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Monitoring and Evaluation of Meteorological Drought in Malatya Station: Standard Precipitation Index (SPI) and Reconnaissance Drought Index (RDI)

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Malatya İstasyonunda Meteorolojik Kuraklığın İzlenmesi ve Değerlendirilmesi: Standart Yağış İndeksi (SPI) ve Keşif Kuraklık İndeksi (RDI)

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Abstract
Drought is one of the biggest natural disasters in our country and in the world. It brings many financial and moral problems in all geographies where it is seen socially and economically. In this study, the impact of drought, which causes so many negativities, on Malatya province is discussed. With the help of the widely used Standardized Precipitation Index (SPI) and Reconnaissance Drought Index (RDI), detailed drought analyses were made for 3, 6, 9, and 12 months, time intervals using data form 1957-2018. According to the results of the analysis, approximately one out of every two months in the study region was dry. Although the two methods give similar results, slight differences are observed. The reason for this is; unlike SPI, RDI includes temperature data along with precipitation. The driest periods for both methods were observed between 2012 and 2014. According to the SPI method; the driest month was July 2014 with an index value of -3.62, while according to the RDI; July 2014 was again observed with an index value of -3.52. Trend analysis of precipitation and temperature data was made and it was determined that precipitation tends to decrease and temperature tends to increase. It is obvious that climate change, increasing temperature and decreasing precipitation will expose the region to the threat of severe drought in the coming years. The study provides basic information to local administrators and researchers.

Keywords: Drought analysis, Drought assessment, Precipitation, Standardized precipitation index, Reconnaissance drought index.

Öz
Kuraklık, ülkemizde ve dünyada oldukça geniş bölgelere yayılmış en büyük doğal afetlerin başında gelmektedir. Sosyal ve ekonomik olarak görüldüğü tüm coğrafyalarda maddi ve manevi birçok sorunu da peşinden getirmektedir. Yapılan bu çalışmada bunca olumsuzluğa sebebiyet veren kuraklığın Malatya ili için olan etkisi ele alınmıştır. Oldukça yaygın olarak kullanılan Standart Yağış İndeksi (SPI) ve Keşif Kuraklık İndeksi (RDI) yardımıyla 1957-2018 arasındaki veriler kullanılarak 3, 6, 9 ve 12 aylık zaman aralığı için detaylı kuraklık analizleri yapılmıştır. Yapılan analiz sonuçlarına göre; çalışma bölgesinde yaklaşık olarak her iki aydan biri kurak geçmiştir. İki yöntemde birbirine yakın sonuçlar vermesine rağmen düşük oranda farklılıklar gözlemlenmiştir. Bunun sebebi ise; SPI'dan farklı olarak RDI, yağışla birlikte sıcaklık verisini de dahil etmesidir. Her iki yöntem içinde en kurak dönemler 2012-2014 yılları arasında gözlemlenmiştir. SPI yöntemine göre; en kurak ay -3,62 indeks değeriyle Temmuz 2014 olurken, RDI'ya göre ise; -3,52 indeks değeriyle yine Temmuz 2014 görülmüştür. Yağış ve sıcaklık verilerinin trend analizleri yapılmış olup, yağışın azalma, sıcaklığın ise artma eğiliminde olduğu tespit edilmiştir. İklim değişikliği, artan sıcaklık ve azalan yağış gelecek yıllarda bölgeyi çok ciddi kuraklık tehdidiyle karşı karşıya bırakacağı aşikardır. Çalışma yerel yöneticilere ve araştırmacılara temel bilgiler sunmaktadır.

Anahtar Kelimeler: Kuraklık analizi; Kuraklık değerlendirme; Yağış; Standart yağış indeksi; Keşif kuraklık indeksi

1. Introduction

Water is probably the most important natural resource in the Middle East due to its historical significance in establishing human life in Mesopotamia (Gezici *et al.* 2024). Abnormal changes in precipitation and temperature are the main causes of flood hazards and, for some regions, drought phenomena (Dehghani *et al.* 2022, Çirağ and Fırat 2023). Drought can be defined as a natural disaster or extreme weather event caused by a prolonged lack of precipitation (Katipoğlu *et al.* 2021). According to the physical impact of drought on the environment, there are four categories of drought: meteorological, agricultural, hydrological, and socioeconomic drought (Wilhite and Glantz 1985, Addi *et al.* 2021, Topçu 2022). Meteorological drought is a drought that can last for months to years and occurs as a result of less than normal precipitation (Hobbins *et al.* 2008, Çelik and Yakar 2024). As drought develops to a certain extent, water storage

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and river flow in aquifers, lakes or reservoirs will be affected, leading to hydrological drought and socioeconomic losses (Mehran *et al.* 2015, Xu *et al.* 2019, Xu *et al.* 2021). Agricultural drought can be defined as a deficiency in soil moisture that can cause great damage to agriculture and socioeconomically (Zhang *et al.* 2021).

Drought is a disaster that develops slowly and shows its effects for many years, unlike disasters that occur rapidly such as earthquakes and floods (Şener 2021). Drought therefore has no clear beginning and end (Kchouk *et al.* 2022). However, there are various drought indices to determine the impact and severity of drought. Drought indices provide insight into changes over time by determining the characteristics of drought, such as its severity. They therefore form the basis of drought management plans (Wilhite 2005, Katipoğlu *et al.* 2020). Liu *et al.* (2021) conducted drought analysis in Sichuan province in southwest China using SPI (Mckee *et al.* 1993) and the standardized precipitation evapotranspiration index (SPEI). As a result of the study, they reported that there were significant differences between the two indices for some regions. They also attributed the main causes of frequent drought in this region to synoptic climatology and atmospheric anomalies of precipitation circulation. Taylan and Bahşi (2021) aimed to analyze the drought of Gaziantep province in Türkiye by using SPI. As a result of the study, they stated that the longest dry period in Gaziantep station occurred between 1950-1960. Mohammed and Yimam (2021) examined the intensity of drought with RDI (Tsakiris *et al.* 2005) for the Lakes' Region of Ethiopian Rift Valley using rainfall and temperature data between 1986 and 2019 for 3 and 12 months. They stated that drought was experienced in almost all stations within the study area. Mondol *et al.* (2021) used the Effective Drought Index (EDI) to investigate the frequency and severity of drought in the Barind tract and the Teesta floodplain in Bangladesh. They concluded that the results and findings of the study indicate that drought is on an increasing trend. Kartal (2024) aimed to analyze the drought of Elazığ province in Turkey using SDI, RDI and the Effective Reconnaissance Drought Index (eRDI). As a result of the study, it was emphasized that the results of the three indices were very similar to each other.

This study aims to analyze the drought intensity and the trend of precipitation and temperature values of Malatya province, which provides a significant amount of Türkiye's and the world's fresh and dried apricot needs. In this context, using monthly temperature and precipitation data from 1957 to 2018, drought indices were calculated employing the SPI and RDI methods, yielding outputs across different time scales (3, 6, 9, and 12 months). Innovative Trend Analysis (ITA) method was used for trend analysis. Within the scope of the study, drought values were determined using monthly data, analyzed according to drought classification and the similarity between the indices was analyzed. The study presents the drought trend of the region on a temporal scale in detail by using long-term measurement records. The study also aims to contribute to the understanding of the impact of climate change at the local scale.

2. Materials and Methods

2.1 Study area

Malatya province (Figure 1), which provides a significant amount of Türkiye's and the world's apricot demand, was selected as the study area. Malatya is located between 35 54' and 39 03' north latitudes and 38 45' and 39 08' east longitudes in the Upper Euphrates Basin of the Eastern Anatolia Region in Türkiye and has a surface area of 12.313 km2 and a population of 808.692 people (Çırağ and Fırat 2022). According to the data of the Turkish Meteorology General Directorate (MGM) (Int. Kyn. 1), the highest total daily precipitation between 1927 and 2023 was 88.9 mm (11.06.1997), the highest snowfall was 33 cm (31.01.1950), the highest temperature was 41°C (27.07.2012) and the lowest temperature was -24.9°C (05.01.1942). The average temperature and total precipitation data used for this study were obtained from the Meteorological observation station located at the coordinates 38°20'12.00"N - 38°13'2.40"E in Malatya province and 950 m above sea level.

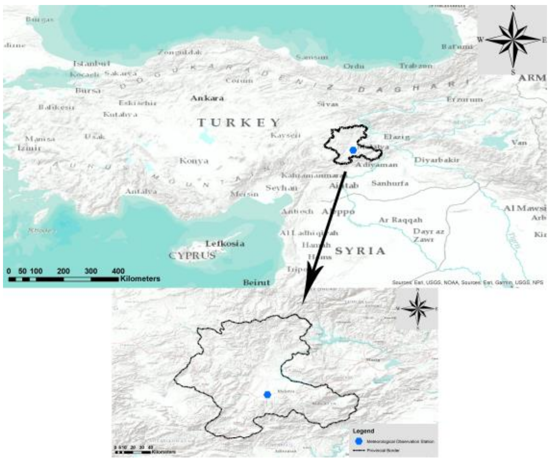

Figure 1. Location of the meteorological observation station in Malatya province

2.2 Drought indices

2.2.1 SPI

The SPI is calculated by fitting the gamma probability density function to a given precipitation time series (Zarch *et al.* 2015). Precipitation is transformed into normalized numerical values and the SPI expresses the amount by which observed precipitation deviates from the long-term average in terms of standard deviation (Equation 1). Therefore, the SPI can be used to describe and compare drought conditions in different regions. The index provides a reliable estimate of the magnitude, severity and spatial extent of drought. The SPI is positive when precipitation is above the long-term average, while the SPI is negative when precipitation falls below the long-term average (Tirivarombo *et al.* 2018).

$$SPI = \frac{x_i - \bar{x}}{\sigma} \quad (1)$$

where, xi is the precipitation amount of the selected period i, x̄ is the long-term average precipitation and σ is the standard deviation for the selected period.

2.2.1 RDI

First proposed by Tsakiris *et al.* (2005), it is an index for monitoring agricultural and meteorological drought that requires cumulative precipitation and potential evapotranspiration (PET) data (Topçu and Seçkin 2022). The RDI is a meteorological index widely used in the assessment of drought. The RDI is expressed in three different ways: initial value (a), normalized RDI and standardized RDI. The initial value (a) is presented aggregated over monthly time periods and can be calculated on a monthly, seasonal or annual basis (Ansarifard *et al.* 2018). When expressing the Exploratory Drought Index, (α_k^i) and ($\mathrm{RDI_{st}}$) (standardized) are used. The calculation should be started by finding the initial value (α_k^i) of the Exploratory Drought Index. Let P denote precipitation for month j of year i (j = 1 (October),..., 12 (September)) and PET denote potential evapotranspiration for month j of year i (j = 1 (October),..., 12 (September)). In this case, (α_k^i) can be calculated as given in Equation 2, where N is the number of hydrological years and k is the number of months (Taşkolu 2023).

$$\alpha_k^i = \frac{\sum_{j=1}^{k} P_{ij}}{\sum_{j=1}^{k} PET_{ij}},\ i = 1,2,\ldots,N\ ,\ j = 1,2,\ldots,k \quad (2)$$

In this study, the Thornthwaite potential evapotranspiration method, which is easier and more practical than other methods, was used to calculate PET. In the Thornthwaite method, potential evapotranspiration is estimated as given in Equation 3 (Thornthwaite, 1948; Taşkolu and Güngör, 2025).

$$PET = 16\left(\frac{N}{12}\right)\left(\frac{m}{30}\right)\left(10\,\frac{T_{mean}}{I}\right)^{a} \quad (3)$$

$$I = \sum_{i=1}^{12}\left(\frac{T_{mean}}{5}\right)^{1.514} \quad (4)$$

$$a = (6.75)10^{-7}I^3 + (-7.71)10^{-5}I^2 + (1.79)10^{-2}I + 0.49 \quad (5)$$

where T_{mean} is the monthly average temperature (°C), N is the monthly average daylight hours (hours/days), a is the coefficient, and I is the heat index.

As stated by Zarch *et al.* (2015), SPI and RDI can be classified according to the drought classification in Table 1.

Table 1. SPI and RDI classification (Zarch *et al.* 2015)

SPI and RDI value	Drought category
2 or more	Extremely wet
1.5–1.99	Very wet
1–1.49	Moderately wet
0.99–0.0	Normal
0.0 to −0.99	Near normal
−1 to −1.49	Moderately dry
−1.5 to −1.99	Severely dry
−2 and less	Extremely dry

For both indices, different time periods such as monthly (i) can be determined by considering the effect of precipitation deficiency on different water resources. In general, studies use different time periods such as 1, 3, 6, 12, 24 and 48 months (i) to see short-term and long-term effects. This methodology is based on how long it takes for the impact of a lack of precipitation over time periods to be felt on available water resources. For example, while a decrease in precipitation in any given month can have a rapid impact on soil moisture, the impact on groundwater and streams occurs over a longer period of time (Özfidaner and Topaloğlu, 2020). Therefore, it is necessary to study different time periods to see short-term and long-term effects.

These time periods are characterized by the total precipitation in each month and the preceding months. For example, for SPI-3, the value in March is based on the values in January, February and March. Therefore, for time scales, the analysis is performed by shifting from the initial data to the time scale. In other words, if precipitation values starting from January 1957 are available, the first SPI-3 value can be obtained in March. Thus, 3-month timescales can be used to analyze drought in fast-responding systems such as agriculture, 6-month timescales for seasonal droughts and 12-month timescales for long-term droughts.

2.3 Trend analysis

2.2.1 ITA

The ITA method, first proposed by Şen (2012), was developed to analyze the trends of hydrological time series values. The fact that it does not require any assumptions is the main reason why the ITA method is preferred (Caloiero *et al.* 2018). In the application phase of the ITA method, firstly, the available hydrological data set is divided into two equal parts according to time series consecutively. These divided time series data are ordered from smallest to largest and marked in the Cartesian coordinate system. The first half time series is placed on the x-axis (X_i), while the second half time series is placed on the y-axis (X_j). Finally, a 1:1 line is drawn and it can be interpreted that if there is a clustering in the upper region of the 1:1 line, there is an increasing trend, if there is a clustering in the lower region, there is a decreasing trend and if there is a clustering on the line, there is no trend (Taşkolu 2023). The degree of trend is determined by the distance from the origin (0,0). The closer to the origin, the lower the degree of trend, and vice versa, the further away from the origin (closer to the extreme region of the 1:1 line), the higher the degree of trend (Şen 2012, Şen 2014).

2.4 Performance evaluation criteria for correlation analysis

Coefficient of determination (R^2) and the root mean square error (RMSE) performance evaluation criteria were used to determine the agreement between SPI and RDI drought indices. R^2, which can be defined as the ratio of the variance of the dependent variable estimated from independent variables, takes the lowest value -∞ and the highest value +1 (Chicco *et al.* 2021). RMSE analyzes the distribution of data around the line of best fit and takes values between 0 and ∞. A value of 0 indicates a state of perfect fit (Gezici and Şengül 2023). The following equations are used to calculate these criteria:

$$R^2 = \frac{\sum_{i=1}^{n}(b_i - b_{ort})^2 - \sum_{i=1}^{n}(b_i - y_i)^2}{\sum_{i=1}^{n}(b_i - b_{ort})^2} \quad (6)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(b_i - y_i)^2}{n}} \quad (7)$$

where b_i is the observed value, y_i is the output value, and b_{ort} is the average of observed values.

3. Results and Discussions

3.1 SPI and RDI analysis results based on monthly time series

Drought is an important natural disaster with environmental, economic and social impacts worldwide. It brings many negative consequences such as decreasing water resources, decreasing agricultural productivity, damaging ecosystems, and societies experiencing problems in water supply (Gümüş *et al.* 2016). Therefore, the detection, monitoring and management of drought is of great importance. In this study, comprehensive analyses were conducted using SPI and RDI to examine drought and humidity conditions in Malatya province in detail.

SPI is a widely used method for determining drought and humidity levels by expressing the amount of precipitation in a given period in terms of standard deviation. Analyses at different time scales (SPI-3, SPI-6, SPI-9, SPI-12 and RDI-3, RDI-6, RDI-9, RDI-12) reveal both short-term and long-term drought trends. RDI provides a more comprehensive analysis with PET data along with precipitation (Vangelis *et al.* 2013). The data obtained with these methods are of great value for water resources management, agricultural planning and climate change adaptation strategies.

The data obtained as a result of the analyzes carried out in the study region reveal the temporal distribution of drought and humidity conditions. In this context, the most humid and driest months obtained in SPI-3, SPI-6, SPI-9, SPI-12 and RDI-3, RDI-6, RDI-9, RDI-12 scales were determined, and the rates of observations in various drought categories in monthly time series were detailed. SPI and RDI results for 3-6-9-12 months are given in Figure 2 below. According to SPI-3 results, the wettest month was in September 1991 with a value of 2.88. On the other hand, the driest month was observed in July 2014 with a value of -3.62. According to SPI-6 results, the wettest month was recorded in December 1991 with a value of 1.96. The driest month was recorded in August 2012 with a value of -3.06. According to SPI-9 data, the wettest month was recorded in September 1969 with a value of 1.71. The driest month was recorded in June 2014 with a value of -3.05. According to SPI-12 analysis, the wettest month was recorded in October 1988 with a value of 1.54. The driest month was recorded in August 2014 with a value of -2.99. According to RDI-3 results, the wettest month was February 1972 with a value of 5.02. On the other hand, the driest month was observed in July 2014 with a value of -3.52. According to RDI-6 results, the wettest month was recorded in March 1987 with a value of 2.06. The driest month was recorded in May 2014 with a value of -3.00. According to RDI-9 data, the wettest month was June 1993 with a value of 1.72. The driest month was recorded in June 2014 with a value of -3.01. According to RDI-12 analysis, the wettest month was recorded in October 1993 with a value of 1.63. The driest month was recorded in August 2014 with a value of -2.94. During these dry months, decreased crop productivity occurred in the Malatya basin as stated in the study of Sunkar *et al.* (2013). In the study, when 'extremely dry, severely dry, moderately dry and near normal' classes were taken as dry periods, the number of drought events (from 3 to 12 months) decreased as the time scale increased, similar to the results of Yılmaz (2023).

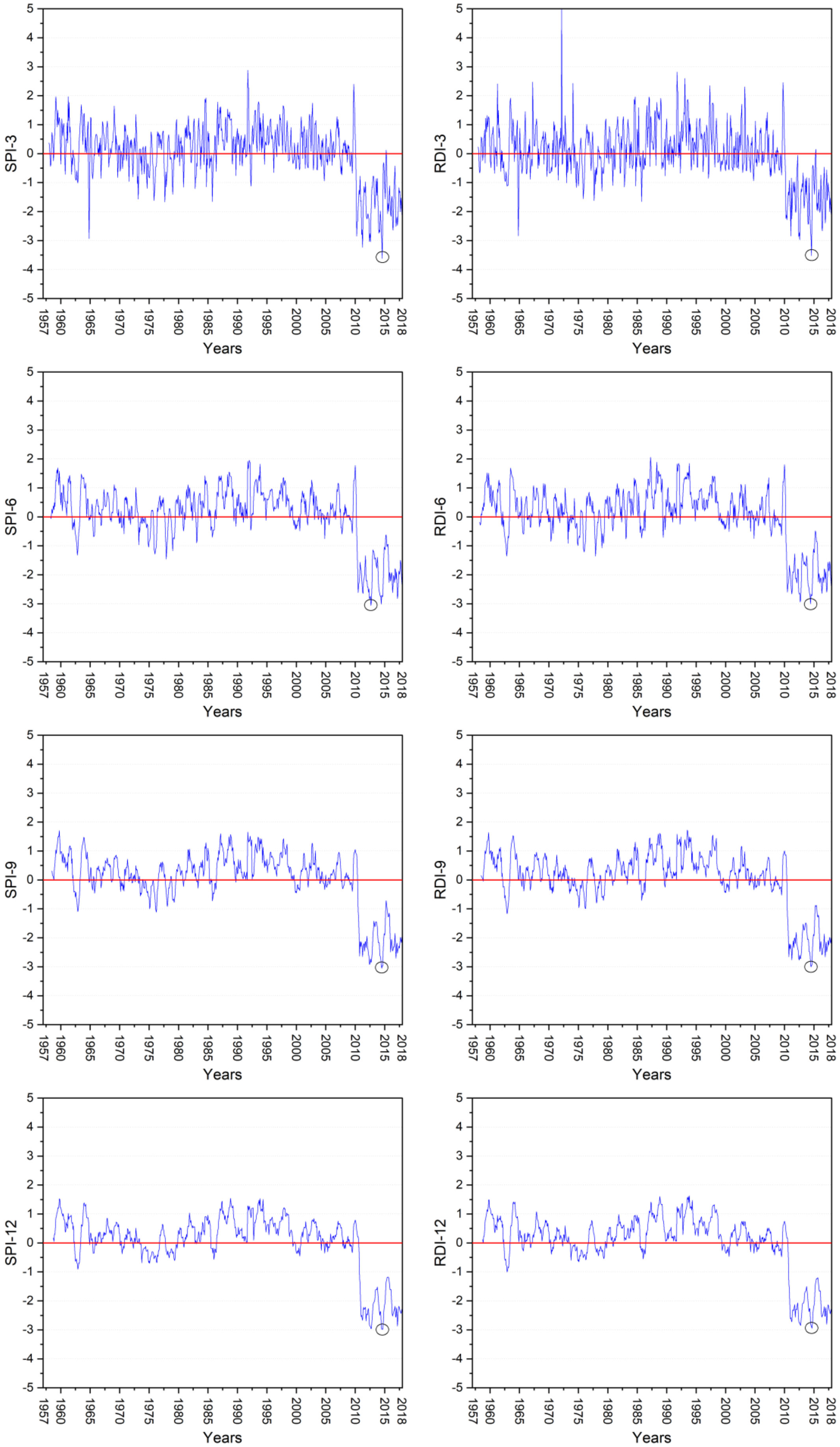

Figure 2. SPI ve RDI comparison of time series of SPI and RDI

According to the results of both indices at all time scales, a dry period started after 2010. This dry period started as a sudden decrease at the end of July 2009 for all time scales. For the drought analysis between 1957-2018, the driest month in all time scales occurred during this dry period. According to Figure 2, the most abrupt transition from wet to dry period occurred during this dry period.

The number of dry periods of 6 months and longer for different time scales according to SPI and RDI values are given in Figure 3.

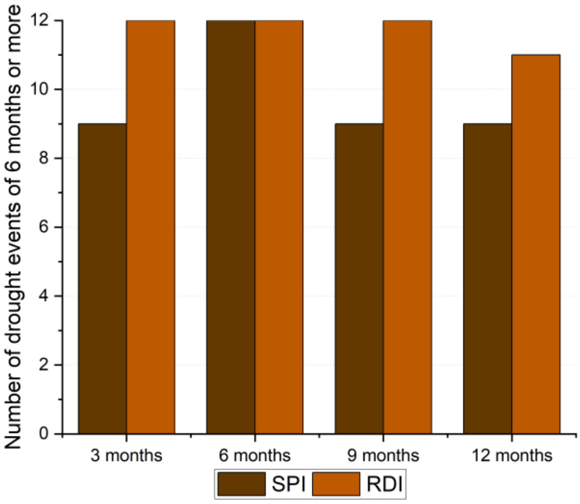

Figure *3.* Number of droughts lasting 6 months or more

As a result of the analysis for SPI 3-6-9-12, the number of consecutive dry periods of 6 months or more was found to be 9-12-9-9, respectively. This situation was again observed as 12-12-12-12-11 for RDI. The main reason for the higher number of long-term dry periods in RDI results is the temperature effect. In their study, Topuz and Karabulut (2020) made a similar statement; they stated that the number of snow-covered days and the number of snowy days decreased in Malatya station, that is, the number of dry periods increased in line with this. In addition, Çelik *et al.* (2018), in their study using the SPI index, stated that drought may pose a significant problem in Malatya according to the trends.

3.2 Analysis results according to drought classes

In line with the results of SPI and RDI methods, drought forecasts for the study region are organized according to 8 different drought classes from extremely dry to extremely wet. Values less than 0 are considered as dry and values greater than 0 are considered as wet. The results obtained are given in Figure 4 below.

In this study, the 'near normal' class is not considered as months with intense drought in order to see the time periods when drought is intense. 'Extremely dry, severely dry and moderately dry' classes are defined as months with intense drought. These months will be referred to as 'dry months' in the rest of the study. In this context according to SPI-3 results, when the monthly time series were analyzed, it was determined that 5.6% of the data were extremely dry, 4.1% were severely dry, 4.7% were moderately dry and 27.1% were close to normal. These data show that 14.4% of the total number of dry months were observed. When the SPI-6 results were analyzed, it was observed that 7.7% of the monthly time series were extremely dry, 3.3% were severely dry, 3.9% were moderately dry and 23.0% were close to normal. These results indicate that there were 14.9% dry months in total. According to the monthly time series for SPI-9 data, 9.0% were extremely dry, 2.8% were severely dry, 2.3% were moderately dry and 23.6% were near normal dry months. These data show that there are 14.1% dry months in total. And according to the SPI-12 analysis, in the monthly time series, 10.3% of extreme dry months, 1.8% of severe dry months, 1.4% of moderate dry months and 21.9% of near-normal dry months were observed. These results show that there are 13.5% dry months in total. Similarly, Başak (2017) determined that the percentage of drought of Malatya station between 1929 and 2014 was below 50% according to the SPI method.

According to the RDI-3 results, when the monthly time series were analyzed, it was determined that 3.8% of the data were extremely dry, 4.0% were severely dry, 5.5% were moderately dry and 36.8% were close to normal. These data show that a total of 13.3% of dry months were observed. When the RDI-6 results were analyzed, it was observed that 7.3% of the monthly time series were extremely dry, 4.5% were severely dry, 2.5% were moderately dry and 25.3% were close to normal. These results reveal that there are 14.3% dry months in total. According to the monthly time series for RDI-9 data, 9.4% were extremely dry, 2.6% were severely dry, 1.8% were moderately dry and 24.7% were near normal dry months. These data show that there are 13.8% dry months in total. And according to the RDI-12 analysis, in the monthly time series, 10.5% of extreme dry months, 1.7% of severe dry months, 1.4% of moderate dry months and 22.3% of near-normal dry months were observed. These results indicate that there is a total of 13.6% dry months. Cebeci *et al.* (2019) classified Malatya province as 'very drought' in their drought analysis for the whole of Turkey. They also stated that the drought index value has increased in recent years.

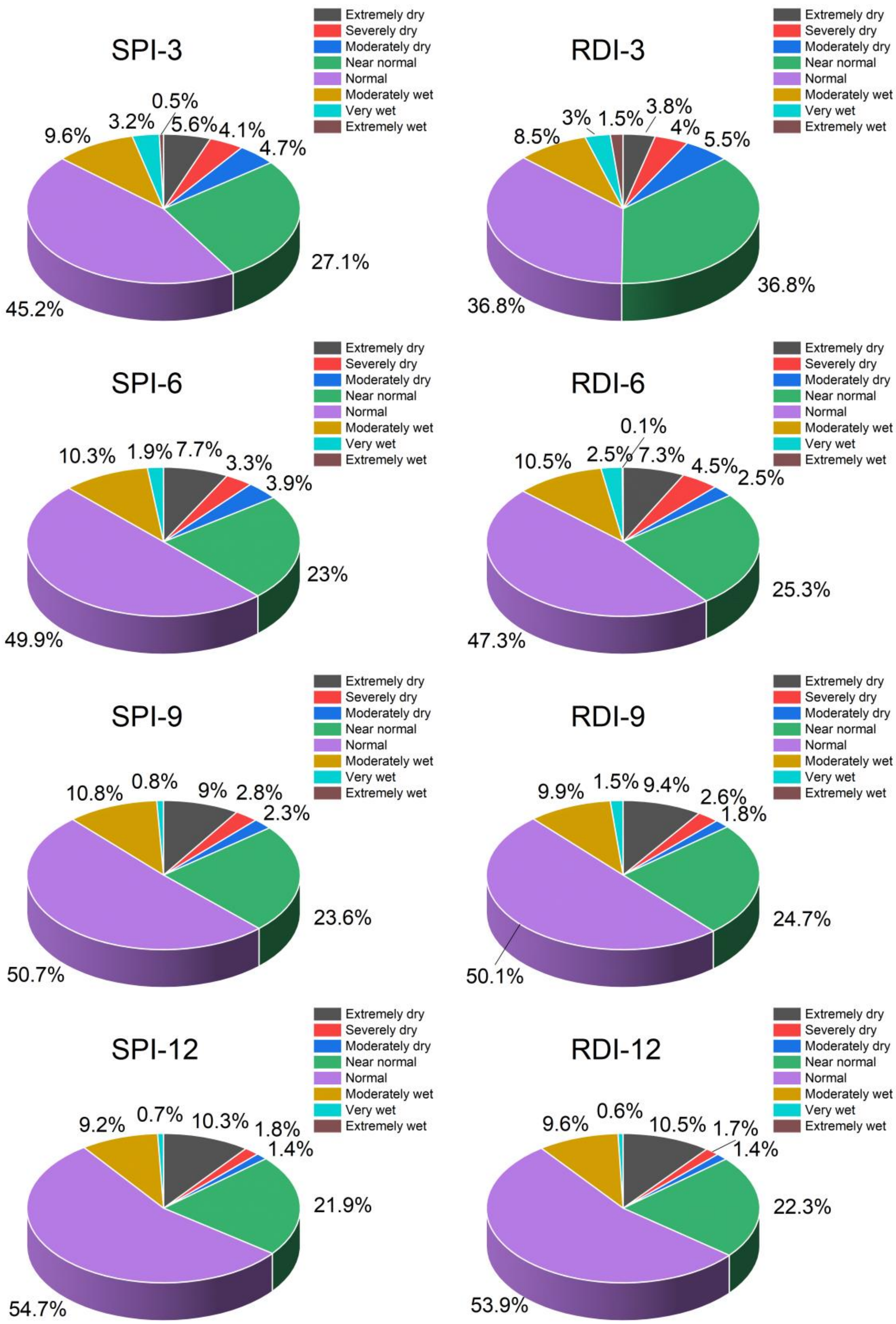

Figure 4. Comparison of SPI and RDI according to drought classes at different time scales

3.4 Correlation analysis

Correlation analysis is a statistical method that determines whether there is a linear relationship between two numerical data and, if so, the direction and severity of this relationship (Özgün *et al.* 2020). In this study, it was used to make sense of the relationship between SPI and RDI. The relationship between SPI and RDI drought values in 3,6,9 and 12-month time series and performance evaluation criterion values are given in Figure 5.

3.4 Results of trend analysis

The two most important parameters in drought analysis studies are precipitation and temperature. Many indices make analyzes in the light of these parameters. Lack of precipitation leads to a decrease in soil moisture, destruction of ecosystems and many socioeconomic problems. In regions with low precipitation, it is very common that agricultural yields cannot be obtained and irrigation water is depleted. In such cases, not only agricultural damages but also economic problems occur (Deniz 2009). With these negative effects; the water level in rivers, lakes and dams drops below normal and there are difficulties in providing drinking water. At the same time, an increase in temperature can also have negative consequences such as lack of precipitation. Drought is a very common natural disaster in extremely hot regions (Kurnaz 2023). In line with the mentioned negativities; it is very important to make trend analyzes for precipitation and temperature in drought studies. Trend analyses support the analysis of the drought situation of the region by providing information on the trend of the climatic characteristics of the region (Taşkolu 2024). The results of the trend analysis of precipitation and temperature as a result of the station data used in this study are presented in Figure 6.

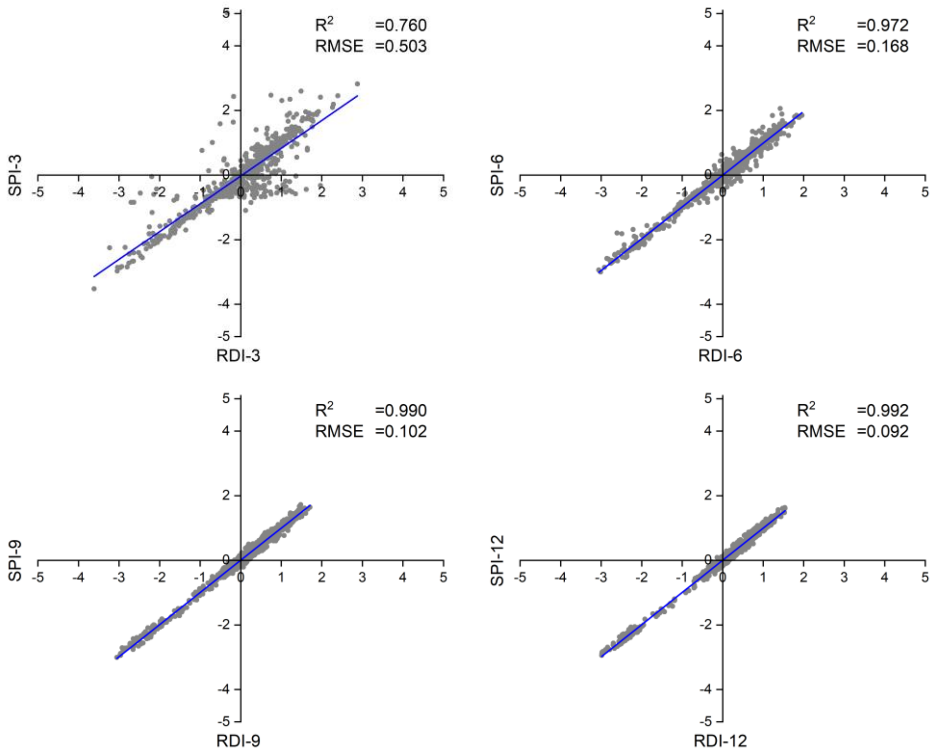

Figure 5. The relationship between SPI and RDI

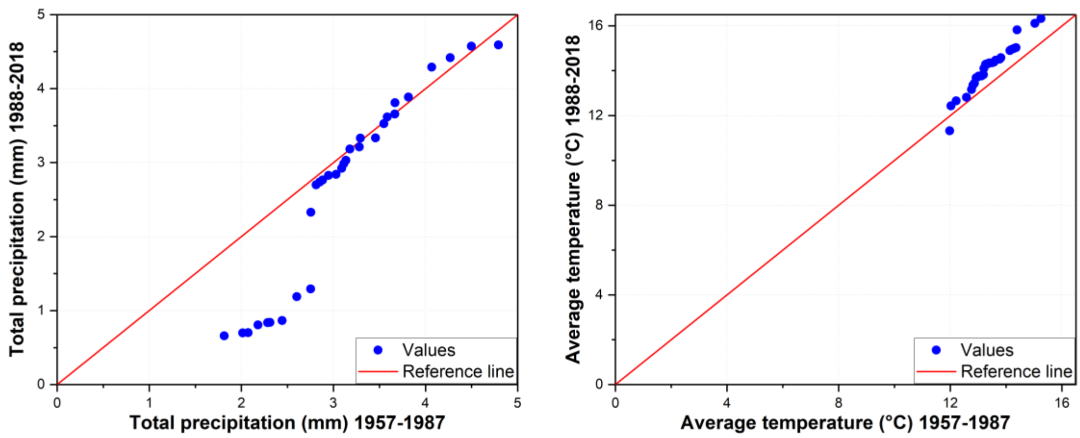

Figure 6. Precipitation and temperature trend according to ITA

When we look at the precipitation trend analysis, the values are clustered in 2 regions in total, above the 1:1 line and in the lower triangular area. This clearly shows that there is a decreasing trend. In the temperature trend analysis, on the contrary, there is a clustering in the upper triangular area. The fact that this clustering is the farthest from the point (0,0) indicates that there is a high increasing trend. This region, where precipitation decreases and temperature increases, faces a serious drought threat. In parallel with the studies of Çelik *et al.* (2018), an increasing drought trend was detected in Malatya province with increasing temperature. In addition, Avcı and Esen (2019), in their study for Malatya station, stated that similar to the current study, precipitation has a decreasing trend and temperature has an increasing trend. Similarly, Keskin *et al.* (2018) reported a decrease in the annual average of precipitation trends and an increase in the annual average of temperature trends for Malatya province. Finally, Keskin and Saplıoğlu (2023) investigated the temperature trends of the Eastern Anatolia Region and found that the temperature in Malatya province is in an increasing trend.

4. Conclusions

In this study, drought values at different time periods (3-6-9-12 months) were analyzed using SPI and RDI, which examines the effect of precipitation deficiency and temperature increase on soil moisture, reservoirs and natural lakes. Then trend analyses were made with precipitation and temperature data sets. The data sets of the Malatya province station, which is the study region, between 1957-2018 were used.

As a result of the analyzes obtained; except for the 3-month RDI (RDI-3), Malatya province station region is in the humid class in total percentage for both methods and for each period. However, if we look at the results of ITA; with increasing temperature and decreasing precipitation values, there is a strong possibility that the region will be in the drought class as a total percentage for both methods and time periods in a short time.

Although the fact that the region is in the humid class in total percentage does not mean that there is no drought, the fact that approximately one of the 2 months is dry is a serious threat for the region. When we look at the SPI 3-6-9-12 monthly values, 14.4%, 14.9%, 14.1%, 13.5% had a dry period, respectively. When we look at the values of RDI 3-6-9-12 months, 13.3%, 14.3%, 13.8%, 13.6% had a dry period, respectively. The small differences between these indices, which are close to each other, are due to the fact that the RDI method uses PET data together with precipitation. Such large percentages of aridity have negative consequences in many areas such as access to drinking water for the local people, the variety of crops in agriculture and access to water used in industry. In line with the results of SPI and RDI analysis, the lowest drought values in 2012-2014 are the main reason for the low crop quality and difficulties in drinking water supply during that period.

The positive correspondence between SPI and RDI values is highest in the 12-month time interval. In this context, it is seen that the relationship between the two indices increases as the time interval increases.

Trend analysis using ITA showed a generally decreasing trend in precipitation data and an increasing trend in temperature data. This finding indicates that long-term water management and agricultural planning studies in Malatya province should take into account the impacts of climate change. The decreasing trend in precipitation poses potential threats to the sustainability of water resources in the region, and it is necessary to re-evaluate water management policies and develop climate change adaptation strategies.

This study constitutes an important step in terms of analyzing long-term data and identifying climatic trends. These findings, which are a basic reference for future research, will contribute to a better understanding of the impacts of climate change at local scales. In this context, conducting similar analyses with the data of other meteorological stations in the region will enable the development of more comprehensive climate strategies at regional and national scales.

Declaration of Ethical Standards
The authors declare that they comply with all ethical standards.

Credit Authorship Contribution Statement
Author 1: Conceptualization, Methodology / Study design, Software, Validation, Formal analysis, Investigation, Resources, Writing – original draft
Author 2: Writing – review and editing, Supervision
Author 3: Conceptualization, Methodology / Study design, Validation, Formal analysis, Investigation, Resources, Writing – original draft, Writing – review and editing, Visualization, Supervision

Declaration of Competing Interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability
The meteorological dataset from The Turkish Meteorology General Directorate is not available to the public. Accessible only through submission of an application by scientific researchers.

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