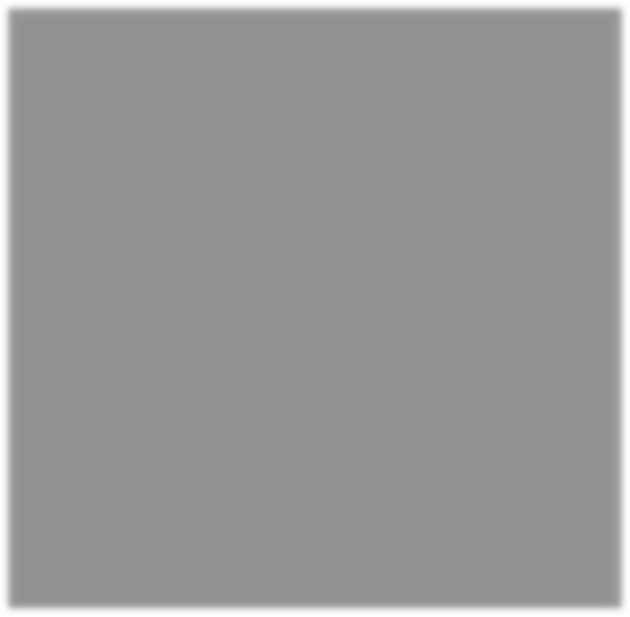
ASSESSMENT OF PM 2.5 LEVELS IN PUNJAB AND DELHI NCR: A COMPARATIVE STUDY

MINOR PROJECT REPORT

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Department of Chemical Engineering

# Dr. B.R. Ambedkar National Institute of Technology Jalandhar, Punjab, May 2024

## CANDIDATE DECLARATION

We hereby declare that the work which is being presented in the minor project report "Assessment of PM 2.5 levels in Punjab and Delhi NCR: A Comparative Study” submitted towards the partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Chemical Engineering Dr. B.R. Ambedkar National Institute of Technology Jalandhar is an authentic record of our work carried out from July 2023 to April 2024 under the supervision of Dr. Shailendra Bajpai, Department of Chemical Engineering, NIT Jalandhar, The matter embodied in this project report has not been submitted by us for any other degree or diploma.

PLACE: - NIT JALANDHAR

DATE: - 29 May 2024

CERTIFICATE

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Date: 29 May 2024

Dr. Shailendra Bajpai Dr. Poonam Gera

(Supervisor) (HOD)

## ACKNOWLEDGMENT

The satisfaction that accompanies the successful completion of any work would be incomplete unless we mention the names of the people who made it possible by giving constant guidance and encouragement.

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*INTRODUCTION*

PM 2.5 are airborne particles defined as having a diameter of 2.5 micrometers or less, they have a varied combination of liquid and solid particles dispersed in the environment. PM 2.5 is undetectable to the naked eye but it causes serious hazards to ecosystems, human health, and the global climate system. These tiny particles penetrate deep into our lungs, posing a significant health hazard. A significant and seasonal contributor to elevated PM 2.5 levels, especially in agricultural regions, is stubble burning. Execution of this involves setting fire to the remaining crop residues, particularly in regions like northern India after the harvest of crops such as rice and wheat. Farmers consider stubble burning as a quick and profitable way to clear fields for the next planting season. However, this practice releases large quantities of PM 2.5 and other pollutants into the air, amplify air quality issues and contributing to severe smog conditions.

The interaction between agricultural practices and air pollution highlights the need for sustainable farming techniques and effective policy interventions. Addressing the rising PM 2.5 levels requires a diverse approach, including promoting alternative methods to stubble burning, enhancing air quality monitoring, and implementing stricter emission controls to protect public health and the environment. Our project tackles this critical issue by assessing PM2.5 levels in Punjab and Delhi NCR. By analyzing this data, we aim to elucidate on the severity of air pollution in these regions and pave the way for effective solutions to combat this environmental crisis. The further study analyses its connection with stubble burning. It also evaluates why PM 2.5 is higher in winter than in monsoon or summer. It also suggests ways for lowering PM 2.5 level.

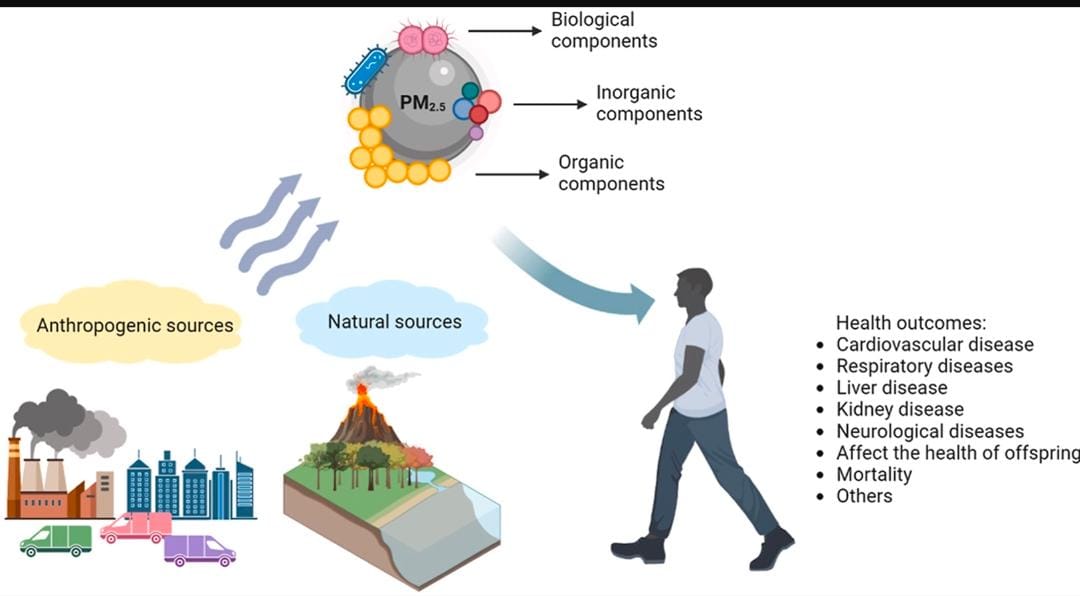


Fig 1 :-

LITERATURE REVIEW

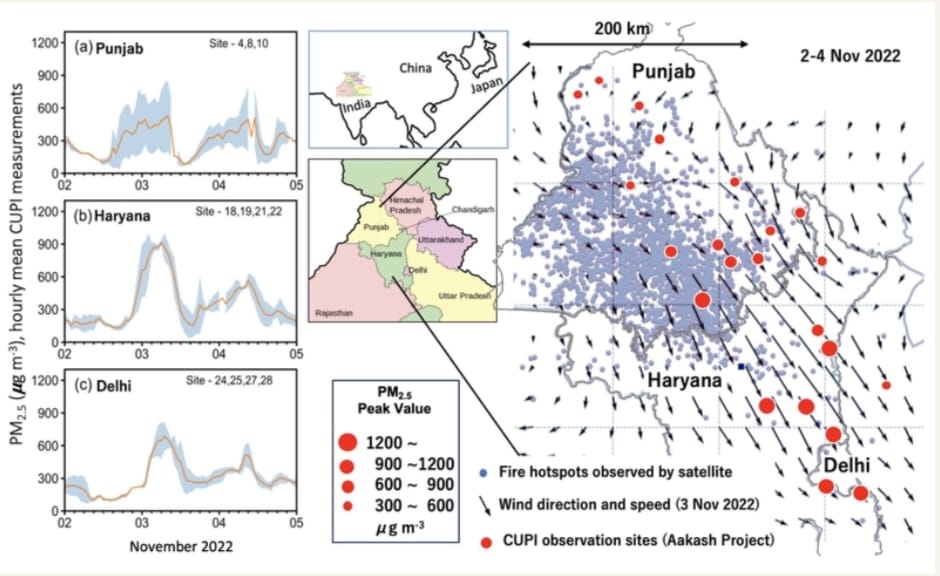
Atmospheric pollution has emerged as a primary global environmental pollution problem. Atmospheric particulate matter (PM) is a major contributor to air pollution and PM 2.5 is hazardous to even biological health.

These tiny droplets can penetrate deep into the lungs and even enter the bloodstream, causing a range of health issues including respiratory problems, cardiovascular diseases, and premature death. Key challenges include accurately monitoring PM2.5 levels, identifying and mitigating sources of pollution, implementing effective policies to reduce emissions, and ensuring equitable access to clean air for all communities. Every winter, in the bustling city of Delhi and its neighboring areas, a thick layer of smog settles and the air there is heavy with pollution - the consequence of a widespread agricultural practice known as stubble burning. Stubble burning, the practice of setting fire to crop residues after harvesting, allowing farmers to prepare their land for the next sowing season without investing in costly machinery or labor is widespread in agricultural regions of India, particularly in the northern states of Punjab, Haryana, and Uttar Pradesh.

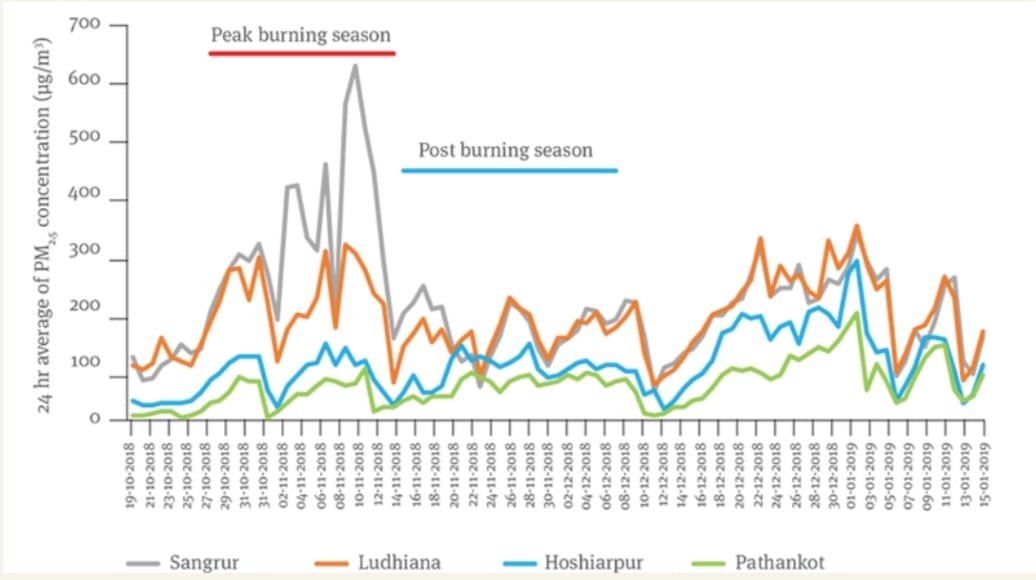
When this agricultural waste is burned, it releases a significant amount of pollutants, including PM2.5, into the air. These fine particles can remain suspended for long periods and can travel long distances, affecting air quality not only in the local area but also in neighboring regions and even countries.

Many studies have tried to understand the influence of parali or stubble on PM 2.5. One of the studies concluded that As the number of fire counts increases or decreases in Punjab and Haryana, there is a corresponding increase or decrease in the particulate matter concentration with a time lag of a few days (1 to 2 days). One of the studies estimated that stubble burning contributes a 50-75 % increment in PM 2.5 in October and November.

In one of the research an intensive field campaign involving the states of Punjab, Haryana, and Delhi NCR was conducted from September 1 to November 30 in 2022 using 29 Compact and Useful PM2.5 Instruments with Gas sensors (CUPI-Gs). PM2.5 in the region increased gradually from less than 60 µg m-3 from 6–10 October to up to 500 µg m-3 on 5–9 November, which subsequently decreased to about 100 µg m-3 from 20–30 November. The Indian national air quality standards for PM2.5 are 40 and 60 µg m-3 for annual and 24-hour exposure, respectively. The measurements show PM2.5 values in the Punjab to Delhi NCR remained over 60 µg m-3 from mid-October to the end of November and crossed over 200 µg m-3 for the first two weeks of November at many sites.



DATA FOR PM 2.5 LEVELS IN PUNJAB FOR BURNING OF CROP RESIDUE



VARIOUS CAUSES OF INCREASE IN PM 2.5 CONCENTRATION

* COMBUSTION PROCESSES: - Vehicle Emissions - Exhaust from Trucks, cars, buses, and other vehicles emit PM 2.5 as a by-product of burning fossil fuels like gasoline and diesel. Emissions from vehicles, especially diesel-powered ones, contribute significantly to PM2.5 pollution.
* Industrial Processes- Manufacturing facilities, power plants, and other industrial activities that involve combustion release PM2.5 into the atmosphere.
* AGRICULTURAL ACTIVITIES: - Stubble Burning - Burning of crop residue releases significant amounts of particulate matter, including PM2.5, into the atmosphere. These fine particles can remain suspended for long periods and are easily transported over long distances, contributing to air pollution.
* CONSTRUCTION: - Activities such as construction, demolition, and road paving can generate PM2.5 from dust and debris. Clearing of land for the establishment of structures, the excavation and compaction of the construction site, and the movement of construction equipment and heavy machinery contribute to the emission of PM 2.5. According to study by WRI India Construction contributes approximately 8% of PM 2.5 in air
* TRANSPORTATION: - Marine vessels burning heavy fuel oil emit PM2.5, especially in port areas and along shipping routes. Aircraft engines produce PM2.5 as they burn aviation fuel. All vehicles produce PM 2.5 as they burn fuel.
* NATURAL SOURCES: - Forest fires and wildfires produce large amounts of PM2.5 as organic material burns. Natural sources are contributed by sea salt aerosols, volcanoes, wildfires, dust storms, living vegetation, and biological aerosol particles.
* The root causes of PM2.5 pollution in Punjab and Delhi are complex and multifaceted, influenced by a combination of natural and anthropogenic factors. Crop residue burning (CRB), occurring immediately after the paddy harvest in the post-monsoon (September–November), is a common practice in Punjab, Haryana, and part of Indo-Gangetic Plain (IGP). 20% of PM 2.5 is contributed by stubble burning in Delhi and Punjab
* Other causes are excessive emissions from power plants, vehicles, manufacturers, and domestic heating released into the atmosphere.
* Due to extensive biomass burning in Punjab, northwestern Delhi, PM2.5 concentrations in the post-monsoon season have reached as high as 200 μg m−3.

## METHODOGY

Data for the past 10 years is gathered for Punjab and Delhi NCR during different times of the year and a comparison is done based on the data.

Interpretation of the data is done and the ways to reduce PM 2.5 concentration in the atmosphere are thus discussed.

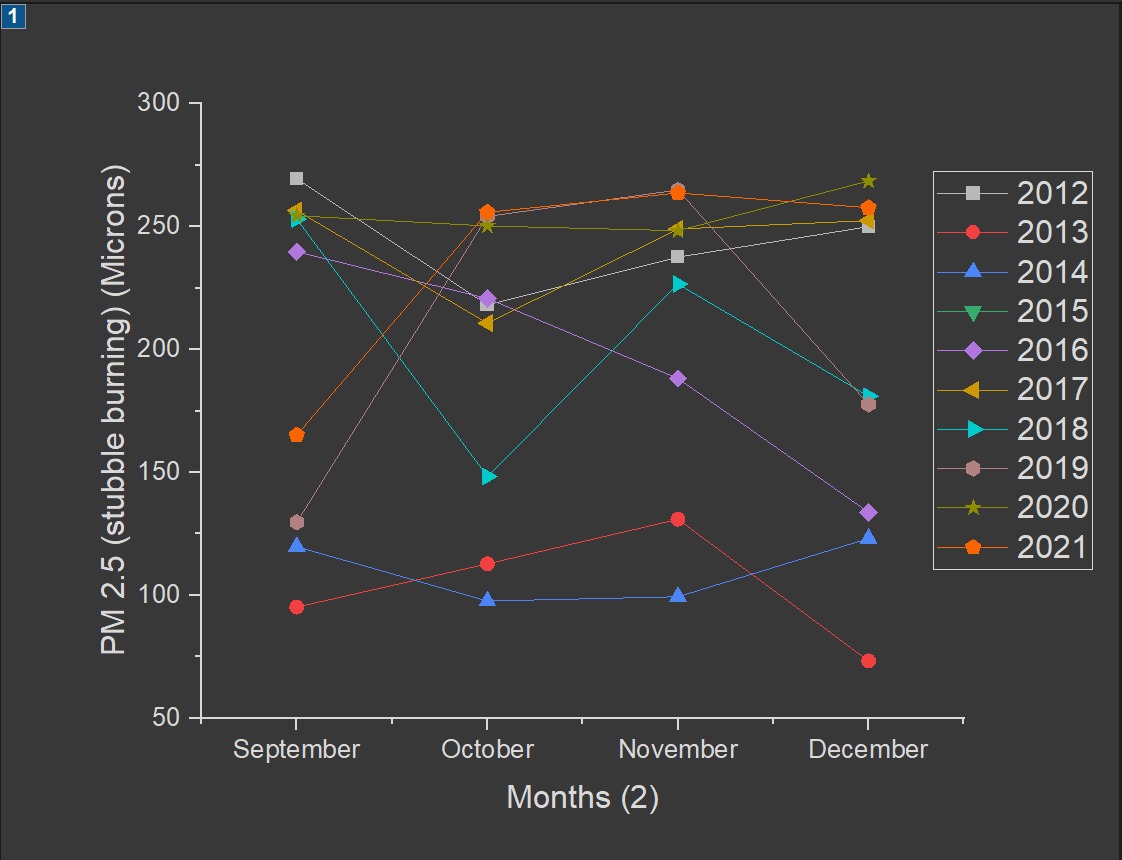


Fig 1: - Data for stubble burning in September to December in last decade in Delhi

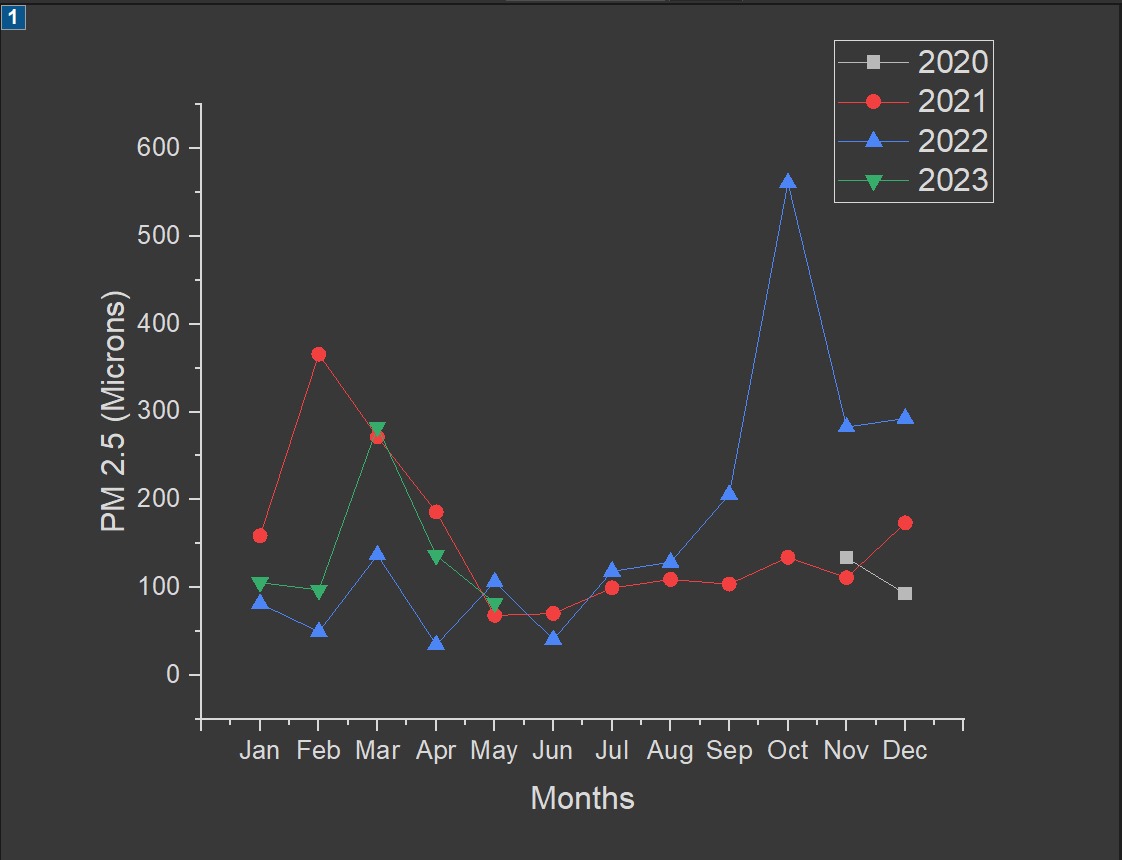


Fig 2: - Data for PM 2.5 from January to December in last 4 years

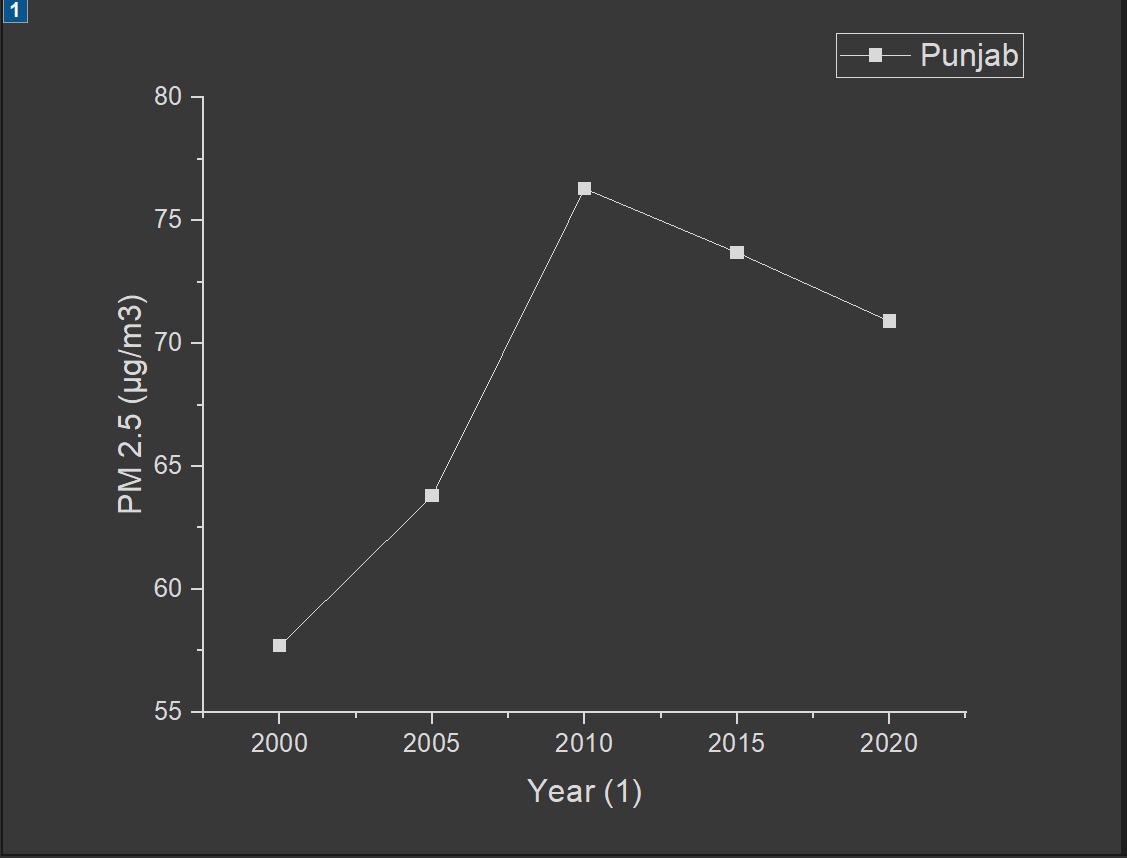


Fig 3: - Data for Past years in Punjab

## RESULTS AND DISCUSSIONS

* During the post-monsoon season (which includes winter), crop residue burning is a common practice in many parts of India.

Crop residue burning releases large amounts of pollutants into the air, including PM2.5.

The increased PM2.5 levels during winter are partly attributed to this agricultural activity.

* Temperature and Relative Humidity play a significant role in PM2.5 concentration.

In the monsoon season, humidity is higher, which can help in settling down particulate matter. As a result, PM2.5 levels are lower.

During winter, lower humidity and cooler temperatures allow PM2.5 particles to remain suspended in the air for longer periods, leading to higher concentrations.

* The specific geography and local patterns of pollution also influence PM2.5 levels. For example, different zones within a state may experience varying pollution levels due to factors like industrial zones, traffic density, and land use patterns.

WAYS FOR LOWERING PM 2.5 LEVEL

1. INDUSTRY - Implement stricter emission controls for industries. Encourage cleaner technologies and energy sources.
2. CONSTRUCTION SITES – Enforce guidelines to minimize dust emissions from construction activities.
3. ROAD DUST – Focus on dust control measures, including regular road cleaning, green cover, and pavement management.
4. WASTE MANAGEMENT – Improve waste collection, segregation, and disposal to reduce open burning and landfill emissions.
5. CLEAN FUELS – Promote the use of clean fuels in industrial processes.
6. ELECTRICITY SUPPLY – Ensure reliable electricity supply to reduce dependence on diesel generators and backup power sources.
7. EDUCATION – Raise awareness about air quality, pollution sources, and individual responsibilities.
8. TRAFFIC EMISSION REDUCTION – Encourage public transport, cycling, and walking. Implement vehicle emission standards and promote electric vehicles.
9. ODD-EVEN RULE – Consider implementing traffic rationing measures like the odd-even rule.
10. BEHAVIORAL CHANGES – Encourage citizens to adopt cleaner practices and reduce personal emissions like smoking, transportation, etc.

CONCLUSIONS

The study highlights the urgent need for comprehensive air quality management strategies in both Delhi and Punjab. While Delhi needs to focus on reducing emissions from vehicles and industrial activities, Punjab must address the issue of agricultural burning. Collaborative efforts, involving government policies, technological innovations, and public awareness, are essential to mitigate PM 2.5 pollution and protect public health in these regions. Long-term solutions require sustained commitment and cooperation between regional authorities, the central government, and the community to achieve cleaner air and healthier living conditions.

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