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Homogeneity and trend analysis of some meteorological data of Karataş Station in Seyhan Basin

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Abstract: In this study, maximum-minimum-average temperature, maximum-minimum-average relative humidity and total-maximum precipitation data covering the years 1965-2016 belonging to Karataş meteorological observation station numbered 17981 in the Seyhan Basin, one of the important basins of Turkey, were used. These data were subjected to homogeneity tests (Pettit Test, Standard Normal Homogeneity Test, Buishand Rank Test, Von Neumann Rank Test) and trend analyzes (Mann Kendall, Sen Innovative Trend Test and Mann Kendall Rank Correlation Test). The results obtained by homogeneity and trend tests were evaluated at the 95% confidence level. According to the results of the 4 homogeneity tests used, P_{total}, P_{max} and RH_{max} parameters are homogeneous and the other parameters are not homogeneous. According to the results obtained, there was a significant increase in T_{min} and T_{mean}, and a significant decrease trend in RH_{min} and RH_{max}. The trends obtained in other parameters are not statistically significant.
Keywords: Homogeneity, Mann-Kendall, Seyhan Basin, Trend

1. Introduction

Water resources and related human activities in our country are at risk due to difficulties in providing adequate and regular water. The most important reason for these difficulties is the amount of precipitation that varies greatly from year to year. Knowing the trend in the course of water amounts over time due to changing climate parameters should be the most important determinant to be considered in investments to be made based on the amount of water. The results of the studies on the trend will shed light on the climate change models that can be established in the future (Cığızoğlu et al., 2004).

Turkes et al. (2002) showed an increasing trend in annual, winter and spring average temperatures in the south of Turkey, and a decreasing trend in summer and autumn average temperatures in the northern and inner parts of Turkey. In the same study, an increase in the spring and summer minimum temperatures and a strong decrease in the daily temperature difference were observed. Turkes et al. (2007), it was stated that while a significant decrease was observed in precipitation in Turkey and throughout the Mediterranean, especially in the winter season, there was an increase in the spring, summer and autumn seasons. In the researches, it is estimated that there will be a decrease of 30-35% in the expected precipitation in the Seyhan Basin (Kanber et al., 2003). It is also predicted that the air temperature in the Seyhan Basin will increase by 2-3.5 ºC until 2070. This situation will increase the probability of experiencing more severe dry periods in the basin, which is on the border of mild and moderate drought (Topcu and Seckin, 2016). In other studies, conducted in the Eastern Mediterranean and our country, considerable and significant increases were observed in temperature indices in general (Kostopoulou and Jones, 2005; Erlat and Yavaşlı, 2011; Yılmaz et

al., 2021; Karabulut, 2012; Acar Deniz and Gönençgil, 2015; Abbasnia and Toros, 2018; Dün and Gönençgil, 2021).

The aim of this study is to analyze the annual scale homogeneity and trend of the data of 8 climatic parameters of Karataş Meteorology Station no 17981 in the Seyhan Basin for the 1965-2016 period.

2. Materials and Methods

2.1. Study Area and Data

The upper part of the Seyhan basin, which covers the east of Kayseri Province, is in Central Anatolia, and the middle and lower parts are in the Mediterranean Region. The Seyhan basin has the appearance of a completely mountainous area. The low and flat Çukurova floor in the south, the high mountainous area that starts immediately after the thin terrace strip in between and approaches the north of the basin, and the hilly part in the north are the main landform units of the Seyhan basin. On the other hand, 185566 hectares of the catchment area is a plain area. The waters of the basin, which has a catchment area of 20450 km2, are collected in the Seyhan River with the Göksu, Zamantı, Körkün, Entertainment and Çakıt streams and their tributaries. 314625 hectares of the basin lands with an annual water volume of approximately 6 billion m^3 can be irrigated. In the Seyhan basin, which has three different climates, summers are hot and dry in the coastal part, and winters are warm and rainy. The northern part of the basin is dominated by hot and dry summers and cold and rainy winters. In the Seyhan basin, the part of the Taurus Mountains, which lies between the arid northern part and the coastal part and extends in the northeast-southwest direction, is more rainy and colder than the other regions. The wettest part is the middle part of the basin, which is high (URL 1).

The vegetation of the Seyhan basin shows three important structures depending on the changes in climate, geology, soil and landforms. While the natural vegetation in the arid areas in the north of the basin is grass and meadow, there are also plants such as pear and oak bushes among this cover. As you go down towards the low area in the south of the Seyhan basin, it is seen that the shrub-maquis community specific to the Mediterranean climate is widespread (URL 1).

In this study, meteorological data of 17981 Karataş Meteorology Station located in the Seyhan Basin were used. Karataş station with an altitude of 21 m is located in the southernmost part of the basin. In the study, annual maximum-minimum-mean temperature (T_{max}, T_{min}, T_{mean}), annual maximum-minimum-average relative humidity (RH_{max}, RH_{min}, RH_{mean}), annual total precipitation (P_{total}) and annual maximum precipitation (P_{max}) data by using homogeneity tests and trend analyzes were performed. The data used covers the 52-year period between 1965 and 2016. The location of Karataş station in the basin is shown in Figure 1.

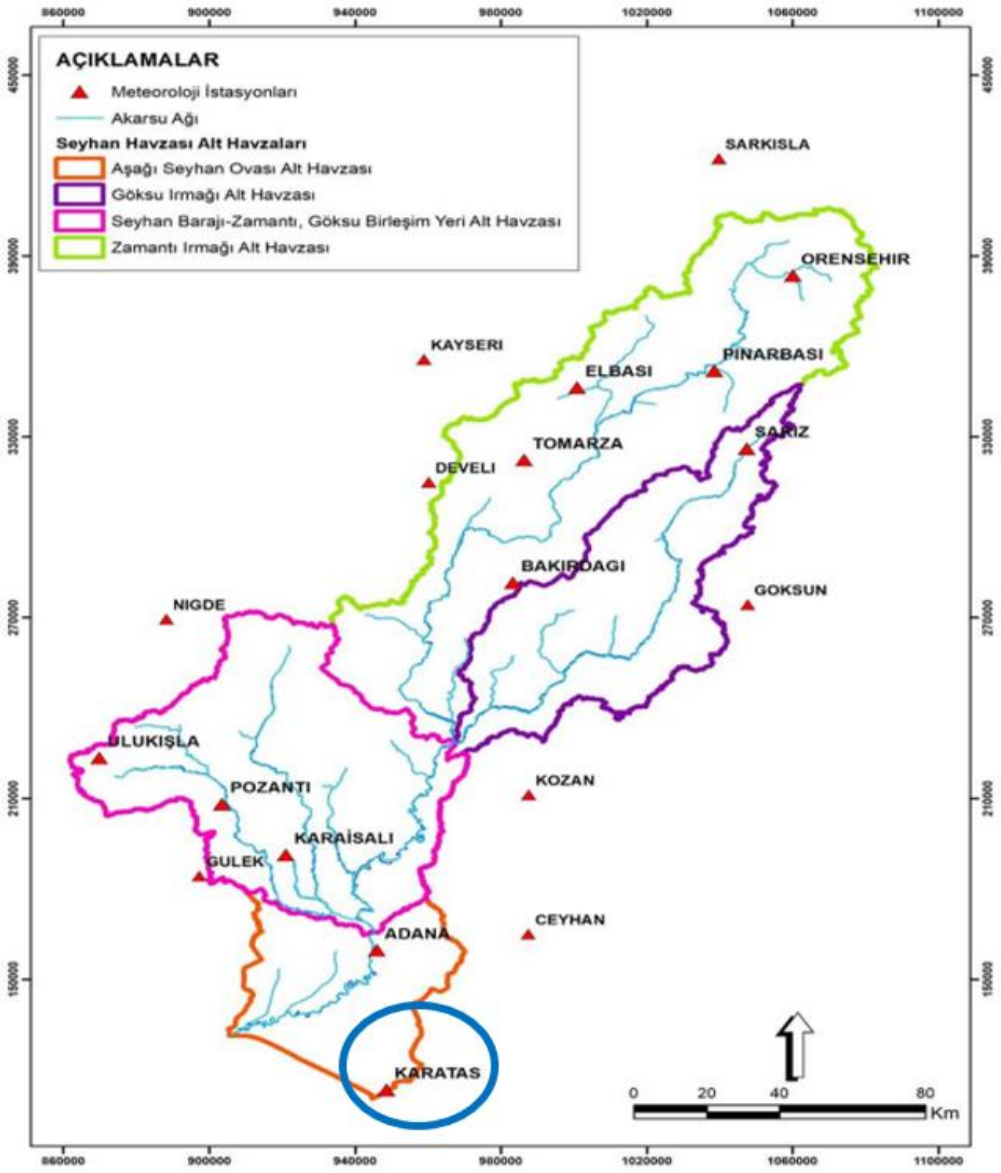

Figure 1. Location of Karataş Station in Seyhan Basin (SYGM, 2019)

2.2. Homogeneity Test

Determining the change point by testing the homogeneity of a hydrological series with statistical methods is necessary to ensure data quality. Homogeneity tests show the breakage year in the data. In the stations that are decided to be non-homogeneous as a result of homogeneity tests, the reason for disturbing the homogeneity should be investigated. If the inhomogeneity is due to natural causes (such as climate change), these stations can be considered homogeneous. Standard Normal Homogeneity (SNHT), Pettitt Test (PT), Buishand Rank (BR) and Von Neumann Rank (VNR) Tests are the most preferred statistical tests with proven reliability for determining the change point. (Alexandersson, 1986; Pettitt, 1979; Wijngaard et al., 2003). For this reason, these tests were used in homogeneity analyzes in this study.

2.3. Trend Analysis Methods

The methods used to determine the trend of a series are grouped under two headings as parametric and non-parametric methods, depending on whether the series is dependent on a distribution (Helsel and Hirsch, 1992). In parametric methods, the actual value of the data in the series is important and this value is used in calculations. However, in non-parametric methods, the number of rows obtained by sorting the data from the smallest to the largest or from the largest to the smallest is used, not the actual value of the data. It is known that non-parametric methods give effective results compared to parametric methods, without having to comply with the normal distribution of the data (Helsel and Hirsch, 1992).

Three different trend analysis methods were used in this study. These; Mann-Kendall (MK) Trend Test, Şen Innovative Trend (ŞIT) Test, Mann-Kendall Rank Correlation (MKRC) Test. Calculation procedures of the methods used in homogeneity and trend analysis are not included here, as there are many studies in the literature (Yu et al., 1993; Burn and Elnur, 2002).

3. Results

3.1 Results of Homogeneity Test

The results obtained from the SNHT, PT, BR and VNR homogeneity tests applied to the annual data of the 8 meteorological parameters used between 1965 and 2016 (52 years) are shown in Table 1.

Table 1 Homogeneity test results

Parameter	PT (Critical value=250.8)	SNHT (Critical value=8.135)	BR (Critical value=1.554)	VNR (Critical value=1.369)	Result
P_{total}	112<	4.28<	0.697<	2.03>	H
P_{max}	115<	2.01<	1.11<	1.91>	H
T_{max}	263>	10.83>	1.59>	1.87>	NH
T_{min}	499>	20.3>	2.24>	1.35<	NH
T_{mean}	455>	18.53>	2.17>	1.67>	NH
RH_{max}	159**<**	8**.**99>	1**.**29**<**	1**.**51>	H
RH_{min}	586>	30.01>	2.61>	0.83<	NH
RH_{mean}	603>	25.83>	2.46>	0.46<	NH

The critical values given in Table 1 of the homogeneity tests used are the values corresponding to 95% significance level and n=52. In the first three methods, if the test statistic value obtained is less than the critical value of that method, the data is homogeneous, if it is large, the data is not homogeneous. The opposite is true in the VNR homogeneity test. An evaluation was made as homogeneous (H) or not homogeneous (NH) according to the condition that at least three of the 4 tests used gave similar results. The results in Table 1 show that the P_{total}, P_{max} and RH_{max}

parameters for the examined period are homogeneous, while the data for the other parameters are not homogeneous.

3.2 Results of Trend Test

The results of the Mann-Kendall (MK) trend method applied to the data of eight meteorological parameters of Karataş station in the period 1965-2016 are given in Table 2, and the graphics of Şen Innovative trend and Mann Kendall Rank Correlation (MKRC)methods are given in Figure 2.

According to the results given in Table 2, there is a statistically significant trend in these parameters since the Z_{MK} values (as absolute values) of the T_{min}, T_{mean}, RH_{min} and RH_{max} parameters are greater than the $z_{critical}$=1.96 value corresponding to the α=0.05 significance level. While there is a significant increasing trend (SIT) in these parameters because the Z_{MK} values found for T_{min}, T_{mean} are positive, there is a significant decreasing trend (SDT) in these parameters because the Z_{MK} values found for RH_{min} and RH_{max} are negative. There is a statistically insignificant decreasing trend (IDT) in the annual P_{total} and RH_{max} parameters, and an insignificant increasing trend (IIT) in the P_{max} and T_{max} parameters.

Table 2 MK trend test results

Parameter	Z_{MK}	Result	Parameter	Z_{MK}	Result
P_{total}	-0,86	IDT	**T_{mean}**	3,68	SIT
P_{max}	0,070	IIT	**RH_{max}**	-0,95	IDT
T_{max}	1,86	IIT	**RH_{min}**	-4,79	SDT
T_{min}	4,85	SIT	**RH_{mean}**	-4,92	SDT

According to the Şen Innovative trend graphs, since all values of T_{min} and T_{mean} (RH_{min} and RH_{mean}) parameters are located in the area above (below) the 1:1 line, there is a monotonic increasing (decreasing) trend in these indices. The values of the T_{max} parameter are also in the increasing trend region and there is a monotonic increasing trend. In this parameter, Z_{MK} = 1.86, which is very close to the critical value at the 95% significance level. In other indices, it exhibits a change similar to the MK trend results.

According to MKRC graphs, there is an increasing trend in temperature parameters and annual maximum precipitation, and a decreasing trend in relative humidity parameters. In annual total precipitation, there is no trend since the ut and u't curves intersect many times. There was a statistically significant increase trend in T_{min} and T_{mean} parameters, and the trend beginning years were 1994 and 2005, respectively. There are also significant decreasing trends in the RH_{min} and RH_{mean} parameters. In these parameters, the trend start years are 1997 and 1995, respectively (Figure 2).

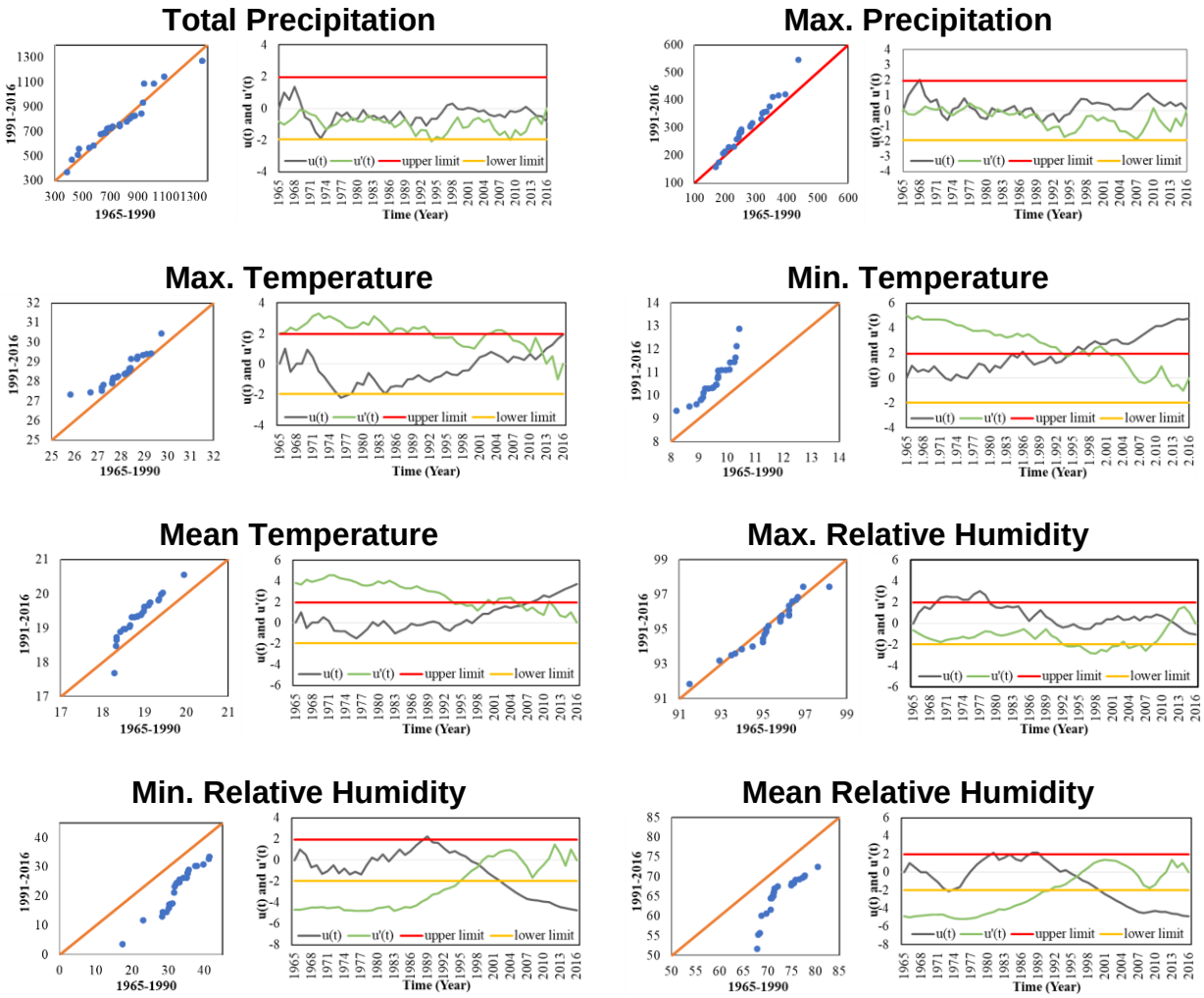

Figure 2. Şen Innovative and Mann Kendall Rank Correlation test graphs

4. Conclusion

In this study, homogeneity tests and trend analysis studies were carried out for the parameters of the Karataş meteorological observation station in the Seyhan Basin, located within the borders of Kayseri province. The precipitation, temperature and partial humidity parameters obtained for the study area were examined. Homogeneity tests (Pettitt, SNHT, Buishand and Von Neuman Rank) and trend tests (Mann Kendall, Şen Innovative and Mann Kendall Correlation) were applied to 52 annual data between 1965 and 2016.

According to the results of the homogeneity test; of the 8 parameters, 3 (P_{total}, P_{max} and RH_{max}) are homogeneous, while 5 (T_{max}, T_{min}, T_{mean}, RH_{min} and RH_{mean}) are not.

According to the results of the homogeneity test, P_{total}, P_{max} and RH_{max} parameters are homogeneous and other parameters are not homogeneous. Despite the decrease in annual total precipitation and relative humidity parameters, an increase trend in temperature parameters was obtained.

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