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Study on Imapct of Coimbatore Climate

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Abstract: Coimbatore is always known for its equable climate condition. The main aim of this study is to detect the climatic changes in Coimbatore for the past 19 years (2000-2018) have an impact within the city. The estimation of temperature in Coimbatore is humid in comparison to past years. Coimbatore temperature will increased in the upcoming years. The research done in this study will help to detect the climatic changes going to occur. This study carried out to describe the temperature and wind speed time series from the online resources wrapping the past 19 years (2000-2019) records. The annual changes of mean temperature for 12 months over the years are represented graphically. Computing Roughness coefficients (RC) for average of temperature and wind speed. The Pearson's correlation between temperature and wind speed using 12 months average over years. The parameter of temperature and wind speed for 12 months average over years is analyzed using regression. Also, the regression analysis is predicted for the succeeding years.

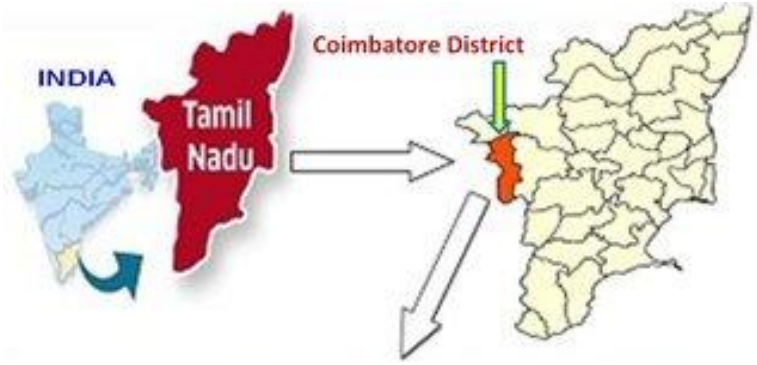
Keywords: Climate change, Trend, Time series, Regression, Predictions

I. Introduction

Coimbatore which is also known as kovai has a salubrious climate. This place has moderate summer and mild winter. Due to the North East and the South West monsoons Coimbatore is recorded for rainfall more than other cities. This makes it to be cooler and a pleasant climate. However, now a day the temperature is increasing in Coimbatore due to urbanization and deforestation. The pleasant weather in the past years may turn into a hot weather.

II. Study of the Area:

Coimbatore is situated in Tamil Nadu, southern part of India of latitude of 11.0168° N and longitude of 76.9558° E.



III. Methodology and Data:

Time series of monthly mean temperature, annual mean temperature and annual mean humidity from www.weatheronline.com .the data covers about 19 years from 2000 to 2018.

3.1 Data Sources

Time series of monthly and annual mean temperature and annual mean wind speed from weather online Ltd. Metrological services which is located in 483 Green Lanes London, N13 4BS, United Kingdom and Metroblue Ltd which is located in metroblue AG, PO Box 39, CH-4005 Basel, Switzerland.

3.2 Time Series and Roughness Coefficient:

The natural order time series views are taken in accordance. Smoothing will be usually done to help us to see patterns in a time series in a better way. This will lead to smoothen the irregular roughness to view a

clearer signal. At first we have examine the time series roughness scale by computing the Roughness coefficient (RC).

$$\text{RC} = \frac{\sum_{t=2}^{n}(x_t - x_{t-1})^2}{\sum_{t=2}^{n}(x_t - \bar{x})^2}$$

$x_1, x_2, \ldots, x_n$ are the views of this series, is the average of time series elements, and n is the number of time series elements. The lesser the coefficient, the more smooth the data is. If not, we smooth the time series by using a moving average.

3.3 Roughness coefficient from 2000 to 2018:

Table: 1

Month	RC
January	4.2
February	2.7
March	33.9
April	19.6
May	19.6
June	5.6
July	14.1
August	372.2
September	178.3
October	188.3
November	65.1
December	185.6
Mean annual temperature	85.9
Mean annual wind speed	95.6

3.4 Ordinary Least Square:

Ordinary least squares is a technique is used in statistics that uses sample data to estimate the true population relationship between two variables. The following approach has been adopted to perform the analysis,

$$y_i = a + bx \text{ (i = 1,2,3,…n)}$$

Here the equation mentioned above is describing the linear regression between the time series and climate variable (Temperature or Wind speed) for the specified time period of 2000-2018.

Considering as independent and dependent variable, regression coefficient 'b' and the regression constant 'a' of least-squares estimation have been calculated respectively by using the following relations.

$$\sum y = Na + b\sum x$$
$$\sum xy = a\sum x + b\sum x^2$$

3.5 Pearson's Coefficient of Correlation:

Pearson's correlation is denoted by '**r**' correlation coefficient commonly used in linear regression.

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

Here, i = 1,2,3,…n (Time series)

x = Monthly mean temperature

y = Monthly mean wind speed.

The calculation is done for temperature and wind speed in the below Table : 2

x	y	xy	x^2	y^2
30.9	7.3	225.57	954.81	53.29
33.1	8.0	264.8	1095.61	64
35.3	8.5	300.05	1246.09	72.25
36.2	9.2	333.04	1310.44	84.64
34.4	12.8	440.32	1183.36	163.84

32.1	16.9	542.49	1030.41	285.61
31.6	17.3	546.68	998.56	299.29
31.7	15.9	504.03	1004.89	252.81
32.4	13.7	443.88	1049.76	187.69
31.6	8.7	268.6	998.56	72.25
30.0	5.7	171	900	32.49
29.8	6.7	199.66	888.04	44.89

The value of Pearson's Correlation is 0.09377 by using the above formula .This value shows there is no correlation between temperature and wind speed.

3.6 Coefficient of Derterminationn:

The coefficient of determination which is denoted by R^2 that indicates how well data points fit a line or curve using the data collected. There are many definitions for R^2. One of those definition is the squaring of correlation coefficient will be the coefficient of determination.

3.7 Result:

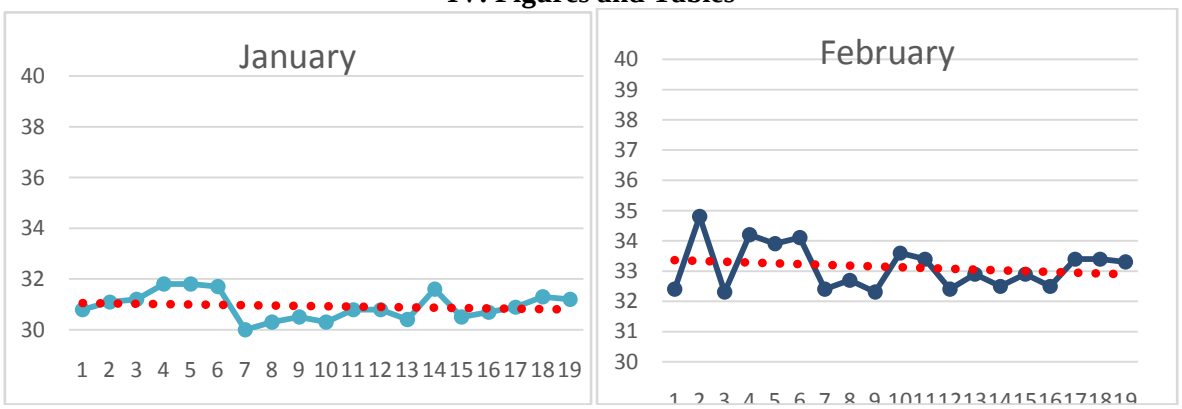
First, we examined the time series whether it was rough or smooth, Roughness coefficients were computed by using equation (1). Table (1) shows the results, all values in the table are small so that the time series is smooth and it is not necessary to smooth it.

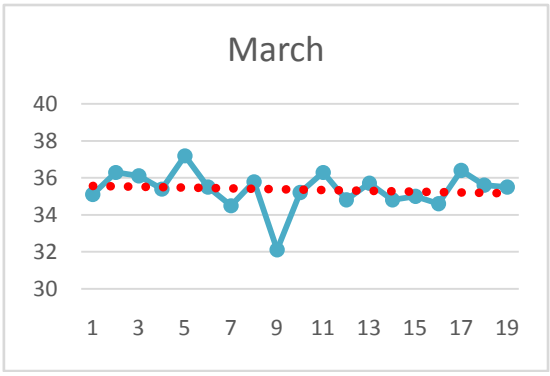
Table (1) indicates Roughness coefficient for monthly and annual mean temperature time series.

3.8 Temperature:

Annual mean temperature for each month of the year, plotted in MS Excel, and the linear trends observed were represented graphically for www.weatheronline.com with respect to their mean of 18 years (2000–2018). The graph shows the changes for mean temperature for 12 months (January 2000 - 2018, February2000 – 2018, March 2000 - 2018, April 2000 - 2018, May2000 -2018, June 2000-2018, July 2000-2018, August 2000-2018, September 2000-2018, October2000-2018, November2000-2018, December 2000-2018). The regression equation and the coefficient of determination (R^2) are determined by ordinary least squares method.

IV. Figures and Tables

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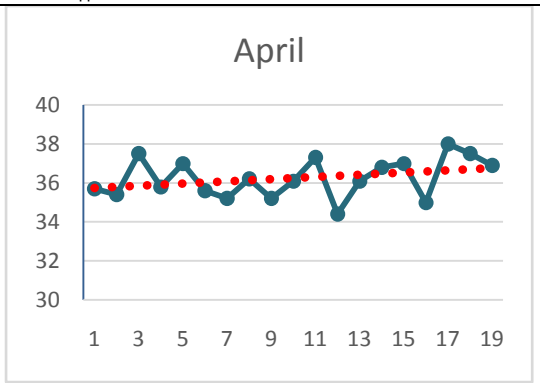
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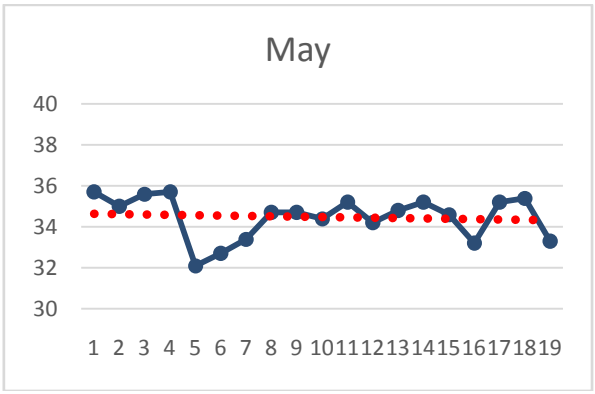
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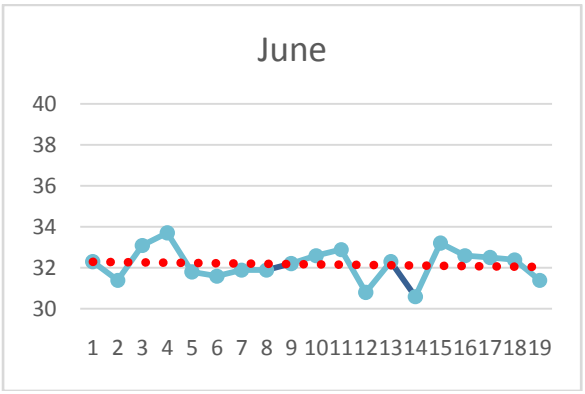
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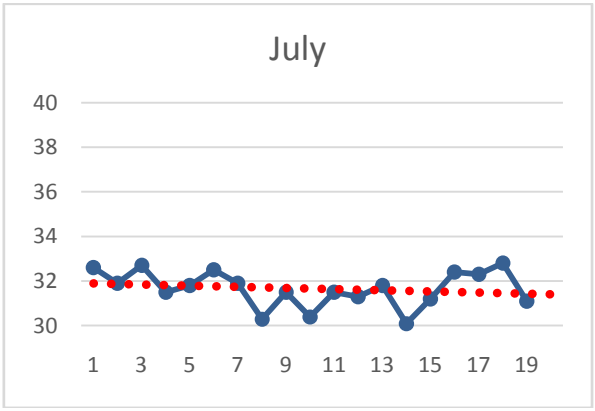
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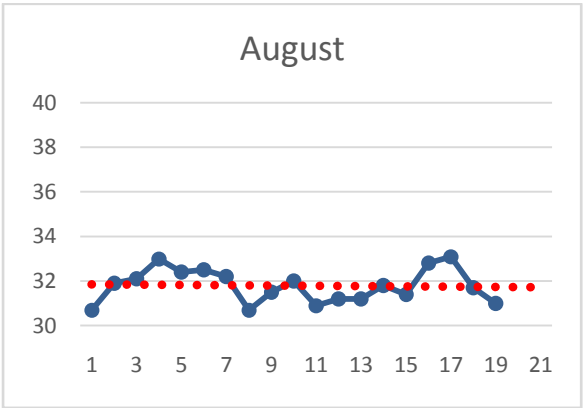
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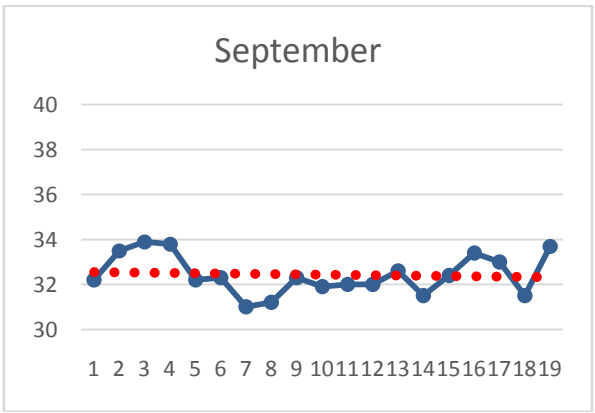
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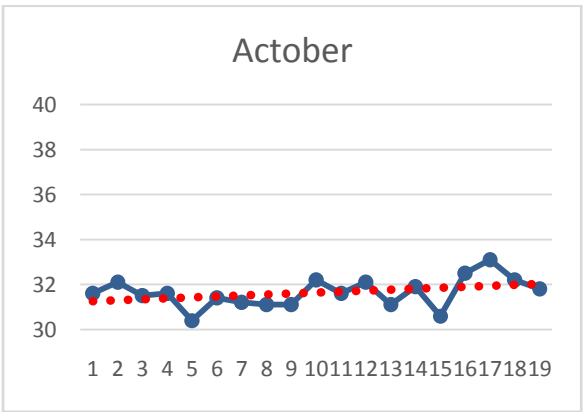
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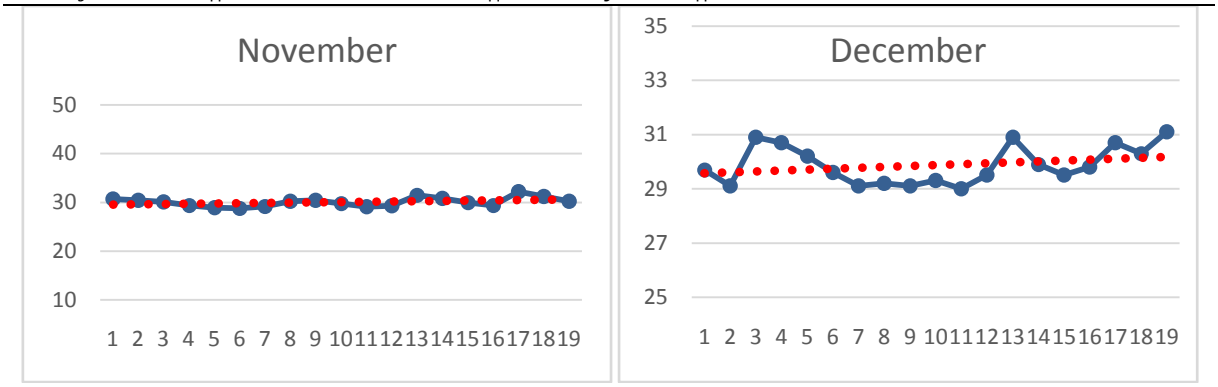


Table (4): Show the regression equation and coefficient of determination for wind speed

Table (2) Show the regression equation and coefficient of determination for temperature

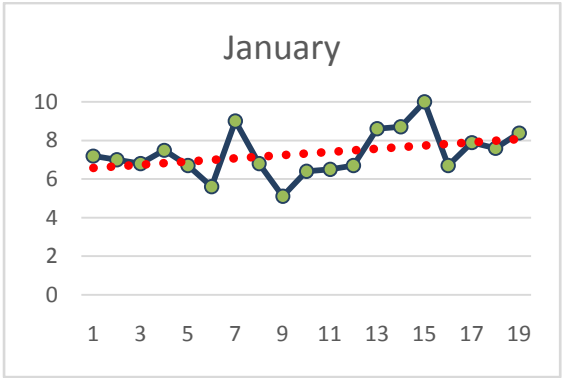
Months and annual	Formula number	Formula	Coefficient of determination
January	1	y= -0.01396x+58.98526	$R^{2=}$ 0.02073
February	2	y= -0.02423x+81.80452	$R^{2=}$ 0.03949
March	3	y = -0.02297x+81.51074	$R^{2=}$ 0.01416
April	4	y = 0.05308x-70.38193	$R^{2=}$ 0.10153
May	5	y = -0.01910x+72.6731	$R^{2=}$ 0.00867
June	6	y = -0.01439x+61.0698	$R^{2=}$ 0.01026
July	7	y = -0.02561x+83.1271	$R^{2=}$ 0.03201
August	8	y = -0.00614x+44.1307	$R^{2=}$ 0.00212
September	9	y = -0.01281x+58.1714	$R^{2=}$ 0.00660
October	10	y = 0.04281x-54.3624	$R^{2=}$ 0.013418
November	11	y = 0.05947x-89.3984	$R^{2=}$ 0.13190
December	12	y = 0.0333x-37.09298	$R^{2=}$ 0.07040

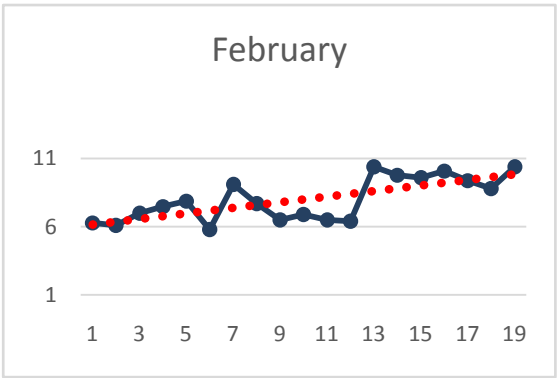
Table (3) show prediction of monthly temperature in (^{0}C)

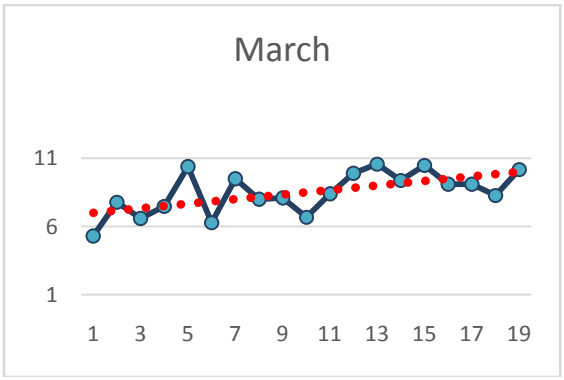
Years / Months	2019	2020	2021	2022
January	30.8000	30.78606	30.7721	30.7581
February	32.8841	32.85992	35.3821	32.8356
March	35.1343	35.11134	35.08837	35.0654
April	36.7865	36.83967	36.89275	36.9458
May	34.2919	34.2729	34.25389	34.2348
June	32.01639	32.002	31.9876	31.97322
July	31.41511	31.4097	31.3841	31.3382
August	31.73404	31.7279	31.7217	31.7156
September	32.30801	32.2952	32.2823	32.2695
October	32.70399	32.1138	32.1566	32.1994
November	30.67153	30.731	30.649	30.8499
December	30.13972	30.17302	30.2063	30.2396

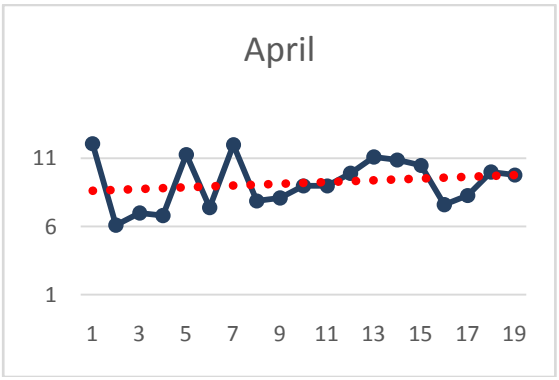
Wind Speed:

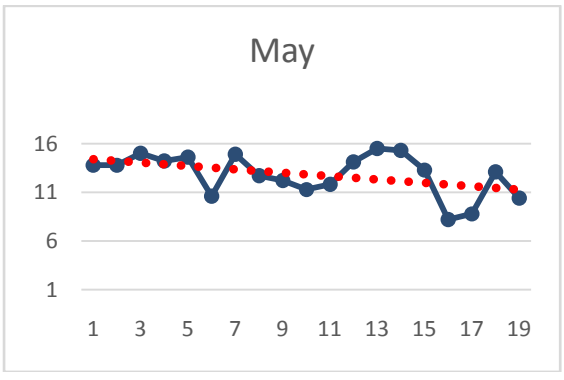
Annual mean wind speed for each month of the year, plotted in MS Excel, and the linear trends observed were represented graphically for www.weatheronline.com with respect to their mean of 18 years (2000–2018). The graph shows the changes for mean wind speed for 12 months (January2000 - 2018, February2000 – 2018, March 2000 - 2018, April 2000 - 2018, May2000 -2018, June2000-2018, July 2000-2018, August2000-2018, September2000-2018, October 2000-2018, November2000-2018, December2000-2018). The regression equations and the coefficient of determination (R^2) are have been determined by ordinary least squares method.

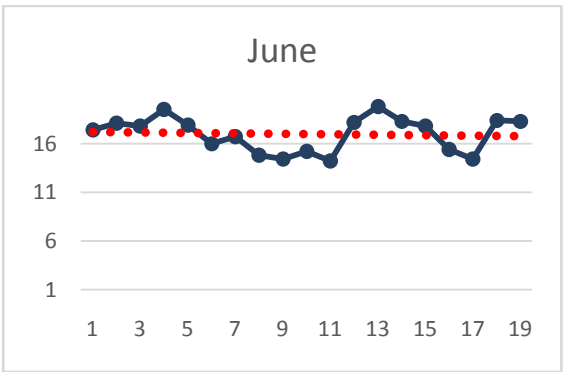


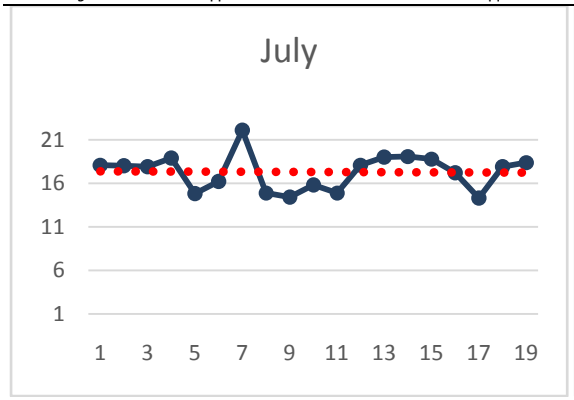


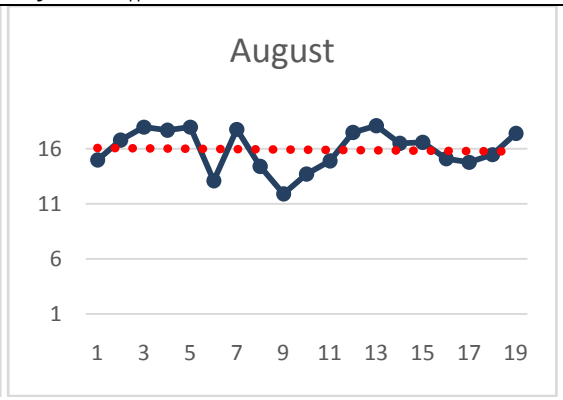


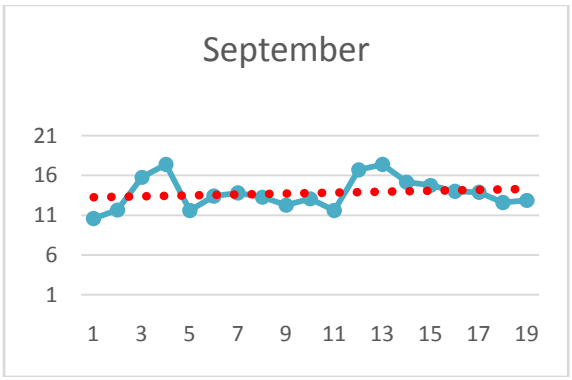


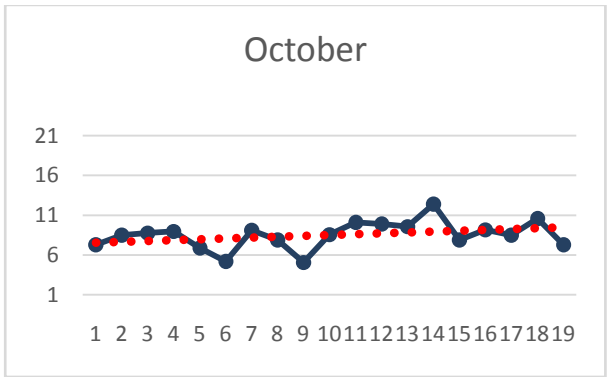


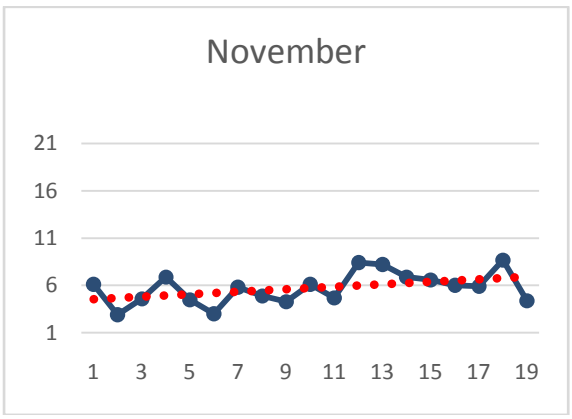












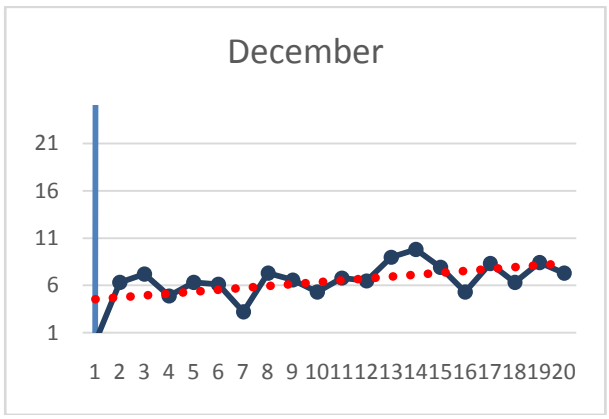


Table (4) : Show the regression equation and coefficient of determination for wind speed

Months	Formula Number	Formula	Coefficient of determination
January	1	y = 0.08316x-159.7378	R^2 = 0.14944
February	2	y = 0.20474x-403.30578	R^2 = 0.51385
March	3	y = 0.16754x-328.08509	R^2 = 0.36971
April	4	y = 0.06421x-119.789895	R^2 = 0.03908
May	5	y = -0.17386x+362.10509	R^2 = 0.20661
June	6	y = -0.02333x+63.85561	R^2 = 0.00541
July	7	y = -0.00754x+32.46088	R^2 = 0.00042
August	8	y = -0.01772x+51.53491	R^2 = 0.00290
September	9	y = 0.06018x-107.09772	R^2 = 0.02904
October	10	y = 0.10561x-203.65754	R^2 = 0.11528
November	11	y = 0.05947x-89.39842	R^2 = 0.20105
December	12	y = 0.12053x-235.35842	R^2 = 0.19278

Table (5): Show the predictions of monthly wind speed in (km/h) in years

Years / Months	2019	2020	2021	2022
January	8.1622	8.2454	8.3487	8.4117
February	10.06642	10.2690	10.4737	10.6785
March	10.17817	10.3457	10.5132	10.6807
April	9.8504	9.9143	9.9785	10.0427
May	11.08175	10.9078	10.73403	10.5601
June	16.8129	16.7896	16.76631	16.74301
July	17.2376	17.23008	17.222	17.215
August	15.7582	15.7405	15.7227	15.70507
September	14.4057	14.4658	14.52606	14.5852
October	9.5690	9.6746	9.7802	9.8858
November	30.67151	30.7309	30.7904	30.8499
December	7.9916	8.1121	8.2327	8.3532

V. Conclusion

The purpose of our study gives the future prediction which is going to be high in both temperature and wind speed, we have predicted for 12 months (January 2000-2018, February 2000-2018, March 2000-2018, April 2000-2018, May 2000 to 2018, June 2000-2018, July 2000-2018, August 2000-2018, September 2000-2018, October 2000-2018, November 2000-2018, December 2000-2018. Also we have predicted till 2022.

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Website

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