Brazilian Journal of Biological Sciences, 2019, Vol. 6, No. 12, p. 189-201.
ISSN 2358-2731
https://doi.org/10.21472/bjbs.061218

Long-term trend analysis of climatic variables and reference evapotranspiration over different urban areas in Tunisia

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Abstract. In this study, the trend analysis of annual climatic variables including T_{max}, T_{min}, T_{mean}, RH_{mean}, WS and SR as well as FAO-56 PM ET0 were investigated in three locations in Tunisia during 1984-2007. The Mann-Kendall Test, the Sen's Slope Estimator and linear regression tests were used for the analysis. The obtained results showed a significant increasing trends ($\alpha < 0.001$) and ($\alpha < 0.01$) in annual T_{max}, T_{min} and T_{mean} at all the considered locations. However, T_{min} increase faster than T_{max} with a slope of magnitudes ranging between 0.057 to 0.1°C year^{-1}. For RH_{mean}, a non-significant tendency of decrease was observed in Chott-Mariem station. However, significantly increasing trends were found for Kelibia and Tunis Carthage. Concerning the WS variable, a tendency of decrease is observed during the study period for all the stations. Nevertheless, the statistical analysis of decreasing tendency of wind speed varied from non-significant for Tunis Carthage to highly significant ($\alpha \leq 0.001$) at Chott-Mariem and Kelibia. Despite the highly significant upward trend of temperature, the temporal pattern of mean annual FAO56 PM-ET0, over the different stations, did not exhibit any significant trend except for Kelibia station.

Keywords: Trend analysis; Mann-Kendall Test; Sen's Slope Estimator; Linear regression; Climatic variables; FAO56 PM ET0; Tunisia.

Received
December 12, 2018

Accepted
March 29, 2019

Released
April 30, 2019

Full Text Article

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Introduction

Over the last century, atmospheric concentration of CO_2 has increased significantly which resulted in an increment by 0.74 °C of the average global temperature as compared with the preindustrial era (UNFCCC, 2007). In fact, an increasing trend of urban area has been detected worldwide over the last 50 years which results in a phenomenon called "urban heat islands" where the average temperature within an urban area can be several degrees warmer than the surrounding, undeveloped countryside (Crawley, 2008). In this context, trends in climate change is considered as an indisputable environmental issues (Gocic and Trajkovic, 2014), that have been identified not only in individual parameters, such as temperature or precipitation, but also in integrated parameters, like reference evapotranspiration (ET0) (Ma et al., 2017). Trend analysis of long term time series of climatic variables is a fundamental task in studies on climate change detection that has received a greater attention from scientists (Kumar et al., 2010; Tabari and Hosseinzadeh Talaee, 2011; Asfaw et al., 2018; Kamruzzaman et al., 2018).

Tabari et al. (2011b) studied the trends of the annual maximum, minimum and mean air temperatures and precipitation time series in the west, south and southwest of Iran for the period 1966–2005. They showed warming trend in annual Tmean, Tmax and Tmin at the majority of the stations. However, increasing and decreasing trends of the precipitation series over the region were observed. Kumar et al. (2016), investigated the temporal variation of trend in rainfall, temperature and potential evapotranspiration in the Giridih District in Jharkhand (India) for the period 1901-2002. Their results showed a significant upward trend for maximum and minimum temperature during winter season. Whereas, no significant trend was observed during monsoon and summer seasons. Hence rainfall is concerned, a significant decreasing trend was observed during the monsoon season with a slope value of 2.04 mm $year^{-1}$. Chaouche et al. (2010), analyzed the time series of annually and monthly temperature, rainfall and potential evapotranspiration to assess the climate variability in the western part of the French Mediterranean area. Their results revealed a significant increasing trend of annual mean temperature and potential evapotranspiration, while annual precipitation has not exhibited any trend. They also showed that, at monthly scale, a strong seasonal variability was observed for all the considered climatic variables.

Reference evapotranspiration is, an integrated climate parameter (Ma et al., 2017), widely used for irrigation scheduling, to enhance efficient use of water resources and sustainability of agro-ecosystem productivity as well as to protect the environment (Gocic and Trajkovic, 2014; Minacapilli et al., 2016). Different studies have shown that the FAO-Penman Monteith equation (FAO56-PM) can be used under different climatic weather. It is considered as the standard method for estimating reference evapotranspiration (ET_0) since it requires several daily measurements of climatic variables (Minacapilli et al., 2016). Thus, any change in meteorological variables due to climate change will affect evapotranspiration (Tabari et al., 2011a). Therefore, several studies have been conducted in order to assess the potential impact of climate change on reference evapotranspiration (Espadafor et al., 2011; Darshana et al., 2013; Pingale et al., 2016). According to climate change model predictions, reference evapotranspiration is presumed to increase in the next years on a par with temperature rise (Espadafor et al., 2011). The results obtained by Tabari et al. (2011a), on investigation of trends in annual, seasonal and monthly reference evapotranspiration in the western half of Iran during 1966-2005, also showed an increasing trend of annual ET0 over 70% of the stations, when using the non-parametric Mann-Kendall test, with a magnitude of significance varying from +11.28 to +2.30 mm year^{-1}.The authors attributed the main cause of increasing in ET0 to the increase in air temperature in the region. In addition, they revealed that, at seasonal scale, the increasing trend was greater in winter and summer than in spring and autumn seasons. Nevertheless, in trend analysis of potential evapotranspiration during 1961-2008 in China, Yin et al. (2010) detected a decreasing trend for the whole country and in most climate regions except for the cold temperate humid region in Northeast China. In addition, Xu et al. (2006) studied the spatial and temporal patterns of trend in reference evapotranspiration and pan evaporation in Changjiang (Yangtze River) catchment in China, at 150 meteorological stations, for the period 1960-2000. Their results showed a significant decrease in both reference evapotranspiration and pan evaporation for the whole catchment as a consequence of significantly decrease in the net total radiation and wind speed.

Trend analysis of long-term time series consists of the magnitude of trend and its statistical significance (Kumar et al., 2016). Many statistical techniques have been developed to detect trends in meteorological and hydrological time series. They can be classified as parametric and non-parametric tests (Zhang et al., 2006; Gocic and Trajkovic, 2014). Parametric trend tests are more powerful than non-parametric ones, but they require data to be independent and normally distributed (Shadmani et al., 2012). However, non-parametric trend tests are more suitable for non-normally distributed, outlier, censored and missing data, and require only that the data be independent (Asfaw et al., 2018). The Mann-Kendall Test, Sen's Slope Estimator and Spearman's Rho are examples of non-parametric tests that are eventually used to detect the trends in time series (Kumar et al., 2010; Shadmani et al., 2012; Gocic and Trajkovic, 2014; Wang et al., 2014; Pingale et al., 2016; Salami et al., 2016; Djaman et al., 2017; Jaiswal et al., 2018; Kamruzzaman et al., 2018).

A limited number of studies have been carried out on the temporal variability of meteorological data and reference evapotranspiration in Tunisia. Therefore, the objective of this study is to investigate the annual trends of different climatic variables and FAO-56 PM ET0 series over different locations in Tunisia for the period 1984-2007. The temporal variability of the time series were analyzed using the non-parametric Mann-Kendall test and the magnitude of the trend was determined based on the Sen's slope estimator and the linear regression method.

Materials and methods

Study area and data collection

Series of daily meteorological data of maximum (T_{max}) and minimum (T_{min}) air temperature, relative humidity (RH_{mean}) and wind speed (WS) were collected from 3 stations over different urban locations in Tunisia for the period 1984-2007. The sunshine duration data are available only for Chott-Mariem station. Due to the lack of this variable in Tunis Carthage and Kelibia stations, data relative to solar radiation were taken from POWER-NASA website (http://power.larc.nasa.gov/cgi-bin/agro.cgi?na). In fact, the suitability of the mentioned website to predict daily solar radiation was assessed in semi-arid region in Sicily, Italy, by Negm et al. (2017). However, for Chott-Mariem Station, solar radiation was estimated based on the Angstrom Formula:

$$SR = \left(a + b\frac{n}{N}\right) R_a \quad (1)$$

Where: Rs is the solar radiation (MJ m^{-2} day^{-1}), n is daily bright sunshine duration (h), N is maximum possible duration of sunshine or daylight hours (h), n/N is relative sunshine duration, Ra is extraterrestrial radiation (MJ m^{-2} day^{-1}), a and b are regression coefficients. The recommended values a = 0.25 and b = 0.50 proposed by Allen et al. (1998) were used in this study.

The geographical coordinates of the stations under study are summarized in Table 1.

Table 1. Geographical coordinates and data period of the selected stations

Locations	Latitude (°N)	Longitude (°E)	Altitude (m)
Tunis Carthage	36.51	10.23	4
Kelibia	36.50	11.50	30
Chott Mariem	35.50	10.34	15

Calculation of the reference evapotranspiration (ET0)

The FAO-56 Penman-Monteith Equation (FAO-56 PM) is recommended by the Food and Agriculture Organization of the United Nations (FAO), as standard equation for estimating ET0 (Allen et al., 1998). The method has been selected because it is physically based and explicitly incorporates both physiological and aerodynamic parameters (Xu et al., 2006):

$$ET_0 = \frac{0.408\,\Delta(Rn - G) + \gamma\left(\frac{900}{T_{mean} + 273}\right)u_2(e_s - e_a)}{\Delta + \gamma(1 + 0.34u_2)} \quad (2)$$

Where: ET0 is the reference evapotranspiration mm d^{-1}, Rn the net radiation at the crop surface MJ m^{-2} day^{-1}, G the soil heat flux density MJ m^{-2} day^{-1}, T_{mean} the mean daily air temperature at 2 m height (°C), u_2 is the wind speed at 2 m height (m s^{-1}), e_s the saturation vapour pressure (kPa), e_a the actual vapour pressure (kPa), Δ is the slope of vapor pressure curve (kPa°C^{-1}), γ (kPa°C^{-1}) is the air psychrometric constant.

For daily ET0 estimations, G can be neglected, as its magnitude is relatively small.

Temporal trend analysis

Mann-Kendall Test. The Mann-Kendall test is one of the widely used nonparametric tests to detect significant trends in time series in hydro-climatic variables (Espadafor et al., 2011; Mansour et al., 2017). Two main advantages are attributed to the Mann-

Kendall Test (Tabari et al., 2011b). First, it does not require the data to be normally distributed. Second, this test is low sensitive to abrupt breaks due to inhomogeneous time series. The related equations for computing the Mann-Kendall test statistic (S) and the standardized test statistic Z are as follows:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} \operatorname{sign}(y) \qquad (3)$$

$$\text{Where: } sign\ (y) = sign\ (x_j - x_i) = \begin{cases} +1 \text{ if } y > 0 \\ 0 \text{ if } y = 0 \\ -1 \text{ if } y < 0 \end{cases} \qquad (4)$$

Where: x_j and x_i are the annual values in years j and i (j > i), n is the length of the data set. It has been documented that when the number of observations is more than 10 (n ≥ 10), the statistic S is approximately normally distributed with the mean zero and a variance computed as:

$$\text{Var (S)} = \frac{n(n-1)(2n+5) - \sum_{i=1}^{m} t_i(t_i-1)(2t_i+5)}{18} \qquad (5)$$

Where: n is the number of data points, m is the number of tied groups (a tied group is a set of sample data having the same value), and t_i is the number of data points in the i^{th} group. The standardized test statistic Z is computed as follow:

$$Z = \begin{cases} \frac{S-1}{\sqrt{\text{Var (S)}}} & \text{if } S > 0 \\ 0 & \text{if } S = 0 \\ \frac{S+1}{\sqrt{\text{Var (S)}}} & \text{if } S < 0 \end{cases} \qquad (6)$$

Where: Z follows a normal distribution, a very high positive value of Z is an indicator of an increasing trend, and a very low negative value indicates a decreasing trend. When testing a trend at α level of significance, H_0 is rejected if the absolute value of Z is greater than $Z_{1-\alpha/2}$.

Sen's Slope Estimator. The non-parametric Sen's slope estimator, following the Mann-Kendall test, was employed to determine the magnitude of the slope of the trend in the time series (change per year of the trends) inthe hydro-climatic time series. Details of the method are available in (Tabari and Hosseinzadeh Talaee, 2011).

The Mann Kendall test and Sen's slope estimator calculations for various time series of climate variables and ET0 were performed using the Excel-based template MAKESENS 1.0, developed by researchers at the Finnish Meteorological Institute (Salmi et al., 2002).

Linear regression method. Simple linear regression as well as Mann-Kendall Test and Sen's Slope Estimator, is applied for identifying linear trend in a time series. The main statistical parameter obtained from the regression analysis is, the slope, indicates the mean temporal change of the studied variable. Positive values of the slope show increasing trend, while negative values of the slope indicate decreasing trend. The total change during the period under observation is obtained by multiplying the slope by the number of years (Tabari and Hosseinzadeh Talaee, 2011).

Results and discussion

Temperature trends

The main results of the non-parametric Mann–Kendall test, the Sen's slope estimator and linear regression applied to detect the annual trends in minimum, maximum, and mean air temperature over the considered locations for the period (1984-2007) are summarized in Table 2.

A clear warming trend for T_{mean}, T_{max}, and T_{min} annual values was detected for all the investigated stations. For Tmean, a high significant increasing trend was found ($\alpha \leq 0.001$) for all the stations. The magnitude of the significant increasing trend ranged between 0.05°C year^{-1} and 0.072°C year^{-1}, respectively for Chott Mariem and Kelibia station. In fact, the Sen's slope values of annual T_{mean} are of the same order of magnitude of that referred by (Wang et al., 2014) who found a slope value of annual trend in T_{mean} equal to 0.06°C year^{-1} in Hetao station (Northern China) for the period 1954-2012. These results are also in good agreement with those published by (Tabari et al., 2011a; Kamruzzaman et al., 2018), who found a significant upward trend in annual Tmean in 70% of the stations located in the western half of Iran and in different stations in the western part of Bangladesh respectively using the Mann-Kendall test.

Table 2. Statistical tests for annual minimum, maximum, and mean air temperature over the period 1984-2007.

Locations	First year	Last year	Test Z	Signific.	Sen's slope	b (°C/year)
T_{max}						
Kelibia	1984	2007	3.696	***	0.064	0.062
Tunis Carthage	1984	2007	2.803	**	0.056	0.050
Chott Mariem	1984	2007	2.928	**	0.045	0.044
T_{min}						
Kelibia	1984	2007	3.894	***	0.059	0.057
Tunis Carthage	1984	2007	4.390	***	0.106	0.111
Chott Mariem	1984	2007	3.101	**	0.057	0.056
T_{mean}						
Kelibia	1984	2007	3.944	***	0.062	0.059
Tunis Carthage	1984	2007	3.944	***	0.082	0.081
Chott Mariem	1984	2007	3.349	***	0.050	0.050

*** α=0.001 level of significance; ** α=0.01 level of significance.

For both Tmin and Tmax variables, the increase was statistically significant, with a significant level of at $\alpha \leq 0.001$ and $\alpha \leq 0.01$. The magnitudes of the significant increasing trends varies between 0.045 and 0.064°C year^{-1} and from 0.57 to 0.1°C year^{-1} for T_{max} and T_{min}, respectively. These values are of the same magnitude with those obtained with the linear regression method. A more detailed analysis evidenced that the increment of the minimum temperature is faster than the maximum. Similar results were obtained by Asfaw et al. (2018), Karl et al. (1993), and Wang et al. (2014), who found that the increasing trends in the T_{min} series were more pronounced than those in the T_{max} series. According to Soltani and Soltani (2008) and Tabari and Hosseinzadeh Talaee (2011), the warming trends in T_{min} and T_{max}, may refer to global warming and other probable reasons such as increased concentrations of anthropogenic greenhouse gases, increased urbanization and industrialization, aerosols which exert cooling effects on the climate increase in natural and anthropogenic clouds.

Relative humidity trends

The Mann-Kendall Test, Sen's Slope Estimator and linear regression were also applied to detect annual trends in RH for the stations under study during the period 1984-2007. The obtained results are summarized in Table 3.

Table 3. Statistical tests for annual Relative Humidity over the period 1984-2007.

Locations	First year	Last year	Test Z	Signific.	Sen's slope	b (%/year)
Kelibia	1984	2007	2.307	*	0.251	0.329
Tunis Carthage	1984	2007	1.811	+	0.311	0.359
Chott Mariem	1984	2007	-0.372	ns	-0.025	0.025

ns: non-significant; * α=0.05 level of significance; + α=0.1 level of significance.

A mix of positive and negative trends was identified when using the Mann-Kendall Test. A significantly increasing trends ($\alpha \leq 0.05$) and ($\alpha \leq 0.1$) were observed for Kelibia and Tunis Carthage stations, while a non-significant trend was detected at Chott Mariem station. The magnitude of the significant increasing trends is around 0.25 and 0.31%year^{-1} respectively for Kelibia and Tunis Carthage. Salami et al. (2016), observed a significant positive trend in annual relative humidity, using Mann-Kendall test, at Victoria Island Marine Station for the period 1992-2012. Nevertheless, these results are in disagreement with the findings of Djaman et al. (2017), Espadafor et al. (2011) and Ma et al. (2017), who found a significant decreasing trends in annual relative humidity when using Mann-Kendall Test, whereas, they revealed a positive trends at a specific seasonal scales. On the other hand, in the western half of Iran, the percentage of stations with a significant increasing trends in annual relative humidity are equal to the significant decreasing ones (Tabari et al., 2011a). However, for seasonal scale, the number of stations with significant positive trends is greater than those with significant negative trends except for winter season.

Wind speed trends

Mean values of wind speed have been analyzed for all stations under study using Mann-Kendall Test, Sen's Slope Estimator and linear regression. The obtained results are summarized in Table 4.

Table 4. Statistical tests for annual wind speed over the period 1984-2007.

Locations	First year	Last year	Test Z	Signific.	Sen's slope	b (m/s/year)
Kelibia	1984	2007	-4.539	***	-0.051	-0.049
Tunis Carthage	1984	2007	-0.571	ns	-0.012	-0.013
Chott Mariem	1984	2007	-4.093	***	-0.019	-0.018

ns: non-significant; *** α=0.001 level of significance

Among the study stations, Tunis Carthage did not exhibited any significant trend in term of annual wind speed. However, significant negative trends were detected for Kelibia and Chott-Mariem stations at $\alpha \leq 0.001$ significance level. The magnitude of decrease in annual wind speed were around (-0.5) and (-0.2) m s^{-1} $decade^{-1}$ for Kelibia and Chott-Mariem, respectively. The same magnitude of slope is achieved when using both Mann Kendall and linear regression methods. The negative trend of annual wind speed might be as a result of the rapid urbanization pressure increase in recent years. In fact, Weber and Puissant (2003), have located and quantified an increase of built-up areas of 13% in 10 years (1986_1996) in the periphery of the Metropolitan Area of Tunis. Considering Chott Mariem station, the achieved results are consistent with those recently published by Mansour et al. (2017) in investigation carried out at the same station for the period 1973-2007. The authors, revealed a significantly decreasing trend ($\alpha \leq 0.001$) in annual wind speed using Mann-Kendall Test. In addition, relatively similar results were obtained by Ma et al. (2017), who found a significantly decreasing trend in annual and seasonal wind speed, using Mann-Kendall Test, in investigation in 21 stations around the Songnen Grassland, Northeast China, during 1960-2014. Furthermore, Yin et al. (2010), observed a significantly decreasing trend in wind speed in most climate regions in China mainly distributed in West and North China, during the study period.

Solar radiation trends

The results of the application of the Mann-Kendall Test, Sen's Slope Estimator and linear regression tests for trend identification of annual solar radiation are summarized in Table 5.

Table 5. Statistical tests for annual solar radiation over the period 1984-2007,

Locations	First year	Last year	Test Z	Signific.	Sen's slope	b ($MJm^{-2}day^{-1}$ $year^{-1}$)
Kelibia	1984	2007	2.654	**	0.045	0.068
Tunis Carthage	1984	2007	1.315	ns	0.027	0.024
Chott Mariem	1984	2007	1.737	+	0.032	0.032

ns: non-significant; + α=0.1 level of significance; ** α=0.01 level of significance.

In general, positive trends were detected for all the considered stations. A significant upward trend was observed for Kelibia and Chott-Mariem stations with a significance level of ($\alpha \leq 0.01$) and ($\alpha \leq 0.1$), respectively, while, no significant positive trend was observer for Tunis Carthage station. The Sen's slope values are about 0.45 and 0.32 $MJm^{-2}day^{-1}decade^{-1}$, respectively for Kelibia and Chott-Mariem. Previous works also detected a clear linear increasing tendency of solar radiation as from 1980s, after a decrease during 1950-1980 (Wild, 2009; Espadafor et al., 2011) Moreover, for Chott-Mariem, the test Z value (1.74) is of the same magnitude of that inferred by Mansour et al. (2017), while a negligible difference was noticed between the two values related to the difference between the considered study periods.

Reference evapotranspiration trends

The trend analysis of annual reference evapotranspiration using the linear regression method are illustrated in Figure 1. Time series and linear trends of annual FAO-56 PM ET0 at all the considered stations.

The results of the used statistical tests on annual reference evapotranspiration are summarized in Table 6.

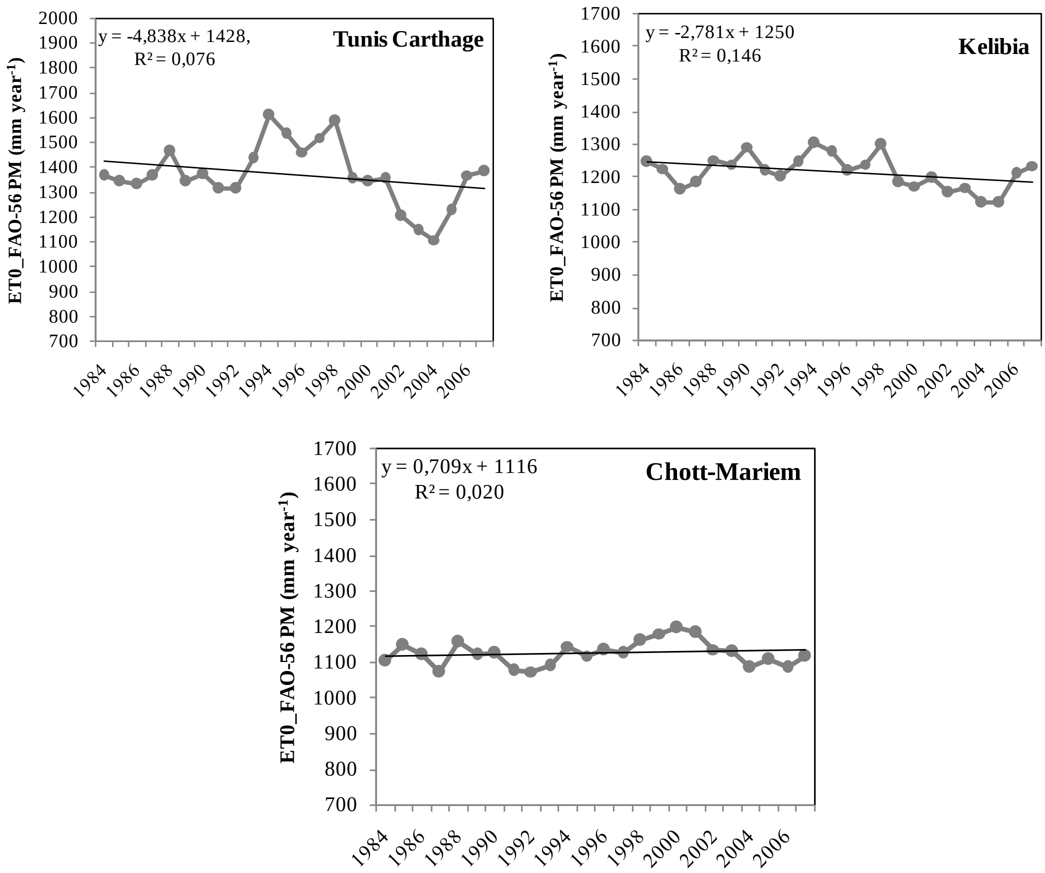

Figure 1. Time series and linear trends of annual FAO-56 PM ET0 at all the considered stations.

Table 6. Statistical tests for annual reference evapotranspiration over the period 1984-2007.

Locations	First year	Last year	Test Z	Signific.	Sen's slope	b (mm/year)
Kelibia	1984	2007	-1.811	+	-3.121	-2.781
Tunis Carthage	1984	2007	-0.769	ns	-3.182	-4.838
Chott Mariem	1984	2007	0.620	ns	0.683	0.709

ns: non-significant; + α=0.1 level of significance.

The Mann-Kendall Test showed a significantly decreasing trend ($\alpha < 0.1$) for Kelibia Station with a slope of magnitude of -3.12 mm $year^{-1}$. Despite the increasing trend in annual temperature among all the investigated stations, no significant positive or negative trend was detected by the non-parametric Mann-Kendall Test in annual ET0 for Tunis Carthage and Chott-Mariem Stations. These results are consistent with those obtained by Gocic and Trajkovic (2014) and De La Casa and Ovando (2016) who investigated trend analysis of reference evapotranspiration, over 21 stations in Serbia and in the Central Region of Argentina, respectively. The authors found that, according to Mann-Kendall Test, 41.67% among all the studied stations in Serbia, and more than 91% of the central region of Argentina didn't exhibited any significant annual trends in term of ET0. On the other hand, ET0 has been shown to increase in different locations throughout the world (Chaouche et al., 2010; Espadafor et al., 2011; Tabari et al., 2011a). In contrast to the expected upward trend in reference evapotranspiration as a consequence of temperature rise, significant decreasing trend in reference evapotranspiration were detected in different regions (Roderick et al., 2004; Chen et al., 2005; Xu et al., 2006; Yin et al., 2010; Darshana et al., 2013).

According to Irmak et al. (2012), there is no scientific common findings about which meteorological variable(s) mainly responsible on the general decrease in ET0 and that the trend and magnitude of reference evapotranspiration cannot be influenced by only one or two climatic variables. Thus, they all need be collectively accounted for in a combination-based energy balance equations when used in climate change study. Xu et al. (2006), showed that the decrease in ET0 is due to the decreasing trend is the net total radiation followed by wind speed. Chattopadhyay and Hulme (1997), in investigation over the Indian region, indicated that both pan evaporation (Epan) and ET0 have decreased and that increases in relative humidity and decreases in radiation were correlated with the decreasing trend in ET0. In addition, Irmak et al. (2012), suggest that decrease in ET0 is mainly due to significant increase in precipitation that results in significant reduction in Rs and Rn. Furthermore, the authors revealed that decreasing trend in wind speed would generate a decreasing trend in ET0 under the assumption that the other meteorological variables that drive ET0 remain constant.

Conclusion

Trend analysis of climatic variables and reference evapotranspiration were analyzed using the Mann-Kendall test, the Sen's slope estimator and linear regression method for three climatic stations in Tunisia during 1984-2007. At an annual time scale, the trend tests showed a statistically significant increase in Tmean, Tmax and Tmin in all the analyzed locations. In addition, significantly decreasing trends of wind speed series were observed for Kelibia and Chott-Mariem stations as a result of the rapid urbanization. Moreover, significant increasing trends were detected in term of solar radiations for both Kelibia and Chott-Mariem stations. The results also revealed that, except for Kelibia, there were no significant upward or downward trends in the annual FAO-56 PM ET0.

The observed behavior of ET0 trend could be justified by the antagonist effect between the aerodynamic and energetic components of evapotranspiration term. Thus, it can be inferred from the results that the trend and magnitude of reference evapotranspiration cannot be defined by the effect of single climatic variables and that it resulted from the combined effect of each parameter.

The results of the study, suggest the need for more detailed analysis on the effect of climate change on climatic variables and reference evapotranspiration at different time scales and to investigate the sensitivity of reference evapotranspiration to each climatic variables in time and space. Finally, for agricultural purposes, these results are to be considered only for urban agriculture since the stations under study are placed in urban areas.

Conflict of interest

The authors declare that there are no conflicts of interest.

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