# Air Quality index (AQI) In Delhi

Delhi faces significant air quality challenges, with frequent episodes of hazardous pollution that affect public health, economic productivity, and quality of life. The AQI is an aggregated index that communicates air pollution levels to the public by combining concentrations of major pollutants (PM2.5, PM10, NO2, SO2, CO, O3). This project outlines a comprehensive approach to analyze AQI trends, drivers, and implications for the city.

## NAQI CATEGORIES AND RESPECTIVE HEALTH STATEMENT

| AQI | Color code | Associated health impacts |
|---|---|---|
| Good (0–50) | | Minimal impact |
| Satisfactory (51–100) | | May cause minor breathing discomfort to sensitive people |
| Moderate (101–200) | | May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults |
| Poor (201–300) | | May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease |
| Very poor (301–400) | | May cause respiratory illness to the people on prolonged exposure. The effect may be more pronounced in people with lung and heart diseases |
| Severe (> 401) | | May cause respiratory effects, even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced light physical activity even during |

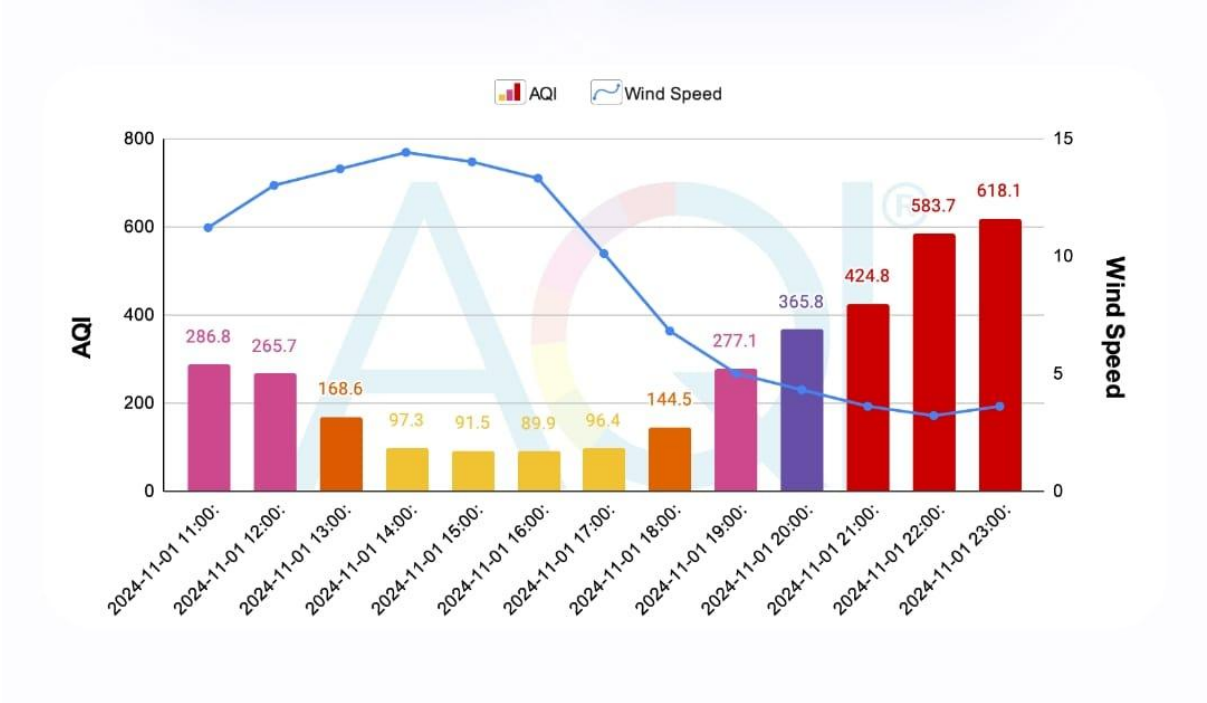
## THE CORRESPONDING CONCENTRATION BREAKPOINTS FOR EACH OF THE POLLUTANT :

| AQI Category | AQI | Concentration Range* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $PM_{10}$ | $PM_{2.5}$ | $NO_2$ | $O_3$ | CO | $SO_2$ | $NH_3$ | Pb |
| Good | 0-50 | 0-50 | 0-30 | 0–40 | 0-50 | 0-1.0 | 0-40 | 0-200 | 0-0.5 |
| Satisfactory | 51 - 100 | 51-100 | 31-60 | 41-80 | 51-100 | 1.1-2.0 | 41-80 | 201-400 | 0.5-1.0 |
| Moderately Polluted | 101-200 | 101-250 | 61-90 | 81-180 | 101-168 | 2.1-10 | 81-380 | 401-800 | 1.1-2.0 |
| Poor | 201-300 | 251-350 | 91-120 | 181-280 | 169-208 | 10-17 | 381-800 | 801-1200 | 2.1-3.0 |
| Very Poor | 301–400 | 351-430 | 121-250 | 281-400 | 209-748* | 17-34 | 801-1600 | 1200-1800 | 3.1-3.5 |
| Severe | 401-500 | 430+ | 250+ | 400+ | 748+* | 34+ | 1600+ | 1800+ | 3.5+ |

* CO in $mg/m^3$ and other pollutants in $\mu g/m^3$; 24-hourly average values for $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$, $NH_3$, and Pb, and 8-hourly values for CO and $O_3$.

## About National Air Quality index

1. Air Quality Index is a tool for effective communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour.
2. There are six AQI categories, namely Good, Satisfactory, Moderately polluted, Poor, Very Poor, and Severe. Each of these categories is decided based on ambient concentration values of air pollutants and their likely health impacts (known as health breakpoints). AQ sub-index and health breakpoints are evolved for eight pollutants (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which short-term (upto 24-hours) National Ambient Air Quality Standards are prescribed.
3. Based on the measured ambient concentrations of a pollutant, sub-index is calculated, which is a linear function of concentration (e.g. the sub-index for PM2.5 will be 51 at concentration 31 µg/m3, 100 at concentration 60 µg/m3, and 75 at concentration of 45µg/m3). The worst sub-index determines the overall AQI.




There are six NAQL categories ,

Namely Good, satisfactory, Moderate, poor, severe and Hazardous. The proposed NAQL will consider eight pollution CO2,SO2,CO,O2,NH2 and pb for which short-term National Ambient Air Quality Standard are prescribed.

| Year | Good | Moderate | Poor | Unhealthy | Severe | Hazardous |
|---|---|---|---|---|---|---|
| 2024 | 2 | 60 | 100 | 107 | 77 | 20 |
| 2023 | 2 | 61 | 121 | 87 | 70 | 23 |
| 2022 | 3 | 45 | 69 | 120 | 99 | 9 |
| 2021 | 2 | 81 | 125 | 55 | 77 | 27 |
| 2020 | 2 | 100 | 117 | 55 | 76 | 16 |

## DELHI AQL BEFORE AND AFTER LOCKDOWN

Before the lockdown, Delhi consistently recorded AQI levels in the range of 250–400, which falls under the 'Very Unhealthy' category. The city faced severe pollution due to heavy traffic, industrial emissions, and construction dust. However, during the COVID-19 lockdown in 2020, the AQI dropped drastically to around 50–100, indicating 'Moderate' or even 'Good' air quality on several days. The reduction in vehicular movement, industrial shutdowns, and construction bans led to a visible improvement in air quality. After restrictions were lifted, AQI levels gradually increased again, returning to pre-lockdown levels due to resumption of human and industrial activities.

## AIR QUALITY OVER DELHI REGION

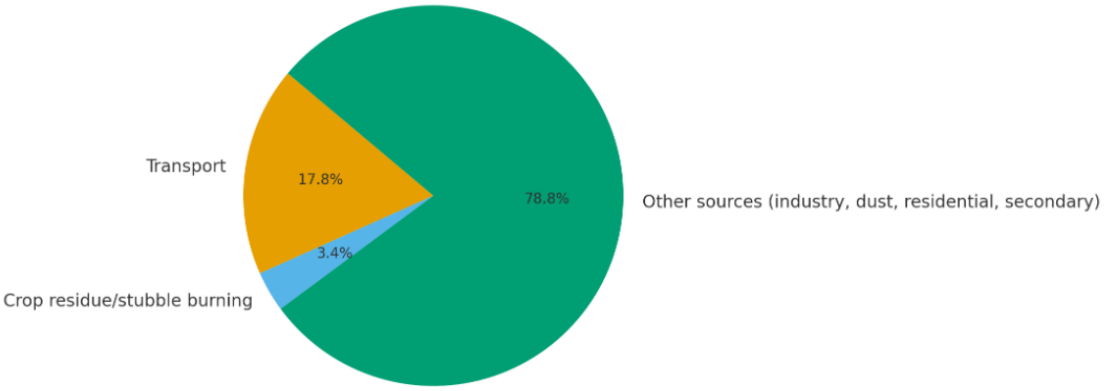
### AQL Category -new delhi

Measurement of AQL from JAN 2020-2024

In 2020, Delhi's annual average PM2.5 level was 89g/m³, a reduction from previous years due to the COVID-19 lockdown. Although the lockdown caused a dramatic drop in air pollution, as restrictions eased, PM levels began to rise. Delhi experienced only fou good" days in 2020, with the lowest PM2.5 level recorded at 11g/m³

- Annual Average: The annual average PM2.5 level was 89g/M³ in 2020.
- Lockdown Effect: The coronavirus lockdown led to a significant reduction in air pollution in Delhi.
- Post-Lockdown: PM levels increased after lockdown restrictions were relaxed. "Good" Days: Delhi had only 4 "good" days for air quality in 2020.

- Lowest PM Level: The lowest recorded PM2.5 level in 2020 was 11g/M³.




## public-health recommendations

1. **Seasonal preparedness (short-term):** intensify restrictions and targeted interventions before and during the November–January peak: stricter vehicle emission enforcement, dust control on construction sites, early alerts and public-health advisories, and rapid on-ground measures during inversion episodes.
2. **Regional coordination:** strengthen cross-state coordination (Punjab/Haryana) to reduce stubble burning through incentives, mechanized residue management, and near-real-time enforcement and alternatives—this reduces the regional background that fuels Delhi episodes.
3. **Transport policy:** accelerate low-emission public transport, electrification of buses, cleaner fuels and stricter inspection & maintenance of vehicles; as transport is a sizable contributor (~18% reported), this yields measurable gains.
4. **Dust & construction control:** enforce best practices for roads, coverings and water sprinkling on construction sites and uncapped loads on trucks—road/dust is a large but addressable source.
5. **Health protection & alerts:** expand real-time monitoring coverage and targeted health advisories/school policies for vulnerable groups during peaks, plus subsidized indoor air purification for hospitals and schools.

In [1]:
```
import pandas as pd
df =pd.read_csv("delhiaqi.csv")
df.head()
```

Out[1]:

| | date | co | no | no2 | o3 | so2 | pm2_5 | pm10 | nh3 |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 01-01-2023 00:00 | 1655.58 | 1.66 | 39.41 | 5.90 | 17.88 | 169.29 | 194.64 | 5.83 |
| 1 | 01-01-2023 01:00 | 1869.20 | 6.82 | 42.16 | 1.99 | 22.17 | 182.84 | 211.08 | 7.66 |
| 2 | 01-01-2023 02:00 | 2510.07 | 27.72 | 43.87 | 0.02 | 30.04 | 220.25 | 260.68 | 11.40 |
| 3 | 01-01-2023 03:00 | 3150.94 | 55.43 | 44.55 | 0.85 | 35.76 | 252.90 | 304.12 | 13.55 |
| 4 | 01-01-2023 04:00 | 3471.37 | 68.84 | 45.24 | 5.45 | 39.10 | 266.36 | 322.80 | 14.19 |

```
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

```
df = pd.read_csv('delhiaqi.csv')
```

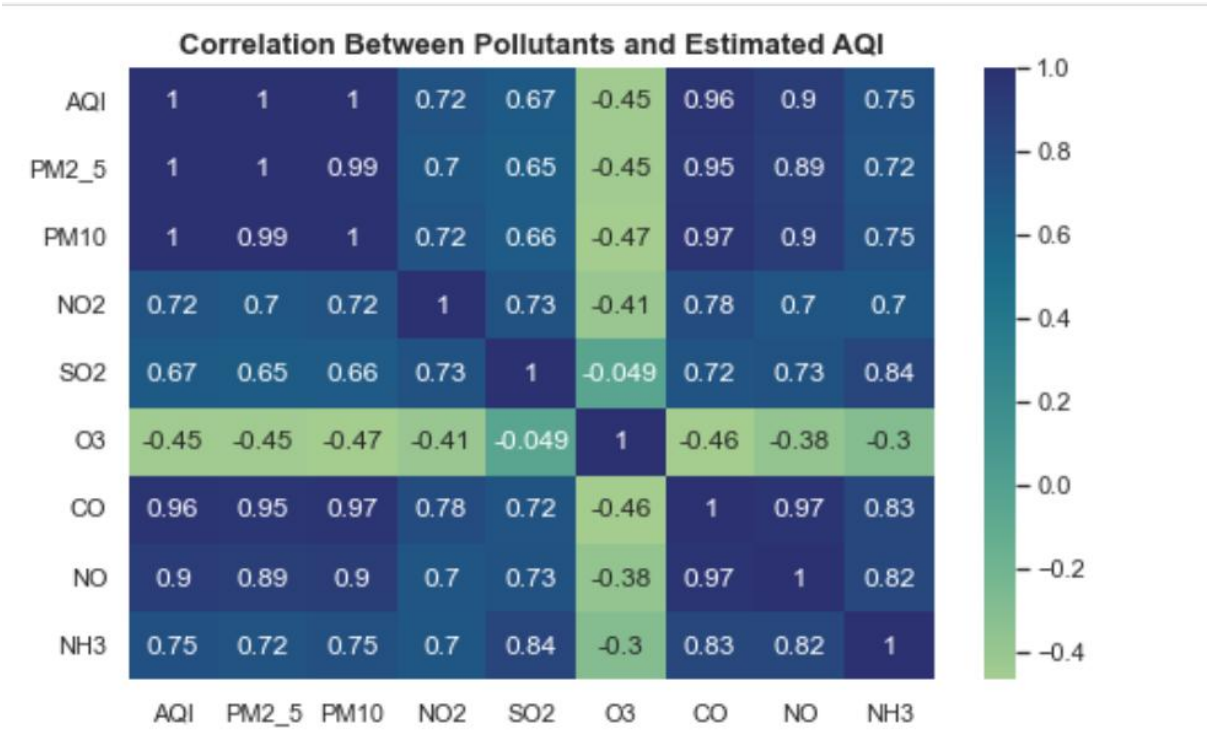
```
pollutants = ['PM2.5', 'PM10', 'NO2', 'SO2', 'O3', 'CO', 'NO']
```

```
print(df.columns)
```

```
Index(['date', 'co', 'no', 'no2', 'o3', 'so2', 'pm2_5', 'pm10', 'nh3'], dtype='object')
```

```
# Step 4: Plot the heatmap
plt.figure(figsize=(8,5))
sns.heatmap(corr, annot=True, cmap='crest')   # You can change cmap here
plt.title('Correlation Between Pollutants and Estimated AQI', fontsize=13, weight='bold')
plt.show()
```

## Output :




As the lockdown restriction were released the PM level started going up as Delhi observed only 4 ‘good’ days in 2020 with the lowest PM level of 11 ug/$m^2$

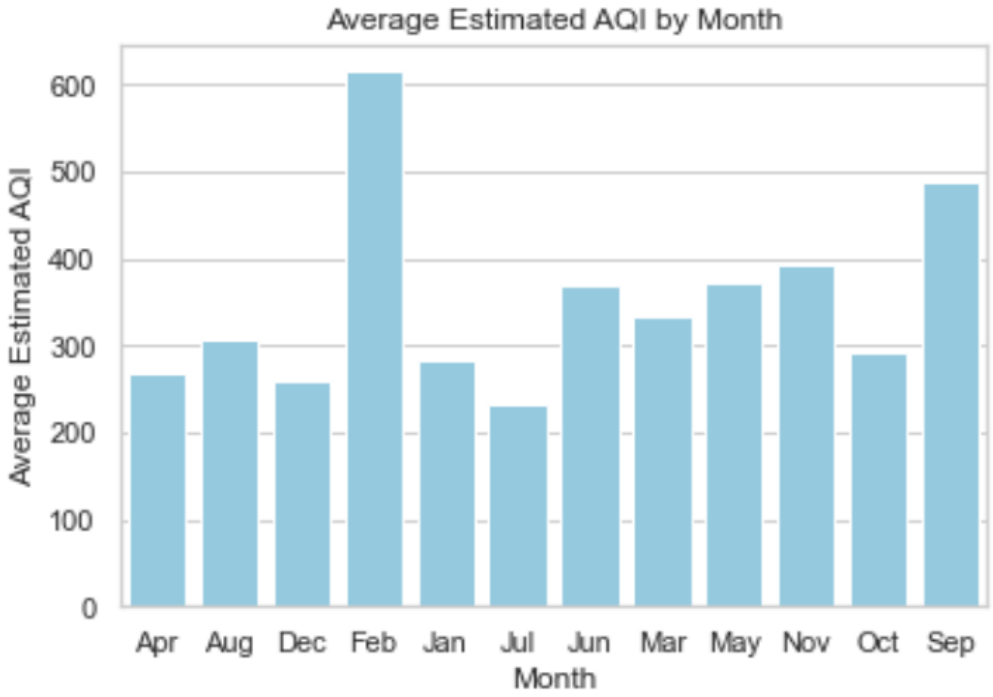
The PM2.5 and PM10 concentrations in Delhi remained critically high throughout most of the year, with severe spikes recorded during the winter months. The air quality typically ranged between the ‘Unhealthy’ and ‘Hazardous’ categories, mainly due to temperature inversion, vehicle emissions, and crop residue burning in nearby states. Although there have been minor improvements due to government initiatives such as the Odd-Even Scheme and on industrial emissions, the overall pollution levels continue to exceed the safe limits set by the WHO

## Inference:

These findings highlight that despite periodic interventions, Delhi’s air quality remains one of the poorest among global cities. Prolonged exposure to high PM levels has increased health risks, particularly respiratory and cardiovascular diseases, emphasizing the urgent need for sustained and comprehensive air quality management strategies.

```
import seaborn as sns
monthly_aqi = df.groupby('Month_Name')['AQI'].mean()
sns.barplot(x=monthly_aqi.index, y=monthly_aqi.values, color='skyblue')
plt.title('Average Estimated AQI by Month')
plt.xlabel('Month')
plt.ylabel('Average Estimated AQI')
plt.show()
```

## Output:




## Conclusion :

Delhi remains a high-burden city for air pollution with **PM2.5** as the principal health driver. Recent summaries suggest **modest improvement** in aggregate AQI for 2025 (Jan–Oct) compared with 2024 and earlier years, but the city still experiences **severe seasonal episodes in winter** driven by a mix of local sources (transport, residential, dust, industry) and **regional contributions (stubble burning, transported pollution)** amplified by meteorology (inversions and weak ventilation). Targeted, seasonally timed interventions, stronger regional coordination and continued enforcement of transport/dust controls can produce meaningful improvements in population exposure and health.