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TRENDS IN AIR POLLUTION CONCENTRATION BEFORE AND AFTER THE PANDEMIC-INDUCED LOCKDOWN: IN HYDERABAD, INDIA.

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Abstract

India's nationwide shutdown began on March 25, 2020. More lockdown phases were added throughout time, and strict restrictions were gradually relaxed as part of the unlocking process, which got underway on June 1st, 2020. Despite being challenging and laborious, the lockout and stage wise unlock periods gave us the ability to gradually assess the air load of automotive pollution. Although doing so would aid policymakers in setting vehicle regulations for a long-term solution to automotive pollution, the bulk of research carried out so far do not contrast pre- and post-lockdown times. The fluctuation of mutually supportive trace chemicals in the atmosphere in accordance to the boldness of their anthropogenic sources would be really fascinating to study. The pandemic-induced lockdown proved to be a blessing in disguise for studying the natural purifying procedures of the environment because there aren't many such studies on India. The alleged enhancements in air quality during the lockdown may serve to relieve severe the COVID-19 distress issue. A consensus on reasonable restrictions for the industrial and transportation industries to minimize trace gas emissions from various anthropogenic sources across the country is created via scientific literature on air quality. In this review, an effort has been directed to elucidate the pattern of air pollution fluctuations that were observed during, before, and after the lockdown, in India, with specific emphasis on the city of Hyderabad.

Keywords: COVID-19, Air quality, Lockdown, Air quality index, Ambient concentration, India, Hyderabad.

1. Introduction

1.1.1 Air quality of India with a specific focus on Hyderabad

Air pollution has grown to be a major issue on a global scale, especially in emerging countries like India. Since obtaining democracy in the 1990s, India has experienced significant urbanization, industrialization, and infrastructural development. In addition, air pollution in India has gotten to the point that it is a major cause of early mortality and a substantial threat to the general public's health. Ambient particulate matter (PM) pollution was responsible for almost a million fatalities in India alone in 2015. Indian cities have continuously been among the top 20 most polluted in the world over the past several years, exceeding the standards for air quality established by the Central Pollution Control Board and the World Health Organization (CPCB). The primary causes of PM, the most persistent kind of pollution, in many parts of India include dust, homes, electricity, and industrial sources (Garaga et al.,2018). The National Clean Air Programme (NCAP) released a five-year action plan in 2019 with the aim of reducing PM by 30% countrywide to address the severe air pollution in the nation. Can the predicted decrease in air pollution be achieved with good strategy and execution? The answer is unclear since nonlinear atmospheric mechanisms that control air pollution levels also have a substantial influence on pollution generation.

Government agencies employ an air quality index (AQI) to tell the public how polluted the air is now or is expected to be in the future. The air quality index is produced by aggregating data from an air quality sensor, which may increase due to traffic, forest fires, or other possible causes of increased air pollution (AQI). Ozone, nitrogen dioxide, and sulfur dioxide are a few of the contaminants that are evaluated. Health risks for the general public increase when the AQI rises, especially for small children, the elderly, and those with pre-existing respiratory or cardiovascular disorders. Governmental agencies frequently encourage residents to limit or even stop their outdoor activity at particular times (Ravindra et al.,2016).

Immediately after, the Indian government proclaimed a total state of emergency, prohibiting all domestic and foreign trains, planes, and automobiles save from those required for absolutely necessary travel, beginning on March 24, 2020, and continuing for 21 days (until 14 April 2020). Absolute lockdown was unheard of in any other country; this level of closure was only ever experienced in India. This impulsive decision impacted the poor and migrant workers in large cities like Delhi and Mumbai(Navinya et al.,2020). Because they were paid daily, these migrant workers were unable to survive if they lost their jobs. Migrant workers in Delhi and Mumbai even started to walk from far regions to their hometowns because there were no transit choices available. Poor air quality and atmospheric pollution are widespread in India's northern areas, and they are mostly brought on by pollutants from automobiles, businesses, brick kilns, coal-fired power plants, and the burning of agricultural waste. For instance, New Delhi, the capital of India, has more pollution overall and poorer air quality than Beijing. The air quality may improve when emissions from diverse sources are tightly managed. Regulators may be able to enhance their air pollution reduction plans using this information. Over the past 20 years, urbanization and industrialization have rapidly increased in a number of Indian cities. Hyderabad, the capital of Telangana State, is one of the nation's fastest-growing, biggest urbanized, and most industrialized cities. The industrial and transportation sectors caused the air quality over Hyderabad to drastically deteriorate(Yerramsetti et al.,2013). Using a chemical mass balance receptor model to quantify the sources of particulate matter over Hyderabad, it was shown that road dust and vehicle exhaust accounted for more than 60% of all pollution.

1.1.2 Major air pollutants in India

In South Asia, especially India, the adulteration of gasoline and diesel with less expensive fuels is quite frequent. Some adulterants cause hazardous pollutant emissions from moving cars to rise, hence exacerbating urban air pollution. The tailpipe emissions of hydrocarbons (HC), carbon monoxide (CO), oxides of nitrogen (NOx), and particulates are all increased by adulterated gasoline (PM). Both benzene and polyaromatic hydrocarbons (PAHs), which are air toxic emissions that come under the category of uncontrolled emissions, are well-known carcinogens. Kerosene has a harder time burning than gasoline, and even in cars with catalysts, the addition of kerosene results in higher levels of HC, CO, and PM emissions. Kerosene's higher sulfur concentration is another issue(Kumar & Mishra, 2018). Compared to what they would if there was less traffic congestion, Indian cars use a lot more gasoline, have a large carbon footprint, and produce air pollutants 4 to 8 times more frequently. Particle and heavy metal emissions increase over time because measures to minimize emissions lag behind fleet and mileage growth.

1.1.3 Initiatives taken for improving air quality in India

Traffic Junction Air Pollution Abatement Plan

DST and CSIR-NEERI have developed Wind Augmentation and Air Purifying Unit (WAYU) devices that may be deployed in commercial structures, apartment buildings, and educational facilities adjacent to traffic road junctions or barriers in an effort to lessen air pollution. To mitigate airborne poisons and remove active pollutants from the air, this device principally uses two ideas(Gulia et al.,2022). The system would employ low-speed wind generators and filters of the appropriate size for a long operating cycle at a respectable efficiency. "Additionally, it will have an oxidizing unit for the removal of hydrocarbons, such as carbon monoxide and VOCs. WAYU can reduce PM10, PM 2.5, carbon monoxide (CO), volatile organic compounds (VOCs), and hydrocarbon airborne emissions (HC). In order for this device to work, it largely relies on two ideas: active pollution removal and wind generation for air contaminant dilution. Every day, the appliance consumes half a unit of energy to run for 10 hours."

2. Landfill Fire Control Mechanism through Integrated Approach

"Landfills are the ultimate disposal option adopted in India. In India, most of the landfills are non-scientific and non-engineered which do not have any leachate and gas collection systems. Open burning of waste and landfill fires are among the largest sources of air pollution in Indian cities and towns(Bedi & Toshniwal,2021) . Landfill fires emit nearly 22000 tons per year of pollutants into the air in the city of Mumbai alone. These pollutants include Carbon Monoxide (CO), Hydrocarbons (HC), Particulate Matter (PM), Nitrogen Oxides (NOx) and Sulfur Dioxide (SO_2) plus an estimated 10000 TEQ grams of dioxins/ furans. In view of these facts, this project will understand the cause, source, type and effects of fire in a dumpsite/landfill and to develop an integrated approach for its proper control".

Suddha Vaayu: An Electrical Chamber for Detection and Mitigation of Air Pollution

There are two stages to the planned project. The electrical abatement chamber sample would be constructed initially. The purifying procedure is broken down into three parts in the suggested prototype. Large particles will be eliminated in the first step utilizing metal mesh or any other best available approaches. In the following stage, a fiber filter with a 5 m pore diameter will be used to get rid of PM 10 emissions. The third phase will use a paper-made rundfilter with a 2 m pore diameter to get rid of PM 2.5. The walls of the abatement device have been coated with silica gel to lessen the quantity of moisture in the air. In alternative to using external electricity, the mitigation equipment may be powered by the solar energy generated by the panels mounted on top of it. This system is frequently powered by a 250 watt solar panel with a 24 volt input. For the elimination of PM 2.5 and PM10, the electrical chamber efficiency of the SuddhaVaayu system is predicted to be between 88 and 90%. Based on the outcomes of the first phase, the second phase will include the manufacturing and deployment of several pilot chambers at various Delhi sites(Balakrishnan et al.,2019). The thorough air quality sensor platform developed and validated as a deliverable of this project will be utilized to examine the pilot units' ability to function in real time.

1.1.4 Impact of Covid-19 on the air quality of India

The COVID-19 outbreak among patients and its effects on the Indian healthcare system were both slowed down by the lockdown procedures. The prohibition on industrial activity and public transportation resulted in a large reduction in anthropogenic emissions. Numerous studies also showed that considerably reducing emissions had a positive influence on air quality and had a major impact on the growth of air pollution. Therefore, the lockout provides a vital opportunity to assess how rapidly anthropogenic emissions have fallen and how this has affected air quality(Singh & chauham(2020).

Additionally, it was claimed that pollution levels had significantly dropped in a number of locations. The majority of Indian research claimed that PM2.5, or particles with an aerodynamic diameter less than 2.5 mm, had decreased by 50%. Even after large emission reductions, severe air pollution events persisted due to unfavorable meteorological conditions, and a rise in ozone (O3) quantities were observed. Additional analysis reveals that, in contrast to what was anticipated given the execution of the stay-at-home order, the COVID-19 pandemic lockdown had a less significant effect on PM2.5 and O3 pollution levels. Therefore, the implications and potential results of lockdown strategies are yet unknown.As a result, it's crucial to thoroughly understand the mechanisms involved in producing air pollution both before and after significant changes in emission levels, as well as comparing air pollution levels. According to the National Air Quality Index, India's overall air quality, particularly in Delhi, significantly improved between 24 March and 14 April. The percentages of the main air pollutants have been determined to have decreased dramatically as a result of emission reductions(Mahato et al.,2020). It has also been claimed that both Delhi and Mumbai exhibit a declining trend in the concentration of important pollutants like PM2.5. These research demonstrated that the air quality improved during the lockdown relative to the period just before lockdown, depending on the lockdown's length. Aerosol concentration levels were also stated to have been at their minimum during lockdown compared to the comparable time period in previous years, thus according to satellite data.In Gujarat state in western India, the Air Quality Index (AQI) increased by 58 percent during lockdown compared to 2019. In comparison to 2019, the mean PM2.5 concentration fell by 42.25 % from January to May in 2020. In a similar vein, the Indo-Gangetic Plain (IGP) cities all saw significant drops in PM2.5 levels compared to 2018 and 2019. These observation-based studies only revealed the phenomena of concentration reduction and switching of major primary pollutants, mostly in big centers, therefore it is unclear how climatic circumstances and chemical reactions contribute to changes in air quality(Shehzad et al.,2020). India's observation statistics are limited as a result of the country's small figure of monitoring stations and uneven distribution according to the criteria set by the regulatory agencies.

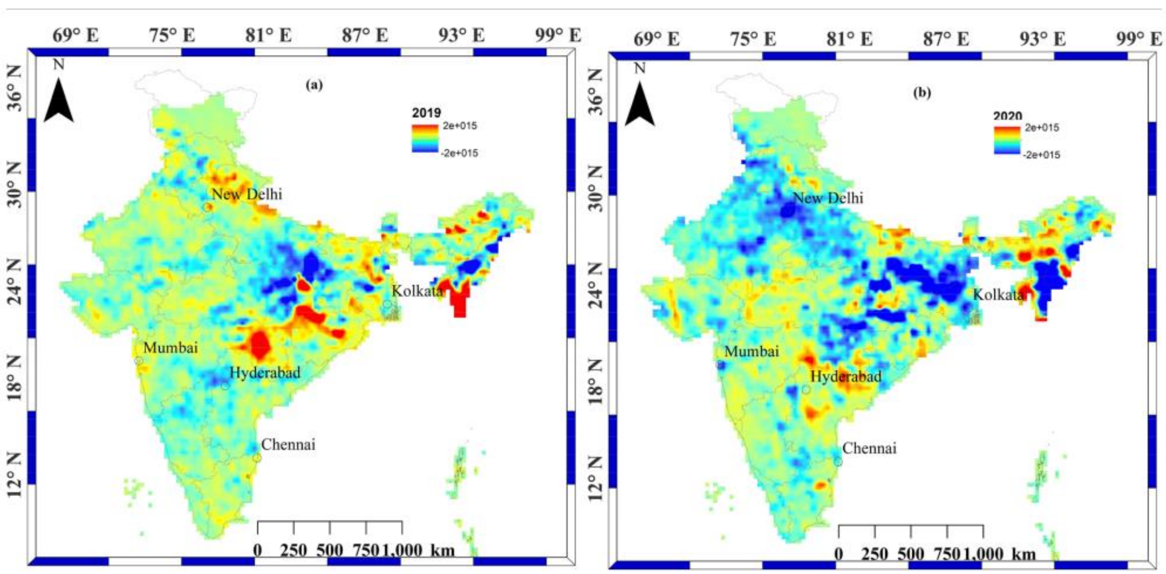

Figure 1: "The disparity in tropospheric NO2 spatial fluctuations across India for before and after concentration during (a) 2019 and (b) 2020 adapted from Singh & Chahuan(2020)".

1.2 Aims and Objectives of the study

The aim of the present study is on analyzing the changes in air quality patterns during the Covid-19 lockdown and compares it with prior and posts the

pandemic.

In alignment with the aim of the study, the objectives of the study are:

- To analyze majorly the ambient air quality of Hyderabad city and surroundings during the three phases of the lockdown period - before, during and after the COVID 19 pandemic [Before conditions – November 2019, During conditions – April 2020, After conditions – April 2022].

- To understand the level of pollutant accumulation during these phases considering PM2.5, PM10, NOx, SO2, CO, NH3, Benzene and ozone.

- To evaluate the air quality by ambient air quality monitoring data from TSPCB using statistical methods and considering meteorological parameters

- To assess hourly averaged data from the air quality monitoring stations

- To provide recommendations for decision and policy makers to address air pollution control measures ahead and potential future challenges.

2. Body of review

2.1 Air quality trend in Indian metropolitans

"Even though the less stringent NAAQS for PM (National Ambient Air Quality Standard) standards are not even met, almost all of India's population lives in areas where the WHO Air Quality Guidelines are surpassed.India's median exposure to PM2.5 is 66 g/m3, with lesser and greater limits of 45 g/m3 and 97 g/m3, respectively, according to WHO air quality models. Despite the country's poor air quality, there is little to no monitoring of air pollution levels in rural and small towns, let alone in the biggest cities. The Central Pollution Control Board of the Government of India and its corresponding state-level boards presently operate 92 PM2.5 and 573 PM10 monitoring sites. These figures are small in a nation with a 3.3 million km2 land area, nearly 1.3 billion people, and a city population of 34%."

A megacity, according to the United Nations, is a metropolitan area having at least 10 million inhabitants. Despite a projected 30% increase by 2020, World Urbanization Prospects estimates that 9.9% of the global population resided in megacities in 2011. By 2025, that percentage is projected to rise to 14.1%. Due to their high population density, megacities place a substantial strain on the environment, human health, basic urban infrastructure, and utility services.

"A study's creation of the multi-pollutant index (MPI) revealed that just 5 of the world's 18 megacities were evaluated as having "fair" air quality, while the other 13 had "poor" air quality. With an MPI of 0.92, Delhi was ranked seventh among the 18 megacities considered for air quality, trailed by Kolkata on MPI-0.59 and Mumbai on MPI-0.39. According to the World Air Quality Report 2021 by IQAir, a Swiss-based air quality technology company, Hyderabad was ranked as the fourth-worst polluted city in India in 2021 with a rise in PM 2.5 levels from 34.7 micrograms per cubic meter of air in 2020 to 39.4 in 2021".

2.2 Ambient pollutant concentration during the lockdown period

"The majority of the examined cities in India exhibited a significant drop in AQI values for all of the air pollutants (met adjusted) during the COVID period versus the reference period. For all pollutant AQIs, an average drop of greater than 24% has been seen across all cities; PM2.5 reduced by 45%, PM10 declined by 48%, and CO decreased by 41%. The NO2 AQI has shown the greatest reduction across all cities, with a total reduction of 52% when the majority of the cities are taken into account." The decline in PM pollution and gaseous pollutants throughout the lockdown is accurately outlined by the decrease in transportation and industrial activity (CO and NO2). The concentrations of SO2 and O3 were also reduced during the lockdown phase than they were during the direct relation, with the exception of a small number of cities in which these species showed an increase in concentration even during the lockdown phase when compared to the control period.

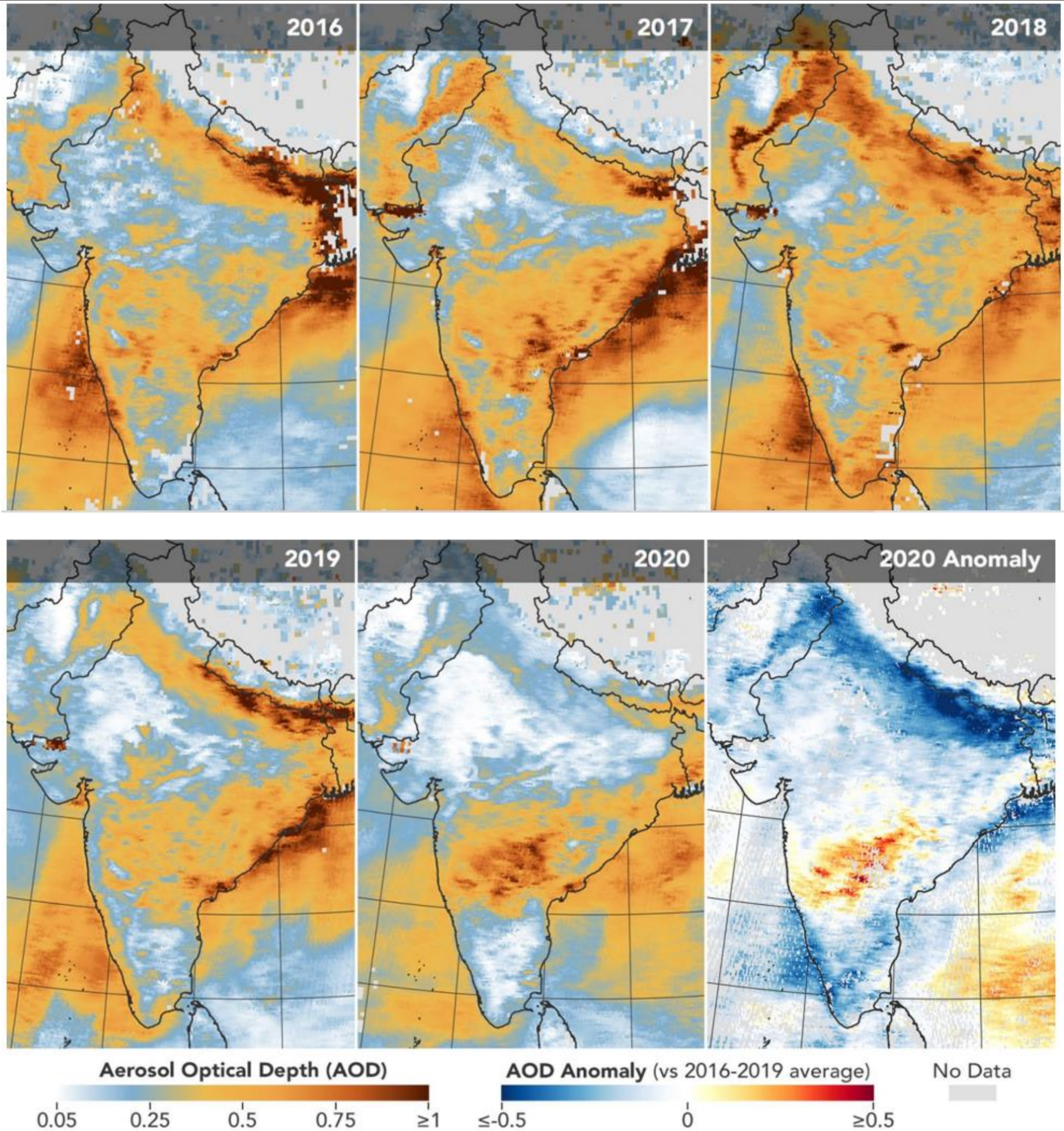

Figure 2: "Sequence representing concentration of aerosol optical thickness in India from the period of March 31 to April 5 in 2016, 2017, 2018, 2019, and 2020 (NASA 2020)".

2.3 Impact of vehicular traffic on atmospheric emissions

Analysts estimate that one-third of regional and local air pollution is caused by automobiles. PM2. 5 levels in Hyderabad were 70.4 micrograms per cubic meter of air. This was 14.1 times the World Health Organization's annual air quality guideline value (WHO). The biggest sources of pollution, particularly Particulate Matter (PM) 2.5, or minute particles, were industries and cars. According to analysts, one-third of the city's air pollution is caused by automobiles. PM2.5 levels in Hyderabad were 70.4 micrograms per cubic meter of air. This was 14.1 times the yearly air quality guideline value recommended by the World Health Organization (WHO). Scientists contend that vehicular pollution, rather than the burning of solid waste or the usage of fossil fuels, is the primary factor contributing to Hyderabad's declining air quality. Like many other cities throughout the world, particularly those in India, Hyderabad's air quality did not reach the WHO's 5 micrograms per cubic meter of air standard. "Hyderabad was judged to be the fourth-worst polluted city in India in 2021, according to the World Air Quality Report 2021 by IQAir, a Swiss-based air quality technology business, with an increase in PM 2.5 levels from 34.7 micrograms per cubic meter of air in 2020 to 39.4 in 2021. Between 2017 and 2020, the city's PM 2.5 concentration decreased, and this was credited to environmentally friendly driving and stringent car emission standards". The study discovered that while PM 2.5 values peaked in December at 68.4 micrograms, they averaged 39.4 micrograms per cubic meter of air in 2021. The average amount of PM 2.5 in the air in July was 12 micrograms per cubic meter, which is generally better. Even yet, this is a factor of two above the WHO-permitted maximum of 5.

2.4 Emission reduction in Hyderabad, India

In terms of reducing pollution, Hyderabad did well throughout the lockdown. The information that was provided painted a clear picture of the contaminants' quick reduction. During a research (Gautam et al., 2021) there was a significant drop in NO2 with a loss of 46% within two weeks of lockdown. But prior to lockdown, NO2 concentration likewise rose to comparable rates. By the end of the eight weeks of lockdown deployment, other contaminants also decreased. “The weekly average level of pollutants before lockdown were 81.85 ± 15.36 µg/m3 (PM2.5), 91.85 ± 8.61 µg/m3 (PM10), 51.28 ± 3.35 µg/m3 (NO2), 2.71 ± 0.76 µg/m3 (SO2) and 58.28 ± 6.23 µg/m3 (CO). The weekly pollutants in the second last week (sixth week) of the study were 65.40 ± 3.91 µg/m3 (PM2.5), 59.57 ± 4.07 µg/m3 (NO2), 4.28 ± 0.75 µg/m3 (SO2) and 31.28 ± 19.49 µg/m3 (CO). The gaseous pollutants have been observed to be increasing after a few weeks of lockdown, which was due to the relaxations given to the public.”

2.5 Ways of emission reduction and normalizing the work-from-home as an option

Among the most noticeable and long-lasting modifications to the way we live that the COVID-19 epidemic has brought about is working from home.Freelancing or working from home grew even before the pandemic because of the potential economic, social, and environmental benefits. Working from home saves time and money on transportation by removing the need for it. Lower greenhouse gas emissions will eventually be the outcome of less travel. The quantity of gas emitted will be dramatically decreased if all workers begin working from home, even for a small period of the week. Warming of the planet is caused by greenhouse gasses. The combustion of fossil fuels is the main human activity that contributes to the creation of these gasses. Because of how much gasoline is used by car engines, there is dangerous pollution (YILDIRIM,2021). Mobility emissions are produced by vehicles like cars, vans, employee minibusses, light-duty trucks, and SUVs that utilize fossil fuels. Because there are less gas emissions, the air is cleaner and safer. Cities are experiencing backed-up traffic. When pollution levels increase, more individuals become unable to breathe clean air, which exacerbates pre-existing respiratory conditions like asthma or lung infections. One-third of the total quantity of nitrogen dioxide in the atmosphere is produced only by driving automobiles on the road. Since fewer automobiles would be on the road as a consequence of remote employment, the environment would be cleaner and greener (Zhao et al.,2021).

Research Gap:

Hyderabad being the mega city is notorious for being one of the most polluted city, the quality of air in the city has only been declining, from couple of years, imposing threat to the health of localites, however the trend of improvement that was observed at the time of covid pandemic has given a ray of hope, to cope up with the air pollution problem of the city. Not only in Hyderabad but almost every important urban city has seen improvement in their air quality. However the research emphasizing specifically on the evaluation of air pollution pattern is scarce, for the state of telangana and the city hyderabad. Therefore, the research if conducted in this area would be beneficial, as it would confer with the understanding of the primary and the associated factors more precisely which lead to the air pollution at such large scale in hyderabad, and may provide insights which may lead to bridge the knowledge gap and eventually would assist in reduction of air pollution in Hyderabad.

Conclusion:

The COVID-19 necessitated lockdowns all across the world. Due to the ban on outdoor activities, including travel, industry (which includes essential industries like the food, pharmaceutical, and power industries), operational environments, the tourism industry, construction, and other anthropogenic sources, the thresholds of APs have evolved dramatically throughout the board. The air pollution trends began to decrease over the entirety of India. As a result of the lockout, the region is now densely populated and polluted, and people have new ideas about how to lessen air pollution there. Some locations, most notably Kolkata, Mumbai, and Delhi, saw a significant improvement in AP levels as a result of lower anthropogenic pressure.

“The air quality above Hyderabad is impacted by the government's COVID-19 response measures, according to several studies. We observed an overall reduction in PM2.5 (27%) and PM10 (34%) levels compared to readings before the lockout. The government's restrictions on industrial, construction, and transportation activity during lockdown cause PM concentrations to drastically decrease. Comparing PM levels in 2020 to the same period in 2018 and 2019, COVID 19 epidemic standard precautions showed a significant drop in PM levels. Despite lower concentrations, PM2.5 still makes up 46% of PM10 during lockdown, which is the same as in prior years.” In addition to particulate matter, there was a large decline (33%) in NO2, which may have been caused by the lockdown's restriction on industrial and transportation operations that decrease NO2 emissions. Another noteworthy finding was that, during the research period, the mean concentration of other air pollutants only slightly increased and continued to be within permitted levels (NAAQS). The current results offer the authorities hope that if the air quality control policies are implemented strictly, a remarkable increase in air quality might be anticipated.

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