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DATA-DRIVEN AIR QUALITY INSIGHTS: A DECADE OF AQI TRENDS IN INDIA (2015–2025)

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ABSTRACT
Over the past 10 years Air Quality in India has become a major problem. Poor air quality has impacted human health, climate and overall way of life across India. This research paper is based on India's Air quality Index among the states and cities from year 2015 to 2025. To make the pattern of population easily visible and understandable, we have developed a dashboard using Microsoft Power BI. The data Analysis helped us to understand the air quality so we can make better decisions in future for our country to make our air quality good. Visualizations made easier to understand by non-technical persons. The air quality dashboard has different ways to display data, such as charts and maps, which help us find the most polluted areas and harmful elements that polluted the air quality. The results show that some northern states have higher air quality index values, and Delhi often has the highest pollution levels. Top 5 highest AQI states in India are Delhi, Himachal Pradesh, Bihar, Uttar Pradesh, Haryana, those who live in these states they suffer from lungs disease, breathing problems, Dust allergies etc. The analysis also shows that small particles like PM2.5 and PM10 are common contributors to air quality. Overall, this study shows how using data can help us understand environmental issues and make better decisions about air quality in India.

1. INTRODUCTION

India is currently facing a major environmental challenge in the form of air pollution. Rapid urbanization, industrial growth, increasing vehicular emissions, and large-scale construction activities have significantly contributed to the decline in air quality across many regions of the country. As cities expand and economic activities intensify, the pressure on environmental resources continues to grow.

Air pollution has serious implications for human health and the environment. Prolonged exposure to polluted air can lead to respiratory disorders, cardiovascular diseases, reduced lung function, and even premature death. It also affects ecosystems, reduces visibility, and contributes to climate change.

To monitor and communicate air pollution levels effectively, the Air Quality Index (AQI) is used. AQI converts complex data on multiple pollutants into a single, easy-to-understand numerical value, along with categories such as Good, Moderate, Poor, and Hazardous. This helps both policymakers and the general public understand the severity of air pollution and take necessary precautions.

The primary objective of this project is to analyse AQI data across various states and cities in India from 2015 to 2025. An interactive dashboard has been developed using Microsoft Power BI to visualize trends and patterns in air quality. This dashboard enables users to filter data by year, state, and city, making the analysis more dynamic and user-friendly.

2. OBJECTIVES OF THE STUDY:

The study is conducted with the following objectives:

To analyse the trends in air quality across India from 2015 to 2025.

To identify the most polluted states and cities based on AQI values.

To examine the major pollutants contributing to air pollution.

To develop an interactive dashboard for better data visualization and understanding.

To generate insights that can support decision-making for pollution control.

To enhance awareness and understanding of air pollution patterns in India.

3. DATA DESCRIPTION

The dataset used in this study contains detailed information about air quality across multiple states and cities in India over a ten-year period (2015–2025).

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Key Variables in the Dataset:

- Date of observation
- State name
- City or area name
- AQI value
- Air quality category (Good, Moderate, Poor, etc.)
- Major pollutant (PM2.5, PM10, NO_2, CO, etc.)

This dataset allows for a multi-dimensional analysis of air pollution. By examining AQI values over time and across regions, we can identify patterns and trends. The inclusion of pollutant-specific data also helps in understanding the primary causes of poor air quality in different locations.

4. METHODOLOGY

The analysis was conducted using a structured approach to ensure accuracy and clarity:

4.1. Data Collection:

The AQI dataset for India (2015–2025) was obtained from reliable sources and compiled into a structured format.

4.2. Data Cleaning and Preparation:

Removed missing or inconsistent values, Standardized city and state names, Verified AQI ranges and categories, Handled duplicate records.

4.3. Data Transformation:

Created calculated columns (e.g., year, month), Categorized AQI values into standard air quality levels, Aggregated data for yearly and city-level analysis.

4.4. Data Visualization (Power BI)

An interactive dashboard was developed using Microsoft Power BI with:

- Filters (Year, State, City)
- KPI cards (Average AQI, Most Polluted City)
- Trend charts (AQI over time)
- Maps (geographical distribution)
- Pollutant analysis charts

4.5. Analysis Approach:

- Trend analysis over years
- Comparative analysis across cities and states
- Identification of dominant pollutants
- Highlighting high-risk regions

4.7 AQI Categories: there are groups of pollutants that can affect our health.

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AIR QUALITY INDEX (AQI)	CATEGORY
0-50	Good
51-100	Satisfactory
101-200	Moderate
201-300	Poor
301-400	Very Poor
401-500	Severe

4.7.1 AQI Range Air Quality Category:
The Air Quality Index categories are very important because it helps people to know if the air quality is safe or not. The Air Quality Index categories make easier for people to understand the air quality and how it can affect in our daily life, we should know that the air quality is very important in our life it can cause health problems.

We have mentioned 6 types of categories they are –

Good (0-50): it is the best air quality for our health.

Satisfactory (51 -100): in this category the air quality is not good but not bad for health.

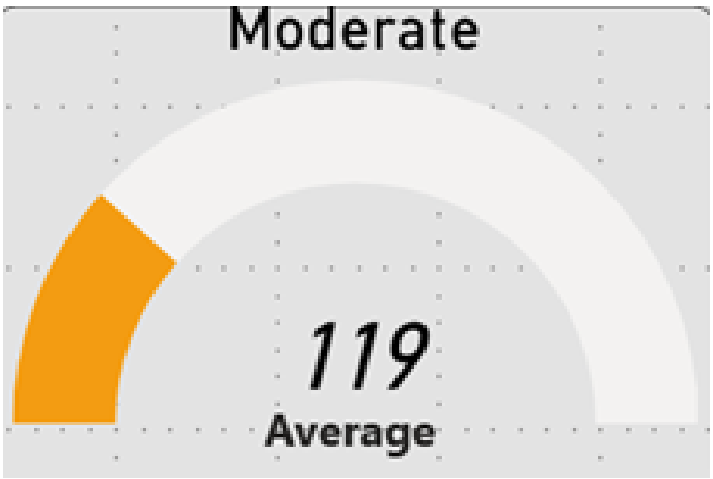
Moderate (101-200): in this category the air quality is getting bad for health, if someone lives in the moderate air quality area it can cause health issues.

Poor (201-300): in this category the air quality is not good for health, if someone live in the area where the air quality is poor, they can have lungs problem and can have breathing issues.

Very poor (301-400): in very poor air quality areas is it dangerous for humans and animals to live in that area, they cannot breathe in the area. It will cause so many health problems.

Severe (401-500): in severe category it is impossible to live in the area where the air quality is severe. It is hazardous for humans and animals to live there.

4.8 Dashboard Analysis:



4.8.1 Average AQI Level- We made a dashboard where a chart chows the average Air quality Index value. In the analysis we found that the Average AQI is 119. This considered as Moderate.

4.8.2 Maximum AQI- The dashboard also shows the highest AQI value is 430 in Delhi. As we know that the minimum AQI is 20 and maximum is 500, the difference between them is very big, it means the air quality is different in different states in India.

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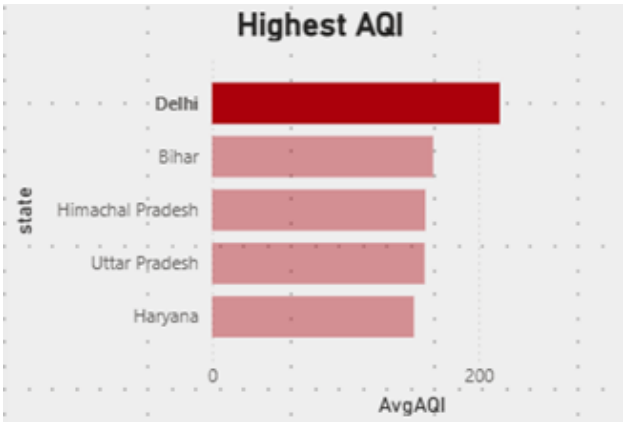
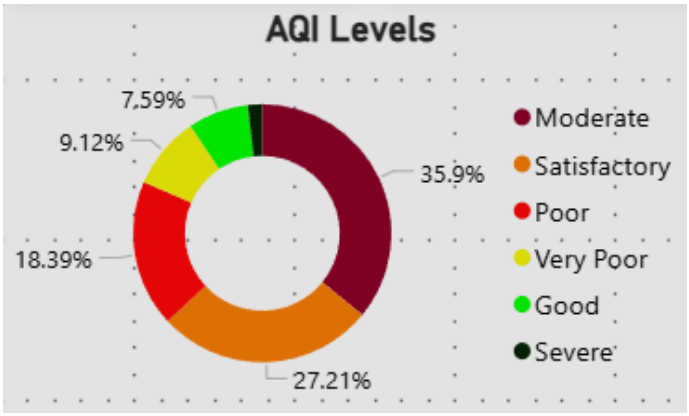
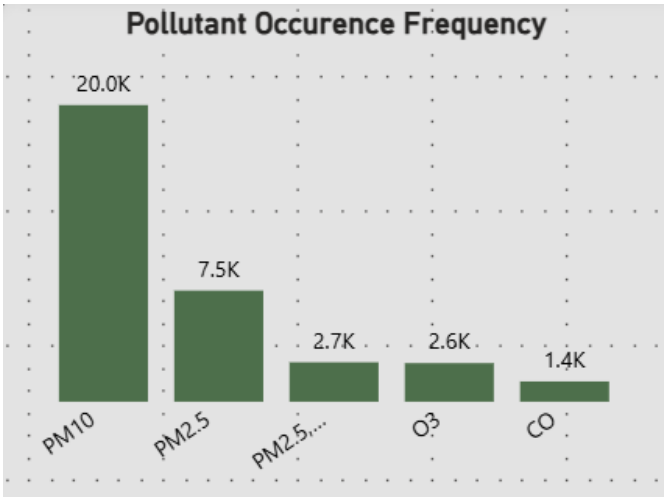


4.9 States with Highest AQI: in our analysis the bar chart shows the states with high AQI and with pollution. The highest AQI states are Delhi, Bihar, Himachal Pradesh, Uttar Pradesh, Haryana as we can see in the chart. Delhi is on the top of the chart it means it has the worst Air Quality, the people who live in Delhi have the highest rate of lung s issue and breathing problems because of their air quality, it is hazardous for their health to breath.



4.10 Distribution of AQI Levels: the dashboard also shows how AQI values spread across categories. Most data points are in Moderate categories. The pie chart shows that the good air quality in India is much smaller, it means many regions in India have air quality Problems. Only 7.59% of Indian states have good air quality and others are moderate or poor air quality.

AQI Category	Percentage (%)
Moderate	35.9%
Satisfactory	27.21%
Poor	18.39%
Very Poor	9.12%
Good	7.59%
Severe	1.78%



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4.11 Pollutant Frequency:
Pollutant Occurrence Frequency is another most important visualization in our analysis, it shows how often different pollutants appear in the dataset.

In our analysis we found that PM10 and PM2.5 are the common pollutants. They appear often more than other pollutants like carbon monoxide.

Particulate matter is especially bad for our health, these tiny particles can get into our lungs, bloodstream and it can cause many health issues. Pollutants continuously enter in the body through breathing, food, leading to long-term damage. Even low levels can become harmful if exposure is repeated often.

The pollutants can cause-

Respiratory issues: Asthma, bronchitis, breathing difficulty due to polluted air

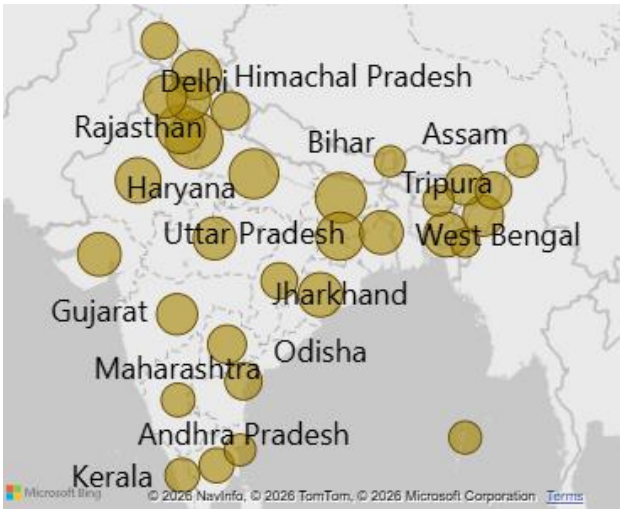
Cardiovascular diseases: Increases risk of heart attack and high blood pressure.

Allergies & irritation: Eye irritation, skin rashes, throat irritation.

Lung damage: Reduced lung function over time.

Neurological effects: Headaches, dizziness, reduced concentration.

Cancer risk: Long-term exposure to toxic pollutants can increase chances of cancers (especially lung cancer).



4.12 Geographic Distribution: The map shows the pollution levels across India. The image shows a spatial distribution map of pollutant occurrence frequency across India, where the circular marks indicate the intensity and frequency of pollutants in specific regions.

The larger and denser circles are mainly in northern and eastern states, such as Delhi, Uttar Pradesh, Bihar, and West Bengal. Showing higher pollutant occurrence frequency in these areas.

In central and western regions like Maharashtra, Gujrat, and Rajasthan has Moderate levels of pollutant frequency. It indicates a balance but still we need to concern by the level of the environment exposure.

In Kerala and parts of Andhra Pradesh there is fewer and smaller marks are visible, reflecting lower pollutant occurrence frequency

5. LITERATURE REVIEW

Air pollution is a subject that has been the focus of extensive research by scholars, as it exerts a profound impact on our health, climate, and social environment. For a considerable period, researchers have endeavoured to understand the actual mechanisms of the pollution process, the specific consequences of pollution, and how we might effectively improve air quality. Furthermore, they seek to determine what additional precautionary measures could be implemented to prevent air pollution. The Air Quality Index (AQI) serves as a metric that researchers utilize to measure the levels of air pollution and to conduct analyses regarding this issue. In various studies, researchers have observed how countries and cities—such as those in India—have become increasingly polluted over time. The primary contributors to this pollution are industrial facilities, vehicular traffic on the roads, and the development of dense human settlements within limited geographical spaces. Through extensive experimentation, researchers have determined that microscopic to ultrafine particulate matter—specifically

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PM2.5 and PM10—poses a severe threat to both human health and the broader environment. This is because these particles infiltrate our lungs, thereby compromising our physical well-being. Air pollution is a critical issue that exerts a profound impact on the human race; consequently, research dedicated to the subject of air pollution is absolutely essential for gaining a deep understanding of this problem and devising effective solutions.

Researchers have further observed that air pollution levels in various Indian cities are frequently significantly higher than in other regions. The primary causes for this are the burning of crop stubble by farmers, as well as seasonal shifts in temperature, climate, and weather patterns during the winter months. These factors trap atmospheric pollutants; consequently, the Air Quality Index (AQI) levels in cities—such as Delhi and its surrounding areas—have been rising alarmingly. Air pollution constitutes a deeply critical issue in these urban centres, and resolving this problem is imperative for the advancement of public health.

Currently, in many research studies, researchers are utilizing computers and specialized tools to analyse environmental data. By employing tools such as Microsoft Power BI, they can generate various charts and visualizations. These tools enable them to scrutinize vast repositories of data and help identify patterns that might not be readily apparent through standard reports alone. In the context of air pollution research, this approach provides researchers with a deeper understanding of the dynamics of pollution. Ultimately, this facilitates the formulation of strategies aimed at mitigating air pollution.

Moreover, studies conducted by numerous environmental monitoring groups and research organizations have demonstrated that monitoring air quality—and disseminating the associated data—serves to reach everyone.

Furthermore, studies conducted by numerous environmental monitoring groups and research organizations have demonstrated the critical importance of monitoring air quality and making the associated data publicly accessible. By analysing long-term Air Quality Index (AQI) data, researchers can discern how pollution levels have evolved over time; consequently, this information aids them in formulating effective strategies. Such measures are indispensable for combating the challenges of air pollution and for improving overall air quality. All in all, research findings underscore that the utilization of data and visualizations for analysis can significantly enhance our understanding of environmental issues, thereby facilitating the development of more sophisticated approaches to control and mitigate air pollution. Research into air pollution is therefore essential for resolving this pressing issue, and it is poised to remain a central focal point in the years to come.

6. DISCUSSION

The study is about the Air pollution in India from 2015 to 2025 and it gives us some important information. We have looked at the air Quality Index, it's a way to measure how polluted the air quality is, we have used a special tool called Power BI. This tool helped us to see that how air pollution is different in parts of the country at different times.

An important thing that we found out is that the average Air Quality Index Value is 119, it's not good for people's health. It means that in parts of India the air is not clean enough to breath easily. Even if the pollution is not that bad but it can still be very harmful for people who are sick or children and old people. Breathing for a long time in the polluted air can be harmful for people.

We also analysed that the air pollution is not same in India, some of Indian states in the north have much more polluted air than the other states. Delhi often has polluted air because of traffic, factories, construction and burning cops.

Power BI helped us to visualize the raw data; it is very helpful to understand the information. The tool helped us to analyse the data using maps, charts and other visual tools make it easier to understand the pattern and trends.

As cities are growing by more industries, they are making the air more polluted. If we do not do something to stop it then the air could get more polluted. We need to maintain rules, better transportation.

In the end of the study, it shows that air pollution in India is a problem that is affected by many things. By using data visualization tools, we can understand the problem better, also we can come up with solutions to make the air quality good and safer to breathe. The study about air pollution gives us a lot of information that can help us make things better in future.

8. CONCLUSION

Air pollution in India is a very serious issue driven by rapid urbanization, industrial growth, increasing vehicles, and population rise. The study is from 2015 to 2025, we have analysed the data using Microsoft Power BI which shows that the average Air Quality Index is unhealthy and it's affecting children, elders, and people with

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respiratory problems. In highly polluted cities like Delhi face major challenges due to traffic, industrial work, construction work, and agricultural activities.

The concern is the presence of harmful particles in air like PM2.5 and PM10, which can penetrate the lungs and bloodstream, and it can cause serious health issues. The study highlights the need to control emissions from vehicles, factories, and construction activities.

The Power BI dashboard helped visualize pollution trends, compare regions, and identify critical areas, making the data easier to understand. Overall, reducing air pollution requires combined efforts from the government, industries, and individuals through stricter policies, cleaner technologies, better urban planning, and increasing awareness.

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