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TEMPERATURE-RAINFALL TREND ANALYSIS RELATIONSHIPS WITH AGRO-WATER PRODUCTIVITY AT SEMI-ARID KONYA REGION OF TURKEY

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ABSTRACT

The aim of the current research was to assess some climate indicators such as temperature and precipitation relevant to 1972-2011 period at eight locations belonging Konya city of Turkey. In such study, trends in such parameters were analyzed by usage of Non-Parametric Mann-Kendall Test. In Konya general, increasing trend was found at absolute maximum temperature, and number of summer and tropical days. The decreasing trend related to absolute minimum temperature was detected. Although maximum rainfall was obtained from both winter, and spring seasons followed by autumn, the lowest one was observed at summer season. There was found important reducing trend at only Kulu and Karapınar places relevant to spring precipitation. In that regard, water resources should be managed with great care for reducing negative effects of climate changes on agro-production areas particularly water shortage regions such as Konya Closed Basin, Turkey.

INTRODUCTION

Rainfall and temperature are well-known components showing huge fluctuations within the whole climate characteristics. Those are very important role to play for assessment of climate change impacts (Demir et al. 2017). It is noted that negative effects of climate change are more common than positive effects (Türkeş, 2020). Ray et al. (2018) stated that crop yield should be improved to meet the future food demand of the human and one of the major causes of the yield losses under both the rain-fed and irrigated agriculture is drought.

Agricultural activities are highly or possibly the maximum affected sector from the daily weather events as well as global warming. The reason behind the global warming is rises in greenhouse gases at air resulting from the human activities (Tıraşcı & Erdoğan, 2021). As we all know that precipitation is only source of water and has effects on all sectors including agriculture (Hamjah, 2014). The negative effects of global warming in Turkey are reduction in water resources, yield losses, forest fires, drought and desertification (Gümüş, 2006). Rainfall and temperature patterns have a lot of effects such as on available water potential, soil tillage, sowing time, irrigation and machinery uses (Adeyemo et al. 2014). Ali et al. (2021) reported that increase in air temperature as 1% from the mean level the yield loss was as around 6% by comparison to the mean yield at constant precipitation amount.

Increase in the precipitation amount as 1% resulted as 0.6% yield reduction from the mean yield under constant air temperature.

Beside that temporal trends will reduce between 13% and 42% crop water consumption of wheat plant under Morocco environments. The reason behind is shortening crop growth cycle (Bauras et al. 2019).

Konya plain known as semi-arid climate is about 300 mm annual average rainfalls. In that regard, water shortage is the major problem affecting agro-production. The common crops are cereals, sugar beet, maize, alfalfa, dry bean, sunflower, and carrot in region. The high water consuming crops such as sugar beet and maize have threatened the sustainability of groundwater in region. Yavuz et al. (2014) reported the applied water of sugar beet, dry bean, and carrot plants as 979 mm, 818 mm, and 1010 mm, respectively.

Economical yield can be obtained from the irrigated conditions particularly for summer crops in Konya region. Irrigation is maximal energy utilization activity in agriculture such as around 44% of energy inputs at potato production in Konya region (Yavuz et al. 2016). Therefore, there is a direct relationship between applied water and energy consumption in irrigation under pressurized irrigation utilizations.

One of the practical ways for improvement of water use efficiency in water poor ecologies is deficit irrigation. The 25% deficit irrigation with 7-day irrigation interval had no significant seed yield of pumpkin in Konya plain of Turkey so it can be highly recommended for well water productivity in irrigated areas (Yavuz et al. 2015). The major problem in analysis of the climate data for long term is differences between the records. The reasons behind data variations are changes of stations, and devices and so on in times (Şen & Koçak, 1994).

The aim of the present study is to examine the rainfall and temperature for long period and giving the practical recommendations for sustainable water use in agriculture particularly for water poor ecologies like Konya basin of Turkey.

MATERIAL AND METHODS

In this study, long term, 1971-2011 climate records obtained from eight different meteorological stations located at Konya province were used (fig 1). In research, annual extreme air temperatures, summer days, tropical days, annual and seasonal rainfall, and rainy days were comparatively analysed for those stations.

Mann-Kendall trend test, highly tolerant to missing data, was used (Kalaycı & Kahya, 1998) for evaluation of the temperature and rainfall variation in time. This equation can be used also to determine variations in water quality and stream flow (Büyükyıldız, 2011). In the interpretation of the results in Mann-Kendall test, critical value of ±1.96 known previously was used in this study. If calculated value is higher than this value of ±1.96 means positive or increasing, and lower than that value means negative or reducing trend. In order to determine the starting point of trend Mann-Kendall exponential test was applied (Büyükyıldız, 2011). In current study, the main objective was ‘how can be improved water productivity’? in agriculture for semi-arid Konya plain of Turkey under the recent climate changes.

Figure 1. The locations of stations

RESULTS AND DISCUSSIONS

A- Analysis of Temperature Variations

Positive trends were detected in extreme maximum temperature, annual total summer days and annual total tropical days (Table 1). In extreme minimum temperature, negative trends were found at Konya and Çumra location and positive trends were at other six provinces (fig 2). The possible reasons of negative trends at Konya and Çumra locations are having similar characteristics in accordance of environmental conditions.

The Mann-Kendall values relevant to the seasonal extreme maximum temperature are given at Table 2. In that table there was found increased trends in summer months for whole examined stations. In addition, there was slightly increasing trend for whole seasons at annual absolute maximum temperature in all examines provinces.

The trend of summer days was shown at fig 3. In such graph, there was an important increasing trend of summer days for whole stations.

Table 1

Mann-Kendall test results for examined parameters (1972-2011)

Stations	Absolute min temp. °C	Absolute max. temp. °C	Annual Summer days	Annual tropical days	Annual rainfall, mm	Winter precipitations	Spring precipitations	Summer precipitations	Autumn precipitations	Annual total rainy days
Konya	-0,339	**2,212**	**2,169**	**3,494**	-0,387	-0,435	-1,560	-0,617	0,484	0,476
Beyşehir	0,315	**3,267**	**3,324**	**3,890**	1,355	0,242	0,218	0,339	1,210	0,445
Cihanbeyli	1,095	**3,678**	**4,588**	**5,449**	0,290	0,290	-1,887	1,331	1,028	**-2,286**
Çumra	-0,326	**2,660**	**2,633**	**4,035**	0,012	0,484	-1,500	1,040	0,750	0,811
Ereğli	1,097	**3,376**	**3,693**	**4,865**	0,460	0,206	-1,440	1,161	1,621	0,223
Karapınar	0,396	**2,521**	**2,690**	**4,351**	-0,992	-0,060	-1,258	-0,012	0,024	-0,965
Kulu	1,458	**2,550**	**2,376**	**4,084**	-0,194	0,339	**-2,347**	0,774	0,798	0,023
Seydişehir	0,664	**3,247**	**3,382**	**4,501**	-1,125	-0,895	**-2,637**	0,665	1,367	-1,473

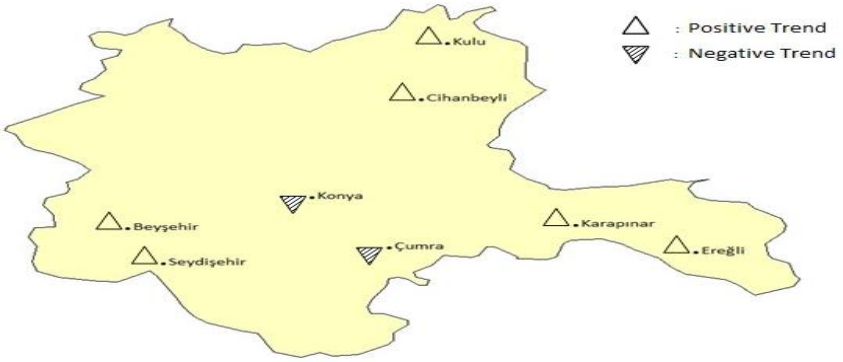


Figure 2. Annual absolute minimum temperature trends

Table 2

Mann-Kendall values for absolute maximum temperature

Stations	Periods	Winter	Spring	Summer	Autumn	Annual
Konya	1972-2011	0,2422	1,4661	**2,1582**	-0,0122	**2,1582**
Beyşehir	1972-2011	1,5759	1,8999	**3,1275**	1,9009	**3,1490**
Cihanbeyli	1972-2011	1,9251	**2,0874**	**3,7433**	1,9691	**3,7433**
Çumra	1972-2011	**2,0123**	**2,1054**	**3,1032**	1,4305	**2,8474**
Ereğli	1972-2011	1,9136	**2,3045**	**3,2752**	**2,2863**	**3,2752**
Karapınar	1972-2011	1,7503	**2,3497**	**2,7191**	0,2909	**2,7191**
Kulu	1972-2011	1,7017	1,2229	**3,4567**	1,2290	**3,4567**
Seydişehir	1972-2011	**2,1152**	1,5833	**3,3701**	**2,2709**	**3,3371**

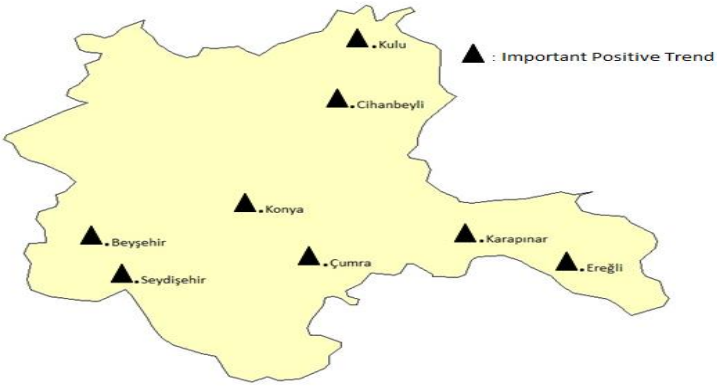


Figure 3. Trends of annual summer days

Like the positive trends at absolute maximum temperature, similar situation was observed also at trends of total summer days. Demir et al. (2017) stated temperature increase for annual, monthly and seasonal in Bingöl province of Turkey, but the variation was statistically not found significant. There was important increasing trend in whole research areas related to the annual total tropical days (fig 4).

Increase in temperature has led to over evaporation so capacities of lakes, dams and streams have reduced dramatically in region. Such increment in temperature has caused rises of crop water use so over water extraction from the groundwater resources are inevitable in our region. This situation has increased irrigation energy cost due to the pumping irrigation water from lower parts of the wells.

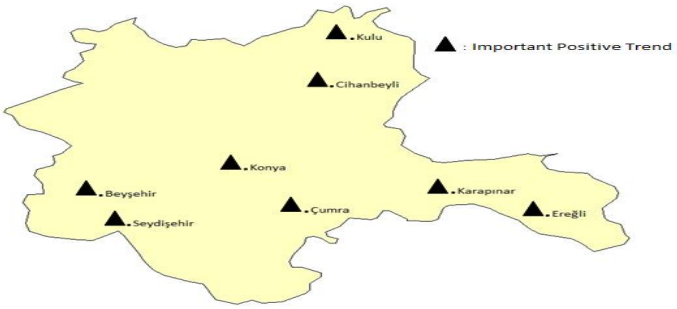


Figure 4. Trends of annual tropical days

B- Trends in precipitation

In examine research period, marginal increase or decrease was detected in general. The increase or reduction in trend was found not statistically significant (fig 5). Franke et al. (2020) also mentioned similar results, no significant, in South Africa in the analysis of precipitation for potato growing cycles at 1960-2050. They obtained

increment in fresh tuber yield in such periods. Demir et al. (2017) reported negative trends at annaul, seasonal, and monthly rainfall at Bingöl province of Turkey.

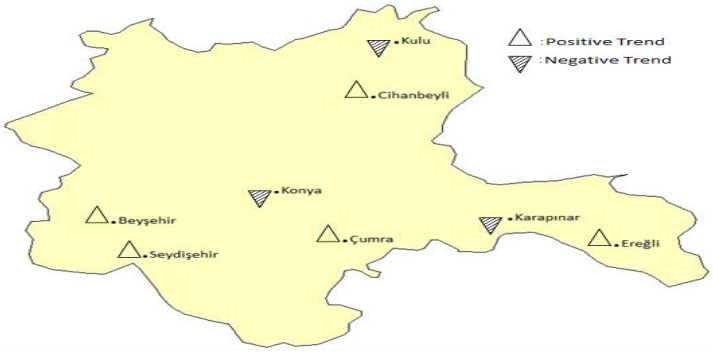
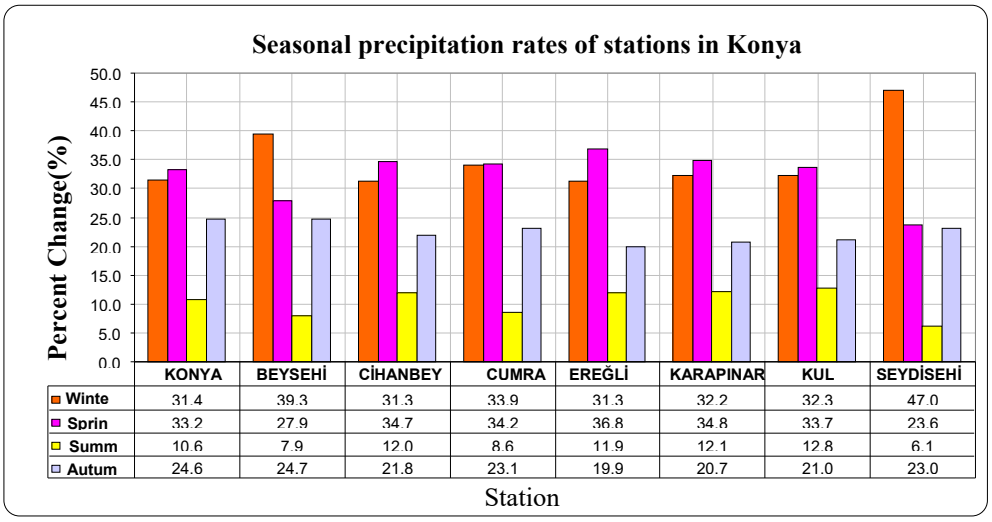


Figure 5. Variations in total rainfall

The maximum rainfall was recorded at both the winter, and spring followed by autumn (fig 6). In one research (Korkmaz & Efe, 2021) there was found increasing trend at precipitation amount for winter, spring and summer seasons at Samsun province of Turkey.



	KONYA	BEYSEHİ	CİHANBEY	CUMRA	EREĞLİ	KARAPINAR	KUL	SEYDİSEHİ
Winte	31.4	39.3	31.3	33.9	31.3	32.2	32.3	47.0
Sprin	33.2	27.9	34.7	34.2	36.8	34.8	33.7	23.6
Summ	10.6	7.9	12.0	8.6	11.9	12.1	12.8	6.1
Autum	24.6	24.7	21.8	23.1	19.9	20.7	21.0	23.0

Figure 6. Seasonal rainfall patterns of research locations

In examined rainfall variations of winters, although there was a negative trend in Konya and Kulu, it was positive trend in other locations; both the negative and positive variations were not found meaningful. There was a negative important trend at only Kulu and Karapınar locations in regard to spring precipitation. The possible reason of positive trends at Beyşehir and Seydişehir is being transitional zone of Mediterranean climate so they have more precipitation than others.

In examined the summer rainfall variations, there was slightly reduce in Konya, and marginal increase at other locations.

There was found very little increasing trend in autumn rainfall at whole stations. In contrast to that during the 2020-2021 autumn periods the precipitation was observed less than the average long-year, and last year. The decrease in precipitation was found maximum at Central Anatolia Region as about 31% (https://www.zraporu.com/dosya/tarimda-kuraklik-riski/). In that regard, possibly Konya plain was one of the highest negatively affected places from the climate change within the whole agro-zones of Turkey.

In examine the annual total annual rainy days, although there was found none trend for Karapınar, important reducing trend at Cihanbeyli, decreasing trend at Kulu and Seydişehir, and little increasing trend at other stations.

CONCLUSIONS

The irrigated agriculture is very intense at most parts of Konya plain due to the low amount of rainfall with not regular and high temperature. Over water extraction from the groundwater reservoir is present to meet most of crop water use in most parts of region. Since high water consuming crops having large-sized cultivated lands are the main cause of the over water pumping. There are serious environmental problems such as formation of very huge sinkholes such as at Karapınar region and drying lakes resulting from over water use from the current water supplies of the Konya plain. Therefore, we should organize our farming activities in accordance of climate change or current water supplies for better water productivity in agriculture. The practical solutions could be as; increase cultivated land size with favour of less water consuming crops such as cereals, chick pea, dry bean, lentil and so on; rain-fed farming system in more areas; 25% deficit irrigation for maximizing water saving. Monitoring the climate data is vital important for organizing future farming plans particularly water scant regions. In addition, forestation is very useful way to improve rainfall amount in those environments. Beside those, pressurized irrigation technologies should be strongly recommended for obtaining high irrigation efficiency under well management.

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CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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