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RESEARCH ARTICLE

IMPACT OF CORONAVIRUS ON AIR QUALITY: BENEFITS OVER HARM?

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Abstract

The coronavirus pandemic is one of the most devastating crises in recent times. The first coronavirus case was reported on the 31st of December 2019 in Wuhan, China (World Health Organization, 2020), and, to date (as of May 2021) more than 170 million cases have been reported, with 3.54 million deaths, in 220 countries and territories (Worldometer). With the advent of the coronavirus, there has been a considerable impact on the environment's air quality. This study does two case studies - in New York and New Delhi - to evaluate the change in air quality before and during the pandemic. The lockdowns led to the closure of public spaces, with limited access to only the essentials. However, owing to the lifting of these restrictions, the emissions of air pollutants have again soared to extremely high levels, outweighing the benefits of the reduction in emissions of pollutants during the peak of the pandemic.

Introduction:-

The coronavirus, which was declared as a "pandemic" by WHO (World Health Organization) on the 11th of March 2020, has had a dramatic impact on the air quality of the environment This novel virus was first detected in Wuhan, China, and has quickly spread to 220 countries and territories, totaling the case numbers to 178,371,838 (as of June 2021) globally. (Worldometer, 2020)

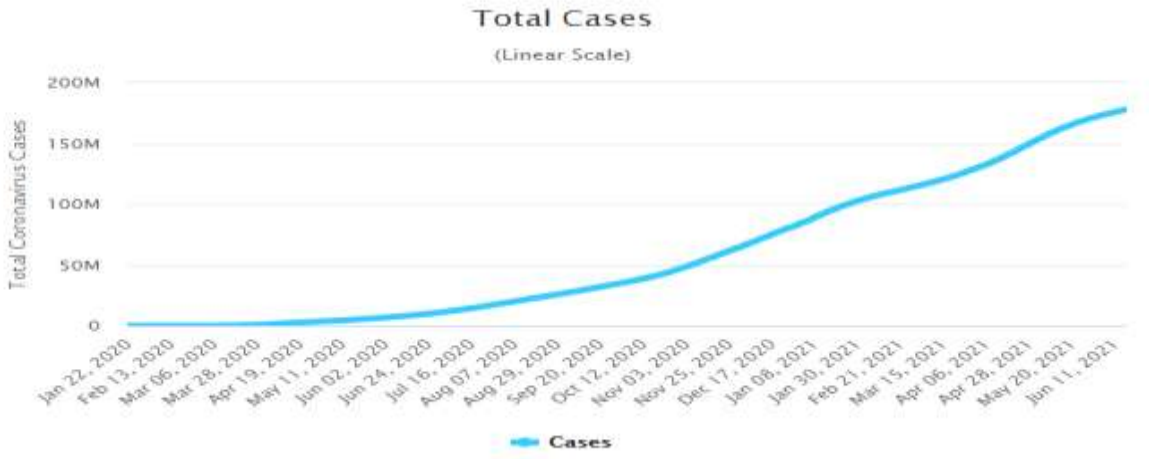

Figure 1:- Total Coronavirus Cases (Worldometer, 2021).

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The virus is spread when aerosols and droplets containing the virus are directly inhaled, and the recovery period from the virus is approximately two weeks, varying on the severity of the infection (World Health Organization, 2020). It poses a greater threat to elderly people and those who have existing medical conditions. This global health concern, spreading at a geometric rate, urged health ministers to announce nationwide lockdowns leading to the closures of schools, workplaces, markets, and other places of public entertainment. This forced more than 3.9 billion people, or half of the world's population, to stay at home, gradually requiring a shift to the work-from-home culture.

Due to this new culture, or what we, nowadays, call the "new normal", there was a considerable reduction in the use of transportation, especially automobiles, airplanes, and railways, as people were required to stay at home and avoid any form of contact with others. According to a study at Rice Kinder Institute for Urban Research, it was found that the VMT (Vehicles miles traveled) decreased from 9 billion miles a day to 7.9 billion - an 11.4% decrease in VMT.

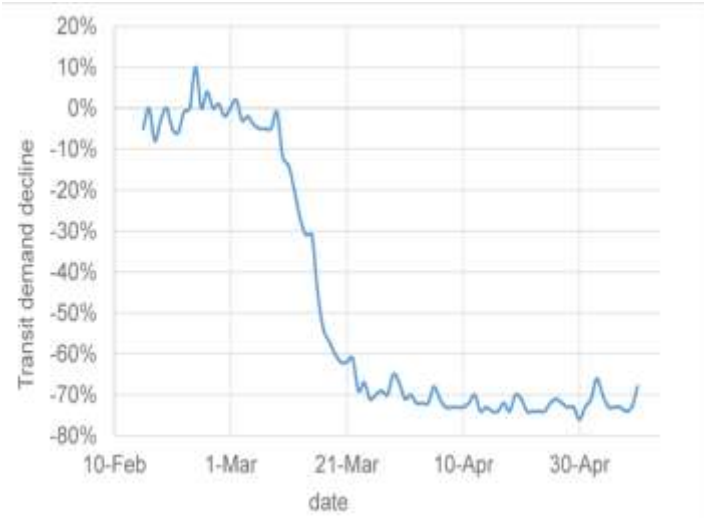

Figure 2:- Temporal Pattern of Average Transit Demand.

The coronavirus pandemic improved air quality in 84% of the countries worldwide. (Yeung, 2021)Transportation is one of the leading contributors of greenhouse gases and particulate matter, and, therefore, this reduction has played a major role in minimizing the air pollutants released onto the environment. Despite the decrease in the pollution levels, researchers estimate the originals levels of air pollution to come up again on the lifting of lockdowns and restrictions imposed due to COVID-19.

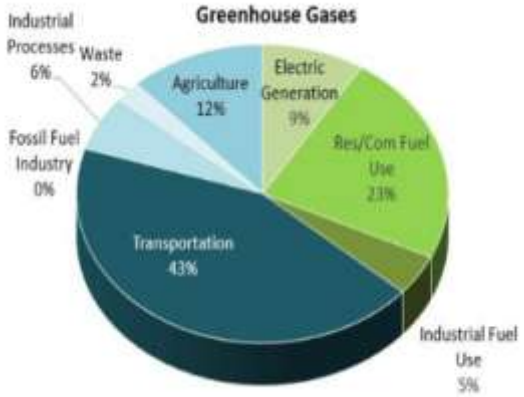

Figure 3:- Gross Emissions by Sector, Vermont 2014 National Emissions Inventory.

This paper studies the impact of coronavirus on the environment using two case studies: New York and New Delhi, and compares their air quality data before and during the pandemic. To understand the pollution levels in these cities, it is important to know the different levels of air pollution (difference in Air Quality Index ranges) and the

health concerns associated with them, as prescribed by the US Environmental Protection Agency The most common diseases caused by increased levels of pollutants in the atmosphere are ischemic heart disease, stroke, chronic pulmonary, lung cancer, and acute lower respiratory infections in children. The air quality levels and the health implications will be discussed in further depth.

Material And Methods:-

This study performs case studies on two cities, New Delhi and New York, using the air quality and the coronavirus data between 2019 and 2021.

COVID-19 data is obtained from Worldometer, a website that provides real-time data of the coronavirus in the world.

Air pollution data is obtained from Environmental Protection Agency, Air Quality Index, and other sources cited in this paper. The comparison of AQIs in different years is based on the AQI's data on two specific dates as shown on the graph.

Air Pollution

Air pollution is the presence of harmful substances in the Earth's atmosphere that can cause harm to human health and the environment. There are various types of air pollutants: gases (ammonia, carbon dioxide, methane, sulfur dioxide, nitrous oxides, etc), particulates (particulate matter, aerosol particles, etc), and solid particles (dust, dirt, soot, smoke, etc). Air pollution is caused by both anthropogenic (influenced by human beings) and natural sources, which include transportation, industrialization, use of fertilizers, burning of waste, volcanic eruptions, and forest fires. These pollutants can cause damage to the human brain, kidneys, heart**,** lungs, liver, and cause respiratory diseases like emphysema. It's a serious health concern, especially in Asian countries, which include but not limited to Bangladesh, China, India, and Kuwait, where air pollution levels pose a significant risk to people's health According to the World Health Organization's estimates, air pollution results in seven million deaths and more than 91% of the world's population lives in places where air quality levels exceed WHO's limits for the acceptable level of air quality. According to a prior study performed to determine the relationship between the mortality rate and the particulate matter present in the atmosphere, it was found that the mortality rate increases by 0.7% per 10 microg/m(3) increase in PM(10) concentrations.

The average US Air Quality Index (AQI) in India, in 2019, was 152, which is considered to be unhealthy by the WHO. However, due to the coronavirus pandemic, in 2020, the air quality in India improved during the initial months of lockdown, while averaging at 141 at the end of the year, which is still considered unhealthy but only for sensitive groups of people.

Figure 4:- New Delhi's India Gate war memorial on October 17, 2019 (left) and on April 8, 2020 (right).

This picture shows the difference in pollution levels in the historic India Gate in New Delhi, India, and is taken before and during the lockdown. A significant improvement has been observed throughout the pandemic in cities globally, especially in the ones polluted heavily like New Delhi.

Air Quality Index Scale And Color Legends

The Environmental Protection Agency (EPA) establishes an Air Quality Index for five major pollutants regulated by the Clean Air Act. These pollutants have a natural air quality standard set by the EPA to protect public health:

- ground-level ozone
- particle pollution (also known as particulate matter, including PM(2.5) and PM(10))
- carbon monoxide
- sulfur dioxide
- nitrogen dioxide

Good: When the Air Quality Index (AQI) is between the range of 0 to 50, the air quality is considered to be at a "good" level, and is expected to propose little or no risk on exposure. The color "green" denotes that the air quality level is good.

Moderate: When the Air Quality Index is between the range of 51 to 100, the air quality is marked as "moderate". This level of air quality is acceptable, but can moderately pose health concerns to people who are very sensitive to air pollution. This quality of air requires children and adults with respiratory diseases, such as asthma, to limit outdoor exposure for a long time. The color 'yellow" denotes that the air quality level is moderate.

Unhealthy for sensitive groups: When the Air Quality Index, or the AQI, is between the range of 101 to 150, the air quality is considered to be unhealthy for "sensitive people", but the common group is not likely to be affected. Those children and adults with respiratory diseases, such as asthma, should limit exposure for extended periods. The color "orange" denotes that the air quality level is unhealthy for sensitive groups.

Unhealthy: When the Air Quality Index is between the range 151 to 200, even the common people begin to experience some form of health effect, with serious damage to sensitive groups of people. Everyone should limit exposure for long periods, while those with respiratory diseases should avoid exposure as a cautionary measure. The color "red" denotes that the air quality level is unhealthy.

Very Unhealthy: When the Air Quality Index is between the range 201 to 300, there are health warnings of emergency conditions, posing health concerns to everyone, without any exception. While people suffering from respiratory diseases should avoid all forms of outdoor activities, everyone else should limit exposure for long durations. The color "purple" denotes that the air quality level is very unhealthy.

Hazardous: When the Air Quality Index is above 300, it's an "alert". It poses serious health concerns to every group of people, not just those suffering from other kinds of illness. Everyone should avoid outdoor exertions. The color "maroon" indicates that the ar quality level is hazardous.

Case Studies

New Delhi

The first coronavirus case in New Delhi was found on the 2nd March 2020, and, to date (as of June 2021), there are over 1.4 million cases. It was also one of the worst-hit cities when the case spiked in India's second wave of the coronavirus. As a preventive measure against the pandemic, it went into a national lockdown on the 24th of March, 2020, until the end of May, thereafter which only the contaminated zones were in lockdown while the other zones had reopened in a systematic approach.

Before the pandemic, in 2019, the average AQI level in New Delhi was 195 (unhealthy), a 4% decrease from the levels in 2018. The main cause of pollution in New Delhi is vehicular emissions, burning of open wastes and organic matter, and overpopulation (30.2 million in 2020). These emissions emit large amounts of sulfur, smog, and haze to the environment. With such high levels of pollution, New Delhi was declared the most polluted capital for three straight years in 2020 and the 10th most polluted city in the world, and the level of contamination remained almost six-fold higher than the specified World Health Organization, also known as the WHO, limits, according to a Greenpeace Southeast Asia analysis of IQAir data.

Figure 5:- New Delhi AQI before (red) and after (blue) the lockdown.

The impact of poor air quality in New Delhi has been devastating, with nearly 54,000 deaths in 2020 and 349,926 deaths in Uttar Pradesh (state surrounding Delhi on one side) in 2019. Nearly 2.2 million, or 50%, of the children, suffer from irreversible lung damage due to the bad air quality in New Delhi.

Due to lockdowns and restrictive measures adopted by the city due to the pandemic, research shows that there has been a significant improvement in air quality in New Delhi. As shown on Real-Time Air Quality Index, particulate matter PM(2.5) dropped from 165µg/m3 (unhealthy level) on the 21st March 2020 to 64µg/m3 (moderate or acceptable level) on 29th March 2020. However, the concentration of PM(2.5) is still twice the WHO exposure limits. The data shown in the two graphs below represent the level of pollutants in New Delhi on 31st May 2020 and 31st May 2019 respectively.

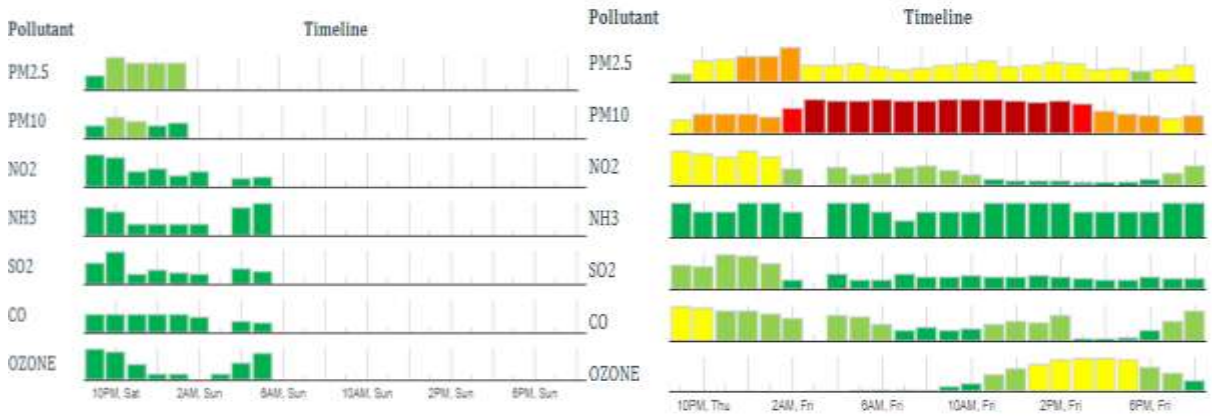

Figure 6:- Pollution Levels in New Delhi on May 31, 2020 (left) and on May 31, 2019 (right).

During the early lockdown months, including March, April, and May (2020), there were an 86% fall in carbon monoxide (CO) levels in New Delhi (Marar, 2021). In addition, there was also an 87.9% decline in nitrogen oxide levels, transportation being the main contributor (Khajuria, 2020).

New York City

The first coronavirus-positive case in New York City (NYC) was found on the 1st of March, 2020, with over 21,05,081 confirmed positive cases as of June 2021. Being one of the most populous cities in the United States, in no time, New York had become the epicenter of the pandemic and went into complete lockdown from March 2020 to April 2020. The businesses, schools, museums, libraries, restaurants, and theatres came to a standstill. The

transition to digital learning and telecommuting led to a complete halt in the transportation industry - including land, air, and water transports - one of the leading contributors of greenhouse gases.

One of the immediate results of lockdown in New York was a 30% decrease in traffic levels as compared to 2019. This reduction directly impacted the emissions of polluting agents and greenhouse gases to the environment, as car pollution contributes to nearly 1/5th, of the United State's global warming pollution.

Despite its dense population, New York has always had an Air Quality Index of less than 50, which comes under the category "good", as considered by the US Environmental Protection Agency, or the EPA. Although the air quality in New York is well within the limits (0-50) prescribed by the EPA, air pollution remains an important health concern to New Yorkers.

Figure 7:- New York City's view before (left) and during (right) the lockdown (Lewis, 2020).

The difference in visibility in the diagrams shown above reflects upon the improvements in air quality in New York throughout the course of the pandemic. The diagram was taken in 2019 when the pollution levels were relatively high as compared to that in 2020.

Although the city observed a reduction in PM(2.5) pollutants, or fine particulate matter, by 25%, as a direct result of the lockdown imposed in New York, the concentration level is still three times the WHO exposure recommendations. The reduction in PM(2.5) levels caused a decrease in the number of deaths and infections caused by the pollutant, which had resulted in over 3,000 deaths and 2,000 hospital admissions for coronary and respiratory conditions annually as reported by the New York Health Department.

The figure below shows the estimated decrease in the levels of PM(2.5) pollution levels during the Covid-19 lockdown period in contrast to the high levels of this pollutant in the years 2015-2018 in New York City.

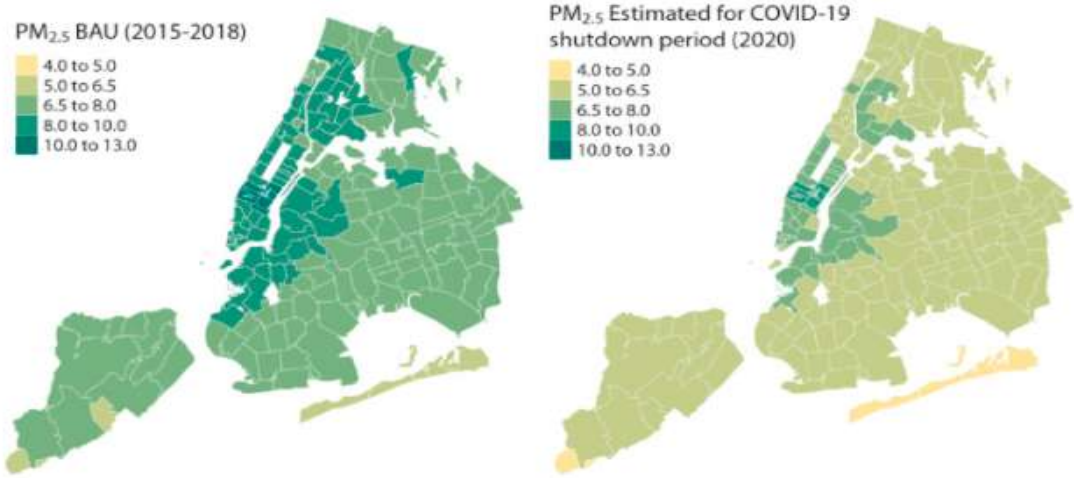

Figure 8:- PM2.5 concentrations across New York City from 2015-2018 (BAU) compared with PM2.5 during the Covid-19 shutdown period (2020).

According to research by Dr. RoisonComanne, an atmospheric chemist at Lamont-Doherty Earth observatory, a monitor that was set to check pollutant levels at the City College of New York campus showed a 10% decrease in carbon dioxide(CO2) and methane (CH4) levels, while a 50% drop in carbon monoxide (CO) levels.

Conclusion:-

The coronavirus pandemic has had a devastating impact on the lives of people, including the innumerable number of deaths, social and economical losses, and financial losses due to the eruption of millions of jobs and increased poverty at an international scale. It has also changed the course of the education system, especially in the poorer countries where technology is not well-adapted and in practice, with everything turning into virtual and students attending classes from home.

However, despite the irreparable losses incurred, the pandemic has had a positive impact on the air quality of the environment all across the globe: improved air quality of 84% of the countries worldwide. There was a 25% fall in the levels of fine particulate matter in New York City, while it dropped from $165\mu g/m3$ to $64\mu g/m3$ in New Delhi. The carbon monoxide levels reduced by 86% and 50% over the course of the pandemic in New Delhi and New York respectively. An 87.9% decrease in nitrogen oxide was observed in the Indian capital (New Delhi), while a 10% reduction in carbon dioxide (CO2) and methane (CH4) levels was witnessed in New York.

Although the decrease in CO2 levels is insubstantial, it brings with it a hope of a cleaner and greener tomorrow. Deaths caused by air pollution in New Delhi in 2020 declined significantly as compared to the distressing figures in 2019 (add the death numbers). However, these environmental benefits are temporary, owing to the lifting of lockdowns and restrictions, which will ramify the unprecedented number of vehicles in the transportation sector. The pollution levels will rise to their original levels, or even increase further, in the coming decades.

Non-governmental organizations like the World Wide Fund for Nature and governmental agencies like the Environmental Protection Agency and the United Nations Environment Programme need to continue to take action to reverse this trend and work towards the implementation of greener technologies in the daily lives of the people. Nevertheless, it requires a collaborative effort from the government and the people to reduce pollution within safety limits.

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