



IMPACT OF COVID-19 ON AIR POLLUTION OF JHARKHAND

Puja¹, Anurag Sinha² and Amrit Kumar Bhadani³

¹Department of Biotechnology, Scholar, Amity University Jharkhand Ranchi, Jharkhand (India)

²Department of computer science and IT, Scholar, Amity University Jharkhand Ranchi,

ARTICLE INFO

Article History:

Received 10th December, 2020

Received in revised form 2nd

January, 2021

Accepted 26th February, 2021

Published online 28th March, 2021

Key words:

Air Pollution, Covid-19, Jharkhand
Pollution Control

ABSTRACT

In December 2019, an outbreak of the COVID-19 took place in Wuhan, China which spread to almost all the parts of world. It was declared a global pandemic in March 2020 by the World Health Organization (WHO). The outbreak of the corona virus has emerged as one of the deadliest pandemics in human history. The ongoing COVID-19 pandemic has forced many countries around the world to look for a complete lockdown that forced people to stay in their homes. India also faced a total closure phase for 21 days (first phase) to prevent the spread of coronavirus at a very high rate. The closure contributed to decline in the pollution levels and improved air and water quality in the short term due to very limited human activities. In this project work available data on the state of air pollution before and after lockdown had been analyzed to develop a strategy for dealing with the increased pollution level in Jharkhand, India. The analysis was based on pre-lock and post-lock air quality data (first 21-day period) for 21 days each. The results showed a significant decrease in the considered air pollution indicators and showed an improvement in air quality in Jharkhand. Significant impact was observed at PM_{2.5}, NO₂ and CO levels. SO₂ levels showed a slight decrease during closure. The results are presented with future ideas for reducing air pollution soon by adopting short and periodic closures as a tool. Based on the information provided by the JSPCB changes in Jharkhand air quality was analyzed before and after Lockdown.

Copyright © 2021 Puja et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Air pollution is one of the greatest challenges affecting the humans. It is considered as one of the leading problems in the world. It refers to the pollution by harmful chemicals or gases. According to the world's worst polluted areas by the Blacksmith Institute in 2008, the two most polluting problems in the world are: urban air pollution and domestic air pollution. Air pollution equally damages crops and animals. While autonomous approaches, such as distance to roads, were associated with significant health outcomes (Hoek *et al.*, 2002). In December 2019, there was an outbreak of a new disease in the Chinese city of Wuhan. Another disease about pneumonia has been announced by the Chinese government (Li *et al.*, 2020). The symptoms of COVID-19 are very similar to those of the already emerging epidemics of SARS and MERS (Wang *et al.*, 2020), but its mortality rate is different. Early symptoms of cough, severe body pain and high fever that over time develop and lead to severe lung infections that eventually lead to death (Holshue *et al.*, 2020; Perlman, 2020). The World Health Organization (WHO) has declared a global health emergency due to this novel disease. There were 1,279,722 confirmed patients infected with the virus as of April (Şahin, 2020), which raised major WHO concerns while recommending drastic measures to prevent the disease through

social initiatives to prevent public contact. In this regard, countries have launched a ground-breaking campaign and banned activities such as aviation, trade in educational institutions, and travel services. The main goal was to reduce social interaction within the community. Apart from this, in February, the infectious disease spread to Iran and Italy. By the end of March, the pandemic had affected more than half of the world's population. Over time, it had been hypothesized that COVID-19 had a direct effect on climate change, which could lead to the spread of the epidemic. Climate change, such as temperature and humidity, can enhance its efficiency (Tosepu *et al.*, 2020). On the contrary, the air quality of various countries has proved to be very improved. Conversely, due to the closure of local transportation, and general public services, oil consumption in each country has been significantly reduced (Muhammad *et al.*, 2020). The purpose of this paper is to study the impact of total lockdown in the air quality (PM_{2.5}, AQI, and NO₂) of Jharkhand during COVID-19 by comparing air quality parameters from March 2020 onwards. Results showed a sharp decline in PM_{2.5}, AQI, and NO₂ in Jharkhand after the complete lockdown.

REVIEW OF LITERATURE

K Wark, CF Warner, D Wayne, in the year 1998 published a research article on Air pollution: origin and affects. In this

*Corresponding author: Puja

Department of Biotechnology, Scholar, Amity University Jharkhand Ranchi, Jharkhand (India)

paper continue to expose students to both the quantitative and practical aspects of air quality management and air pollution control with a number of new questions and concerns, with more SI units emphasized than ever before. The Internet is also presented as an important source of additional information.

DW Dockery, CA Pope – in year 1994 published a research article on Acute Respiratory Effects of Particulate Air Pollution in this paper focused attention on the potential for adverse health effects of air pollution.

A Seaton, D Godden, W MacNee, K Donaldson -The lancet, in year 1995 published a research article on Particulate air pollution and acute health effects. In this paper studies have consistently shown an association between particulate air pollution and not only is there an increase in morbidity in people with respiratory diseases but also an increase in the number of deaths from cardiovascular disease in the elderly.

AJ Cohen, H Ross Anderson, B Ostro... - Journal of Toxicology in year 2005 published in a research article on The Global Burden of Disease Due to Outdoor Air Pollution. In this paper the report is based on estimates that existing air pollution, in terms of systemic air pollution (PM_{2.5}), causes approximately 3% of deaths from heart disease, approximately 5% of deaths from trachea, bronchus, and lung cancers, and about 1% of deaths from acute respiratory infections in children under five, worldwide. This amounts to approximately 0.8 million (1.2%) of premature deaths and 6.4 million (0.5%) years of loss of life (YLL).

JJ Kim – Pediatrics in year 2004 published in a research article on Ambient air pollution: health hazards to children. Report is based on finding important health effects from air pollution at levels once considered safe. Babies and infants are among the most affected by air pollution.

MATERIALS AND METHODS

Study Area

The state of Jharkhand was created in the year 2000 by bifurcating the hilly and plateau regions of the erstwhile Bihar state. The state has an area of 79714 sq. km and is home to 3.3 crore people (Government of Jharkhand, 2009). Jharkhand is predominantly an agrarian state with 80% of the population still depending on agriculture and allied industries for economic development and sustenance. But the vast mineral resources clubbed with the human resource are shaping the future of the state.



Figure 1 Map of Jharkhand showing all districts (Source:www.jharkhand.gov.in)

The state has proven reserves of 40% of the mineral resources of the country, and it ranks first in the production of coal, mica, kyanite and copper in the country. On top of it, the state is the sole producer of cooking coal, uranium and pyrite (Department of Industries, Jharkhand).

Jharkhand is closely linked by the Indian states of West Bengal (east), Uttar Pradesh (west), Chhattisgarh (west), Bihar (north) and Odisha (south). It is spread out across 30,778 square meters. Ranchi is the state's capital, whereas the largest city for industrial purposes is Jamshedpur (www.jharkhand.gov.in).

The population of Jharkhand is 32.96 million (males: 16.93 million; females: 16.03 million). Jharkhand comprises of 24 districts and 32,620 villages. Out of this number, 28 percent of the people consist of tribes and 12 percent of the population is from scheduled caste (Census Of Jharkhand 2011).

In this review project I will basically deal with some of main districts of Jharkhand and will compare the environmental changes that have been seen till 2019. Because, there are many environmental alterations seen in the some districts of Jharkhand.

DATA COLLECTION AND METHODOLOGY

The changes in the natural environment over these districts is assessed by changes in population size, built up area, number of industries, number of vehicles annually registered, seasonal variation in ground water availability and usages etc. The data related to these parameters have been collected from

Various secondary sources viz. documents, reports, journals, websites and newspapers. The study period is from after and before covid-19. To assess the impact of covid-19 in air pollution of Jharkhand mean monthly data on air pollution for the after and before Covid-19 data were collected from Jharkhand pollution board department.

These Data Have Been Collected From The Respective Zonal Weather Department Office And Analyzed Usinga Data Visulaisation Method. Same Is Attached Below:-

Table Ambient air quality data for so² and no₂ monitored by Jharkhand state pollution board

Sl.no	Hrs.Date	SO ₂								NO ₂								Weather Condition
		06-10.	10-14.	14-18.	18-22.	22-02.	2.06	4hr max.	24 hrs avg	06-10.	10-14.	14-18.	18-22.	22-02.	02-06.	8hr max.	24 hrs avg	
1	02-03.07.20	14.2	12.65	12.42	10.65	9.28	16.24	16.24	12.57	30.16	32.18	28.66	26.7	33.48	35.66	35.66	31.14	Cloudy
2	06-07.07.20	13.18	11.7	11.24	10.72	9.2	15.36	15.36	11.9	30.2	31.2	26.38	24.3	32.4	33.28	33.28	29.62	Cloudy & Raniy
3	09-10.07.20	14.2	12.96	12.3	11.65	10.36	16.9	16.9	13.06	30.46	30.46	30.36	24.8	31.5	34.4	34.4	29.96	Cloudy & Raniy
4	13-14.07.20	14.35	13.65	12.78	11.76	10.4	16.98	16.98	13.32	30.56	30.56	32.4	25.1	32.96	33.5	33.5	30.5	Cloudy & Raniy
5	16-17.07.20	15.16	13.7	13.8	12.65	11.31	17.77	17.77	14.06	34.6	34.6	31.6	30.65	32.8	35.98	35.98	33	Cloudy
6	20-21.07.20	15.2	14.8	13.78	12.9	11.2	16.55	16.55	14.07	33.76	33.76	32.1	40.12	35.6	36.96	36.96	33.5	Cloudy
7	23-24.07.20	15.65	14.76	14.2	13.96	12.98	18.2	18.2	15.12	34.2	34.2	32.96	32.18	34.7	38.2	38.2	34.57	Cloudy & Clear
8	27-28.07.20	16.72	14.3	14.85	12.78	12.2	18.56	18.56	14.9	34.38	34.38	32.7	33.1	32.16	37.55	37.55	34.22	Cloudy & Clear
9	30-31.07.20	17.6	16.24	15.32	14.8	13.65	18.2	18.2	15.91	32.18	32.18	30.4	31.78	34.2	38.24	38.24	33.74	Cloudy & Clear

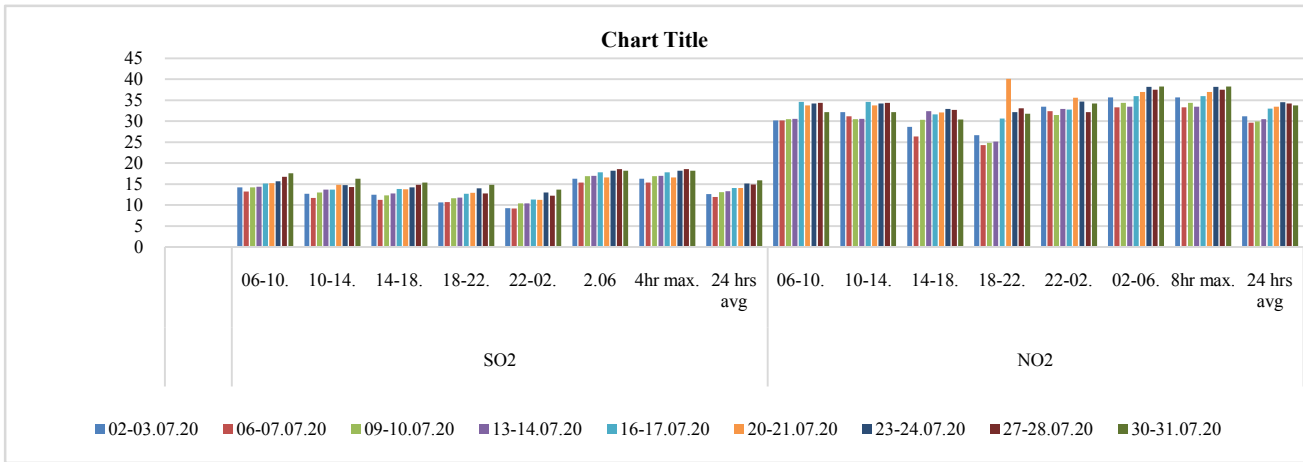
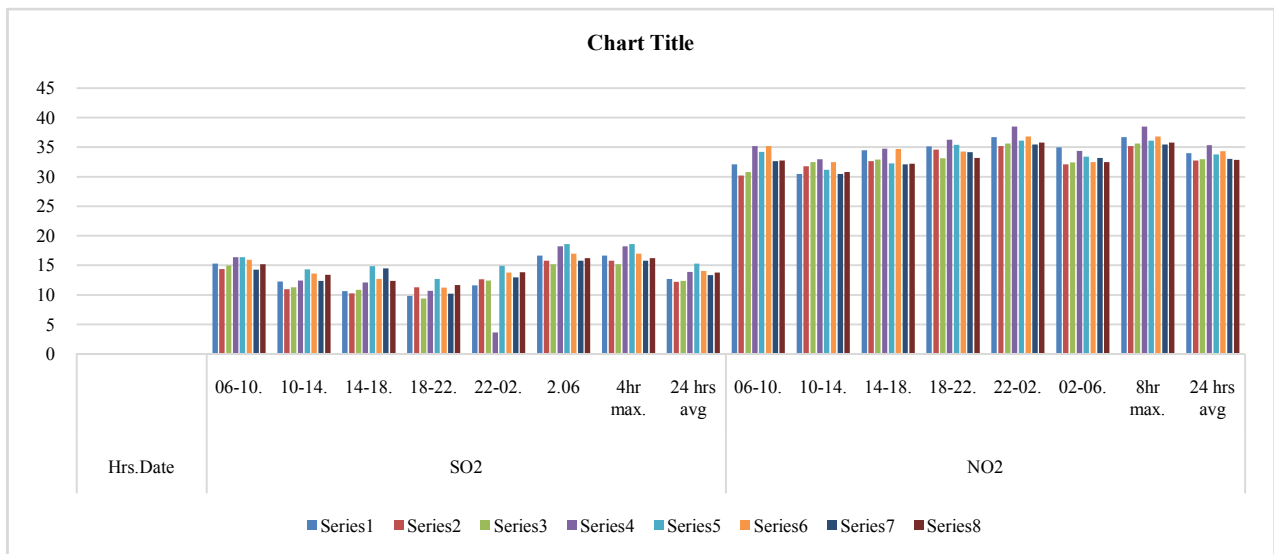
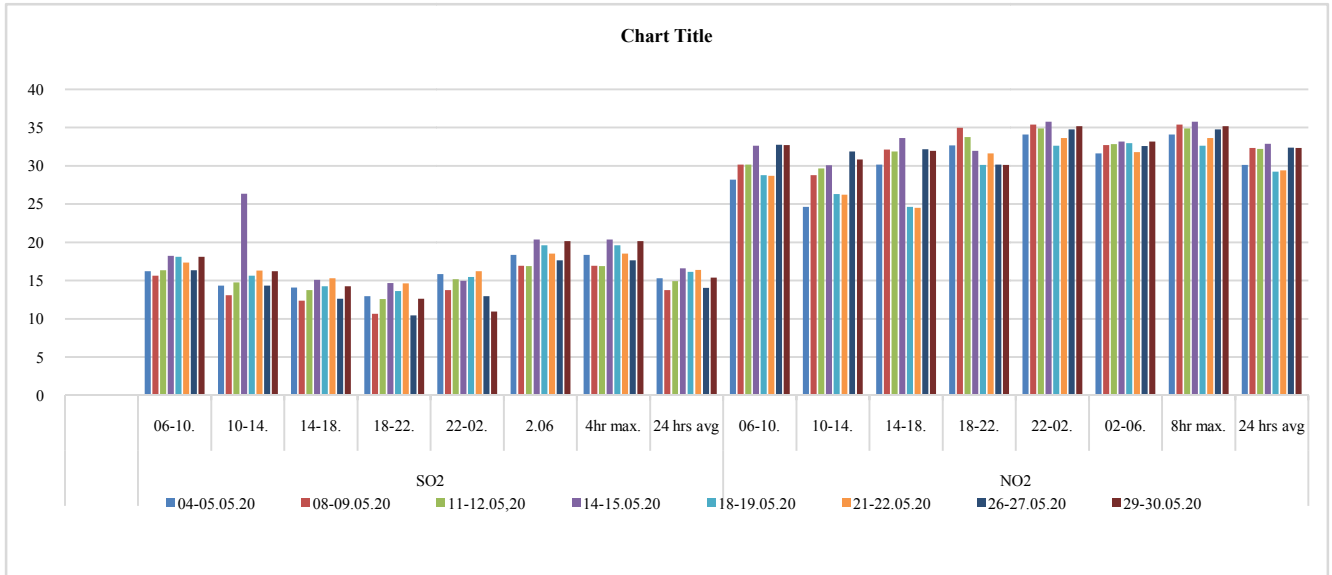


Figure weather condition Jharkhand hazaribagh region

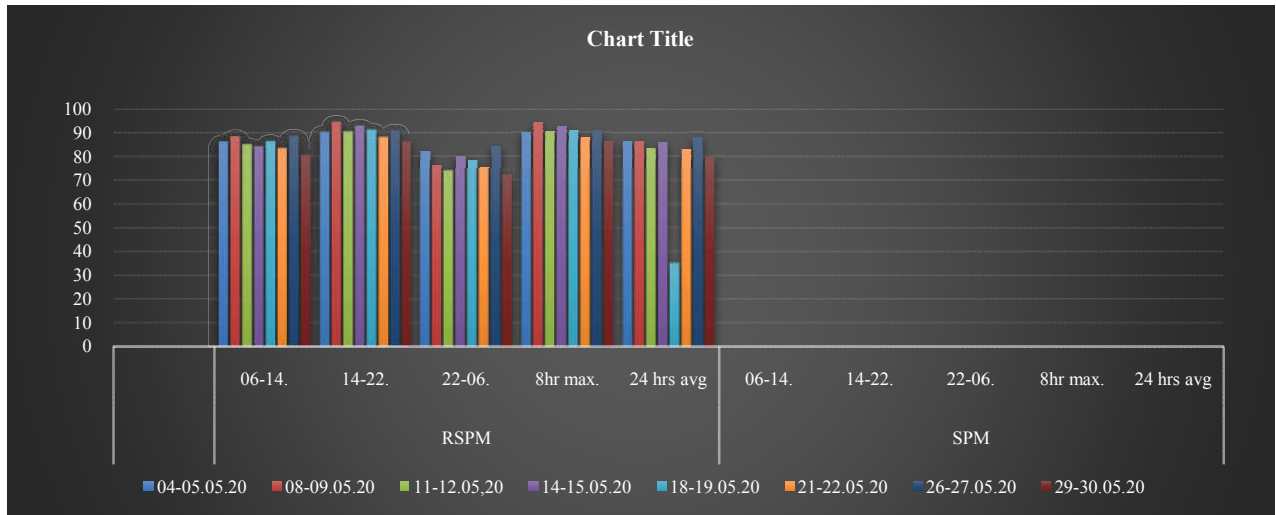
Sl.no	Hrs.Date	SO ₂								NO ₂								Weather Condition
		06-10.	10-14.	14-18.	18-22.	22-02.	2.06	4hr max.	24 hrs avg	06-10.	10-14.	14-18.	18-22.	22-02.	02-06.	8hr max.	24 hrs avg	
1	02-03.06.20	15.28	12.26	10.65	9.8	11.6	16.65	16.65	12.7	32.12	30.48	34.48	35.12	36.68	34.96	36.68	33.97	clear
2	05-06.06.20	14.36	10.96	10.26	11.28	12.63	15.78	15.78	12.21	30.18	31.76	32.65	34.6	35.16	32.1	35.16	32.74	Cloudy
3	09-10.02.20	14.98	11.28	10.85	9.36	12.44	15.2	15.2	12.35	30.78	32.48	32.9	33.1	35.6	32.4	35.6	32.97	Cloudy
4	12-13.06.20	16.36	12.42	12.1	10.68	3.65	18.22	18.22	13.9	35.16	32.96	34.78	36.28	38.5	34.36	38.5	35.34	Cloudy & Clear
5	16-17.06.20	16.4	14.3	14.85	12.7	14.9	18.62	18.62	15.29	34.2	31.18	32.28	35.4	36.1	33.4	36.1	33.76	Cloudy & Clear
6	19-20.06.20	15.92	13.6	12.68	11.24	13.78	16.96	16.96	14.03	35.18	32.46	34.7	34.24	36.8	32.48	36.8	34.31	Cloudy & Clear
7	24.25.06.20	14.28	12.36	14.48	10.2	12.96	15.78	15.78	13.34	32.65	30.46	32.1	34.18	35.46	33.2	35.46	33	Cloudy
8	27-28.06.20	15.2	13.4	12.38	11.65	13.85	16.2	16.2	13.78	32.76	30.78	32.18	33.2	35.76	32.48	35.76	32.86	Cloudy



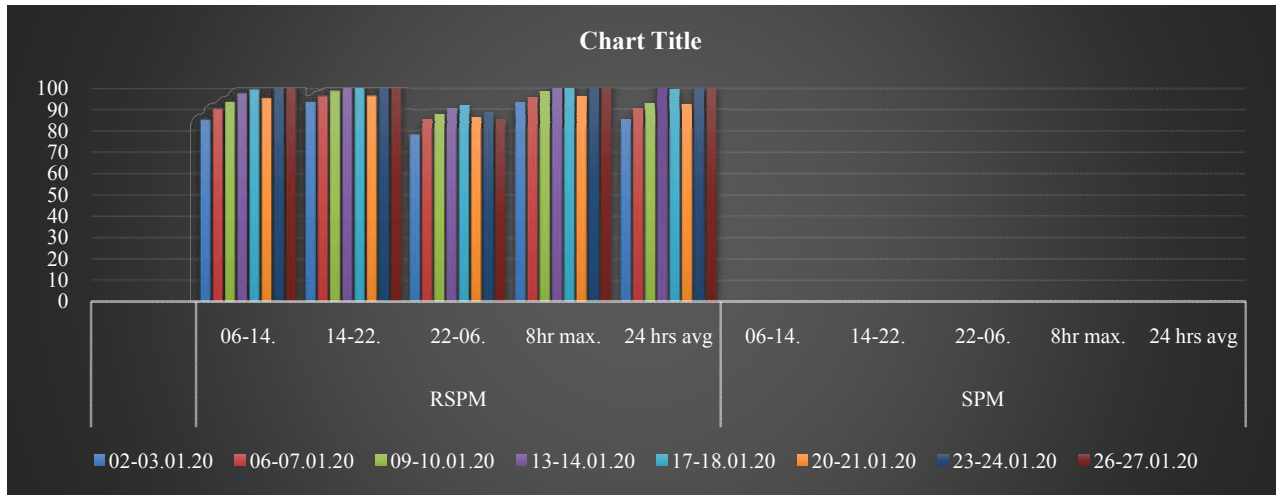
Sl.no	Hrs.Date	SO2						NO2						Weather Condition				
		06-10.	10-14.	14-18.	18-22.	22-02.	2.06	4hr max.	24 hrs avg	06-10.	10-14.	14-18.	18-22.		22-02.	02-06.	8hr max.	24 hrs avg
1	04-05.05.20	16.24	14.36	14.12	12.96	15.85	18.35	18.35	15.31	28.18	24.65	30.18	32.66	34.12	31.65	34.12	30.12	Clear
2	08-09.05.20	15.65	13.1	12.38	10.65	13.78	16.96	16.96	13.75	30.16	28.78	32.12	34.96	35.38	32.7	35.38	32.35	Clear
3	11-12.05.20	16.38	14.78	13.76	12.6	15.2	16.92	16.92	14.94	30.18	29.65	31.9	33.78	34.9	32.85	34.9	32.21	Clear
4	14-15.05.20	18.24	26.36	15.1	14.68	14.96	20.38	20.38	16.62	32.65	30.1	33.65	31.96	35.78	33.18	35.78	32.88	Clear
5	18-19.05.20	18.1	15.65	14.28	13.65	15.48	19.62	19.62	16.13	28.78	26.3	24.65	30.12	32.65	32.98	32.65	29.24	Semi Cloudy
6	21-22.05.20	17.36	16.3	15.32	14.65	16.24	18.55	18.55	16.4	28.7	26.24	24.5	31.65	33.65	31.78	33.65	29.4	Semi Cloudy
7	26-27.05.20	16.36	14.35	12.65	10.44	12.96	17.66	17.66	14.07	32.78	31.9	32.18	30.18	34.76	32.6	34.76	32.4	Clear
8	29-30.05.20	18.12	16.24	14.28	12.65	10.96	20.16	20.16	15.4	32.7	30.85	31.96	30.12	35.18	33.18	35.18	32.33	Clear



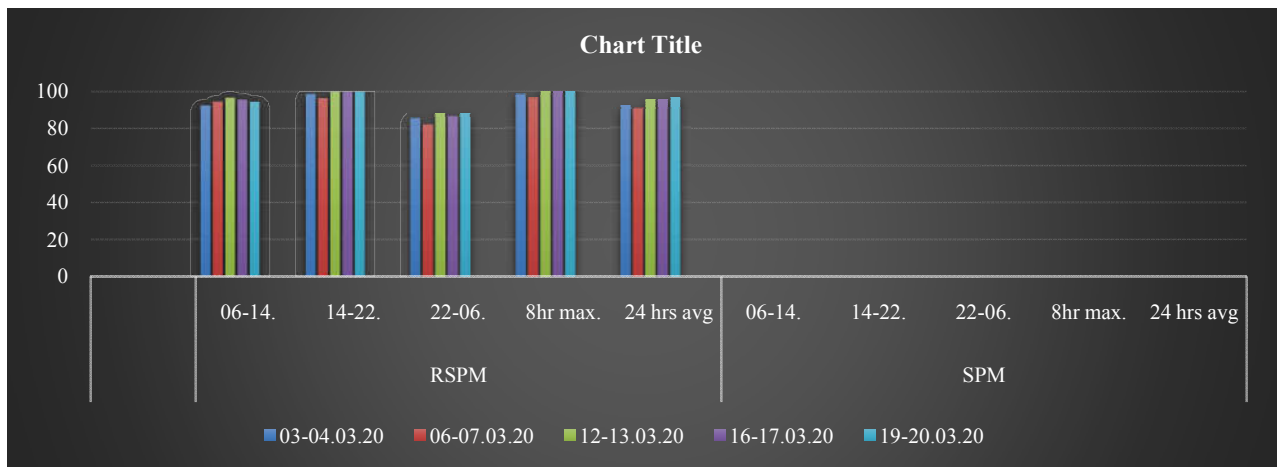
Sl.no	Hrs.Date	RSPM					SPM					Weather Condition
		06-14.	14-22.	22-06.	8hr max.	24 hrs avg	06-14.	14-22.	22-06.	8hr max.	24 hrs avg	
1	04-05.05.20	86.26	90.36	82.18	90.36	86.26						Clear
2	08-09.05.20	88.36	94.52	76.36	94.52	86.41						Clear
3	11-12.05.20	85.1	90.4	74.18	90.4	83.22						Clear
4	14-15.05.20	84.28	92.82	80.24	92.82	85.79						Clear
5	18-19.05.20	86.35	91.24	78.38	91.24	35.32						Semi Cloudy
6	21-22.05.20	83.42	88.1	75.4	88.1	82.97						Semi Cloudy
7	26-27.05.20	88.65	90.85	84.4	90.85	88.03						Clear
8	29-30.05.20	80.6	86.44	72.4	86.44	79.81						Clear



Sl.no	Hrs.Date	RSPM					SPM					Weather Condition
		06-14.	14-22.	22-06.	8hr max.	24 hrs avg	06-14.	14-22.	22-06.	8hr max.	24 hrs avg	
1	02-03.01.20	85.16	93.36	78.36	93.36	85.6						Cloudy
2	06-07.01.20	90.28	96.1	85.31	96.1	90.56						Cloudy
3	09-10.01.20	93.44	98.65	87.76	98.65	93.28						Cloudy
4	13-14.01.20	97.38	103.72	90.32	103.72	97.14						Clear
5	17-18.01.20	99.28	108.22	92.18	108.22	99.89						Clear
6	20-21.01.20	95.16	96.18	86.24	96.18	92.52						Cloudy
7	23-24.01.20	102.74	110.65	88.65	110.65	100.68						Clear
8	26-27.01.20	104.18	113.76	85.28	113.76	101.07						Clear
9	29-30.01.20	101.24	101.88	87.2	101.88	99.47						



Sl.no	Hrs.Date	RSPM					SPM					Weather Condition
		06-14.	14-22.	22-06.	8hr max.	24 hrs avg	06-14.	14-22.	22-06.	8hr max.	24 hrs avg	
1	03-04.03.20	92.18	98.65	85.65	98.65	92.16						Clear
2	06-07.03.20	94.36	96.3	82.1	96.3	90.92						Clear
3	12-13.03.20	96.4	102.18	88.36	102.18	95.64						Clear
4	16-17.03.20	95.36	104.14	86.8	104.14	95.43						Clear
5	19-20.03.20	94.1	108.92	88.28	108.92	97.1						Semi Cloudy
												Semi Cloudy
												Clear
												Clear



Sampling Date	6-14	14-22	22-06	8 Hourly Max	24 Hourly Avg.	Weather Con**	Remarks Temp. Min.-Max.
02.01.2020	108	122	96	122	108	Clear	7-21
06.01.2020	104	124	90	124	106	Clear	8-22
08.01.2020	100	118	98	118	105	Clear	7-22
10.01.2020	104	118	96	118	106	Clear	8-21
14.01.2020	110	126	98	126	111	Clear	9-23
17.01.2020	112	124	96	124	110	Clear	7-20
21.01.2020	108	120	94	120	107	Clear	8-21
23.01.2020	106	124	98	124	109	Clear	7-22
27.01.2020	108	122	96	122	108	Clear	7-20

Fig Ambient Air Quality Data for RSPM Monitoring by State Pollution Control Board

Sampling Date	SO2								Nox								Weather Con**	Remarks Temp. Min.-Max.
	6-10	10-14	14-18	18-22	22-02	02-06	4 Hourly Avg.	24 Hourly Avg.	6-10	10-14	14-18	18-22	22-02	02-06	4 Hourly Max	24 Hourly Avg.		
02.01.2020	16.5	18.2	19.5	17.2	18.5	19.9	19.5	19.2	31.8	32.9	37.1	40.1	35.1	34.2	40.1	35.1	Clear	7-21
06.01.2020	15.9	16.4	17.5	18.9	21.0	17.2	21.0	17.8	34.0	35.5	39.9	38.7	36.0	34.8	39.9	36.2	Clear	8-22
08.01.2020	16.2	18.5	19.5	17.5	18.0	18.8	19.8	19.1	35.3	34.7	38.0	40.8	38.0	33.9	40.8	36.8	Clear	7-22
10.01.2020	17.1	18.3	19.0	20.1	22.1	16.4	22.1	18.8	32.1	33.6	37.9	39.1	36.2	35.3	39.1	35.7	Clear	8-21
14.01.2020	16.5	17.0	19.6	18.4	17.2	16.3	19.6	17.5	35.0	34.7	38.3	40.0	38.2	33.9	40	36.7	Clear	9-23
17.01.2020	15.0	16.3	17.6	20.0	18.3	18.4	20.0	17.2	31.0	34.3	36.7	40.2	37.5	34.1	40.2	35.6	Clear	7-20
21.01.2020	16.0	17.4	18.2	21.01	17.6	15.6	20.1	17.4	31.3	32.0	37.1	38.6	35.7	34.8	38.6	35.0	Clear	8-21
23.01.2020	15.3	16.5	17.4	18.3	21.0	17.2	21.0	17.6	34.3	35.8	39.9	38.7	36	34.8	39.9	36.3	Clear	7-22
27.01.2020	15.6	16.3	17.6	20.0	18.3	16.4	20.0	17.3	31.6	32.9	37.7	40.1	35.1	34.2	40.1	35.2	Clear	7-20

RSPM							
Sampling Date	6-14	14-22	22-06	8 Hourly Max	24 Hourly Avg.	Weather Con**	Remarks Temp. Min.-Max.
03.02.2020	110	126	98	126	111	Clear	10-32
05.02.2020	104	124	90	124	106	Clear	9-30
07.02.2020	100	118	98	118	105	Clear	9-29
10.02.2020	108	122	96	122	108	Clear	11-32
12.02.2020	106	124	98	124	109	Clear	9-30
14.02.2020	108	120	94	120	107	Clear	10-33
18.02.2020	112	124	96	124	110	Clear	9-31
20.02.2020	108	120	94	120	107	Clear	10-30
25.02.2020	106	124	96	124	108	Clear	11-32

Jharkhand State Pollution Control Board Central Laboratory, Jamsedpur

Station Code	Sampling Date	Area Class	City	State Name	8hr. value of SO2	8hr. value of SO2	8hr. value of SO2	8hr. value of SO2	8hr. value of SO2	8hr. value of SO2	8hr. value of NOX	8hr. value of NOX	8hr. value of NOX	8hr. value of NOX	8hr. value of NOX	8hr. Value of RSPM	8hr. Value of RSPM	8hr. Value of RSPM	8hr. Value of TSPM	8hr. Value of TSPM	8hr. Value of TSPM	
351	03.02.2020	Resi.	Jr.	Jharkhand	41.66	46.60	39.47	37.28	43.86	49.34	49.49	55.13	47.61	45.73	52.63	58.89	142.95	179.60	161.24	300.64	372.82	336.18
351	06.02.2020	Resi.	Jr.	Jharkhand	32.34	36.73	41.11	34.53	29.60	38.37	40.10	47.61	50.75	42.60	39.02	47.61	141.16	154.40	128.16	293.17	318.04	265.17
351	10.02.2020	Resi.	Jr.	Jharkhand	38.37	44.95	40.02	47.69	41.66	36.18	46.99	53.25	49.49	57.01	50.12	43.86	151.54	184.62	170.73	316.53	382.79	354.34
351	13.02.2020	Resi.	Jr.	Jharkhand	38.92	40.57	42.76	44.95	37.28	41.66	46.99	50.12	52.63	55.13	45.73	48.24	164.81	177.66	147.51	341.40	368.00	306.12
351	17.02.2020	Resi.	Jr.	Jharkhand	41.66	46.05	39.47	36.18	37.82	43.86	50.75	55.13	47.61	43.86	45.73	52.63	133.13	172.04	148.71	278.96	355.51	310.30
351	20.02.2020	Resi.	Jr.	Jharkhand	37.28	44.40	40.02	35.08	37.82	46.60	46.36	52.63	48.87	42.60	50.12	56.39	141.80	172.25	156.08	295.19	357.22	324.76
351	24.02.2020	Resi.	Jr.	Jharkhand	38.92	41.66	44.40	46.60	37.28	40.57	45.73	50.12	53.88	56.39	43.86	48.24	120.16	138.77	103.48	249.83	288.47	215.79
351	27.02.2020	Resi.	Jr.	Jharkhand	34.53	37.28	39.47	43.86	36.18	38.37	40.72	44.48	50.26	51.37	43.23	48.87	161.79	172.93	142.61	333.83	358.06	296.58
382	04.02.2020	Ind.Ar.	Jr.	Jharkhand	38.37	40.02	33.99	44.40	42.76	36.18	46.36	48.87	45.63	53.88	50.75	43.86	154.81	182.96	141.26	318.94	376.68	293.19
382	07.02.2020	Ind.Ar.	Jr.	Jharkhand	33.44	29.60	41.66	40.57	34.53	31.25	42.60	37.59	47.61	51.37	40.72	48.87	105.67	134.65	121.30	220.26	280.49	254.03
382	11.02.2020	Ind.Ar.	Jr.	Jharkhand	37.28	42.76	40.57	44.40	34.53	31.79	45.11	52.00	47.61	53.88	43.23	40.10	161.96	174.83	143.48	334.01	358.83	296.88
382	14.02.2020	Ind.Ar.	Jr.	Jharkhand	40.57	43.86	45.50	38.92	35.08	37.28	47.61	50.12	56.87	45.73	41.35	43.86	152.16	171.53	145.83	315.00	355.17	301.83
382	18.02.2020	Ind.Ar.	Jr.	Jharkhand	36.73	42.76	46.05	42.21	38.92	34.53	45.11	52.00	55.13	50.12	48.24	42.60	143.64	176.49	155.24	298.05	366.53	321.91
382	22.02.2020	Ind.Ar.	Jr.	Jharkhand	39.47	41.66	43.86	46.60	42.76	43.50	46.36	50.75	52.63	55.13	49.49	53.88	145.49	176.83	158.09	301.24	366.33	327.28
382	25.02.2020	Ind.Ar.	Jr.	Jharkhand	40.02	47.45	48.24	43.31	37.82	34.53	48.87	57.54	61.50	56.21	47.61	45.63	151.88	167.65	135.33	314.52	345.90	280.83

Station Code	Sampling Date	Area Class	City	State Name	4Hr. value of SO2	4Hr. value of SO2	4Hr. value of SO2	4Hr. value of SO2	4Hr. value of SO2	4Hr. value of SO2	4Hr. value of NOx	4Hr. value of NOx	4Hr. value of NOx	4Hr. value of NOx	4Hr. value of NOx	4Hr. value of RSPM	4Hr. value of RSPM	4Hr. value of RSPM	4Hr. value of RSPM	4Hr. value of RSPM	4Hr. value of TSPM	4Hr. value of TSPM
614	03.02.2020	Resi.	Jsr.	Jharkhand	37.82	41.66	45.50	47.69	40.02	43.86	48.94	53.57	54.51	54.89	48.87	52.91	138.72	173.44	161.12	286.54	357.05	332.33
614	06.02.2020	Resi.	Jsr.	Jharkhand	40.02	44.40	42.21	47.69	37.28	35.08	48.24	52.63	50.12	56.39	43.86	41.98	151.37	173.78	138.72	315.69	358.74	289.97
614	10.02.2020	Resi.	Jsr.	Jharkhand	39.47	42.76	44.95	47.14	37.28	40.57	47.61	50.12	52.63	55.13	45.73	48.24	156.75	176.50	148.18	324.93	359.67	307.46
614	13.02.2020	Resi.	Jsr.	Jharkhand	39.47	44.40	36.18	42.76	46.60	37.82	47.61	52.00	43.86	53.25	56.39	45.73	133.73	164.97	145.16	277.05	342.99	301.24
614	17.02.2020	Resi.	Jsr.	Jharkhand	34.53	41.66	48.79	50.98	39.47	37.82	45.86	51.37	57.64	60.77	48.87	46.36	143.14	174.33	157.09	298.22	361.33	324.09
614	20.02.2020	Resi.	Jsr.	Jharkhand	36.18	40.02	42.76	46.05	34.53	38.37	42.60	47.61	51.37	55.13	40.72	48.24	153.66	178.59	150.06	318.33	370.30	310.47
614	24.02.2020	Resi.	Jsr.	Jharkhand	33.44	40.02	42.21	34.53	37.82	43.86	40.10	47.61	50.75	41.98	45.11	53.25	118.61	137.87	88.41	249.83	288.96	186.48
614	27.02.2020	Resi.	Jsr.	Jharkhand	33.44	37.28	41.66	50.34	41.11	46.87	41.98	48.28	52.00	60.84	52.24	57.14	144.83	170.36	156.50	300.84	352.32	322.83
615	04.02.2020	Ind.	Jsr.	Jharkhand	20.83	26.31	15.35	12.06	17.54	16.44	25.06	28.19	20.05	18.17	23.18	26.94	81.31	58.83	92.90	172.55	127.50	196.91
615	07.02.2020	Ind.	Jsr.	Jharkhand	19.73	23.57	15.89	13.15	17.54	21.38	26.68	31.74	21.30	17.54	24.47	29.76	58.29	73.16	82.66	125.00	155.17	175.74
615	11.02.2020	Ind.	Jsr.	Jharkhand	15.89	14.62	18.64	20.28	16.08	21.38	21.30	17.54	23.81	25.68	19.21	27.56	78.59	98.62	96.98	169.57	209.85	207.32
615	14.02.2020	Ind.	Jsr.	Jharkhand	19.18	15.35	21.92	16.44	13.70	20.28	25.06	20.05	28.19	21.92	24.43	26.31	75.43	104.84	91.06	159.27	221.54	291.36
615	18.02.2020	Ind.	Jsr.	Jharkhand	17.54	19.73	15.35	13.15	18.64	21.38	20.67	23.81	18.79	16.29	23.18	26.31	85.50	104.33	81.87	181.17	220.09	168.53
615	22.02.2020	Ind.	Jsr.	Jharkhand	17.54	15.35	19.73	21.93	16.21	15.89	21.93	18.37	24.43	27.56	20.88	20.05	76.65	92.23	90.78	165.31	196.40	196.09
615	25.02.2020	Ind.	Jsr.	Jharkhand	18.64	20.83	15.35	17.54	21.93	24.67	22.55	25.68	20.67	24.83	27.56	30.07	95.02	80.81	105.18	200.54	171.03	222.22

3. Details of Amount to be released :-

Sl. No.	Monitoring Station	Parameter Monitored	No. of Days*	Remarks
1	Bistupur Vehicle Testing Centre, Jamshedpur (Code no. :-351)	SO2, Nox, RSPM & TSPM	8	Work Done
2	Golmuri Vehicle Testing Centre, Jamshedpur (Code no. :-382)	SO2, Nox, RSPM & TSPM	7	Work Done
3	Regional Office Saraikela Kharsawan (Code no. :-614)	SO2, Nox, RSPM & TSPM	8	Work Done
4	Roof of Central Hospital Barajamda, West Singhbhum (Code no. :-615)	SO2, Nox, RSPM & TSPM	7	Work Done

Sl. No.	Date	METEOROLOGICAL INFORMATION															Remarks			
		6 to 10			10 to 2			2 to 6			6 to 10			10 to 2				2 to 6		
		Temp	Rh	WSD	Temp	Rh	WSD	Temp	Rh	WSD	Temp	Rh	WSD	Temp	Rh	WSD		Temp	Rh	WSD
1	03.02.2020	14	71	7/EES	23	55	9/SSE	25	46	1.325/EES	18	58	1.45/EES	12	78	1.1/SSE	9	81	.825/SSW	Clear
2	06.02.2020	11	75	1.025/EES	17	70	.875/SSE	16	53	9/EES	13	46	1.275/EES	11	53	.975/SSE	9	70	1.05/SSW	Cloudy/Rainy
3	10.02.2020	13	75	1.05/SSE	21	61	1.4/SSE	22	49	1.8/EES	16	60	1.625/SSE	11	77	1.575/SSE	9	84	.875/SSW	Clear
4	13.02.2020	15	76	1.1/SSE	25	63	1.25/SSE	27	50	1.25/EES	23	58	1.2/SSE	19	75	1.275/SSE	13	82	.975/SSW	Clear
5	17.02.2020	20	72	.85/SSW	28	58	1.25/SSW	29	35	1.5/WWS	22	57	1.65/SSW	17	76	1.425/SSW	14	83	.875/WWS	Clear
6	20.02.2020	19	67	.95/SSE	27	51	1.2/EEN	30	38	1.65/EEN	22	52	1.475/EEN	16	73	.9/WNE	NNE	80	.775/EES	Clear
7	24.02.2020	16	75	1.1/SSE	23	61	1/SSE	25	63	1.25/SSW	20	83	1.275/SSW	17	87	.875/WWS	14	80	1.05/SSW	Cloudy
8	27.02.2020	18	72	1/WWS	25	63	1.05/SSE	26	53	1.425/SSE	23	45	.95/WWS	19	51	.8/WWS	16	66	.925/SSW	Clear/Cloudy

TABLE A: Ambient Air Quality Data for SO2 and NOx Monitoring by : Jharkhand State Pollution Control Board

Sampling Location Address : MADA, Jharia
 City : Dhanbad
 State : Jharkhand
 Station Code: 332 Station Type: I Month: January Year: 2020

N- 23°45'12.0
 E- 86°24'44.1

Parameter	Units
SO2	µg/m ³
NOx	µg/m ³

S.No.	Date	SO ₂								NO _x								Weather Conditions	Remarks
		06-10	10-14	14-18	18-22	22-02	02-06	4 Hrs. Max.	24 Hrs. Avg.	06-10	10-14	14-18	18-22	22-02	02-06	4 Hrs. Max.	24 Hrs. Avg.		
1	04-05/01/2020	10.98	13.07	13.94	13.62	12.53	13.07	13.94	12.87	30.47	34.72	39.96	33.73	32.74	33.33	39.36	34.06	Clear	
2	07-08/01/2020	12.55	11.98	11.50	18.35	12.30	13.62	18.35	13.38	31.43	34.72	32.38	48.52	31.43	33.73	48.52	35.37	Clear	
3	10-11/01/2020	11.50	16.04	17.43	14.64	12.55	13.60	17.43	14.29	29.52	41.90	43.17	38.09	33.33	34.28	43.17	36.72	Clear	
4	17-18/01/2020	12.30	13.07	13.60	14.64	12.55	11.50	14.64	12.94	32.38	34.28	36.19	33.33	31.43	30.47	36.19	33.01	Clear	
5	20-21/01/2020	11.50	13.94	12.55	13.07	12.30	14.64	14.64	13.00	30.47	38.09	32.38	33.33	31.43	39.36	39.36	34.18	Clear	
6	24-25/01/2020	12.30	13.62	13.94	13.62	12.53	13.07	13.94	13.18	31.43	34.72	39.36	35.71	32.74	33.33	39.36	34.55	Clear	
7	27-28/01/2020	12.30	13.60	12.55	11.98	13.07	14.71	14.71	13.04	31.43	32.38	30.47	29.76	33.33	35.71	35.71	32.18	Clear	
8	30-31/01/2020	16.04	17.43	16.73	13.60	12.30	11.50	17.43	14.60	43.17	45.71	41.90	33.33	30.47	31.43	45.71	37.67	Clear	

TABLE A: Ambient Air Quality Data for SO2 and NOx Monitoring by : Jharkhand State Pollution Control Board

Sampling Location Address : Bastacola
 City : Dhanbad
 State : Jharkhand
 Station Code: 612

N- 23°46'10.6
 E- 86°24'39.8

Station Type : I Month: January Year : 2020

Parameter	Units
SO ₂	µg/m ³
NO _x	µg/m ³

S.No.	Hrs. Date	SO ₂								NO _x								Weather Conditions	Remarks
		06-10	10-14	14-18	18-22	22-02	02-06	4 Hrs. Max.	24 Hrs. Avg.	06-10	10-14	14-18	18-22	22-02	02-06	4 Hrs. Max.	24 Hrs. Avg.		
1	04-05/01/2020	10.98	13.07	12.30	14.80	12.30	13.62	14.80	12.85	30.47	33.73	33.33	41.43	31.43	34.72	41.43	34.19	Clear	
2	07-08/01/2020	10.98	16.63	10.46	13.07	12.55	13.60	16.63	12.88	28.57	44.44	46.98	32.38	31.43	33.33	46.98	36.19	Clear	
3	10-11/01/2020	16.73	18.13	19.53	13.07	12.20	10.98	19.53	15.11	40.63	44.44	46.98	32.38	31.43	30.47	46.98	37.72	Clear	
4	17-18/01/2020	11.50	12.30	13.07	12.55	10.98	13.94	13.94	12.39	30.47	31.43	33.33	32.38	29.52	38.09	38.09	32.54	Clear	
5	20-21/01/2020	11.98	13.07	11.44	14.16	12.53	13.62	14.16	12.80	31.74	32.74	34.72	32.74	33.73	35.71	35.71	33.56	Clear	
6	24-25/01/2020	12.55	13.60	14.12	13.62	12.30	15.25	15.25	13.57	30.47	32.38	33.33	32.74	29.52	35.71	35.71	32.36	Clear	
7	27-28/01/2020	16.04	13.07	18.83	14.78	12.55	11.50	18.83	14.46	41.90	32.38	46.98	45.71	33.33	30.47	46.98	38.46	Clear	
8	30-31/01/2020	16.73	18.13	17.43	18.83	11.50	12.30	18.83	15.82	41.90	44.44	46.98	43.17	34.28	30.47	46.98	40.21	Clear	

RESULTS AND DISCUSSION

Improvement in air quality of Dhanbad

The closure has significantly increased air pollution in Dhanbad, which recently made headlines for being the second most polluted city in the country. A study by Biswajit Paul, an associate professor in the Department of Environmental Sciences and Engineering at IIT (ISM), found that pollution levels in Dhanbad had dropped dramatically in four days after closure despite the normal operation of 45 Bara Coking Coal Limited (BCL) sites. Collieries are freed from closure because coal mining is important in generating electricity. Studies have shown that pollution in Dhanbad is largely due to traffic leaks, street sweeping and burning biomass and coal,"Paul told The Telegraph. "I started this study 2-3 days after the country closed on March 25. It showed that pollution levels were high in Dhanbad this morning due to activities such as street sweeping, garbage collection and burning coke ovens," he said. The average PM10 level of Dhanbad before the closing time was almost 170 micrograms per cubic meter (µg / m³) while the average five-day closing time from March 25 to March 29 when he conducted the study was 48 µg / m³, said Paul. The safe limit for PM10 is 60µg / m³. "Pollution levels are likely to improve further during the closure," he said. Paul said. PM10, or particulate matter 10 micro-meter or less in diameter, is a serious risk to humans. Paul, who is also a member of the Dhanbad environmental committee, said the research report was very different from the common belief that pollution in Dhanbad was caused by mining activities. "Based on the findings I recommend that vehicle pollution be reduced by conducting proper inspections of all vehicles," said Paul According to a Greenpeace India report released on January 22, Jharia and Dhanbad were listed as the most polluted cities in the two hundred and seventy-two with PM10 levels of 322 and 264 µg / m³, respectively, in 2018. Under the national clean air system. Launched in 2019, the center listed Dhanbad among 102 cities where pollution levels should be reduced by 30 percent by 2024.

There has been an appreciable improvement in air quality in the three commercial hubs of Jamshedpur and the adjoining industrial belt of Adityapur, a recent survey has revealed, indicating how A few vehicles on the roads in the last two months of closure have significantly reduced pollution levels By the Jharkhand State Pollution Control Board (JSPCB) in mid-May, data from the study revealed that pollutants such as sulfur dioxide and nitrogen dioxide were significantly below the limits. In Bistupur, Sakchi, Golmuri in Jamshedpur and in the Adityapur industrial area in the Sereraikela-Kharsawan region. RSPM has been found to be below normal limits in all these areas. At Bistupur roundabout, opposite the landmark Regal Building, RSPM was found to be 72.04 µg/m³, which is 28 µg/m³ less than the permissible limit of 100 µg/m³).RSPM in Adityapur, an industry hub, was a bit higher at 80.23 µg/m³ but around 20 µg/m³ less than the permissible limit. In mid-March, before the closure, RSPM was around 160 µg / m³ in Adityapur. In steel city business centres like Bistupur, Sakchi and Golmuri, RSPM levels were away above permissible limits, ranging between 140 µg/m³ and 150 µg/m³ prior to the lockdown. The JSPCB survey team used respirable dust samplers to measure pollution levels in all these places. The other two elements, sulphur dioxide and nitrogen dioxide, on which the ambient air quality is judged, were also found to be way below prescribed limits According to a recent study report, the sulfur dioxide (SO₂) levels in Bistupur, Golmuri and Sakchi were 18.64 µg / m³, 16.35 µg / m³ and 18.32 µg / m³ respectively when the set limit was 80 µg / m³. found to be 16.63 µg / m³ .In an earlier survey carried out in mid-March, SO₂ levels in Bistupur, Golmuri and Sakchi were 37.25 µg/m³, 36.10 µg/m³ and 35.56 µg/m³ respectively. At Adityapur, the SO₂ level was around 40 µg/m³. 'Apart from the three places in the steel city and Adutyapur industrial, area a similar survey was also carried out at Barajamda in adjoining West Singhbhum, a mining hub. All the parameters were much below prescribed limits at that mining hub too,' he said. A member of the survey team said the nationwide lockdown had enforced restrictions and self-quarantine measures, which reduced emissions from vehicles as well as industries.' The latest air quality index (AQI) indicates over 50 per cent reduction in pollution in the steel city due to declining levels of various air pollutants, ' he said.



Fig Lockdown helped clean up in Jamshedpur air

He said fewer heavy vehicles, all diesel run, had contributed to cleaning up the air. 'Emissions from diesel contribute more to air pollution. Oxides of nitrogen and un-burnt hydrocarbons released by vehicles increases pollution,' he explained.

Impact of lockdown: Improvement in air quality of Hazaribagh

Hazaribagh: The changing of Hazaribagh is reminiscent of the weather years ago. The climate here has been attracting the people of the country. People living in the metropolises of North India used to visit the place during summer and for health benefits. Suhana enjoyed the weather. After the lockdown, the temperature in Hazaribagh has decreased by three to six degrees. The amount of dust in the air has been reduced by 34.17 micrograms per cubic meter, sulfur dioxide 5.36 micrograms per cubic meter and nitrogen dioxide 2.45 micrograms per cubic meter. Hazaribagh had a temperature of 39 degrees in April 2018, while 33-35 degrees is currently being recorded.

How the fall in city pollution

Hazaribagh is completely closed after lockdown. Vehicles are not running on the roads. Factories are locked. Due to which there is no amount of sulfur dioxide and nitrogen dioxide in the smoke that comes out after burning petroleum material and coal. These two gases pollute the air more. According to government statistics, 15 thousand new vehicles are registered every year in Hazaribagh. At the same time there are 59 big factories in the district, which are the factors that increase the level of pollution. Apart from this, building construction, road construction and other construction works are closed after lockdown. Due to which dust, sand and ash are not blowing. Hazaribagh Pollution Regulatory Board Regional Officer Ashok Kumar Yadav said that after the lockdown, the quantity of ambient air quality, sulfur dioxide and nitrogen dioxide in the air has been taken from the pollution measuring device installed in the regional office premises.

He said that the amount of dust in the air should be 100 micrograms per cubic meter. Similarly, sulfur dioxide and nitrogen dioxide should be 80-80 micrograms per cubic meter. The pollution level in Hazaribagh has come down significantly.

Nation Ambient Air Quality Monitoring Program (NAMP) - Air quality monitoring stations operating under the National Ambient Air Quality Monitoring Program (NAMP) with the financial assistance of the Central Pollution Control Board (CPCB) in respect of operating and maintenance costs. Monitoring is done on 104 days and 24 hours a year as per the frequency specified by the CPCB guidelines. Information obtained from these channels is transmitted to the CPCB online and then to the Environmental Data Bank (EDB).1. RANCHI-

A) Elber Ekka Chwck, Ranch (Station Code- 402)

Jamshedpur

- Bistupur Vehicle Testing Centre (Station Code-351)
- Golmuri Vehicle Testing Centre (Station Code-382)
- Regional Office, SaraikelaKhersawan (Station Code-614)
- Roof of Central Hospital, Barajamda, West Singhbhum (Station Code- 615)

DHANBAD

- Roof of Regional Office. Housing Colony, Bartand, Dhanabd (Station Code-44)
- MADA, Jharia, Dhanbad (Station Code-332)
- Bastacola, Dhanbad (Station Code-612)
- CGMO, Kusunda, Dhanbad (Station Code-611)
- PDIL, Sindri, Dhanbad (Station Code- 46)

Methods of Source & Ambient Air Quality Monitoring

Sl.No.	Method
1	EPA Method 1 - Traverse points
2	EPA Method 2 - Velocity
3	EPA Method 3 - Molecular weight & Gas composition
4	EPA Method 4 - Molecular Weight

5	EPA Method 5
6	EPA Method 17
7	M-06-Sourceemission-Sulphurdioxide
8	M-07-Sourceemission-nitrogen oxides
9	M-23a - Dioxin & Furans
10	M-26 - HCl, HF, Nonisokinetic
11	M-26a - HCl, H
12	M-29 – Metals
13	QUAM2012 P1

Procedure for obtaining a work permits under the Air Act, 1981 and accreditation under Hazardous & Other Waste (M&TM) Rules, 2016 By Jharkhand State pollution board.

Procedure for Grant of Consent to Operate (CTO) for Red, Orange and Green Category units

I. First Consent to Operate The new units after installation of their project, are required to obtain consent to operate under Air Act, 1981 before starting even trail production. No separate trial consent will be granted. Ist consent to operate will include trail consent. Those industries will apply for a permit to operate the Online Consent Management and Monitoring System (OCMMS) under the terms of the Air Pollution Control (Pollution Control and Control) Act, 1981 respectively and documents as per check list, compliance with CTE terms and Environmental Removal (if applicable) and permit fees In the event that this unit is merged under the Hazardous & Other Waste (Management, Trans boundary & Movement) Regulations, 2016, it will operate simultaneously. For hazardous waste application, fee is required to be deposited.

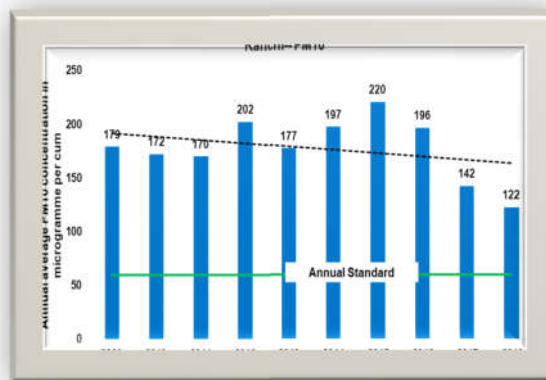
Inspection of the industry will be carried out by the authorized officer/ officers of the Board before commissioning of the production in the unit and before giving the Ist CTO, after approval from the Competent Authority to check the status regarding installation of pollution control measures/ devices undertaken at the time of obtaining the CTE as well as their structural adequacy before deciding the cases of Ist CTO under Air Act, 1981 and also authorization under Hazardous Waste Management Rules (if applicable).

In case the analysis report of samples of Air are found complying the standards prescribed under EP Rules, 1986, the 2nd CTO will be granted for the period of CTO for which it has been applied based upon the category of the unit or as was demanded by the unit but in case of failure of sample The CTO the offer will be deducted / canceled after following the correct procedure. The validity of the Air Act, 1981, will be subject to the following: -

Industry/Project Category	Validity Period
Red Category	5 Years
Orange Category	10 years
Green Category	15 years

The current study reports the concentration of the PM10 position and the corresponding heavy weights The present study reports the ambient concentrations of PM10 and associated heavy metals are weighed at 3 sites in the Jharia field mines between October 2012-February 2013. After acid digestion, quantification of 5 major heavy metals (Co, Cd, Mn, Ni and Pb) was done using Atomic Absorption Spectrophotometer (AAS). Out of 5 metals studied two metals (Ni and Pb) are criteria pollutants as per NAAQS (2009). As per the magnitude of the mean concentrations, these can be ranked in the following order Mn > Ni > Co > Cd > Pb. PM10

and heavy metals loading in coal mining area was found to be almost 2 times higher than that of control site. The analysis of PM10 and heavy metals detected in the present study was compared with those previously reported from other parts of India and the world. In coal mining areas the level of these pollutants has been found to be higher than in most other cities. Compliance analysis showed a strong relationship between Cd-Ni, Ni - Mn, and Cd - Mn.



Long-term Trend of PM10 concentration in Ranchi

Source: CSE's analysis based on CPCB air quality data ENVIS centre and data submitted to Lok Sabha

- Decreasing trend in PM 10 concentration
- Reduction target- Approximately 61 per cent PM10 has to be reduced to meet the current air quality standard.
- Status of actions in Ranchi city

Sector-wise measures Implemented	Initiatives undertaken
Industry	Ensuring installation and operation of air pollution control devices in industries. Ensuring emission standards in industries. ^{cxxv} ^{cxxvi} Adoption of cleaner technology in industries. Conversion of natural draft brick kilns to induced draft ^{cxxvii} by March 2020. Flue gas emission control by adopting cleaner fuel or change in APCM technology. ^{cxxviii}
Power Plants	Shifting or ban on Polluting industries within city limits NA Prepare action plan to check fuel adulteration and random monitoring of fuel quality data. ^{cxxix}
Sector-wise measures implemented	Initiatives undertaken Banning of 12 years old commercial vehicles. Installation of PUC centers in petrol pumps. ^{cxxx} Ranchi Mobility Partnership Programme (2014) – partnership between ITDP, various NGOs and civic agencies ^{cxxxi}
Vehicles and Traffic management	Jharkhand State Transit Oriented Development Policy ^{cxxxii} (2016) Public Bicycle Sharing system, with total 1200 bicycles – operated by Chartered Bikes ^{cxxxiii} (2018) 190 minibuses procured by State through JNNURM, out of which
Public Transport	70 for Ranchi ^{cxxxiv} (2010) 26 GPS-enabled buses added to the fleet by RMC (2017) State adopted e-mobility programme in partnership with EESL -
Electric Vehicle Policy	50 electric vehicles to be deployed at various JBVNL offices ^{cxxxv} (2018) 12 charging stations set up at 4 offices of JBVNL, including corporate offices in Ranchi (2018)
Parking	Pilot smart parking management (a progressive on street parking management system) on chock-a-block M.G. Marg – 12 fold annual revenue increase ^{cxxxvi} (2017) Water Sprinkling on road through tankers. Regular cleaning of road dust. Ensure Carriage / Transportation of construction materials like sand, soil, stone, chips etc. in covered system. ^{cxxxvii}
Waste Burning	Enforcement of Construction and Demolition Waste Management Rules, 2016. Prohibition of burning of any kind of waste including agro residues. ^{cxxxviii} Regular Check and Control on open burning of

Monitoring and Graded response action plan

municipal solid waste, Biomass, plastic, horticulture waste etc. Installation of additional NAMP monitoring stations at Ranchi. Currently one exists at Albert Ekka Chowk, Main Road. cxxxix Establishment of CAAQMS, currently no real time monitoring stations exist. Source Apportionment study of Ranchi is underway.

References

1. Agbaire PO, and Esiefarienrhe E. 2009. Air Pollution Tolerance Indices (APTI) of some plants around Otorogun gas plant in Delta State, Nigeria. *J. App. Sci. Environ. Manage.* 13: 11-14.
2. Honour SL, Bell JN, Ashenden TW, Cape JN and Power SA. 2009. Responses of herbaceous plants to urban air pollution: Effects on growth, phenology and leaf surface characteristics. *Environ. Pollut.* 157: 1279-1286.
3. Singh, S.K., Rao, D.N., Agrawal, M., Pandey, J., Narayan, D.: Air pollution tolerance index of plants. *J. Environ. Manage.* 32, 45–55 (1991)
4. Prajapati, S.K., Tripathi, B.D.: Anticipated performance index of some tree species considered for green belt development in and around an urban area: a case study of Varanasi city, India. *J. Environ. Manag.* 88, 1343–1349 (2007)
5. Dhankhar, R., Mor, V., Lilly, S., Chopra, K., Khokhar, A.: Evaluation of anticipated performance index of some tree species of Rohtak city, Haryana, India. *Int. J. Recent Sci. Res.* 6(3), 2890–2896 (2015)
6. Sen, D.N., Bhandari, M.C.: Ecological and water relation to two *Citrullus* spp. In: Althawadi, A.M. (ed.) *Indian Arid Zone, Environmental Physiology and Ecology of Plants*, pp. 203–228 (1978)
7. Arnon, D.I.: Copper enzymes in isolated chloroplast polyphenol oxidase in *Beta vulgaris*. *Plant Physiol.* 24, 1–15 (1949)
8. Liu, Y.J., Ding, H.: Variation in air pollution tolerance index of plants near a steel factory: implications for landscape-plant species selection for industrial areas. *WSEAS Trans. Environ. Dev.* 4, 24–32 (2008)
9. Singh, S.K., Rao, D.N.: Evaluation of plants for their tolerance to air pollution. *Proceeding of Symposium on Air Pollution Control*, vol. 1, pp. 218–224. Indian Association of Air Pollution Control, New Delhi (1983).
10. Gupta, S.P., Gupta, M.P., 2008. *Business Statistics*. Sultan Chand and Sons Educational Publishers, New Delhi

How to cite this article:

Puja et al (2021) 'Impact of Covid-19 on Air Pollution of Jharkhand', *International Journal of Current Medical and Pharmaceutical Research*, 07(03), pp 5611-5621.
