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Air Quality Status of Anuppur Town, District Anuppur, Madhya Pradesh

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ABSTRACT:
The present study examines the current status of ambient air quality in Anuppur Town, Madhya Pradesh, India. Key parameters, including particulate matter (PM10 and PM2.5), Sulfur dioxide (SO2), and Nitrogen oxides (NOx), were monitored using a Continuous Ambient Air Quality Monitoring System (CAAQMS). The results indicate that while concentrations of PM10 and PM2.5 remain below CPCB standards (2009), the PM10 level reached 92.46 µg/m³ in January, which is very close to the maximum permissible limit of 100 µg/m³. Values for SO2, NOx, CO, and Ozone were well within prescribed norms with no significant monthly variations. However, the highest concentrations of PM10 and PM2.5 were recorded during the winter months, primarily due to low wind speeds and poor dispersion. Based on all monitored parameters, the Air Quality Index (AQI) was calculated as 74 according to CPCB guidelines. When the AQI and monitored values were compared with national standards, the air quality was classified as 'Satisfactory'.

Key Words: Ambient, Air, Concentration, Pollution, Quality,

1. INTRODUCTION:

The Air pollution is the introduction of harmful pollutants into the air by means of various natural as well as anthropogenic means, released in the air due to industrial and commercial activities. Air pollution has become a major environmental problem faced by the people globally in both developing and developed countries in recent times. Ambient air quality in India have progressively deteriorated due to rapid urbanization and industrialization. Increasing population resulted in a tremendous increase in the number of motor vehicles[1]. The vehicular emissions constitute a major source to detoriate the ambient air quality of Anuppur City. The major problem that the atmosphere is being subjected to is pollution. In India, morethan 100 million tons of pollutants are being added to the atmosphere every year. Although some natural processes such as volcanic eruptions and wildfires may pollute the air but most often, it is caused by human activities such as transportation, industrial work, mining, construction, agriculture, smelting, etc. The pollutants are found in both gaseous and solid form (as particulate matter) [1-2].

The primary sources of air pollution in Anuppur City are vehicular exhaust and fugitive emissions caused by heavy vehicle movement and poor road infrastructure. Significant commercial vehicle traffic exists in and around Anuppur due to construction activities, industrial and municipal waste disposal, and the transportation of coal and sand from local mines [3-7]. Gaseous emissions originate mainly from vehicular exhaust and the combustion of coal and diesel as fuel.

Particulates refers to minute particles of solid or semi-solid materials dispersed in the atmosphere. Visible 'brown clouds,' haze, or smog are forms of particulate matter. Particulates ranging from 0.1 to 45 microns (µm) are designated as Suspended Particulate Matter (SPM). Furthermore, particles between 0.1 and 10 microns are classified as PM10, while those ranging from 0.1 to 2.5 microns are classified as PM2.5 (CPCB, 2001)[8].

This study analyzes the air quality parameters of Anuppur Town (MP). The monitoring of ambient air quality was conducted using an Online Ambient Air Quality Monitoring System installed at the Anuppur Collectorate Gate.

2. MATERIAL AND METHODS:

Air pollution is a major concern for the environment and public health. To control and manage air pollution effectively, it is essential to monitor air quality continuously and accurately. For this study, ambient air quality was monitored through an online monitoring system installed at the main gate of the Collector Office, Anuppur. This system, known as Continuous Ambient Air Quality Monitoring (CAAQM), is a modern technology that measures air pollutants in real-time and transmits the data automatically to the regulatory authority. In this study, Particulate Matter (PM10 & PM2.5), Sulfur Dioxide (SO_2), Nitrogen Oxides (NOx), Carbon Monoxide (CO), and Ozone (O_3) were monitored, and records were maintained for further analysis[8].

The online air quality monitoring process utilizes advanced instrumentation, primarily specialized air quality analyzers. Particulate matter is measured using PM analyzers based on Beta Attenuation or laser technology, while gaseous pollutants are analyzed through specific methods: UV Fluorescence for SO_2, Chemiluminescence for NOx, and Non-Dispersive Infrared (NDIR) for CO. The infrastructure includes a comprehensive sampling system consisting of an air inlet, sampling probe, filters, tubing, and a sample conditioning system. All data is managed by a Data Acquisition System (DAS), which collects and processes information from all analyzers to store average values over 1-hour, 8-hour, and 24-hour intervals. Throughout this continuous monitoring, the instruments sample the air and analyze pollutant concentrations, which are automatically recorded, averaged over predefined timeframes, and systematically checked for errors or instrument faults [2,9].

3. RESULT AND DISCUSSION:

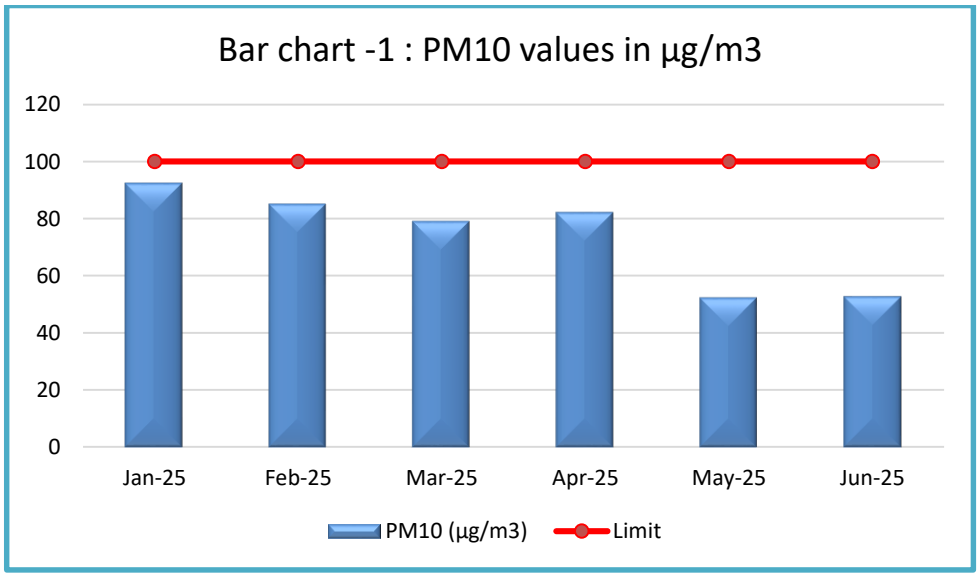
The monitoring results for various air quality parameters from January to June 2025 are summarized in Table 1, which includes the prescribed limits for each parameter to facilitate comparison with the National Ambient Air Quality Standards (NAAQS). Additionally, 2-dimensional bar charts have also been plotted to visually demonstrate the gap between the regulatory standards and the actual monitored values.

Table-1: Ambient air quality monitoring results.

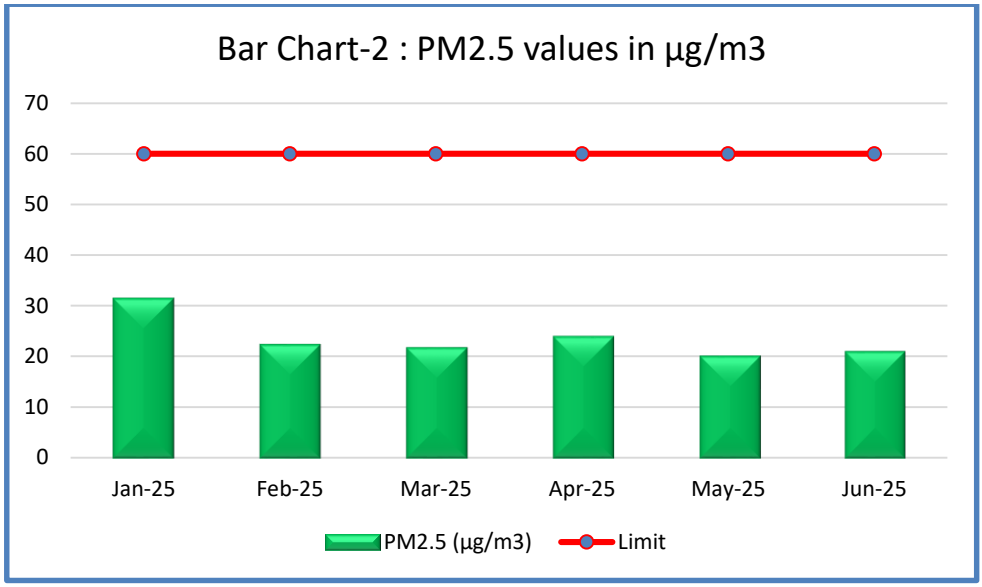
Online Pollution Monitoring Portal							
Sl No.	**Month**	**PM10 (µg/m^3)**	**PM2.5 (µg/m3)**	**SO2 (µg/m3)**	**Nox (µg/m3)**	**CO mg/m3)**	**O_3 (µg/m3)**

1	Jan-25	92.46	31.13	12.27	14.09	1.17	14.45
2	Feb-25	85.18	22.02	12.35	14.06	1.14	14.45
3	Mar-25	79.17	21.45	12.56	14.32	0.76	14.52
4	Apr-25	82.25	23.62	13.8	14.49	0.5	14.59
5	May-25	52.47	19.78	14.5	14.72	0.44	14.65
6	Jun-25	52.85	20.68	14.56	15.09	0.37	14.66
7	Prescribed Standards (Limit)	0 - 100	0 - 60	0 - 80	0 - 80	0 - 4	0 - 180
8	Maximum Value	92.46	31.13	14.56	15.09	1.17	14.66
9	Maximum Value At Time	2025-01-01	2025-01-01	2025-06-01	2025-06-01	2025-01-01	2025-06-01
10	Minimum Value	52.47	19.78	12.27	14.06	0.37	14.45
11	Minimum Value At Time	2025-05-01	2025-05-01	2025-01-01	2025-02-01	2025-06-01	2025-01-01
12	**Geometric Mean**	**74.06**	**23.11**	**13.34**	**14.46**	**0.73**	**14.55**

The PM10 concentration in the ambient air of Anuppur city varied between 52.47 and 92.46 $\mu g/m3$ from January to June 2025. The highest PM10 value was recorded in January, while the lowest was observed in May. Although the values remained within the prescribed limits each month, they approached the maximum permissible limit of $100\mu g/m3$ [6-7].

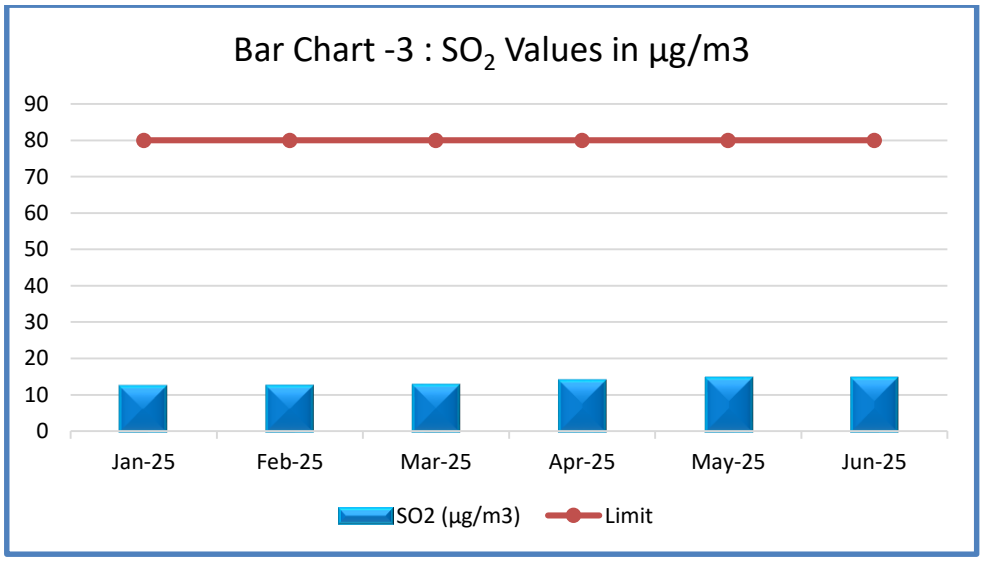


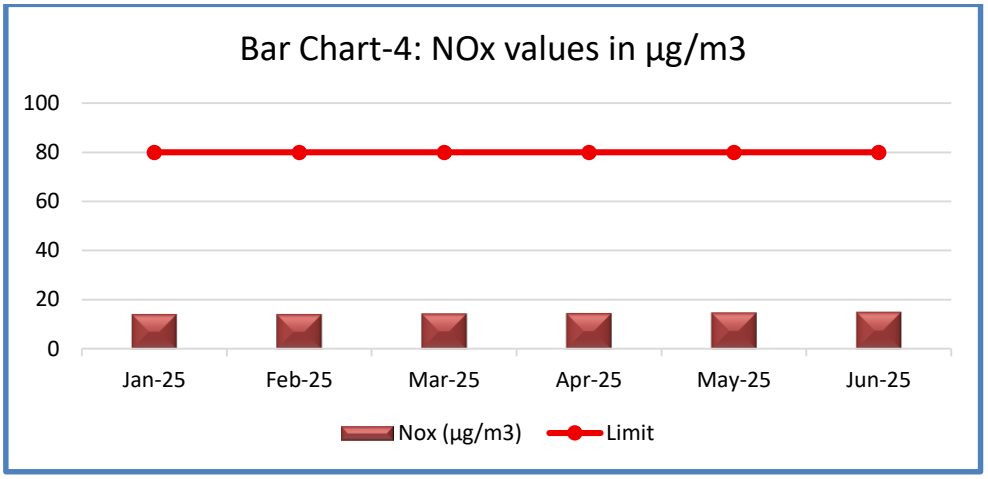
The PM2.5 concentration in the ambient air of the study area ranged from 19.78 µg/m³ to 31.13 µg/m³. The maximum PM2.5 value was recorded in January, while the minimum value was observed in May. All values remained well within the prescribed limits set by the Central Pollution Control Board (CPCB)[8].



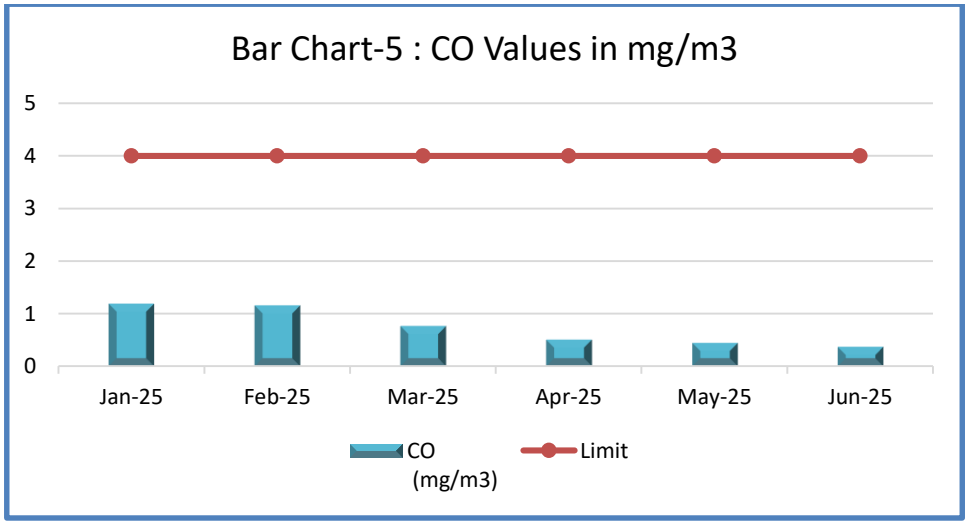
Because of all the particulates matters (PM_{10} & $PM_{2.5}$) values found within the limit, no significant advarse impact are expected under the normal exposure conditions. However, continuous monitoring is essential tom ensure that air quality remains within the safet limits and to protect sensitive groups such as children, the elderly, and indivisuals with respiratory or cardiac condition.

The SO_2 Values were found to the range between 12.27 to 14.56 µg/m^3 while NO_x levels ranged from 14.06 to 15.09 µg/m^3 accros all the studied months [6-7, 11-14].

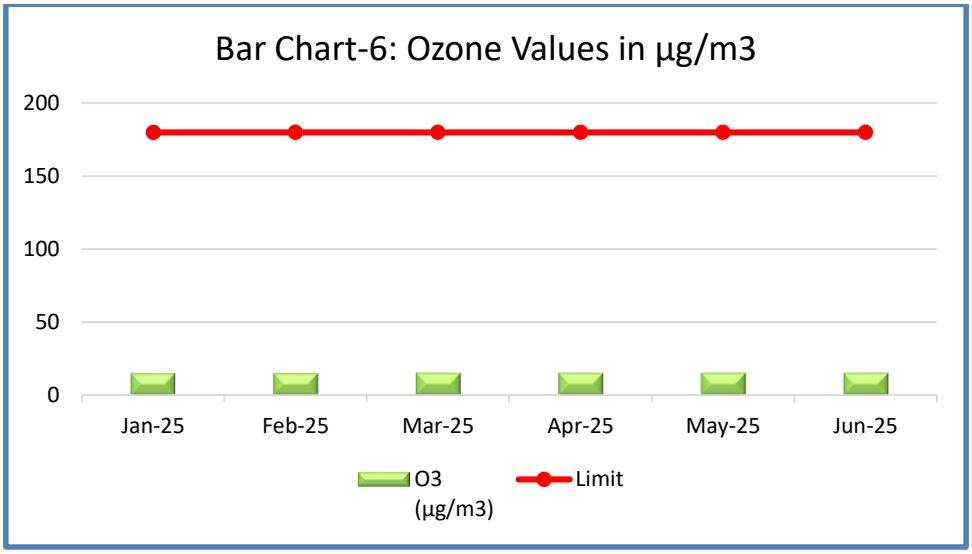




The CO values were found to range from 0.37 to 1.17 mg/m³, which is well within the limits prescribed by the Central Pollution Control Board (CPCB), Government of India.



The Ozone (O_3) values were found to range from 14.45 to 14.66 µg/m³, which is well within the 180 µg/m³ limit set by the Central Pollution Control Board (CPCB), Government of India.



4. CONCLUSION:

The monthly trend indicates that the lowest concentrations of particulate matter (PM_{10} and $PM_{2.5}$ occur during May and June, whereas the highest concentrations are found in January. The elevated values during the winter months may be attributed to ambient moisture. Moisture in the atmosphere prevents particulate matter from dispersing over a large area, causing it to settle near the source, which results in higher recorded values.

Because of all the particulates matters (PM_{10} & $PM_{2.5}$) values found within the limit, no significant advarse impact are expected under the normal exposure conditions. However, continuous monitoring is essential to ensure that air quality remains within the safet limits and to protect sensitive groups such as children, the elderly, and indivisuals with respiratory or cardiac condition[12-15].

The higher values of of SO_2 and NO_x were observed in June, while the lowest were recorded in January. However, there appears to be no significant variation in SO_2 and NO_x levels throughout the study period. Similarly, ozone (O_3) concentrations varied narrowly between 14.45 and 14.66 µg/m³, with the minimum in January and the maximum in June. Based on all monitored parameters, the Air Quality Index (AQI) was calculated as 74 according to CPCB guidelines. When the AQI and monitored values were compared with national standards, the air quality was classified as 'Satisfactory'.

5. RECOMMENDATIONS:

To transition air quality from 'Satisfactory' to 'Good' levels, the following multi-sectoral interventions are recommended:

- Waste Management Infrastructure: Relocate disposal sites to the town periphery and implement scientific landfilling to prevent spontaneous combustion. Strict enforcement against the open burning of municipal solid waste is mandatory.
- Vehicular Emission Control:

  - Traffic Diversion: Construct peripheral bypass roads to divert heavy-duty transit traffic from the town center.
  - Fleet Modernization: Implement a mandatory scrappage policy for end-of-life vehicles while providing fiscal incentives for the adoption of CNG and Electric Vehicles (EVs).
- Dust Mitigation & Road Maintenance: Deploy mechanical road sweepers integrated with water-sprinkling systems to minimize the re-suspension of crustal dust.
- Urban Green Infrastructure: Develop Greenbelts in available open spaces using species with a high Air Pollution Tolerance Index (APTI) to serve as natural biological filters.
- Household Energy Transition: Facilitate a complete shift from biomass-based cooking to LPG or electric induction to eliminate significant sources of indoor and localized ambient air pollution.
- Data-Driven Governance: Establish Real-time Monitoring Stations to provide transparent, hyper-local AQI data. This should be coupled with community-level capacity building and awareness programs to foster public participation in pollution reduction.

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