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Drought analysis of Kahramanmaraş province with standardized precipitation index method

Standartlaştırılmış yağış indeksi yöntemi ile Kahramanmaraş ilinin kuraklık analizi

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Abstract
With the developing world, deterioration in natural balances has occurred, leading to climate change, which is one of the important problems for the world. Drought, which occurs as a result of climate change due to global warming in the world and in our country, causes precipitation to fall below the long-term average values within a certain period. Turkey is located in the semi-arid, semi-humid mid-latitude region. Therefore, drought, which is one of the devastating effects of climate change, poses an important problem for our country, some of which is in the semi-arid climate zone. In this study, meteorological drought analysis was performed in the province of Kahramanmaraş, which is located in the Mediterranean region, using the Standardized Precipitation Index (SPI) method in 3, 6, 9 and 12 month time periods. The Average Monthly Total Rainfall Amount between 1990-2020 of Afşin Elbistan, Göksun and Kahramanmaraş-central meteorological observation stations was used. As a result, an increase was found especially in drought periods of 2000 and later for 4 meteorology stations according to all time scales. While long years of dry periods were found in Kahramanmaraş-center and Göksun region according to SPI values, no significant changes were found in annual total precipitation amount data during the dry periods in Kahramanmaraş-centre. This shows that the amount of precipitation has not changed, while the number of rainy days has decreased. It was found that the dry periods in Afşin and Elbistan region were relatively shorter. Turkey is located in the semi-arid semi-humid middle latitude region. Therefore, drought, which is one of the devastating effects of climate change, poses an important problem for our country, some of which is in the semi-arid climate zone.

Keywords: Kahramanmaraş, Meteorological drought, Precipitation, Standardized precipitation index

Öz
Gelişen dünya ile birlikte doğal dengelerde bozulmalar oluşmuş ve dünya için önemli sorunlardan biri olan iklim değişikliği meydana gelmiştir. Ülkemizde ve dünyada küresel ısınmaya bağlı iklim değişikliğinin bir sonucu olarak ortaya çıkan kuraklık, belli bir dönem içerisinde yağış miktarlarının uzun yıllık ortalama değerlerin altına düşmesine neden olmaktadır. Türkiye yarı kurak yarı nemli orta enlem bölgesinde bulunmaktadır. Dolayısıyla bir kısmı yarı kurak iklim kuşağında bulunan ülkemiz için de iklim değişikliğnin yıkıcı etkilerinden birisi olan kuraklık önemli bir sorun oluşturmaktadır. Bu çalışmada, Akdeniz bölgesinde yer alan Kahramanmaraş ilinde, Standartlaştırılmış Yağış İndeksi (SPI) metodu kullanılarak 3, 6, 9 ve 12 aylık zaman periyotlarında meteorolojik kuraklık analizi yapılmıştır. Afşin Elbistan, Göksun ve Kahramanmaraş-merkez meteorolojik gözlem istasyonlarına ait 1990-2020 yılları arasındaki Aylık Toplam Yağış Miktarı Ortalaması kullanılmıştır. Sonuç olarak, 4 meteoroloji istasyonu için tüm zaman ölçeklerine göre özellikle 2000 yılı ve sonrasında kurak dönemlerde artış olduğu belirlenmiştir. Kahramanmaraş-Merkez ve Göksun bölgesinde SPI değerlerine göre uzun yıllar kurak dönemler yaşandığı ancak Kahramanmaraş-Merkez'de yaşanan kurak dönemlerde yıllık toplam yağış miktarı verilerinde ise anlamlı değişimler bulunmamaktadır. Bu durum yağış miktarının değişmediğini ancak yağışlı gün sayısında azalma olduğunu göstermektedir. Afşin ve Elbistan bölgesinde ise yaşanan kurak dönemlerin nispeten daha kısa zamanlı olduğu belirlenmiştir.

***Anahtar kelimeler**: Kahramanmaraş, Meteorolojik kuraklık, Yağış, Standartlaştırılmış yağış indeksi*

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1. Introduction
1. Giriş

Increasing human activities in fields such as industry, transportation, agriculture and energy increase greenhouse gas emissions into the atmosphere and strengthen the greenhouse effect. As a result of this, an increase occurs in global average temperatures (Doğan & Tüzer, 2011). This global warming has affected climates and created variability, while this problem has become a climate crisis today. Climate crisis is defined as a situation that requires immediate action to reduce and stop climate variability. Temperatures increasing with climate variability will increase the rate of evaporation on earth and cause a decrease in water resources. Therefore, drought, which is one of the most devastating effects of climate change, will occur in our country, some parts of which are in semi-arid climate zone (Şahin & Kurnaz, 2014).

Water is one of the natural resources human beings need to continue their lives. Water scarcity is another disaster that will threaten the human generation and another meaning of water scarcity is drought at any time and any place. There are four types of drought. These are meteorological, agricultural, hydrological and socio-economic drought. Meteorological drought is the amount of precipitation in a region being less that the amount of evaporation in that region; therefore, it is a type of drought in which the decrease in precipitation is taken as a criterion. Agricultural drought is when a plant in the soil cannot find water. Hydrological drought is the type in which a decrease occurs in underground and surface water resources. Socio-economic drought is the situation in which social and economic negativities are experienced in the society due to drought (Arslan et al., 2016). Since the time, duration, severity and location of these droughts cannot be predicted beforehand, they must be constantly monitored temporally and spatially (Keskiner et al., 2016). Therefore, drought analyses are extremely important to see the dimensions of disasters that may occur in the future.

Meteorological drought, which deals with the amount of precipitation falling on earth, is an important natural phenomenon that triggers the occurrence of other droughts. The effects of meteorological drought are generally first seen in the agriculture sector, later in other water-dependent sectors (Kapluhan, 2013). Meteorological drought occurs in two main phenomena in itself. One of these phenomena is the precipitation on the ground remaining below the average for a long time, in other words, a decrease in precipitation. Therefore, water resources will not be fed by precipitation and the soil will not be able to meet the moisture it needs. The second phenomenon is increased evaporation due to highly increased temperatures. Increase in evaporation will cause water resources to dry up and even dissolve and the soil to lose its moisture content. A decrease in precipitation and increase in evaporation and temperature will cause meteorological drought (Şahin & Kurnaz, 2014).

Each year, 6,000,000 hectares of land becomes desert in the world. In order to fight the problem of desertification caused by drought, Convention to Combat Desertification, which was initiated by the United Nations and came into force in 1994, was signed by 197 countries, including Turkey. The convention recognizes that people living in arid areas are threatened with life and aims to mitigate the effects of drought in areas under the threat of desertification. In our country, the National Drought Management Strategy Document and Action Plan (2017 - 2023) was signed and it is still in effect. The application plans to minimize the effects of drought with measures to be taken before, during and after drought.

Turkey is located in the semi-arid, semi-humid mid-latitude circle. Especially South and southeast regions are in the semi-arid climate zone and they are faced with the threat of desertification (Şahin & Kurnaz, 2014). Although there are no fully arid areas in our country, semi-arid climate zone covers 37.3% of our country's land (Turan, 2018). Serious meteorological droughts occurred in Turkey in 1971-1974, 1983-1984, 1989-1990, 1996, 2001, 2007-2008, 2013-2014 years (Türkeş, 2009; Kurnaz, 2014).

In the field of drought monitoring, drought indices are used to determine the status of drought. Currently, various drought indices have been developed and used worldwide. The drought index is a quantitative indicator of the severity of drought and the evolution of drought (Kang and Moon, 2014). The most common of these are standard precipitation index (SPI), Palmer drought severity index (PDSI) and Percent of normal index (PNI). SPI, which was developed by Mckee et al. (1993) is calculated by taking the difference of each precipitation value from average precipitation in a given period of time and dividing it with standard deviation. PDSI, which was developed by Wayne Palmer in 1965, is found by using data on precipitation, temperature and water holding capacity of soil. PNI is obtained by dividing the

amount of precipitation in a specified period of time by average precipitation (Willeke et al., 1994).

Considering the increasing trend in global temperatures and the impact on local climate, it has been pointed out that climate change may alter the frequency and severity of extreme events such as droughts (IPCC 2013). Therefore, drought analysis with respect to the effect of climate change has received more attention over recent decades (Jiang et al., 2015; Wu et al. 2016, Grillakis 2019; Mehr et al., 2020; Beden et al., 2020). In a study conducted by Ceylan et al. (2009) in Akçakale, Şanlıurfa, Iğdır, Tuzluca and Konya, it was found that meteorological drought was close to limit values according to drought indices. In a study conducted by Fidan (2011) in Eastern Mediterranean region, according to SPI drought analysis, it was found that "heavy rainfall" period was predominant in Kahramanmaraş and around between 1985 and 1990 and 1995 and 2000; while severe droughts occurred between 2000 and 2005 and later moderate droughts occurred. Meresa et al. (2016) showed that the temporal patterns of drought over the Polish basins varied significantly with the type of drought index: SPEI showed drier conditions for the future of the basins, while SPI showed wetter climates. Mehr et al. (2020) showed that Ankara experienced six severe and two extreme drought events during the reference period, 1971-2000. However, the projections indicated fewer drought events for the near-future period of 2016-2040, with no potential extreme drought events. Reis and Dutal (2015) conducted a hydrological drought prediction analysis for Kahramanmaraş by using Markov Chain Model. In their study, they found that "moderately dry" class would dominate with a probability of 79% between 2015 and 2020 and stated that Kahramanmaraş province hydrological drought would not change at least until 2020. Considering the above-mentioned trend in drought analysis within the scope of climate change, the main purpose of this study is to determine the current and predicted meteorological drought condition throughout the metropolitan city of Kahramanmaraş, Turkey. In this study, meteorological drought analysis was made by using precipitation data for years between 1990 and 2020 for Kahramanmaraş province by using SPI.

2. Material and method
2. Materyal ve metod

2.1. Study area
2.1. Çalışma alanı

Kahramanmaraş (Figure 1), which is the area where the study was conducted, is located in Mediterranean region, it is 14,346 km^2 wide and it is located between 37-38 north parallels and 36-37 east meridians (Kahramanmaraş Directorate of Environment and Urbanization, t.y). The altitude varies between 350 m and 3090 m in Kahramanmaraş province (Gürbüz, 2014). 59.7% of the land in the province is mountains, 24% is plateaus and 16.3% is plains (Karademir et al., 2018). Kahramanmaraş is at the location where the Mediterranean, Eastern Anatolia and South-eastern Anatolia regions are closest to each other. Among the three different climate types, it shows a climate characteristics close to Mediterranean climate. Continental climate characteristics are seen to the North with altitude (Kahramanmaras Directorate of Agriculture and Forestry, t.y). According to 1930 - 2019 years measurement period, annual average temperature is 16.6° C, annual average sunshine duration is 80.8 hours and annual total precipitation amount is 719.7 mm in Kahramanmaraş (General Directorate of Meteorology, t.y.). Table 1 shows information about the automatic meteorological observation stations in Kahramanmaraş region where precipitation data for SPI drought analysis was taken.

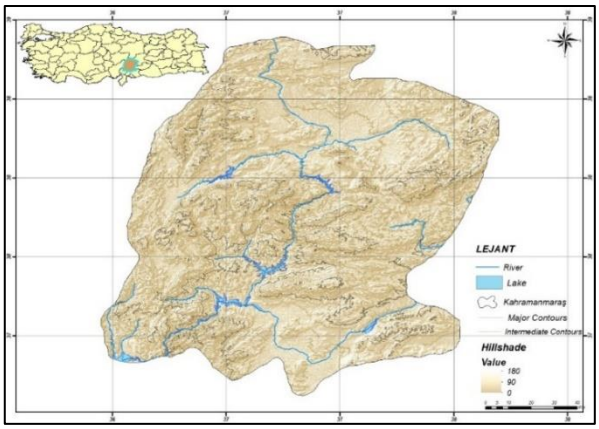

Figure 1. Study area
Şekil 1. *Çalışma Alanı*

Table 1. Information of the stations where drought analyses were made
Tablo 1. *Kuraklık analizi yapılacak istasyonların bilgileri*

Station Name	Station No	Observation year	Latitude	Longitude
Afşin	17868	1990 - 2020	38°14'25.8"K	36°55'08.4"D
Elbistan	17870	1990 - 2020	38°12'13.7"K	37°11'53.5"D
Göksun	17866	1990 - 2020	38°01'26.4"K	36°28'56.3"D
Kahramanmaraş-Center	17255	1990 - 2020	37°34'33.6"K	36°54'54.0"D

2.2. Standardized precipitation index
2.2. Standartlaştırılmış yağış indeksi

SPI method, which was developed by McKee et al. (1993), is one of the widely used methods to monitor meteorological drought. Analysis can be made for different time periods. It is a dimensionless drought index. Precipitation data index is first applied into an appropriate probability distribution. After probability density function is determined, the cumulative probability of an observed precipitation amount is calculated. Next, Gauss function is applied to cumulative probability.

SPI is obtained by dividing the difference from the mean of the precipitation over the specified period of time by standard deviation (Equation 1) (McKee et al., 1993; Tsakiris & Vangelis, 2004). In this study, meteorological drought analysis of Kahramanmaraş region was performed by using SPI method. In standardized precipitation index analysis, precipitation data of the region between 1990 and 2020 years were used. Meteorological drought analysis was made by using Rstudio program in time periods of 3, 6, 9 and 12 months. In addition, the Levene homogeneity test was applied to the precipitation data of all stations and it was seen that the data were homogeneous.

$$SPI = \frac{x_i - x_{ort}}{\sigma} \quad (1)$$

SPI: Standardized precipitation index, X_i : Observed precipitation (mm), X_{ort}: Mean precipitation of the data set and σ: standard deviation of the series. It is possible to classify SPI values (Table 2). In a drought assessment made by taking SPI values into account, the time period when the index is continually negative is defined as the dry period. While the month when the index first falls below zero is considered as the beginning of drought, the month when the index rises to a positive value is evaluated as the end of drought (McKee et al., 1995).

Table 2. SPI Drought Classification (Karadaş & İmamoğlu, 2019)
Tablo 2. *SPI Kuraklık sınıflandırması* (Karadaş & İmamoğlu, 2019)

SPI value	Drought severity
≥2	Exceptionally wet
1.60 – 1.99	Extremely wet
1.30 – 1.59	Severely wet
0.80 – 1.29	Moderately wet
0.5 – 0.79	Mildly wet
0.50 – -0.50	Near normal
-0.51– -0.79	Mildly dry
-0.80 – -1.29	Moderately dry
-1.30 – -1.59	Severely dry
-1.60 – -1.99	Extremely dry
≤ -2.0	Exceptionally dry

3. Results
3. Sonuçlar

3.1. Temporal distribution of long years average rainfall amount
3.1. Uzun yıllar ortalama yağış miktarının zamansal dağılımı

Table 3 shows long years monthly average total amount of precipitation and seasonal averages of Kahramanmaraş-centre, Afşin, Elbistan, Göksun automatic meteorological observation stations between 1990 and 2020 for each station. According to the mean total precipitation amount, while the least precipitation (1%) was observed in July and August in Afşin, Elbistan, Göksun districts, no precipitation was observed in Kahramanmaraş-centre in July and August. The highest amount of precipitation was observed with a rate of 15% in December in Afşin and Göksun, with 14% in April in Elbistan and with 18% in January in Kahramanmaraş-centre.

Seasonal average of precipitation was found for each station between 1990 and 2020 (Table 3). According to precipitation amount normal value, the lowest precipitation occurred with a rate of 5% in summer in Afşin and Göksun, with a rate of 7% in Elbistan in summer and with a rate of 2% in summer in Kahramanmaraş-centre. The lowest precipitation occurred with a rate of 39% in winter in Afşin and Göksun, with a rate of 50% in winter in Kahramanmaraş-centre and with a rate of 37% in spring in Elbistan. According to seasonal average, the highest amount of precipitation was recorded in Kahramanmaraş with 58,9 mm, while the lowest amount was recorded in Elbistan with 31.8 mm.

Table 3. Long years monthly average total amount of precipitation and seasonal averages (mm)
Tablo 3*. Uzun yıllar aylık toplam yağış miktarı ortalaması ve mevsimsel ortalaması (mm)*

Time	Afşin	Elbistan	Göksun	Kahramanmaraş -Center
January	52.3	39.0	72.4	128.0
February	48.8	37.9	61.7	109.9
March	49.1	44.2	67.8	91.3
April	52.8	51.2	60.2	71.8
May	48.0	45,3	55.1	40.3
June	14.7	19.4	17.4	8.0
July	3.5	5.3	5.9	1.2
August	2.8	2.4	6.4	1.0
September	11.4	13.3	15.0	13.0
October	32.2	38.6	41.1	40.5
November	41.7	41.9	60.1	79.8
December	63.4	40.1	78.9	117.6
Winter	54.6	39.0	70.8	118.5
Spring	50.0	46.9	61.0	67.8
Summer	7.3	9.6	10.0	3.8
Autumn	28.8	31.7	39.6	45.5
Average total amount of precipitation (mm)	35.1	31.8	45.3	58.9

Temporal distribution of annual total precipitation data for all stations is shown in Figure 2. According to annual total precipitation data of 1990-2019 years, maximum annual total precipitation amount took place as 1169 mm in Kahramanmaraş-centre station in 1996, while the minimum annual total precipitation amount took place as 181,6 mm in Göksun station in 2013.

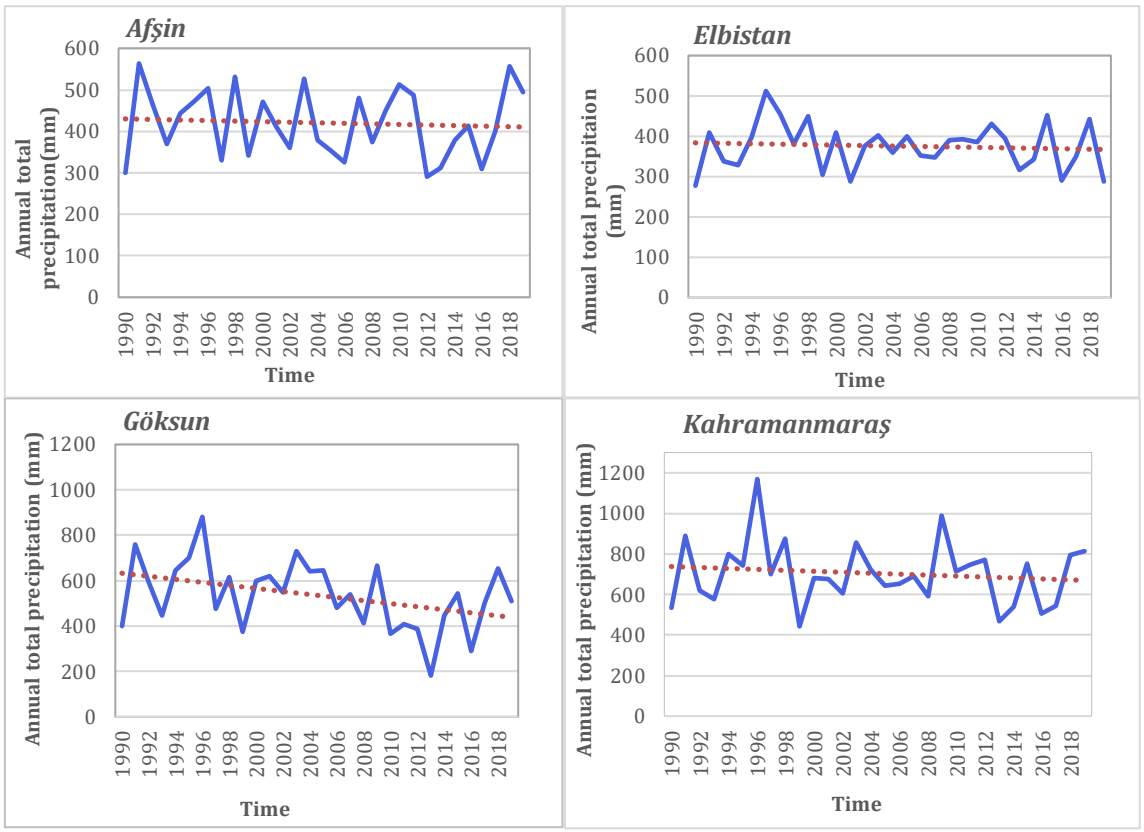

Figure 2. Annual total precipitation amounts
Şekil 2*. Yıllık toplam yağış miktarları*

3.2. Standardized precipitation index
3.2. Standartlaştırılmış yağış indeksi

SPI time series analyses were made for 3, 6, 9 and 12 month periods in Kahramanmaraş, Afşin, Elbistan and Göksun stations between 1990 and 2020 (Figure 3-Figure 6). Percentage distributions of 3, 6, 9 and 12 month SPI values of 4 meteorological stations in Kahramanmaraş region were calculated according to drought classification (Table 4-Table 7). According to the 12-month SPI values of the stations, it was found that Afşin was in highest wet (34.44%) and highest dry (31.67%) class when compared with the other stations. However, these drought index values are predominantly within mild and moderate dry classes in Afşin. Göksun was found to have severe, extreme and exceptional drought index values (10.56%).

According to 3, 6, 9 and 12 months all SPI values, Göksun and Kahramanmaraş-centre are severely, extremely and exceptionally wet, while Afşin and Elbistan are moderately and mildly wet (Table 4-Table 7). It was also found that Afşin and Elbistan were mildly and moderately wet, while Göksun and Kahramanmaraş were severely, extremely and exceptionally dry. The result that both severely wet and severely dry classes were prevalent in Göksun and Kahramanmaraş SPI data shows the irregularity of precipitation in these regions. For Afşin and Elbistan districts, which received less precipitation than these stations, SPI data showed that moderately wet, normal and moderately dry classes were predominant in these regions and that they received relatively more regular precipitation.

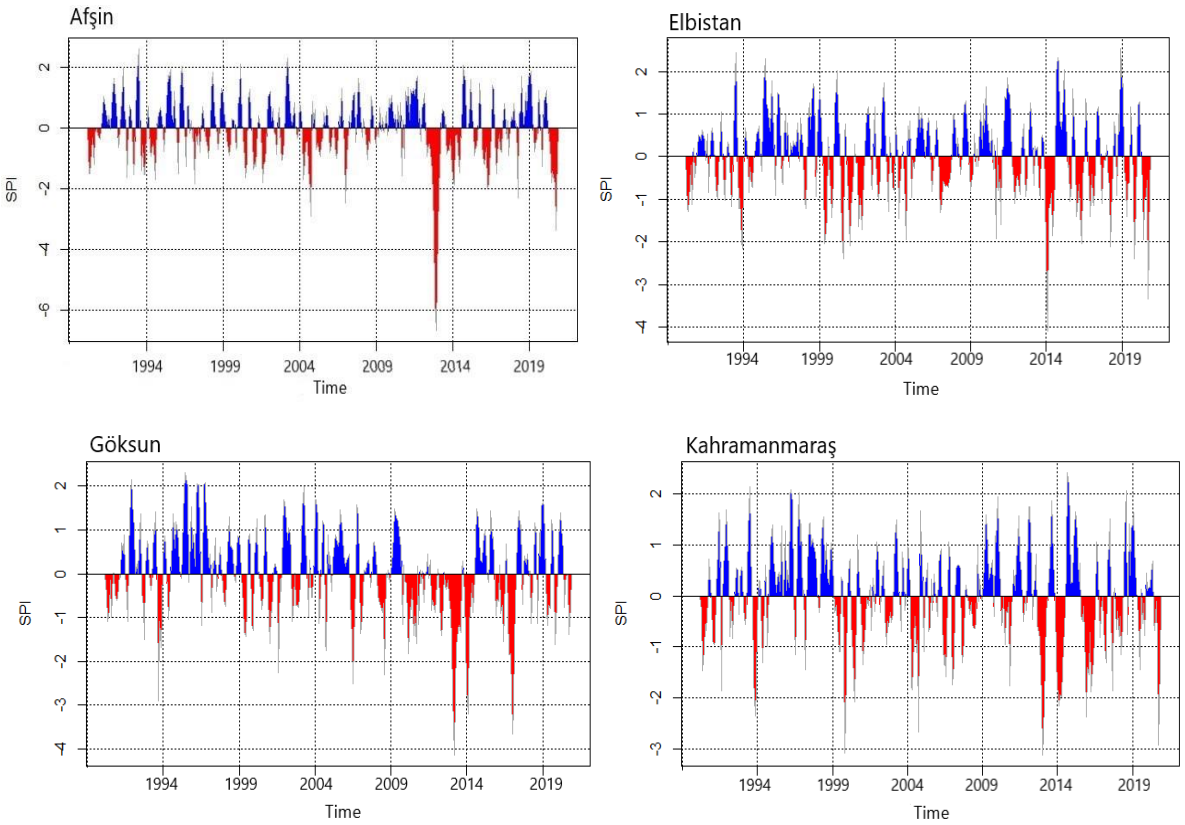

Figure 3. SPI time series for 3-month period
Şekil 3*. 3 aylık dönem için SPI zaman serisi*

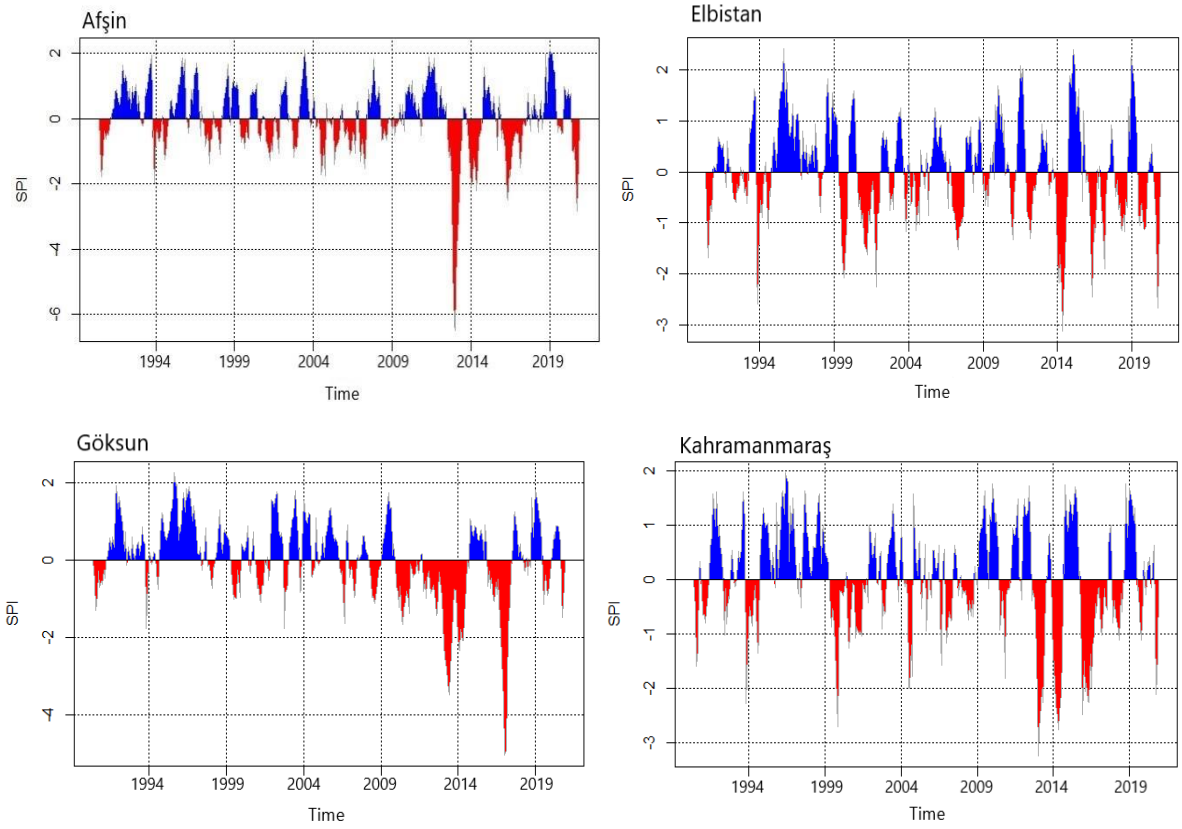

Figure 4. SPI time series for 6-month period
Şekil 4*. 6 aylık dönem için SPI zaman serisi*

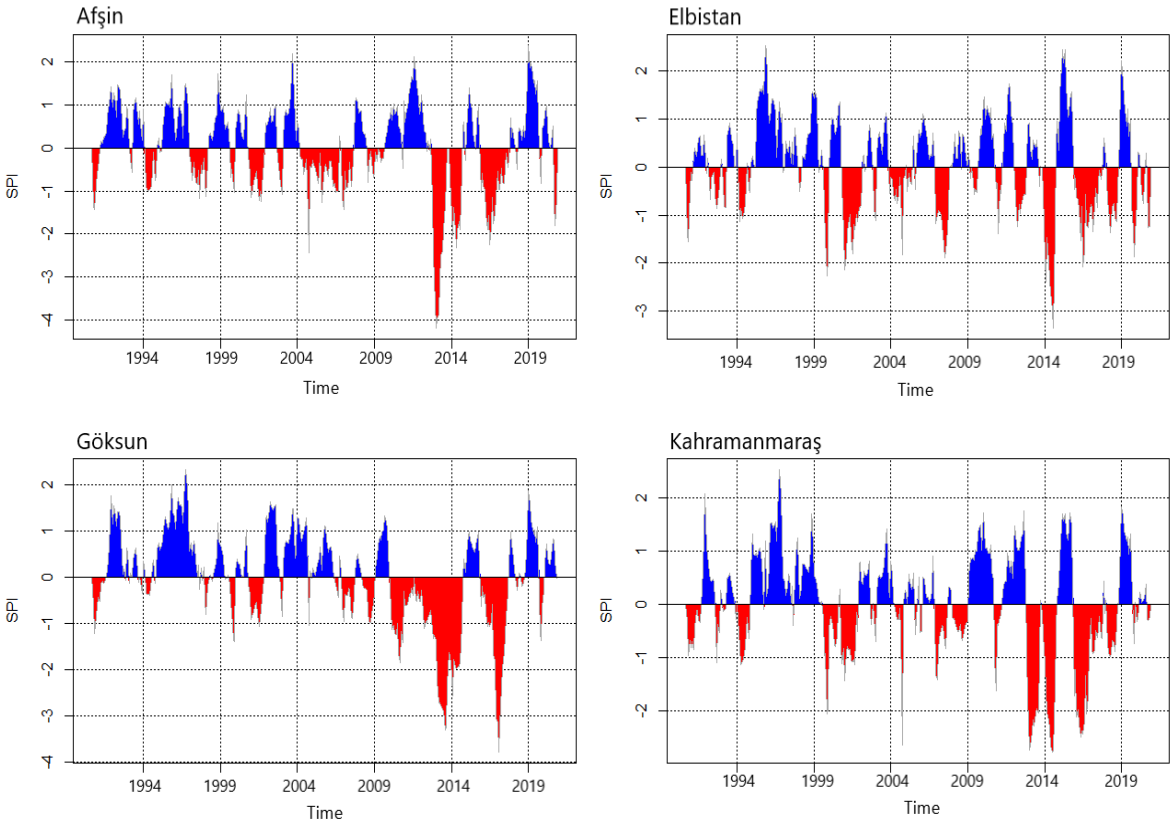

Figure 5. SPI time series for 9-month period
Şekil 5. *9 aylık dönem için SPI zaman serisi*

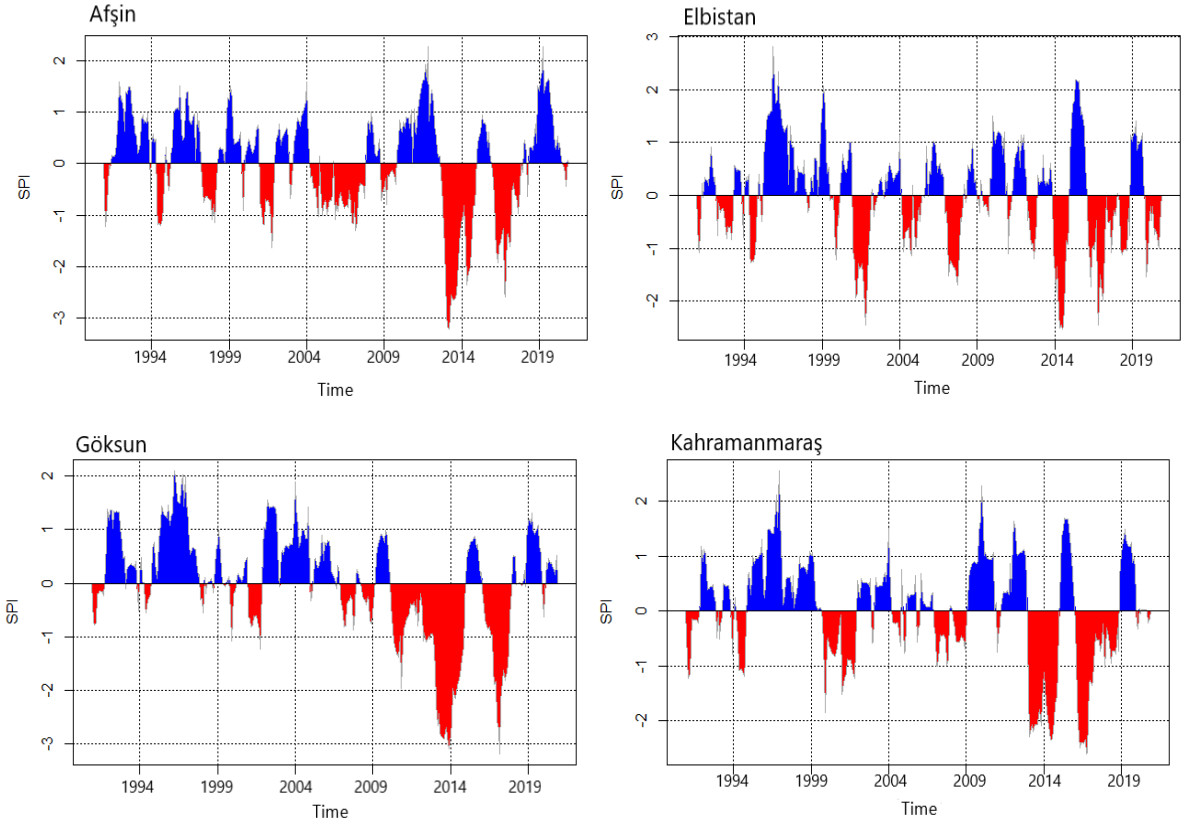

Figure 6. SPI time series for 12-month period
Şekil 6*. 12 aylık dönem için SPI zaman serisi*

Table 4. Percentage distribution of 3-month SPI values according to drought classification
Tablo 4. *3 aylık SPI değerlerinin kuraklık sınıflandırmasına göre yüzdelik dağılımları*

SPI Drought Classification	Afşin	Elbistan	Göksun	Kahramanmaraş-Center
Exceptionally wet	1.90	1.90	1.90	1.63
Extremely wet	4.07	2.98	2.44	3.25
Severely wet	2.71	3.25	4.88	4.88
Moderately wet	11.38	13.01	13.82	11.38
Mildly wet	13.01	10.84	8.94	11.11
Near normal	36.86	34.69	37.67	39.57
Mildly dry	10.30	12.74	9.76	8.40
Moderately dry	9.49	12.47	10.57	8.40
Severely dry	4.07	2.71	4.61	5.15
Extremely dry	3.79	2.44	2.44	3.52
Exceptionally dry	2.44	2.98	2.98	2.71

Table 5. Percentage distribution of 6-month SPI values according to drought classification
Tablo 5. *6 aylık SPI değerlerinin kuraklık sınıflandırmasına göre yüzdelik dağılımı*

SPI Drought Classification	Afşin	Elbistan	Göksun	Kahramanmaraş-Center
Exceptionally wet	0.55	2.19	0.27	0.00
Extremely wet	4.10	3.28	4.37	4.10
Severely wet	3.55	4.37	5.74	5.74
Moderately wet	15.03	11.48	10.93	13.39
Mildly wet	9.56	8.47	11.48	11.20
Near normal	37.98	38.80	38.25	36.61
Mildly dry	10.66	11.20	9.29	8.20
Moderately dry	9.84	12.02	10.38	10.66
Severely dry	3.01	2.46	2.73	2.46
Extremely dry	2.46	2.46	2.46	2.73
Exceptionally dry	3.28	3.28	4.10	4.92

Table 6. Percentage distribution of 9-month SPI values according to drought classification
Tablo 6. *9 aylık SPI değerlerinin kuraklık sınıflandırmasına göre yüzdelik dağılımı*

SPI Drought Classification	Afşin	Elbistan	Göksun	Kahramanmaraş-Center
Exceptionally wet	0.83	1.93	0.83	1.10
Extremely wet	2.20	1.93	1.65	2.20
Severely wet	4.68	5.51	6.06	6.06
Moderately wet	16.25	10.47	13.22	12.40
Mildly wet	11.02	12.12	11.02	9.92
Near normal	34.16	37.19	39.67	39.67
Mildly dry	9.64	9.09	7.99	9.37
Moderately dry	12.67	12.12	9.64	9.64
Severely dry	2.48	4.41	1.65	1.38
Extremely dry	2.75	2.75	3.86	2.20
Exceptionally dry	3.31	2.48	4.41	6.06

Table 7. Percentage distribution of 12-month SPI values according to drought classification
Tablo 7*. 12 aylık SPI değerlerinin kuraklık sınıflandırmasına göre yüzdelik dağılımı*

SPI Drought Classification	Afşin	Elbistan	Göksun	Kahramanmaraş-Center
Exceptionally wet	0.56	2.22	0.56	0.83
Extremely wet	1.67	2.22	1.39	2.22
Severely wet	5.83	3.89	7.50	4.72
Moderately wet	13.61	11.67	11.39	15.28
Mildly wet	12.78	8.33	13.33	10.28
Near normal	33.89	42.78	38.61	37.22
Mildly dry	11.11	6.39	8.06	10.00
Moderately dry	11.39	13.33	8.61	9.44
Severely dry	2.78	3.61	1.67	1.94
Extremely dry	1.94	3.06	3.61	2.50
Exceptionally dry	4.44	2.50	5.28	5.56

3.3. Dry periods and their duration
3.3. Kurak dönemler ve süreleri

It was found that SPI values were constantly negative (dry periods) for all stations in periods of 3, 6, 9, 12 months between 1990 and 2020 (Table 8). According to SPI index values, the least negative values (dry) were for 12 months. In this study, the longest dry period was found in Göksun and Kahramanmaraş-centre. According to 9 and 12 month SPI values, the longest dry period was 58 months between years 2010 and 2014, while according to 12 month SPI values, the longest dry period was 34 months in Kahramanmaraş-centre between years 2016 and 2018.

Although there are fluctuations in annual total precipitation amount in Kahramanmaraş region, no large slope is seen in the annual total precipitation curve. However, according to SPI values, while dry periods increased especially after 2000, their duration also began to get longer. It can be seen that there was a dry period of 31 months between 2004 and 2006 and a dry period of 28 months between 2012 and 2014 in Afşin (Table 8). In Elbistan, both total annual amount of precipitation (Figure 2) and drought according to SPI are highly variable. In this region, the longest drought was 24 months between 2016 and 2018 according to 12-month SPI values. A 58-month very long period of drought took place in Göksun between 2010 and 2014 in a time period of 9 and 12 months. The minimum total amount of precipitation (181.6 mm) was in 2013 in Göksun and a short period of increase was found to occur in precipitation in the following years (Figure 2). In Kahramanmaraş-centre, a dry period of 38 months was observed between 2016 and 2018 in a period of 12 months. However, this situation did not cause an obvious change in total annual amount of precipitation (Figure 2). The reason for this may be the decrease in the total number of wet days, although the amount of precipitation did not change.

Table 8. Dry periods according to SPI values
Tablo 8. *SPI değerlerine göre kurak dönemler*

Period	Dry period	Drought Duration (months)
	Afşin	
3	1990 – 1991	12
	2012 – 2013	12
	2012 – 2013	12
6	2013 – 2014	12
	2015 – 2017	20
	1997 – 1998	15
	2000 – 2001	13
9	2004 – 2006	31
	2008 – 2009	14
	2012 – 2013	13
	2015 – 2017	23
	1997 – 1998	13
	2001	12
12	2005 – 2007	24
	2008 – 2009	12
	2012 – 2014	28
	2015 – 2017	25
	Elbistan	
3	-	-
6	2000 – 2002	19
	2013 – 2014	12
	2000 – 2002	16
9	2003 – 2004	14
	2006 – 2007	12
	2015 – 2017	23
	1992 – 1993	14
	2001 – 2002	14
12	2006 – 2008	15
	2013 – 2014	13
	2016 – 2018	24
	2019 – 2020	13
	Göksun	
3	2012 – 2013	13
	2009 – 2011	20
6	2011 – 2014	36
	2015 – 2017	19
	2000 – 2001	13
9	2010 – 2014	58
	2015 – 2017	22
	2006 – 2007	12
12	2010 – 2014	58
	2016 – 2017	23
	Kahramanmaraş-Center	
3	2015 – 2016	12
	1999 – 2000	13
6	2000 – 2001	15
	2012 – 2013	12
	2015 – 2017	21
	1990 – 1991	13
	1993 – 1994	12
9	1999 – 2000	13
	2000 – 2001	14
	2008 – 2009	13
	2015 – 2017	23
	1999 – 2001	28
12	2006 – 2007	13
	2013 – 2015	25
	2016 – 2018	34

4. Discussion
4. Tartışma

Drought is obviously one of the more damaging yet hardly determined natural disasters among others. Drought monitoring using drought indices often serves as an important base. Drought indices computed from forecasted rainfall gives a better outlook of potential risk that may be inflicted upon the region. In this study, meteorological drought analysis was made and evaluated for long years (1990 -2020) in Kahramanmaraş region. According to the results found, it can be seen that total mean amount of precipitation was higher in Kahramanmaraş-centre and Göksun regions than the total mean amount of precipitation in Elbistan and Afşin regions. However, depending on the total annual amount of precipitation, irregular precipitation was observed in Göksun region according to SPI data. In this region, 58-month long meteorological drought was observed between the years 2010 and 2014. Kahramanmaraş-centre shows severely wet and severely dry characteristics according to SPI index due to irregular precipitation. In addition, the longest dry period was found to last for 34 months between 2016 and 2018 in Kahramanmaraş-centre. Although there are irregular rains in Afşin, it has been determined that although there are many dry periods, the droughts are relatively short. Elbistan is the region with the least rainfall. However, shorter dry periods are seen compared to Göksun and Kahramanmaraş-Center. Although more irregular precipitation and drought periods were observed in Afşin, drought was found to last relatively shorter. Elbistan is the region with the lowest amount of precipitation. However, shorter dry periods are observed in Elbistan compared to Göksun and Kahramanmaraş-center. As a result, it was found that there were long periods of meteorological drought in Göksun and Kahramanmaraş-centre and meteorological drought was more severe in this region. On the other Kahramanmaraş-centre and Göksun district have both the highest average values of total precipitation and long drought periods in various periods compared to other districts. This shows that erratic and sudden precipitation, which is one of the consequences of climate change, may also occur.

Since SPI, which has been mainly used for drought analysis, is calculated only by considering precipitation, there is a limit to applying SPI to the establishment of drought adaptation measures that reflect the effects of global warming. In the journey of climate change adaptation policy to drought to gain public confidence, there is a need for studies on alternatives to complement the problems exposed in SPI. In light of these needs, the development of new drought indices that reflect various future climate variables, including precipitation, or the development of combined drought indices that can incorporate various currently used drought indices based on different meteorological variables will be a prerequisite for establishing climate change drought adaptation measures

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Author contribution
Yazar katkısı

All authors contributed to the study conception and design. Data collection was done by SA. The study of analysis was performed by MP. The first draft of the manuscript was written by MP and SA commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflicts of interest
Çıkar çatışması beyanı

The authors declare that there is no conflict of interest

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