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Drought Analysis in northwest Turkey

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ABSTRACT

One of the major results of long term trends in climatic factors is the climate change. It can cause increases in the number and effect of some natural disasters like flood, hail, forest fire, etc when the drought phenomenon is in question. Simulation outcomes of regional climate models that are derived from those of the general circulation models indicate that Turkey's latitudes will be affected by drought during the following 100 years. For this reason, any kind of possible drought occurrence is to be evaluated and its effects should be estimated on this area. This analyze is a prior necessity from an agricultural meteorological viewpoint. This study represents the results of a research project on the evaluation of the Thrace Region, which takes one of the most important parts of agricultural production of Turkey. Long term meteorological data in that region have been used to analyze the drought levels. The results of the SPI values show that the Thrace region was under the effect of the severely drought conditions in 2000 and 2001, except Istanbul.

Key-words: agricultural meteorology, drought level, Thrace Region

INTRODUCTION

As a natural disaster, drought develops slowly (Wilhite, 2000). There are many types of drought like agricultural, meteorological, and hydrological. Drought is a result of climate change. In recent years, many researchers focused on the effects of the climatic change and their effects on the earth's live. The predictions showed that one of the important effects of climate change is the changing rain regime in different latitudes. The increase or decrease of the total precipitation amount influences on our ecosystem. Especially the crops cannot easily adapt to new climatic conditions. A decrease trend in precipitation on the arid or semi-arid regions can cause significantly decreases in the agricultural production. This is because the growth mostly depends on the distribution and amount of the rainwater.

As mentioned in Ji and Peters (2003) and Wilhite et al. (2000), many indices such as the Palmer Drought Severity Index (PDSI) (Palmer, 1965), the Surface Water Supply Index

(Shafer and Dezman, 1982), and the Standardized Precipitation Index (SPI) (McKee et al., 1993), the Crop Moisture Index (Palmer, 1968) have been developed to define the drought. These indices are used to understand the change of climate and predict its future effects.

STUDY AREA

Turkey is located in Asian and European continents (Eurasia). Generally, Turkey is under the effects of the semi-arid conditions. For this reason, the level of the production of agriculture is related to atmospheric factors. The amount and distribution of precipitation play a key role for the agricultural production. Cultivars like winter wheat are planted broadly because of their adaptation capabilities to the limited water conditions. The average annual amount of the precipitation over Turkey changes between 500 mm and 800 mm and depends on topography. On the other hand, the evapotranspiration is very high related to the high mean air temperature. 3 % of Turkey's total area located in Europe is called as the Thrace, whereas 97 % of the total area in Asia called Anatolia. Thrace region takes part in the northwestern Turkey and consists of Kırklareli, Tekirdağ, Edirne and the European parts of Çanakkale and Istanbul cities (Figure 1).

In this study, an attempt has been done to analyze the drought in the northwestern Turkey (Thrace), which is the most important area for Turkish agricultural production.

In the Thrace Region, main agricultural production is based on wheat, barley, rice, sunflower and sugar beet. The wheat planted on app. 550 000 ha area in Thrace. This region has 5.5 % of the total wheat area of Turkey. The total wheat production per year changes between 1.5 and 2.0 million tons. Additionally, the average wheat production in Thrace is app. 50 % more than the average wheat production of Turkey. Moreover, 70 % of the total sunflower planting area and 75 % of the total sunflower production of Turkey are in this region. Another important crop in the Thrace region is the rice. It contains app. 50 % of the total area and production of the rice in Turkey (Süzer, 2004).

In this study, the drought levels were calculated for the whole Thrace Region by using the Standardized Precipitation Index and the Percentage of Normal Index.

METHODS

Percentage of Normal (PN) and Standardized Precipitation Index (SPI) indices have been used to estimate the drought levels in the Thrace region. The percentage of normal is one of the most simple measurements of rainfall for a site and time period (usually 30 years). Another index is the Standard Precipitation Index (SPI) developed by McKee et al. (1993), which calculates levels of the drought. SPI is based on the probability for precipitation any time period. McKee et al. (1993) used the classification system that is normalised so that wetter and drier climates can be represented in the same way by the use of the SPI. In addition, wet periods can also be monitored using the SPI (McKee et al., 1995). They also defined the criteria for a "drought event" for any of the time scales. A deficit occurs any time when the SPI is negative. The SPI is probability based and was designed to be a spatially invariant indicator of drought that recognises the importance of time scales in the analysis of water availability and water use. It is essentially a standardizing transform of the probability of the observed precipitation (Sırdaş and Şen, 2003). Both indices have some advantages and disadvantages.

RESULTS

Calculating the percentage of the normal precipitation gives reliable results for short time periods and small areas. This index was applied to four sites, namely Kırklareli, Tekirdağ, Istanbul and Edirne.

Long term average (1938-2001) of the annual total precipitation in Kırklareli is 564.83 mm. Percentage of the annual total precipitation amount (PN) decreased to 55.8 % in 2000 with 315.4 mm. In 2001, this rate decreased to 66.4 % with 380 mm. It shows that the lowest PN value in 2000 has been obtained during the latest   63 years period. Similar results have been found for 2001 in Kırklareli. Figure 2 shows the variation of the PN values in Kırklareli, Tekirdağ, (Sarıyer) Istanbul, Edirne (Şaylan et al., 2003).

Average of the annual cumulative precipitation (574.3 mm) in Tekirdağ between 1931 and 2001 is more than that of in Kırklareli. The lowest PN value in Tekirdağ is calculated as 54 % in 1932. 58 % PN value is calculated in 1941. In recent years, the PN value in this site decreased to 67 % and 73 % in 2000 and in 2001, respectively.

In this study, the database of the Sarıyer meteorological station in Istanbul has been used. Average of the annual total precipitation amount between 1949 and 2001 in Sarıyer is 797.98 mm. The lowest PN value at this site has been estimated 72.04 % in 1960. In comparison with the results of Kırklareli and Tekirdağ, opposite ratios have been determined in Istanbul for 2000 and 2001.

Long term average of the annual total precipitation in Edirne is 584.0 mm. Like Kırklareli, the lowest PN values in this location were estimated for 2000 and 2001. These values have decreased to 71.7 % and 57.7 % in 2000 and in 2001, respectively. Lowest PN values were recorded in 1948, 1949 and 1950 and changed between 66 % and 71 %. The lowest annual total precipitation between 1938 and 2001 was in 2000.

Comparison of all PN values for these sites shows that the driest climatic condition in the Thrace Region occurred in Kırklareli, Edirne and Tekirdağ in 2000 and 2001. The Standard Precipitation Index (SPI) needs only the precipitation parameter for the calculations of the drought levels, that's why it is commonly used. This index has been calculated for the same period of the PN. As seen in Figure 3, Kırklareli City is under the effect of a general drought phenomenon since 1983. Especially, two consequent years, 2000 and 2001, showed severely dry climatic conditions and forced the limit of extremely drought level. This situation has been determined in the associated PN values for this city. Similar drought level occurred in 1934.

The results of the SPI values show that the Thrace region is under the effect of the severely drought conditions in 2000 and 2001, except Istanbul. As a result, the drought phenomenon over Turkey has to be continuously observed and measured. Additionally, some scenarios for agriculture and water resources have to be developed for the possible drought condition.

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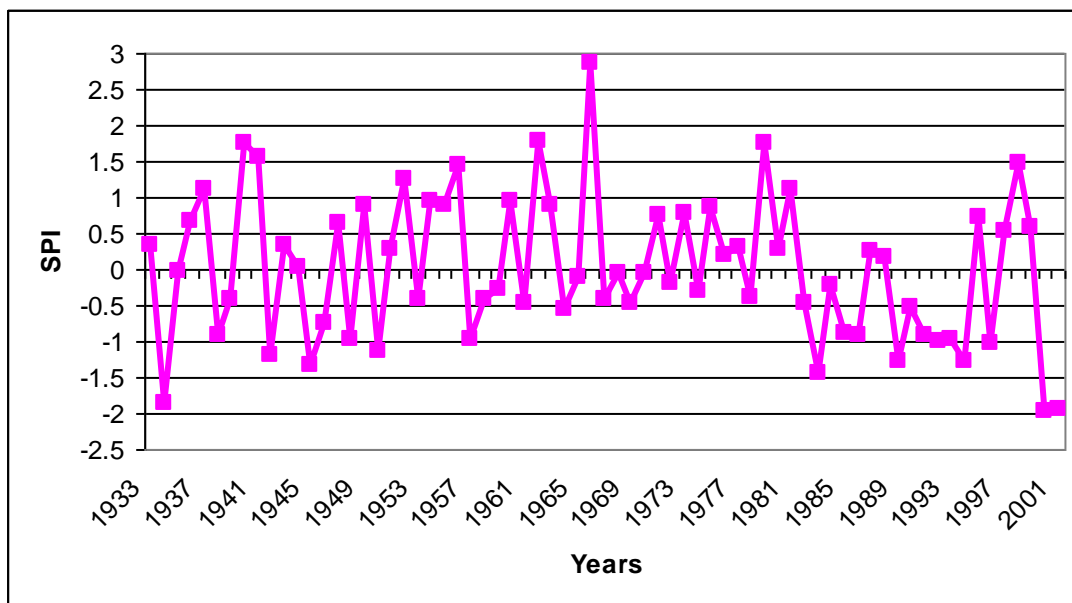
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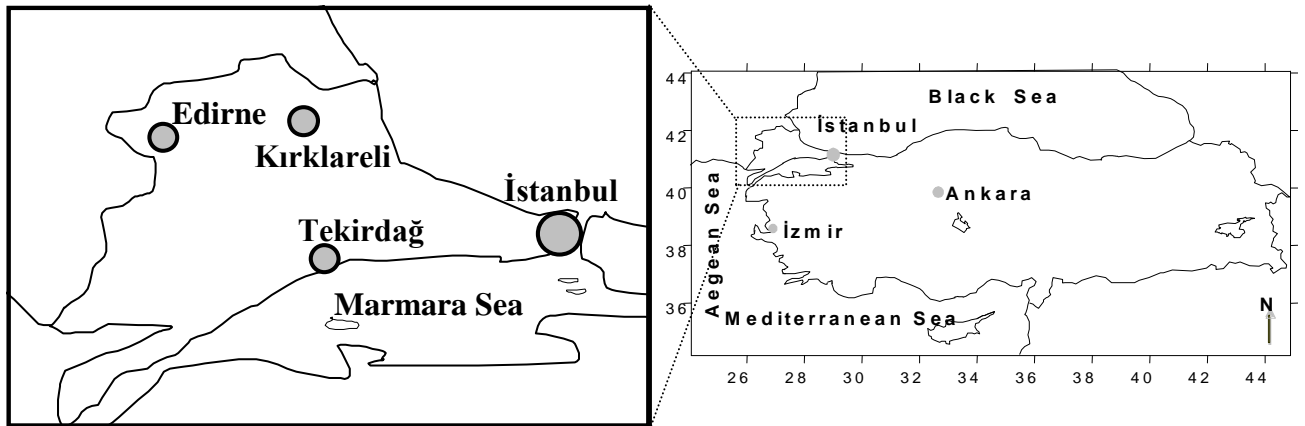
Figure 1. Locations of the study sites in Thrace region.
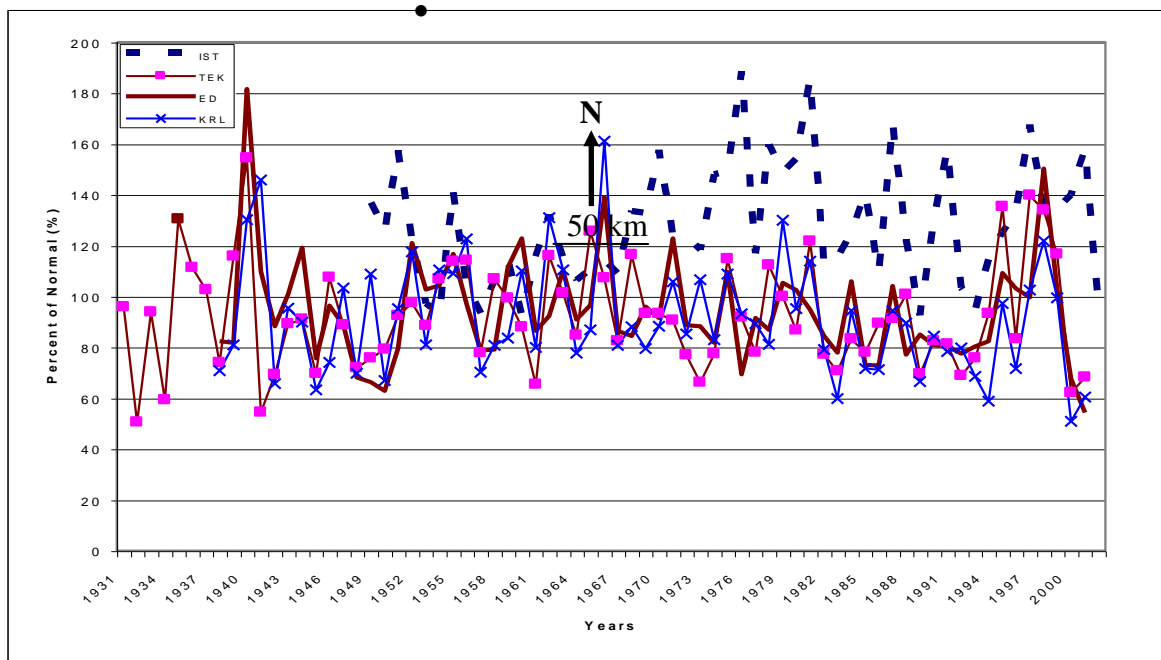
Figure 2. Variations of the PN values in Kırklareli, Tekirdağ, (Sarıyer) Istanbul, Edirne.

Figure 3. Variation of SPI in Kırklareli.