International Journal of Geography and Regional Planning IJGRP
Vol. 6(1), pp. 138-145, June, 2020. © www.premierpublishers.org. ISSN: 2021-6009

Research Article

Evaluation of Maximum and Total Open Surface Evaporation by Using Trend Analysis Method in Nigde Province of Turkey

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This study was carried out Center of Nigde Province in Turkey. Trend analysis was performed on monthly total and maximum open surface evaporation data. In the study, a total of 42 years of data between 1978-2019 was used monthly. The data of the climate station in the center of Niğde province were used in the research. For many years, the maximum and total open surface evaporation data were applied to Mann-Kendall, Sperman's Rho correlation tests and Sen's slope method. According to the research results; for many years, the total monthly open surface evaporation averages were 215,1 mm in June, 272,2 mm in July and 259,5 mm in August. For many years, the total evaporation in the summer months was recorded as 746,8 mm and the average evaporation as 248,9 mm. Maximum of the total open surface evaporation for many years in Niğde Center was calculated as 10,5 mm in June, 11,5 mm in July and 10,7 mm in August. The average of the total monthly open surface evaporation observed in the summer months is 10,9 mm. According to the trend analysis results made in Niğde Center, it has been observed that there is an increasingly significant trend in the monthly total and maximum open surface evaporation data for many years.

Keywords: Open Surface Evaporation, Mann-Kendall, Spearman's Rho, Trend Analysis, Niğde Province, Turkey

INTRODUCTION

Annual water potential in Turkey is 501 billion m^3. 69 billion m^3 of this is mixed with groundwater. Only 110 billion m^3 of the annual water potential is usable water potential. In Turkey, the average rainfall is 643 mm/year. The calculated evaporation amount is 274 mm/year. 28 billion m^3 of it feeds surface water again.

In this case, 55% of our water resources are mixed into the atmosphere without being used. Turkey's per capita amount of water used in 1528 m^3 / year (Bilen, 2008).

According to calculations made for water reservoir areas, evaporation calculated from 352 storage areas (lake, dam, pond, regulator) is 6,8 billion m^3 / year (Gökbudak and Özhan, 2006).

In the atmosphere, precipitation occurs when the water in gas form condenses and descends from the clouds to the ground. 60-75% of this precipitation is mixed into the atmosphere again by evaporation and sweating from plants. The remaining 40-25% is seized by plants and leaks from the ground into the lower layers of the soil. The remaining water flows from streams and reaches the sea or lakes. In the water leaking into the lower layers of the soil, it finally reaches the surface of the ground by underground flow and participates in the surface flow. In this way, the waters that mix into the seas-lakes are mixed with the atmosphere in the form of gas again from here (Beyazıt, 2003).

Evaporation is generally divided into two parts: land and water. Evaporation occurring on the water surface and wet surfaces is in a continuous motion. The amount of evaporation on the water surface varies according to the

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characteristics of the air, water and environment on the unit area. Losses occurring on the surface of the open water are called evaporation, and water loss from plants is called sweating. The loss of water in plants and soil is called evapotranspiration (Aydın and Topaloğlu, 2010).

Turkey is in the middle latitudinal belt (30 - 60º N) is located. Considering the future climate scenarios, the average temperature increase estimated in the middle latitude countries for the period between 2080-2100 is 4-6ºC (Anonymous, 2013). Climate, according to scientists, is the air that can change in the atmosphere, the name given to all of the atmospheric events anywhere and anytime on earth. In general, climate change can be defined as long-term and slowly developing changes in climate conditions with large-scale (global) and important local effects, regardless of the cause (Türkeş, 1997).

Climate changes include precipitation changes between the glacial and interglacial ages, as they occur in the form of major changes in average temperatures in various parts of the world. Throughout the very long geological history of the earth, there have been many changes in the climate system naturally. Climate changes in geological periods have not only changed the geography of the world, especially through glacial movements and changes in the sea level, but also created permanent changes in ecological systems (Türkeş *et al*., 2000).

Water is in nature in three states as solid, liquid and gas, and in cycles on all roads between different layers of the earth. All of these roads where water is in nature are called hydrological cycles. Evaporation, which is one of the important parameters of the hydrological cycle, is used in the planning and operation of water resources, in the design, planning and operation of water structures, in determining the amount of irrigation water, in meteorological and atmospheric studies (Çıtakoğlu and Güney, 2017).

The evaporation of liquid particles to gases by defeating the inter-particle attraction force of particles with high kinetic energy from liquid molecules on the surface at any temperature is called evaporation. Approximately 90% of the evaporation in the atmosphere consists of oceans, seas, lakes and rivers, while the remaining 10% consists of evaporation on the soil and plant surface (Çıtakoğlu and Güney, 2017).

This study was carried out within the scope of evaluation of total and maximum open surface evaporation data observed in Niğde Center between 1978-2019 by trend analysis. Since the amount of evaporation in the summer months is the most, only the trend analysis of the summer months was carried out. For this purpose, Mann-Kendall test and Spearman's Rho test and Sen's slope method were used. At the end of the study, the evolution of open surface evaporation by years has been demonstrated.

MATERIAL AND METHOD

The study area is located in the Central Anatolia region of Turkey, Nigde province. The location of the Niğde Center evaluated within the scope of the research are shown in Figure 1.

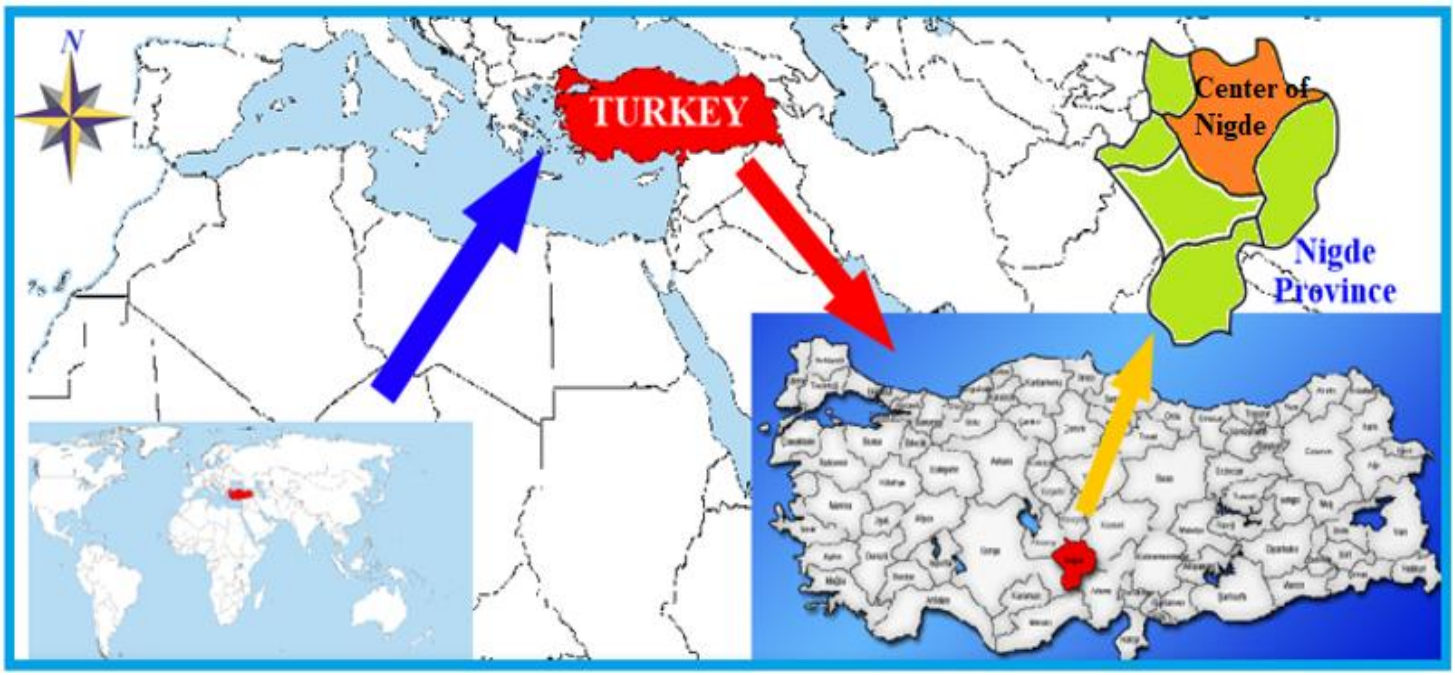

Figure 1: Locations of the studied area

In the study, monthly changes of the open surface evaporation values observed between 1978-2019 in the meteorology station in Niğde Center were used (Anonymous, 2019). In the study, total open surface evaporation and maximum monthly open surface evaporation changes for many years were subjected to trend analysis. In this sense, Rhona Test and Sen Trend Trend method of Mann Kendall and Sperman were used to evaluate the data. Evaluations were made within the 95% confidence level (Mann 1945; Kendall 1975; Sen 1968). A software called "Trend Analysis for Windows" was used in the study. This software uses Mann-Kendall, Spearman's Rho and Sen's Trend Slope methods and applies the data as graphics and text (Gümüş and Yenigün 2006).

RESEARCH FINDINGS

The trend analysis results for the long-term maximum and total open surface evaporation values between 1978-2019 are presented in detail below.

Total Open Surface Evaporation

Average open surface evaporation changes for many years in June

The change of total open surface evaporation in June for many years is given in Figure 2.

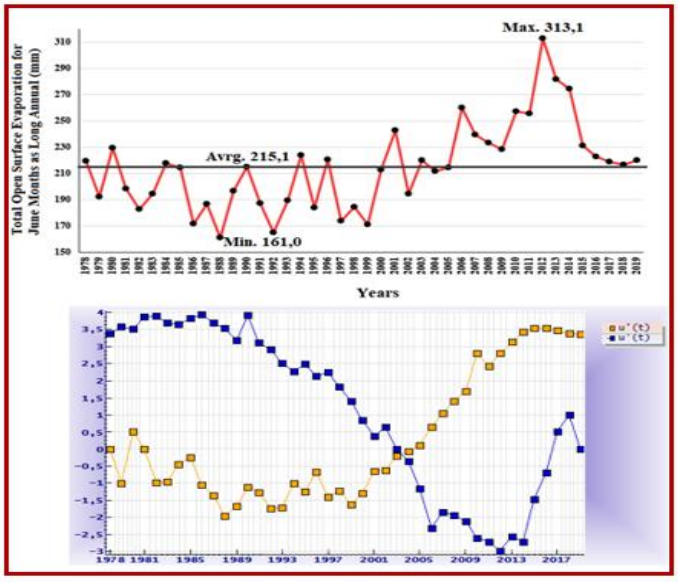

Figure 2. Total Open Surface Evaporation (mm) Changes in June (1978-2019)

Considering the total open surface evaporation changes in June for many years, the highest open surface evaporation was recorded as 313,1 mm in 2012. The lowest total open surface evaporation was found to be 161,0 mm in 1988. In total open surface evaporation, the average of June for many years was recorded as 215,1 mm. Total Open Surface Evaporation Changes Trend Analysis Results in Long Years June are given in Figure 3.

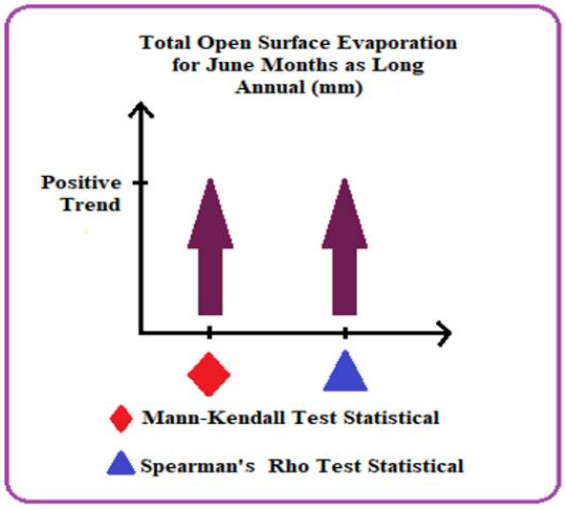

Figure 3. Trend Analysis Results of Total Open Surface Evaporation Changes in June of Long Years (1978-2019)

Looking at the total open surface evaporation in June, it has been seen that there is an increasingly significant trend.

Average open surface evaporation changes for many years in July

The variation of the total open surface evaporation values over the years is presented in detail in the graphic given in Figure 4.

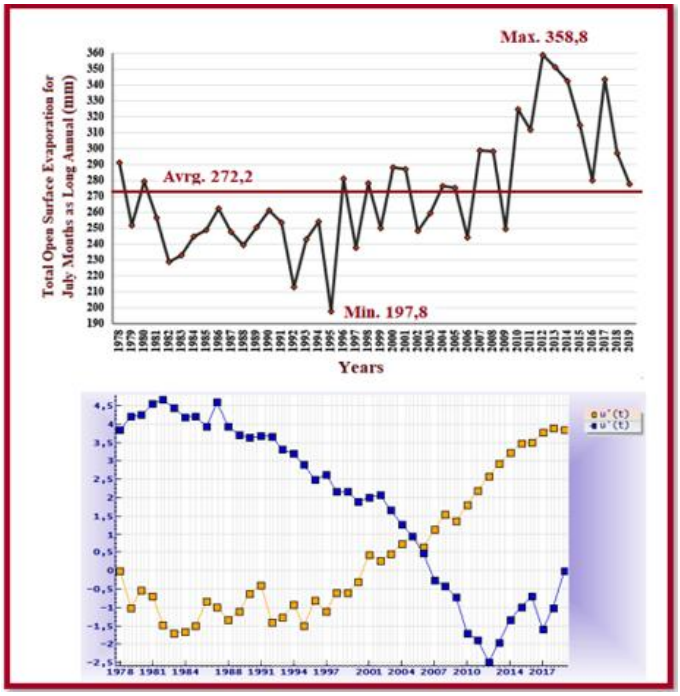

Figure 4. Total Open Surface Evaporation Changes in July (1978-2019)

According to the results, the highest value of total open surface evaporation changes in July was 358,8 mm in 2012, while the lowest open surface evaporation was recorded as 197,8 mm in 1995. The average value of the total open surface evaporation in July is 272,2 mm.

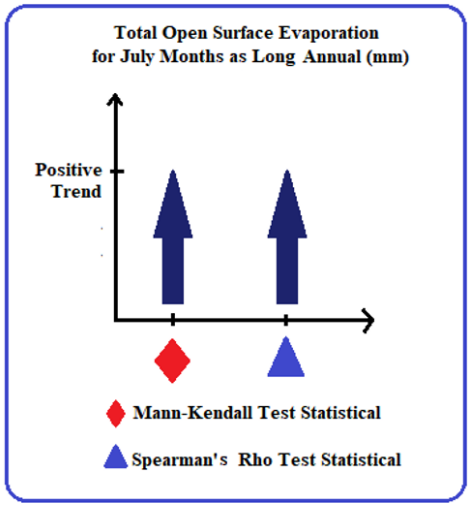

Figure 5. Trend Analysis Results of Total Open Surface Evaporation Changes in July of Long Years (1978-2019)

According to Mann-Kendall and Sperman's Rho; an increasingly significant trend was determined in total open surface evaporation values.

Average Total Open Surface Evaporation Changes for Many Years in August

The variation of the total open surface evaporation in August data for long periods (1978-2019) is presented in detail in the graph in Figure 6.

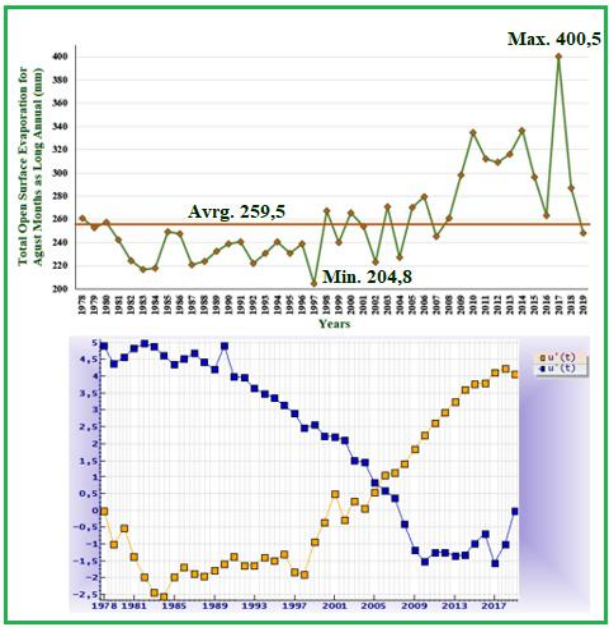

Figure 6. Total Open Surface Evaporation Changes in August of Long Years (1978-2019)

Looking at the total open surface evaporation changes in August for many years; The highest open surface evaporation was recorded as 400,5 mm in 2017, while the lowest open surface evaporation was determined as 204,8 mm in 1997. The average value of total open surface evaporation in August was recorded as 259,5 mm.

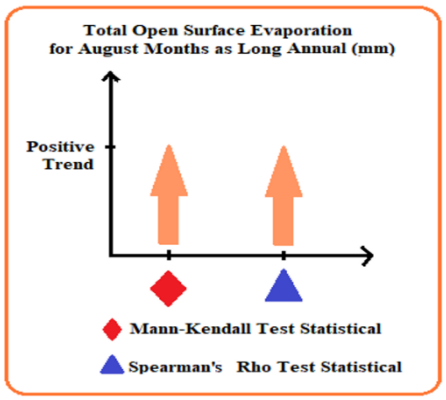

Figure 7. Trend Analysis Results of Total Open Surface Evaporation Changes in August (1978-2019)

According to the results of the trend analysis, an increasingly significant trend was determined in the total open surface evaporation in August of Long Years (1978-2019).

Total open surface evaporation changes for many years

For many years (1978-2019) total open surface evaporation values were evaluated by trend analysis. The change of long-term total open surface evaporation values by years is given in detail in the graph given in Figure 8.

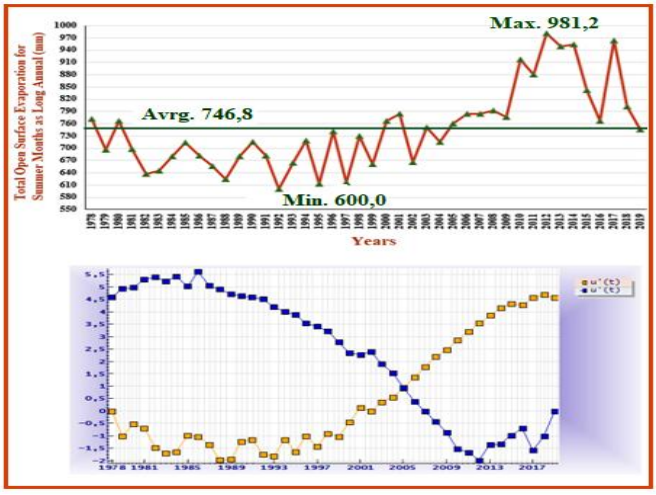

Figure 8. Total Open Surface Evaporation Changes in (1978-2019)

According to the analysis, the highest value of total open surface evaporation changes for many years was found to be 981,2 mm in 2012. The lowest total open surface evaporation was recorded as 600,0 mm in 1992. The

average value of total open surface evaporation was recorded as 746,8 mm. Trend analysis results of total open surface evaporation changes for many years are given in Figure 9.

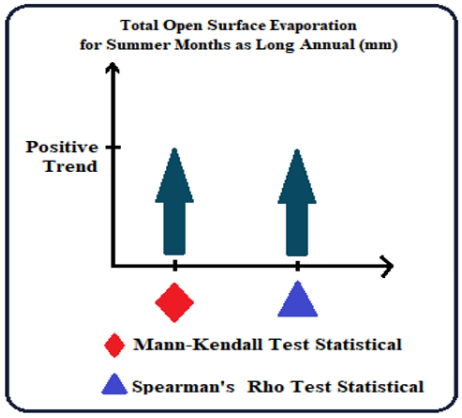

Figure 9. Trend Analysis Results of Total Open Surface Evaporation Changes in Long Years (1978-2019)

According to the trend results for the open surface total evaporation for many years on the basis of Niğde Center, it was concluded that both Mann-Kendall and Sperman's Rho tests were significant trend increasingly.

Maximum Open Surface Evaporation

Maximum open surface evaporation changes in June for many years

For long years (1978-2019), the maximum open surface evaporation changes of June according to the years are given in detail in Figure 10.

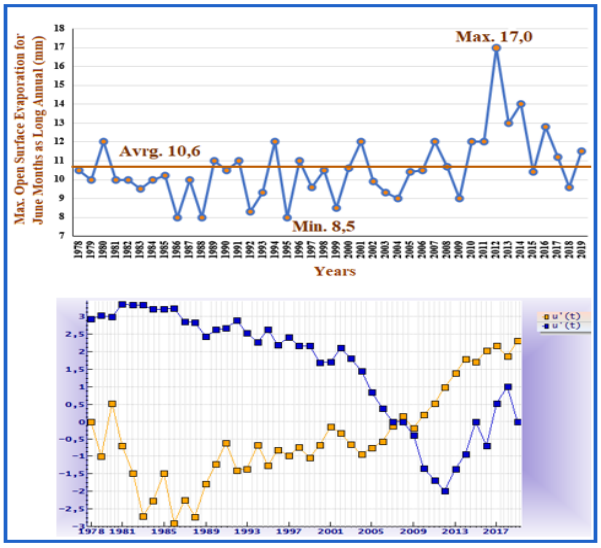

Figure 10. Maximum Open Surface Evaporation Changes in June of Long Years (1978-2019)

According to the maximum open surface evaporation changes in June; the highest maximum open surface evaporation was recorded as 17,0 mm in 2012. The lowest maximum open surface evaporation was 8,5 mm in 1995. The average value of maximum open surface evaporation in June was recorded as 10,6 mm. Trend analysis results related to maximum open surface evaporation changes for many years are given in Figure 11.

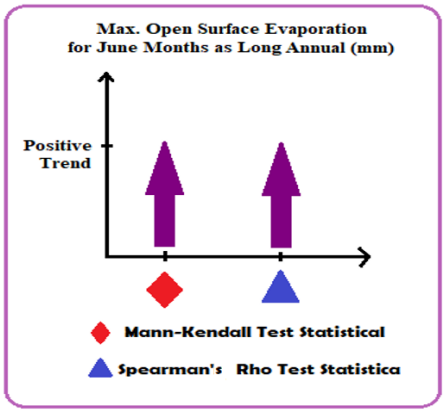

Figure 11. Trend Analysis Results of Maximum Open Surface Evaporation Changes in June of Long Years (1978-2019)

According to the trend results regarding maximum open surface evaporation for many years in Niğde Center in June, it has been determined that there is an increasingly significant trend.

3.2.2. Maximum open surface evaporation changes in July for many years

Maximum open surface evaporation data for July were evaluated by trend analysis. The change of long-term (1978-2019) maximum open surface evaporation values by year is given in Figure 12.

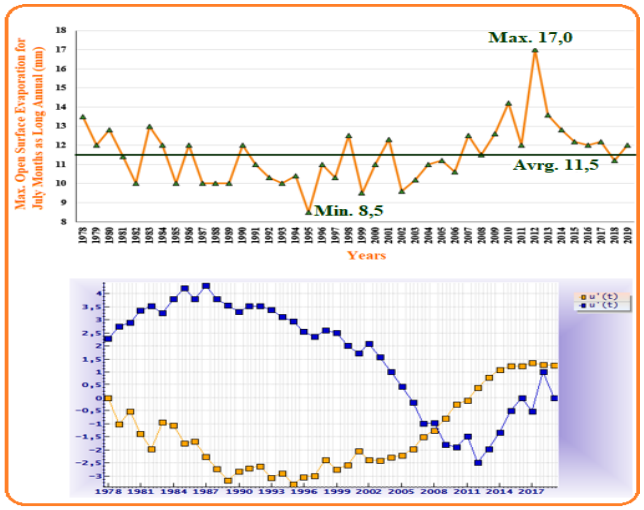

Figure 12. Maximum Open Surface Evaporation Changes in July of Long Years (1978-2019)

Considering the results, the maximum open surface evaporation changes in July for the long years were found to be the highest maximum open surface evaporation was 17,0 mm in 2012, The lowest maximum open surface evaporation was recorded as 8,5 mm in 1995. The average

value of maximum open surface evaporation in July was recorded as 11,5 mm. Trend analysis results related to the maximum open surface evaporation changes for many years are given in Figure 13.

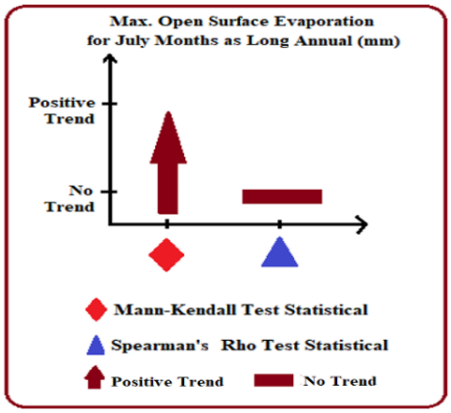

Figure 13. Trend Analysis Results of Maximum Open Surface Evaporation Changes in July (1978-2019)

According to the trend results regarding maximum open surface evaporation for many years in July, it has been seen that there is an increasingly significant trend as a result of Mann-Kendall Test. However, it has been determined that Sperman's Rho Test is not a significant trend.

Maximum open surface evaporation changes in August for many years

Maximum open surface evaporation in August data of Niğde center was evaluated by trend analysis. The variation of long annual maximum open surface evaporation values by years is given in Figure 14 in detail.

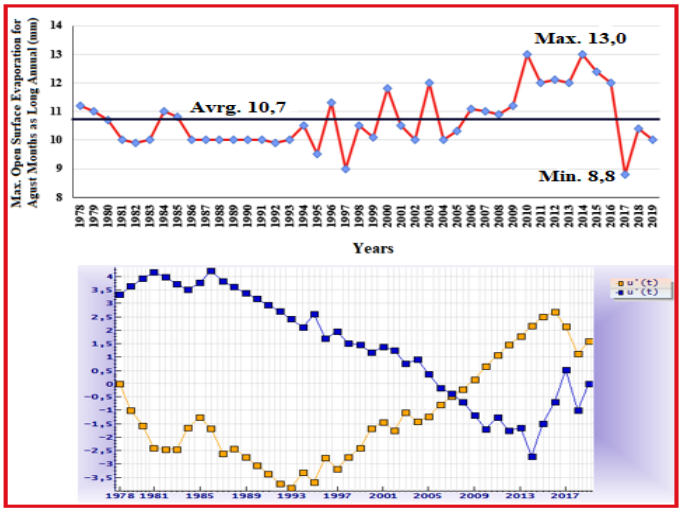

Figure 14. Maximum Open Surface Evaporation Changes in August of Long Years (1978-2019)

According to the results of the analysis, the highest value of the maximum open surface evaporation changes in July was determined as 13,0 mm in 2014. The lowest maximum open surface evaporation was recorded as 8,8 mm in 2017. The average value of maximum open surface evaporation in August was determined to be 10,7 mm. Trend Analysis Results of Maximum Open Surface Evaporation Changes for August in Long Years are given in Figure 15.

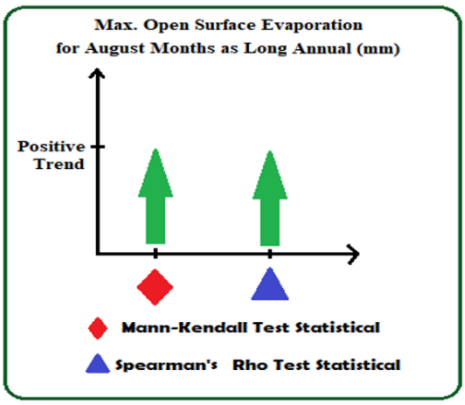

Figure 15. Trend Analysis Results of Maximum Open Surface Evaporation Changes in August (1978-2019)

According to the analysis results of Mann-Kendall and Sperman's Rho Tests, it was determined that there was an increasing trend in August.

The average changes of maximum open surface evaporation (June, July, August) for long years

Maximum open surface evaporation summer months average data were evaluated by trend analysis. The change of maximum open surface evaporation values for the long summer months is given in detail in Figure 16.

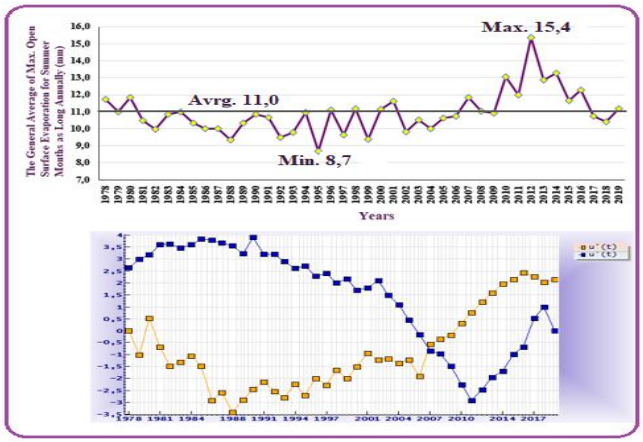

Figure 16. Changes of Average Maximum Open Surface Evaporation in Summer Months in 1978-2019

According to the data of maximum open surface evaporation summer months for many years; The highest value was recorded as 15,4 mm in 2012. The lowest maximum open surface evaporation was determined as 8,7 mm in 1995. The average value of the maximum open surface evaporation in the summer months was determined to be 11,0 mm.

The trend of maximum open surface evaporation changes in the summer months for long years is shown in Figure 17.

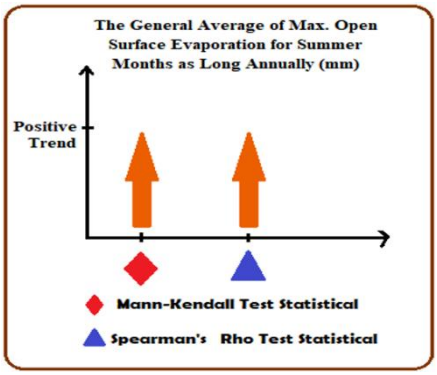

Figure 17. Trend Analysis Results of Maximum Open Surface Evaporation in Summer Months (June, July, August) of LongYears (1978-2019)

According to the trend results regarding maximum open surface evaporation in the summer months for many years, it is determined an increasingly significant trend in Mann-Kendall and Sperman's Rho tests. Maximum and Total Open Surface Evaporation values for long years (1978-2019) summer months are given in Figure 18.

Figure 18. Maximum and Total Open Surface Evaporation Values in Summer Months in 1978-2019

In the study, the total open surface evaporation (mm) for many years in the center of Niğde was found to be 215,1 mm in June. This value is seen as 272,2 mm in July. These values were recorded as 259,5 mm for the August average. For many years, the total evaporation value in the summer months was calculated as 746,8 mm. The average of the summer months was recorded as 248,9 mm.

For many years, the maximum total open surface evaporation of the month is determined as 10,5 mm in June. The average of July was calculated as 11,5 mm. The average for August was recorded as 10,7 mm. The maximum open surface evaporation average in the summer months for many years was 10,9 mm.

According to the results of the trend analysis, it was observed that there was an increasingly significant trend in summer months and averages in total open surface evaporation for many years. It has been calculated that there is a increasingly significant trend in summer months for maximum open surface evaporation for many years.

CONCLUSION AND SUGGESTIONS

Water resources management is becoming increasingly important due to reasons such as current water resources, population growth, climate change and unconscious water use in agriculture. It is of great importance to monitor how the hydrological water budget components, precipitation, evaporation-perspiration (ET), surface flow and infiltration change in spatial and temporal dimensions in the effective management of water resources (Çetin, 2018). All the mediums in which water spins in nature in different physical states are called hydrological cycle (Korkmaz, 2015).

Evaporation, which forms part of the hydrological cycle, is defined as the return of water in liquid and solid form to the atmosphere as a result of meteorological events. The source of water vapor in the atmosphere; seas, lakes, streams, moist soils and vegetation areas that contain water in the earth (Bacanlı and Tanrıkulu, 2017).

As a result of the analyzes made in Niğde Center, the monthly maximum open surface evaporation (mm) was the highest value in June and 17,0 mm, while the lowest value was 8,5 mm. July was similar to June and the highest value was determined as 17,0 mm. The lowest value was determined as 8,5 mm. For August, the highest value was calculated as 13,0 mm and the lowest value as 8,8 mm. Maximum open surface evaporation was 15,4 mm in summer, while the lowest was recorded as 8,7 mm.

For many years, the total open surface evaporation values were seen as 313,1 mm and the lowest 161,0 mm for June. While the highest for July values is 358,8 mm, the lowest value is 197,8 mm. These values were the highest value for August, 400,0 mm while the lowest value was 204,8 mm. In the total evaporation values, the highest value was recorded as 981,2 mm, while the lowest value was recorded as 600,0 mm.

In this study, Niğde Center has been evaluated for many years with monthly and maximum open surface evaporation trend analysis. It is concluded that there is a significant increase in open surface evaporation.

Increasing the necessary studies and measures will play an important role in the improvement so that measures that will minimize the greenhouse gas effect should be taken all over the world and these measures will also prevent global warming and to minimize the carbon emissions that will trigger it.

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Accepted 1 June 2020

Citation: Bağdatlı MC, Arıkan EN (2020). Evaluation of Maximum and Total Open Surface Evaporation by Using Trend Analysis Method in Nigde Province of Turkey. International Journal of Geography and Regional Planning **6(1): 138-145.**