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The Study of Climate Change Using Statistical Analysis Najaf City as Case Study

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Abstract **Original Research Article**

Climate change means any significant long-term change in the weathering rate (which can include temperature, wind conditions and rainfall) that occurs in a particular area. Changes can occur due to the dynamic processes of the Earth, external forces and human activities. A study was carried out to identify trends in mean temperature (maximum and minimum), air temperature, and relative humidity time series of weather station covering a period of 50 years in Najaf city south-west of Iraq. To determine a strong relationship between two variables between years and months of mean temperature (maximum and minimum), air temperature, and relative humidity forecasting the parameters, which were statistically measured by Pearson's Correlation coefficients(r) using SPSS program. Also, the variables are plotted. Variables and Regression equations were considered for analysis 12 a month basis. The results show that mean minimum temperature have increased month to month, but month July the trend increased more than before up to the maximum value (0.04). While relative humidity trends have decreased by a value except for November.
Keywords: Change climatic, Relative humidity, Temperature, SPSS.

INTRODUCTION

Several types of adverse impacts of climate change in global and Asian context are seen in various parts of our life.in general, categorized in the following: water, health, agriculture, forestry, biodiversity, economy. The Intergovernmental Panel on Climate Change (IPCC) was established jointly by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to provide an authoritative international statement of scientific understanding of climate change. Four Assessment Report and many hundreds of international experts assess climate change [1-4]. The analysis by [5] using station metadata and improved areal coverage for much of the Southern Hemisphere landmass, which indicates the diurnal temperature range (DTR) is continuing to decrease in most parts of the world. In addition, Atmospheric aerosol loading is much less than that in the Northern Hemisphere due to a number of factors, such as increases in cloudiness. Considerable future climatic changes in Australia indicate increases in annual average temperatures of (0.4–2.0°C) by 2030 and (1.0–6.0°C) by 2070, but uncertainty remains as to future changes in El Niño Southern Oscillation events, rainfall, and tropical cyclone activity [6]. This study purposes to estimate the impacts of climate change on humidity, rainfall, and temperature extreme climate events are widely reported in local media. The climate of Arab countries (such as Saudi Arabia 52°C and Kuwait 52.6 °C) will experience surpassing extremes, where temperatures will reach new highs, less rainfall, and water availability will be reduced with a growing population.

Therefore, the already region may not have sufficient supplies to provide drinking; water irrigates crops, support industry [7]. For investigating in the potential result of climate change, based on an internally consistent set of climatological relationships that has been build that a plausible and often simplified representation of the future climate [8]. Also, the study can serve the present and future on Iraq general Najaf city particularly and as a resource for researchers to begin to assess climate risks.

Study area

Najaf city (Figure 1), is located in the south-west part of Iraq, between Kuwait and Saudia, lies within 30° 50′ 00″ to 32° 25′ 00″N and longitudes 42° 20′ 00″ to 44° 30′ 00″E with a total area of (28824) Km2 and current population 1,221,248(2011) with administrative divisions consist of three districts: Najaf, Kufa, and Manatharah. Monthly and quarterly temperatures vary due to the variation in the amount of solar radiation reaching the surface. Temperatures reach extreme, where the highest and lowest temperatures levels (44.4 °C) and (28.9°C) respectively in summer. While the lowest and highest temperature levels (16.2°C) and (5.5 °C), respectively in winter. Relative humidity is reduced in the

hot summer months, with a significant increase from November (55%) to January (69%). Najaf receives small amounts, varying and fluctuating rainfall. Fall during the short winter months, while the hot summer months dry no rain.

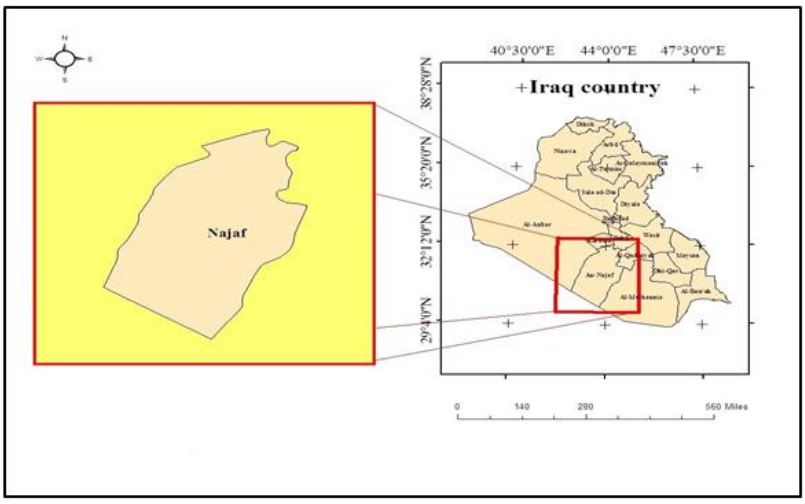

Fig-1: Study Area

METHODOLOGY

Collection Data

Time series of monthly mean temperature (maximum and minimum), air temperature, and relative humidity from weather station which located on (32.010486N, 44.327135E) covering a period of 50 years (1963–2013) were analyzed for this study. This data was provided by the Najaf meteorological. The temperature data was in degrees Celsius, and humidity as a percentage.

Statistical Process (Correlation, Regression, and Roughness coefficient)

This section covering the nature of the statistical relation between years and months of mean temperature (maximum and minimum), air temperature, and relative humidity forecasting the parameters

To find the relation between two parameters two main processes: correlations and regression (linear relationships) are observed in the data that used.

Correlation (r)

The correlation process coverage primarily on an association to establish any effect and cause. There are several types of correlation coefficient: Pearson's correlation, Spearman rank, and Kendell rank correlation. this study Pearson's correlation was used ,that it is ranged from ($-1 \leq r \geq +1$), as shown following formula:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (1)$$

Where:

n: element of the time series.

$\sum x$: is the sum symbol l (x_1, x_2, x_3,……..).

$\sum y$: is the sum symbol 2 (y_1, y_2, y_3,……..).

Regression

Regression models that consider the relationship of a replied parameter which is determined by one independent variable. There are two types of regression: simple, and multiple, where done use in this study simple Regression. Simple Regression the relationship between a couple of variables that show in a data set, as shown following formula:

$$Y = \beta_0 + \beta_1 X \quad (2)$$

The above equation found linear regression between, the time series X, and climate variable Y (temperature or humidity or rainfall) for the specified study time period. Considering X as an independent and Y dependent variable, regression coefficient 'β_1' and the regression constant 'β_0' estimation have according to[9].

Coefficient of Determination (R^2)

Coefficient of Determination is used as a evidence to measure the precision of the model. Also, predicts future outcomes [10].

$$R^2 = r^2 \quad (3)$$

Where:

r^2: Square correlation coefficient.

Roughness Coefficient (RC)

Time series is a group of time opinion taken in accordance to with the natural demand, where the smooth out to see a clearer signal and doesn't provide us with a model. In addition, it can be a good first phase to describing a various complex of the series [11], as shown following formula.

$$RC = \frac{\sum_{t=2}^{n}(X_t - X_{t-1})^2}{\sum_{t=2}^{n}(X_t - \bar{X})^2} \quad (4)$$

Where:

X_t: is the opinion of this series.

$\bar{X}$: is the average of time series.

Note: If the roughness coefficient is less, the data is smooth.

RESULTS

First, we tested the time series if it was rough or smooth. Roughness coefficients were calculated by using formula (4). All values in the Table (1) are small so that the time series is smooth.

Table-1: Roughness coefficient for months of mean temperature (maximum and minimum), air temperature, and relative humidity

Roughness coefficient for period 1963-2013											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
		1.06	0.77	3.5	0.87	0.59	1.13	1.8		0.88	1.33

Temperature

Mean temperature for each a month of the year (maximum and minimum) air temperature, and relative humidity time series have been plotted by using SPSS program, and the linear trends observed were represented graphically for station with respect to their mean of 50 years (1963–2013). Figures (2-8) have been selected from 12, which represent a mean minimum temperature for the months (March, April, May, June, July, August, and December), Figure (9) represent air temperature for the month of December, and Figures (10-13) represent relative humidity for the months (June, July, September, and November).

In order to measure the strength of association between years and mean temperature (maximum and minimum), air temperature, and relative humidity, Pearson product-moment correlation coefficient has been shown in Table (2) by using formula No. (1) for Najaf city for the period (2063 to 2013).

The regression equations and the coefficient of determination (R^2) which have been determined by statistical technique (ordinary least squares method) have been placed in Table (2).

The results are shown in Table (3), the mean minimum temperature in Najaf city is expected to increase to (13.17,19.05,24.26,28.20,30.78,30.56,9.54 °C respectively) for a month (March, April, May, June, July, August, and December) by 2019, while mean minimum temperature is expected to increase to (13.25,19.09,24.32,28.25,30.82,30.63,9.63 °C respectively) for a month (March, April, May, June, July, August, and December)by 2020. This expectation is close to that of [3] (the amount of the global average surface temperature has increased by 0.6 ± 0.2°C).

Table-2: Show regression equations and the coefficient of determination (R^2)

Month	Formula		r	R^2
Jan				
Feb				
Mar	Mean min. temperature	Y= -152.384+0.082X	0.864	0.747
Apr	Mean min. temperature	Y= -63.723+0.041X	0.700	0.490
May	Mean min. temperature	Y= -90.815+0.057X	0.825	0.681
Jun	Mean min. temperature	Y= -84.861+0.056X	0.900	0.810
	Humidity	Y= -265.513+0.146X	0.735	0.540
Jul	Mean min. temperature	Y= -60.075+0.045X	0.933	0.871
	Humidity	Y= -195.840+0.109X	0.927	0.860
Aug	Mean min. temperature	Y= -112.782+0.071X	0.839	0.704
Sep	Humidity	Y= -241.793+0.134X	0.759	0.576
Oct				
Nov	Humidity	Y= -494.280+0.274X	0.828	0.686
Dec	air temperature	Y= -88.619+0.051X	0.703	0.494
	Mean min. temperature	Y= -164.085+0.086X	0.833	0.780

Table3: Show prediction of monthly for minimum temperature in (ºC), air temperature in (ºC), and relative humidity in (%)

Month		2019	2020
Jan			
Feb			
Mar	Mean min. temperature	13.17	13.25
Apr	Mean min. temperature	19.05	19.09
May	Mean min. temperature	24.26	24.32
Jun	Mean min. temperature	28.20	28.25
	Humidity	29.26	29.40
Jul	Mean min. temperature	30.78	30.82
	Humidity	24.23	24.34
Aug	Mean min. temperature	30.56	30.63
Sep	Humidity	28.75	28.88
Oct			
Nov	Humidity	58.92	59.2
Dec	air temperature	14.35	14.40
	Mean min. temperature	9.54	9.63

DISCUSSION

The resultant indicates how strong the correlation in mean minimum temperature, air temperature, relative humidity, and whether it is increasing or decreasing as shown in Figures (2-13).

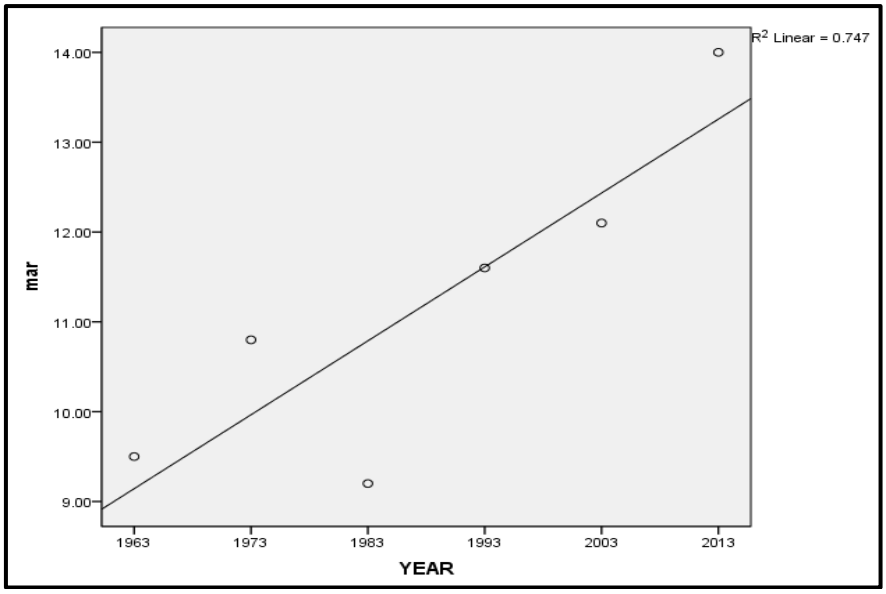

Fig-2: March

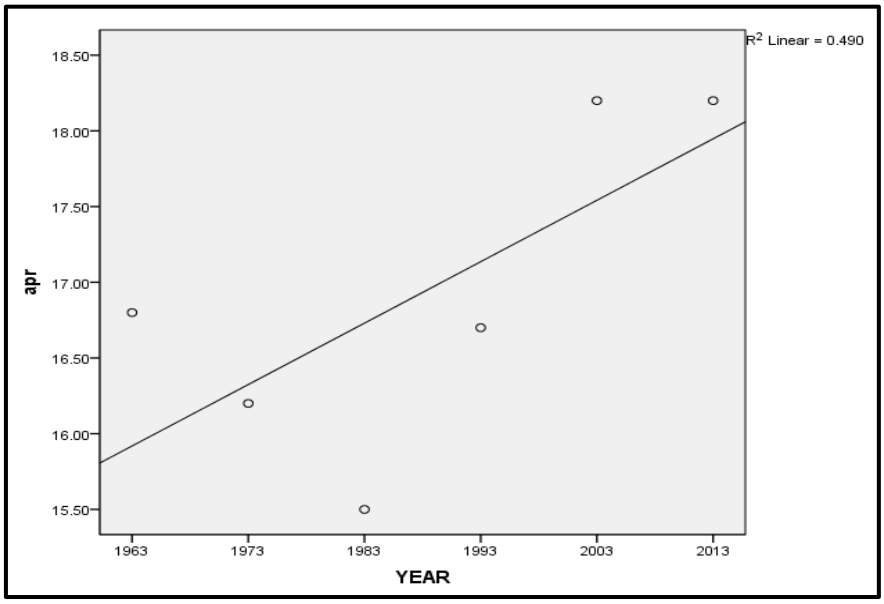

Fig-3: April

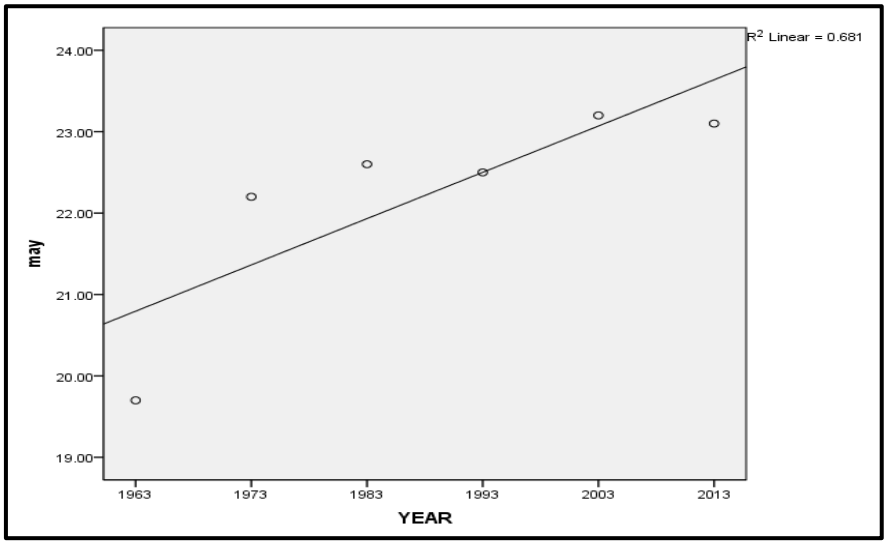

Fig-4: May

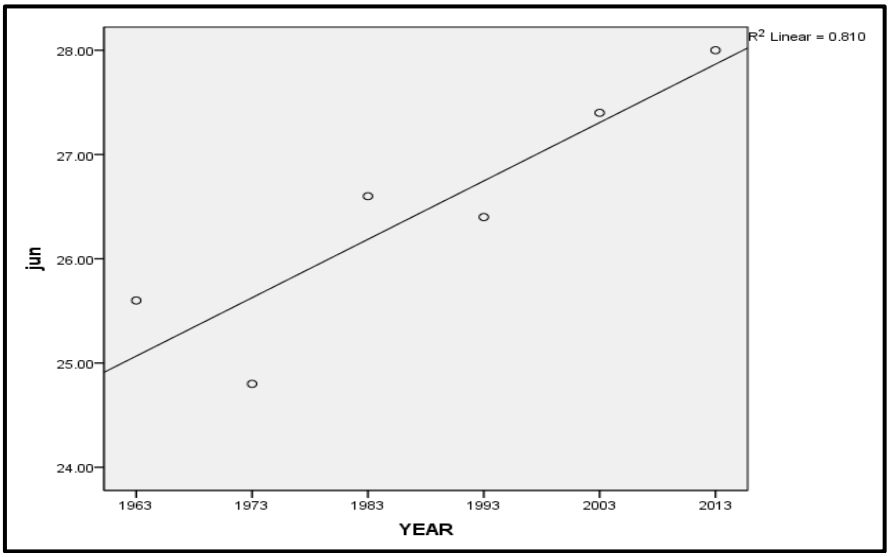

Fig-5: June

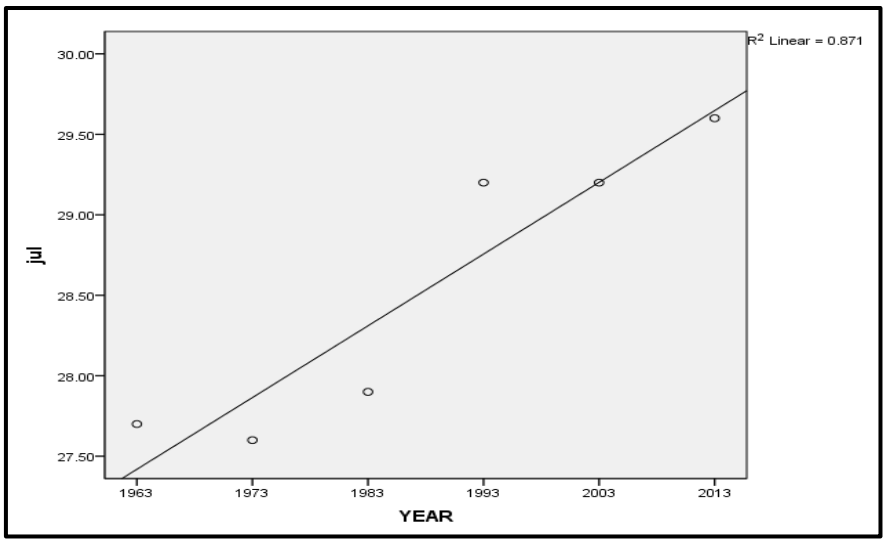

Fig-6: July

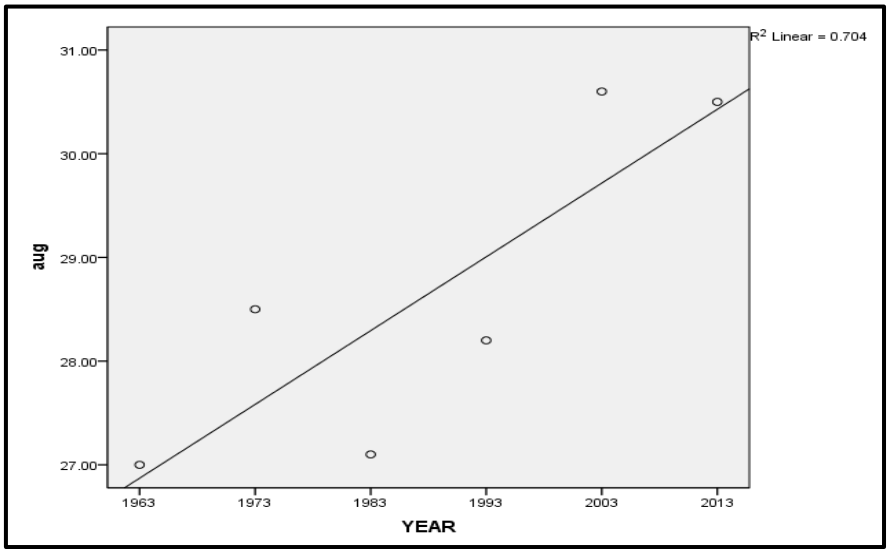

Fig-7: August

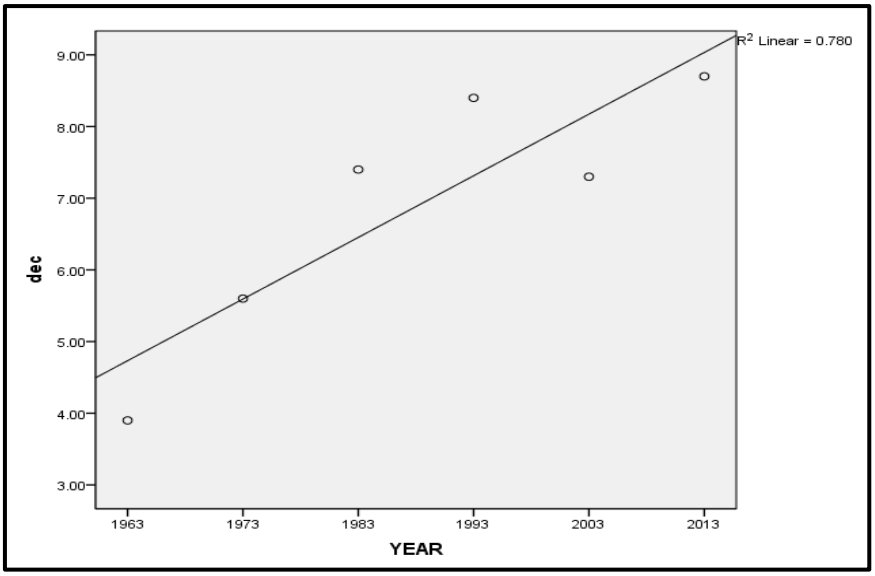

Fig-8: December

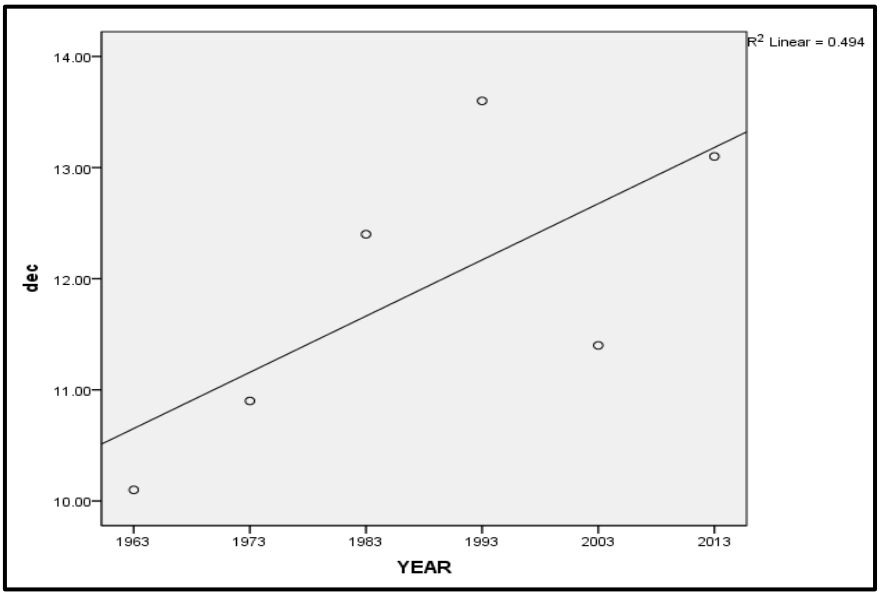

Fig-9: December

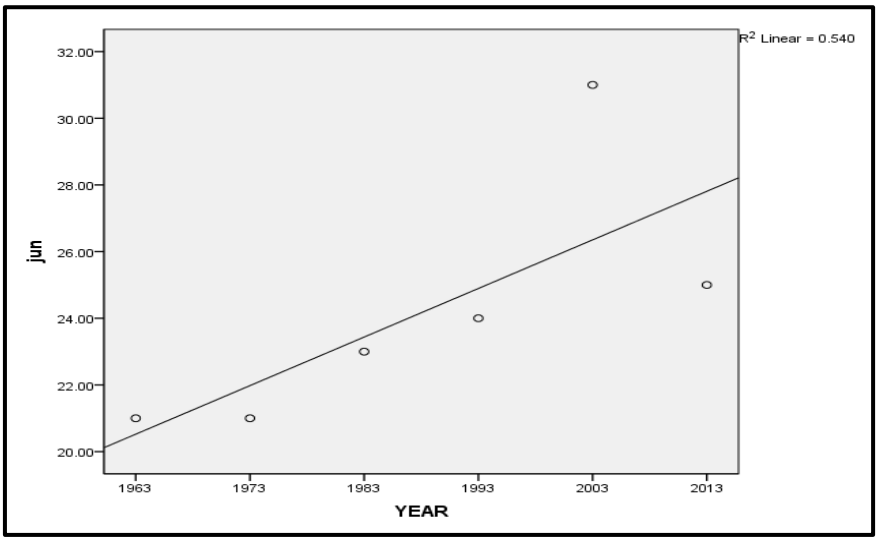

Fig-10: June

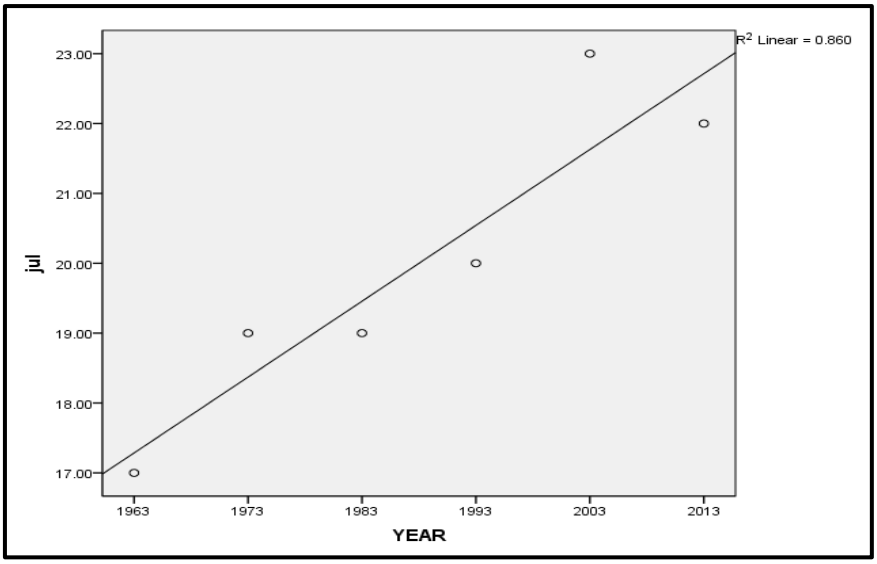

Fig-11: July

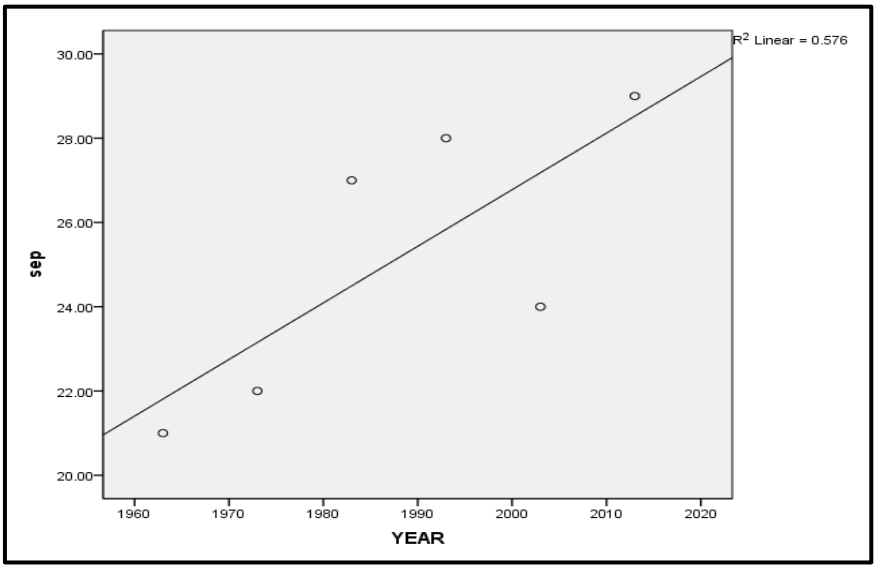

Fig-12: September

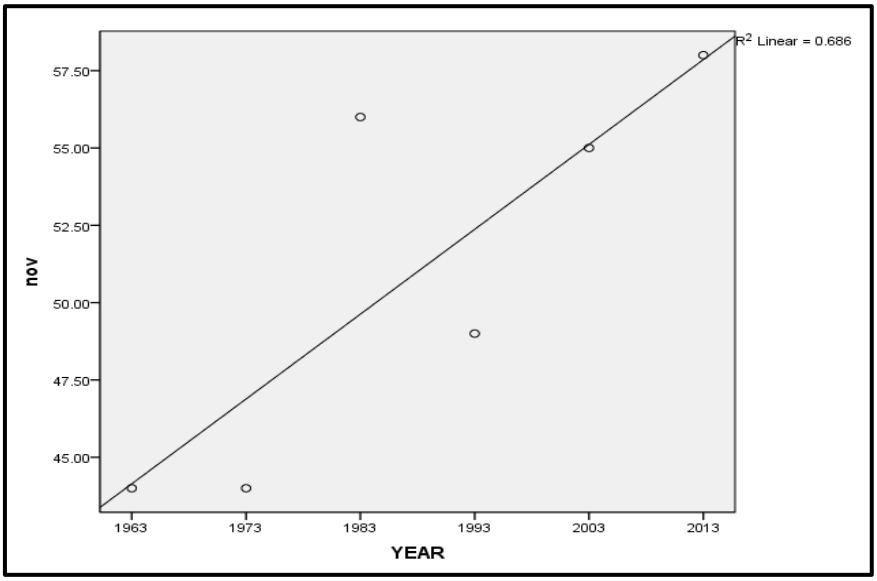

Fig-13: November

Figures (2,3,4,5,6,7,8) represents variations of the mean minimum temperature for the months (March, April, May, June, July, August, and December), with predicted value to 2019 and 2020, it is clear that the trend is increased from month to month by a rate of (0.08,0.04,0.6,0.05,0.04,0.7,0.09 °C), Fig(9) represents variation of the air temperature for the month of December, with predicted value to 2019 and 2020, it is clear that the trend is increased from month to month by a rate of (0.05 °C), Fig(10,11,12,13) represents variations of the mean minimum temperature for the months(June, July, September, and November), with predicted value to 2019 and 2020, it is clear that the trend is increased from month to month by a rate of (0.14,0.11,0.13,0.1 °C). This value is less than that presented by [4] (the global average temperature has increased by approximately 0.74 ± 0.18°C, over the past 100 years). the global temperature mainly rely on how much energy the earth receives from the Sun and the amount of energy radiated by the earth depends significantly on the chemical a composition of the atmosphere.

CONCLUSION

In this study, the trends of the mean minimum temperature, air temperature, and relative humidity time series were tested in the city of Najaf for a period of 50 years (1963 to 2013). The time series had been examined and found to be smooth. The slope of the regression line was increasing gradually. In March, the trend line has a small value (0.08), in April the trend increased more than before (0.04) and so on, but in July the trend increased more than before up to maximum value (0.04), after that the trend values in December decreased gradually, where for relative humidity, the trend decreased by a value except for November.

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