Exploring the impact of SARS COVID-19 on Environmental Attributes

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Abstract:
Covid-19 which is addressed as one of the major tempting challenges has struck the entire world community with tremendous loss in every sectors. The paper tries to evaluate (i) whether environmental factors like Temperature, Pressure, and Humidity etc. have any impact on the spread of novel Corona virus using statistical tools like Pearson Correlation (ii) the measure by which pandemic has its effect on environmental attributes like air and water quality. The daily Covid-19 cases have been correlated with various weather parameters to determine whether they portray a positive or negative linear variation because of the known fact that climate change has a significant role in the spread of epidemics. The quality of air has started to improve and all other environmental parameters such as water quality in rivers have started giving a positive sign towards restoring as a part of Covid-19 preventive measures. Our findings suggest that there is ample scope for restoring the global environment from the ill-effects of industrial activities through temporary shutdown measures like lockdowns followed.
Key words: Covid-19, Weather Parameters, Air Quality Index, Water Quality Index

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I.   INTRODUCTION

Due to the deadly spread of Corona virus at a higher speed, a great attention is given to find the factors especially environmental factors that act as the carriers of virus to know the way by which it will survive and thereby to reduce the peak of transmission. In 2020, severe acute respiratory syndrome corona virus 2 (SARS-CoV-2), struck the world through widespread human transmission creating a sort of great fear and fright among people all over the globe. It all started with the origin of a novel respiratory disease in late December 2019 in Wuhan, a city of the Hubei Province of China. As a result of increasing death tolls combined with its massive spreading WHO declared Covid-19 as "Public Health Emergency of International Concern (PHEIC)" and thereby as a global pandemic on 30th January 2020. The first case of the COVID-19 pandemic in Kerala (which was also the first in all of India) was confirmed in Thrissur on 30th January 2020. On 12 May 2021, Kerala reported the largest single day spike with 43,529 new cases. As of the study period ranging up to 30th May 2021, there have been 25,14,279 confirmed cases, test positivity rate is at 13.77% (12.76% cumulative), (more than the national average) with 22,81,519 (90.74%) recoveries and 8,641 deaths in the state.

As again the second wave is hitting hard, the fact that there is no conclusive evidence for the carriers of Covid-19 virus till date is pathetic. Even though from the beginning there was a suspect on the environmental factors as the carriers still remains as a suspect itself. Present research works portrays the fact that contagious power is higher in cold climate rather than in hot climate. Apart from Temperature other parameters like Humidity, Pressure and Precipitation is correlated with the daily active case datasets of pandemic within the entire study area. The rate of spreading of virus and the massive hike in the number of patients are correlated using Pearson Correlation. The results of the study indicates that the increase in the number of cases varies positively with Atmospheric Pressure in almost all districts while all other parameters doesn't show a conclusively evident correlation. Though the significance of correlations are feeble, it doesn't give a positive conclusion. The seasonal nature in the outbreaks of respiratory virus infections is a common phenomenon. The mechanism underlying these patterns of climate determination that lead to infection and possible disease transmission is associated with the ability of the virus to survive external environmental conditions before staying in a host. This information could be useful to develop and implement an efficient health information system to control the incidence, and to curb the spread of COVID-19 in the world. Further the study helps to analyse the impacts of weather attributes on Covid-19 spread

The measures to mitigate the spread of COVID-19 pandemic include lockdown, social distancing, isolation, and home quarantine. As a positive seed during the negative times these measures have a positive impact on the environment. The cities in Kerala have always been discussed as a hub of pollution with high

population, heavy traffics and polluting industries leading to high Air Quality Index (AQI) values. But after the declaration of measures like lockdown to mitigate Covid-19 spread, the air quality of Kerala has a whole has been improved. The period of lockdown has acted as a healing period for nature to nourish in all its means. Major impact of reduced human interference with nature has brought drastic change in the quality of air than any other environmental attributes. Along with air, the quality of water also needs to be checked to analyse the natures curing by itself. The situation today is a "reset" for nature and mankind, giving us a prospect to observe and analyse in and around. Outcomes of the study helps the policy makers to adopt better strategies for a better quality of future environment

II. EFFECTS OF WEATHER PARAMETERS ON COVID19

The climate of Kerala, as per Koppen's classification, is tropical monsoon with seasonally excessive rainfall and hot summer except over Thiruvananthapuram district, where the climate is tropical savanna with seasonally dry and hot summer weather. The entire state is classified as one meteorological sub division for climatological purposes. The year may be divided into four seasons. The period from March to the end of May is the hot season. This is followed by the Southwest Monsoon season that continues till the beginning of October. From October to December is the Northeast Monsoon season and the two months January & February winter season. The climate is pleasant from September to February. Summer months March to May are uncomfortable due to high temperature and humidity. The State is extremely humid due to the existence of Arabian Sea to the west of it.

The weather parameters considered for the analysis included Maximum temperature, Minimum temperature, Average temperature, Humidity, Pressure, Sun hour, Wind speed, Wind gust, Precipitation, UV index, Heat Index, Cloud Cover and Dew Point. And the Covid-19 statistical data (active cases). The analysis under Pearson Correlation of each Parameter against Covid19 Active Cases gave some good results, parameters such as the average temperature, dew point, heat index and wind chill showed a negative correlation in almost all districts indicating as one parameter increase Covid-19 active cases decreased, while parameters such as the Atmospheric Pressure, cloud cover, humidity and precipitation showed a positive correlation indicating that as the value of parameter increases the active Covid-19 cases increases. Other remaining parameters showed a mixed relation which can be attributed due to the breaches in social distancing and lockdowns.

But as a whole, considering the extremely high population density of Kerala the effect of weather parameters become secondary and are undermined by social distancing factor and shows feeble impacts. The relationships between confirmed cases or deaths by COVID-19 and environmental factors has been studied throughout Kerala. Atmospheric Pressure and Temperature appears to be the environmental factors most related to COVID-19 spreading. However, those recent results should be weighed with caution. A study performed in several locations across the globe found that environmental factors by them-selves could not explain variations in those cases of confirmed COVID-19.

It is necessary to assess whether environmental factors really have a cause-and-effect relationship for infection cases or deaths by COVID-19. The spread of SARS-CoV-2 is very complex, because the factors involved, including climatic factors, are very heterogeneous and dynamic, even confining observations to a single city during daylight hours. This heterogeneity of climatic factors generates dynamic scenarios that influences the number of confirmed cases. The table shows the results of Correlation between weather parameters and Covid-19 active cases across 14 districts of Kerala:

Table 1: SPSS Pearson Correlations of Weather Parameters and Covid-19 Active cases of Kerala

Districts	Average Temp. ℃	Dew Point	Heat index ℃	Wind Chill ℃	Precipitation Mm	Humidity	Cloud cover
Ernakulam	-0.245**	-0.426**	-0.293**	-0.180**	-0.175**	-0.114*	-0.210**
Kannur	-0.193**	-0.462**	-0.515**	-0.402**	-0.204**	-0.086	-0.184**
Kozhikode	-0.179**	-0.484**	-0.502**	-0.377**	-0.124*	-0.086	-0.177**
Pathanamthitta	0.099	-0.686**	-0.550**	-0.571**	-0.088	-0.357**	-0.310**
Thiruvananthapuram	-0.331**	-0.051	-0.269**	-0.284**	0.063	0.294**	0.122*
Thrissur	-0.119*	-0.347**	-0.350**	-0.285**	-0.118*	-0.129*	-0.149**
Wayanad	-0.340**	-0.217**	-0.194**	-0.162**	0.011	0.104	0.139*
Kollam	-0.11	-0.429**	-0.292**	-0.144*	-0.214**	-0.270**	-0.243**
Kottayam	0.113*	-0.559**	-0.426**	-0.294**	-0.199**	-0.261**	-0.275**
Kasargode	-0.346**	-0.316**	-0.438**	-0.407**	-0.087	0.175**	-0.106*
Malappuram	-0.218**	-0.532**	-0.655**	-0.656**	-0.088	-0.004	-0.113*
Palakkad	-0.303**	-0.254**	-0.347**	-0.326**	0.01	-0.066	-0.158**
Alappuzha	-0.067	-0.300**	-0.138*	-0.071	-0.113	-0.283**	-0.065
Idukki	-0.497**	-0.004	-0.107	-0.109	-0.1	0.269**	-0.120*

*Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed)

III. EFFECT OF COVID-19 ON AIR QUALITY

Air is a dominant and an indispensable component of earth's environment and a slender change in its composition can have miscellaneous effects on growth and development of life forms on this planet. The principal cause for air pollution is industrial release along with automobile emissions. Air pollutants have a lot of unfortunate   effects on countless tenets. In retaliation to the COVID-19 outbreak, Kerala had implemented diverse non-pharmaceutical interventions such as personal protection and   hygiene, physical distancing, restriction of private and public transportation, suspension of educational /commercial/ business/ religious activities, and geographical area quarantine etc. to slow down and to reduce the mortality rates associated with the COVID-19, with the ultimate objective to reach and to maintain the state of low-level or no transmission. However as a blessing in disguise, these measures leads to an improvement in air quality across the state. To arrive convincing conclusion on "effect of covid-19 on pollutant concentration", Pearson correlation test was performed to analyse the data, with a hypothesis that mean pollutant concentration has no effect with the spread of covid-19. The results for different parameters including $PM_{2.5}$, PM_{10}, SO_2, NO_2, O_3, NO, NH_3 and CO is shown in Table 2.

Pearson correlation shows that for $PM_{2.5}$, PM_{10}, NH_3, and CO the sig value is < 0.01 for all stations considered for analysis, leading to rejection of null hypothesis implying that increased number of COVID-19 cases had significant impact on concentration of these parameters. For NO, NO_2, NO_x and SO_2, the sig value is > 0.01 for some stations, which lead to acceptance of hypothesis that increase in number of COVID-19 cases has no impact on their concentration or air quality. The reason behind this may be that there are two major activities which leads to existing concentration of SO_2 and oxides of nitrogen: first, the vehicular activities, which was immediately restored after the national wide lockdown and therefore doesn't create much impact on concentration. Other sources of oxides of nitrogen are burning of fossil fuels which were continued during lockdown.

The main effects of COVID-19 on human health are related to respiratory problems. The respiratory system can also be affected by air pollution, mainly by fine particulate matter such as $PM_{2.5}$, PM_{10} produced by diesel engine combustion, coal and wood burning, and industrial emissions. This fine particulate matter can obstruct the airways, exacerbating the effects of COVID-19. Pearson correlations so far show a positive correlation between $PM_{2.5}$, PM_{10} and COVID-19. Moreover, a recent study showed that fine particulate matter that is $PM_{2.5}$ is a carrier of SARSCoV-2, indicated by the presence of viral RNA, although more research is needed on this matter. The evidence indicates that particulate matter appears to play a key role in the incidence and severity of cases of COVID-19, because it acts as a carrier of viruses, influences lung obstruction, and produces immunological effects by chemicals associated with it. NO and NH_3 shows a negative pearson relation indicating its decreased concentration with increased COVID-19 cases.

In order to understand the extend up to which covid-19 and corresponding lockdown influence the air quality index of Kerala, three major pollutant that is PM $_{2.5}$, NO$_2$ and SO$_2$ concentration are collected for the year 2019 and 2020. The stations chosen for study are located at Plamoodu and Karyavattom (Thiruvananthapuram), Polayathodu (Kollam), MG Road, Vyttila, and Eloor (Ernakulam), Thrissur (Corporation limits), and Thavakkara (Kannur). By comparing the trend lines for these pollutants the reduction in concentration is obtained for six stations. Overall the pollutants are reduced by a percentage of around 16.17 for PM$_{2.5,}$ 10.02 for SO$_2$ and 7.13 for NO. It can be considered as a huge blessing in disguise that due to the measures adopted to prevent the spread of pandemic the environment has healed to a great extent especially the air quality across the study area. The nature has acquired a special sort of greenery along with the returning of many species of birds during these periods. Further, these days gifted us with those skies which we all were waiting for i.e., without the dark lining of pollutants on the cloud margins. It should be noted that within a short span of restrictions during these busy days brought some sort of drastic changes. Thereby it provides a way to the policy makers to rethink on the existing policies and to bring a change in those ones to gift us not only with a very benevolent and nourishing environment but also with fresh and good air

Table 2: SPSS Pearson Correlations of Air Quality Parameters and Covid-19 Active cases of Kerala

Stations	PM2.5 (µg/m3)	PM10 (µg/m3)	NO (µg/m3)	NO2 (µg/m3)	NOx (ppb)	NH3 (µg/m3)	SO2 (µg/m3)	CO (mg/m3)
Kannur	0.282**	0.225**	-0.139**	0.024	-0.04	-0.141**	0.271**	0.782**
Kollam	0.400**	0.499**	-0.078	0.263**	-0.048	-0.179*	-0.092	-0.281**
Thrissur	-0.098	-0.05	-0.286*	-0.266*	-0.254*	-0.243*	-0.449**	0.689**
Thiruvananthapuram	0.224**	0.207**	-0.045	0.225**	0.170*	-0.219**	0.114	0.716**
Vyttila	0.594**	0.589**	0.314**	0.008	0.714**	-0.386**	0.288**	-0.515**
Eloor	0.594**	0.598**	0.402**	-0.036	0.675**	-.391**	0.262**	-0.552**

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed)

IV. EFFECT OF COVID-19 ON WATER QUALITY

Water pollution is a major environmental issue in India. The largest source of water pollution in India is untreated sewage. Other sources of pollution include agricultural runoff and unregulated small-scale industry. Most rivers, lakes and surface water in India are polluted due to industries, untreated sewage and solid wastes. A 2007 study found that discharge of untreated sewage is the single most important source of pollution of surface and ground water in India. There is a large gap between generation and treatment of domestic waste water in India. The problem is not only that India lacks sufficient treatment capacity but also that the sewage treatment plants that exist do not operate and are not maintained.

It was recently reported that the Ganga witnessed a significant reduction in water pollution during the lockdown. Unfortunately, the rivers in Kerala has not been as lucky. Twenty-one rivers including two tributaries are considered to plot the change. The rivers selected for study include Morgal, Uppala, Kallai, Ramapuram, Peruvamba, Kuppam, Kavvayi, Bharathapuzha, Kadalundi, Tirur, Kuttyadi, Karamana, Pamba, Manimala, Kadambrayar, Peruvanna, Karuvannur, Kecheri, Periyar, Puzhakkal, and Chithrapuzha. Water quality parameters concentration were collected for the year 2019 and 2020 april to get the variations in concentrations.

The rivers which shows slight Positive impacts during the study include Ramapuram, Peruvambra, Kadalundi, Karamana, Pamba, and Manimavala where DO level is increased and both BOD and COD level were dropped.Since lockdown did not impact sewage discharge into the river, there was no significant reduction in pollution levels in the Periyar, the longest river in Kerala. KSPCB officials had inspected the industries along the river stretch to check for any discharge from the factories but found nothing. Civic bodies have been asked to regulate the discharge of sewage from households into the river. As per the statement by KSPCB settlement of organic matter was high on upstream Pathalam stretch while the downstream stretch had a high concentration of chloride ions and water conductivity due to saline water intrusion in Periyar. Data collected earlier by environmental scientists at the pollution control board indicated that industrial effluents were not the cause of pollution in the rivers Karuvannur Puzha, and Puzhakkal Puzha. Not many industries are located around their banks. The water quality in these rivers was well within the permissible limits with the faecal coliform measuring below 500 CFU/100 ml and BOD level below 3mg per litre even earlier. Based on these data, there were proposals to exempt them from the list of the most polluted rivers, according to environmental scientists.

The readings taken during the lockdown in April indicate that the BOD level at Kanakkan Kadavu in Karuvannur Puzha was 2.3mg/litre and at Thirukuzhi it was 1.4mg/litre. The corresponding figures during March were 1.2mg/litre and 1.1mg/litre, indicating that the water quality has only dipped, though marginally, during this period. However, the faecal coliform level has reduced at Kanakkan Kadavu from 300 CFU/100 ml (March) to 100 CFU/ml (April) during this period. On the other side, the faecal coliform level has gone up from 300 CFU/100ml to 400 CFU/100 in Thirukuzhi. In the case of Puzhakkal River, the

BOD level at Sobha City area is 1.7mg/ litre in March and rose to 2.3mg/litre in April. However, the faecal coliform level remained static at this point at 100 CFU/100 ml in March and April. The worst case were shown by Bharathapuzha were almost all parameter concentration keeps rising inspite of lockdown and restrictions. Experts said lapses in management of sewage systems seems to be a major factor for the non-improvement of water quality in the rivers.

Table 3: Water Quality Variations in Kerala for 2019-2020 period

Parameters	p^H	Turbidity NTU	COD (mg/L)	BOD (mg/L)	DO (mg/L)	Total Alkalinity (mg/L)	Chlorides (mg/L)
2019	7.76	4.05	7.56	2.82	5.62	43.35	46.02
2020	7.34	2.1	3.99	2.19	5.72	34.76	29.32
Variance	0.42	1.95	3.57	0.63	1	8.59	16.7
Variance %	5.41	48.14	47.22	22.34	1.78	19.82	36.28

V. CONCLUSION

The effectiveness of mandatory lockdown measures to control COVID-19 was analysed by studying the concentration of several environmental pollutants in Kerala. Reduction in economic activities, less road traffic, and state-wide mandatory "stay at home orders" have contributed to lower environmental pollutant emissions. However, it turns into a blessing for the environment. These measures have a positive effect on the environment in terms of reduction in toxic gasses like nitrogen dioxide, aerosols, atmosphere ozone, particulate matter, and improvement in air quality.

The study on the dependence of Covid-19 spread with various weather parameters only showed a feeble correlation. Even though they showed a less significant correlation, some of them showed the correlations in an opposite manner in which they have been supposed to. The correlation of Temperature, Pressure, Humidity and Precipitation is given due importance since they effect the changes of Kerala to a great extent. The study can be considered as a reference for future study on the correlations of pandemic with weather parameters with an improved datasets with hand.

Environmental pollution is the major source of ailments and deaths all over the world. A large population of the world dies due to the diseases associated with air pollution. Therefore, in this distressing time nature is in self-healing mode as many of the harmful pollutant in the world are minimum levels. In this study, the effect on environmental parameters due to the lockdown as a preventive for COVID-19 has been analysed for Kerala. Due to the lockdown, throughout Kerala, a significant reduction in the emissions like nitrogen dioxide, carbon monoxide, sulphur dioxide, ozone and particulate matter has been observed from the results. Clear skies, reduced carbon emissions, and cleaner breathing air are some of the consequences of the lockdown. Similarly, water bodies like the rivers Yamuna and Ganga have shown significant improvement since the enforcement of lockdown. According to the Central Pollution Control Board (CPCB) the water quality of the Ganga has improved and it can be suitable for bathing and propagation of wildlife and fisheries. However, on the other side the pandemic has resulted in an increase in the amounts of bio-medical and hazardous waste. Furthermore, usage of plastics has increased and recycling of wastes has reduced which can be a concern in the future. When the pandemic will be over the concentration of government may majorly focus on reducing unemployment and engaging people in increasing economic activities which could result in neglecting the focus on go green concept, climate change, and environment development in the near future. Therefore, it is necessary for the government to formulate appropriate strategy so that people, economy, and environment are rightly balanced. Therefore, the current situation can act as a wakeup call for the government, policymakers, businessmen, and environmentalists to come together and handle ongoing climate change issues and design a cleaner and greener future for the generations to come.

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