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Research Paper

Comparison of the air quality within the northern region of India both during and after the lockdown

Nabin Sharma[1*], Kalpana Patel[2], Sarvan Kumar[3]
[1*,2]Department of Physics, SRM Institute of Science and Technology, Delhi-NCR Campus, Modinagar, Ghaziabad, India.
[3]Department of Earth and Planetary Sciences, VBS Purvanchal University, Jaunpur, Uttar Pradesh, India.

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ABSTRACT

The World Health Organization (WHO) declared COVID-19 a global pandemic due to the novel infectious coronavirus disease found in late 2019. Some positive impacts have been seen on the natural environment during the outbreak of COVID-19. In this study, we have tried to analyse the impact of lockdown on air quality at four major northern states of India (Delhi, Uttar Pradesh, Rajasthan, and Haryana) located in the National Capital Region (NCR). This study compared the variation in air pollutants during the first lockdown phase (25th March to 15th April) 2020 and after the lockdown phase (25th March to 15th April) 2022, including PM10, PM2.5, NO2, and SO2. The average concentration of PM10, PM2.5, NO2, and SO2 reduced by 70.43%, 64.7%, 66.37%, and 36.89% over National Capital Region (NCR) during the lockdown phase. A good pollution control plan can lead to significant improvements in air quality in the future, which should provide confidence to policymakers involved in developing air quality policies.

Corresponding Author:
Nabin Sharma
Department of Physics, SRM Institute of Science and Technology, Delhi-NCR Campus, Modinagar, Ghaziabad, India.
Email: ns6153@srmist.edu.in

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1. INTRODUCTION

In recent decades, one of the most harmful and critical problems in the world has been air pollution. Due to the fast-rising trends in urbanization, industrialization, population, and accompanying

energy demands, particularly in developed nations like China, India, Brazil, etc. [1], [2], [3], [4]. Not much long back the worldwide human population was consequentially affected by the coronavirus pandemic (Covid-19). In March 2020, the World Health Organisation (WHO) declared Covid-19 to be a worldwide pandemic and advised global action to reduce its negative consequences. Hence, as a confinement step, many governments put their nations under lockdown through the end of March 2020 [5], [6]. On 30 January 2020, the state of Kerela reported the first confirmed case of COVID-19. (WHO 2020a). Several new cases have been reported since 4th March 2020 in other regions of the country. On 12 March 2020, COVID-19 caused the first death in the country. (WHO 2020b). A 14-hour curfew was declared by the Prime Minister on March 22, 2020, as the number of COVID-19 cases reached 500. On 24th March 2020, the Indian government issued a complete nationwide lockdown starting at midnight for 21 days. A preventive measure was urged by the government to manage the worsening pandemic of the disease in the country by strictly following social distancing measures. (https://www.mha.gov.in/).All public meeting places, including restaurants, movie theatres, schools, commercial complexes, and even educational institutes, were under lockdown for the entire duration. Road, rail, and air transportation services were all prohibited apart from those that were mostly and majorly necessary. Due to a reduction in commercial activity and transportation, the whole lockdown had a severe economic impact on the nation, but it also significantly reduced air pollution [7]. Thus, the major lockdown situation presents a unique research opportunity to assess how human activities affect greenhouse gas concentration and air quality and their effects on both a global and regional scale. In terms of environmental mitigation and sustainable development, this data will be helpful to policymakers [4]. The present study examined air quality variation across the National Capital Region (NCR) (Indian states of Delhi, Haryana, Rajasthan, and Uttar Pradesh) during the lockdown period of 2020 and after the lockdown in the same period of 2022. PM10, PM2.5, NO2, and SO2 levels were compared. Air pollutants were measured during the first lockdown phase (25th March to 15th April) 2020 and after the lockdown phase (25th March to 15th April) 2022. During the lockdown phase, the average levels of PM10, PM2.5, NO2, and SO2 in the National Capital Regio n (NCR) decreased by 70.43%, 64.7%, 66.37%, and 36.89%, respectively.

2. DATA METHODOLOGY

In the National Capital Region (NCR), data from four Indian states were analyzed to determine how the lockdown affected air quality, including Delhi, Haryana, Rajasthan, and Uttar Pradesh. The Central Pollution Control Board (CPCB) internet site was used to get the air quality data for the time periods of 25th March to 15th April 2020 and 25th March to 15 April 2022. The online portal (https://airquality.cpcb.gov.in/ccr/#/caaqm-dashboard/caaqm-landing/data). The National Capital Regions are overrun with several industries, including those in the textile, pharmaceutical, and leather sectors [8], [7]. In addition, these regions have large population densities, with most people being employed, which adds to the intense traffic on the roads. The two primary causes of air pollution in these areas (NCR) are industrial emissions and the daily routine of traffic. In the current study, the hourly concentrations of five major air pollutants were used: nitrogen dioxide NO2, sulphur dioxide SO2, particulate matter with a diameter of 2.5 to 10 μm (PM10), and particulate matter with a diameter of 2.5 μm or less (PM2.5). The air quality trends were evaluated in two phases: during the lockdown period (25th March to March 15th April 2020) and after the lockdown period (25th March to 15th April 2022). The daily (24h) concentrations of PM10, PM2.5, NO2, and SO2 have been calculated to look at the difference in their mean concentrations between the lockdown and after-lockdown periods.

3. RESULT AND DISCUSSION

The countrywide lockdown that India imposed on March 25th, 2020, significantly improved the country's air quality. This section contains an examination of air quality data during the lockdown period (25th March – 15th April 2020) and the post-lockdown period (25th March – 15th April 2022) at four northern states of NCR (Delhi, Haryana, Rajasthan, and Uttar Pradesh).

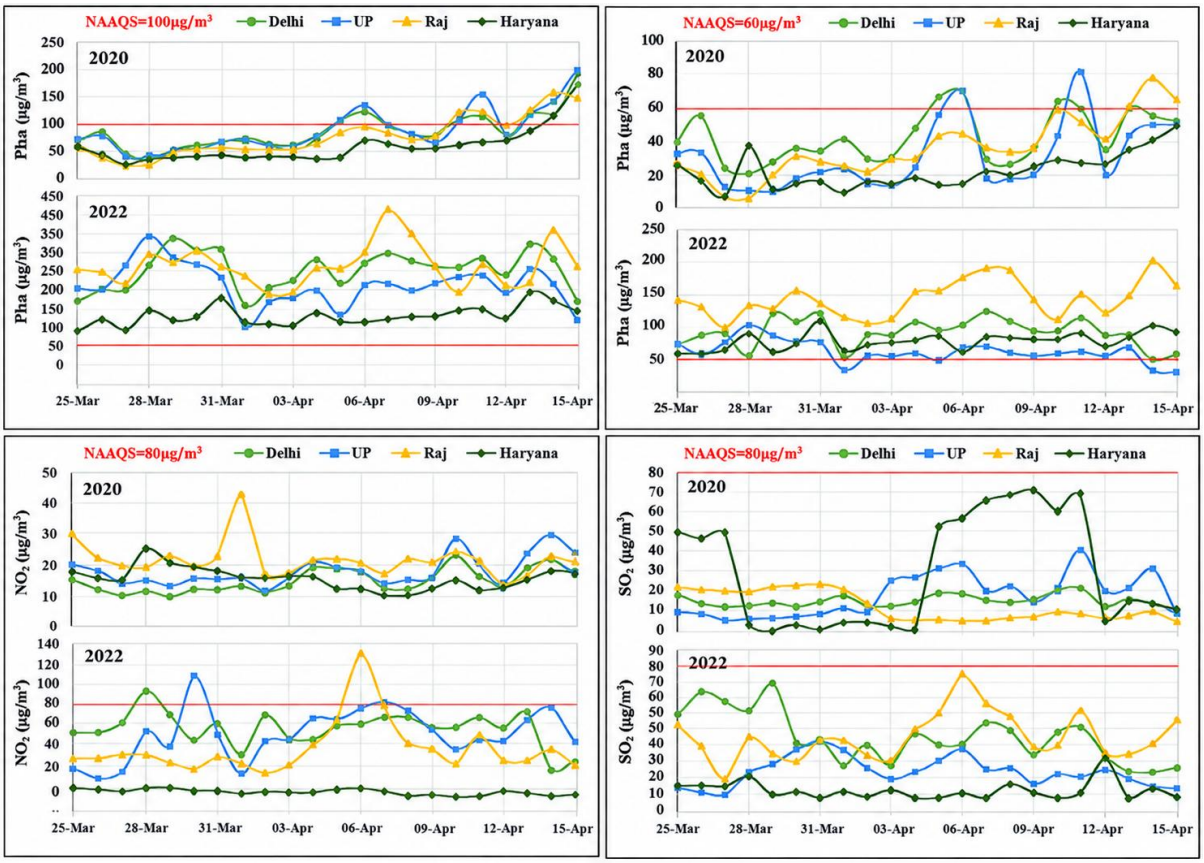


Figure 1. Daily (24 H) Concentrations of PM10, PM2.5, NO2, and SO2 between 25th March To 15th April 2020 and 25th March to 15th April 2022 in Four Northern States: Delhi, Haryana, Rajasthan, And Uttar Pradesh

The daily concentration of significant air pollutants is shown in Figure *1*, during the lockdown (25th March – 15th April 2020) and post-lockdown (25th March – 15th April 2022) phases for Delhi, Haryana, Rajasthan, and Uttar Pradesh. During the lockdown period, a considerable drop in the daily concentration of PM10, PM2.5, NO2, and SO2 was seen in Delhi, Rajasthan, and Uttar Pradesh (Figure *1*). Apart from SO2, daily concentrations of three air pollutants (PM10, PM2.5, and NO2) are much lower in Haryana during the lockdown period. Based on this data, the unique result of this study is a significant decrease in the daily concentration of SO2 during the post-lockdown period While NO2 and SO2 levels during the post-lockdown phase were approx. 80% lower than the NAAQS daily standard values. There were 16 out of 22 days in the post-lockdown phase where PM10 values were within the daily standard limit set by the National Ambient Air Quality Standards (NAAQS) [9].

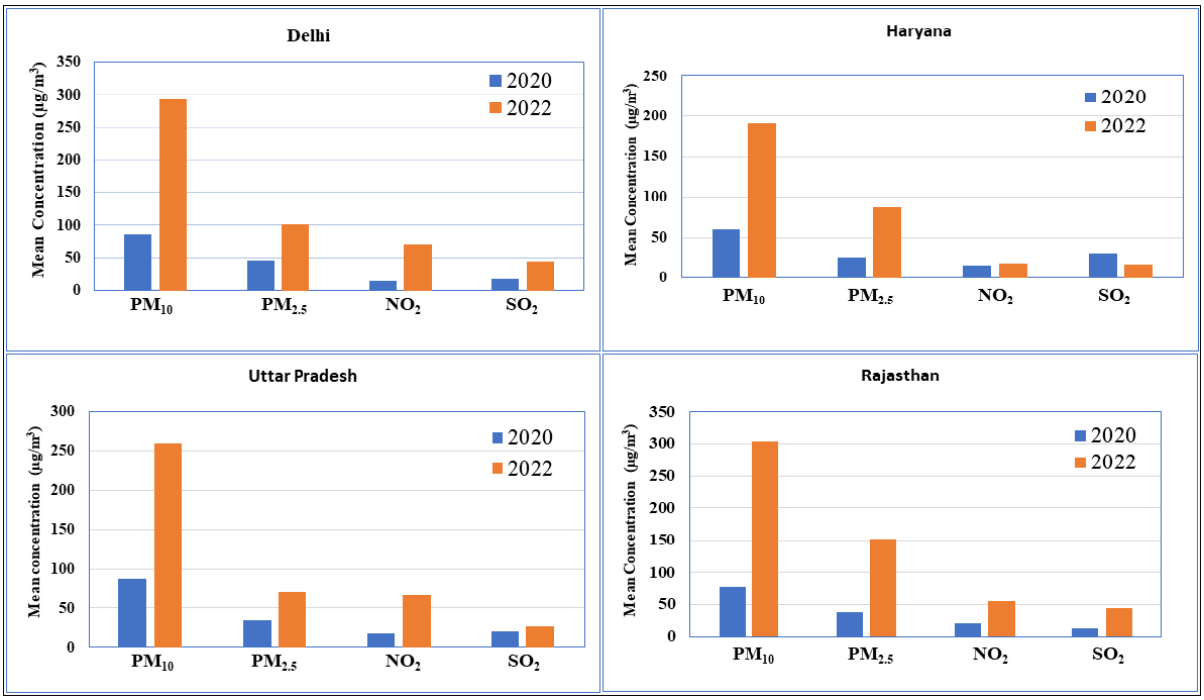


Figure 2. Variations in Concentrations Based on Mean of PM10, PM2.5, NO2, and SO2 During the Lockdown 2020 and After Lockdown Phases 2022 in (A) Delhi, (B) Haryana, (C) Rajasthan, and (D) Uttar Pradesh

During the lockdown period, a considerable drop in the mean PM10, PM2.5, NO2, and SO2 concentrations was seen in Delhi, Rajasthan, and Uttar Pradesh. Figure 2 in contrast, all three air pollutants (PM10, PM2.5, and NO2), apart from SO2, were much lower in mean concentration in Haryana throughout the lockdown period. This analysis shows that the unique outcome of this investigation was a considerable decrease in the mean SO2 concentration during the post-lockdown period. During the lockdown period, the major air pollutants (PM10, PM2.5, and NO2) were drastically lowered as a result of restrictions put on the transportation sector, industrial and commercial activity. Overall, compared to the post-lockdown period, PM10, PM2.5, NO2, and SO2 levels at NCR decreased by 70.4%, 64.7%, 66.37%, and 36.89%, respectively. Except for SO2, every significant air pollutant has seen a drop in trends throughout the lockdown period (Figure *1*). Except for Haryana, where SO2 levels were seen to rise throughout the lockdown period, all three NCR states analysed that mean concentrations of PM10, PM2.5, NO2, and SO2 stayed below NAAQS on all days of the lockdown. The mean concentrations of PM10, PM2.5, NO2, and SO2 were found to be lower during the lockdown period as compared to the post-lockdown period, apart from Haryana, where the mean concentration of SO2 was found to be higher during the lockdown period (Figure *2*). Due to the significant drop in SO2 levels in Delhi and Rajasthan during the shutdown, it is possible that these two states are more heavily affected by SO2 emissions from coal-based power plants than Haryana and Uttar Pradesh. Compared to Delhi and Rajasthan, the lockdown had a less favourable effect on the air quality in Haryana and Uttar Pradesh. The concentration of major pollutants (PM10, PM2.5, NO2, and SO2) has increased throughout the post-lockdown period, apart from Haryana, where SO2 has decreased (Figure *1*). During the lockdown, the daily average levels of NO2 and SO2 stayed generally below the NAAQS standard limit. As a result of a post-lockdown period, PM10 and PM2.5 levels exceeded the NAAQS reference values. Haryana has a higher SO2 level than Delhi, Rajasthan, and Uttar Pradesh, with most of this pollution originating from the coal-fired power station [10], [11].

4. CONCLUSION

Although COVID-19 provides a danger to the world's economy and public health, it has had some beneficial effects on the environment since pollution is declining and the earth is renewing itself. The impact of a total countrywide lockdown started on March 25, 2020, on the air quality in four Indian states—Delhi, Haryana, Rajasthan, and Uttar Pradesh over National Capital Region (NCR)—was thoroughly examined in the current study. During the lockdown period, a significant decrease in PM10, PM2.5, NO2, and SO2 concentrations was seen in NCR. On the contrary, SO2 concentration in Haryana increased during the lockdown which might be attributed to the running of coal-fired power plants. Comparatively, to the same period of 2022 and the first lockdown phase of 2020, the air quality in the NCR significantly improved during this lockdown phase. According to the preliminary analysis of data on air quality conducted for the current study, the COVID-19 epidemic may prove to be a "blessing in disguise," improving air quality and reviving the environment. Air pollution can be reduced through the regulation of key air pollutants, resulting in drastic reductions in asthma, cardiovascular disease, respiratory illnesses, and early mortality. The government and authorities may have confidence in their ability to impose strict air quality rules and emission control measures, knowing that doing so will considerably enhance the environment and people's health.

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Authors Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Nabin Sharma	✓	✓			✓		✓		✓		✓	✓	✓	
Kalpana Patel	✓		✓		✓	✓		✓			✓			✓
Sarvan Kumar			✓	✓		✓	✓	✓	✓			✓		✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

No conflict of interest.

Informed Consent

Not Applicable.

Ethical Approval

Not Applicable.

Data Availability

This study draws on publicly available data. No new datasets were created.

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BIOGRAPHIES OF AUTHORS

	**Nabin Sharma,** is a researcher in the Department of Physics at SRM Institute of Science and Technology, Delhi-NCR Campus, Modinagar, Ghaziabad, India. His research interests include atmospheric physics, air quality, atmospheric pollution, aerosol science, and air-pollution modelling. His research work focuses on aerosol characteristics, particulate matter, atmospheric parameters, and air-quality assessment using observational, remote-sensing, and computational approaches. His contributions support a better understanding of atmospheric processes and environmental pollution over northern India. Email: ns6153@srmist.edu.in
	**Kalpana Patel,** is affiliated with the Department of Physics at SRM Institute of Science and Technology, Delhi-NCR Campus, Modinagar, Ghaziabad, India. Her academic and research interests include atmospheric science, atmospheric processes, aerosols, air quality, and ionospheric studies. She has contributed to research involving atmospheric and aerosol characteristics as well as variations in atmospheric parameters. Her research activities contribute to a broader

	understanding of atmospheric phenomena, environmental conditions, and their implications for air quality and climate-related studies.
	**Sarvan Kumar,** is affiliated with the Department of Earth and Planetary Sciences at VBS Purvanchal University, Jaunpur, Uttar Pradesh, India. His academic and research interests include Earth and planetary sciences, atmospheric studies, aerosols, air quality, and environmental research. He has contributed to studies examining aerosol characteristics, particulate matter, atmospheric parameters, and environmental conditions over northern India. His research contributes to understanding atmospheric processes and environmental changes through scientific analysis and interdisciplinary approaches.