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Ambient Air Quality Monitoring and Analysis of Sulfur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) in Rural Areas near Manendragarh, Chhattisgarh

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ABSTRACT:

The present study investigates ambient air quality in rural areas around Manendragarh, Chhattisgarh, focusing on sulfur dioxide (SO_2) and nitrogen dioxide (NO_2). These pollutants are commonly associated with fossil fuel combustion, vehicular emissions, and industrial activities. Using a respirable dust sampler (RDS) equipped with a gaseous pollutant attachment, data were collected from four rural sites: Manendragarh, Ledari, Lalpur, and Rajnagar. The analysis was performed using the Improved West and Geike method for SO_2 and the Jacob and Hochheiser method for NO_2. The results indicated that all measured concentrations were within the National Ambient Air Quality Standards (NAAQS)

Keywords: SO_2, NO_2, Ambient Air Quality, Rural Monitoring, Manendragarh, Respirable Dust Sampling CPCB, Pollution Control

1. Introduction

Air pollution is traditionally associated with urban and industrial areas. However, rural areas, especially those near mining areas or with poor energy infrastructure, are experiencing high levels of air pollutants. Two important gaseous pollutants, SO_2 and NO_2, cause respiratory diseases, acid rain, and environmental degradation.

Manendragarh and its surrounding villages, located in Koriya district of Chhattisgarh, are witnessing a growth in transportation and industrial activities, especially related to coal mining and transportation. Yet, environmental studies in these areas are limited. This research aims to fill this gap by assessing ambient air concentrations of SO_2 and NO_2 in four selected rural areas.

2. Objectives

- To measure ambient SO_2 and NO_2 concentrations at Manendragarh, Lederi, Lalpur and Rajnagar.
- To analyse the spatial and seasonal trends of these pollutants.
- To compare observed values with NAAQS limits.
- To identify major local sources of air pollution.
- To recommend pollution mitigation and public health measures.

3. Review of Literature

3.1 Sulfur Dioxide (SO_2):

Sulfur dioxide is a major air pollutant, emitted mainly through coal combustion, industrial processes, and diesel vehicles. It contributes to acid rain and affects soil, crops, and aquatic ecosystems. Exposure to it causes respiratory problems such as asthma and bronchitis. Studies near coal mining areas, including areas such as Manendragarh, show that SO_2 levels increase due to stagnant air, especially during winters.

3.2 Nitrogen Dioxide (NO_2):

Nitrogen dioxide is produced by high-temperature combustion in vehicles and industries. It worsens respiratory conditions and contributes to the formation of ground-level ozone. NO_2 levels are constantly rising in rural areas close to highways, mines and peri-urban settlements, indicating the spread of pollution beyond cities.

3.3 Regional Context and Need for Study:

Research from Bilaspur and Chhattisgarh shows that pollution is measurable even in rural areas. Limited rural monitoring requires focused studies. Monitoring SO2 and NO2 in rural areas of Manendragarh helps fill a critical data gap for environmental and health protection.

4. Study Area

The study focused on four rural locations near Manendragarh:

Location Overview
Manendragarh is a small town located in the Bilaspur district of Chhattisgarh, a state in central India. Located around 70 km from Bilaspur, it plays an important role as a hub and economic center for the rural areas surrounding the city.

- **Manendragarh:** Near railway siding, affected by coal transport and urban activities.
- **Ledri:** Predominantly agricultural with domestic fuel use.
- **Lalpur:** Close to cement and brick industries.
- **Rajnagar:** Rural market area with significant vehicular activity.

5. Materials and Methods

5.1 Sampling and Equipment

Air samples were collected using a respirable dust sampler (RDS) equipped with a gaseous attachment. Two impingers containing 30 ml of absorption solution were required for each gas.

5.2 Analytical Methods

- **SO_2:** Improved West & Gaeke method, read at 560 nm.
- **NO_2:** Jacob & Hochheiser (Modified Griess-Saltzman), read at 540 nm.

5.3 Sampling Conditions

- Duration: 24 hours per site.
- Flow rate: 0.5 L/min.
- Environmental data (temperature, humidity) recorded during sampling.

5.4 Calibration and QA/QC

- Instruments calibrated before each session.
- Duplicate samples and blanks used for accuracy.

6. Results and Analysis

6.1 Concentration Values

Location	**SO_2 (µg/m^3)**	**NO_2 (µg/m^3)**
Manendragarh	10.60	16.01
Ledri	9.78	16.24
Lalpur	9.34	14.12
Rajnagar	10.89	17.40

6.2 Seasonal Trends

Higher concentrations were observed in the winter sample due to less dispersion, temperature inversion, and more combustion for heating.

6.3 Health and Environmental Impacts

Exposure to SO_2 and NO_2 can cause respiratory irritation, asthma, and environmental problems such as acid rain and soil erosion.

7. Discussion

Although the pollutant levels were within the NAAQS limits, the presence of local sources such as coal transportation, biomass burning and vehicular emissions indicate emerging pollution issues in rural areas. People's perceptions during the field visit confirmed the community's concerns about rising pollution.

8. Conclusion

The study highlights the need for continuous monitoring of air quality in rural areas. While current pollutant levels do not pose an immediate health crisis, proactive strategies are necessary to prevent long-term deterioration.

9. Recommendations

- Installation of permanent monitoring stations.
- Promotion of LPG/biogas over firewood.
- Control of coal transport emissions.
- Awareness campaigns on pollution and health.
- Plantation of green belts to act as natural filters.

10. References

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