

# **Investigation of Rainy Days Based on Global Climate Change: A Case Study from Siirt Province of Turkiye**

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**Abstract**— Long-term rain day records from 1970 to 2019 in Siirt province (Turkiye) were examined in this study, focusing on the total number of rainy days. In this context, the long-term total number of rainy days were subjected to Mann-Kendall, Sperman Rho and Sen's Trend Slope method tests. As a result of the research, the average rainy days for spring seasons were calculated as 38 days, the average for summer months was 5 days, the average for autumn months was 18 days and the average for winter months was 35 days. The average rainy days for many years were found to be 96 days. Seasonal analysis showed that the highest number of rainy days occurred in winter 1987 with 48 days, in spring 1976 with 52 days, in summer 1988 with 13 days, and in autumn 1994 with 35 days. The highest total of rainy days for many years were found to be 119 days in 1976. The results of the trend analysis revealed no significant upward or downward trends in the total number of rainy days across all seasons.

**Index Terms**— Rainy Days, Trend Analysis, Climate Change, Siirt Province, Turkiye

## **I. INTRODUCTION**

Global climate change is a complex process that has become increasingly pronounced over the last century due to human activities and affects various climate parameters worldwide. With the increasing concentration of greenhouse gases in the atmosphere, observed changes in temperature regimes significantly affect not only average temperatures but also precipitation patterns. In this context, changes in the number of precipitation days stand out as a critical indicator for understanding the impacts of climate change on the hydrological cycle. The number of rainy days are defined as the total number of days with daily precipitation above a certain threshold and is frequently used in climate analyses conducted at regional and global scales.

This parameter has direct and indirect impacts on many areas from agricultural production and water resource management to disaster risks and ecosystem sustainability. Recent studies have revealed that while the number of precipitation days is decreasing in some regions, there are increasing trends in others, and that these changes are strongly linked to regional climate regimes.

The impacts of global climate change on precipitation patterns have been the subject of increasing research in recent years. In this context, long-term changes in the number of precipitation days, in particular, are considered an important climate indicator in the analysis of climatic statistics. Studies have shown that the number of precipitation days is closely related not only to total precipitation but also to its intensity, duration and distribution [1,2]. It has been reported that increases in the frequency of heavy rainfall days are observed in tropical and high-latitude regions, while decreasing trends in the total number of rainfall days are prominent in semi-arid and arid regions [3]. This highlights the spatially heterogeneous impacts of climate change and the need for detailed analyses at the regional level [4].

They found that the number of days exceeding daily precipitation thresholds ( $\geq 10$  mm/day) in the Northern Hemisphere has tended to increase throughout the 20th century, with these increases becoming particularly pronounced in winter. Analyzing global statistics for the period 1950-1998, showed significant increases in the frequency and intensity of extreme precipitation events and that these changes may be significantly linked to greenhouse gas emissions [5].

Examined rainy day data for the period 1930–2000 across Turkiye, found decreasing trends in the rainy days in the western and southern regions, while increasing trends were observed in some Black Sea sub-basins [6].

Changes in precipitation patterns and rising temperatures determine the average number of dry days. Severe droughts have occurred throughout Turkey over the last 30 years and continue to do so. Increased population growth and migration, coupled with climate change in our region, combined with a 20-30% decrease in total precipitation by the end of the century, will make drought one of the most significant risk factors [7].

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Furthermore, studies using climate model simulations and reanalysis datasets suggest that the number of precipitation days will vary regionally under future climate scenarios. In their analysis of CMIP5 model outputs, reported that significant decreases in the number of precipitation days are expected in southern Europe towards the end of the 21st century, while increases are expected in the north. These results are of critical importance for policymakers in areas such as agricultural production, water resources management, and flood risk [8].

In this research, long-term records of rainy days in Siirt province covering the period from 1970 to 2019 were analyzed using trend analysis methods. The temporal variability of rainy days was assessed in relation to the regional impacts of global climate change, and potential driving factors were examined. The results are intended to contribute to climate change adaptation planning and the sustainable management of natural resources.

## II. MATERIALS AND METHODS

This study was conducted in Siirt province, located in the Southeastern Anatolia Region of Türkiye. Siirt is a province rich in history and culture, as well as possessing a strategic location. Because it forms a transitional area between Eastern and Southeastern Anatolia, it possesses a complex climatic, physiographic, and cultural structure. The location and location of Siirt province, where the study was conducted, is shown on the map in Figure 1.

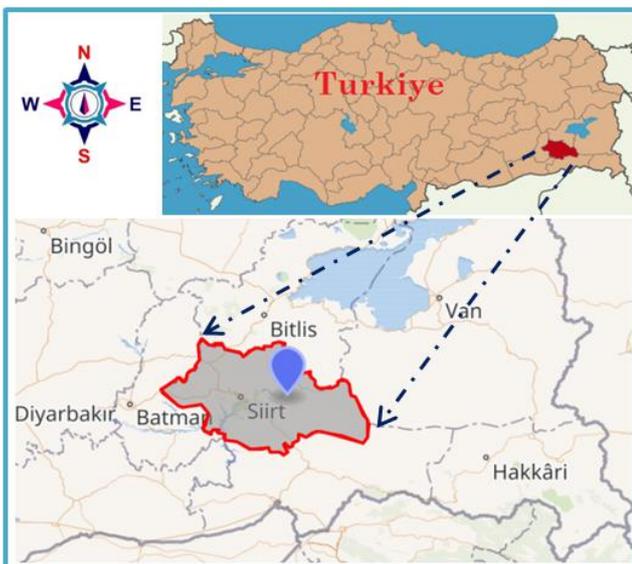


Fig 1. The location of research area

Siirt province has a continental climate. Summers are hot and dry, while winters are cold and rainy. In the south, especially in lower elevations like the Botan Stream valley, influences of the Mediterranean climate are occasionally felt. Average annual temperatures range from 15–17°C, and annual precipitation is around 700–1000 mm. In recent years, climate change has led to irregularities in precipitation patterns and extreme weather events.

The total population of Siirt province is approximately 335,000. A significant portion of the population consists of young people, with the 0-24 age group comprising approximately 45% of the total population. Approximately 70% of the province's population lives in the central district and its surrounding districts, while the rural population still holds a significant share. Migration is a significant factor for Siirt province; there is a significant trend of province migration, particularly due to unemployment and economic hardship [9].

Siirt's economy is largely based on agriculture and animal husbandry. Wheat, barley, lentils, and pistachios are among the main agricultural products. Siirt pistachios are the province's most renowned agricultural product in terms of both quality and economic value, and carry a registered geographical indication. Animal husbandry is widespread in mountainous areas.

In this research, the rainy days in Siirt province center between 1970 and 2019 was examined [10]. In this research, the examined data were primarily classified according to season. Mann-Kendall and Sperman's Rho correlation test and Sen's Trend slope method tests were applied to the seasonally classified data [11,12,13].

The Mann-Kendall order correlation test is a nonparametric test used to determine the statistical significance of one-way trends in time series data [11,12]. This test is widely preferred in climate change studies because it makes no assumptions about the distribution of the data. A positive Z value indicates an increasing trend, a negative value indicates a decreasing trend, and a trend is considered significant at a 95% confidence level when  $|Z| > 1.96$ .

Sen's slope estimator was used to determine the direction and magnitude of the trend, along with the Mann-Kendall test [13]. This method determines the median slope by calculating the slope between two observations and expresses the rate of change per unit of time throughout the time series. The results are interpreted as the annual average increase or decrease in the observed change. For this purpose, the total number of rainy days was subjected to trend analysis using the Trend Analysis for Windows package program, which was developed and used to evaluate some long-term data through trend analysis [14].

## III. RESEARCH FINDINGS AND DISCUSSION

Türkiye, over many years (1970-2019). First, the number of rainy days was grouped seasonally, and long-term averages and minimum and maximum values were calculated across seasons. Furthermore, the obtained data were evaluated using seasonal trend analysis. The results are detailed below under the following subheadings.

### Trend Analysis of Rainy Days in Winter Seasons

Long-term observations of the number of rainy days in Siirt province were analyzed through trend analysis, and the results are comprehensively presented in Figure 2.

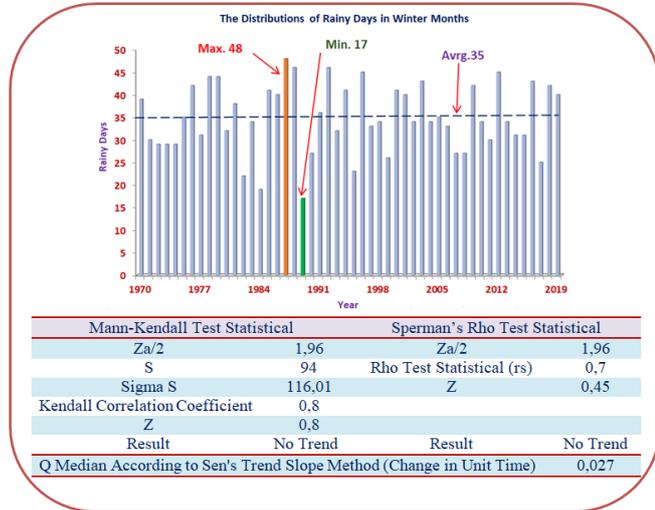


Fig 2. Distribution of rainy days for winter periods and trend analysis results

An analysis of winter rainy day records for Siirt Center indicates that the minimum number of rainy days was 17 in 1989, while the maximum reached 48 days in 1987, with a long-term mean of 35 days. Winter rainy day data were subjected to trend analysis. Examination of the summary statistics revealed that, for both applied tests, the absolute Z-statistic values were lower than the critical value ( $Z\alpha/2 = 1.96$ ), indicating the absence of a statistically significant trend at the 95% confidence level.

### Trend Analysis of Rainy Days in Spring Seasons

The number of the rainy days in Siirt province were subjected to trend analysis. The results are summarized in Figure 3.

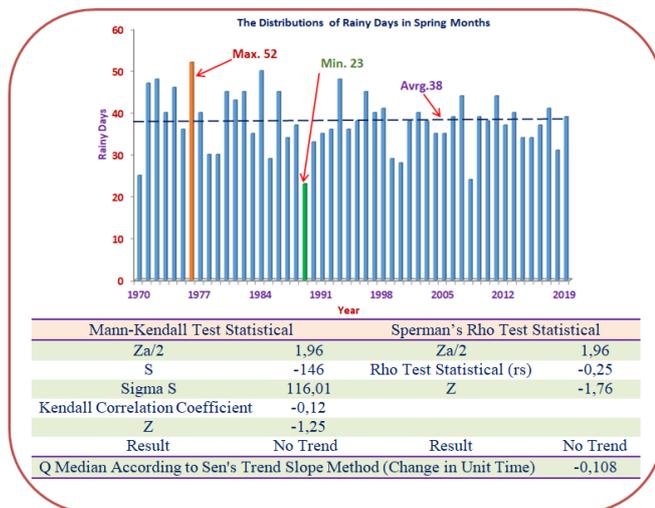


Fig 3. Distribution of rainy days for spring seasons and trend analysis results

Analysis of the spring rainy day records shows that the minimum number of rainy days was 23 in 1989, whereas the maximum reached 52 in 1976, with a long-term mean of 38 days.

Evaluation of the summary statistics indicates that the absolute Z-statistic value remains below the critical threshold ( $Z\alpha/2$ ), demonstrating the absence of a statistically significant trend in the spring rainy day time series.

### Trend Analysis of Rainy Days in Summer Seasons

When examining the summer rainy day data for Siirt province, the lowest rainy days were 0 day in 2000, while the highest rainy days for the summer months were 13 days in 1988. The average rainy days were 5 days.

The rainy days were subjected to a trend analysis test using the summer data (Figure 4). The applied trend analysis revealed the absence of any statistically meaningful trend in the rainy day time series.

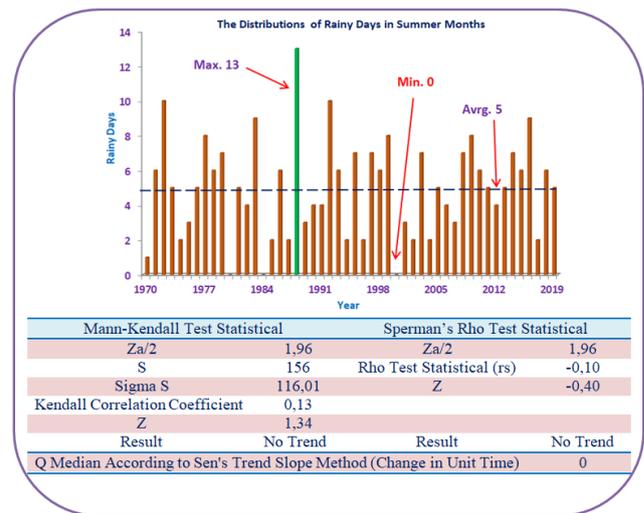


Fig 4. Distribution of rainy days in summer periods and trend analysis results

### Trend Analysis of Rainy Days in Autumn Seasons

Long-term records for Siirt province indicate that the minimum number of rainy days during autumn was 7 days in 1977, while the maximum reached 35 days in 1994, with a long-term mean of 18 days. Autumn rainy day data were subjected to trend analysis, and the corresponding results are presented in Figure 5.

Examination of the summary statistics (Figure 5) demonstrates that the absolute Z-statistic value remains below the critical threshold ( $Z\alpha/2$ ), indicating the absence of a statistically significant trend in the analyzed time series.

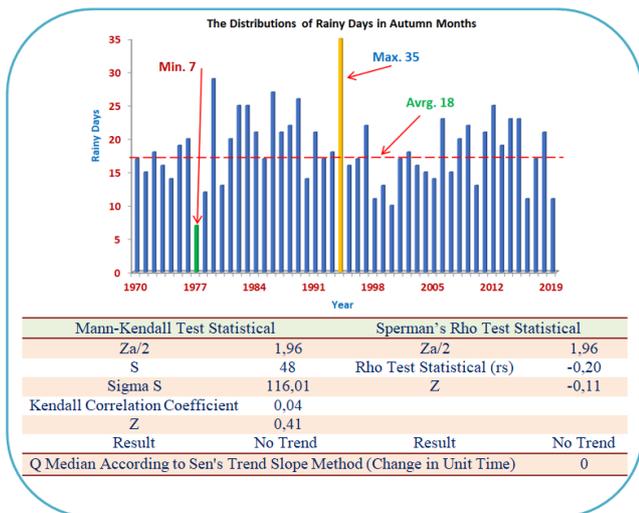


Fig 5. Distribution of rainy days in autumn months and trend analysis results

### Trend Analysis of Average Rainy Days in Long-Term

Analysis of the annual average number of rainy days in Siirt province reveals that the minimum value was 69 days in 1989, whereas the maximum reached 119 days in 1976, with a long-term mean of 96 days. The average rainy day series was subsequently subjected to trend analysis, and the corresponding results are presented in Figure 6.

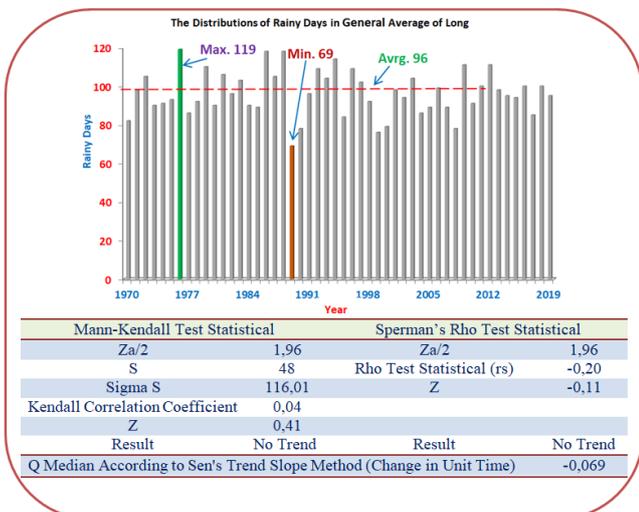


Fig 6. Distribution of average rainy days for 1970-2019 years and trend analysis results

When examining the summary table for the annual average number of precipitation days in Siirt province, it was determined that there was no significant trend in the examined time series, as the absolute value of the Z statistic was less than  $Za/2$ .

In recent years, numerous studies in the literature have been conducted to evaluate certain climate data using trend analysis.

For example, precipitation data observed in Siirt, Trukiye, over many years (1970-2019) were evaluated using trend analysis. Mann-Kendall and Sperman's Rho tests, along with Sen's trend slope methods, were applied to the precipitation data [15].

## IV. RESULTS AND RECOMMENDATIONS

In this study, long-term records of rainy days in Siirt province were analyzed using trend analysis. The results indicate that climate change exerts a significant influence not only on mean temperatures but also on the frequency of rainy days, which constitutes a critical component of the hydrological cycle. The findings demonstrate that declining trends in rainy days are particularly pronounced in subtropical and semi-arid regions, whereas increasing trends are observed at higher latitudes and in certain monsoon-affected regions. Such shifts are likely to have direct implications for multiple sectors, including water resources management, agriculture, energy, urban infrastructure, and disaster risk management.

Focusing on Turkiye, statistically significant decreases in the number of rainy days have been observed over the past 50–70 years, especially in the western, central, and southern regions. This reduction may contribute to more frequent dry spells, diminished soil moisture, and disruption of ecosystem equilibrium. Simultaneously, despite the overall decline in rainy days, the heightened frequency of short-duration, high-intensity rainfall events exacerbates flood and inundation risks, highlighting the influence of climate change on extreme hydrometeorological events. In response to these challenges, the following recommendations are proposed:

-Enhancement of Long-Term Monitoring and Modeling: Integration of high-resolution climate models with long-term observational datasets is essential to more accurately assess trends in precipitation days at local and regional scales.

-Strengthening of Early Warning Systems: Given the increasing frequency and intensity of extreme weather events, the development and local integration of robust meteorological early warning systems is critical.

-Formulation of Sectoral Adaptation Strategies: Adaptation measures should be designed for agriculture, water management, and urban planning to mitigate the impacts of changing precipitation patterns.

-Promotion of Public Awareness: Raising awareness regarding the effects of climate change on precipitation regimes can enhance adaptive capacity among local authorities and communities.

-Facilitation of Data Sharing and Interdisciplinary Collaboration: Multi-disciplinary, data-driven initiatives that integrate meteorology, hydrology, agriculture, and urban planning should be promoted.

Overall, systematic monitoring and analysis of changes in the number of rainy days is strategically essential for reducing climate vulnerability and enhancing societal resilience. Coordinated research and policy interventions at local, regional, and global scales are imperative to address these emerging challenges effectively.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

## REFERENCES

- [1] L.V. Alexander, X. Zhang, T.C. Peterson, et al., "Global observed changes in daily climate extremes of temperature and Precipitation". *Journal of Geophysical Research*, 2006, 111, D05109, p.1-22, Doi: 10.1029/2005JD006290
- [2] D. R. Easterling, G. A. Meehl, C. Parmesan, et al., "Climate extremes: observations, modeling, and impacts". *Science*, 2000, 289(5487), 2068–2074. Doi: 10.1126/science.289.5487.2068
- [3] IPCC "Sixth Assessment Report (AR6) – Working Group I: The Physical Science Basis". the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2021.
- [4] P. Y. Groisman, R. W. Knight, D. R. Easterling, T. R. Karl, G.C. Hegerl, V.N. Razuvaev, "Trends in intense precipitation in the climate record". *Journal of Climate*, 2005, 18(9), 1326–1350. Doi: 10.1175/JCLI3339.1
- [5] P. Frich, L. V. Alexander, P. Della-Marta, B. Gleason, M. Haylock, A.M.G. Klein Tank, T. Peterson, "Observed coherent changes in climatic extremes during the second half of the twentieth century". *Climate Research*, 2002, 19(3), 193–212. Doi: 10.3354/cr019193
- [6] M. Türkes, E. Erlat, "Precipitation changes and variability in Turkey linked to the North Atlantic Oscillation during the period 1930–2000". *International Journal of Climatology*, 2003, 23(14), 1771-1796. Doi: <https://doi.org/10.1002/joc.962> (in Turkish)
- [7] M. L. Kurnaz, "İklim Değişikliği ve Uyum Süreçlerinde Türkiye", *Dirençlilik Dergisi*, 2023, 7(1)199-208, Doi: 10.32569/resilience.1312684 (in Turkish)
- [8] M. G. Donat, L. V. Alexander, H. Yang, et al., "Updated analyses of temperature and precipitation extreme indices since the beginning of the twentieth century: The HadEX2 dataset". *Journal of Geophysical Research: Atmospheres*, 2013, 118: 2098-2118. Doi: 10.1002/jgrd.50150
- [9] TUIK, "Siirt ili Nüfus istatistikleri", Türkiye İstatistik Kurumu, 2023, Ankara, Türkiye (in Turkish)
- [10] MGM, "Yağışlı Gün Sayıları Verisi", Meteorolojik Veri Bilgi Sistemi, Meteoroloji Genel Müdürlüğü, 2019, Türkiye (in Turkish)
- [11] H.B. Mann, "Nonparametric Tests Against Trend". *Econometrica*, 1945, 13: 245-259.
- [12] M.G. Kendall, "Rank Correlation Methods". 1975, Griffin. London, UK.
- [13] P.K. Sen, "Estimates of the regression coefficient based on Kendall's Tau". *Journal of the American Statistical Association*, 1968, 63(324): 1379-1389.
- [14] V. Gümüş, "Fırat Havzası Akımlarının Trend Analizi ile Değerlendirilmesi". Harran Üniversitesi Fen Bilimleri Enstitüsü, İnşaat Mühendisliği Anabilim Dalı Yüksek Lisans Tezi, 2006, Şanlıurfa. (in Turkish)
- [15] M. C. Bağdath, Y. Ballı, "Investigation of Long-Year (1970-2019) Total Precipitation Based on Global Climate Change: A Case Study from Siirt Province of Türkiye", *International Journal of Environmental Trends (IJENT)*, 2024, 8(2): 52-66, ISSN: 2602-4160

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