International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 8 Issue 12, December- 2018
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

The temperature of a place dramatically depends upon the Sunshine duration: A Chennai-based study

Dr. Mukesh Yadav
Associate Professor in Geography, Government College for Women, Hisar, Haryana

ABSTRACT

Background: Climate change and global warming are the biggest concerns that the world is facing in the modern context. Many factors, both known and unknown,are notable for their impact on altering thetemperature of any place. This study, therefore, studied different parameters to exhibit their effects on the temperature (Temp) variations in a city or district.
Methods: An MLR-based approach was employed to predict the cause ofTemperature rise in the Chennai district of Tamil Nadu, India.
Results: All four factors, namely: Rainfall, Humidity, Avg. sun hours, andAtmospheric pressure, correlated statistically with the Temperature rise in the district; however, only'Avg. Sun hours' ($p < 0.05$)was significant in predicting the dependent variable 'Temp' (temperature).
Conclusion: The study focussed on the factors affecting the Temperature of Chennai and inferred the exciting findings that can be used in addressing the existing complications associated with climatic changes. Further, researchers can also extend this study over a more extensive topography.

Keywords:*Temperature; Climate change;Atmospheric pressure; Humidity; Sun shine hours; Multiple Linear Regression*

1. Introduction

As is well known, the sun is the primary source of heat on Earth, and sunshine duration is the aspect of solar radiation that reaches the planet's surface that has been used and measured the most frequently (Matuszko & Wglarczyk, 2015). Since 1882, measurements of the length of the sun's rays have been taken often over the globe. A sunshine duration number offers information on the amount of total solar energy even though it only specifies the time when direct solar radiation reaches the Earth's surface (Suehrcke et al., 2013). The statistical correlations between sunshine duration and solar radiation intensity or total amount have been used in several climatological investigations (Gopinathan,1992; Wu et al., 2016; Power, 2001). Krakow is one of the few towns in Europe where air temperature and sunshine duration measurements have been made continuously throughout a measurement period. These observations form an uninterrupted set of climatological data. Since 1792, the air temperature has been recorded in this location. In June 1883, barely two years after the instrument was built and connected to the global network of heliographic measurement, sunshine duration was first recorded using a Campbell-Stokes sunshine recorder.

The connections between air temperature and sunshine duration still need to be fully understood. The system of the Earth's surface temperature and atmospheric water vapour is one of the most critical coupling processes. The amount of atmospheric water vapour, the most potent greenhouse gas, rises due to increased ocean water evaporation due to rising temperatures. As a result, the greenhouse effect intensifies and causes a subsequent temperature rise. According to Schneider, (1972), a rise in water vapour concentration can result in an increase in cloud cover as well as changes to the quantity and type of cloudiness, which alters the amounts of solar radiation reaching the Earth's surface (Twomey, 1991). The Earth's surface may warm or cool due to variations in cloud cover. Low clouds with lots of water droplets that are close together strongly reflect sunlight during the day and amplify the greenhouse effect at night. High clouds made of evenly spaced ice crystals allow sunlight to enter while successfully blocking the escape of infrared radiation from the Earth into space, which heats the planet's surface. The climate will cool due to changes like rising low cloud cover and declining high cloud cover. The opposite mechanism can increase the Earth's surface temperature. Positive feedback, or a temperature rise, has been observed in the equatorial and subtropical zones due to the findings. This mechanism was further supported by measurements of the cloud cover made by satellites across the entire planet. Positive feedback is caused by the modification, which lengthens and raises the temperature of the sunshine (Hansen & Nazarenko, 2004; Liu et al., 2018).Therefore, this study aims to gather and analyzethe secondary climate data of Chennai, Tamil Nadu, to assess the factors leading to climate change (change in temperature) in the area.These data are crucial for a compelling study into the development ofnecessary inferences regarding climate change and the causative factors, so creating a method that works well is necessary.

2. Materials and Methodology

2.1 Study area and data

The study was conducted in the Chennaidistrict of Tamil Nadustate, located at13°04'23.6136" N and 80°15'39.3048" E, with a geographical area of 426square kilometres in the central part of India. The study analyses the relationship between different climatic factors and the district's temperature. The secondary data detail climatic and weather phenomenahave been composed by the Indian Meteorological Department (IMD), Tamil Nadu Energy Development Authority (TEDA) Chennai. The monthly data were collected for the years 2011-2018 (Table 1). In this study, multiple regressions analysis is performed between the dependent variable, Temperature (°C) and a set of independent variables such as Rainfall (mm), Humidity (%), Sun hours (hours), and Atmospheric pressure (bar).

Table 1: The table showing the recorded data of relevant data for the years 2011-2018

Months	Rainfall (mm)	Humidity (%)	Avg. sun hours (hours)	Atmospheric pressure (Bar)	Avg. temperature (°C)
January	17	74	7.40	0.94	24.30
February	9	73	8.20	0.93	25.30
March	11	72	8.90	0.94	27.40
April	18	73	9.60	0.92	29.60
May	48	66	10.90	0.94	31.30
June	68	62	11.20	0.94	30.80
July	70	63	10.90	0.91	30.00
August	99	68	10.60	0.88	29.20
September	110	73	10.10	0.94	28.70
October	223	80	8.40	0.94	27.30
November	228	80	7.30	0.91	25.70
December	113	77	6.80	0.94	24.60

Source: Different agencies, as mentioned above

2.2 Empirical method

The study employed MS-Excel tool and linear mathematical model to explore the relationship between theTemperature (Temp)of the district and different climatic factors; the algorithm, thus followed is as follows:

$$Y_{Temp} = \alpha R + \beta H + \gamma S + \delta P + \psi$$

Where Y_{Temp} is the dependent variable denoting the Temperature of the district and $\alpha, \beta, \gamma, and\ \delta$ respectively, are the coefficients ofRainfall, Humidity, Sun hours,and Atmospheric pressure. The constant term or intercept is denoted as$'\psi'$.The multiple regression analysis introduces one independent variable at each stage. The coefficient of correlation (multiple R) and coefficient of determination (R^2) is calculated mainly to assess the percentage of explanation provided by each independent variable on the dependent variable.

3. Results and Discussion

The parameters used in the study significantly affect thevariableTempin the district. These descriptors were studied in an MLR model to display their role in predicting the temperature of a particular district or area:

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 8 Issue 12, December- 2018
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

3.1 Effect of different climatic factors on the variable Temp

The factors incorporated in the study to build a relationship with the variable Temp were positively correlated with the latter. All the factors,Rainfall (0.002007987),Humidity (0.079295494), Avg. sun hours (1.800519181), and Atmospheric pressure (9.417970077) are found to be positively correlated with the Temperature of a place, which means that increase in any of these will increase the temperature of the area. However, only the "Avg. sun hours" factor is significant in predicting the variable Temp (p-value less than 0.05). Rest, all other factors are insignificant in predicting the Temp (with a p-value higher than 0.05). The entire output data of multiple linear regression is reflected in Table 2.

The significantTemp-associated factor, 'Avg. Sun hours,'was also studied for their impact on the dependent variable, which exhibited a similar trend. The representation of thisrelationshipis shown in Figure 1with the help of an X-Y plot. It can be inferred that the average sun hours impacted the city's temperature significantly in Chennai, where the study was done. However, other factors like Rainfall, Humidity, and Atmospheric pressurestrongly correlate with the dependent variable, but they are not significant in their contribution towards the Temperature of the district.

Table 2: The output summary of the MLR analysis of the Temp-associated factors

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.965556142
R Square	0.932298664
Adjusted R Square	0.893612187
Standard Error	0.796710977
Observations	12

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	4	61.18676133	15.29669033	24.09882528	0.0003442
Residual	7	4.443238668	0.634748381		
Total	11	65.63			

	Coefficients	*P-value*
Intercept	-3.308570936	0.836157511
Rainfall (mm)	0.002007987	0.648125526
Humidity (%)	0.079295494	0.442246061
Avg. sun hours (hours)	1.800519181	0.000923869
Atmospheric pressure (bar)	9.417970077	0.49540629

International Journal of Research in Economics and Social Sciences(IJRESS)
Available online at: http://euroasiapub.org
Vol. 8 Issue 12, December- 2018
ISSN(o): 2249-7382 | Impact Factor: 6.939 |

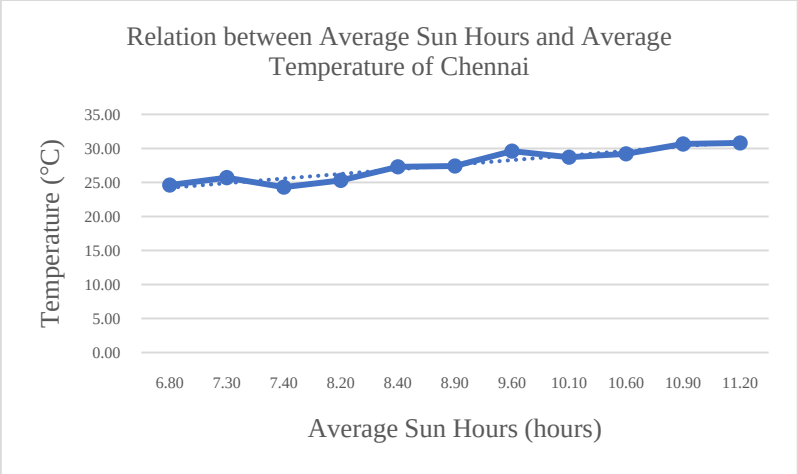

Figure 1: Relation between Average sun hours (hours) and Average temperature (°C) of Chennai

3.2 Equation of Prediction

The multiple regression model has provided the coefficient values to each independent variable which can be aggregated to form the Equation of Prediction;

$$Y_{Temp} = 0.002007987R + 0.079295494H + 1.800519181S + 9.417970077P - 3.308570936$$

The factors, Rainfall, Humidity, and Atmospheric pressure, are not noteworthy in the equation as it does not hold any significance in the prediction.The coefficient of correlation (multiple R) and coefficient of determination (R^2) of the data model is also found to be appropriate with a value above 0.96 and 0.93, respectively (Table 2). These coefficients are calculated mainly to assess the percentage of explanation provided by each independent variable on the dependent variable.

4. Conclusion

Although many studies and reports highlight climate change in the world, only a few have been dedicated to the context of India; therefore, this study examined the causes of the changes in temperaturein Chennai.The study established a strong correlation and significance of sunshine duration on a place's temperature or climate change, which can draw the keen interest of climatologists to interpret the underlying mechanisms of temperature or climate change concerning sunshine durations.

References

1. Gopinathan, K. K. (1992). Estimation of hourly global and diffuse solar radiation from hourly sunshine duration. *Solar Energy (Phoenix, Ariz.)*, *48*(1), 3–5. https://doi.org/10.1016/0038-092x(92)90170-f
2. Hansen, J., & Nazarenko, L. (2004). Soot climate forcing via snow and ice albedos. *Proceedings of the National Academy of Sciences of the United States of America*, *101*(2), 423–428. https://doi.org/10.1073/pnas.2237157100
3. Liu, Y., Chen, Q., Ge, Q., Dai, J., Qin, Y., Dai, L., Zou, X., & Chen, J. (2018). Modelling the impacts of climate change and crop management on phenological trends of spring and winter wheat in China. *Agricultural and Forest Meteorology*, *248*, 518–526. https://doi.org/10.1016/j.agrformet.2017.09.008
4. Matuszko, D., & Węglarczyk, S. (2015). Relationship between sunshine duration and air temperature and contemporary global warming. *International Journal of Climatology: A Journal of the Royal Meteorological Society*, *35*(12), 3640–3653. https://doi.org/10.1002/joc.4238
5. Power, H. C. (2001). Estimating clear-sky beam irradiation from sunshine duration. *Solar Energy (Phoenix, Ariz.)*, *71*(4), 217–224. https://doi.org/10.1016/s0038-092x(01)00049-4
6. Schneider, S. H. (1972). Cloudiness as a global climatic feedback mechanism: The effects on the radiation balance and surface temperature of variations in cloudiness. *Journal of the Atmospheric Sciences*, *29*(8), 1413–1422. https://doi.org/10.1175/1520-0469(1972)029<1413:caagcf>2.0.co;2
7. Suehrcke, H., Bowden, R. S., & Hollands, K. G. T. (2013). Relationship between sunshine duration and solar radiation. *Solar Energy (Phoenix, Ariz.)*, *92*, 160–171. https://doi.org/10.1016/j.solener.2013.02.026
8. Twomey, S. (1991). Aerosols, clouds and radiation. *Atmospheric Environment*, *25*(11), 2435–2442. https://doi.org/10.1016/0960-1686(91)90159-5
9. Wu, B., Liu, S., Zhu, W., Yu, M., Yan, N., & Xing, Q. (2016). A method to estimate sunshine duration using cloud classification data from a geostationary meteorological satellite (FY-2D) over the Heihe river basin. *Sensors (Basel, Switzerland)*, *16*(11), 1859. https://doi.org/10.3390/s16111859