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A COMPREHENSIVE ASSESSMENT OF AIR QUALITY IN BILASPUR DISTRICT IN RELATION TO NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS) 2009

Neeta Mishra [1], Milan Hait [2]

[1] Research Scholar, Department of Chemistry, Dr. C. V. Raman University, Bilaspur, Chhattisgarh-495113, India
[2] Research Supervisor, Department of Chemistry, Dr. C. V. Raman University, Bilaspur, Chhattisgarh-495113, India

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ABSTRACT

Air pollution has become one of the most serious environmental issues that have an impact on human health and ecosystem stability. This paper revolves around observing and explaining the ambience of the major pollutants like $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO and O_3, in some urban and semi urban locations within the Bilaspur district. The sources used to gather data varied between various sites during a set amount of time. The concentrations were examined by standardised approach documented by IS, APHA and CPCB. A variety of instruments which include analytical balances, spectrophotometers, atomic absorption spectrometers and gas chromatographs were used in order to get accurate assessment. The research aids in defining areas of local pollution as well as determining whether the allowable levels are being adhered to and this finally leads to improved air quality management policies.

Keywords: Air Pollution, $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, O_3, Bilaspur, Urban Pollution, Semi-Urban Monitoring, CPCB, Environmental Assessment

1. INTRODUCTION

Air is very essential for all living things. Clean air assists in healthy breathing. But today, in virtually all locations, the air is not clean. It is a pollutant which emits harmful gases and smallest particles. These unhealthy things in the air are called "pollutants."

1.1. SOME COMMON AIR POLLUTANTS ARE

- **$PM_{2.5}$:** Tiny dusts which penetrate deep inside our lungs.
- **PM_{10}:** Very slightly larger dust particles which are capable of damaging our intake of air.

- **SO_2 (Sulfur Dioxide):** Is coming out of hotwire-wiring factories in essentially burnout-wiring and fuelling. It may trigger respiratory problems.
- **NO_2 (Nitrogen Dioxide):** Comes from vehicles trucks and cars. It is not good for our lungs also.
- **CO (Carbon Monoxide):** An environmental gas gets from ships and harmful major to breath long future.
- **O_3 (Ozone):** It is all right in the high sky, but it is no good on the ground. It can also chafe our lungs.

Bilaspur is one of the developing districts in Chhattisgarh. It contains busy city (urban) parts, as well as laid back village-like (semi-urban) parts. The air pollution is on the rise as more individuals, vehicles and buildings are put up. However, we lack too much data to understand the extent to which the levels of pollution are adversely affected in various areas of Bilaspur.

This study is done to find out

- What is the level of pollution in Bilaspur air.
- What are the regions which are more or less polluted.
- The extent to which the pollution is at safe limit or not.

The level of $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO, and O_3 will be examined in the air. We shall take different air samples where some will be in the city and others outside the city. After this we shall analyze the air in laboratory with the help of scientific tools.

Through this, we will be conversant of the most polluted areas, and we can make efforts to renovate the air. The study will assist the people in Bilaspur in a healthy and clean environment.

2. LITERATURE REVIEW

Several researchers in India have researched on air pollution and on its impacts on the lives of humans and the environment. Ghosh and Desai (2017) evaluated the quality of air in Indian cities and determined that the pollution levels were frequently higher than the safe ones. They also documented that unhealthy air led to difficulties resulting in inability to breathe and other conditions to both children as well as the elderly population. On the same note, Sharma and Singh (2016) conducted research among major cities and showed that contamination is increasing through traffic, the industry, and construction works.

A similar comparison between PM2.5 and 10 levels was done by Chatterjee and Ghosh (2015) in urban and semi-urban areas. They revealed that dust and harmful particles were more frequent in the urban areas than semi-urban ones. Studies in the air quality in Delhi were conducted by Kumar and Pathak (2014). They did not just check air pollution; they also identified the pollutant sources such as automobiles and combustion of fuel.

According to Tiwari, Srivastava, and Bisht (2015), air pollution varies depending on seasons. During the winter, the pollution was greater since the cold air retains the pollutants near to the ground. This aggravated health issues in the winter. Rani and Pandey (2018) have compared air quality in rural and urban and revealed that rural areas were better, however, were still under threat because of the spread of vehicles and wastes burning.

Singh and Dey (2012) carries out an experimentation to see how weather conditions, in terms of wind status, rainfall, and temperature, influence air

contaminations. They discovered pollution changes according to the weather and this can influence how people feel or breathe. Bhanarkar, Srivastava and Joseph (2010) looked at the issue of air pollution in Nagpur. They said both urban and suburban areas are affected by pollution and monitoring is required to find out the solutions.

Beig et al. (2015) have done big study under SAFAR project. They examined history of air pollution in various Indian cities and provided nice data which can help in planning and control. Rajput and Sahu (2019) studied Bilaspur in which low-cost sensors were used for dust particles. The research did a valuable local bit of work and also can aid below at information of ether regarded pollution small metropolis like Bilaspur.

Saxena and Ghosh (2018) looked into how urbanization in Chhattisgarh, conspicuously in cities such as Raipur and Bilaspur, is causing pollution of air. They said additional structures, traffic and industries have been the primary causes for a dirty atmosphere. Mishra and Kumar (2020) examined the impact of Particulate matter 2.5 (pm2.5) on public health. They alerted that fine dust could go into the lungs and leads to serious sicknesses. In the end, Sharma and Jaiswal (2014) also directly investigated the Air Quality Index (AQI) of Bilaspur and Raipur. They demonstrate that pollution amounts frequently exceed the safe levels; this can be unhealthy for the people.

Patel and Sharma (2022) researched low-cost sensors to determine the air pollution levels in Tier-2 Indian cities. As their study revealed these sensors are useful to provide timely and viable information regarding the quality of air at a lesser level, particularly in smaller cities where high-cost machines cannot be afforded. They identified that there was a lot of PM 2.5 and PM 10 concentration in crowded sites such as markets and along the roads. The research demonstrated that we could have a control of pollution and take initiative early even using basic instruments.

Deshmukh and Verma (2023) paid attention to the impacts of urban transportation on the air in the Central Indian cities. They noted that the cause of increasing level of NO2 and CO in urban regions was pollution produced by cars, buses, and two-wheelers which was a major factor. They concluded that the bus stops and main roads where the traffic congestion was huge were much dirtier as compared to residential areas that were quite quiet. This demonstrates the need to enhance the population transportation system and regulate the emission of vehicles in traffic.

Khan and Tripathi (2024) surveyed different downtowns of Chhattisgarh, including semi urban and developing populations such as Bilaspur. They followed the air quality standards of CPCB and discover that pollution levels are gradually increasing in these places. Research by them reveals that PM and gas pollution has been increasing from the rising construction activity, traffic and the burning of waste. The research shows that improved frequencies of air monitoring and awareness in rapidly growing areas are required.

3. OBJECTIVES OF THE STUDY

- To check the ambient levels of $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO and O_3 on the selected urban and semi-urban areas of Bilaspur district.
- To make an analysis of the level of pollutants between urban and semi-urban areas.

- To understand the current in the background of the CPCB air quality guidelines.
- To determine possible spots of pollution that can be intervened and acted upon in the future.

4. RESEARCH METHODOLOGY

One step at a time we have done our research on air pollution at Bilaspur district. First, we picked up some of the places of the city (urban areas) and some village-like areas (semi-urban areas). Such locations had been selected depending on how congested they are, how traffic there is, and whether or not there are factories close to them. We tried to measure the change in air quality of busy areas and less busy areas.

We collected air using the air sampling machines in all the places during 24 hours. These instruments assist us in catching the small particles ($PM_{2.5}$ and PM_{10}) and also take gas sample such as SO_2, NO_2, CO and O_3. We made this on various days so as to obtain the accurate and comprehensive data.

We then got the air samples, and we tested them in laboratory. We applied the normal procedures provided by the Indian Standards (IS), APHA (American Public Health Association) and CPCB (Central Pollution Control Board). These are reliable approaches that are employed in every region within India to monitor pollution.

4.1. FOR TESTING, WE USED SCIENTIFIC INSTRUMENTS LIKE

- **Analytical Balance:** to measure the weight of dust particles.
- **Spectrophotometer:** to check the number of gases like SO_2 and NO_2.
- **Atomic Absorption Spectrometer (AAS):** to check for any harmful metals if needed.
- **Gas Chromatography (GC):** to test for gases like CO and O_3.

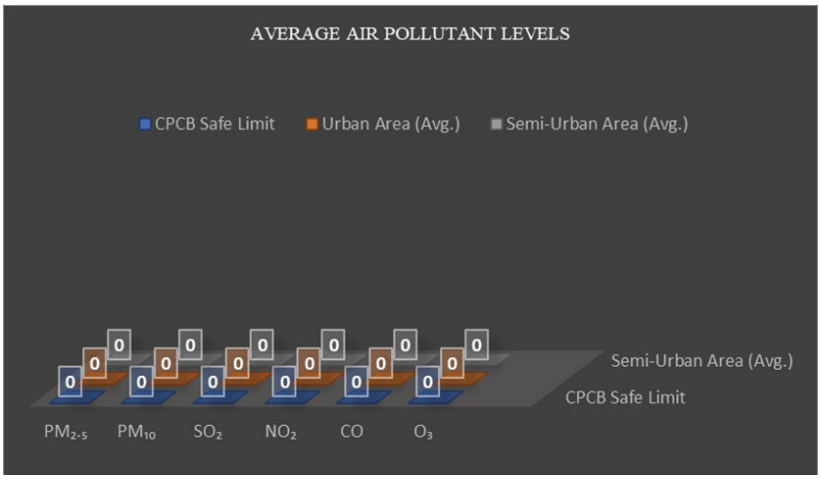
The reading of all the readings was noted, and the readings were crosschecked against the safe air limit provided by CPCB. This enabled us to know the extent to which the air in various areas in Bilaspur is polluted and of what kind of problems.

Table 1

Table 1 Average Air Pollutant Levels (in µg/m³ or mg/m³) in Urban and Semi-Urban Areas of Bilaspur

Pollutant	CPCB Safe Limit	Urban Area (Avg.)	Semi-Urban Area (Avg.)
$PM_{2.5}$	60 µg/m³	98 µg/m³	52 µg/m³
PM_{10}	100 µg/m³	165 µg/m³	85 µg/m³
SO_2	80 µg/m³	42 µg/m³	28 µg/m³
NO_2	80 µg/m³	76 µg/m³	44 µg/m³
CO	2 mg/m³	1.8 mg/m³	1.1 mg/m³
O_3	100 µg/m³	88 µg/m³	63 µg/m³

Figure 1



5. RESULTS

1) $PM_{2.5}$ (very small dust particles)

In urban areas, the average value was 98 µg/m^3, which is above the safe limit of 60 µg/m^3.

In semi-urban areas, the average was 52 µg/m^3, which is below the safe limit.

2) PM_{10} (bigger dust particles)

In urban areas, the average was 165 µg/m^3, which is much higher than the safe limit of 100 µg/m^3.

In semi-urban areas, the average was 85 µg/m^3, which is within the safe limit.

3) SO_2 (Sulfur Dioxide)

Both urban (42 µg/m^3) and semi-urban (28 µg/m^3) areas had values well below the limit of 80 µg/m^3.

4) NO_2 (Nitrogen Dioxide)

Urban areas had 76 µg/m^3, which is close to the safe limit (80 µg/m^3).

Semi-urban areas had 44 µg/m^3, which is safe.

5) CO (Carbon Monoxide)

In urban areas, the level was 1.8 mg/m^3, which is below the safe limit of 2 mg/m^3.

In semi-urban areas, it was even lower at 1.1 mg/m^3.

6) O_3 (Ozone)

Urban average was 88 µg/m^3, which is below the safe limit of 100 µg/m^3.

Semi-urban was 63 µg/m^3, also safe.

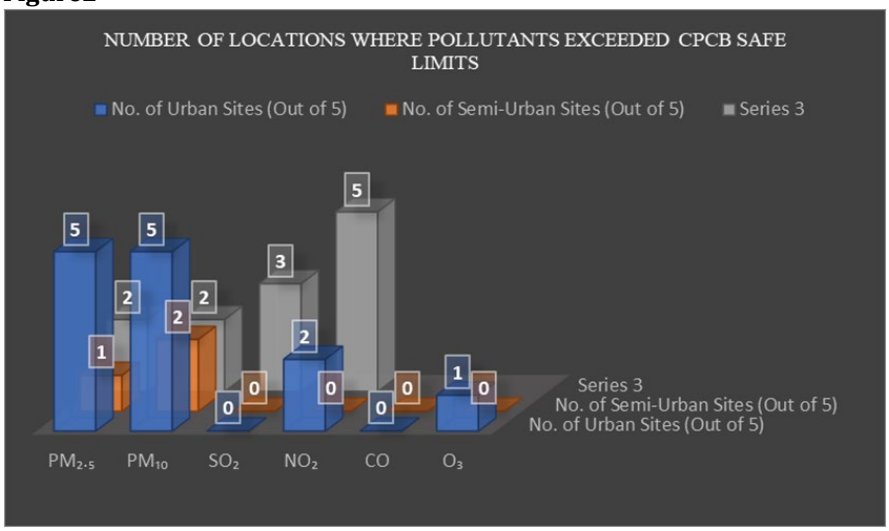
Table 2

Table 2 Number of Locations Where Pollutants Exceeded CPCB Safe Limits

Pollutant	No. of Urban Sites (Out of 5)	No. of Semi-Urban Sites (Out of 5)
$PM_{2.5}$	5	1
PM_{10}	5	2
SO_2	0	0
NO_2	2	0
CO	0	0

O_3	1	0

Figure2



6. RESULTS

- $PM_{2.5}$ crossed the safe limit at all 5 urban sites, but only 1 semi-urban site.
- PM_{10} was high at all 5 urban sites, but only 2 semi-urban sites.
- SO_2 was within the limit everywhere, both in urban and semi-urban areas.
- NO_2 crossed the limit at 2 urban sites, and none in semi-urban areas.
- CO was within safe limits at all locations.
- O_3 was slightly above limit at 1 urban site, but safe in all semi-urban areas.

7. CONCLUSIONS OVERALL RESULTS

The research has been conducted with the purpose of verifying the quality of air in the varying regions of the Bilaspur district comprising the cases of urban (city) and semi-urban (village like) settlements. We considered six air pollutants which are harmful $PM_{2.5}$, PM_{10}, SO_2, NO_2, CO and O_3.

We found that:

- The concentration of dust ($PM_{2.5}$ and PM_{10}) was high in urban places, and it is not healthy.
- Less pollution could be witnessed in semi-urban areas, and they still require monitoring.
- Gases such as SO_2, NO_2, CO and O_3 presented levels mostly at safe levels but in various locations, they were about or a little bit above the limit.

This implies that the citizens inhabiting urban regions of Bilaspur are more vulnerable to health issues with the presence of low-quality aerial environment.

8. OVERALL RESULTS

- Most urban places exceeded the safe levels of $PM_{2.5}$ and PM_{10}).
- Better PM concentration was recorded in semi-urban settings although PM_{10} was high in certain areas.
- All the locations were safe in SO_2 and CO.
- Only some urban places showed high NO_2 and O_3.
- The cities require greater priority and measures to control pollution.

9. FUTURE SCOPE OF THE STUDY

This is only an introduction to this study. The following is the things that can be done in the future:

- Staying longer in various locations in Bilaspur to monitor its air quality.
- Comparing the various seasons (summer, rainy, winter, etc.) and the change in air pollution.
- Testing the well-being of the individuals residing in the high-contamination regions to comprehend the impact of air pollution.
- Real time air monitoring based on new and smart technology.
- Education to build awareness among the people about pollution and how to prevent themselves against the same (i.e. plantation, wearing masks, etc.).
- Assisting local bodies and the government to make more sensible rules and plans in Bilaspur, in reducing pollution.

CONFLICT OF INTERESTS

None.

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None.

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