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Air Pollution Trends in the port city of Visakhapatnam during Covid-19 outbreak

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ABSTRACT

India is one of the affected countries by the end of January 2020 due to Covid-19. The Indian government imposed a national wide complete lockdown from 24th March to 3rd May because of the virus's contagious nature. All activities, like mass transportation and industrial activities, were prohibited. As a result, air pollution levels drastically reduced across the country. The present work focused on the degree of reduction in air pollutant parameters $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, O_3 at the port city of Visakhapatnam located on the east coast of India during the pre and lockdown period (3rd March to 14th April), 2020. The data during the lockdown period (24th March to 3rd May) is also compared with last year, 2019 data for the same time. During the pre and lockdown period, the reduction in $PM_{2.5}$ and PM_{10} is about -20.74% and -12.7 %, respectively. Among other pollutants, CO fell drastically by -83.36 %, and O_3 increased by 27.74% during the lockdown phase compared to pre lockdown. Compared to last year, at the same time, $PM_{2.5}$ and PM_{10} witnesseda decline of about -34.2% and -35.9%. CO, NO_2, and SO_2 seen a drop of about -82.9%, -12.39%, and -15.10%, respectively, and O_3 increased by 65.45%.

Key words : *COVID 19, Air pollution, Emission, $PM_{2.5}$, PM_{10}*

Introduction

The outbreak of the novel coronavirus towards the end of January 2020 became a pandemic threatening people worldwide irrespective of their social and economic background. Originating from one of China's biggest cities, the virus spread globally through human to human transmission. India is one of the most affected countries because of the novel coronavirus. A national-wide complete lockdown was imposed from 24thMarch to 3rdMay to prevent the coronavirus spread. The Government of India imposed a strict lockdown from 24th March to 14th April 2020, prohibiting all activities, including mass transport and industries, and was relaxed to some extent in the second phase from 15th April to 3rd May. Several studies reported a significant improvement in pollution levels across the country due to the lockdown effect (Bera *et al.*, 2020, Lokhandwala *et al.*, 2020; Pathakoti, Mahesh *et al.*, 2020; Mahato Susanta *et al.*, 2020; Singh *et al.*, 2020). Massive emissions reduction in transportation and industry due to lockdown would not help avoid pollution if meteorology is unfavorable (Wang Pengfei *et al.*, 2020). The part of meteorology and chemistry, too, plays an essential role in reducing air pollution. Meteorology plays a vital role in pollution formation, transport, and deposition.

Visakhapatnam (17°422N; 83°202E) is a major industrial city in the northeastern coastal Andhra Pradesh, India. The jurisdictional city area is about 680 km^2 is surrounded on three sides by mountains

and the Bay of Bengal on the fourth. It is effectively shielded from many winds, with only marine air moving into the basin. The city experiences four seasons and has a tropical climate. March to May are summer months. The annual mean temperatures range between 24.7–30.6 °C, with the maximum in May and the minimum in January. The maximum temperature reaches 45 °C, and humidity remains high, making climate sultry during summer months. It receives rainfall from the South-west and North-east monsoons.

The city is a hub of major industries such as Hindustan Zinc Limited (HZL), Coromandel Fertilizers Limited (CFL), Visakhapatnam Port Trust (VPT), Hindustan Petroleum Corporation Limited (HPCL), Bharat Heavy Plates and Vessels (BHPV), Hindustan Polymers Limited (HPL), Visakhapatnam Steel Plant (SP), Coastal Chemicals (CC), Andhra Cement Company (ACC) and Simhadri Thermal Power Corporation (STPC). Steel and aluminum are major industrial products in this location because of manganese and bauxite reserves' availability. About 200 ancillary industries developed to supplement the primary industries, which turned Visakhapatnam's central basin into an "air-polluting chimney." The major industries and the Port were 13 km away from the coast.

The present work is an effort to measure the degree of reduction in air pollutant parameters $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, O_3 at the port city of Visakhapatnam located on the east coast of India during the pre and lockdown period, 2020 and compare with last year, 2019 data for lockdown period. The study also focusses on identifying the source of pollution in the city.

Materials and Methods

The real-time hourly mass concentrations of $PM_{2.5}$, $PM_{10,}$ Ozone (O_3), CO, $NO_{2,}$ and SO_2 were recorded by the National air quality index of Central Pollution Control Board compiled for each city under the Ministry of Environment, Forests and Climate Change, India. The instruments measuring the mass concentrations are located in the central point of the city. The mass concentrations of $PM_{2.5}$ and PM_{10} are calculated using the beta attenuation method and Ozone using UV Photometric method. The gas pollutants NO_2, SO_2, and CO, are measured using the gas phase chemilumine scence method, ultraviolet fluorescence method, and NDIR spectroscopy, respectively. The data are publicly accessible, and data used in this paper were obtained from the website (https://app.cpcbccr.com/AQI_India/).

The 24-hourly mean variations of $PM_{2.5}$, $PM_{10,}$ NO_2, $SO_{2,}$ and 8-hr mean variations of O_3 and CO during the pre and lockdown period 3rd March to 14th April 2020 are measured. The data during the lockdown period 24th March to 3rd May 2020, and last year, 2019 data at the same time, is also considered in the study.

Results and Discussion

The transport sector and power plants play a vital role in the release of NO_2. Transportation, industries, power plants, and dust generated from constructional activities play a crucial role in releasing particulate matter $PM_{2.5}$, $PM_{10,}$ and other gaseous pollutants NO_2, SO_2, and CO. Maximum emission of CO and SO_2 is due to vehicular emissions and industries. The gaseous pollutants NO_2, $SO_{2,}$ and CO cause respiratory problems and effects the health severely. NO_2 causes diseases like asthma, cardiovascular disease, and lung infections. Several epidemiological studies reported an increase in air pollution levels increased premature deaths, morbidity, and cancer.

The imposed lockdown limited vehicular movement and curtailed the discharge of poisonous gases, combustion of coal and petroleum waste, and lessened fuel energy usage. Several studies reported that the imposed lockdown improved air quality throughout the world (He Guojun *et al.,* 2020; Islam *et al.,* 2020; Chauhan *et al.,* 2020; Muhammad *et al.,* 2020). Figure 1 represent changes in averageair pollutants' concentrations betweenthe pre and during the study place's lockdown period.

Pre lock down the 24 hr average minimum and maximum value of $PM_{2.5}$ are 23.6 and 107.2 μg/m$^{3.}$ The levels declined to 14.29 and 55.07 μg/m^3 during the lockdown. On 24th March, the $PM_{2.5}$ value is 70.12 μg/m^3 and on 31st March, it was 31.2 μg/m$^{3.}$ Similarly, PM_{10} varied from 37.29 – 125.46 μg/m^3 pre lockdown, and during the lockdown, it ranged from 29.6 – 86.2 μg/m$^{3.}$ On 24th March, the PM_{10} value is 89.6 μg/m^{3,} and on 31st March, it was 52.3 μg/m^3. The mean concentrations of $PM_{2.5}$ and PM_{10} during lockdown were reduced by –20.7% and –12.7%, respectively when compared to the pre lockdown period.

The range of NO_2 did not show a significant

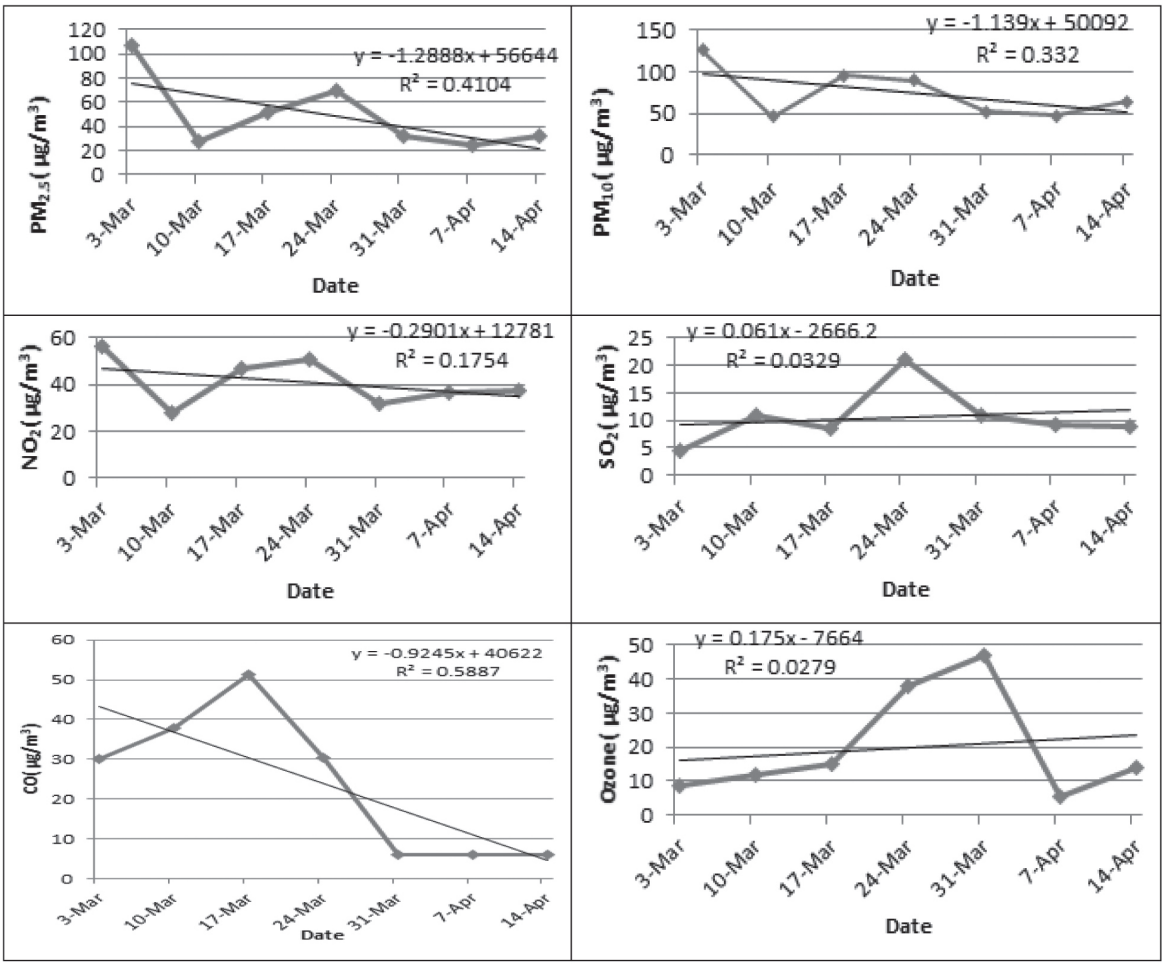

Fig. 1. 24 hr concentrations of $PM_{2.5}$, PM_{10}, NO_2, SO_2 and 8 hr concentrations of CO and O_3 between March 24th and 3rd May (pre and during lockdown period)

change. NO_2 during the study period showed an insignificant difference by +0.29% when compared to other pollutants.

The range of SO_2 pre and during the lockdown period was 4.42–31.8 µg/m^3 and 6.8 – 16.4 µg/m^3. On 24th March, the $_{SO2}$ value is 20.95 µg/m^{3,} and on 31st March, it was 10.76 µg/m$^{3.}$ The reduction in the average concentration of $SO_2$is -16.20%. Partial controlled industrial and vehicular activities could be the reason.

The 8-hr. averaged CO level declined from 14.5 – 51.4 µg/m^3 to 4.5 – 13.3 µg/m^3. On 24thMarch, the CO value is 30.4 µg/m^3 and on 31st March, it was 6 µg/m^3. The decline in CO's 8 hr average concentration is -83.3% compared to pre lockdown. However, and O_3 exhibited a significant rising trend by +27.7% during the lockdown. After one week of the lockdown, the O_3 concentration levels increased to 46.99 µg/m^3.

The 24 hr and 8 hr averaged concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO, $O_{3,}$ respectively during the lockdown period, have been compared with last year's data for the same period (24th March to 3rd May). From Table 1 and Figures 2- 4, it is evident that there is a significant reduction in $PM_{2.5,}$ PM_{10} by -34.2%, and 35.9%, respectively. CO drastically has fallen in the year 2020 when compared to 2019. The average concentration of CO is 38.84 µg/m^3 in 2019, and it was 6.76 µg/m^3 in 2020. There is a reduction of about -82.59%.

On the contrary, there is a 65.45% increase in O_3concentration compared to last year for the same period. O_3 was 12.19 µg/m^3 in 2019 while it increased to 20.17 µg/m^3 in 2020, representing a rebounding tendency of air quality in the city during the lockdown period.

Table 1. Statistics of particulate matter and air pollutants for the period 24th March to 3rd May during 2019 and 2020

	Mean ± SD		Maximum		Minimum	
	2019	2020	2019	2020	2019	2020
PM2.5 (μg/m^3)	48.0±18.14	31.56±13.31	121.22	70.12	17.63	10.75
PM10 (μg/m^3)	88.74±23.02	56.88±15.80	168.11	89.62	43.76	29.66
NO2 (μg/m^3)	38.96±11.00	34.13±7.44	61.22	50.66	16.15	17
SO2 (μg/m^3)	11.26±7.11	9.56±3.09	28	20.95	3.08	4.4
CO (μg/m^3)	38.84±7.74	6.76±4.27	56.50	30.49	20.40	4.23
Ozone (μg/m^3)	12.19±6.17	20.17±11.82	31.80	51.55	4.54	5.49

However, for SO_2 and NO_2, the decrease has counted very low in comparison to the others. The reduction in NO_2 and SO_2 is about -12.39% and -15.10 %, respectively. In 2019, SO_2 in the atmosphere was 11.26 μg/m^3, which declined to 6.76 μg/m^3 in 2020. On the other hand, NO_2 wasreduced to 34.13 μg/m^3 in 2020 from 38.96 μg/m^3 in 2019. The major contributing factors for SO_2 may be coal stocked in Port and used in thermal power plants and other industries and vehicle exhaust. The emission of NO_2 and CO is mainly due to combustion by traffic and to a small extent by industries and power plants. The wind flows from southwest direction during the summer season, where all industries were located. When meteorology is unfavorable, a considerable reduction from transport emissions and a slight industrial reduction will not help avoid severe air pollution.

Conclusion

During the pre and lockdown period, the reduction in $PM_{2.5}$ andPM_{10} is about -20.74% and -12.7 %, respectively. Among other pollutants, CO fell drasti-

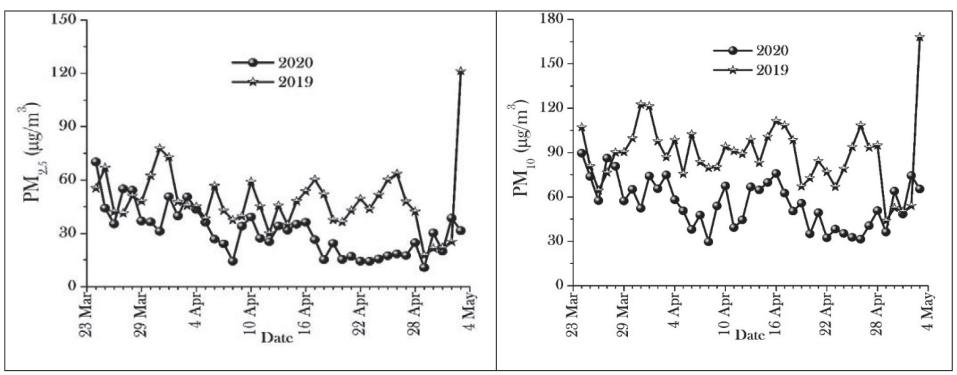

Fig. 2. 24 hr Figure 2: 24 hr concentrations of $PM_{2.5}$ and PM_{10} for lockdown period 24th March - 3rdMay during 2019 and 2020

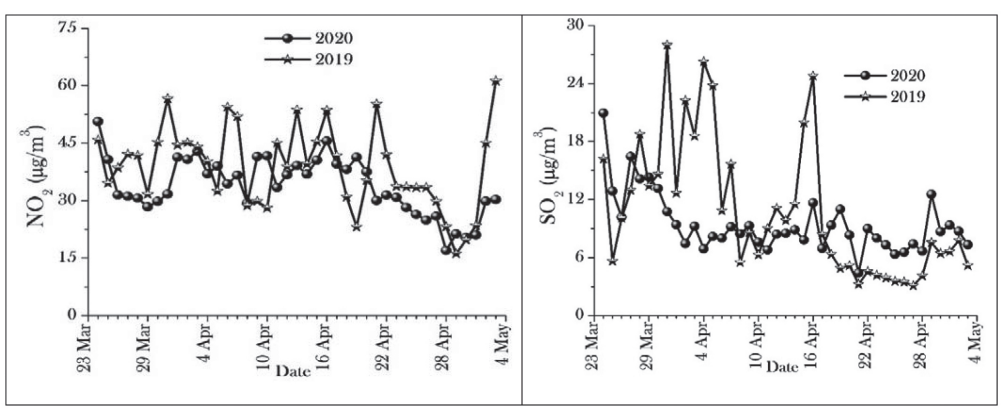

Fig. 3. 24 hr concentrations of NO_2 and SO_2 for lockdown period 24th March -3rd May during 2019 and 2020.

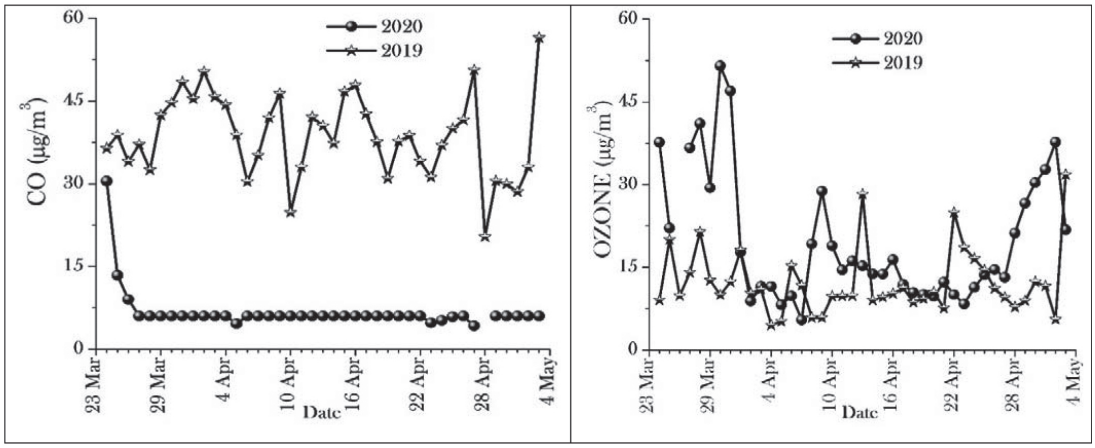

Fig. 4. 8 hr. concentrations of CO and O_3 for lockdown period 24th March -3rd May during 2019 and 2020.

cally by -83.36 % during the lockdown phase compared to pre lockdown. Compared to last year, at the same time, $PM_{2.5}$ andPM_{10} witnesseda decline of about -34.2% and -35.9%. Among other air pollutants, NO_2 and SO_2 seen a drop of about- 12.39% and -15.10%, respectively, and O_3 increased by 65.45%. The average concentrations of particulate matter and other pollutants fell due to the reduced release of pollutants from traffic and industry—a significant reduction in CO and an increase in O_3 is observed. COVID 19 provided an opportunity to study and identify the source of contaminants in the city of Visakhapatnam. The results show that a temporary lockdown may help reduce air pollution and improve air quality standards.

References

Bera, B., Bhattacharjee, S. and Shit, P.K. 2020. Significant impacts of COVID-19 lockdown on urban air pollution in Kolkata (India) and amelioration of environmental health. *Environ Dev Sustain*. 1–28.

Chauhan, A. and Singh, R. P. 2020. Decline in $PM_{2.5}$ concentrations over major cities around the world associated with COVID-19. *Environmental Research.* 187: 109634.

He, Guojun, Yuhang Pan and Takanao Tanaka, 2020. COVID-19, City Lockdowns, and Air Pollution: Evidence from China. *Med Rxiv*. *Inreview*: 1-39.

Islam, M.S., Tusher, T.R. and Roy, S. 2020. Impacts of nationwide lockdown due to COVID-19 outbreak on air quality in Bangladesh: a spatiotemporal analysis. *Air Qual Atmos Health*. In press

Lokhandwala, S. and Gautam, P. 2020. Indirect impact of COVID-19 on environment: A brief study in Indian context. *Environmental Research.* 188 : 109807.

Mahato, Susanta, Pal, Swades and Ghosh, Krishna, 2020. Effect of lockdown amid COVID-19 pandemic on air quality of the megacity Delhi, India. *Science of The Total Environment*. 730 : 139086.

Muhammad, S., Long, X. and Salman, M. 2020. COVID-19 pandemic and environmental pollution: A blessing in disguise?. *The Science of the Total Environment*. 728: 138820.

Pathakoti, Mahesh, Muppalla, Aarathi, Hazra, Sayan., Dangeti, Mahalakshmi, Raja Shekhar, Sarraju, Jella, Srinivasulu, Mullapudi, Sesha, Andugulapati, Prasad and Vijayasundaram, Uma, 2020. An assessment of the impact of a nation-wide lockdown on air pollution -a remote sensing perspective over India. *Atmospheric Chemistry andPhysics Discussions.* In review: 1-16.

Singh, R. P. and Chauhan, A. 2020. Impact of lockdown on air quality in India during COVID-19 pandemic. *Air Quality, Atmosphere, & Health.* 13 : 921–928.

Wang, Pengfei, Chen, Kaiyu, Zhu, Shengqiang, Wang, Peng and Zhang, Hongliang, 2020. Severe air pollution events not avoided by reduced anthropogenic activities during COVID-19 outbreak. *Resources, Conservation and Recycling*. 158 : 104814.