The Effects of COVID-19 in Global Warming Through the Application of Data Science

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Abstract— Global warming is a constant alarming concern. Simultaneously, temperature escalation throughout the world, too in Asia, has turned into dismay which is indicating unexpected natural disasters and inconvenience. Covid-19 has added a new disruption to conventional viability. As a consequence of temporary confinement, a perceptible change in places might be noted in electricity as well as motor vehicle usage before and after the Covid-19 pandemic. This research is inspired by Sustainable Development Goals 7 and 13 which is Affordable and clean energy and the Climate Action to investigate the scale of climate change in several Asian regions before and after the Covid-19 pandemic. The focal point is concerning two contrasted states of global warming whether Covid-19 has any influence in this regard. Some contemporary temperature datasets, Nitrogen Dioxide emission datasets, that incorporate years (2016 to 2021), have been analysed, using machine learning algorithms in order to accomplish the assertion. According to the analysis, the average temperature has come down from 25.5°C(in 2019) to around 24°C(in 2021) along with a detectable change in carbon as well as nitrogen emission. Therefore, the pandemic is supposed to be positively correlated to global warming. For future work, a further investigation might be conducted concerning situations of the possible smallest region in alongside a dataset with a much-improved algorithm in order to resolve the examination more productively.

Keywords— Covid-19, Global Warming, Climate Change, Sustainable Development Goals, Affordable and clean energy, Climate Action, fb prophet.

I. INTRODUCTION

Climate change is a warm topic as always because of the increasing difficulty on a daily basis due to high rising temperature and thus, destruction of the Ozone layer that assists us to save ourselves from the danger of a couple of harmful rays coming from the sun. The recent concerned issue, that is Covid-19, has committed some significant changes in lifestyle all over the world. On one side human beings are suffering and struggling their best to cope up with this tiny breathtaking virus, while on the other hand the other lives on the earth are counting the whole situation as a blessing.

Fig. 1 Positive aspects of covid-19

Only because people are not likely to visit outside due to shutdowns, as the tourist points are out of service nowadays, animals have been roaming around fearlessly. This research has taken the Sustainable Development Goals 7 (Affordable and clean energy) and 13 (Climate Action) to look for the catalyst of global warming thus, climate change in several significant Asian places before and after the Covid-19 has outbroken. However, the current situation regarding the pandemic is resulting in a slight substitute in the usage of energy as well as motor vehicles.

To find the noticeable place which has been going through environmental change inside Asia, at first, China comes to mind due to some important reasons such as vast popularity, rising industrialization at large, the causing of pollution and disasters, etc. The more these aspects are noted, the more those could be affected by surroundings. So, it happened as planned. The result might be a little doubtful if only one place would have been taken in consideration from one specific perspective. This thought led us to investigate the same aspects in terms of another comparatively less polluted country on the basis of which, Malaysia has been selected for further inspection.

The name of the datasets that have been operated till finding and analysis are the temperature datasets, nitrogen dioxide emission datasets, of around six years 2016 to 2021.

II. RELATED WORK

The issue is pretty hard, the latest that researchers have been investigating is global warming. As an Asian native, it

was just about a bit straightforward to be inspired by acknowledging the situation of global warming along with the prospect of climate change in Asia. Moreover, almost most of the countries located inside the Asian part are tropical or tropical islands. As a result, these regions have been facing plenty of natural calamities while thinking from a scientific perspective. Throughout the decades, it has been well recognized because of the appreciation of not only science and technology but also because of the credit of the researchers. a La Nia–like cooling trend has Characterised the present global warming in the equatorial Eastern Pacific Ocean. In most cases, the heating up of the Indian and tropical Atlantic Oceans complemented the situation of this regional warming up. According to the article, the rise of strong meteorological storms in Eastern Asia's riverine regions since 1998 has been linked to contemporary global warming [1].

According to Dongdong Peng and his colleagues in their spectacular journal, Middle Asia is formed by a geographic area which is notably vulnerable to rough climatic manifestations. The sensitivities of extreme environmental occurrences in Middle Asia to high emissions, in addition, the impact of climate change prospects is then analysed depending on experimentally limited projections. Numerous strategies for predicting environmental change had been considered [2]. This paper is based on multi-model simulation of the South Asian Regional Climate, provides a detailed explanation of potential impacts in precipitation and temperature extremes over Southeast Asia under two degrees Celsius global warming.

The year 2041 has been selected as the year in which the global average temperature reaches 2 degrees Celsius over pre-industrial levels, according to the Karmalkar and Bradley unconstrained climate change scenario (2017). Statistics show that the most significant changes happened between the years 2031–2051. Under a 2°C global warming scenario, strong increases in CDD suggest Indonesia would become drier, whereas rises in RX1day suggest more severe rainfall events across most of Indochina.

Additionally, increase in R50mm, CDD, and RX1day are expected in north part of Myanmar, indicating that the region may be subjected to more catastrophic consequences than other parts of Southeast Asia. Some noticeable investigation has been undertaken that shows an approximate line of temperature over the year until 2051 using the ensemble mean model [3].

Another journal says that, Over Eastern Europe, North-East Asia and the North Atlantic Ocean, they demonstrate ability in forecasting temperatures increase, comparative to a consistent pattern, for around one and two to five years compared to a steady increase. They undertook the dataset during the time series of 1960 to 2014 and drew a stroke respecting the surface temperature.

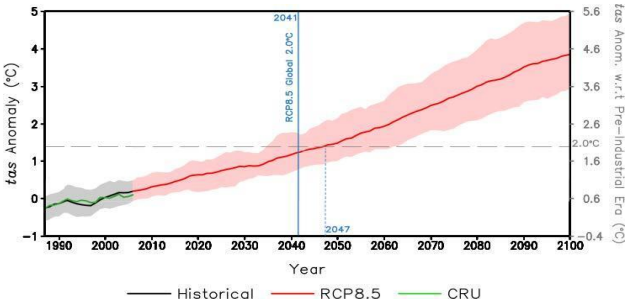


Fig. 2 The growth rate of the temperature in future.

. In order to do that, they have tried to slightly modify the climate model that might turn out to be a better version of the traditional outcome in terms of prediction. Thus, they used their improved version of the climate model [4]. But there are some catalysts that have been influencing climate change thus, global warming since the very beginning. Greenhouse gas emissions are a major contributor to the growth of the economy (Carbon DiOxide, Nitrogen DiOxide, etc.) which is slowly destroying the Ozone layer that protects the surface from scorching summer and the sun heat. The usage of certain so-called lifesaver machines (air conditioner, motor vehicle, refrigerator, etc.) indicates the amount of greenhouse gas emission in the environment. Therefore, the more the gas emission will take place, the more the atmosphere will get negatively affected. The emission has slightly come down after the epidemic has started according to the journal [5].

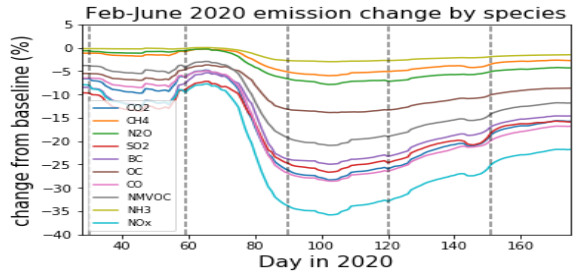


Fig. 3 The average percentage of global emissions has changed by 2020.

Another journal has attempted to predict the greenhouse gas emission in China thus, in Asia, using the XGBoost machine learning algorithm assisted and directed by GEOS-Chem atmospheric chemistry model as well as GEOS Earth System Model [6].

S. Cheval and his colleagues provided a good overview of the COVID-19's observed and probable environmental implications. They claim that COVID-19's impact on cities and public health is largely due to anthropogenic reasons that are becoming more apparent as human activity declines

around the world. Because of the enormous regional scope, complexity, and even uniqueness of the COVID-19 pandemic, environmental repercussions have been unparalleled. Everything in Europe's large urban agglomerations with far more than one million residents was effectively paralysed in terms of movement, traffic, and commerce. Only two months after it began, the catastrophe had already reached global proportions (i.e., February through March 2020). In spite of six earlier pandemic outbreaks occurring in the 21st century, society was still ill-prepared for a worldwide occurrence. One of the major repercussions of the COVID-19 pandemic is likely to be a major shift in human behaviour, and They focuses on that environmental impact. They stated that "It is essential to monitor socio-ecological circumstances to prevent spreading in the pandemic and the risk of pandemic in the first place. As a result of the data, tools, and lessons learnt, future pandemics could be better prepared for" [7].

According to Le Quéré et al. before the covid situation co2 production increased at a 1% annual rate during the past decade. However, after the covid pandemic the annual rate CO2 emission increased almost 0%. Fossil CO2 emissions are expected to fall by as much as 17% (−11 to −25%) per day if world populations are severely and forcibly restricted, a level that has probably never been achieved before. However, these are only based on 2006 emissions levels. To reduce global warming to 1.5 degrees Celsius over the next few decades, annual reductions must be as low as −4.2 to −7.5 percent, as determined by their sensitivity studies. As a result, most of the shifts we see in 2020 are only going to last a few years before returning to their previous states. Even while confinement may alter the trajectory in unforeseen ways, social responses alone will not drive very substantial and consistent reductions needed to achieve net-zero carbon emissions. Mandatory confinement does not meet the goal of balancing reduced demand with increased well-being in climate stabilisation scenarios examining low energy and/or material demand. Despite this, there are still ways to apply economic incentives that are linked with low-carbon paths. How responsive emissions from surface transportation can be to policy and economic adjustments is revealed by their efforts. Cycling and Walking have social distancing qualities which are expected to be preferred for few periods and could assist reduce CO2 emissions into the atmosphere as imprisonment is eased. Active transportation accounted for approximately half of the reduction in carbon during confinement. The trajectory of CO2 emissions will be influenced for decades to come depending on how much global leader considers total-zero emission objectives and the consequences of climate change when designing the economic response to COVID-19 [8].

According to Weber et al., reducing SO2 emissions and increasing oxidising capability results in a decrease in sulphate aerosol and an increase in aerosol size, resulting in a decrease in cloud droplet concentration. Black carbon emissions have been reduced significantly, which has led to an increase in aerosol albedo. Direct impacts of ozone and aerosol variations on radiative forcing range from 33 to 78 milliwatt metres per second. To put it another way, COVID-induced emissions reductions are unlikely to have a long-term effect on environment if emissions return to pre-intervention levels. A decrease in NOx emissions led to a decrease in tropospheric O3 and an increase in methane lifetime, which was accompanied by an increase in oxidizing capability. Sulphate burden decreased because of reductions in SO2 emissions and a decrease in tropospheric oxidising capacity. An overall lower number of sulphate aerosols generated in the nucleation mode is attributable to a lower rate of SO2 gas-phase reduction compared to SO2 aqueous-phase reduction, as evidenced by both a rise in aerosol effectiveness and a decrease in CDNC [9].

An essential meteorological metric, aerosol size distribution, can be affected by changes in the oxidant concentrations in the atmosphere. It's true that their model reveals positive feedback from the aerosol direct impact over China when comparing scenarios with a 25% drop in industrial emissions. Global radiative forcing from direct effects of aerosols was reduced by 25 percent due to the drop in BC emissions, with localized forcing's exceeding 1 Wm2 in the Middle East. Combining with the negative effect of tropospheric O3 decrease, these factors resulted in a tiny net forcing of 33 to 78 mWm2. This is a transient and hypothetical drop in CO2 concentration of 3–6 parts per million. For forcing factors like clouds and water vapour, the Great Dividing Range makes the clean atmosphere and aerosol-cloud interactions components negligible (95% confidence level) [9].

III. Methodology

For the research, we followed the standard data-science lifecycle. We have applied various visualizing libraries such as base map, matplotlib, Plotly, and so on. after obtaining the necessary dataset. All the steps in Fig. 4 show the methodological cycle.

A. Data Collection and Categories

The temperature and No2 datasets were obtained via the Nasa website [10] and EARTHDATA [11]. Moreover, the CO2 dataset was collected from the ICOS data portal websites [12]. For the NO2 dataset, it was in netCDF format. So, we had to extract data from netCDF to 2d visualization data format. On the contrary, the dataset of temperature and CO2 was in CSV format. Both websites offer complementary

datasets that may be viewed and used for additional research.

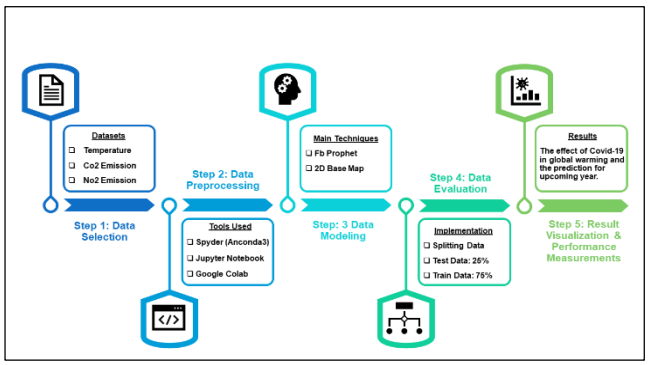
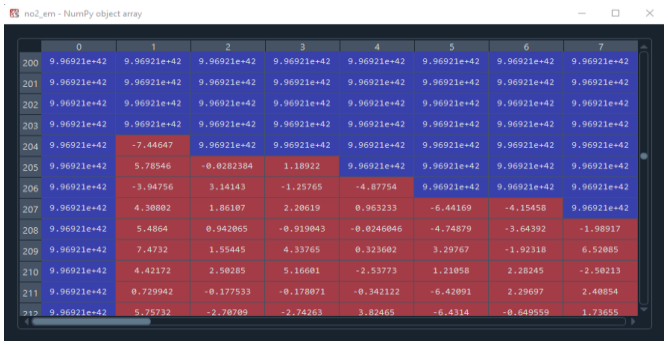


Fig. 4 Methodology

The datasets were accessible as open source on the website. However, it is permissible to use research purposes.

	Latitude	Longitude	Year	Month	Day	Max Temperature	Min Temperature	Avg Temperature	Relative Humidity	Specific Humidity	Eart Skin Temparature
1923	4.00971	102.34831	2021	4	7	29.64	22.80	25.72	87.08	18.48	25.50
1924	4.00971	102.34831	2021	4	8	28.91	23.36	25.63	87.79	18.55	25.40
1925	4.00971	102.34831	2021	4	9	29.97	22.25	25.79	82.24	17.54	25.48
1926	4.00971	102.34831	2021	4	10	30.05	22.12	25.69	84.63	17.92	25.48
1927	4.00971	102.34831	2021	4	11	29.79	21.82	25.47	87.33	18.25	25.48
1928	4.00971	102.34831	2021	4	12	29.12	22.03	25.27	88.22	18.21	25.33
1929	4.00971	102.34831	2021	4	13	29.03	22.72	25.56	87.59	18.41	25.41
1930	4.00971	102.34831	2021	4	14	29.76	23.15	25.94	86.46	18.60	25.45
1931	4.00971	102.34831	2021	4	15	28.63	22.24	25.42	86.33	18.01	25.08
1932	4.00971	102.34831	2021	4	16	30.12	22.08	26.03	84.49	18.27	25.68
1933	4.00971	102.34831	2021	4	17	29.86	22.02	25.74	83.99	17.82	25.53
1934	4.00971	102.34831	2021	4	18	30.27	21.88	25.93	78.35	16.80	25.34
1935	4.00971	102.34831	2021	4	19	28.82	22.49	25.31	86.07	17.83	25.01
1936	4.00971	102.34831	2021	4	20	29.89	22.43	26.00	84.93	18.34	25.71
1937	4.00971	102.34831	2021	4	21	29.83	23.10	26.22	87.51	19.15	25.57

Fig. 5 Temperature Dataset from NASA Website.



	0	1	2	3	4	5	6	7
200	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
201	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
202	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
203	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
204	9.96921e+42	-7.44647	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
205	9.96921e+42	5.78546	-0.0282384	1.18922	9.96921e+42	9.96921e+42	9.96921e+42	9.96921e+42
206	9.96921e+42	-3.94756	3.14143	-1.25765	-4.87754	9.96921e+42	9.96921e+42	9.96921e+42
207	9.96921e+42	4.30802	1.86107	2.20619	0.963233	-6.44169	-4.15458	9.96921e+42
208	9.96921e+42	5.4864	0.942065	-0.919043	-0.0246046	-4.74879	-3.64392	-1.98917
209	9.96921e+42	7.4732	1.55445	4.33765	0.323602	3.29767	-1.92318	6.52085
210	9.96921e+42	4.42172	2.50285	5.16601	-2.53773	1.21058	2.28245	-2.50213
211	9.96921e+42	0.729942	-0.177533	-0.178071	-0.342122	-6.42091	2.29697	2.40854
212	9.96921e+42	5.75732	-2.70709	-2.74263	3.82465	-6.4314	-0.649559	1.73655

Fig. 6 No2 Dataset from EARTHDATA.

	REGION_ID	REGION_CODE	REGION_NAME	TIME_POINT	DATE	TOTAL_CO2_MOD	PWR_CO2_MOD	IND_CO2_MOD	TRS_CO2_MOD	PUR_CO2_MOD	RES_CO2_MOD	AVI_CO2_MOD	TOTAL_CO2_LOG
0	78	MYS	Malaysia	56	2020-02-25	-0.005683	0.0	-0.001969	-0.002779	-0.000125	0.0	-0.000877	-0.000060
1	78	MYS	Malaysia	57	2020-02-26	-0.011367	0.0	-0.003805	-0.005559	-0.000249	0.0	-0.001753	-0.000120
2	78	MYS	Malaysia	58	2020-02-27	-0.017050	0.0	-0.005708	-0.008338	-0.000374	0.0	-0.002630	-0.000179
3	78	MYS	Malaysia	59	2020-02-28	-0.022733	0.0	-0.007611	-0.011117	-0.000498	0.0	-0.003507	-0.000239
4	78	MYS	Malaysia	60	2020-02-29	-0.028416	0.0	-0.009514	-0.013897	-0.000623	0.0	-0.004383	-0.000299
5	78	MYS	Malaysia	61	2020-03-01	-0.034100	0.0	-0.011416	-0.016676	-0.000747	0.0	-0.005260	-0.000359
6	78	MYS	Malaysia	62	2020-03-02	-0.039783	0.0	-0.013319	-0.019456	-0.000872	0.0	-0.006137	-0.000418
7	78	MYS	Malaysia	63	2020-03-03	-0.039783	0.0	-0.013319	-0.019456	-0.000872	0.0	-0.006137	-0.000418
8	78	MYS	Malaysia	64	2020-03-04	-0.039783	0.0	-0.013319	-0.019456	-0.000872	0.0	-0.006137	-0.000418
9	78	MYS	Malaysia	65	2020-03-05	-0.039783	0.0	-0.013319	-0.019456	-0.000872	0.0	-0.006137	-0.000418

Fig. 7 Co2 Dataset from ICOS Data Portal.

B. *Research Environment and Setup*

We have used three python platforms, For instance, Google Colab and Jupyter notebook as an IDE, and programming language python with the analysing tool spyder (Anaconda).

- Google Colab and jupyter notebook: In order to carry out the coding experiments, Google colab is a cloud-based service developed and hosted by Google. And Jupyter is being developed in the open on the GitHub platform. and One of the most significant advantages of the Colab and jupyter is, both platforms are free to use, and the runtime can be customized. In the lab environment, the Python programming language is implemented. It is simple to conduct an analysis on the csv dataset in colab. The majority of datasets contain trash data. As a result, colab makes it simple to deal with garbage datasets.

- Spyder: Spyder is an integrated development environment (IDE) for programming in the Python language that is available as an open-source, cross-platform project. It works with a variety of well-known Python analytical libraries, such as NumPy, SciPy, Matplotlib, and pandas as well as IPython, SymPy, and Cython, as well as other free and open-source software. For analysing the two-dimensional data such as base map, bar graph Spyder can be a useful tool. Moreover, the features of these tools have a unique coalescence of advanced coding, error handling, and analysis. Basically, it is indeed a comprehensive development tool that includes data exploration, dynamic execution, deep analysis, and best visualization capabilities typically associated with analytical packages.

- Basemap: Basemap is a wonderful tool for building 2D maps using python in a concise manner. It basically matplotlib extension, which contains all the features of the library to generate data visualizations and includes geographical projections and some data sets so that it can plot coast lines, countries, and so on straight from the library. We have used this tool for visualizing the NO2 emission data in several countries such as China and Malaysia.

C. *Performance Measurement*

R2 score, MSE (Mean Squared Error) and MAE (Mean Absolute Error) are a few of the metrics we utilized to assess the algorithms' overall performance. In an attempt to improve accuracy, we experimented with several parameters, but the results were unsatisfactory. To minimize overfitting, we concentrated more on data

augmentation, which allowed us to build a more reliable prediction.

D. Data Cleaning and Pre-processing

The datasets to be utilized are first reviewed and, if required, cleansed. Several data cleaning procedures were used to guarantee that the datasets were suitable for testing. The following graphic depicts the data cleaning procedures that were performed using Google collab.

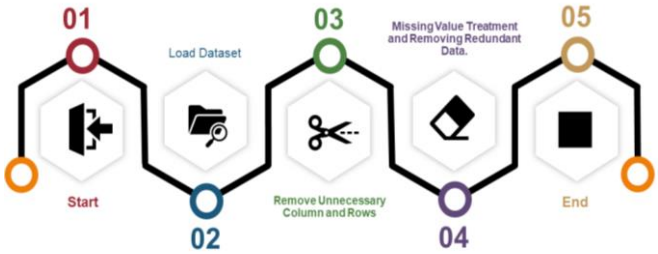


Fig. 8 Flowchart for data Cleaning and Pre-processing.

To begin, the dataset's directory is specified. After that, the dataset is loaded into Google collab. For our project. Raw data will have missing values, columns containing information that we do not want, and some of them may be duplicated. To delete any columns that we do not need for our project, we have used the instruction datasets.drop (['column_name'], axis='columns', inplace=True) where datasets are the name of our data and ['column_name'] is the column that we want to remove, in this case, columns 'Earth Skin Temperature', 'Specific Humidity' and 'Related Humidity' have been dropped.

In addition, we tried to eliminate the rows with missing values, So, we used the python command isnull().sum() to see the null values or missing values and .notna() to remove missing values from the dataset. We only want the completed version of the dataset with no missing values since we want to achieve an accurate result. Moreover, we did some pre-processing on the date format to analyse better. The date of the temperature dataset comes with the three columns as day, month, year. So, we changed the date into standard date format using to_datetime (dataset['Date'], format='%Y%m%d') and 'Date', inplace=True. Moreover, in handling netCDF data set for visualizing the emission of NO_2, we found the large number of values appear, so we decided to fill value with nan by using this command 'fill_val = np.nan'.

IV. Modelling and Implementation

After cleaning the datasets and selecting the sample to utilize, we proceed to the modelling stage. The Algorithm chosen for the dataset is Prophet model.

A. Correlation Test:

Following clustering on the training set, a correlation test is performed to determine whether there is a strong, weak, or no association between two variables. The direction of the association between the variables is also revealed by the correlation test heatmap. The correlation coefficient is usually between +1 and -1, with the positive side indicating a stronger degree of relationship. When the coefficient hits one, the correlation is said to be perfect. Pearson and Spearman's Rank correlations are examined in this dataset.

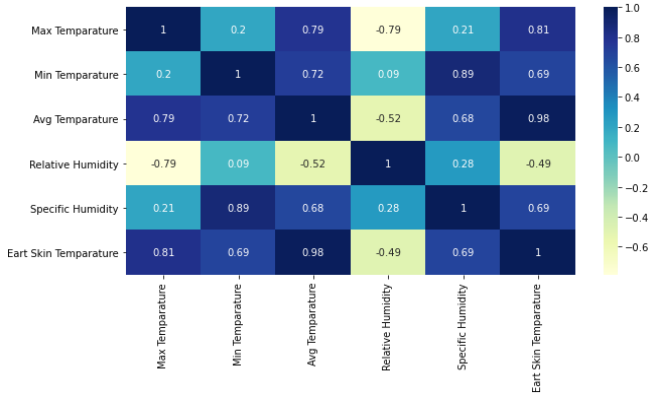


Fig. 9 Correlation between rows and columns.

B. Train the Dataset

After EDA has been used to analyse the dataset, it is divided into two sets: one for the training phase and one for the testing phase. The data is divided into 7.5: 2.5 ratios, with 75 percent of the data serving as the training set and the remainder serving as the test set. Prophet model is used to implement the training set.

C. Prophet Model

Prophet is a process for forecasting time series data that is based on an iterative manner that fits non-linear trends with annual, weekly, and daily periodicity, as well as holiday effects. It can be done effectively with time series and statistical data from numerous seasons. This approach can also operate with incomplete data and pattern, and it usually tackles the outliers very well.

The Prophet library is free and open-source forecasting library for time series dataset. It is simple to implement and can automatically determine an optimal collection of model hyperparameters in order to produce accurate forecasts for data that includes the patterns and time structure by default. It has the capacity to construct accurate time series predictions using basic intuitive parameters.

V. Visualization

The figure below shows the box plot of the average temperature decrease in Malaysia. As we know Covid was started in the last quarter of 2019. However, from the below graphs we can clearly state that the average temperature

was increasing gradually before the covid pandemic, and the temperature was at the highest peak in 2019 which is approximately 26 degrees. Nevertheless, after the covid pandemic, it is noticeable that after 2019 the average temperature is decreasing significantly which is around 24.5 degrees.

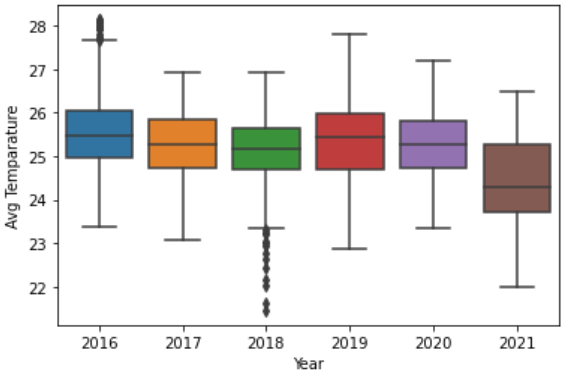


Fig. 10 The average temperature from January 2016 to March 2021.

China has the world's largest total population according to numerous investigations by different organizations around 1.37 billion people. (Set 2016; source CIA World Facebook). The growth rate in 2017 was estimated by the UN to be 0.43%, significantly lower than a world average of approximately 1.11% pa. The rate of pollution is always at a high range even according to several publications (Xiao Lu et al. 2018). The country administration is always looking for ways to reduce pollution as much as possible (such as to recycle). The below geographical maps show the total amount of NO2 emission before the covid pandemic. Since according to proper records, the first-ever Covid-19 positive case was discovered at the edge of November 2019.

An inspection was held over the dataset achieved of the NO2 emission between the prior period and the later span of the Covid pandemic in the densely populated and contaminated Asian geographical area, specifically China. The time span was around the year 2018 to 2020. While visualizing, it shows that, in 2018, thus, before the Covid situation, the emission reached about 500 micro molecule per square meter, which is absolutely dangerous according to the standard scale. Already It had reached the red zone. Fig. 11 exhibits the evidence. *Fig.* 12, on the other hand, is manifesting the positive change. The emission of NO2 in the same place has clearly come down by the last half of March 2020, which is around 300 molecules per square meter. The changes have significantly affected global warming, which is shown in Fig. 12.

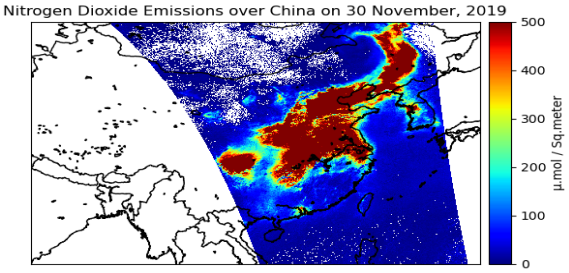


Fig. 11 NO2 Emission in China pre Covid 19 situation.

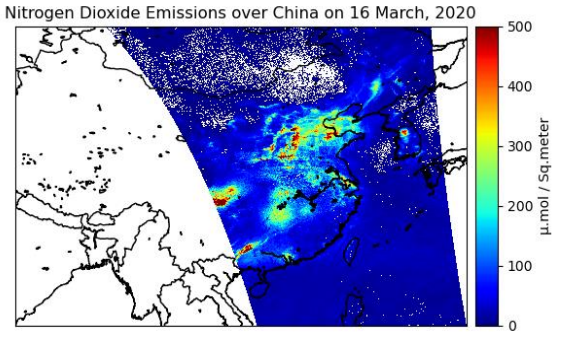


Fig. 12 NO2 Emission in China pos Covid 19 situation.

Conversely, Malaysia deserves the acknowledgment of being a less polluted country. The air inside the country is either good or pretty moderate, which could be declared nearly as perfect as needed for human beings to live in.

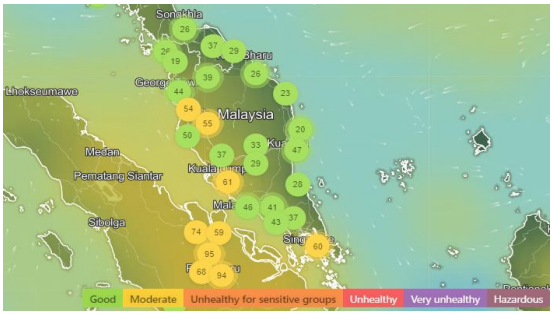


Fig. 13 Air circumstance of Malaysia.

In order to look into the NO2 emission situation before and after the Covid pandemic, which was in December 2019 and April 2020, in Malaysia, several related datasets were examined. The result was more or less unexpected. It provides evidence of reducing NO2 emission as well as the previous discovery related to China. *Fig.* 14 and *Fig.* 15 express the outcome one by one.

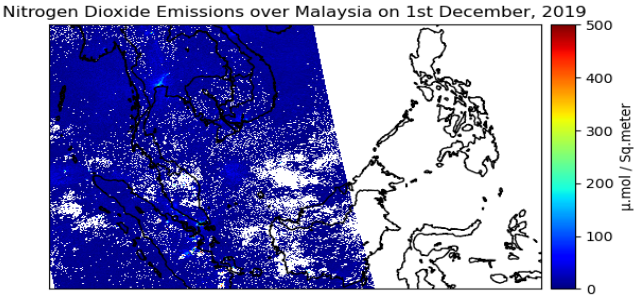


Fig. 14 NO2 Emission in Malaysia pre Covid 19 situation.

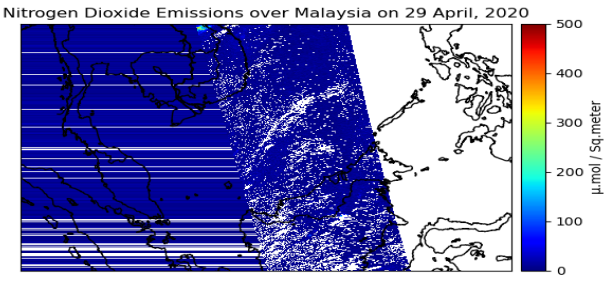


Fig. 15 NO2 Emission in Malaysia pos Covid 19 situation.

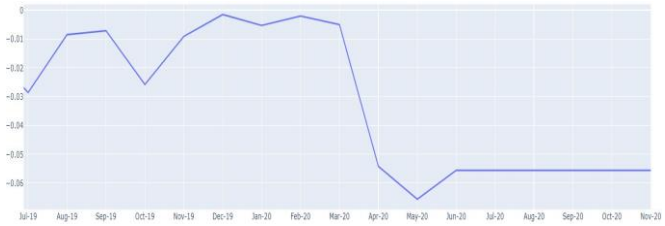


Fig. 16 The carbon dioxide emission from July 2019 to November 2020.

VI. Result Analysis

A. Accuracy

Accuracy is measured the ratio of test predictions that were correct. It is easily measured by calculating the number of true predictions by the total number of predicted events. As an initial phase, we had a proposition to deal with global warming in Asia until we acquired the significant change in several geographical regions based on the research history of those related places such as central Asia and Southeast Asia. According to the visualization obtained from certain datasets following particular methods, it might be declared that China has had a remarkable positive change that happened during the Covid pandemic. The nitrogen Dioxide emission has been reduced to a noteworthy extent. We wanted to find some other country that is less polluted to justify the actual consequence once again. So, we chose Malaysia and began the exploration. While receiving the outcome, it stunned us when we noticed that Malaysia has fewer emissions too. Based on the derived visualization, it could simply be announced that Covid-19 is throwing a positive impact on global warming.

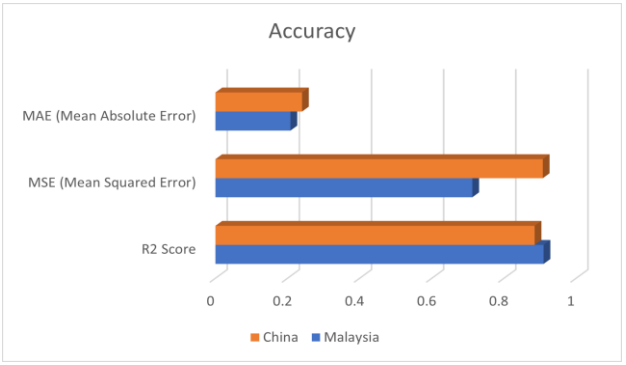


Fig. 17 The Accuracy of our model.

As we know Covid was started in the last quarter of 2019. However, most of the countries were under lockdown as well as Malaysia due to the pandemic. For that reason, the emission of CO2 from industrial, Transport, Power were being stopped. That might affect the atmosphere in a slight way which has been observed thoroughly in the visualizations below. These major changes have the possibility to affect the average temperature in this specific geographical location.

Fig. 18 and Fig. 19 shows the forecast for the next year gradually in China as well as in Malaysia.

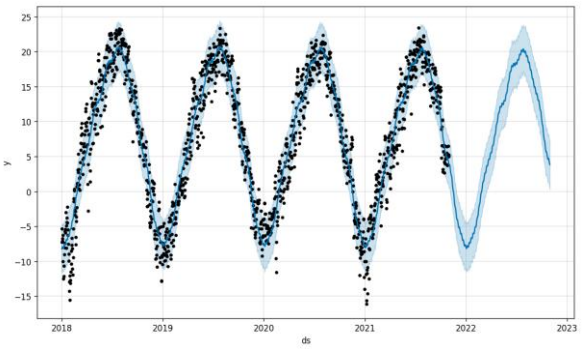


Fig. 18 The average temperature in China for upcoming year.

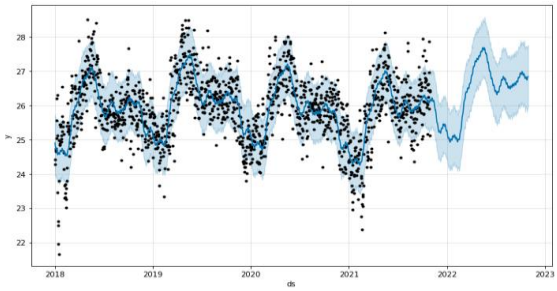


Fig. 19 The average temperature in Malaysia for upcoming year.

B. R-squared

In statistics, the coefficient of determination, also written coefficient, denoted R2 or r2 and pronounced "R squared",

is the fraction of the variation in the dependent variable that is expected from the independent variable(s). The determination coefficient generally runs from 0 to 1. Additionally, there is no correct answer to the question of what R2 should be. 100 percent signifies perfect correlation. Nonetheless, there are some algorithms with a minimal R2 which are still quite good. Here, the r2_score achieved is 0.8850044637732566, which is nearly 1, means almost 100%.

C. *MSE (Mean Squared Error)*

MSE (Mean Squared Error) is the average of squared differences between original and forecasted data points in a dataset. The variance of the residuals is measured by this method. However, there is no correct value for MSE. But the lower the value is, the more that algorithm should be reliable. In case, the value of MSE is 0, that means the model is perfect. The value of MSE in this paper is 0.7336823241367788, which is less than 1. Based on the R2 and MSE score, the algorithm might be widely appreciated for the daily temperature forecasting purpose.

D. *MAE (Mean absolute error)*

The Mean absolute error is used to obtain an average of the absolute deviations between anticipated and actual values. This approach is used to calculate the dataset's residual average. In our case, the value for MAE is 0.208. Which is quite good.

VII. Future Work

We plan to predict the temperature of the whole world for the next four to five years. We also aim to look for the assumption of the greenhouse gas emission of the mentioned geographical region. We will try use other machine learning algorithm which will be fitted most to our model and will give the better accuracy with better prediction. As an extension, we intend to discover the nearest reason as well as the gateway of less emission thus, less climate change.

VIII. Conclusions

To sum up, we can conclude that, the Covid-19 pandemic has caused enormous alterations in people's lifestyles. The average global temperature has dropped from 25.5°C to approximately 24.5°F which indicates the positive changes in global warming. However, the motive of the research demonstrates to figure out whether Covid-19 has an impact on global warming through dataset analysis. The consequence acquired from the inspection manifests a significance that is, the condition of the atmosphere in the two areas (China and Malaysia) throughout the whole period of the Covid pandemic has been acknowledged to change positively. According to that investigation, it might be stated that global warming has pragmatically changed because of the ecofriendly sequels taken place because of the pandemic. It might be considered as an advantageous side of the situation that has provided people the opportunity to find gateways to lead nature in its own way. Additionally, in China, the amount of nitrogen dioxide emissions has been significantly reduced. Alternatively, it can be stated that Malaysia also emits less NO2 emissions. The average temperature in this area could be affected by these large changes. From our analysis the pandemic is positively correlated to global warming for instance, reducing the emission of carbon monoxide, nitrogen dioxide which has significant impacts in global warming. "Affordable and clean energy" and the "climate action" are two of the Sustainable Development Goals that have been considered in this study.

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References

[1] J. Zhao, R. Zhan, and Y. Wang, "Global warming hiatus contributed to the increased occurrence of intense tropical cyclones in the coastal regions along East Asia," *Sci. Rep.*, vol. 8, no. 1, pp. 2–10, 2018, doi: 10.1038/s41598-018-24402-2.

[2] D. Peng, T. Zhou, L. Zhang, W. Zhang, and X. Chen, "Observationally constrained projection of the reduced intensification of extreme climate events in Central Asia from 0.5 °C less global warming," *Clim. Dyn.*, vol. 54, no. 1–2, pp. 543–560, 2020, doi: 10.1007/s00382-019-05014-6.

[3] F. Tangang *et al.*, "Future changes in annual precipitation extremes over Southeast Asia under global warming of 2°C," *APN Sci. Bull.*, vol. 8, no. 1, pp. 6–11, 2018, doi: 10.30852/sb.2018.436.

[4] P. A. Monerie, J. Robson, B. Dong, and N. Dunstone, "A role of the Atlantic Ocean in predicting summer surface air temperature over North East Asia?," *Clim. Dyn.*, vol. 51, no. 1–2, pp. 473–491, 2018, doi: 10.1007/s00382-017-3935-z.

[5] P. M. Forster *et al.*, "Current and future global climate impacts resulting from COVID-19," *Nat. Clim. Chang.*, vol. 10, no. 10, pp. 913–919, 2020, doi: 10.1038/s41558-020-0883-0.

[6] C. A. Keller *et al.*, "Global impact of COVID-19 restrictions on the surface concentrations of nitrogen dioxide and ozone," *Atmos. Chem. Phys.*, vol. 21, no. 5, pp. 3555–3592, 2021, doi: 10.5194/acp-21-3555-2021.

[7] S. Cheval, C. M. Adamescu, T. Georgiadis, M. Herrnegger, A. Piticar, and D. R. Legates, "Observed and potential impacts of the covid-19 pandemic on the environment," *Int. J. Environ. Res. Public Health*, vol. 17, no. 11, pp. 1–25, 2020, doi: 10.3390/ijerph17114140.

[8] C. Le Quéré *et al.*, "Temporary reduction in daily global CO2 emissions during the COVID-19 forced confinement," *Nat. Clim. Chang.*, vol. 10, no. 7, pp. 647–653, 2020, doi: 10.1038/s41558-020-0797-x.

[9] J. Weber, Y. M. Shin, J. Staunton Sykes, S. Archer-Nicholls, N. L. Abraham, and A. T. Archibald, "Minimal Climate Impacts From Short-Lived Climate Forcers Following Emission Reductions Related to the COVID-19 Pandemic," *Geophys. Res. Lett.*, vol. 47, no. 20, 2020, doi: 10.1029/2020GL090326.

[10] Online available: https://power.larc.nasa.gov/data-access-viewer/

[11] Online available: https://go.nasa.gov/32XNeg1

[12] Online available: https://www.icos-cp.eu/gcp-covid19