Çukurova Tarım Gıda Bil. Der.

Çukurova J. Agric. Food Sci.
37(2): 261-272, 2022
doi: 10.36846/CJAFS.2022.93

Research Article

The Use of Some Specific Drought Indices to Evaluate Meteorological Drought Events in the Black Sea Region of Turkey

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ABSTRACT

In this study, Standardized Precipitation Index (SPI) and the Standardized Precipitation Evapotranspiration Index (SPEI) were employed for drought characterization by using precipitation and temperature data series at a 3-month timescale. In addition, correlation coefficients between SPEI and SPI were calculated for twenty meteorological stations located over the Black Sea region of Turkey and were assessed to decide the representative nature of drought indices. Results showed that there is a remarkably strong correlation between SPEI and SPI. The correlation coefficient is equal to or greater than 0.93 in coastal areas, but a gradual decrease in relatively dry zones. The highest and lowest correlations were found to be 0.98 and 0.82 for Rize station located by the sea and the Gumushane station away from the sea, i.e., in the inland region, respectively. Research results suggested that data availability and the site-specific conditions of the region should be taken into account when using indices.

Keywords: Drought, Standardized Precipitation Index (*SPI*), Standardized Precipitation Evapotranspiration Index (*SPEI*), Black Sea Region

Türkiye'nin Karadeniz Bölgesindeki Meteorolojik Kuraklık Olaylarının Değerlendirilmesinde Bazı Spesifik Kuraklık İndekslerinin Kullanımı

ÖZ

Bu çalışmada, yağış ve sıcaklık veri serileri kullanılarak -üç ay zaman ölçeğinde- kuraklık karakterizasyonu için Standardize Yağış İndeksi (SPI) ve Standardize Yağış Evapotranspirasyon İndeksi (SPEI) kullanılmıştır. Ayrıca, Türkiye'nin Karadeniz bölgesinde yer alan yirmi meteoroloji istasyonu için SPEI ve SPI arasındaki korelasyon katsayıları hesaplanmış ve kuraklık indekslerinin "temsil edebilirlikleri" değerlendirilmiştir. SPEI ve SPI arasında oldukça güçlü bir korelasyon bulunmuştur. Korelasyon katsayısı, kıyı bölgelerinde 0.93'e eşit veya daha büyüktür; korelasyon, iç kesimlere gidildikçe göreceli azalmıştır. Deniz kenarında bulunan Rize istasyonu için en yüksek korelasyon (r=0.98) ve denizden uzak ve iç bölgede yer alan Gümüşhane istasyonu için en düşük korelasyon (r=0.82) bulunmuştur. Araştırma sonuçları, kuraklık indeksleri seçiminde veri mevcudiyetinin ve bölgenin kendine özgü iklim koşullarının dikkate alınmasının önem arz ettiğini göstermiştir.

Anahtar Kelimeler: Kuraklık, Standardize Yağış İndeksi (*SPI*), Standardize Yağış Evapotranspirasyon İndeksi (*SPEI*), Karadeniz Bölgesi

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Yayın Kuruluna Geliş Tarihi: 29.11.2022
Kabul Tarihi: 27.12.2022

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1. Introduction

Drought is one of the most serious environmental concerns in arid and semi-arid regions of the world. This phenomenon has become more frequent and more intense in the Mediterranean landscapes over time due to climate change. It affects all the water-demanding sectors, notably agriculture, drinking, hydropower, tourism, etc., and plays an important role to render a change in the plans of agriculture and others. In the last decade, monitoring of drought has been performed regionally and has more practical usage at watershed and local scales (Svoboda et al., 2015). Ojha et al. (2021) indicated that drought evaluation has become more and more essential to establishing adaptation and mitigation strategies for drought types/categories.

Keskiner et al. (2016) stated clearly that conventional scientific literature has accepted four types of drought: meteorological, hydrological, agricultural, and socioeconomic. Generally, when a meteorological drought hits a region, it is preceded by agricultural and hydrological drought. In this study, we will focus on the meteorological drought. The Standardized Precipitation Index hereinafter referred to as *SPI* (McKee et al., 1993) and the Standardized Precipitation Evapotranspiration Index hereinafter referred to as *SPEI* (Vicente-Serrano et al., 2010) are the most frequently used indices for meteorological drought assessment.

A myriad of studies has been done to compare drought indices including *SPI* and *SPEI*. Additionally, many studies compare the *SPI* or the *SPEI* and the Palmer drought severity index hereinafter referred to as *PDSI* (Hayes et al., 1999; Szalai et al., 2000; Lloyd-Hughes and Saunders 2002; Brázdil et al., 2008; Paulo et al., 2012). In the same context, there exist some studies assessing correlations among drought indices. For example, Paulo et al. (2012) found that the correlation coefficients between the *SPI* and the *SPEI* increase from the lower values in the high zones to the high values in the humid zone (coastal areas). Both the *SPEI* and *SPI* are used in this research for detecting and mapping droughts and drought monitoring (Yalti and Aksu, 2019; Eris et al., 2019; Eris et al., 2020; Aksu et al., 2022; Yüce et al., 2022). A comprehensive bibliometric analysis of these studies can be found in Yilmaz and Yilmaz (2022).

Although Turkey is a Mediterranean country, it is also among the countries with a coast to the Black Sea. However, Black Sea Region (hereafter BSR) is prone to natural disasters of climatic character (Aksu et al., 2022), i.e., both droughts and floods, due to its topographical features and different climate patterns. From this point of view, drought analysis in the BSR has been becoming an effective tool to understand the spatiotemporal behaviour of drought episodes. In this regard, acquiring meteorological drought index values is of great importance to determine the likely variability patterns over the region. Determination of the meteorological drought index could help the authority, decision-makers and the end-users understand the risk of drought and take preventive measures for developing tools to mitigate drought hazards.

Considering the variability of precipitation among the seasons, the timescale in this study was determined as a 3-month. The primary objectives of the present study were to: (1) figure out the observed drought frequencies by drought categories for *SPI* and *SPEI* indices at a 3-month timescale over the BSR of Turkey, and (2) assess correlations between *SPI* and *SPEI* for twenty meteorological stations over the BSR. A brief description of the study area, precipitation and temperature data for calculating drought indices, and methodology of *SPI* and *SPEI* has been explained in the "Materials and Methods" section, viz., Section 2. Subsequently, research results and discussion were given in Section 3.

2. Materials and Methods

2.1. Study Area and Data

This study was carried out in the Black Sea Region (BSR) of Turkey (Figure 1). The total area of the region is 143 537 km^2 (URL-1). A rainy and temperate climate typically prevails over the coastal part of the BSR (Aksu et al., 2022) while a continental climate dominates in the inland areas. As such, the BSR region is divided into three geographical sub-regions: the eastern sub-region, central sub-region, and western sub-region (Figure 1). Aksu et al. (2021) pointed out that the average annual air temperatures vary between 14°C and 15ºC for the eastern and central while from 13ºC and 15°C for the western regions. The maximum annual precipitation, on average, is 1000–1500 mm in the western sub-region, 1000–1200 mm in the central sub-region, and 2000–2500 mm over the eastern sub-region. Previous studies have shown increasing trends of extreme meteorological events over the BSR (Drobinski et al., 2018; Aziz et al., 2020; Aksu et al., 2021; Oruc, 2021). Daily temperature and precipitation data series were used in this study. The length of the series changed between 56- and 92-year as shown in Table 1 were obtained from the twenty meteorological stations belonging to the Turkish State Meteorological Service. All the weather data series have already been subjected to Quality Control (QC) checks to detect outliers, missing values, jumps, duplicates, etc., in the data.

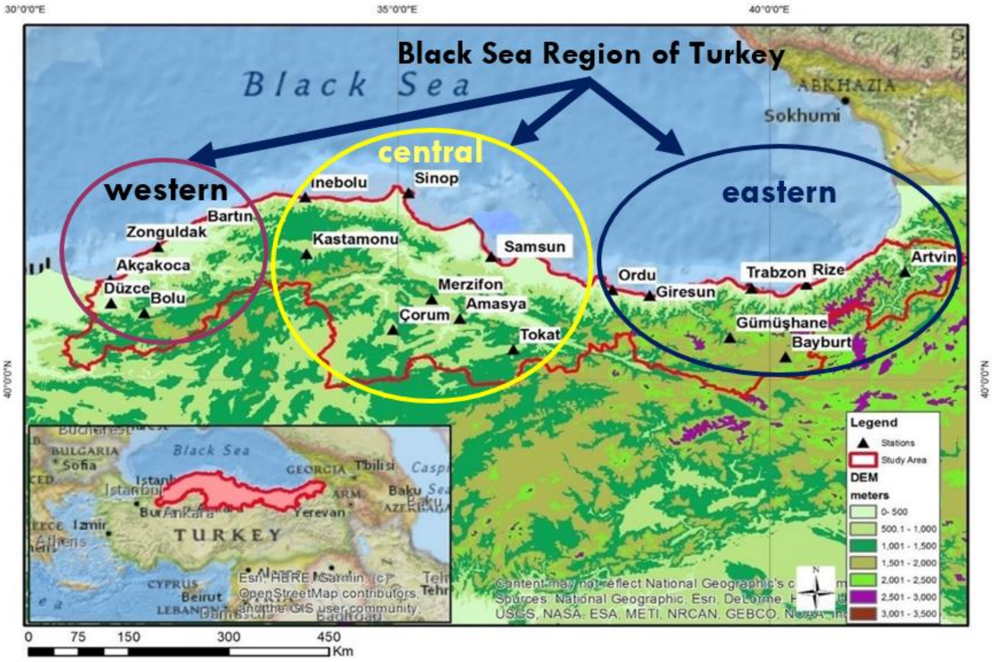


Figure 1. Study area and locations of the meteorological stations over the Black Sea Region of Turkey

Table 1. Some specific characteristics and recording periods of meteorological stations used in the study

Station No	Station Name	Longitude (degree)	Latitude (degree)	Elevation (m)	Data period
17015	Akcakoca	31.14	41.90	10	1959-2019
17085	Amasya	35.84	40.67	412	1961-2019
17045	Artvin	41.82	41.18	597	1948-2019
17020	Bartın	32.36	41.62	30	1961-2019
17089	Bayburt	40.22	40.25	1584	1959-2019
17070	Bolu	31.60	40.73	742	1929-2019
17084	Corum	34.94	40.55	837	1929-2019
17072	Duzce	31.15	40.84	146	1959-2019
17034	Giresun	38.39	40.92	38	1929-2019

Table 1. (Cont.)

Station No	Station Name	Longitude (degree)	Latitude (degree)	Elevation (m)	Data period
17088	Gumushane	39.47	40.46	1219	1961-2019
17024	Inebolu	33.76	41.98	58	1951-2019
17074	Kastamonu	33.78	41.37	800	1930-2019
17083	Merzifon	35.46	40.88	759	1930-2019
17033	Ordu	37.89	40.98	4	1959-2019
17040	Rize	40.50	41.04	4	1927-2019
17030	Samsun	36.26	41.34	4	1952-2019
17026	Sinop	35.15	42.03	36	1936-2019
17086	Tokat	36.56	40.33	608	1950-2019
17037	Trabzon	39.76	41.00	30	1927-2019
17022	Zonguldak	31.78	41.45	42	1938-2019

2.2. Standardized Precipitation Index (*SPI*)

The *SPI* (McKee et al., 1993) is used to quantify the precipitation deficit in meteorological drought characterization. The *SPI* can be calculated for different time scales, i.e., 1-, 3-, 6-month for the short term, and 12-, 24-, and 48-month for the long term (Kumar et al., 2022). In addition, several studies have widely used the *SPI* since it is recommended by the World Meteorological Organization (WMO, 2012) for identifying meteorological drought. However, in our study, the *SPI* values were calculated for a time-scale of 3-month. *SPI* can be calculated by the following equation (Cetin et al., 2018):

$$SPI_{ij\_k} = \left(\frac{X_{ij} - \mu_j}{\sigma_j}\right) \qquad (1)$$

where, X_{ij} is the observed precipitation (in mm) for the time-scale k in the month j ($j=1, 2, 3, \ldots, 12$) of the year i ($i=1, 2, \ldots, n$); μ_j and σ_j are population parameters of the precipitation series, i.e., the expected value and the standard deviation of precipitation in month j, respectively.

Since population parameters are never known in Equation (1), the probability approach is adapted to acquire *SPI* value, and the probability density function of precipitation data series is hence tried to be determined as follows:

$$g(x) = \frac{1}{\beta^{\alpha}\,\Gamma(\alpha)} x^{\alpha-1} e^{\frac{-x}{\beta}}, \qquad x > 0 \qquad (2)$$

where α and β are the parameters of shape and scale. The gamma function is given as:

$$\Gamma(\alpha) = \int_0^{\infty} x^{\alpha-1} e^{-x}\, dx \qquad (3)$$

The optimal values of α and β are estimated as:

$$\alpha = \frac{1}{4A}\left(1 + \sqrt{1 + \frac{4A}{3}}\right)$$
$$\beta = \frac{\bar{x}}{\alpha} \qquad (4)$$
$$A = ln(\bar{x}) - \frac{\sum ln(x)}{n}$$

where n indicates the record length of the precipitation series, i.e., year.

The following equation can be used to compute the cumulative probability for a given month j:

$$G(x) = \int_0^x g(x)\,dx = \frac{1}{\beta^{\alpha}\,\Gamma(\alpha)} \int_0^x x^{\alpha-1} e^{\frac{-x}{\beta}}\,dx \quad (5a)$$

$$H(x) = q + (1-q)G(x) \quad (5b)$$

$$SPI = S\left(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}\right) \quad (6)$$

$$t = \begin{cases} \sqrt{ln\left(\frac{1}{H(x)}\right)^2} & , for\ 0 < H(x) \leq 0.5 \\ \sqrt{ln\left(\frac{1}{1.0 - H(x)}\right)^2} & , for\ 0.5 < H(x) < 1.0 \end{cases} \quad (7)$$

where q is the probability of zeroes; $H(x)$ in Equation 5b is cumulative probability; if $H(x)>0.5$ then $S=1$, else $S=-1$; the constants are $C_0=2.515517$, $C_1= 0.802853$, $C_2=0.020328$, $d_1=1.432788$, $d_2=0.189269$, $d_3=0.001308$. By using Equations 6 and 7, the cumulative probability, $H(x)$, is then transformed to the standard normal random variable Z with mean zero and variance of one, which is the value of the *SPI*. Drought severities are categorized by using the *SPI* and *SPEI* values given in Table 2.

Table 2. Drought classification based on *SPI* and *SPEI* (McKee et al., 1993; Aksoy et al., 2021)

Drought class/category	***SPI* and *SPEI***
Mild Drought	(-1.0)- 0.0
Moderate Drought	(-1.5)- (-1.0)
Severe Drought	(- 2.0)- (- 1.5)
Extreme Drought	≤ (- 2.0)

2.3. Standardized Precipitation Evapotranspiration Index (*SPEI*)

The *SPEI* has been developed to measure drought conditions (Vicente-Serrano et al., 2010). It is based on both precipitation and potential evapotranspiration (*PET*). The procedure of the *SPEI* computation relies on the original *SPI* calculation but uses the monthly difference between precipitation (*P*) and *PET*.

The monthly *PET* in the same unit of *P* (usually in mm) is determined by equation (8):

$$PET = 16K\left(\frac{10T}{I}\right)^m \quad (8)$$

where *K* is a correction coefficient depending on the latitude of the region studied; *T* is the monthly-mean temperature (°C); *I* is the heat index which is the summation of 12 monthly indices, and *m* is a coefficient given as a third-order polynomial depending on the heat index. The climate–water balance was calculated as follows:

$$D_j = P_j - PET_j \quad (9)$$

where *D* is the month moisture deficit (mm), *P* is precipitation (mm) in month *j*, and PET_j is potential evapotranspiration (mm) in month *j*.

SPEI can be calculated (Abramowitz and Stegun 1965) as:

$$SPEI = W - \frac{C_o + C_1 W + C_2 W^2}{1 + d_1 W + d_1 W^2 + d_3 W^3} \quad (10)$$

$$W = \sqrt{-2\,ln(Pr)} \quad for \quad Pr \leq 0.5 \quad (11)$$

$$Pr = 1 - F(x) \quad (12)$$

where $F(x)$ is the cumulative probability of a determined *D* value acquired from log-logistic distribution; the constants are $C_0 = 2.515517$, $C_1 = 0.802853$, $C_2 = 0.010328$, $d_1=1.432788$, $d_2= 0.189269$, and $d_3=0.001308$ (Vicente-Serrano et al., 2010). Vicente-Serrano et al. (2010) explained that *Pr* is the probability of exceeding a determined *D* value, $Pr=1.0-F(x)$. If $Pr > 0.5$, then *Pr* is replaced by $1.0 - Pr$ and the sign of the resultant *SPEI* is reversed. In this study, *SPEI* and *SPI* indices were acquired from *ClimPACT2*, an *R* software package, developed by Alexander and Herold (2016). Drought severity calculations were based on the calendar year.

2.4. Statistical comparisons

In this study, the correlations between *SPEI* and *SPI*, as shown in Equation 13, were statistically assessed by using a simple linear regression approach for all meteorological stations.

$$r = \frac{\sum_{i=1}^{n}(x_i - \overline{x})\ (y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2\ \ \sum_{i=1}^{n}(x_i - \overline{x})^2}} \qquad (13)$$

where x and y stand for *SPI* and *SPEI*, respectively. The correlation coefficient, r, varies between -1 and +1. For the case of a linear model with a single independent variable, the coefficient of determination (R^2) is the square of r. R^2 varies between 0 and 1, representing no correlation and perfectly correlated time series, respectively.

3. Results and Discussion

3.1. Monthly Variations and Observed Drought Frequencies of *SPI* and *SPEI*

Monthly precipitation and temperature data series of each station were acquired from daily data. Then, the *SPI* and *SPEI* series for a 3-month timescale were calculated for twenty meteorological stations by using monthly precipitation and temperature data from 1927 to 2019. Figure 2a and Figure 2b shows the temporal variation of *SPI* and *SPEI* for Rize station as an example. As seen in Figure 2a and Figure 2b the drought severities were remarkably low, getting closer to -7, in the high 1920s. This behaviour indicates that Rize station and its environs experienced the most severe drought episodes in the late 1920s.

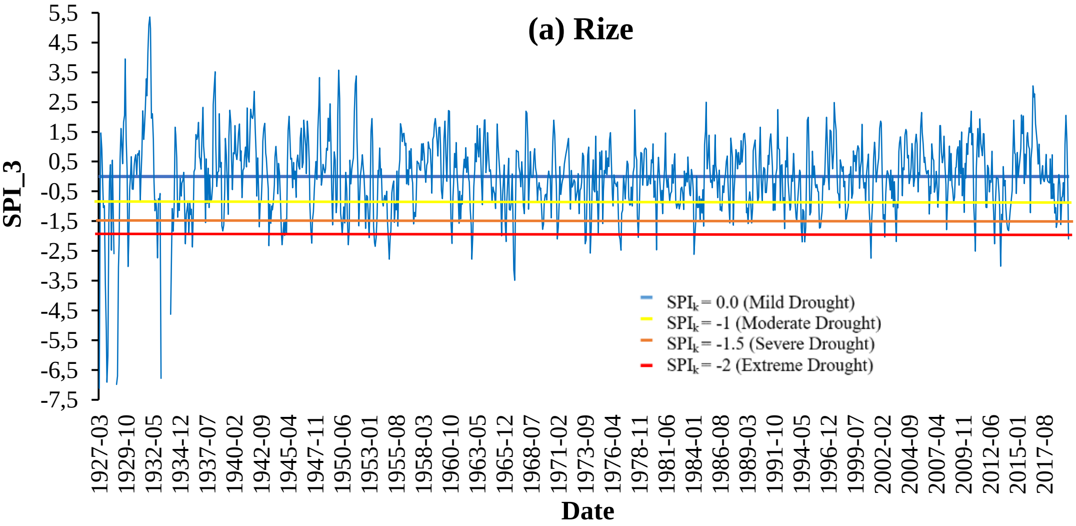


Figure 2a. Temporal variation of *SPI* and *SPEI* in Rize station for a 3-month time scale

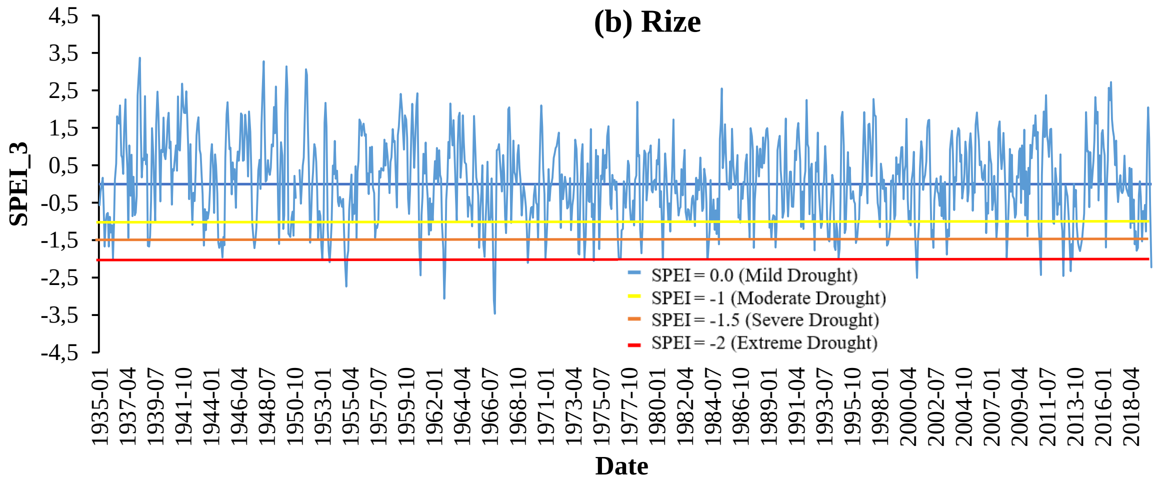


Figure 2b. Temporal variation of *SPI* and *SPEI* in Rize station for a 3-month time scale

To reliably identify drought phenomena, each drought event and drought period were counted from the *SPI* and *SPEI* time series, and then, observed drought frequencies were calculated by utilizing tallies. Drought periods become more evident for the 3-month timescale. Table 3 shows the percentage of the frequencies of observed drought events for the *SPI* and *SPEI* series of all metrological stations. The frequency of droughts in the "*mild drought*" category is prevalent in the region regardless of drought index calculation technique, i.e., either *SPI* or *SPEI*. However, observed frequencies of "*mild drought*"s in the inner meteorological stations are higher than the ones for the coastal meteorological stations. The highest frequency for the "*mild drought"* category is 38.6% and 37.6% for *SPI* and *SPEI*, respectively, in Tokat station. It is evident from Table 3 that the lowest value of observed drought frequencies in the category of *"mild drought"* category is 16.5% of the *SPI* index in the Trabzon station indicating that it is the most risk-free station of the BSR in terms of drought. Therefore, Trabzon station and its environs did not witness any other *drought classes*. This can be explained by the availability of more or less homogeneous rainfall throughout the year. On the other hand, the observed drought frequencies by *SPI* in the "*moderate drought*" category are lower than the ones by *SPEI*, and varied in the range of 3 to 4%.

Table 3. Observed drought frequencies of *SPI* and *SPEI* based on the drought categories in Table 2

Station Name	***SPI***				***SPEI***			
	Mild	**Moderate**	**Severe**	**Extreme**	**Mild**	**Moderate**	**Severe**	**Extreme**
Akcakoca	33.1	7.1	3.5	4.4	32.0	9.7	3.7	2.2
Amasya	33.1	7.5	5.5	4.0	31.4	11.5	5.0	0.6
Artvin	33.3	10.6	5.5	4.0	33.1	13.8	5.6	3.6
Bartın	33.1	8.8	3.8	2.6	33.4	11.9	4.3	1.5
Bayburt	35.8	9.7	5.5	3.6	34.6	12.1	7.4	2.8
Bolu	30.9	10.2	4.4	3.2	33.7	12.7	6.7	1.4
Corum	33.6	8.7	4.9	3.6	30.8	8.7	4.8	0.8
Duzce	29.6	8.0	4.9	2.5	32.0	11.6	3.2	2.3

Table 3. (Cont.)

Station Name	*SPI*				*SPEI*			
	Mild	**Moderate**	**Severe**	**Extreme**	**Mild**	**Moderate**	**Severe**	**Extreme**
Giresun	31.0	9.0	4.1	3.8	29.8	11.6	6.4	4.6
Gumushane	35.8	9.1	3.5	2.4	36.5	11.2	5.0	0.6
Inebolu	32.4	7.3	5.1	4.0	33.9	9.0	5.0	1.9
Kastamonu	34.3	11.1	5.8	2.8	34.7	12.1	6.7	1.9
Merzifon	38.2	8.9	6.5	4.3	35.3	12.3	6.6	3.2
Ordu	31.9	10.3	4.9	4.0	31.2	14.2	4.1	1.5
Rize	28.9	9.1	5.3	4.3	27.2	10.0	6.2	2.8
Samsun	33.2	5.2	9.1	2.0	30.7	10.3	5.0	2.1
Sinop	34.8	9.7	4.6	2.3	33.0	11.0	4.3	1.3
Tokat	38.6	11.2	7.0	4.7	37.6	12.1	7.4	2.2
Trabzon	16.5	0.1	0.0	0.0	36.5	10.4	6.7	3.6
Zonguldak	32.1	10.7	3.3	4.1	32.8	12.3	4.8	2.8

3.2. Correlation Analysis of *SPI* and *SPEI*

Figure 3 shows the spatial variability of correlation coefficients between the *SPI* and *SPEI* series of each station over the BSR. As understood from Figure 3, there exists a clear spatial behaviour of correlation coefficients between *SPI* and *SPEI* series changing by the direction and topographic conditions on the region. As seen from Figure 3, correlation coefficient values of Akcakoca, Zonguldak, Bartin, Inebolu, Sinop, Samsun, Ordu, Giresun, Trabzon, and Rize meteorological stations are greater than or equal to 0.93 along coastal areas of the BSR, i.e., in the west-east direction. Correlation coefficients tend to decrease gradually from the humid zone of BSR in coastal areas to the mountainous south, i.e., rain shadow of the inland locations of the BSR. Therefore, the correlation coefficient was the lowest (*0.82*) in the Gumushane station as shown in Figure 3. A very high correlation ($r=0.98$) was acquired in Rize station, and the lowest correlation coefficient ($r=0.82$) was obtained for the Gumushane station although it may be considered as a high level of relationship ($0.82<r<0.89$) between *SPI* and *SPEI* for 3-month time scale. The correlation between the *SPI* and the *SPEI* for a 3-month timescale was high for different stations. The spatial variability behaviour of the correlation coefficients was in good agreement with the results obtained by Paulo et al. (2012). Paulo et al. (2012) found that the correlation coefficients between the *SPI* and the *SPEI* were rather high as well as strong in the meteorological stations located in coastal areas, and correlation tended to decline from medium and lower values in high terrain areas.

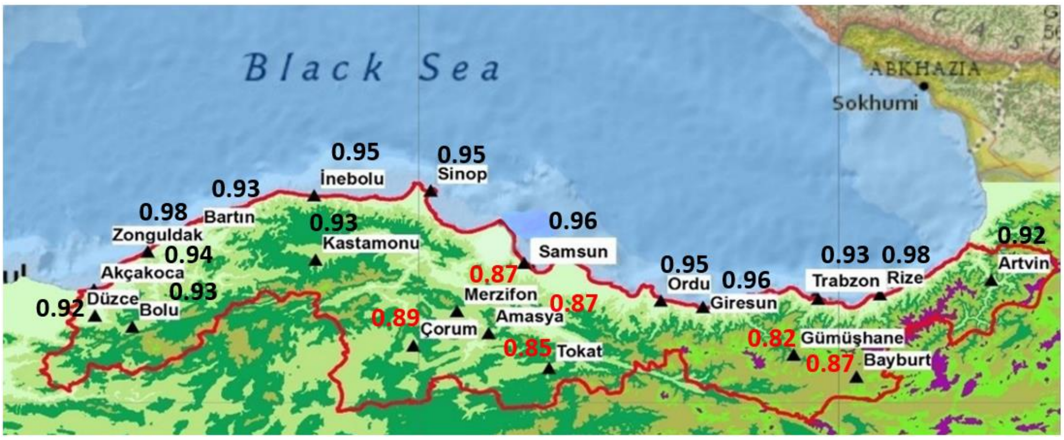


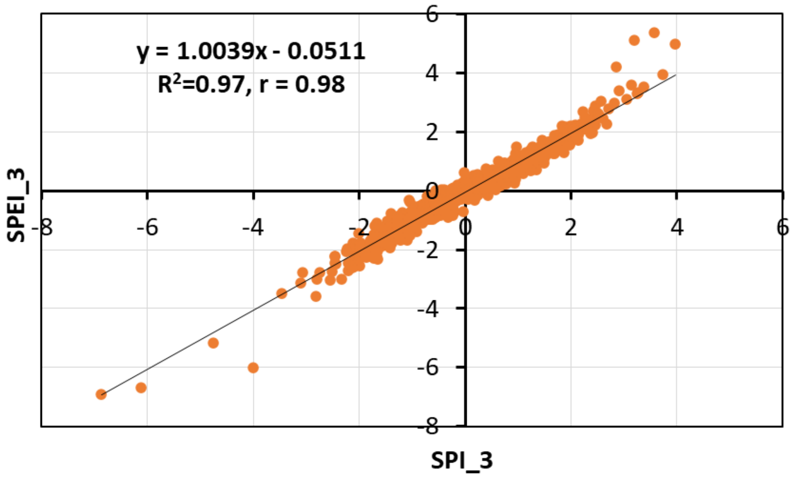
Figure 3. Spatial variability in the correlation coefficients (*r*) between *SPI* and *SPEI* series -acquired for a 3-month timescale- over the BSR, Turkey

3.3. Linear Regression Analysis

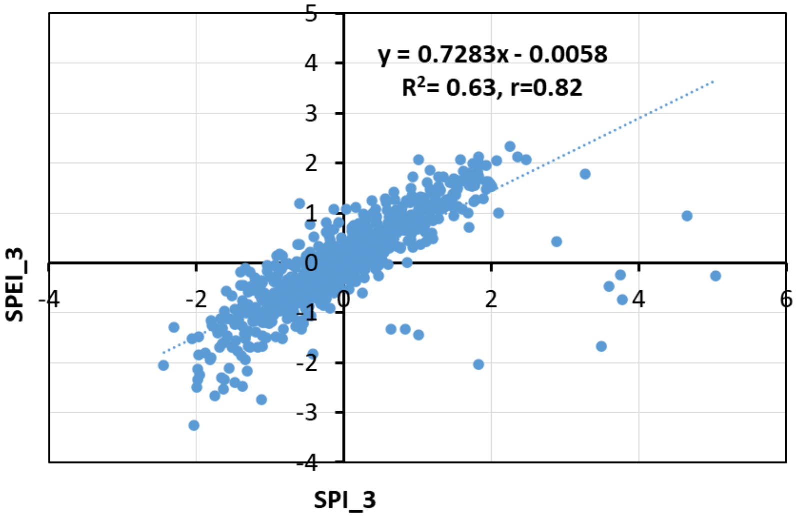
The linear regression analysis has been applied to see the relationship between *SPI* and *SPEI* on a 3-month scale (Table 4). Scatter diagrams have been drawn to show the comparison between *SPI* and *SPEI* indices for all meteorological stations. For example, Figure 4a and Figure 4b show the linear regression model in both Rize and Gumushane stations. As seen in Figure 4a and Figure 4b, if the station is located in a rainy area, the distribution of *SPI* versus *SPEI* lies almost on the 1:1 line indicating that the magnitude of drought severity by precipitation-based drought index (*SPI*) is the same size as precipitation and temperature-based drought index (*SPEI*). Therefore, if temperature and precipitation data are available, Vicente-Serrano et al. (2010) suggested the use of *SPEI* in drier climates for temperature rise markedly affects the severity of droughts. In this context, research results led us to conclude that *SPI* can be considered a suitable tool for drought characterization in the coastal zone of the Black Sea region since it requires only precipitation data. In turn, the supremacy of *SPI* over *SPEI* in drought assessment allows more stations to be used in drought assessment in the coastal zone of the BSR.

Table 4. Linear Regression Analysis of all meteorological stations

Station No	Meteorological Station	Linear Model	Station No	Meteorological Station	Linear Model
17015	Akcakoca	y = 0.9648x - 0.0474	17024	Inebolu	y = 0.989x - 0.0445
17085	Amasya	y = 0.9068x - 0.1086	17074	Kastamonu	y = 0.9479x + 0.0042
17045	Artvin	y = 0.926x + 0.0152	17083	Merzifon	y = 0.8613x - 0.0578
17020	Bartın	y = 0.9096x + 0.0012	17033	Ordu	y = 0.9868x - 0.088
17089	Bayburt	y = 0.8701x + 0.0366	17040	Rize	y = 1.0039x - 0.0511
17070	Bolu	y = 0.9309x + 0.0645	17030	Samsun	y = 0.9575x - 0.0183
17084	Corum	y = 0.9311x - 0.1303	17026	Sinop	y = 0.9595x - 0.0429
17072	Duzce	y = 0.9816x + 0.0689	17086	Tokat	y = 0.8756x - 0.0893
17034	Giresun	y = 0.9816x + 0.0689	17037	Trabzon	y = 0.4652x + 0.5441
17088	Gumushane	y = 0.7283x - 0.0058	17022	Zonguldak	y = 0.9634x + 0.0053



(a) Rize_1927-2019



(b) Gumushane_1961-2019

Figure 4. Scatter diagrams of drought indices (*SPI* and *SPEI*) in both Rize and Gumushane stations for a 3-month timescale

4. Conclusions

The novelty of this research is that the research was conducted in a rainy region and the correlation between two different drought indices was investigated to figure out the most representative drought index for the Black Sea Region (BSR). In the current research, *SPI* and *SPEI* values are calculated for twenty meteorological stations over the BSR in Turkey. Precipitation and temperature data series, observed from 1927 to 2019, of stations were used in the study. The frequency of droughts in the "*mild drought*" category is prevalent in the BSR regardless of drought index calculation technique, i.e., either *SPI* or *SPEI*. The results of the *SPI* and *SPEI* indices for a 3-month time scale showed that observed drought frequencies are higher for the "*mild drought*" class than the other drought classes of all meteorological stations. It was found that there existed a strong linear relationship ($r>0.93$) between the *SPI* and *SPEI* time series of stations located in the coastal zone of the BSR. Surprisingly, correlation coefficients tended to decrease gradually from the humid zone of BSR in coastal areas to the mountainous south, i.e., rain shadow of the inland locations of the BSR. Therefore, the correlation coefficient was the lowest (*0.82*) in the Gumushane station. A very high correlation (*r=0.98*) was acquired in Rize station, and the lowest correlation coefficient (*r=0.82*) was obtained for the Gumushane station although it may be considered as a high level of relationship (*0.82<r<0.89*) between *SPI* and *SPEI* for 3-month time scale. In this context, research results led us to conclude that *SPI* can be considered a suitable tool for drought characterization in the coastal zone of the Black Sea region since it requires only precipitation data. In turn, the supremacy of *SPI* over *SPEI* in drought assessment allows more stations to be used in drought assessment. Furthermore, this research can be repeated in the future by calculating *SPI* and *SPEI* for the longer timescales, i.e 6-, 12- and 24-month, to check long-term persistence in correlations between *SPI* and *SPEI*.

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