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Precipitation trends in Turkey (1969–2018): A spatiotemporal analysis

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Abstract— Global climate change can have significant impacts on different geographical regions. It is very important to analyze the changes in temporal and spatial precipitation patterns. In this study, the monthly and yearly precipitation values in Turkey were examined by combining the nonparametric Mann-Kendall rank correlation test and Getis-Ord G spatial clustering test. The study was carried out by integrating and compiling the data in different formats related to the years 1969–2018 for 233 stations in Turkey. It was observed that the annual total precipitation amounts had decreased significantly in many stations during the studied period. Though most of the stations show a decreasing trend in annual precipitation, only the inner and southern part of the country has significant decreasing trends. The trend analysis on monthly precipitation data reveals that there are significant (confidence level ≥ 95%) decreasing trends in most of the regions of Turkey.

Key-words: spatiotemporal analysis, Mann-Kendall test, Turkey, precipitation hotspot analysis

1. Introduction

Water is vital for both humans and as well as all living beings. It is the main source of life and the sustainable supply of food resources for the continuation of life. The use and management of water have been important since the world existed. Today, due to the increasing environmental pollution, water resources pollution, global warming, and climate change, it becomes more important to learn about the amount of precipitation to protect, use, and manage effectively the existing water resources.

All of the water needed for the life cycle is supplied by precipitation in the world. Changes in the amount of precipitation on earth directly affect agriculture, hydrology, ecosystems, and the management of water resources (*Aslan*, 2017; *Bostan* and *Akyürek*, 2007). Hence, it is very essential to have knowledge about the dynamic balance of water in regard to the efficient management of water resources. Besides, it is essential to understand the spatial and temporal patterns of precipitation and their changes over time to devise strategies for solving problems such as increasing the accuracy of predictions of natural disasters arising from precipitation (*Cannarozzo et al.*, 2006; *Diodato et al.*, 2010; *Shoji* and *Kitaura*, 2006). Determining the spatial distribution and diversity of precipitation at different time periods in various regions contributes to researches on the identification and management of usable water resources, and planning for the sustainable management of natural resources (*Aslan*, 2017). Examining the changes in the spatial and temporal patterns of precipitation regimes plays a very important role to solve the problems of the population growth, economic developments, climate change, food, and agricultural products (*Basistha et al*., 2008; *Shoji* and *Kitaura*, 2006; *Yilmaz* and *Harmancioglu*, 2010).

The use of geographic information systems (GIS) as a supportive tool for decision-making is gaining popularity. With the emergence of the GIS technology, a large amount of spatial data can be easily analyzed. These data can be analyzed with several spatial statistical techniques (*Erdoğan*, 2010). The main objectives of spatial analysis in the GIS technology are to be able to identify and visualize the geographic phenomenon, and to perform spatial analysis of the pattern of events, and spatial modeling (*Haining*, 2003). As stated by many researchers, studies on meteorology and climatology aim to examine the spatial and temporal distributions and variations of these parameters through various climate parameters (*Goovaerts*, 2000; *Li et al*., 2010; *Naoum* and *Tsanis*, 2004; *Şen* and *Habib*, 2001).

In meteorological studies, it is common practice to use interpolation methods to determine the spatial changes of different parameters. Different methods have been proposed for the interpolation of the meteorological parameter measurements, obtained from irregularly distributed stations (*Kebaili Bargaoui* and *Chebbi*, 2009; *Sen* and *Habib*, 2000). These methods often provide an approach to determining the spatial distribution or temporal changes of the meteorological parameters or parameters studied in a given area (*Basistha et al*., 2008; *Mardikis et al.*, 2005). However, the spatiotemporal analysis of these parameters is rarely performed *(De Luís et al., 2000; Suppiah* and *Hennessy*, 1998). With the development of spatial statistical methods, studies on spatial clustering of temporal trends have recently become prominent. Spatiotemporal analysis takes care of the change in the examined parameter in terms of both time and space simultaneously, while interpolation methods only consider the distribution of the parameters in space. With the inclusion of these issues in GIS software, there is an increase in spatiotemporal studies.

When the studies on precipitation studies in the world and Turkey were examined, numerous papers and studies have investigated on drought and desertification (*Türkeş*, 2012). These studies suggest that different meteorological parameters (*Goovaerts*, 2000; *Li et al.*, 2010; *Naoum* and *Tsanis*, 2004; *Şen* and *Habib*, 2001; *Shantz et al*., 2012), especially precipitation values on the scale of a basin (*Karpouzos et al*., 2010; *Tosunoğlu*, 2017) or the scale of a river/lake (*Asfaw et al.*, 2018; *Edossa et al*., 2010; *Suryabhagavan*, 2017; *Taxak et al.*, 2014), on the scale of a city (*Bigi et al*., 2018; *Mendoza* and *Mas*, 2018), are fully country based (*Jain et al*., 2013; *Markets* and *Prohibited*, 2012). In some studies, while only the temporal trend of precipitation has been examined (*Adarsh* and *Janga Reddy*, 2015; *Feng et al*., 2016; *Gluhovsky* and *Agee*, 2007; *Jones et al.*, 2016) in some spatial distribution of precipitation (*Arora et al*., 2006; *Ayugi et al.*, 2016; *Koumare*, 2014; *Millán et al*., 2005) has also been examined.

Various studies of climate variables in Turkey have concentrated on temperature changes (*Kadioğlu,* 1997; *Türkes*, 1996), spatial changes of precipitation (*Sariş et al*., 2010; *Türkeş et al.*, 2009; *Ustaoğlu,* 2012), and temporal changes (*Demircan Mesut et al*., 2017; *Hadi* and *Tombul*, 2018; *Yurtseven* and *Serengil*, 2016). Studies on trend analysis have examined changes in narrow areas of the basins. For example, *Altın* and *Barak* (2014) have examined the long-term trends and changes in annual precipitation in the Antalya Peninsula located on the western Mediterranean coast of Turkey (*Altın* and *Barak*, 2014). *Taylan* and *Aydın*, (2018) studied the trends in the Göller Region, *Gümüş et al.* (2017) examined the hydrological meteorological data (minimum temperature, maximum temperature, average temperature, average humidity, average wind speed, and total precipitation) between 1975 and 2015 in Şanlıurfa. *Asikoglu* and *Ciftlik* (2015) examined the precipitation in the Aegean region using the trend analysis method. In this study, long-term trend changes were investigated using Mann-Kendall rank correlation coefficients between 1970 and 2011.

By a review of the literature indicates that very few studies have carried out analyses covering the whole country (*Partal* and *Küçük*, 2006; *Tayanç et al.*, 2009; *Türkes*, 1996; *Türkeş et al*., 2009; *Yavuz* and *Erdoğan*, 2012). The studies related to Turkey have generally focused on the spatial data representation of the temporal evolution of precipitation, especially regarding the main climatic parameters using meteorological data. In other words, most of the studies are regional. Although the number of stations has increased in recent years, a very limited number of station data are being used in studies involving Turkey. It has been observed that the number of stations in the long-term analyses is very low, and there are very few studies relating to the recent era. However, no study in the literature has examined the spatiotemporal analysis of precipitation data in Turkey. Hence, the goal of this study is a spatiotemporal analysis of the monthly and annual average and total precipitation values of 233 meteorological stations for the 1969–2018 period to examine the precipitation values at different scales in Turkey.

2. Material and methods

2.1. Study area and data

Turkey is located in the world's northern subtropical climate. While the coastal areas of Turkey are affected by the mild Mediterranean climate occurring in the sea air, the inner areas show continental climate (*Şen* and *Habib*, 2001). Due to the landforms and peninsula shape of Turkey, the areas of the basins are generally show different climate forms. According to the Köppen-Geiger climate classification, temperate climate (C) has the widest area, while arid climate (B) has the narrowest area. While common B type climate is observed in Central Anatolia, C type climate is dominant in the coastal regions. Terrestrial climate (D) is observed in the plateaus of the Central Taurus and almost all the Eastern Anatolian regions (*Oztürk et al.*, 2017). In this study, the monthly and yearly average precipitation data of 233 meteorological measurement stations were used to examine the spatiotemporal precipitation trends in both station and basin based belong to the 1969–2018 period. The monthly and annual precipitation values (mm) were obtained from the General Directorate of Meteorology of the Turkish Ministry of Agriculture and Forestry. The location of the stations and basins in the country are shown in *Fig. 1*. These stations consist of both manual and automatic monitoring stations. At the stations, there is an instrument that directly measures the precipitation falling from the atmosphere to the ground surface (Pluviometer) and one instrument (Pluviograph) that records the precipitation falling from the atmosphere to the ground surface on the diagram. The amount of precipitation collected in the pluviometer is measured in millimeters (mm) with a graduated precipitation scale. Some stations in the study area have been established as automatic meteorological stations. These stations consist of sensors sensitive to changes in meteorological parameters, measuring the amount of these changes. The unit of measurement in these sensors is expressed as the amount of water (kilogram) at 1 mm^2. This is equal to 1mm of water height in a rain gauge (MGM, 2020). These sensors also have devices that heat the precipitation collector in order to measure the amount of rainfall in snowy weather conditions (*Gultepe,* 2015; *Gultepe et al*., 2017).

For the study, stations which have the criteria of continuous measurements throughout the 50 years were selected from the meteorological data registers. Despite these criteria, the data suggested that there was missing information in various stations in some months. When missing data were analyzed, a deficiency in 5% of the total data was discovered, and the missing data has been completed using the average values of the nearest 5 neighbors.

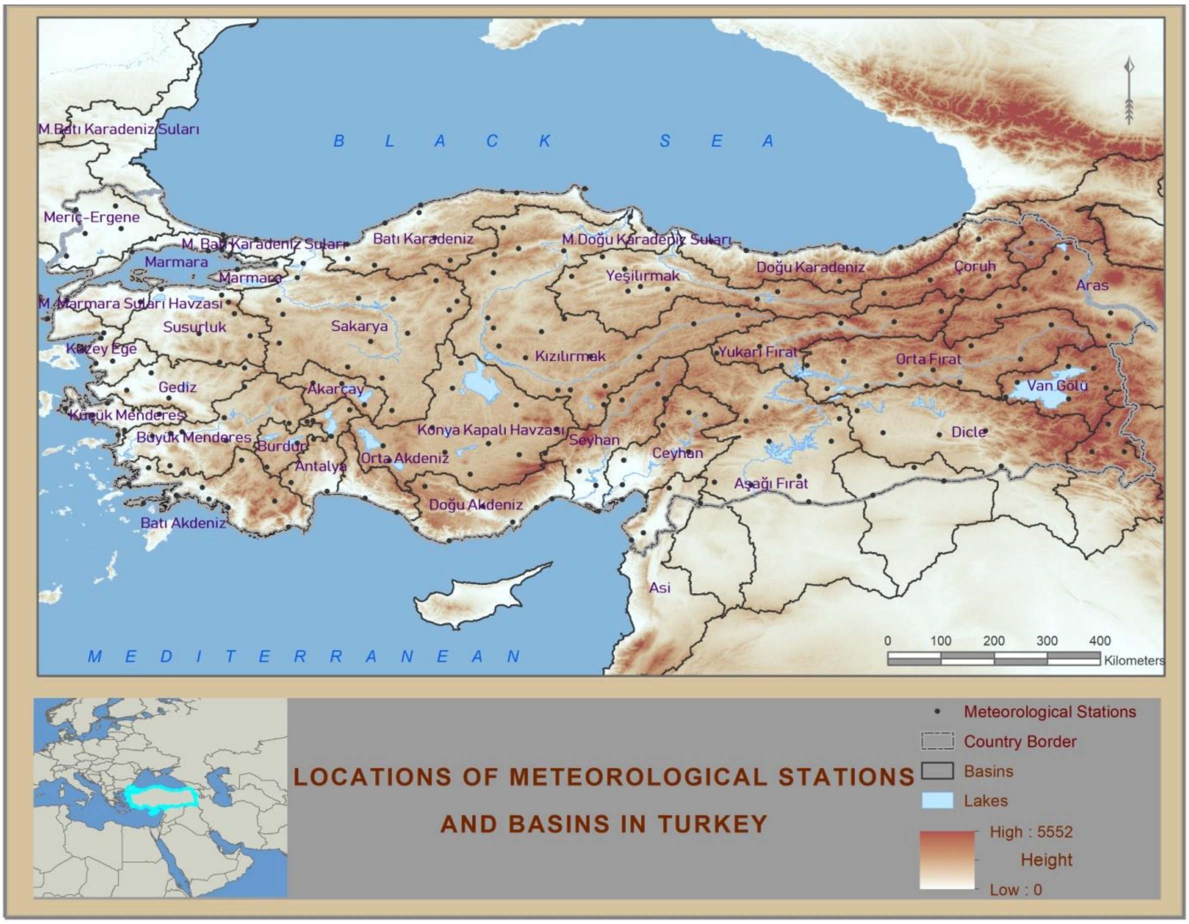

Fig. 1. Distribution of the meteorological stations and basins.

2.2. *Methods*

Although there are different techniques for detecting space-time patterns, we used local indicators of spatial dependence and the Mann-Kendall test to describe the spatiotemporal precipitation trends.

The trends in the precipitation data were determined using the Mann-Kendall nonparametric test. The Mann and the conventional Mann-Kendall test by Kendall were widely used to assess the importance of the monotonic trends in the hydrometeorological time series, such as precipitation, temperature, and flow rate (*Burn* and *Hag Elnur*, 2002; *Gan*, 1998; *Xu et al.*, 2003; *Yang et al.*, 2004; *Zhang et al.*, 2001). The World Meteorological Organization (WMO) has proposed using the Mann-Kendall method for assessing the trends in meteorological data (*World Meteorological Organization*, 1988). This test is also known as Kendall's Tau statistics that are not given any priority in the distribution of data and gives a trend of precipitation data to be observed for a long time. The Mann-Kendall rank correlation statistics τ are derived from the following equation:

$$\tau = \frac{4\sum_{i=1}^{N-1} n_i}{N(N-1)} - 1\ . \tag{1}$$

The Mann-Kendall test has two parameters that are particularly important for the trend. These parameters indicate the significance of the test as well as the magnitude of the direction. In the test results, the positive values indicate the existence of an upward trend, whereas the negative values indicate a declining trend.

For testing the existence of spatial dependence and also clustering in the trends of precipitation values, the Getis-Ord Gi*, known also as hotspot analysis was used. The Getis-Ord Gi* calculates the degree of clustering of the precipitation values' trends belong to the stations and basins. The statistic measures the intensity of the clustering of precipitation trend values in a station/basin relative to its neighboring stations/basins in the whole country. It is computed as the sum of precipitation values within a predefined radius distance from a station/basin as a proportion of the sum of values for all the stations/basins within the entire country. The Getis-Ord Gi* statistic also produces standard deviations and statistical probabilities for each station and basin.

The formula for $G_i^*(d)$ is as follows

$$G_i^*(d) = \frac{\sum_{j=1}^{N} w_{ij}(d)x_j - \bar{x}\sum_{j=1}^{N} w_{ij}(d)x_j}{S\sqrt{[N\sum_{j=1}^{N} w_{ij}^{\,2}(d) - (\sum_{j=1}^{N} w_{ij}(d))^2]/(N-1)}}\ , \tag{2}$$

where w_{ij} (d) is the weight between stations i and j with a specified threshold distance d, which is used to specify the neighborhood size around the station/basin of interest to examine if the station/basin is a high/low spot; and S is the standard deviation of all observations. The G_i* statistic is a z-score, meaning that G_i* values greater than 1.96 or less than -1.96 are considered statistically significant (p=0.05). A statistically significant positive G_i* value ($G_i^*>1.96$) represents a ‘hot spot’, indicating that there is a clustering of high values around station/basin i. A statistically significant negative G_i* value ($G_i^*<-1.96$) is a ‘cold spot’, indicating that the clustering of low values is present around that station/basin.

2.3. Methodology

In order to examine the spatiotemporal analysis of precipitation trends in Turkey, Getis-Ord Gi* and Mann-Kendall tests were performed jointly. The precipitation values were analyzed by using Space Time Pattern Mining module of the ArcGIS software (ESRI). In this procedure, spatiotemporal analysis is performed in two stages. In the first stage, a space-time cube is produced by summarizing the meteorological stations into space-time bins that are saved in a network common data form. This form is a file format used to store array-oriented data in the software. This process will result in a cube. While producing the space-time cube, we set a one-year time step interval, which defines the bin dimensions for the meteorological stations. The time step interval defines the time span for each bin. We produced time cubes for both the stations and basins separately. To compare and understand the regional differences between station and basin borders, station and basin trends were examined separately. The stations and basins were used as input features and were structured into space-time bins. The data structure can be thought of as a three-dimensional cube, made up of space-time bins with the x and y dimensions representing space and the z dimension representing time. For every meteorological station, a precipitation value was assigned for that date and location. For every basin, the sum of precipitation values of meteorological stations in that basin was also assigned for that date and basin's location. Based on the input parameters, the space-time cube took these attribute values and aggregated all the stations inside the basin border and a time-step interval of one year to create a bin (ESRI).

In the second stage, the *Gi** statistics values, z-score values, and p values of each station/bin were computed for each year. The neighborhood distance and neighborhood time step parameters in the software defined how many surrounding bins in both space and time would be considered when calculating the statistic for a specific bin. It then compared the precipitation value of a bin and its neighbors with the mean attribute value of all bins. Calculated z-score values of *Gi** statistics were compared to the expected z-score values to determine the statistically significant hot and cold spots. After the statistically significant hot and cold spots had been computed, the hot spot/cold spot values were analyzed using the Mann-Kendall trend test to detect the temporal trends at each meteorological station and basin. In this stage, the Getis-Ord G^*_i took the space-time cube as an input, and time series of Getis-Ord G^*_i values and z scores of these values were assessed using the Mann-Kendall test for each individual bin. By using the resultant trend z-score and the hot spot z-score values of each station and basin, software categorizes the characteristic of trends as shown in *Table 1*. The clusters and trends resulting from the combination of spatial and temporal statistics were then used to categorize each station and basin's situation in the analysis period.

Table 1. Spatiotemporal cluster characteristics tipes

Type of Characteristic	**Description**
New hot spot	Precipitation trend of station/basin is increasing for the first time in the final time interval of the period 1969–2018.
New cold spot	Precipitation trend of station/basin is decreasing for the first time in the final time interval of the period1969–2018.
Consecutive hot spot	Precipitation trend of station/basin never shows an increase prior to the final run, and less than 90% of all years have statistically significant increase. This location has a single uninterrupted run of a significant increase in the final time-step intervals.
Consecutive cold spot	Precipitation trend of station/basin never shows a decrease prior to the final run, and less than 90% of all years have statistically significant decrease. This location has a single uninterrupted run of a significant decrease in the final time-step intervals.
Intensifying hot spot	At least 90% of the period 1969–2018 have an increasing trend including the final time step, the intensity of clustering of high trends in each time step is increasing overall.
Intensifying cold spot	At least 90% of the period 1969–2018 have a decreasing trend including the final time step, the intensity of clustering of low trends in each time step is increasing overall.
Persistent hot spot	A station/basin that has an increase for 90% of the time-step intervals with no discernible trend indicating an increase or decrease in the intensity of clustering over the period 1969–2018.
Persistent cold spot	A station/basin that has a decrease for 90% of the time-step intervals with no discernible trend indicating an increase or decrease in the intensity of clustering over the period 1969–2018.
Diminishing hot spot	A station/basin that has an increase for 90% of the time-step intervals, including the final time step. In addition, the intensity of an increase in each time step is decreasing overall.
Diminishing cold spot	A station/basin that has a decrease for 90% of the time-step intervals, including the final time step. In addition, the intensity of decrease in each time step is decreasing overall.
Sporadic hot spot	A station/basin that has an on-again then off-again increase. Less than 90% of the time step intervals show an increase, and none of the time-step intervals shows statistically significant decrease.
Sporadic cold spot	A station/basin that has an on-again then off-again decrease. Less than 90% of the time step intervals show a decrease, and none of the time step intervals shows statistically significant increase.
Oscillating hot spot	A station/basin that shows mixed characteristic: some time intervals have an increase, some time intervals have a decrease. For the final time step the interval has an increase.
Oscillating /cold spot	A station/basin that shows mixed characteristic: some time intervals have an increase, some time intervals have a decrease. For the final time step the interval has a decrease.
Historical hot spot	Except the most recent period, at least 90% of the period have an increase.
Historical cold spot	Except the most recent period, at least 90% of the period have a decrease.

3. Results

Maximum values of monthly and annual average precipitation data for the entire country are taken into account in this study. When examining the exploratory statistics of the precipitation values, we noticed that the highest annual precipitation value for Turkey was 796.95 mm in 2009, while the lowest value was 502.11 mm in 2008. The lowest total annual average precipitation value was 113.80 mm in Mardin station in 2010 and the highest was 3380.40 mm in Hopa station in 2016. Precipitation values throughout Turkey between 1969 and 2018 were examined according to maximum, average, and minimum amounts of precipitation value (*Fig. 2*).

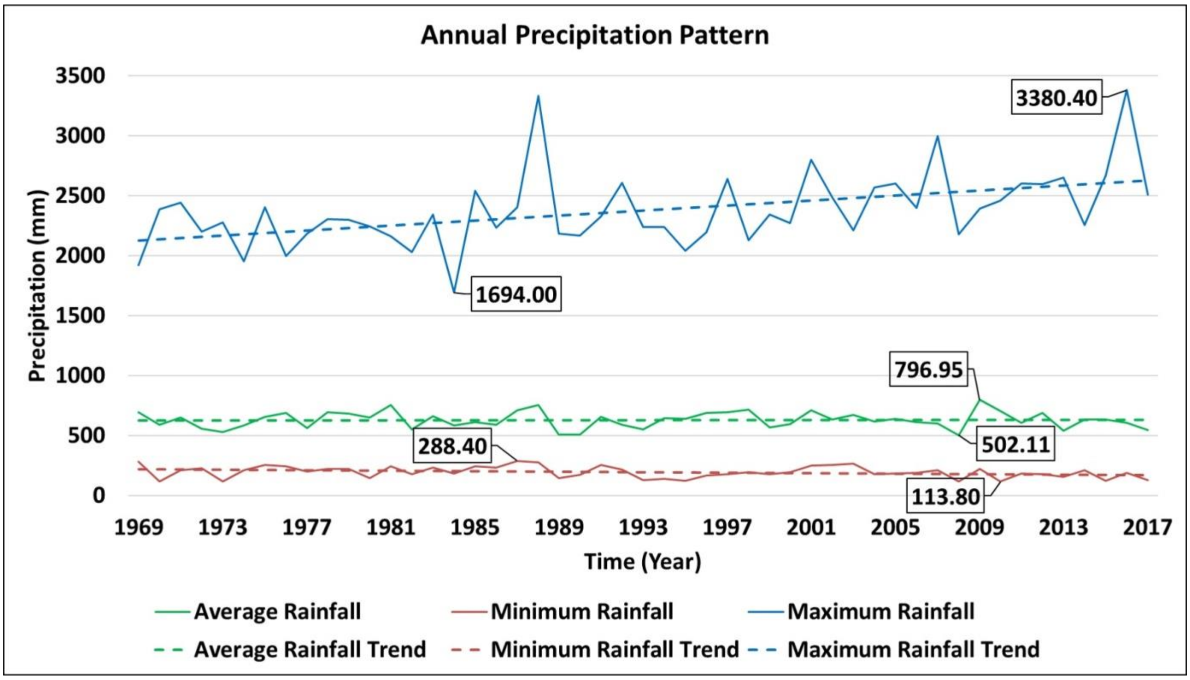

Fig. 2. Precipitation statistics of Turkey.

The plotted graph with the linear trend analysis in *Fig. 2* illustrates the general annual maximum amount of change in precipitation value in Turkey. *Fig. 2* suggests an increasing trend in the maximum precipitation data from 1969 to 2018. The examination of the annual average precipitation value in the same data illustrates a slight, albeit positive change. The minimum precipitation data also suggest a decreasing trend from 1969 to 2018. This situation shows the negative change in both maximum and minimum precipitation values in terms of arising in the extreme precipitation gauges in this period. The monthly average precipitation amounts per decade and their descriptive statistics are shown in *Fig. 3*.

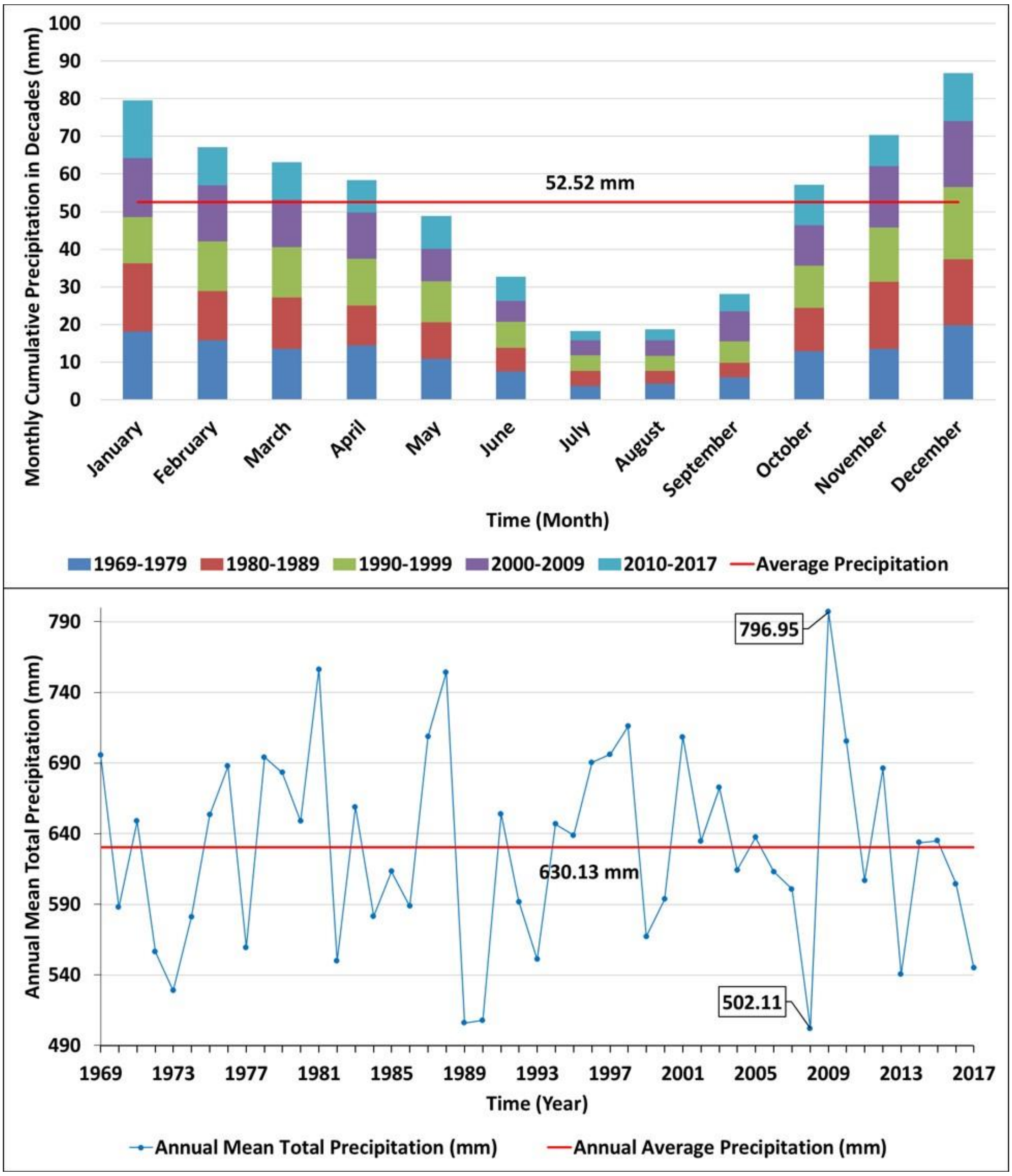

Fig. 3. Percentage of precipitation and total annual precipitation per decade across Turkey.

Monthly precipitation data suggest that the amount of the highest precipitation was 86.79 mm in December, 79.63 mm in January, 70.34 mm in November, and 67.10 mm in February. On the other hand, the amount of the least precipitation value was 18.32 mm in July, 18.78 mm in August, 28.18 mm in September, and 32.72 mm in June. Between 1969 and 2018, the first three stations with the highest precipitation value were Hopa (2264.03 mm), Rize (2228.91 mm), and Rize/Pazar (2033.75 mm). Conversely, Iğdır (260.74 mm), Akçakale (278.02 mm), and

Karapınar (295.73 mm) were the first three stations with the least precipitation value areas between 1969 and 2018. When we examine the extreme precipitations, *Table 2* shows the precipitation dates and amounts of the stations that received the highest amount of precipitation on a monthly basis between 1969 and 2018.

Table 2. The extreme precipitation values

Month	**Station**	**Year**	**Maximum precipitation (mm)**	**Monthly mean precipitation (mm)**
January	Antalya Havalimani	1969	798	80
February	Antalya Havalimani	1974	625	67
March	Antalya Havalimani	2003	399	63
April	Kilis	2015	592	58
May	Hakkari	2015	789	49
June	Hopa	2007	373	33
July	Giresun	2009	522	18
August	Hopa	1988	589	19
September	Hopa	2016	779	28
October	Hopa	2015	626	57
November	Antalya Havalimani	2001	907	70
December	Alanya	1997	705	87

According to *Table 2*, the station that had the most precipitation in Turkey in this period is Antalya Havalimani in November 2001. While in summer and autumn, the northeast region of Turkey has higher extreme values, the Antalya region in winter has extremely high values. Interestingly, the Antalya region has extreme values for five months of the year, and for the other five months of the year, the northeast region shows extreme values.

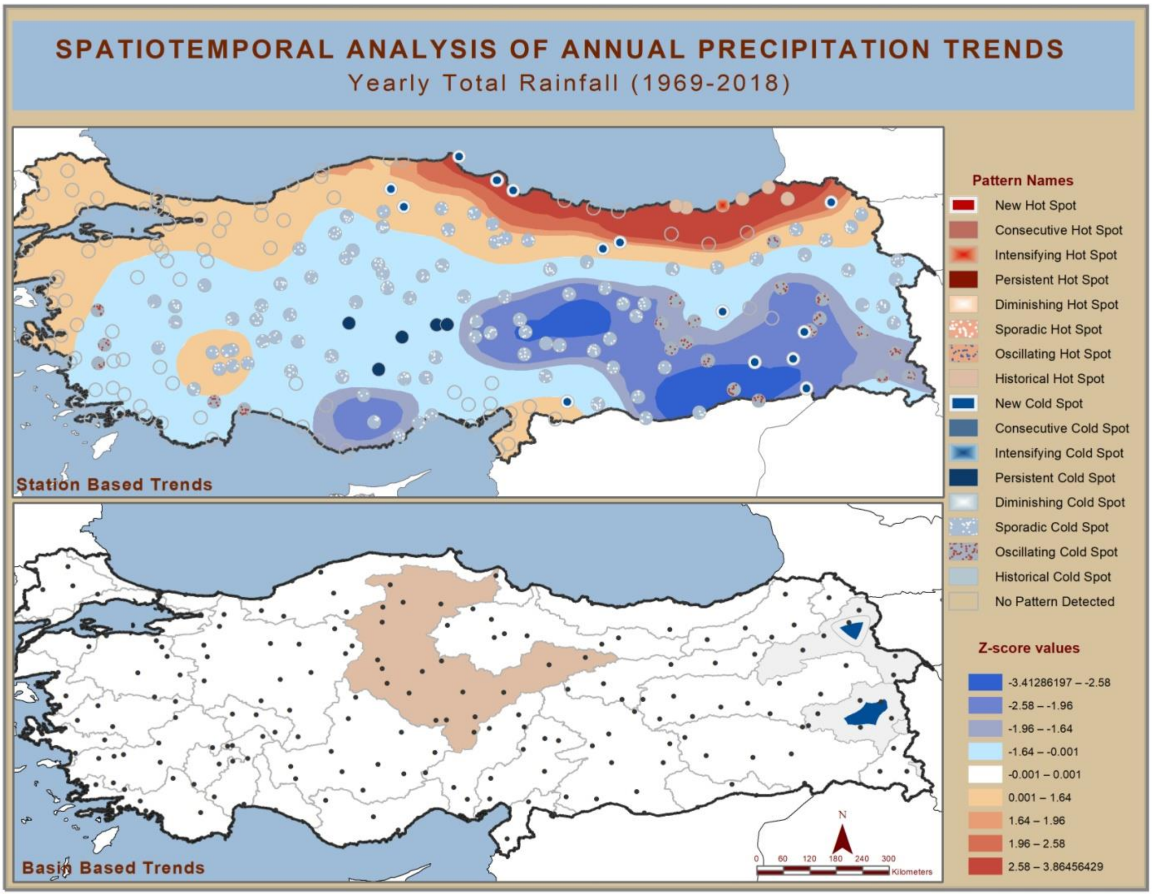

Fig. 4. Spatiotemporal trends of station- and basin-based average annual precipitation values.

When we examine the results of the spatiotemporal analysis, station-based annual average precipitation space-time trends are shown in *Fig. 4*. An outline of the information about the stations was also presented in *Table 2*. It was observed from the data, that the average annual precipitation did not show any significant change for 93 out of 223 stations. Moreover, sporicidal cold spot, oscillating cold spot, persistent cold spot, and new cold spot were observed for 93, 22, 5, and 14 stations, respectively. Considering the increasing trends, while the persistent hot spot has been identified in only five stations, the new hot spot in one station only. The location of the stations with decreasing precipitation trends indicates that the sporicidal cold spots are clustered in Central Anatolia (Karapınar, Aksaray, Ürgüp, Nevşehir, Cihanbeyli, and around the Tuz Gölü stations); the southeastern Anatolia region (Batman, Bingöl, Bitlis, Siirt, and Cizre station), the Western Black Sea (Sinop, Tosya, Samsun, Bafra, and Kastamonu stations), and the Middle Black Sea Region (Susehri and Şebinkarahisar stations). It has been determined that the precipitation with oscillating cold spot has been decreasing recently in 22 stations located in Elazığ, Van, Hakkari, and Erzincan provinces.

According to *Table 3* and *Fig. 5*, the stations with a decreasing trend are around twice as many as those with an increasing trend. The station-based precipitation trends illustrate that the decreases in the trends are dominant in months of January, February, April, October, November, and December. The number of stations showing a dominant increase in precipitation is higher in May and June than those showing a decrease. It is evident that most of the fluctuations in the stations are determined as oscillating and sporadic cold spots. The stations exhibiting cold spot patterns in terms of a decrease in the precipitation are usually located in the central and eastern parts of the country for the months of January, February, April, November, and December. On the other hand, the stations exhibiting hot spot patterns are usually located in the north and northeast regions of the country for the months of May, June, July, August, and September.

Table 3. Summary of spatiotemporal trend statistics of station-based average yearly precipitation values

Trend type	**No pattern detected**	**New cold spot**	**Persistent cold spot**	**Persistent hot spot**	**Sporadic cold spot**	**Sporadic hot spot**	**Oscillating hot spot**	**Oscillating cold spot**	**Intensify hot spot**	**Intensify cold spot**	**Historical hot spot**	**Total hot spot**	**Total cold spot**
January	171				13	8		41				8	54
February	85	8	1		78			61				0	148
March	208				11		12	2				12	13
April	113	6			17	1		96				1	119
May	116				1	45	61	10				106	11
June	134		2	7	20	30	39	1				76	23
July	216			4		10			3			17	0
August	208			2		19			4			25	0
September	208					19			6			25	0
October	119			3	45	3		61	2			8	106
November	148				45	4	9	27				13	72
December	146			4	42	5	16	18		2		25	62
Annual	93	14	5		93			22	1		5		

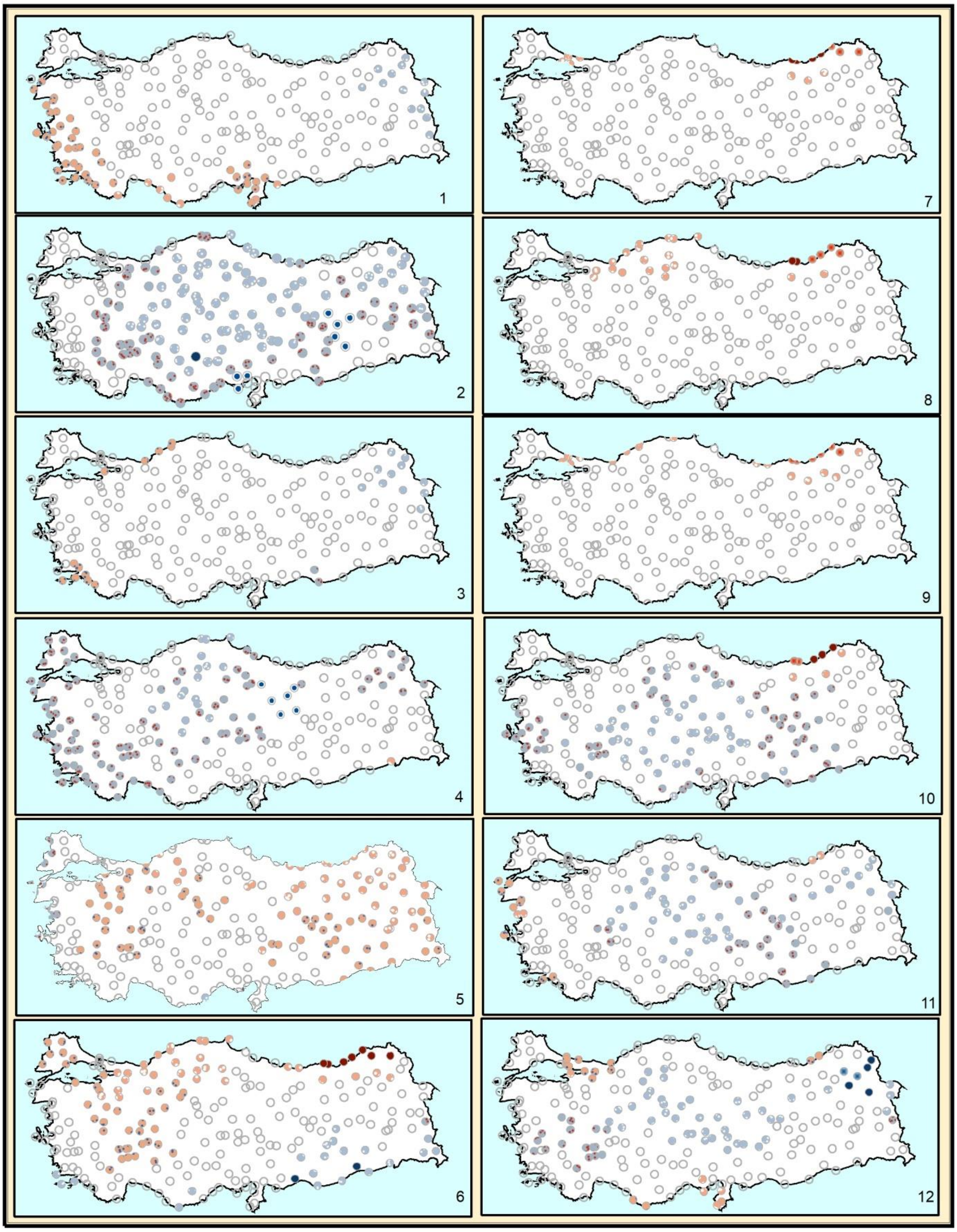

Fig. 5. Spatiotemporal trends of station-based average monthly precipitation values.

Basin-based monthly average precipitation spatiotemporal analysis results are shown in *Fig. 6*. The trends demonstrate a significant decrease in the total amount of precipitation in the basins in February and April. It is noticeable that an increase in precipitation trends are dominant in March, June, and September. Compared with station-based trends, both similarities and differences can be seen.

In many months, the station-based precipitation values were summed and balanced with neighboring stations in the same basin. Therefore, the basin-based maps show smoother surfaces while the station-based values illustrate the minor regional differences. While Konya, East Akdeniz, and Aras basins show a significant decrease in precipitation in February, Büyük and Küçük Menderes, Gediz, West Mediterranean, Meriç Ergene, Marmara Suları Basins show a significant decrease in precipitation in April.

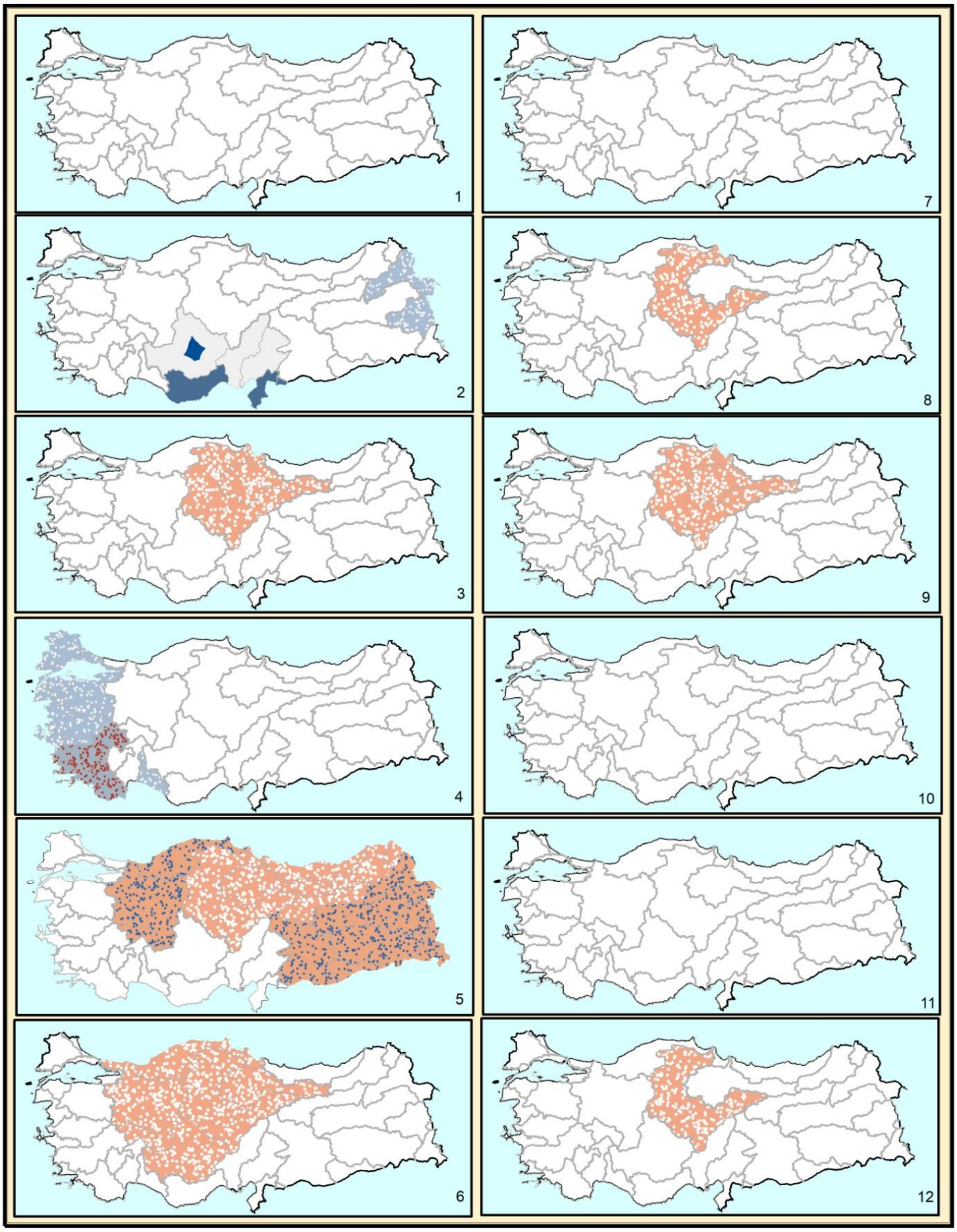

Fig. 6. Spatiotemporal trends of basin-based average monthly precipitation values.

4. Discussion and conclusions

The main objective of this study was to examine in detail the precipitation trends in Turkey from 1969 to 2018. The annual and monthly trends were analyzed using spatiotemporal analysis, which integrates Getis Ord G* hot-spot analysis and Mann Kendall trend analysis.

- Our data demonstrated that the northern part of the country, especially the eastern part of the Black Sea region, had an increasing trend in its annual precipitation, while the middle and south parts of the country, especially the southeastern Anatolian and Central Anatolia regions, had decreasing trends.
- The analyses indicated that the biggest regional changes in the trends of precipitation of stations occurred during February, April, May, and October.
- The monthly precipitation trends generally exhibited a decreasing trend, with the greatest magnitude in February, April, and October. In May, in particular, the trends totally changed in such a way that the upward, dominant trends shifted to June.
- Many of the decreasing trends were recorded for the annual mean precipitation values, predominantly in the center and southern parts of Turkey; however, only six decrease trends were found in the southeast part of the country.

It is estimated that the change in the water cycle will adversely affect agriculture and food security, public health, land and sea ecosystems, coastal regions, and especially, water resources in the world. In this context, it is important to work on precipitation related research in order to minimize the effects of precipitation on our water resources, to understand the expected effects, to complete sectoral and regional fragility studies, and to plan adaptation studies to these. Therefore, we analyzed the monthly and annual average and total precipitation values of 233 meteorological stations for the 1969–2018 period in Turkey. In this concept, we used a combination of spatiotemporal analysis and Mann-Kendall trend analysis. Our study is the first one in Turkey on the subject of the spatiotemporal analysis that analyzing the precipitation and trend of precipitation in both spatially and temporally. Our visualization method improved the understanding of trends by showing decreases, increases, and fluctuations in 17 different symbologies. In the study, we also elaborated on both the small-scale regional precipitation changes, using station-based data and the large-scale regional precipitation changes, using basin-based data. This way, we tried to understand Turkey's small-scale differences and basin-based large-scale trends separately. Given some different results (e.g., *Partal* and *Kahya*, 2006; *Türkeş et al*., 2009), our results largely covers the findings of many of the previous studies (e.g., *Hadi* and *Tombul*, 2018; *Toros*, 2012; *Yavuz* and *Erdoğan*, 2012). In the study, by using a huge number of stations and an efficient classification and visualization technique, we managed to obtain accurate, elaborate, and useful results. In short, the paper presents a detailed and updated summary of the actual precipitation trends in Turkey.

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