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Analysis of precipitation datas by mann kendall and sperman's rho rank correlation statistical approaches in Nevsehir province of Turkey

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ABSTRACT

In this research, the total and maximum precipitation values of long years (1970-2019) of Nevşehir province, Ürgüp districts and 34 years of Avanos 1986-2019 were subjected to the Mann Kendall and Sperman's Rho rank correlation tests. In this study; Change trends of the precipitation are presented with graphic distributions. According to the results of the trend analysis, it has been observed that the average maximum precipitation value for long years in Avanos district, Nevşehir Province and Ürgüp district is 9,1 mm, 11,3 mm, 10,7 mm and average total precipitation is 292,8 mm, 362,9 mm, 326,9 mm respectively. According to the results of maximum precipitation trends, it has been observed that there is a significant increase in Nevşehir province and Ürgüp districts in winter and autumn months. Considering the total precipitation distribution, it is concluded that there is a negative trend in the spring and autumn seasons in Nevşehir province and Ürgüp district.

KEYWORDS: Precipitation, mann kendall, sperman rho correlation, trend analysis, Nevşehir province of Turkey

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INTRODUCTION

Turkey constitutes one of the risky countries can be experienced in the short or long-term climate variability [1]. The tendency of the global increase observed in the increase of temperatures does not show an equal distribution throughout the world. The prolonged warming tendency is higher between the 40° and 70° North latitudes. The greatest effects of climate change occur in countries located in middle and high latitudes [2]. The Central Anatolia Region is among the areas that will be affected by this change due to its geographical location [3]. Global climate change, which has increased the population and its impact in recent years, shows itself negatively in all areas. With the increase of carbon emissions in the air, the world has been threatened by climate change. Carbon is one of the basic elements of life when it is found in sufficient levels. However, when people consume more than they need, it causes serious CO₂ in the atmosphere and decreases the protective effect of the ozone layer and causes irregularities in precipitation. It is known that the increase in carbon will increase over the years. With this increase, CO₂ and greenhouse gases accumulated in the atmosphere descend to the earth with precipitation. This

event is called acid rain. Acid rains change the pH of the water and affect the life of the living creatures in the water. It causes the natural structure of plants to deteriorate.

In this study, it was carried out to analyze the long-term total and maximum monthly precipitation values observed in the Nevşehir province and Ürgüp district of Turkey between 1970-2019 (50 years), Avanos district between 1986-2019 (34 years) by trend analysis and to reveal the increase or decrease tendencies.

MATERIAL AND METHOD

The study area is located in the Nevşehir province of Turkey Located in the Central Anatolia region. In the study, the total and maximum rainfall values of the center and Ürgüp of the climate observation station of Avanos and Ürgüp districts, Nevşehir province belonging to the Turkish General Directorate of Meteorology between 1970-2019 and Avanos between 1986-2019 were used as materials in the study [4]. The location of the districts subject to the research are shown on the map given in Figure 1.

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In the study, monthly changes in rainfall values observed in the meteorology stations of Avanos district, Nevşehir Province, Ürgüp district between 1970 and 2019 and Avanos between 1986 and 2019 were used. A total of 600 months were analyzed and the values obtained were statistically based on graphs and charts. In the study, it was subjected to total and maximum precipitation trend analysis for many years. In this sense, in order to evaluate the data, it was evaluated within the scope of Rho Kendall Test of Mann Kendall and Spearman and Trend Trend method of Sen and it was performed in the 95% confidence level [5,6]. In the study, a software called “Trend Analysis for Windows”, Mann-Kendall test, Spearman’s Rho test, Mann-Kendall Order Correlation test and Sen’s Trend Slope method are applied to the data and the result is given as graphics and text [7].

RESEARCH RESULTS

The trend analysis results regarding the maximum and total precipitation values between the Avanos and Ürgüp districts, Nevşehir Province and Ürgüp between 1970-2019 and between Avanos 1986-2019 are presented in detail below.



Figure 1: Location of the research area

Maximum Precipitation Changes in Long Years

For many years, maximum precipitation changes were evaluated on the basis of seasons and as general average and the results obtained were evaluated within the graphs presented below. The average maximum rainfall values for the spring months observed on the basis of many years are given in Figure 2.

On the basis of maximum rainfall values in spring months, the maximum precipitation value was 21.0 mm in 2009, the lowest was 2.6 mm in 2019, 11.0 mm in 2019 was the average. On the basis of maximum precipitation values in winter months, the maximum maximum precipitation value was observed in 1998 with 24.4 mm, and the lowest average precipitation values in 2018 with the lowest 3.9 mm in 2018. On the basis of the maximum precipitation values in autumn months, the highest maximum precipitation value was 16.6 mm in 2014, the lowest was 1.6 mm and the average average of 9.0 mm in 2016 was observed. On the basis of the maximum precipitation values in the summer months, the highest maximum precipitation value was 22.5 mm in 2011, the lowest was 0.3 mm in 2003 and the average average of 7.4 mm in 2003 was observed. Considering the annual average values, it is seen that the highest value was 14.0 mm in 1998 and the lowest value was 3.0 mm and in 2018, the overall average value was 9.1 mm. Trend analysis results of long-year maximum precipitation values observed in Nevşehir center are given in Figure 3.

According to this results; maximum rainfall values in the spring months, the maximum maximum precipitation value was 21.7 mm in 1994, the lowest average was 6.7 mm in 2018, and the maximum average of 14.0 mm in 2018.

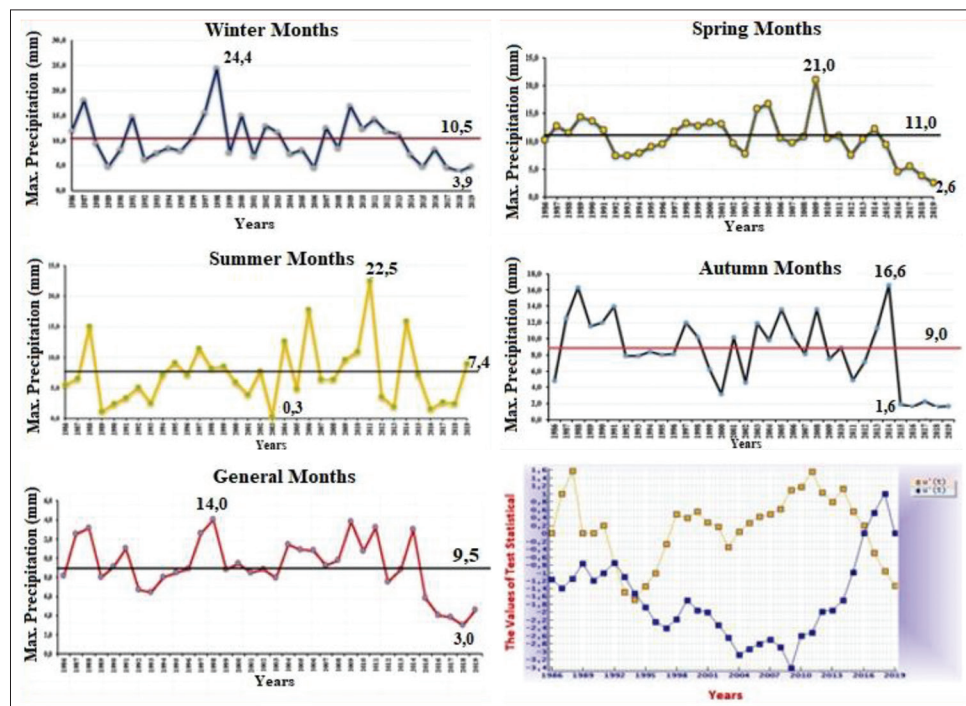


Figure 2: Maximum precipitation changes (mm) of the avanos district in long periods

The maximum precipitation values in winter months, the maximum maximum precipitation value was 24.3 mm in 1998, the lowest 4.8 mm in 1995, and the average average of 12.7 mm in general was observed. On the basis of the maximum precipitation values in autumn months, the maximum maximum precipitation value was 20.9 mm in 1988, the lowest was 3.2 mm and the average average of 11.0 mm in 2019 was the average.

On the basis of the maximum precipitation values in the summer months, the highest maximum precipitation value was observed in 1872 and 1972, and the lowest average rainfall values in 7.7 with the lowest 0.1 mm in 2013. Considering the annual average values, it is seen that the highest value was 16.5 mm in 1987 and the lowest value was 5.8 mm and in 2018, the general average value was 11.3 mm. Trend analysis results of long-year maximum precipitation values observed in Ürgüp district are given in Figure 4.

On the basis of maximum rainfall values in the spring months, the highest maximum precipitation value was observed in 1977 with 24.7 mm, and the lowest average value of 13.4 mm in 1970 with the lowest 5.0 mm. On the basis of maximum rainfall values in winter months, the maximum maximum precipitation value was 24.2 mm in 1998, the lowest was 4.1 mm and 1995, the average average of 11.0 mm in average was observed.

The maximum precipitation values in the summer months, the highest maximum precipitation value was 19.1 mm, in 2006, the lowest was 1.1 mm and the average average of 7.5 mm in 2001 was observed. On the basis of the maximum precipitation values

in autumn months, the highest maximum precipitation value was observed in 1983 with 26.2 mm, and the lowest average of precipitation values was 10.8 mm in 1974 with the lowest 3.7 mm.

The annual maximum average values, it is seen that the highest value is 16.0 mm and the lowest value is 1998 and the lowest average value is 5.7 mm in 2018 and the overall average value is 10.7 mm. Table 1. Trend analysis results of maximum rainfall values of Nevşehir province and Ürgüp, Avanos districts for many years were given in Table 1.

According to the results of trend analysis of the maximum precipitation values of Nevşehir, Mann-Kendall Test shows that there is no trend in all four seasons, while Spearman's Rho Test shows that the trend groove in winter is not in other seasons and the general average is not.

The maximum precipitation values in Ürgüp district, it was observed that the Autumn season was a trend in the Mann-Kendall Test, there was no trend in the Spearman's Rho Test, and in other seasons and the general average was not significant, both tests were observed. The results of trend analysis of Avanos maximum precipitation values, it was observed that there was no significant trend for both tests in general average and in four seasons in terms of overall average.

Total Precipitation Changes in Long Years

Total precipitation values for many years were analyzed in seasons and general average and all evaluations made in the

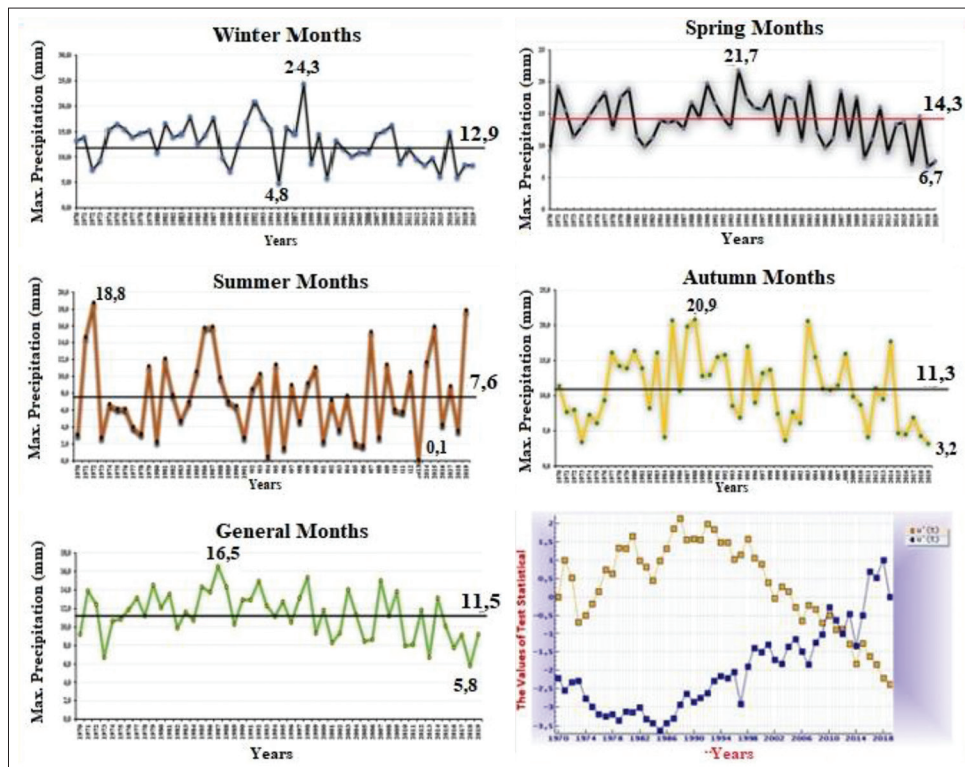


Figure 3: Maximum precipitation changes (mm) of the nevsehir province in long periods

Table 1: Trend analysis results of maximum rainfall values of Nevşehir province and Ürgüp, Avanos districts for many years

Provinces	Years	Seasons	Mann-Kendall Test Statistics	Spearman's Rho Test Statistics
Nevşehir Province	1970-2019 (50 Years)	Spring Months	No Trend	No Trend
		Summer Months	No Trend	No Trend
		Autumn Months	No Trend	No Trend
		Winter Months	No Trend	Negative Trend
		General Average	No Trend	No Trend
Ürgüp District	1970-2019 (50 Years)	Spring Months	No Trend	No Trend
		Summer Months	No Trend	No Trend
		Autumn Months	Negative Trend	No Trend
		Winter Months	No Trend	No Trend
		General Average	No Trend	No Trend
Avanos District	1986-2019 (34 Years)	Spring Months	No Trend	No Trend
		Summer Months	No Trend	No Trend
		Autumn Months	No Trend	No Trend
		Winter Months	No Trend	No Trend
		General Average	No Trend	No Trend

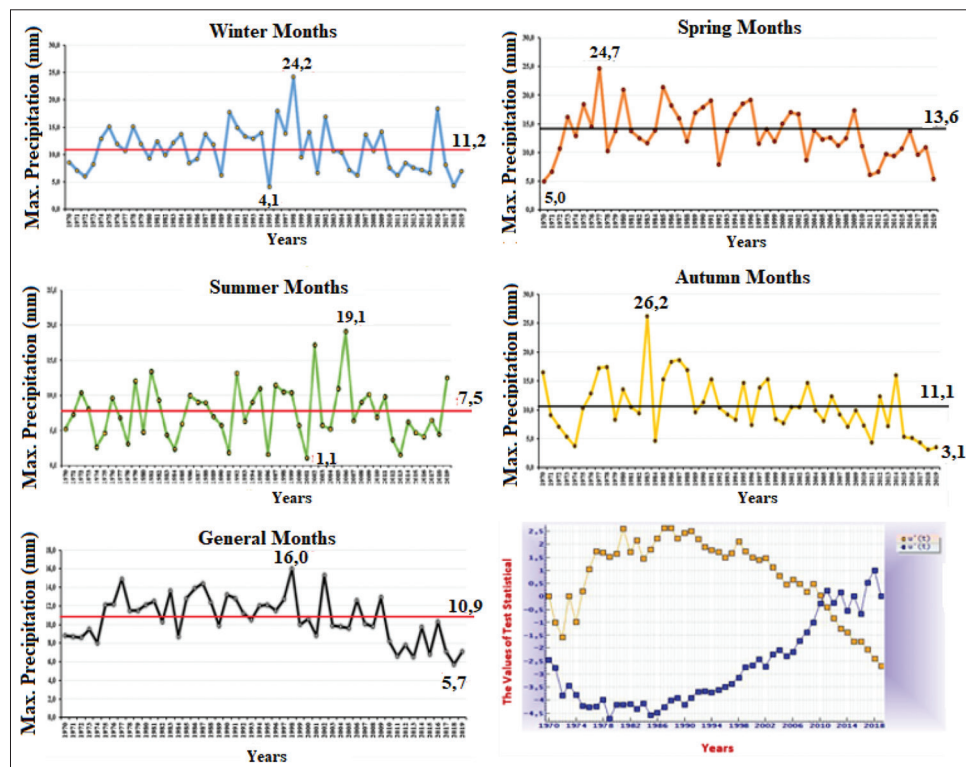


Figure 4: Maximum precipitation changes (mm) of the Ürgüp district in long periods

light of the results obtained were presented graphically. Avanos District Total Precipitation Changes (mm) are given in Figure 5.

In the spring months, the total precipitation values were highest with the highest total precipitation value of 174.8 mm in 2009 and the lowest average of 102.3 mm in 2017 with the lowest of 36.3 mm in 2017. On the basis of total rainfall values in winter months, the

highest total precipitation value was 184.2 mm in 2009, the lowest was 35.5 mm in 2017, with an average of 96.1 mm in total average.

Total precipitation values in autumn months, the highest total precipitation value was 124.7 mm in 1988, the lowest 6.4 mm in 2019, and overall average of 62.1 mm in 2019. On the basis of total rainfall values in the summer months, the highest total

precipitation value was 63.1 mm in 2019, the lowest 6.4 mm in 2016, and overall average of 32.0 mm in 2016.

Considering the annual maximum average values, it is seen that the highest value was 481.8 mm and the lowest value in 2009 was 117.8 mm and the general average value in 2016 was 292.8 mm. Nevşehir Total Rainfall Changes (mm) in long years are given in Figure 6.

The total precipitation values In the spring months were the highest with total precipitation value of 209.4 mm in 1995, with the lowest of 63.7 mm in 2016, the overall average of 130.3 mm was observed. On the basis of total precipitation values in winter months, the highest total precipitation value was observed with an average of 123.5 mm in 1992, with the lowest average of 41.3 mm in 1992, and a total of 123.5 mm in 1995.

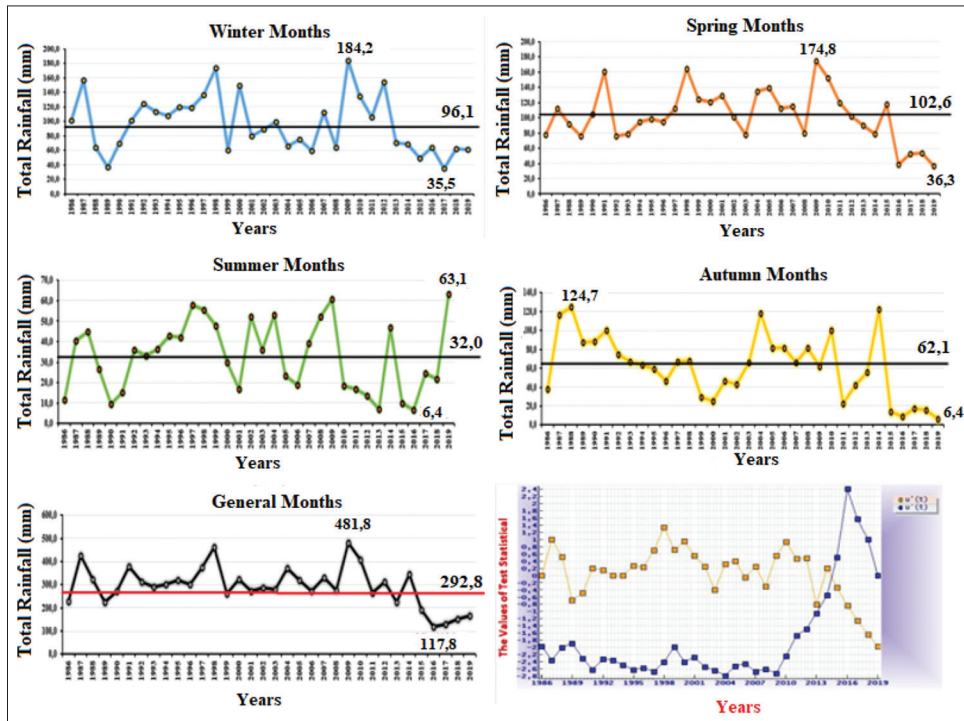


Figure 5: Total precipitation changes (mm) of the avanos district in long periods

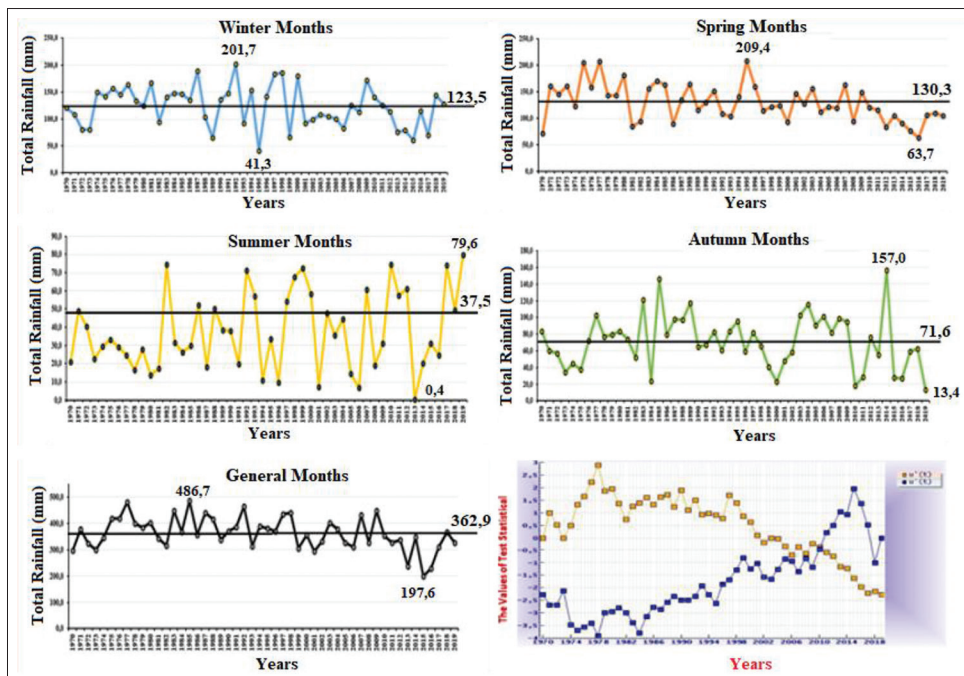


Figure 6: Total precipitation changes (mm) of the nevsehir province in long periods

Total precipitation values in autumn months, the highest total precipitation value was 157.0 mm in 2014, and the lowest was 13.4 mm in 2019, with an overall average of 71.6 mm in 2019. On the basis of total rainfall values in the summer months, the highest total precipitation value was 79.6 mm in 2019, the lowest was 0.4 mm in 2013, and the overall average of 37.5 mm in 2013 was observed. Annual maximum average values, it is seen that the highest value was 486.7 mm in 1985 and the lowest value was 197.6 mm in 2015 and the general average value was 362.9. Total Rainfall Changes (mm) in Ürgüp District for Long Years is given in Figure 7.

In the spring months, the total precipitation values were the highest with the total precipitation value of 195.6 mm in 1980, and the lowest with 70.6 mm in 2014, the overall average of 123.2 mm in average. On the basis of total precipitation values in winter months, the highest total precipitation value was found in 2000 with 159.4 mm, and the lowest average of precipitation values was 95.9 mm in 1989 with the lowest of 44.2 mm.

On the basis of total precipitation values in autumn months, the highest total precipitation value was found in 1987 with 169.6 mm, and the lowest average of 14.5 mm in 2019 with a

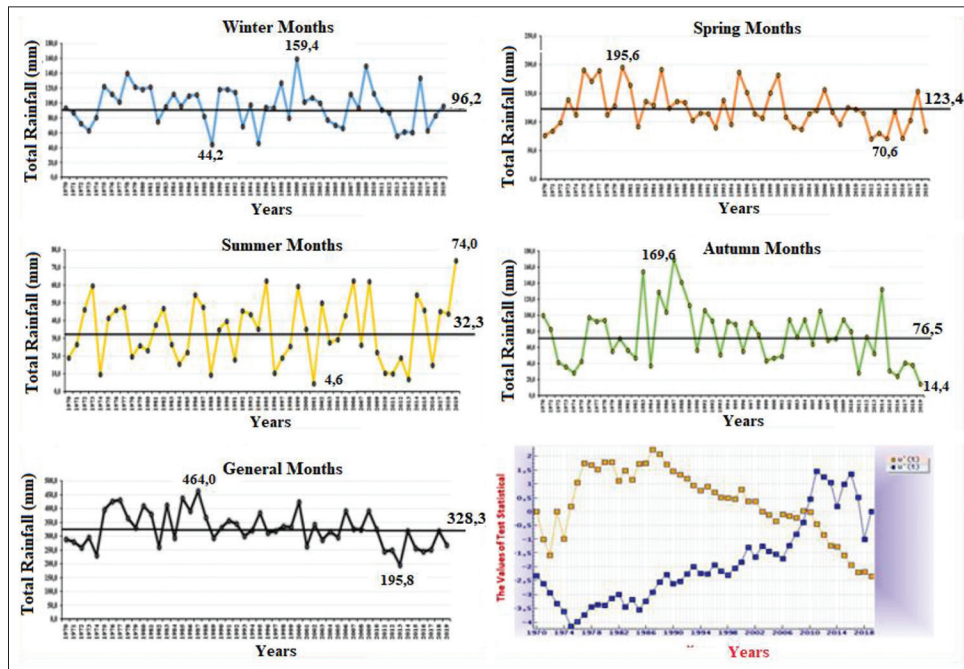


Figure 7: Total precipitation changes (mm) of the Nevşehir province in long periods

Table 2: Trend analysis results of total Precipitation values of Nevşehir province and Ürgüp, Avanos districts for many years

Provinces	Years	Seasons	Mann-Kendall Test Statistics	Spearman's Rho Test Statistics
Nevşehir Province	1970-2019 (50 Yeras)	Spring Months	Negative Trend	Negative Trend
		Summer Months	No Trend	No Trend
		Autumn Months	No Trend	No Trend
		Winter Months	No Trend	No Trend
		General Average	Negative Trend	Negative Trend
Ürgüp District	1970-2019 (50 Yeras)	Spring Months	Negative Trend	Negative Trend
		Summer Months	No Trend	No Trend
		Autumn Months	No Trend	No Trend
		Winter Months	No Trend	No Trend
		General Average	Negative Trend	No Trend
Avanos District	1986-2019 (34 Years)	Spring Months	No Trend	No Trend
		Summer Months	No Trend	No Trend
		Autumn Months	Negative Trend	Negative Trend
		Winter Months	No Trend	No Trend
		General Average	No Trend	No Trend

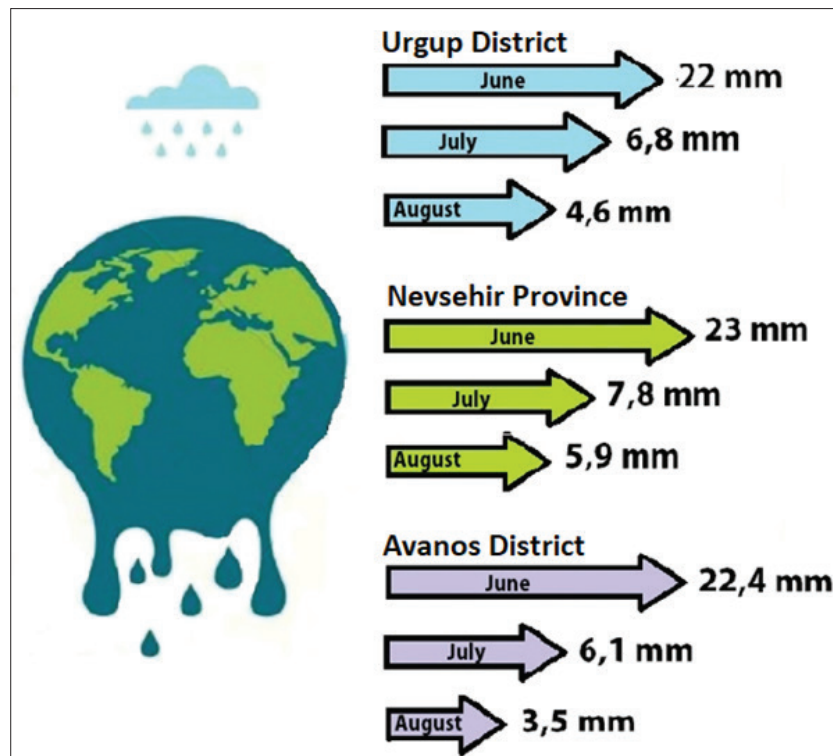


Figure 8: Summary distribution of all results for total precipitation over long period in summer months

total average of 74.5 mm. On the basis of total rainfall values in the summer months, the highest total precipitation value was 74.0 mm in 2019, while the lowest was 4.6 mm in 2001, with an overall average of 33.4 mm.

Annual maximum average values, it is seen that the highest value was 464.0 mm and the lowest value was 1998, while the overall average value was 326.9 mm in 195.8 mm. Trend analysis results of total precipitation values of Nevşehir, Ürgüp, Avanos districts for long years are given in Table 2.

According to the trend analysis results of the total precipitation values of Nevşehir, when Mann-Kendall Test and Spearman's Rho Test, Spring season and general average trends are analyzed, it is seen that there are trends in both tests and there is no trend in other seasons. Considering the trend analysis results of Ürgüp maximum precipitation values, it is seen that both tests are the trend of Spring Season Kendall Test and Spearman's Rho Test. Looking at the general average trends, it is concluded that there is a trend in the Mann-Kendall Test and there is no trend in Spearman's Rho Test, and it is seen that there is no trend in both seasons in both tests. The trend analysis of Avanos maximum precipitation values, it is seen that there is a trend in both seasons for both tests in four seasons and there is no significant trend in general average values in other seasons.

CONCLUSION AND SUGGESTIONS

In this study, in which the total and maximum rainfall values were evaluated for a total of 50 years and 600 months, Avanos 1986-2019 (34 years) and 408 months between 1970 and 1919,

in terms of long years, no increase or decrease trend was observed in precipitation values. A summary schematic image showing the distribution of total precipitation changes in the summer months is given in Figure 8.

Looking at Figure 8, when the precipitation amounts in June, the rainfalls in July and August decrease gradually due to the climate characteristics. The general average of summer months in Nevşehir is 20 mm. In this context, while June is above average, the total precipitation values in July and August are far below average. Looking at the precipitation values; The long-term maximum precipitation averages of Avanos have been determined as 11.0 mm for the spring months, 10.5 mm for the winter months, 9.0 mm for the autumn months, 7.4 mm for the summer months and the general average is 9.1 mm. Long-term maximum precipitation averages of Nevşehir are determined as 14.0 mm for spring months, 12.7 mm for winter months, 11.0 mm for autumn months, 7.7 mm for summer months and 11.3 mm for general average. The long-term maximum precipitation averages of Ürgüp are 13.4 mm for the spring months, 11.0 mm for the winter months, 10.8 mm for the autumn months, 7.5 mm for the summer months and the overall average is 10.7 mm.

Considering the total precipitation values; Avanos long-term changes were recorded as 102.6 mm in spring, 96.1 mm in winter, 62.1 mm in autumn, 32.0 mm in summer and 292.8 mm in average for long years. The long-term changes of Nevşehir province were recorded as 130.3 mm in spring, 123.5 mm in winter, 71.6 mm in autumn, 37.5 mm in summer and 362.9 mm in average for long years. The long-term changes of Ürgüp were recorded as 123.2 mm in spring, 95.9 mm in winter, 74.5 mm in

autumn, 33.4mm in summer and 326.9mm in average for long years. While an increasing trend was observed in all seasons based on maximum and minimum temperature changes, no increase was observed in the distribution of total precipitation values in terms of years in maximum precipitation in winter months only.

It has been concluded that precipitation changes in the provinces of Avanos, Ürgüp and Merkez for many years are increasing in the global climate change with increasingly negative changes in precipitation. Water, which is the source of life for all living things, is gradually decreasing and serious water crisis problems are expected to be at the door in the coming years. Gradually decreasing rainfalls due to climate changes endanger the living habitat. As a precaution, precise solutions are needed to reduce carbon dioxide in the air and slow down global warming and eventually end it. In this way, greenhouse effect and global warming can be prevented.

REFERENCES

1. Türkes M, Sümer UM, Demir İ. Re-Evaluation of Trends and Changes in Mean, Maximum and Minimum Temperatures of Turkey for the Period 1929-1999. *International Journal of Climatology*, 2002: 22 (947-977).
2. Cosun F, Karabulut M. Kahramanmaraş'ta Ortalama, minimum ve Maksimum Sıcaklıkların Trend Analizi. *Türk Coğrafya Dergisi*, 2009: (53)41-50. (in turkish).
3. Kızılelma Y, Çelik MA, Karabulut M. İç Anadolu Bölgesinde sıcaklık ve yağışların trend analizi. *Türk Coğrafya Dergisi*, 2015: 64(1-10), İstanbul (in turkish).
4. Anonymous. Nevşehir Merkez İlçesi Meteoroloji İstasyonları sıcaklık değerleri, Meteoroloji Genel Müdürlüğü, Ankara. 2019. (in turkish)
5. Mann HB, Non-parametric Tests Against Trend. *Econometrica*, 1945: (13)245-259.
6. Kendall M G. Rank Correlation Methods. Charles Griffin, London, 1975:135.
7. Gümüş V, Yenigün K. Fırat Havzası Akımlarının Trend Analizi İle Değerlendirilmesi, Harran Üniversitesi Fen Bilimleri Enstitüsü İnşaat Mühendisliği Anabilim Dalı, Yüksek Lisans Tezi, 2006, Şanlıurfa (in turkish).