Analytic Study of Climate Change In India

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Abstract

Climate change is an important issue that needs to be addressed to improve the quality of life on earth.Using Google Earth Engine and NCEP/NCAR data on surface temperature we can analyze the behavior of temperature changes and the factors that affect it.Using the data predictive analysis can also be done to find the percentage of temperature rise after each year. The results of this analysis can be used to formulate better environmental practices and policies by the governing bodies to minimize the negative effects of climate change.

Keywords: Climate Change, Surface temperature, Temperature rise

1. Introduction

Climate change is affecting every country on every continent. It is disrupting national economies and affecting lives. Weather patterns are changing, sea levels are rising, and weather events are becoming more extreme. Human activities changes a lot of environmental factors such as geology, climate change, air quality etc. Climate action is also one of the 17 sustainable goals released by the UN which urges the world nations to take action against climate change and its impacts Hence it is important to study the effects of climate change and analyze the factors that contribute to it so that the developing countries can formulate and implement climate adaptation plans.

2. Literature Survey

[1] The authors analyze the effectiveness of remote sensing data over traditional observations method in meteorology to study the global surface temperature and its changes. The authors here have also stated that the global carbon dioxide is increasing, while the global temperature is fluctuating thereby supporting our hypothesis that greenhouse gases are a factor to be considered while analyzing surface temperature and climate change.

[2] The authors analyze the correlation between air surface temperature and the vegetation index and provide a case study of the Tangerang Municipality in Indonesia. The UHI (Urban heat Island) was assessed with data from 2001 and 2011 which included land use change data, city planning data and an increase of surface temperature was found. The NDVI value of the area was also compared and an increase was found. This gives us a good reason to also analyze the NDVI values for areas with high temperature increase in our work.

[3] The author proposed a methodology to estimate the welfare effects of ecosystem change at this larger geographical scale. This method is applied to value the impact of climate change on European wetlands for the year from 2000 to 2050. This

methodology also uses a meta analysis to produce a value function. GIS system is used to model the database of wetland sites.

[4] Here the author did research on coastal modeling which is done by lack of techniques for handling uncertainty, like fuzzy set theory for predicting geomorphic hazards subject to uncertainty and random simulation. This model can be used not only to predict different scenarios of coastal hazard,but is also useful to other fields which involve predictive modeling under uncertainty.

[5] In this paper, the author used Arc - Info GIS package to determine the coastal vulnerability to flooding. Results from climatic research and oceanographic research were combined with data on patterns of landuse and sea defences. To estimate flood occurring periods according to different climate change scenarios a risk assessment model was developed for the future years 2050 and 2100. House equivalent concept was used to analyze the damage cost of flood events in future climate change environments.

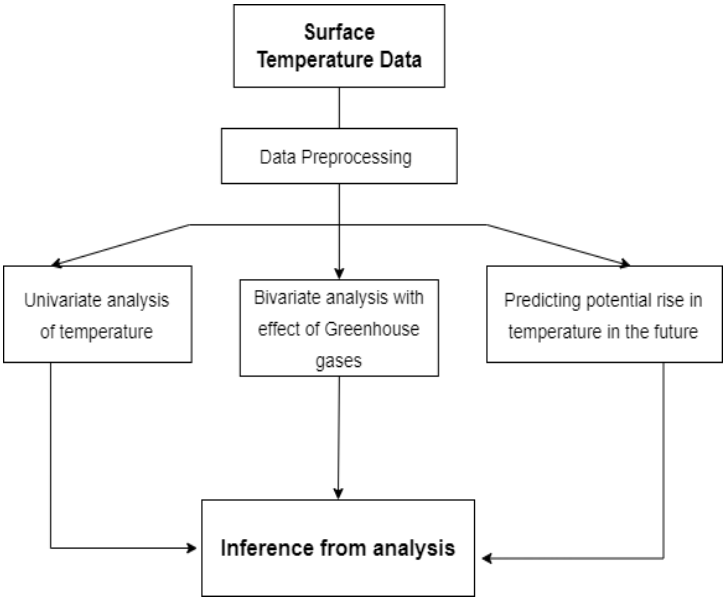
[6] Here, the author used an algorithm-based method for developing quantitative future scenarios of the built environment in East England. It focuses on a coastal management unit. The distributions of new residential properties and non-residential properties were calculated using a GIS-based multicriteria analysis to estimate on the basis of regional demand.

3. Dataset

The size of our dataset is 54120 rows and 4 columns namely City, Ward, Quarter and Avg_Temperature. The dataset is provided by the National Centers for Environmental Prediction (NCEP, formerly "NMC") and the National Center for Atmospheric Research (NCAR) .

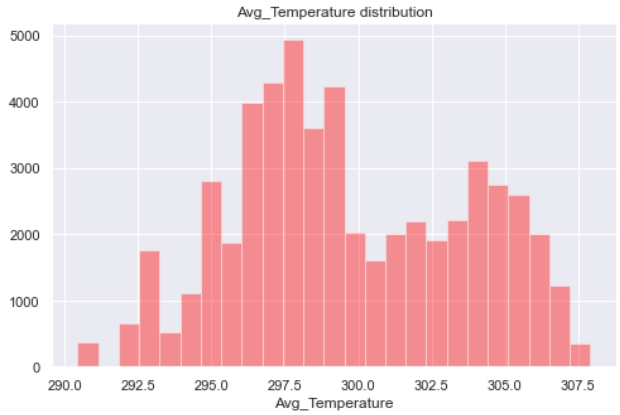
4. Design of the Project

The data taken is to be subjected to several preprocessing techniques to prepare it for analysis. After the data is made ready, Univariate analysis of temperature is done followed by bivariate analysis where we find the correlation between SO2 and Temperature and CO and Temperature for the city of Bengaluru. Finally prediction of potential rise in temperature is done using regression analysis for the next 10 years.

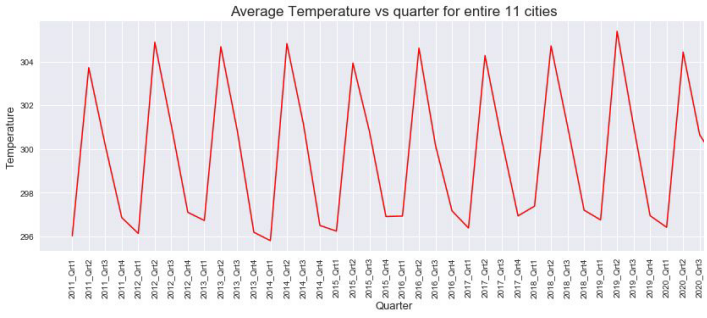


4.1 Univariate Analysis

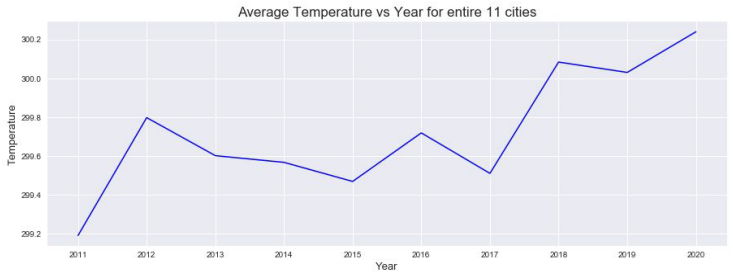
By plotting the histogram the distribution of average temperature can be seen. It is found that the average temperature in indian cities is distributed around 299.72K. The most counted temperature is 297.5 K. Minimum value of Temperature is 290.43 K. Maximum value of Temperature is 307.91 K. Range of Temperature is 17.477 K.



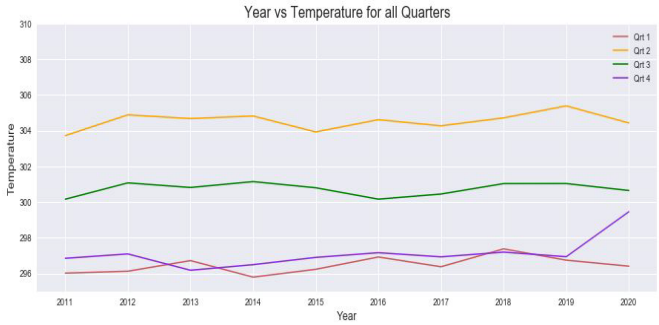
The graph for Average Temperature and Quarter for Indian cities was ploted and the graph explicitly shows the seasonal behaviour of the climate in India.In all the years, The second Quarter is showing a maximum value which depicts the temperature rise in summer season.In all the years, The second Quarter is showing a maximum value which depicts the temperature rise in summer season



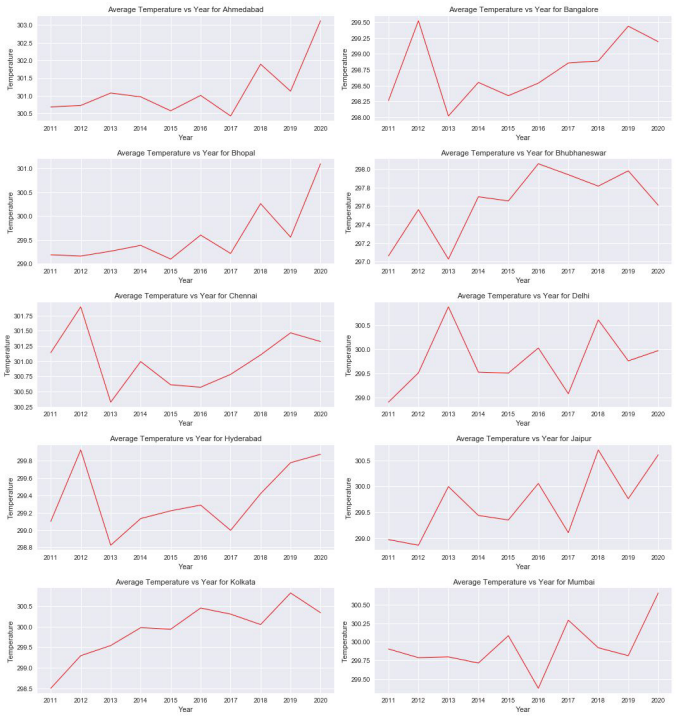
The Average Temperature and Year of Indian Cities graph was plotted. Based on the last 10 year data, The temperature is gradually increasing over the years. A dip in temperature has been observed in the perios 2012-2017. The temperature varies drastically over years, sometimes it is lower than the previous years but the general trend is increasing.



When the average temperature in each quarter and year is plotter it can be seen that Quarter 2 pertaining to the summer season shows the highest value in all year.Quarter and Quarter 1 shows minimal values over years. Quarter however lies between the two and from the plotted lines the temperature gradually increased from 2011 to 2020.



Average temperature across citites is gradually increasing over the years. Ahmedabad showd the maximum average temperature in the past 10 years while Bhubaneswar showed the minimum value of average temperature.



4.2 Bivariate Analysis

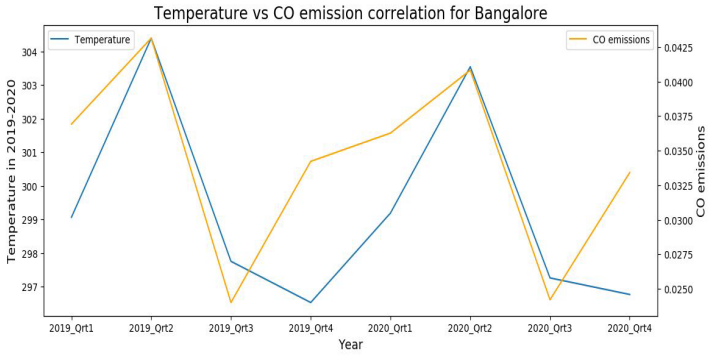
Bivariate analysis for the dataset is done for Carbon Monoxide(CO) and Sulphur Dioxide (SO2)

4.2.2 Correlation between temperature and CO

Carbon monoxide dataset obtained for the the year 2019-2020 for Bangalore was concatenated with temperature for the corresponding years and the following table was obtained.

	Quarter	AVG	CO_density
0	2019_Qrt1	299.054926	0.036923
1	2019_Qrt2	304.335135	0.043139
2	2019_Qrt3	297.741244	0.024007
3	2019_Qrt4	296.501674	0.034224
4	2020_Qrt1	299.174740	0.036271
5	2020_Qrt2	303.509478	0.040826
6	2020_Qrt3	297.253671	0.024205
7	2020_Qrt4	296.762563	0.033414

Carbon monoxide though doesn't affect climate change directly , it can change the amount of the carbon dioxide present in the atmosphere which in turn affects the temperature. Carbon dioxide traps the heat at Earth's surface. So it is important to check the correlation between CO and temperature. The temperature and carbon monoxide correlation graph was plotted for the city Bangalore.



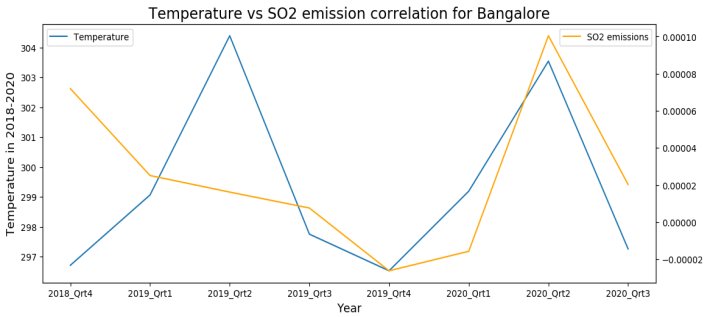
By taking the correlation between temperature and carbon monoxide density we were able to obtain a correlation of 74.78 % i.e. both the graphs representing each quantities plots to almost similar graphs .Which states pretty clearly that rising temperature is dependent on the increasing carbon monoxide amount.

4.2.1 Correlation between temperature and SO2

Sulphur Dioxide dataset obtained for the the year 2019-2020 for Bangalore was concatenated with temperature for the corresponding years and the following table was obtained.

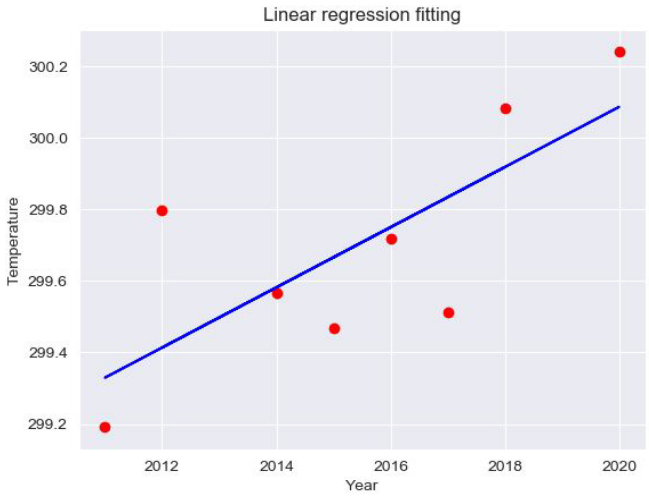
	Quarter	Avg_Temperature	SO2
0	2018_Qrt4	296.714467	0.000072
1	2019_Qrt1	299.067578	0.000025
2	2019_Qrt2	304.396960	0.000016
3	2019_Qrt3	297.755757	0.000008
4	2019_Qrt4	296.529750	-0.000026
5	2020_Qrt1	299.193583	-0.000016
6	2020_Qrt2	303.546840	0.000100
7	2020_Qrt3	297.261841	0.000020

Sulphur dioxide though doesn't affect climate change directly. We found Temperature is having a 34% correlation with Sulphur dioxide. This is due to the reason that higher concentration of Sulphur dioxide causes acid rains and also change the concentration of other greenhouse gases. But Sulphur dioxide also reflects light when released in the atmosphere, which
keeps sunlight out and creates a cooling effect. So presence of Sulphur dioxide can increase as well as decrease the temperature. Hence it must also be considered when analysing it.

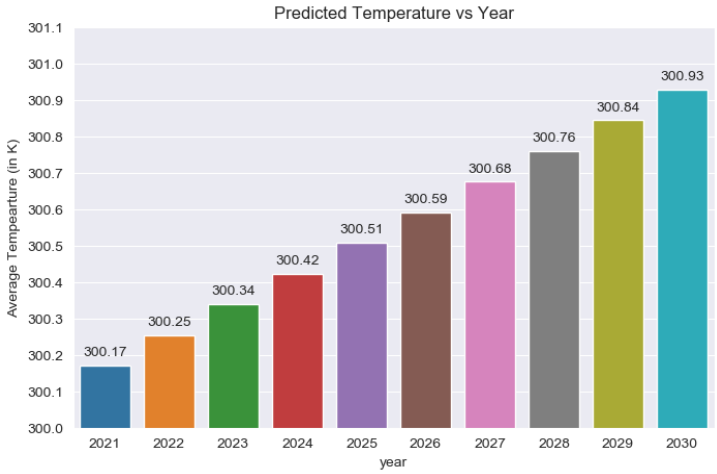


4.3 Linear regression

We used linear regression in order to predict the temperature of next 10 years temperature. The train-test split procedure is used to estimate the performance of machine learning algorithm when they are used to make predictions on data not used to train the model.



Mean Absolute Error: 0.066
Mean Squared Error: 0.0058
Root Mean Squared Error: 0.0765
This analysis ensures us a accurate predictions for next 10 years.



5. Results and Discussions

From the Univariate analysis its clear that, the temperature during quarter-2 and quarter-4 is highest and lowest respectively in every year. It is obvious that the temperature is highest during summer and lowest during winter. There was a decrease in Carbon monoxide during 2020 quarter -2 than expected this is due to the lock-down caused by the covid -19 pandemic,thereby resulting in a great decrease in temperature.

But there is a gradual increase in Carbon monoxide during 2020 quarter-3 and quarter-4. Similarly we have seen a gradual increase in temperature. This confirm a greater dependency of temperature on Carbon monoxide. Dependency of Temperature on Sulphur dioxide is not that apparent as there are other effects coming into play which causes a fluctuation in that regard.

From our analysis, the temperature is going to increase in the coming years In the next decade, the

average temperature across indian cities will raise by 0.75K by next 10 years

6. References:

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