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# Trend analysis and drought evaluation: A case study of Sirnak

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***Abstract*** Water is necessary for sustaining life for all living things. Therefore, it is vital to evaluate the drought and trend analysis. A total of 276 time series were evaluated to assess drought and determine the trend analysis. In this study, meteorological drought analysis and trend analysis were conducted for Şırnak province, located in the Northeastern Anatolia region, monthly and yearly time series using the Standardized Precipitation Index (SPI) and linear trend analysis. Meteorological data (temperature and precipitation) from Şırnak province between 2000-2022 were utilized. The results showed that the region has different drought and wet types. Although there were periods of severe drought, normal drought levels were more observed. The wet and dry periods were identified, and the results were presented graphically. Trend analysis of temperature and precipitation was determined. As a result, the results can contribute to the water resources planning management for the region.

*Keywords – Şırnak, SPI, Water, Drought*

## I. INTRODUCTION

Water is one of the most important elements for living things to survive and is essential for their vital needs. The water needs of living things are met by surface and underground water resources. For the allocation of water resources, it is necessary to determine their efficiency. Historical changes in river flows are vital for water management and water resources planning. The concept of drought is one of the most important issues related to water availability in the context of climate change. Therefore, the measurement of hydrometeorological parameters is very important in the development and planning of the region to assess drought. Changes in hydro-meteorological parameters (precipitation, temperature, runoff, evaporation, etc.) affect climate change in the region. Drought is regarded as a major natural disaster that humanity has faced since ancient times, but it has affected more people than any other hazard and has among the most complex structure of all natural disasters. [1,2]. Unlike other extreme events (cyclones, hurricanes, floods, etc.) drought evolves in slow and steady progression, and its onset and end are not easy to determine [3]. Droughts are particularly more common and severe in arid and semi-arid regions and can last for weeks, months, years, decades or even centuries. The frequency and intensity of drought events are on the rise and have a significant effect on the continued warming of the global climate, human survival, and the sustainable development of society [4]. Wilhite and Glantz, (1985) stated that drought generally forms when a region does not get enough precipitation for a long period of time, leading to water scarcity. drought studies have been common [6–11] in recent years, The standard precipitation index (SPI) is widely used to describe and compare drought in various climatic zones [12,13]. In the present study, drought analysis of Şırnak was carried out by using monthly precipitation, temperature and evaporation data, SPI indices recorded between 2000 and 2022 from the Şırnak meteorological station, considering monthly and yearly time scales.

This study aimed: (1) to obtain SPI drought indices for monthly, seasonally, and yearly, (2) to determine the trend analysis for rain and temperature of Şırnak province.

## II. Study Area

Şırnak is in 37°31 north latitude and 42°28 east longitude. With a surface area of 7,172 km2 and an average altitude of 1,400 metres, the western part of the territory of Şırnak, 75% of its surface area is located in the Tigris Section of the Southeastern Anatolia Region, while the remaining 25% of its surface area is within the Eastern Anatolia Region.

The province is surrounded by Mardin in the west, Siirt in the north, Hakkari in the northeast and Iraq and Syria in the south. The climate in Şırnak differs according to the regions. In the high parts of the province, the harsh black climate of Eastern Anatolia and the continental climate in other parts are dominant. The study area is shown in Fig. 1.

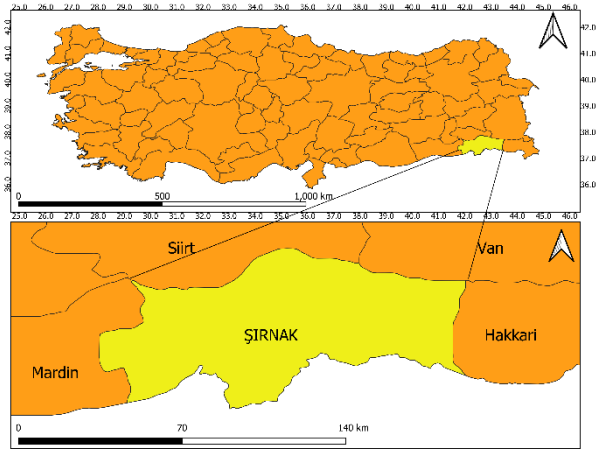


Fig. 1 Study area

## III. Materials and Method

### 3.1. Data Analysis

Meteorological data were obtained from the General Directorate of Meteorology (MGM) as daily data and converted into monthly data. Meteorological data are complete (temperature, precipitation) at the station in Şırnak province. Station name, altitude (m), latitude (°) and longitude (°) are shown in Table 1. The data of the meteorological station used in the study were selected between 2000 and 2022.

Table 1 MGM station

| St. Name | Latitude (°) | Longitude (°) | Altitude (m) |
|---|---|---|---|
| Şırnak | 375209 | 424523 | 1350 |

### 3.2 Drought Indices

#### 3.2.1. SPI

SPI values are affected applying different statistical distribution types since SPI is mainly dependent on the distribution fitting to rainfall time-series. As SPI can be calculated for one month, it also calculated for 3, 6, 9, 12, etc. month SPI values. Gamma distribution was applied to precipitation data as below [14]:

$$(x) = \frac{p^{\alpha-1} e^{\frac{-p}{\beta}}}{\beta^{\alpha} T(\alpha)} \quad (1)$$

$$\propto = \frac{1}{4A}\left(1 + \sqrt{\frac{4A}{3}}\right) \quad (2)$$

$$\beta = \frac{\bar{x}}{\alpha} \quad (3)$$

$$A = \ln(\bar{x}) - \frac{\ln(\bar{x})}{n} \quad (4)$$

in which n: the number of observations, $\beta$:scale parameter, $\alpha$:shape parameter T:Gamma-function by integration, P:precipitation amount.

### 3.2. Linear Trend Analysis

The trend is the variation in the values of a random variable over time in an upward or downward direction. The trend can be computed as below.

$$y = ax + b \quad (5)$$

in which x and y are output and input, and a and b are the coefficients and intercept of variable x, respectively.

Table 2 Drought classification of SPI indice Barua et al. (2011)

| Condition | SPI |
|---|---|
| Extremely wet | $SPI \geq 2.00$ |
| Very wet | $1.50 \leq SPI < 2.00$ |
| Moderately wet | $1.00 \leq SPI < 1.50$ |
| Near normal | $-1.00 \leq SPI < 1.00$ |
| Moderately dry | $-1.50 \leq SPI < -1.00$ |
| Severely dry | $-2.00 \leq SPI < -1.50$ |
| Extremely dry | $SPI \leq -2.00$ |

## IV. RESULTS

### 4.1 CLIMATE DATA FOR ŞIRNAK

In the study, monthly temperature (max, min, average) and precipitation data for Şırnak were investigated for 2000-2022 and descriptive statistics of data was shown in Table 3. The precipitation data for all stations were not randomly distributed.

Table 3 Descriptive statistics of data

| Statistic | Rain | Min T | Av. T | Max T |
|---|---|---|---|---|
| Minimum | 0.0 | -14.5 | -0.1 | 8.6 |
| Maximum | 375.8 | 24.2 | 32.2 | 40.4 |
| Median | 39.0 | 4.6 | 16.1 | 27.0 |
| Mean | 60.1 | 5.8 | 15.8 | 25.5 |
| Variance | 4465.6 | 96.6 | 93.2 | 88.8 |
| Standard deviation | 66.8 | 9.8 | 9.7 | 9.4 |

Linear trend analysis of study area was given in Fig. 2, X-axis represents the time in a month and the Y-axis represents the monthly daily total precipitation in mm. Initially, the climate change effects on temperature, precipitation parameters were analyzed. A backward trend was detected in precipitation data, while an upward trend was detected in temperature and evaporation data based on 95% confidence interval. Secondly, the relationship between the two indices was analyzed in detail for Şırnak province.

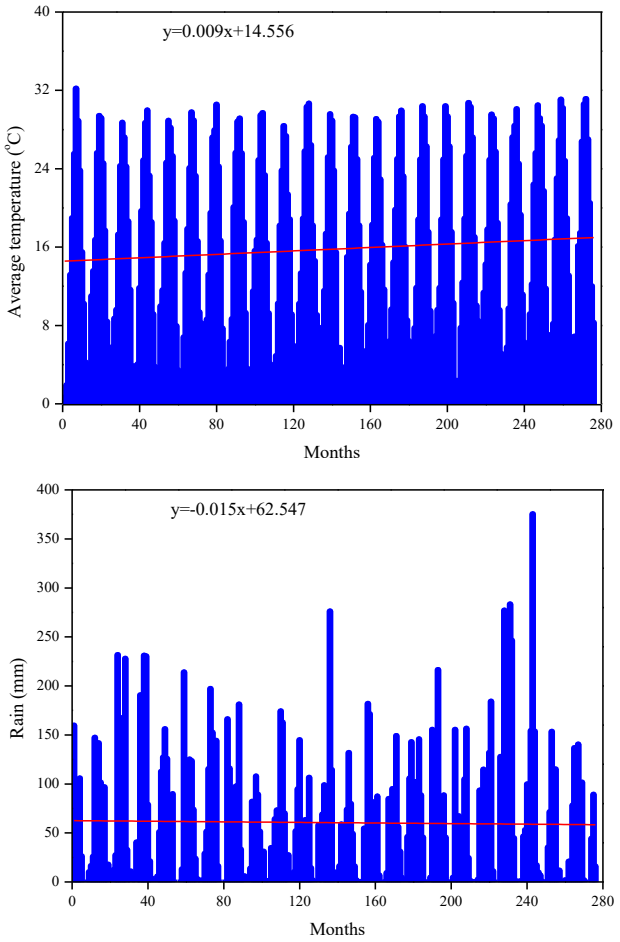


Fig. 2. The trend analysis of rain and average temperature data for Şırnak

### 4.2. SPI DROUGHT INDICES

By applying the SPI drought indices for Şırnak province, analyses were conducted for monthly, seasonally, and yearly time series. The time series are given in Fig. 3. If the drought values of the month are below zero, they represent the dry period, while the drought values are above zero, they represent the humid period. While SPI is calculated using only monthly precipitation data. SPI values were calculated for each month and evaluated by considering the precipitation of each month. To achieve a general conclusion, drought values were plotted for SPI values for monthly, seasonally, and yearly time scale in Fig. 3. As a result, dry and wet periods were observed at Şırnak between 2000 and 2022. As seen in Fig. 3, it is stated that more droughts generally occur in fall and summer season.

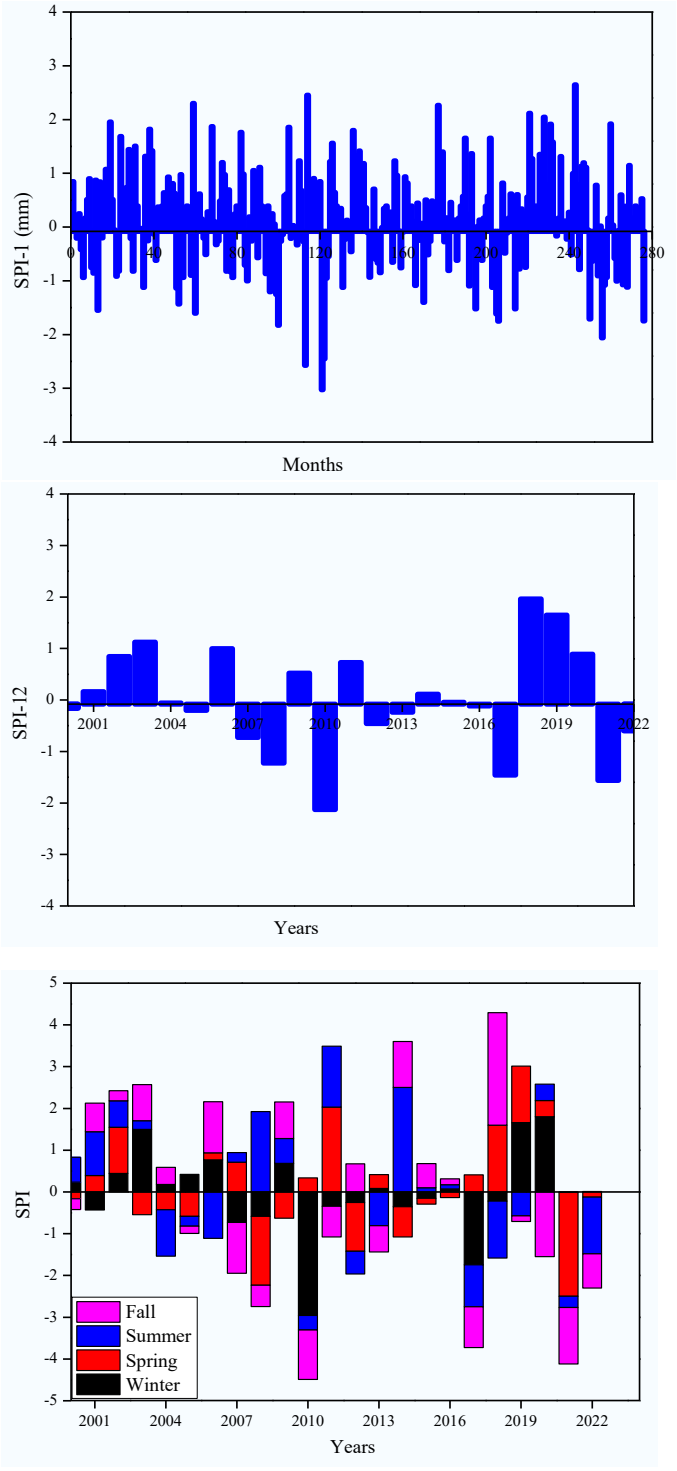


Fig. 3. The SPI results

## V. CONCLUSION

The general objective of this study is to make a detailed drought analysis for Şırnak at monthly, seasonally, and yearly time scales determined using SPI scales. Moreover, drought analysis was conducted by considering the period between 2000-2022 with SPI indices. The effects of climate change on temperature (max, min, average), precipitation, and evaporation parameters were examined in detail. An upward trend was determined in temperature data based on 95% confidence, while a backward trend was backward in precipitation data. Although normal drought has the highest share among drought categories, very severe drought has the lowest share. It is expected to shed light on the drought analyses to be made in the field for Şırnak

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## Declarations

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Conflicts of interest: The authors declare no conflicts of interest.

Data availability: The datasets used and/or analyzed in the present study are available from the corresponding author on reasonable request.

Ethics approval: Not applicable.

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