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Research Article

A Comprehensive Study On Winter Air Quality Of Dholpur City, Rajasthan

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ABSTRACT

Air pollution refers to the contamination of indoor or outdoor environments by chemical, physical, or biological agents that alter the natural characteristics of the atmosphere. The present study investigates the winter air quality status of Dholpur City, Rajasthan, India, using the Air Quality Index (AQI) as a standardized assessment tool. Major sources contributing to air pollution in Dholpur include vehicular emissions, domestic fuel combustion, industrial activities, and seasonal biomass burning.

The Air Quality Index (AQI) is a numerical scale used worldwide to report daily air quality levels and associated health risks. It is calculated based on concentrations of major pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and carbon monoxide (CO).

Daily AQI data collected from 15 December 2023 to 15 January 2024 indicate that air quality in Dholpur during winter predominantly falls in the *Moderate* to *Poor* categories. The findings suggest that winter meteorological conditions, including temperature inversion and reduced wind speed, contribute significantly to pollutant accumulation. A public awareness survey was also conducted to assess community knowledge regarding air pollution and AQI. While general awareness of air pollution was high, understanding of AQI standards was comparatively limited.

The study highlights the urgent need for mitigation measures, improved monitoring, and public awareness campaigns to prevent further deterioration of air quality in Dholpur.

Keywords: Air Pollution, Air Quality Index, $PM_{2.5}$, PM_{10}, Winter Pollution, Dholpur, Public Awareness

1.0 INTRODUCTION

Air pollution is one of the most pressing environmental challenges globally, affecting both human health and ecological balance. The Air Quality Index (AQI) is an effective communication tool designed to convey complex air quality data in a simplified numerical format that is easily understood by the public.

In India, the National Air Quality Index was launched in 2014 by the Central Pollution Control Board under the Ministry of Environment, Forest and Climate Change. The AQI categorizes air quality into six categories: Good, Satisfactory, Moderate, Poor, Very Poor, and Severe.

The AQI is calculated based on concentrations of key pollutants:

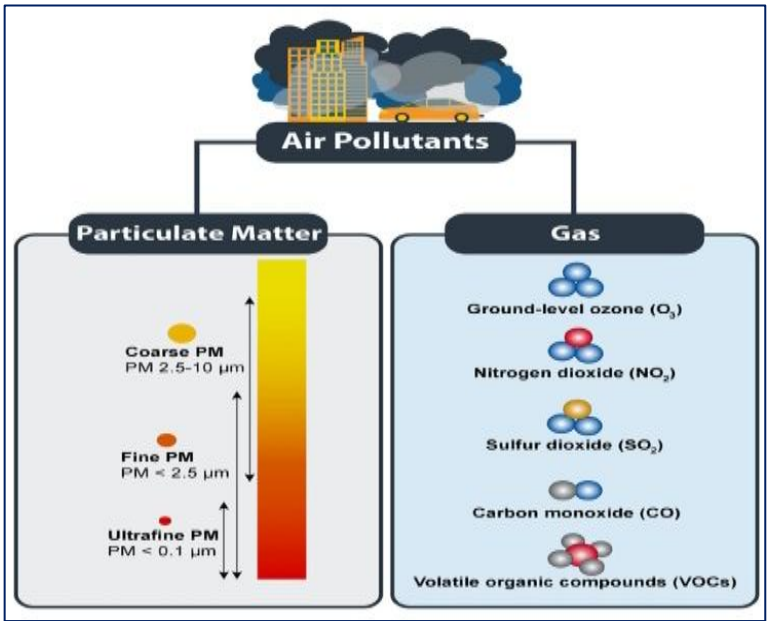
- Particulate Matter ($PM_{2.5}$ and PM_{10})
- Ozone (O_3)
- Nitrogen Dioxide (NO_2)
- Sulfur Dioxide (SO_2)
- Carbon Monoxide (CO)

- Ammonia (NH_3)
- Lead (Pb)

Dholpur, located in Rajasthan, has witnessed increasing air pollution levels due to vehicular growth, urbanization, construction activities, and nearby industrial emissions. Winter months are particularly critical due to stagnant atmospheric conditions that trap pollutants close to the ground.

This study was undertaken to:

- Assess winter air quality in Dholpur using AQI data.
- Identify major contributing pollutants.
- Evaluate public awareness regarding air pollution.
- Suggest measures for improvement.



2.0 PARTICULATE MATTER (PM_{10} AND $PM_{2.5}$)

Particulate matter (PM) is a complex mixture of solid particles and liquid droplets suspended in air. It includes dust, soot, smoke, and other microscopic particles.

• **$PM_{2.5}$**: Fine particles with a diameter ≤ 2.5 micrometers. These particles penetrate deep into the lungs and may enter the bloodstream.

• **PM_{10}**: Coarse particles with a diameter ≤ 10 micrometers. These deposit in the upper respiratory tract.

Exposure to particulate matter can cause:

• Respiratory diseases
• Asthma and bronchitis
• Cardiovascular disorders
• Lung inflammation

Under the National Clean Air Programme (NCAP), the Government of India aims to reduce PM_{10} and $PM_{2.5}$ concentrations by 20–30% (base year 2017).

3.0 MAJOR AIR POLLUTANTS

3.1 Nitrogen Dioxide (NO_2)

Produced mainly from vehicular emissions and fossil-fuel combustion. It contributes to respiratory irritation and smog formation.

3.2 Sulfur Dioxide (SO_2)

Generated primarily from coal-based power plants and industrial processes. SO_2 contributes to acid rain and respiratory diseases.

3.3 Ozone (O_3)

A secondary pollutant formed by photochemical reactions involving NOx and volatile organic compounds (VOCs) under sunlight.

3.4 Carbon Monoxide (CO)

A colorless, odorless toxic gas produced by incomplete combustion of fuels.

3.5 Lead (Pb)
Emitted from industrial processes, mining, and battery recycling.

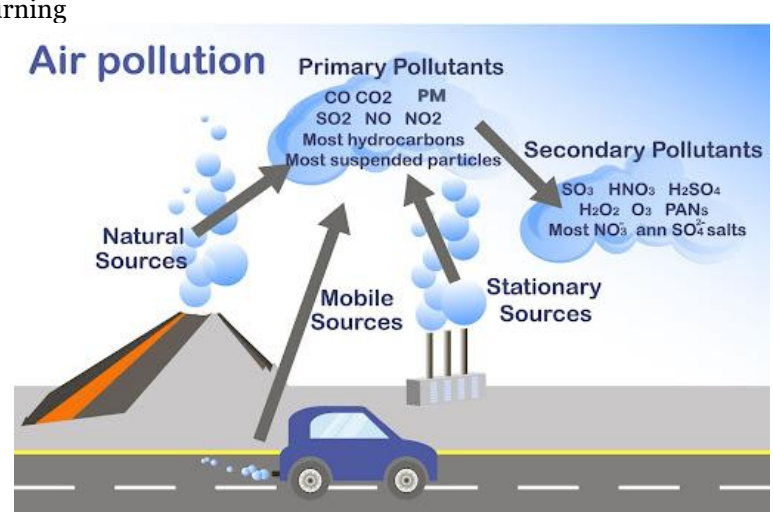
3.6 Ammonia (NH_3)
Released from agricultural activities and waste decomposition; contributes to secondary particulate formation.

Industry	Major Air Pollutant
Thermal Power Plant	NO_2,N_2O, SO_2
Steel Industries	Smoke, Particulates, CO_2 Fluoride
Petroleum Refineries	Smoke, Particulates, SO_2
Metal Smelters	Smoke, Particulates, NO_2,N_2O, SO_2
Fertilizer Plant	NO_2,N_2O, SO_2
Acid Plant	NO_2,N_2O, SO_2
Cement Plant	Smoke, Particulates, SO_2
Soap and detergent Plants	Particulates, Odour
Paper Mills	Particulates, Odour SO_2

4.0 CLASSIFICATION OF AIR POLLUTION
4.1 Based on Origin
Primary Pollutants:
Emitted directly from identifiable sources (e.g., NOx, SOx, CO, hydrocarbons).
Secondary Pollutants:
Formed by chemical reactions in the atmosphere (e.g., ozone, sulfuric acid, smog).

4.2 Based on Source
Natural Sources:
- Forest fires
- Volcanic eruptions
- Dust storms
- Radioactive decay from rocks

Anthropogenic Sources:
- Vehicular emissions
- Industrial activities
- Thermal power plants
- Domestic fuel burning



5.0 OBSERVATIONS AND RESULTS

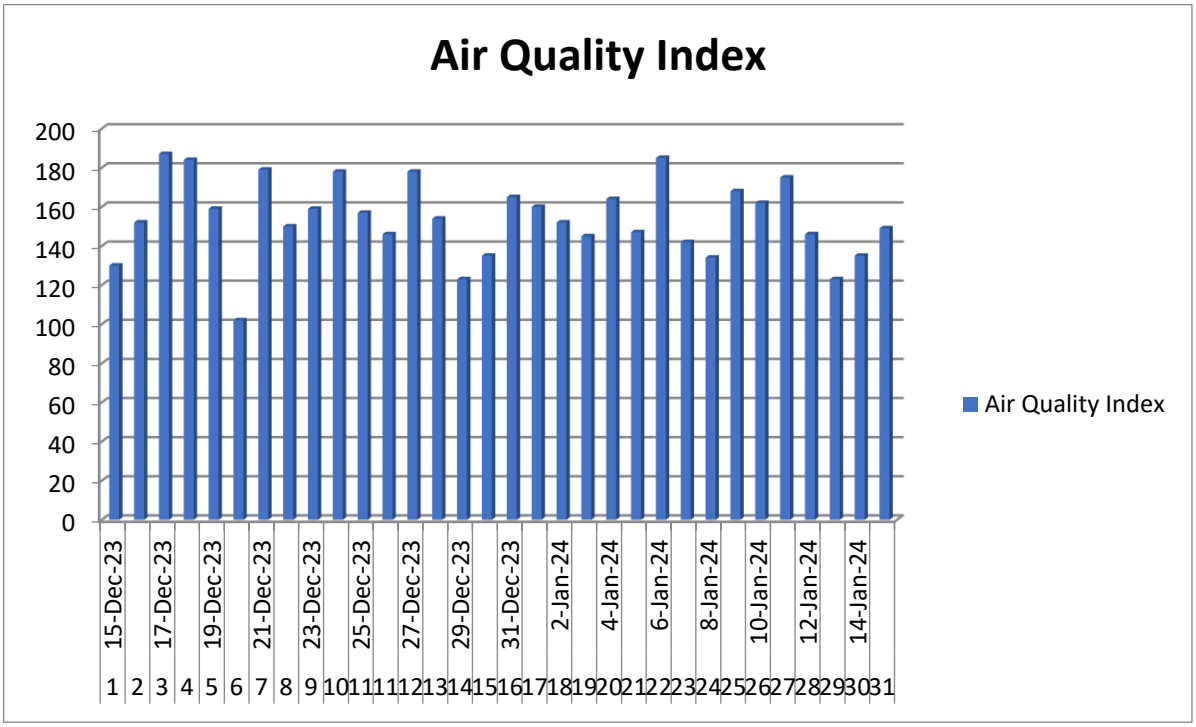
S. No.	Date	Air Quality Index	
1	15-Dec-23	130	
2	16-Dec-23	152	
3	17-Dec-23	187	
4	18-Dec-23	184	
5	19-Dec-23	159	
6	20-Dec-23	102	
7	21-Dec-23	179	
8	22-Dec-23	150	
9	23-Dec-23	159	
10	24-Dec-23	178	
11	25-Dec-23	157	
11	26-Dec-23	146	
12	27-Dec-23	178	
13	28-Dec-23	154	
14	29-Dec-23	123	
15	30-Dec-23	135	
16	31-Dec-23	165	
17	1-Jan-24	160	
18	2-Jan-24	152	
19	3-Jan-24	145	
20	4-Jan-24	164	
21	5-Jan-24	147	
22	6-Jan-24	185	
23	7-Jan-24	142	
24	8-Jan-24	134	
25	9-Jan-24	168	
26	10-Jan-24	162	
27	11-Jan-24	175	
28	12-Jan-24	146	
29	13-Jan-24	123	
30	14-Jan-24	135	
31	15-Jan-24	149	

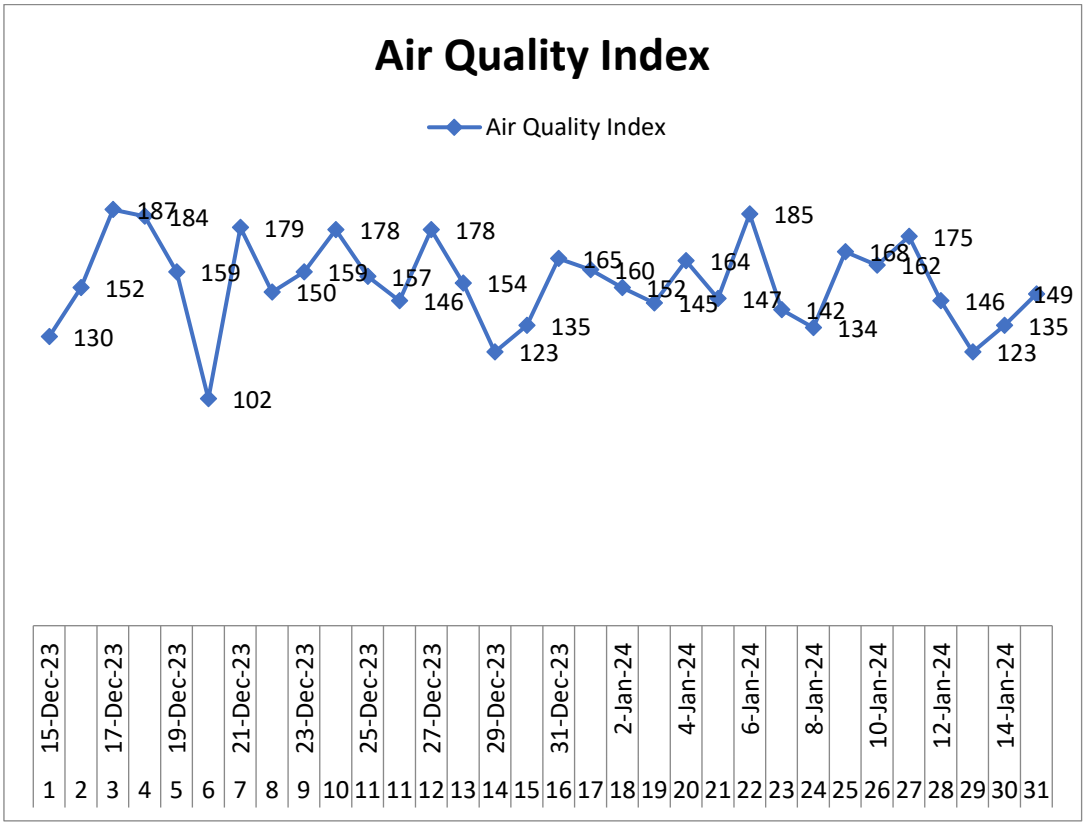
Winter AQI Data (15 December 2023 – 15 January 2024)
The recorded AQI values ranged from **102 to 187**, indicating predominantly *Moderate* to *Poor* air quality conditions.

- **Highest AQI:** 187 (17 December 2023)
- **Lowest AQI:** 102 (20 December 2023)
- **Average AQI (approx.):** ~150 (Moderate category)

The data indicate:

- Frequent transitions into the *Poor* category.
- Increased pollution during colder days.
- Likely contribution of temperature inversion and reduced atmospheric mixing height.





6.0 PUBLIC RESPONSE SURVEY

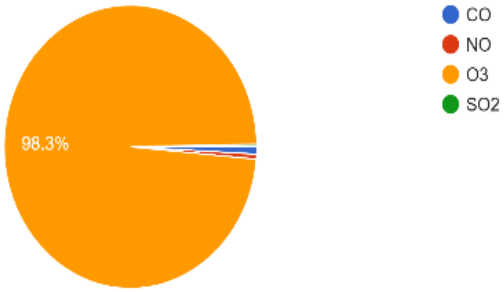
A structured questionnaire was distributed through Google Forms among residents of Dholpur. Key findings include:

- 99% respondents were aware of air pollution issues.
- 97% recognized respiratory health impacts.
- 94% had heard of AQI.
- Only 24% understood AQI numerical categories correctly.

The results indicate high general awareness but limited technical understanding of AQI standards.

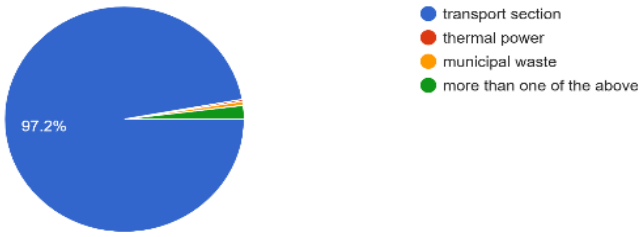
1.Which of the following is not a primary air pollutant ?

356 responses



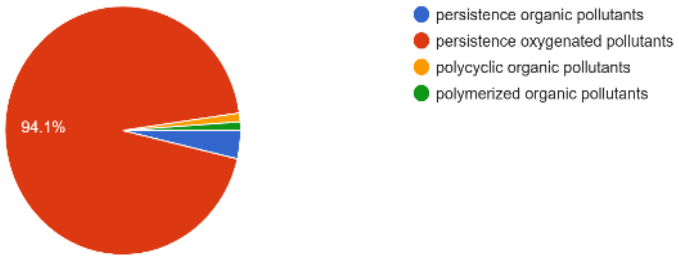
2) In mega cities of India, the dominant source of air pollution is

356 responses



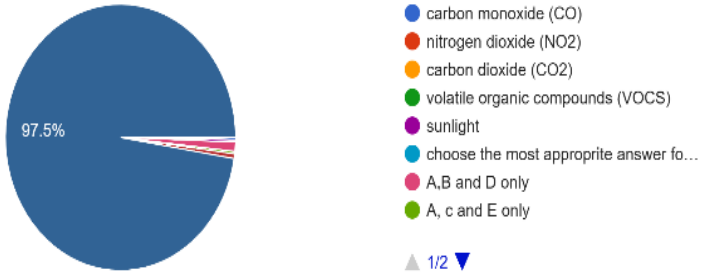
3. What is the full form of POPs?

354 responses

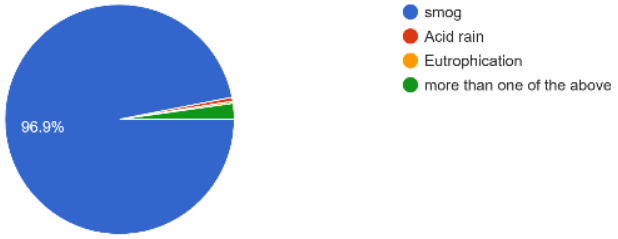


4. which of the following are essential requirements for the formation of photochemical SMOG?

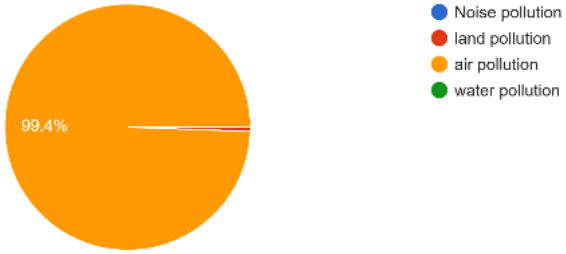
354 responses



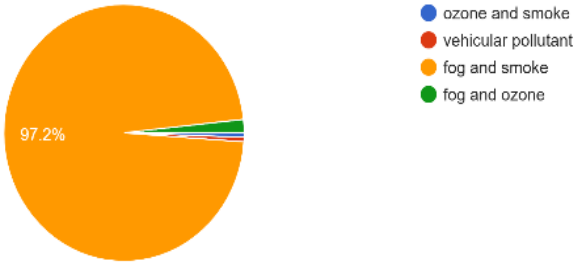
5. Which of the following is a type of air pollution that can cause respiratory problems?
356 responses



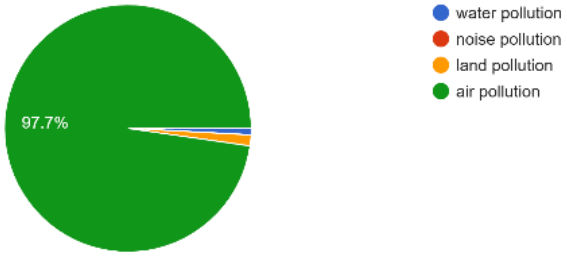
6. What type of pollution causes various diseases related to the respiratory system?
355 responses



7. Smog is:
356 responses

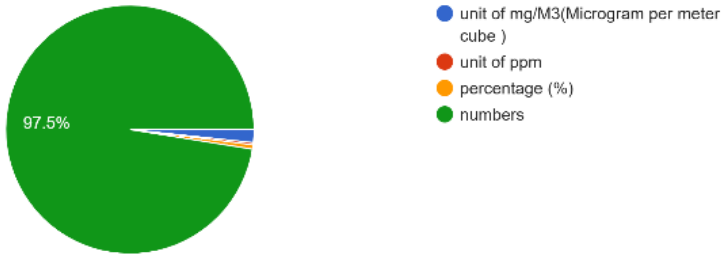


8. Which one of the following is the cause of acid rain?
351 responses



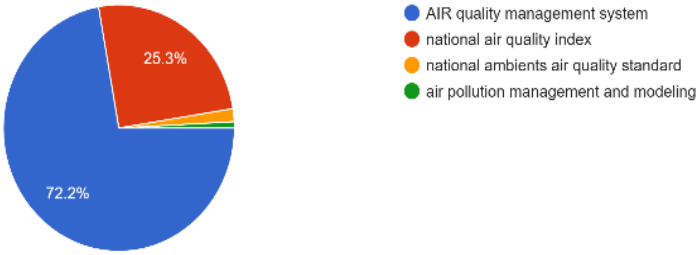
9. air quality index (AQI) is represented in

355 responses



10 _____, launched in India in 2014, is an effective dissemination tool to inform people about air quality.

356 responses



7.0 DISCUSSION

The winter season in Dholpur shows consistent Moderate to Poor AQI levels. Vehicular emissions, dust from construction, biomass burning, and industrial contributions are likely major sources.
Meteorological conditions during winter, including low wind speeds and temperature inversion, significantly worsen air quality by trapping pollutants near the ground.
Survey findings reveal that while people understand health impacts, knowledge about AQI interpretation and government initiatives remains insufficient. This suggests a need for improved environmental education and dissemination strategies.

8.0 CONCLUSION

The study concludes that winter air quality in Dholpur city shows moderate to poor pollution levels, posing potential health risks, particularly to vulnerable populations. Though current levels are not in the severe category, continued urbanization and vehicular growth may worsen the situation in the future.
To improve air quality, the following measures are recommended:

- Promotion of public transportation
- Control of vehicular emissions
- Dust management at construction sites
- Awareness campaigns on AQI interpretation
- Strict enforcement of emission standards

Sustained monitoring and public participation are essential to prevent long-term environmental and health impacts.

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