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

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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 ≤ r ≥ +1), as shown following formula:

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

Where:
- \( n \): element of the time series.
- \( \sum x \): is the sum symbol 1 (x₁, x₂, x₃,……..).
- \( \sum y \): is the sum symbol 2 (y₁, y₂, y₃,……..).

**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:

\[
    Y = \beta_0 + \beta_1 X
\]

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 ‘\( \beta_1 \)’ and the regression constant ‘\( \beta_0 \)’ estimation have according to[9].
**Coefficient of Determination (R²)**

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

\[ R^2 = r^2 \]  

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.

\[ RC = \frac{\sum_{t=2}^{n}(X_t - \bar{X})^2}{\sum_{t=2}^{n}(X_t - \bar{X})^2} \]  

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**

<table>
<thead>
<tr>
<th></th>
<th>Roughness coefficient for period 1963-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jan</td>
</tr>
<tr>
<td>Temperature</td>
<td>1.06</td>
</tr>
</tbody>
</table>

**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 (R²) 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 (R²)

<table>
<thead>
<tr>
<th>Month</th>
<th>Formula</th>
<th>r</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>Mean min. temperature, Y = -152.384 + 0.082X</td>
<td>0.864</td>
<td>0.747</td>
</tr>
<tr>
<td>Feb</td>
<td>Mean min. temperature, Y = -63.723 + 0.041X</td>
<td>0.700</td>
<td>0.490</td>
</tr>
<tr>
<td>Mar</td>
<td>Mean min. temperature, Y = -90.815 + 0.057X</td>
<td>0.825</td>
<td>0.681</td>
</tr>
<tr>
<td>Apr</td>
<td>Mean min. temperature, Y = -84.861 + 0.056X</td>
<td>0.900</td>
<td>0.810</td>
</tr>
<tr>
<td>May</td>
<td>Mean min. temperature, Y = -63.723 + 0.041X</td>
<td>0.700</td>
<td>0.490</td>
</tr>
<tr>
<td>Jun</td>
<td>Mean min. temperature, Y = -265.513 + 0.146X</td>
<td>0.735</td>
<td>0.540</td>
</tr>
<tr>
<td>Jul</td>
<td>Mean min. temperature, Y = -60.075 + 0.045X</td>
<td>0.933</td>
<td>0.871</td>
</tr>
<tr>
<td>Aug</td>
<td>Mean min. temperature, Y = -112.782 + 0.071X</td>
<td>0.839</td>
<td>0.704</td>
</tr>
<tr>
<td>Sep</td>
<td>Mean min. temperature, Y = -241.793 + 0.134X</td>
<td>0.759</td>
<td>0.576</td>
</tr>
<tr>
<td>Oct</td>
<td>Humidity, Y = -494.280 + 0.274X</td>
<td>0.828</td>
<td>0.686</td>
</tr>
<tr>
<td>Nov</td>
<td>Humidity, Y = -88.619 + 0.051X</td>
<td>0.703</td>
<td>0.494</td>
</tr>
<tr>
<td>Dec</td>
<td>Mean min. temperature, Y = -164.085 + 0.086X</td>
<td>0.833</td>
<td>0.780</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Month</th>
<th>2019</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mar</td>
<td>13.17</td>
<td>13.25</td>
</tr>
<tr>
<td>Apr</td>
<td>19.05</td>
<td>19.09</td>
</tr>
<tr>
<td>May</td>
<td>24.26</td>
<td>24.32</td>
</tr>
<tr>
<td>Jun</td>
<td>28.20</td>
<td>28.25</td>
</tr>
<tr>
<td>Jul</td>
<td>29.26</td>
<td>29.40</td>
</tr>
<tr>
<td>Aug</td>
<td>30.56</td>
<td>30.63</td>
</tr>
<tr>
<td>Sep</td>
<td>28.75</td>
<td>28.88</td>
</tr>
<tr>
<td>Oct</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nov</td>
<td>58.92</td>
<td>59.2</td>
</tr>
<tr>
<td>Dec</td>
<td>14.35</td>
<td>14.40</td>
</tr>
<tr>
<td></td>
<td>9.54</td>
<td>9.63</td>
</tr>
</tbody>
</table>

**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-4: May

Fig-5: June

Fig-6: July

Fig-7: August
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, 0.05, 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 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.

REFERENCES