98	Normal
1974	122.19	Normal	1999	77.76	Slight drought
1975	107.17	Normal	2000	77.55	Slight drought
1976	139.3	Normal	2001	74.78	Slight drought
1977	113.48	Normal	2002	115.02	Normal
1978	108.78	Normal	2003	88.14	Normal
1979	112.4	Normal	2004	141.25	Normal
1980	112.14	Normal	2005	109.65	Normal
1981	72.01	Slight drought	2006	113.56	Normal
1982	91.24	Normal	2007	122.52	Normal
1983	113.88	Normal	2008	72.5	Slight drought
1984	80.4	Normal	2009	95.64	Normal
1985	77.23	Slight drought	2010	131.32	Normal
1986	74.78	Slight drought	2011	92.38	Normal
1987	125.37	Normal	2012	99.95	Normal
1988	113.72	Normal	2013	89.93	Normal
1989	69.89	Moderate drought	2014	83.74	Normal
1990	75.6	Slight drought	2015	111.93	Normal
1991	61.58	Moderate drought	2016	108.02	Normal
1992	108.99	Normal	2017	104.76	Normal
1993	144.19	Normal	2018	67.94	Moderate drought
1994	106.71	Normal			

Table 11. Drought monitoring results based on ZSI index

Year	Value	Drought Classification	Year	Value	Drought Classification
1970	-1.38	Moderately dry	1995	1.15	Moderately wet
1971	0.82	Near normal	1996	-1.06	Moderately dry
1972	0.82	Near normal	1997	-1.32	Moderately dry
1973	-0.25	Near normal	1998	0.78	Near normal
1974	1.02	Moderately wet	1999	-1.02	Moderately dry
1975	0.33	Near normal	2000	-1.03	Moderately dry
1976	1.8	Very wet	2001	-1.15	Moderately dry
1977	0.62	Near normal	2002	0.69	Near normal
1978	0.4	Near normal	2003	-0.54	Near normal
1979	0.57	Near normal	2004	1.89	Very wet
1980	0.56	Near normal	2005	0.44	Near normal
1981	-1.28	Moderately dry	2006	0.62	Near normal
1982	-0.4	Near normal	2007	1.03	Moderately wet
1983	0.64	Near normal	2008	-1.26	Moderately dry
1984	-0.9	Near normal	2009	-0.2	Near normal
1985	-1.04	Moderately dry	2010	1.43	Moderately wet
1986	-1.15	Moderately dry	2011	-0.35	Near normal
1987	1.16	Moderately wet	2012	0	Near normal
1988	0.63	Near normal	2013	-0.46	Near normal
1989	-1.38	Moderately dry	2014	-0.74	Near normal
1990	-1.12	Moderately dry	2015	0.55	Near normal
1991	-1.76	Severly dry	2016	0.37	Near normal
1992	0.41	Near normal	2017	0.22	Near normal

1993	2.02	Exteremly wet	2018	-1.47	Moderately dry
1994	0.31	Near normal			

According to table 12, the highest frequency is related to the normal class or close to normal and the lowest frequency is related to the poor wetness and very intense wetness classes.

Table 12 - Frequency of drought classes based on SPI, PNI, CZI, MCZI, DI and ZSI indices

Drought indicators	ZSI	DI	MCZI	CZI	PNI	SPI
Poor drought	-	3	-	-	10	-
Moderate drought	13	2	48	13	4	12
severe drought	1	9	-	1	-	2
Very Severe drought	-	6	1	-	-	-
Normal or near normal	27	4	-	27	35	27
Poor wetness	-	6	-	-	-	-
Moderate wetness	5	11	-	5	-	5
Intense wetness	2	4	-	2	-	3
Very Intense wetness	1	4	-	1	-	-

4-Conclusion

An unexpected decrease in normal rainfall causes drought in any area.Continuing drought has a negative impact on water resources, agriculture and the region's economy. Hydrological drought will occur if drought reduces runoff, lowers aquifers and reduces the discharge of these resources. Since there are no permanent rivers in the study basin, its water resources depend on aqueducts, springs and wells in the basin, which are strongly affected by changes in rainfall. The purpose of this study is to investigate the drought indicators in one of the sub-basins of Dez River. Many indicators are considered to determine the drought and its severity, but in this study, 6 indicators DI, SPI, ZSI, CZI, PNI and MCZI were examined over a 48-year period using DIP software. The results show that SPI, PNI, CZI and ZSI indices have almost the same trend. And the trends of SPI, CZI and ZSI indices are almost the same. With these interpretations, it can be concluded that the three indices SPI, CZI and ZSI for determining dry periods achieve the same results. Also, the trend of PNI index is in line with the trend of these three indicators. The DI index has a trend similar to the four mentioned indices, but the intensity of fluctuations is very high. The MCZI index is quite different from the other five indices in the process and in determining drought. The MCZI index is not able to display and determine the drought and wetness of this region on an annual scale because the results are the same for all years (Moderately dry). Drought can be a kind of natural disaster that occurs in a creepy way, maybe this is the only good thing compared to earthquake, flood and other natural disasters because humans have the opportunity to think and prevent and ultimately manage this disaster. Because drought has a direct impact on human health and the environment, as well as increasing conflicts over water, politics, management, quality of life, as well as human migration, spend time and money to study more about this field is valuable.

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