Air Quality Index (AQI) Analysis of Delhi

1. Introduction

Air pollution is one of the most critical environmental challenges faced by urban regions across the world. Delhi, being one of the largest metropolitan cities in India, frequently experiences severe air pollution due to rapid urbanization, vehicular emissions, industrial activities, construction dust, and seasonal agricultural practices. Poor air quality has a direct impact on public health, contributing to respiratory illnesses, cardiovascular diseases, and reduced life expectancy.

This project presents an in-depth analysis of air quality in Delhi using pollutant concentration data. By examining key pollutants and their temporal variations, the study aims to understand pollution patterns and identify factors influencing air quality levels in the city.

2. Objectives of the Study

The primary objectives of this study are:

- To analyze air pollution levels in Delhi using key pollutant indicators
- To study temporal variations in pollution across months and seasons
- To identify the major contributors to poor air quality
- To examine the relationship between different air pollutants
- To derive insights that can support air quality improvement strategies

3. Dataset Description

The dataset used in this study consists of air pollutant measurements collected for Delhi. It includes hourly observations of major pollutants that significantly affect air quality.

Key Attributes in the Dataset

- **Date –** Timestamp of pollutant measurement
- **PM2.5 –** Fine particulate matter with diameter ≤ 2.5 μm
- **PM10 –** Particulate matter with diameter ≤ 10 μm
- **NO_2 (Nitrogen Dioxide)**
- **SO_2 (Sulphur Dioxide)**
- **CO (Carbon Monoxide)**
- **O_3 (Ozone)**
- **NH_3 (Ammonia)**

4. Methodology

The analysis was carried out using Python and its data analysis libraries. The following steps were performed:

1. Importing and cleaning the dataset
2. Converting date fields into appropriate time formats
3. Extracting monthly and seasonal information
4. Computing statistical measures such as averages and correlations
5. Visualizing pollutant trends using graphs

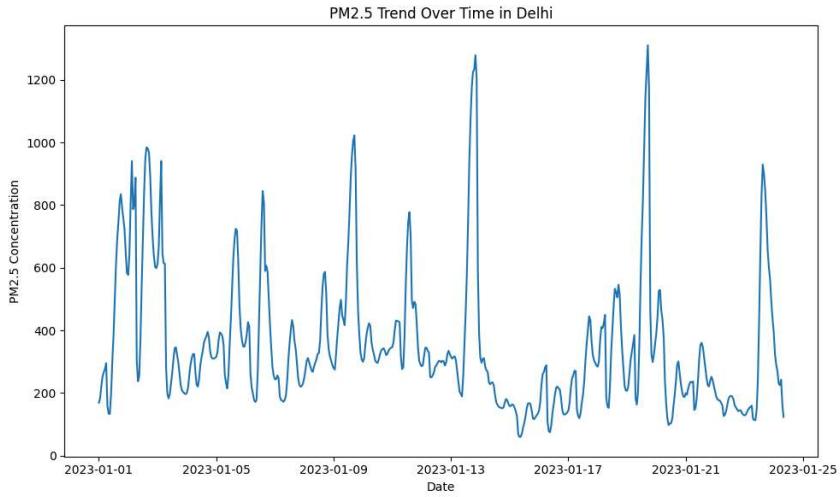
Tools & Libraries Used

- Pandas – Data manipulation
- Matplotlib – Basic plotting
- Seaborn – Statistical visualizations

5. Exploratory Data Analysis and Visualizations

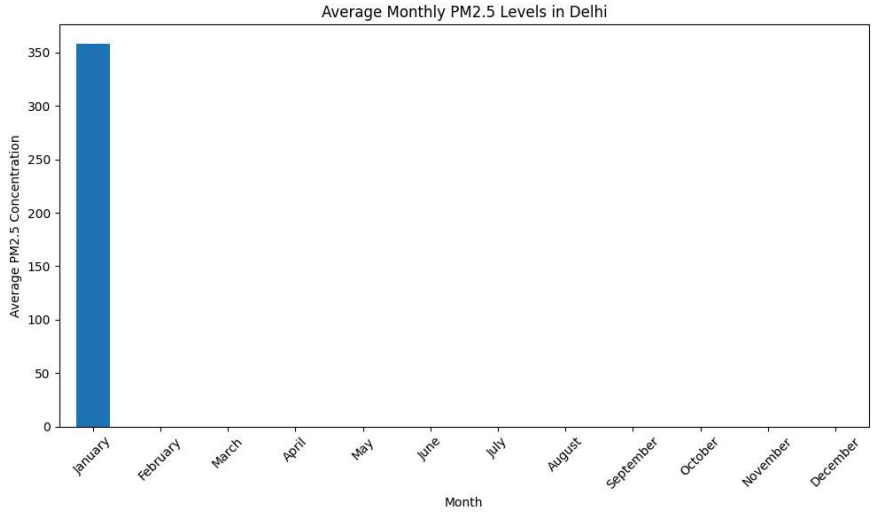
5.1 PM2.5 Trend Over Time

This analysis illustrates how PM2.5 levels fluctuate over time in Delhi. PM2.5 is considered one of the most harmful pollutants due to its ability to penetrate deep into the lungs.



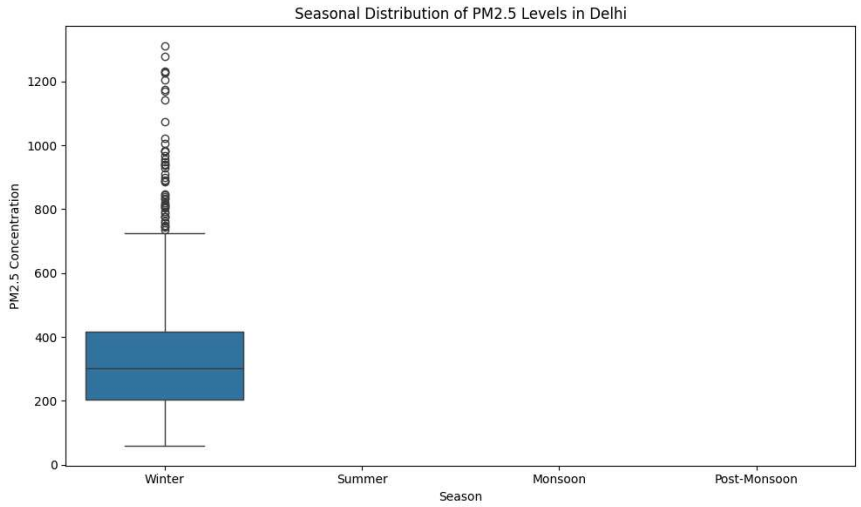
5.2 Monthly Average PM2.5 Levels

This visualization highlights the average PM2.5 concentration for each month, helping identify months with severe pollution levels.



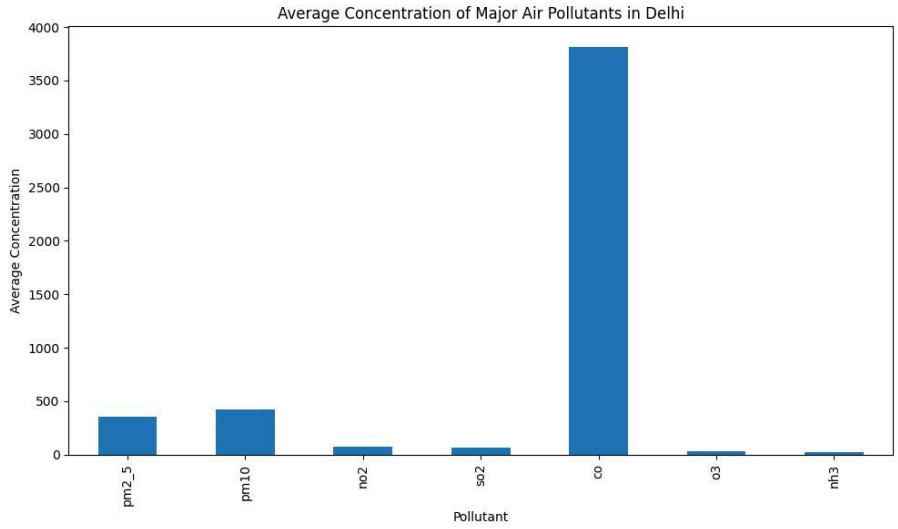
5.3 Seasonal Variation of PM2.5

Seasonal analysis helps understand how weather patterns influence pollution levels. Winter months typically show higher concentrations due to temperature inversion and reduced dispersion.



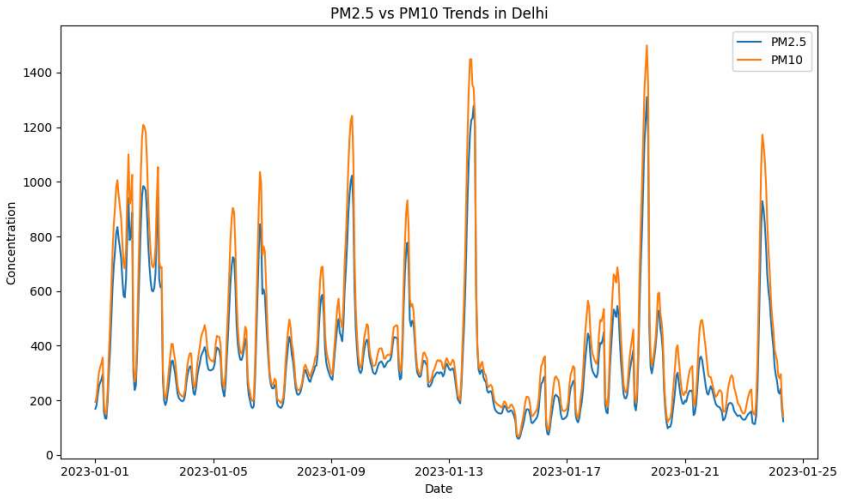
5.4 Pollutant-wise Average Concentration

This section compares the average concentrations of different pollutants to identify the most dominant contributors to air pollution in Delhi.



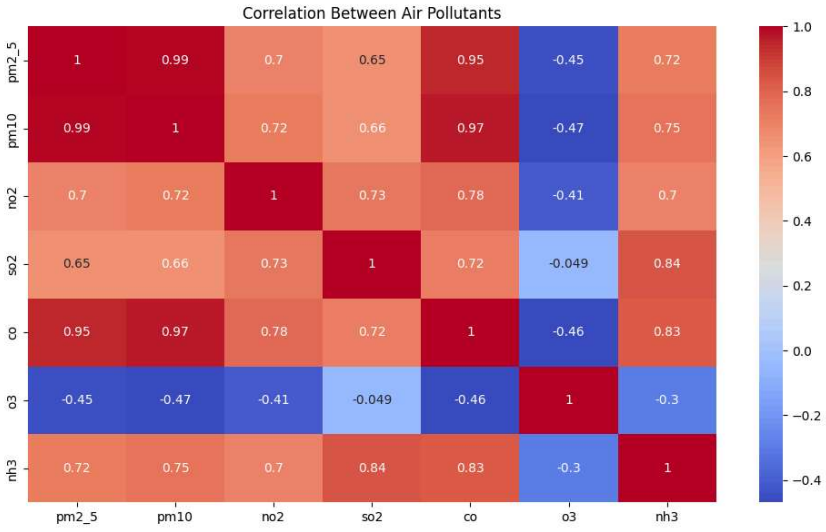
5.5 Comparison Between PM2.5 and PM10

This comparison highlights the relationship between fine and coarse particulate matter and their simultaneous variation over time.



5.6 Correlation Analysis of Pollutants

Correlation analysis helps determine how strongly pollutants are related to each other. A high positive correlation suggests common pollution sources.



6. Key Insights and Findings

- PM2.5 levels show significant seasonal variation, with peaks during winter months
- Winter and post-monsoon seasons exhibit the highest pollution levels

- PM2.5 and PM10 are the dominant contributors to air pollution
- Strong correlation exists between particulate matter and gaseous pollutants
- Weather and geographical conditions significantly impact pollutant dispersion

7. Recommendations

Based on the analysis, the following measures are recommended:

- Strengthening vehicular emission controls
- Promoting public transport and electric vehicles
- Regulating construction activities during high pollution periods
- Implementing stricter industrial emission standards
- Increasing green cover and urban plantations

8. Conclusion

This study provides a comprehensive overview of air pollution patterns in Delhi using pollutant concentration data. The findings reveal significant temporal and seasonal variations in air quality, with particulate matter being the primary concern. The insights derived from this analysis can assist policymakers and environmental agencies in implementing targeted air pollution control strategies to improve public health outcomes.