A Case Study: Monitoring For Pre, During And Post Lockdown on Air Quality Parameters In Bilaspur, (C.G.)

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Abstract- *The Covid-19 blockade is playing an important role in reducing air pollutants across the country. The present work aims to analyze air pollutants such as particulate matter (PM10), Sulphur dioxide (SO2), Nitrogen dioxide (NO2) at Bilaspur Chhattisgarh in 3 Phases Pre-Lockdown phases, During Lockdown and Post-Lockdown in the same time frame i.e., (March 1st - May 31st). All data was taken from the Chhattisgarh Environment Conservation Board (CECB) (https://www.enviscecb.org/) and compared the data of pre, during, and post lockdown to check for increases and decreases in air quality. For these, we used different types of Air Quality Index (AQI) to conclude on quality of air, such as Indian AQI, Oakridge AQI, and Average AQI. Vyapar Vihar Bilaspur Air quality indexwas 56 but during the lockdown (March 1, May 31, 2020) it was reduced to 47, a decrease of 16% and after the lockdown (March 1, May 31, 2021) increases by approximately 9% i., 51. A global study suggests that during the blocking phase (March 1, May 31, 2020) it shows declination, but when the unblocking process begins the main pollutant shows gradually increasing. The current review demonstrates that implementing unlimited air contamination measures can bring immediate air quality benefits.*

Keywords- Covid-19 Lockdown, PM_{10}, SO_2, NO_2, Air Quality Index: IND AQI, AVG AQI, ORAQI.

I. INTRODUCTION

Air is one of the maximum crucial components of our surroundings a median individual calls for approximately 12 kg of air every day, which is sort of 12 to fifteen instances extra than the number of meals consumed. Eventually, even small attention of pollution gift with inside the air turns into greater danger to human fitness, in contrast to comparable concentrations of pollution found in meals. Any alternate with inside the herbal and ordinary composition of the air (both qualitative and quantitative), which can adversely have an effect on the residing system, mainly the human life, continuously reasons air pollution. When the quantum of air pollution exceeds the self-cleaning homes of the ambient air and begins off evolved inflicting dangerous results on human fitness and the encircling abiotic world, then the air is stated to be polluted.

Study Area:

Bilaspur district is situated between 21º47' and 23º8' north latitudes and 81º14' and 83º15' east longitudes. In Bilaspur, one location is considered Regional Office, Vyapar Vihar, Bilaspur which is located at 22.065510 º N 82.145170 º E.

1.1 Various Pollutants Causing Air Pollution:

The atmospheric air may contain hundreds of air pollutants from natural or anthropogenic (manmade) sources. The following five primary pollutants contribute to about90% of the global air pollution. The Important Primary air pollutants are:

S. No.	Pollutant	Characteristics	Source	Health Effects
1.	Suspended particulate matter	Solid particles like dust, smoke and	Dust storm; cigarette	Effects on breathing and
2.	Sulphur dioxide (SO_2)	Colourless gas; taste threshold at	Combustion of oil and coal in	Effects on breathing,
3.	Nitrogen dioxide (NO_2)	NO is a reddish brown highly	High temperature	NO plays a major role in

1.2 Covid Situation

Coronavirus pandemic makes a misfortune our country. It is commenced withinside the Wuhan lab in China. Because of those SARS-CoV-2, the human is inspired with no problem. Toward the start of March 2020, due to its brief spread, the WHO proclaimed COVID-19 as a pandemic. Along those lines, on twenty-second March 2020, the

Government of India declared a Janta curfew time restriction everywhere in the country, but someday is not enough to govern this dangerous contamination so once more on March 24, 2020, a lockdown will be reported. The sizable regions, including air infection, are transport, ventures, strength plants, improved physical games, biomass and decline to consume, road dirt resuspension, and personal physical games. Due to excessive tour obstacles and the recent down of superfluous physical games together with the ones of air contaminating regions, air high-satisfactory development has been stated in several cities and concrete groups. Lockdown due to the COVID-19 pandemic has been introduced to similarly growing the overall air high-satisfactory. Over 40statement in $PM_{2.5}$ and 47% diminishing in PM_{10} in north Indian city groups. Over a 40 statement in CO in north Indian city groups apart from Delhi and Patna.

1.3 Air Quality Index (AQI)

An air quality index is defined as an overall scheme that transforms the weighed values of individual air pollution-related parameters (for example, pollutant concentrations) into a single number or set of numbers (Ott, 1978). The result is a set of rules (i.e., a set of equations) that translateparameter values into a simpler form by 3 means of numerical manipulation. If actual concentrations are reported in µg/m3 or ppm (parts per million) along with standards, then it cannot be considered as an index. At the very last step, an index in any system is to group-specific concentration ranges into air quality descriptor categories.

Indian Air Quality Index (IND-AQI)

Air quality standards are the basic foundation that provides a legal framework for air pollution control. An air quality standard is a description of a level of air quality that is adopted by a regulatory authority as enforceable. The basis of the development of standards is to provide a rationale for protecting public health from adverse effects of air pollutants, to eliminate or reduce exposure to hazardous air pollutants, and to guide national/local authorities for pollution control decisions. With these objectives, CPCB notified (http://www.cpcb.nic.in) a new set of Indian National Air Quality Standards (INAQS) for 12 parameters [carbon monoxide (CO) nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), particulate matter (PM) of less than 2.5 microns size ($PM_{2.5}$), PM of less than 10microns size (PM_{10}), Ozone (O_3), Lead (Pb), Ammonia (NH), Benzo(a)Pyrene (BaP), Benzene(C_6H_6), Arsenic (As), and Nickel (Ni)]. The first eight parameters have short-term (1/8/24hrs) and annual standards (except for CO and O_3) and the rest four parameters have only annual standards.

Indian National Air Quality Standards (units: µg/m^3 unless mentioned otherwise)

Pollutant	SO_2	NO2	$PM_{2.5}$	PM_{10}	O_3		CO		Pb	NH3
Averaging time	24	24	24	24	1	8	1	8	24	24
Standard	80	80	60	100	180	100	4	2	1	400

B(a)P, C6H6, As, and Ni have annual standards

IND-AQI Category and Range

AQI category	AQI Range
Good	0-50
Satisfactory	51-100
Moderate	101-200
Poor	201-300
Very poor	301-400
Severe	401-500

Breakpoints for AQI Scale 0-500 (units: µg/m3 unless mentioned otherwise)

AQI	PM10	PM2.5	NO2	O3	CO	SO2	NH3	Pb 24-
Good	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory	51-100	31-60	41-80	51-	1.1-2.0	41-80	201-400	0.6 –1.0
Moderate	101-	61-90	81-	101-	2.1- 10	81-380	401-800	1.1-2.0
Poor	251-	91-	181-	169-	10.1-17	381-	801-	2.1-3.0
Very poor	351-	121-	281-	209-	17.1-34	801-	1201-	3.1-3.5
Severe	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

Health Statements for AQI Categories

AQI	Associated Health Impacts
Good	Minimal Impact
Satisfactory	May cause minor breathing discomfort to sensitive people
Moderate	May cause breathing discomfort to the people with lung disease
Poor	May cause breathing discomfort to people on prolonged exposure
Very Poor	May cause respiratory illness to the people on prolonged exposure.
Severe	May cause respiratory effects even on healthy people and serious

Interpretation of Air quality using IND-AQI

The sub-index (Ip) for a given pollutant concentration (Cp), as based on 'linear segmented principle' is calculated as:

Ip= [{(IHI - ILO)/ (BHI -BLO)} * (Cp-BLO)] +ILO

BHI= Breakpoint concentration greater or equal to given concentration
BLO= Breakpoint concentration smaller or equal to given concentration
IHI = AQI value corresponding to BHI

ILO = AQI value corresponding to BLO; subtract one from ILO, if ILO is greater than 50
Finally;

AQI = Max (Ip) (where; p= 1,2,...,n; denotes n pollutants).

Average Air Quality Index

Another method to determine the air quality index by (Joshi et al., (2010)) The air quality index (AQI) is a measure of the ratio of the pollutant's concentration to the status of ambient air in places. Indices of air pollutants or air quality have been used for about 25 years.

The following computation was used to drive the air quality index of the sites under consideration:

Avg AQI = 1⁄4(RSPM⁄sRSPM + SPM⁄sSPM+ SO_2⁄sSO_2+ NO_2⁄sNO_2) * 100

Where sRSPM, sSPM, sSO_2, and sNO_2 represent the ambient air quality standards as prescribed by the Central Pollution Control Board of India (CPCB), and RSPM, SPM, SO_2, and NO_2represent the actual values of pollutants obtained on sampling. After compiling the results, the concentration of each pollutant was converted into an AQI. The pollutant with the highest AQI number became the overall AQI for a particular location. The higher the AQI value, the greater is the level of air pollution and the greater the damage to health. The AQI scale was divided into five categories describes the range of air quality and its associated potential health effect. The indices use health• based descriptions to provide meaningful information to the public. The five levels of AQI are depicted in Table

Index values of air quality index calculation

Index value	Remark
0-25	Clean air
26-50	Light air pollution
51-75	Moderate air pollution
76-100	Heavy air pollution
Above 100	Severe air pollution

Oakridge Air Quality Index (ORAQI)

Oak Ridge National Laboratory published the ORAQI in 1971. It was based on the 24-hour average concentrations of the following five pollutants:

1. SO_2
2. NO_2
3. PM
4. CO
5. Photochemical Oxidants

The sub-index is calculated as the ratio of the observed pollutant concentration to its respective standard. As reported by Babcock and Nagda (1972), the ORAQI aggregation function was a nonlinear function:

ORAQI = $\{5.7 \Sigma Ii\}^{1.37}$

Where Ii = (X/Xs) i
X = Observed pollutant concentration
Xs = Pollutant Standard
I = Pollutant
The standards for the pollutants used in developing ORAQI are given below:

BreakPoint Concentrations of ORAQI

Pollutant	Standard Value
Photochemical oxidants	0.03 ppm
Sulphur oxides	0.10 ppm
Nitrogen dioxide	0.20 ppm
Carbon monoxide	7.0 ppm
Particulate matter	150 ug/m^3

The constants (e.g., 5.7 and 1.37 in the equation) are so selected that the ORAQI = 10 when all concentrations are at their naturally occurring or backgrounds levels and ORAQI = 100 when all concentrations are at their standards. Although well-defined descriptors are given, its developers imply no correlation with health effects. It is subjected to eclipsing and ambiguity. It is also difficult to explain to the public and involves complex calculations.

II. LITERATURE REVIEW

This overview addresses pollution, an device used to decide pollution, unique kinds of AQI, their calculation, The AQI is acquired from CPCB became check for 3 lockdown stages researcher in comparison the air nice information for the unlocking section with a coinciding duration in 2019 to decide the extrude in pollutant attention all through lockdown studying the day by day AQI information for 6 pollution (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, and O_3) meta-analyses additionally finished to decide the same old deviation and suggest of every lockdown section and their distinction became computed in percent in contrast to 2019 alongside Linear Correlation and Linear Regression to decide the connection a number of the air pollution and their fashion for the lockdown the end result suggests a few version step by step to speedy discount withinside the most important

pollutant along with PM_{10}, $PM_{2.5}$, SO_2, and CO however the increment in Ozone because of drastic boom in $NO_2$with the aid of using 80% later whilst the to release procedure begins off evolved the principle pollutant display increment step by step. During overall lockdown air nice notably stepped forward which offers statistics of towns management to increase policies and guidelines on how they enhance can the air nice. Studied Impact of Lockdown all through COVID- 19 Pandemic at the Air Quality of North Indian Cities. The most important intention became to decide the extrude in air pollution along with Particulate Matter $PM_{2.5}$ and $PM_{10}$and gaseous pollutant SO_2, NO_2, and O_3in all-area all of the pollution confirmed a declining fashion however O_3 suggests blended version.

III. MATERIAL AND METHODOLOGY

1. Particulate Matter (PM_{10})

Particulate matter is also known as atmospheric aerosol particles, atmospheric particulate matter, particulate matter (PM) or suspended particulate matter (SPM) are microscopic particles of solid or liquid matter suspended in the air. The term aerosol commonly refers to the particulate/air mixture, as opposed to the particulate matter alone. They have impacts on climate and precipitation that adversely affect human health, in ways additional to direct inhalation.

Instrument used / Equipment:

PM 2.5/10 Sampler i.e., Ambient Fine Dust Sampler, Model no. IPM-FDS-2.5/10µ INSTRUMEX is an advanced sampler that conforms to the USEPA and CPCB norms.This sampler uses a set of Impactors standardized by USEPA to separate coarse particulates from the air stream. For a sampling of PM 2.5, particles with an aerodynamic diameter larger than 10 microns are trapped by using the opposed jet impaction over a filter paper of specified Whatman number 7582-004 37mm diameter supported on surface by silicon oil and those having a diameter between 2.5 and 10 Microns are trapped over PTFE filters using the WINS Impactor. But for the sampling of PM 10, the WINS Impactor unit is replaced by PM 10 impactor assembly. Finally, the air stream leaving the WINS Impactor consists of only fine particulates with an aerodynamic diameter smaller than 2.5 microns. The flow is controlled by a microprocessor-based flow controller for maintaining the flow rate constant at 16.67 LPM.

Calculation of the volume of air sampled

V = (F1 +F□) T/2

Were,

V = volume of air sampled in m^3

F1 = measured flow rate before sampling

F2 = measured flow rate after sampling

T = time of sampling

PM 10 concentration is calculated by:

PM 10 = (Wf-Wi) 1000/Va

Were,

PM10 = Mass concentration of PM 10 collected during the sampling period, $\mu g/m^3$

Wf, Wi = final and Initial mass of glass fibre filter paper, mg

Va = Total air volume sampled, m^3

2. Sulphur Dioxide (SO_2)

Sulphur dioxide (SO_2), a Colourless, bad-smelling, toxic gas, is part of a larger group of chemicals referred to as Sulphur oxides (Sox). These gases, especially SO_2, are emitted by the burning of fossil fuels — coal, oil, and diesel — or other materials that contain Sulphur. Diesel vehicles and equipment have long been a major source of Sulphur dioxide, but recent federal regulations to reduce the Sulphur content of diesel fuels have made a significant improvement in emissions from this sector. Sulphur dioxide is also a natural by-product of volcanic activity.SO_2 is the component of greatest concern and is used as the indicator for the larger group of gaseous Sulphur oxides (Sox). Control measures that reduce SO_2 can generally be expected to reduce people's exposures to all gaseous Sox. This May have the important co-benefit of reducing the formation of particulate Sulphur pollutants, such as fine sulphate particles. Emissions that lead to high concentrations of SO_2 generally also lead to the formation of another Sox.

Instrument used / Equipment:

High Volume Samplers are the basic instruments used to monitor ambient air quality. Envirotech APM 415 with its attachment for gaseous pollutant monitoring APM 411 was used. In these samplers, air-borne suspended particulates (SPM) are measured by passing air at a high flow rate of 1.1 to 1.7 cubic meters per minute through a high-efficiency filter paper (Whatman GF/A Glass Microfiber Filters) which retains the particles. The instrument measures the volume of air sampled, while the number of particulates collected is determined by measuring the change in weight of the filter paper as a consequence of the sampling. In High Volume, Sampler provisions have been made for simultaneous sampling of gaseous pollutants. The gaseous attachment contains three impinger bottles of 35 ml capacity for simultaneous absorption of different gaseous pollutants. Here the air is passed through suitable reagents that would absorb

specific gases where gaseous pollutants like SO□, NOx, etc. The gaseous sampling requires only a few LPM (1-3 LPM) of airflow.

With the help of stoichiometric calculations, calculate the concentration of SO2, in the ambient atmosphere.

SO_2 concentration can be calculated by

SO_2 = (Mol. wt. of SO_2 W*10^6)/ (Mol. wt. of $BaSO_4$Va)

Were,
SO□ = Concentration of SO□, µg/m²
V = Total air volume sampled, m^3
W = weight of $BaSO_4$ formed i.e., the difference between filter paper before and after filtration, g
SO□,
Calculation Formula: SO□

SO□ (µgm/m³) = ((As-Ao) x Kc x Vs x 1000)/ (Va (Litres) x Vt)

Here:
Vs - Taken Volume of Absorbing Solution for sampling Vt-Taken Volume of Absorbing Solution for Analysis
Va - Volume of Air Avg. Flow rate (LPM) x Time (min) As per ml absorbance of the sample by Spectrophotometer Ao - per ml absorbance of Blank by Spectrophotometer Ko-Calibration Factor.

3. Nitrogen dioxide

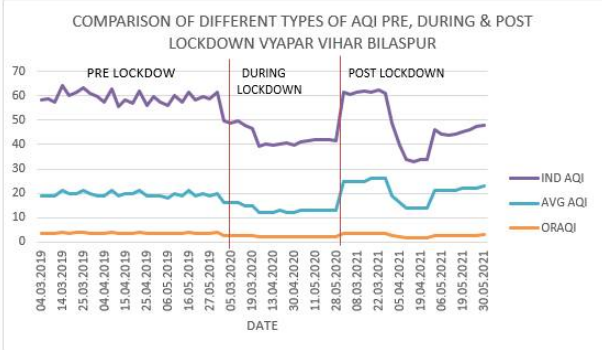
Nitrogen dioxide, or NO_2, is a gaseous air pollutant composed of nitrogen and oxygen and is one of a group of related gases called nitrogen oxides, or NOX.NO2 forms when fossil fuels such as coal, oil, gas, or diesel are burned at high temperatures.NO2 and other nitrogen oxides in the outdoor air contribute to particle pollution and to the chemical reactions that make ozone. It is one of six widespread air pollutants that have national air quality standards to limit them in the outdoor air. NO2 can also form indoors when fossil fuels like wood or natural gas are burned.

Instrument used / Equipment:

NO_2 is a gaseous pollutant and for that high-volume sampler also used the same as SO_2.

IV. RESULT AND DISCUSSION

Comparison of Different types of AQI Pre, During & Post Lockdown in Vyapar Vihar Bilaspur



Pre lockdown all the AQI were plotted and compared in one graph. IND AQI and AVG AQI show some increment and decrement. IND AQI, AVG AQI and ORAQI in overall during lockdown was 59.43, 36.23 and 3.58 respectively. During lockdown all the AQI were plotted and compared in one graph. IND AQI and AVG AQI show some increment and decrement. IND AQI, AVG AQI and ORAQI in overall during lockdown was 43.51, 18 and 2.28 respectively. Post lockdown all the AQI were plotted and compared in one graph. IND AQI and AVG AQI show some increment and decrement. IND AQI, AVG AQI and ORAQI in overall during lockdown was 48.08, 20.74 and 2.70 respectively.

V. CONCLUSION

IND AQI in Pre lockdown for Vyapar ViharBilaspur IND AQI was 56 i.e., it comes inthe category of satisfactory, in during lockdown it shows decrement i.e., 47which means it comes in the category of good, and in post lockdown also showsincrements51 that means it comes in the category of satisfactory.

AVG AQI in Pre lockdown for Vyapar ViharBilaspur in pre lockdown 20, in during lockdown, it shows decrement i.e., 18, in post lockdown also shows increment i.e., 20.

Oakridge Air Quality Index or ORAQI was also calculated for Vyapar Vihar, Bilaspur ORAQI was 3.46 in Prelockdown, during lockdown it shows decrement i.e., 2.90 and in post lockdown also it shows very fewer increments i.e., 2.97.

While Comparing IND AQI, AVG AQI, and ORAQI we have drawn someconclusions from their result that when we use three pollutants i.e., particulatematter, Sulphur Dioxide, Nitrogen Dioxide, and using the formulae of IND AQI,AVG AQI, and ORAQI for them we get that AVG AQI is thrice of IND AQIapproximately and ORAQI is five times of AVG AQI approximately when weuse formula and putting

their concentration and their standard values then thisconclusion evaluated.

Since ORAQI is US-based formula and also the formulae are nonlinear, after calculating it gives data under 10 and cannot be used for Indian standard but when we individual see the graph of IND AQI, AVG AQI, and ORAQI concerning dates the pattern is similar in all. But when we combine IND AQI, AVG AQI, and ORAQI we cannot jump to the conclusion since ORAQI gives a straight line whereas IND AQI and AVG AQI give similar variation from graph comparison.

Based on the observation obtained from the statutory bodies such as (CECB) during this field study and the corresponding data there should be some restrictions periodically followed:

- An odd-even policy should be implemented by the state government.
- Avoid excessive idling of automobiles.
- Refuel your car in the evening when it's cooler.
- Look for the ENERGY STAR label when buying a home or office equipment.
- Use filters for chimneys

VI. FUTURE SCOPE

- Further study can be done using annual data of Particulate Matter, Sulphur dioxide &Nitrogen dioxide for Pre, During, and Post lockdown.
- More stations should be installed as per the National Ambient Monitoring Program site selection Norms.
- Manually calculated data and Continuous Ambient Air Quality Monitoring Systems can be compared for various locations.
- Using ArcGIS software different types of interpolation methods i.e., inverse distance weighting, kriging & spline can be compared for better understanding.
- Further study can be carried out by using air quality data of different districts i.e., Raipur, Durg, Raigarh, and Korba to evaluate the Air Quality Index.
- Different types of pollutants rather than Particulate Matter, Sulphur dioxide, and Nitrogen dioxide such as Carbon monoxide, Lead, Ozone and can also be determined for calculating IND AQI.
- In future scope, New AQI can also be made or altered using ORAQI because it is US based and it cannot compete with Indian Standard so we can alter the formulae.
- By using Linear Regression and correlation we can predict the forecast of air quality approximately. We can also use machine learning for better and accurate predictions of air quality.

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