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# GIS MODELLING AND EVALUATION OF CLIMATE VARIABILITY IN KIZILIRMAK WATERSHED OF TURKEY

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## ABSTRACT

This research was carried out within the scope of analyzing the temperature and precipitation values observed in the Kızılırmak watershed of Turkey between 2002 - 2016 and spatial modeling using GIS. In the study, Mann-Kendall, Spearman's Rho and Sen's trend slope method tests were applied to the climate data. Data from 13 meteorological stations in the Kızılırmak watershed were used. The general average of monthly maximum temperatures varied between 23.5 and 26.4 ºC for many years. The general average of monthly minimum temperatures for many years is -4.5 - 1.2 ºC. The total precipitation average was between 377.5 - 644.8 mm. As a result of the trend analyzes made at the 95% confidence level in the research, it was determined that there was an increasing trend in Kastamonu and Sivas meteorological stations at maximum temperatures, and an increasing trend in Çankırı, Gemerek and Kastamonu stations at minimum temperature changes. It was observed that there was a significant change in total precipitation at Kastamonu and Nevşehir stations.

**Keywords:** Climate Variability, GIS Modelling, Kızılırmak Watershed, Turkey

## 1. INTRODUCTION

In this study, monthly, total precipitation data, and minimum and maximum temperature values for many years (2002-2016) belonging to 13 meteorology stations located in the Kızılırmak watershed were used as material Anonymous

(2016). The changes of the series of these data according to time were determined by trend analysis. In addition, spatial analyses of precipitation and temperature data were performed with the help of spline interpolation techniques using Arc GIS 10.3.1 software, one of the GIS methods. As a result of the research, spatial distribution maps of precipitation and temperature changes in the Kızılırmak watershed were revealed. This research: with the introduction of computer-aided terrain models related to the research area, it has made it possible to provide updates and information exchange in the data flow.

In addition, this study will make positive contributions to the increase in agricultural production by effectively revealing the potential of water and soil resources on the watershed. Considering the development of such a study to include different watershed, it will be seen that the study will set an example. In addition to the infrastructure support it will provide to the official institutions related to the realization of the research, it is thought that it will make important contributions to the planning studies by providing information support to the investor organizations in the region.

## 2. MATERIAL AND METHOD

The scope of the study, the values of total precipitation, minimum and maximum temperature for many years were used. In the research, the data of 13 climate stations of the State Meteorology Affairs were analysed. The location of the research area and the locations of the meteorology stations are presented in Figure 1

**Figure1**

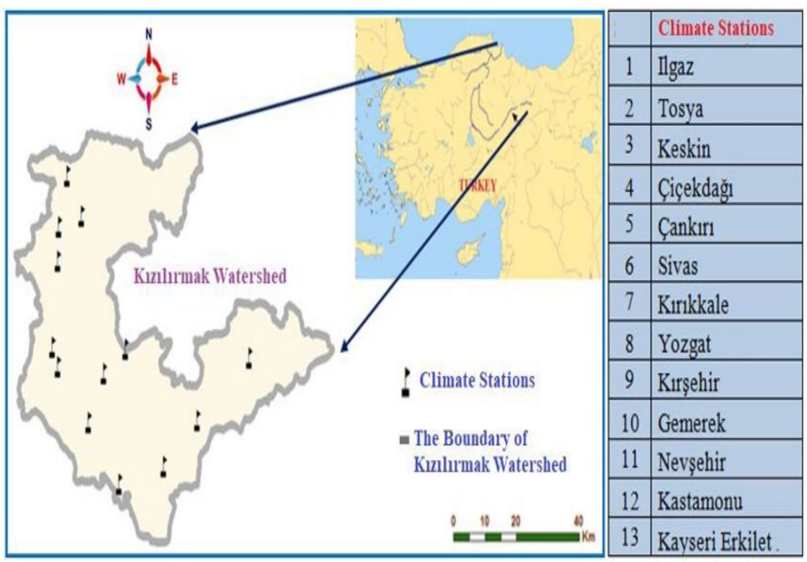


**Figure 1** The location of the research area and the position of the climate stations

In the research, Mann-Kendall and Sperman's Rho Test and Sen's Trend Slope tests were applied at 95% confidence interval for trend analysis of temperature and precipitation data of meteorology stations in the Kızılırmak watershed for many years Mann (1945), Kendall (1975), Sen (1968).

In the research, a software called "Trend Analysis for Windows", which was developed to be used in trend analysis studies, was used Gümüş (2006). In addition, spatial analysis of the data was carried out with the help of spline interpolation method using Arc GIS 10.3.1 software which is one of the GIS programs Anonymous (2010), Hou and Andrews (1978), Hummel (1983), Lee (1983).

## 3. RESEARCH FINDINGS

### 3.1. EVALUATION OF TEMPERATURE DATA FOR LONG YEARS

In the Kızılırmak watershed, the average maximum temperature values in winter months varied between 10.5 - 15.1 oC, while in the spring months it ranged between 22.8 -27.8 oC. The average maximum temperature values in summer months for many years have varied between 33 - 37 oC, 23.9 - 27.2 oC in autumn for many years, and the general average of maximum temperatures has varied between 23.5 - 26.4 oC. For many years, the average minimum temperature values in winter months have varied between (-9.5) - (-17) oC and the average in spring months have varied between -4.7 - 0.3 oC. It has been observed that the average minimum temperature values in summer months for many years vary between 6.6 - 12.4 oC, -2.9 - 2.3 oC in autumn for many years and the general average of minimum temperatures varies between -4.5 - 1.2 oC. The spatial modelling results of the maximum and minimum temperature values observed for many years in the Kızılırmak watershed in the Geography Information Systems (GIS) are presented in Figure 2 and Figure 3.

**Figure 2**

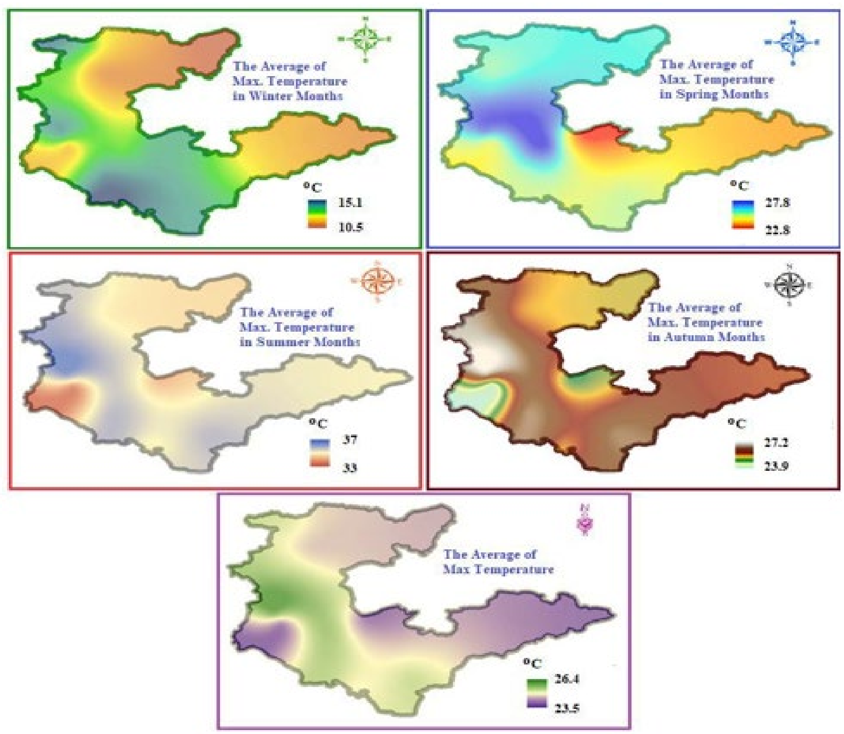


**Figure 2** GIS modelling of maximum temperature averages

**Figure 3**

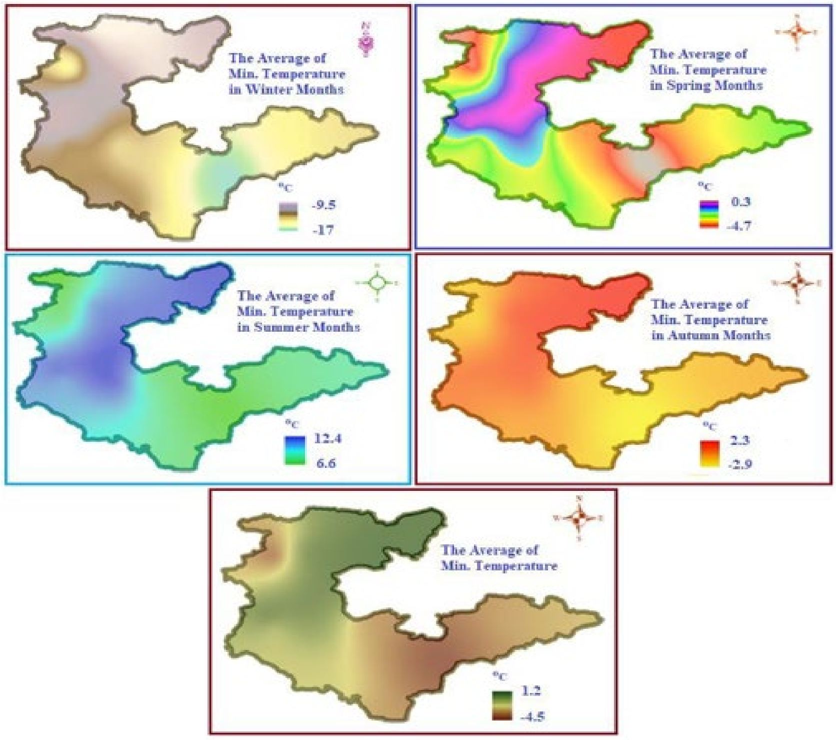


**Figure 3** GIS modelling of minimum temperature averages

## 3.2. EVALUATION OF PRECIPITATION DATA FOR LONG YEARS

The average total precipitation in the winter months for many years was 116.3 - 227.3 mm, the average in the spring months was 117.7 - 202.3 mm, the average in the summer months was

48.5 - 222.8 mm, the average in the autumn months was 71.4 - 288.4 mm, and the general average of the total precipitation for many years ranged between 377.5 - 644.8 mm. The results of the spatial analysis of the total precipitation values for many years in the Geographical Information Systems (GIS) environment are presented in Figure 4.

**Figure 4**

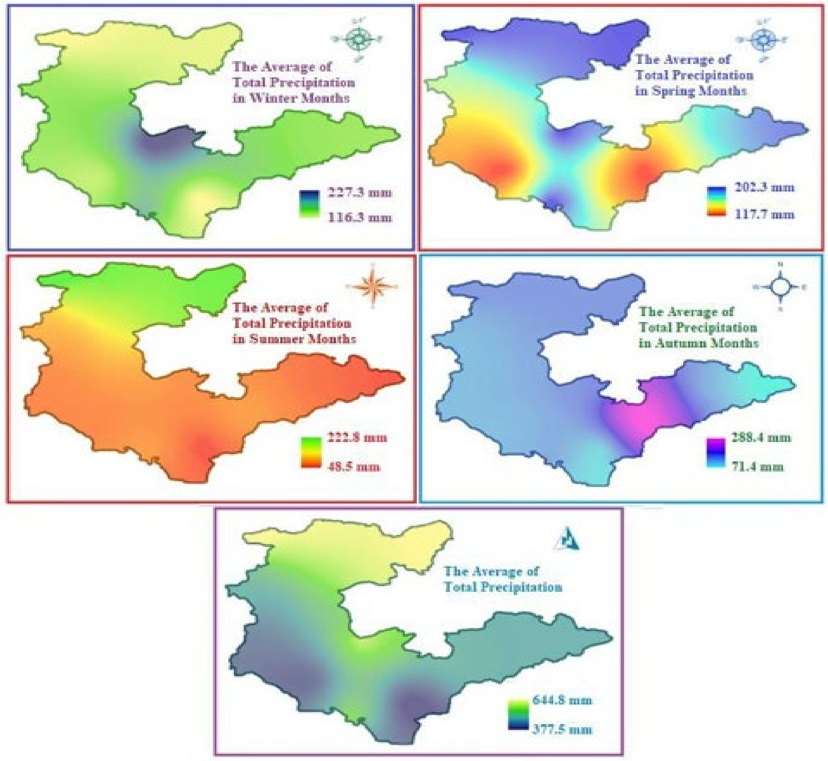


**Figure 4** GIS Modelling of total precipitation averages for many years

## 3.3. TREND ANALYSIS RESULTS OF TEMPERATURE AND PRECIPITATION DATA

It has been observed that there is a significant trend in total precipitation values only in Çankırı station in winter. It has been determined that there is a significant trend in the total precipitation average values for many years in Kastamonu and Nevşehir stations. A significant trend was determined at Çiçekdağı station in average maximum temperature values in spring, a trend in Çankırı and Sivas stations in winter, a significant trend in Siva's station in summer and Kastamonu and Sivas stations in maximum temperature average values for many years. It has been observed that there is a significant trend in the minimum temperatures in the spring months at Ilgaz, Nevşehir and Tosya stations, in the winter months at Çankırı, Gemerek, Nevşehir and in the summer months at the Çankırı, Gemerek, Ilgaz and Sivas stations. It has been concluded that there is a significant trend in the average temperatures in the autumn months at Ilgaz, Kastamonu, Nevşehir, in the summer months at the Çankırı, Nevşehir and Sivas stations and in the minimum temperature averages in the provinces of Çankırı, Gemerek, Kastamonu and Nevşehir. Trend analysis results of total precipitation, maximum and minimum temperature values are given in Figure 5.

**Figure 5**

| Climate Stations | Spring Months Average Min. Temperature (°C) | Winter Months Average Min. Temperature (°C) | Autumn Months Average Min. Temperature (°C) | Summer Months Average Min. Temperature (°C) | Average Min. Temperature (°C) |
|---|---|---|---|---|---|
| Çankırı | - | + | - | + | + |
| Çiçek Dağı | - | - | - | - | - |
| Gemerek | - | + | - | - | + |
| Ilgaz | + | + | + | - | - |
| Kastamonu | - | - | + | - | + |
| Kayseri Erkilet | - | - | - | - | - |
| Keskin | - | - | - | - | - |
| Kırıkkale | - | - | - | - | - |
| Kırşehir | - | | - | - | - |
| Nevşehir | + | - | + | + | + |
| Sivas | - | + | - | + | - |
| Tosya | + | - | - | - | - |
| Yozgat | - | - | - | - | + |

+ There is a significant trend - There is not a significant trend

| Climate Stations | Spring Months Average Max. Temperature (°C) | Winter Months Average Max. Temperature (°C) | Autumn Months Average Max. Temperature (°C) | Summer Months Average Max. Temperature (°C) | Average Max. Temperature (°C) |
|---|---|---|---|---|---|
| Çankırı | - | + | - | - | - |
| Çiçek Dağı | + | - | - | - | - |
| Kastamonu | - | - | - | - | + |
| Kayseri Erkilet | - | - | - | - | - |
| Keskin | - | - | - | - | - |
| Kırıkkale | - | - | - | - | - |
| Kırşehir | - | - | - | - | - |
| Nevşehir | - | - | - | - | - |
| Sivas | - | + | - | + | + |
| Tosya | - | - | - | - | - |
| Yozgat | - | - | - | - | - |

+ There is a significant trend - There is not a significant trend

| Climate Stations | Spring Months Total Precipitation (mm) | Winter Months Total Precipitation (mm) | Autumn Months Total Precipitation (mm) | Summer Months Total Precipitation (mm) | The Average of Total Precipitation (mm) |
|---|---|---|---|---|---|
| Çankırı | - | + | - | - | - |
| Gemerek | - | - | - | - | - |
| Kastamonu | - | - | - | - | + |
| Kayseri Erkilet | - | - | - | - | - |
| Kırıkkale | - | - | - | - | - |
| Kırşehir | - | - | - | - | - |
| Nevşehir | - | - | - | - | + |
| Sivas | - | - | - | - | - |
| Yozgat | - | - | - | - | - |

+ There is a significant trend - There is not a significant trend

**Figure 5** Trend analysis results of minimum and maximum temperature and precipitation

## 4. CONCLUSION AND RECOMMENDATIONS

In order to offer a comprehensive solution to drought, it is necessary to have knowledge about the seasonal changes of hydrological and meteorological events, as well as the behaviour of these events in the long term. Considering that hydrological and meteorological events show differences in each region, it is necessary to conduct research on the basis of the events. Determining the beneficial uses, social and economic structure on the basis of the region, compiling the meteorological and hydrological information in the region, collecting, and compiling the hydrological and meteorological data at the measurement points in the region and making trend analysis using these data are important in terms of reducing the effects of natural disasters. The increase in CO2 and other gases in the atmosphere as a result of industrial activities causes the world to warm up globally. This warming is a factor that accelerates hydrological disasters with the expectation that it may increase extreme values such as floods and droughts as well as climate change Delibaş et al. (2016). Turkey is one of the risky countries where short or long-term climate variability can be experienced. Türkeş (2002)

Oscillations in the climate can lead to other serious problems such as differentiation of vegetation period, land degradation and decrease in agricultural production due to drought. In addition, extreme and unexpected climate variability puts great pressure on water resources. The parameter that shows the most variability in terms of time and space among the climate elements is the amount of precipitation, and the increases and decreases observed in this direction are the most important evidence for climate change Türkeş (1996). As in the whole world, there are temporal changes in the climate elements depending on the global climate change in the Kızılırmak watershed, and an increasing temperature change affects the agriculture of the region negatively.

## ACKNOWLEDGMENT

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