Air Quality Disparities: A Data-Driven Exploration across Coastal, Inland, Metro & Tier-2 Cities
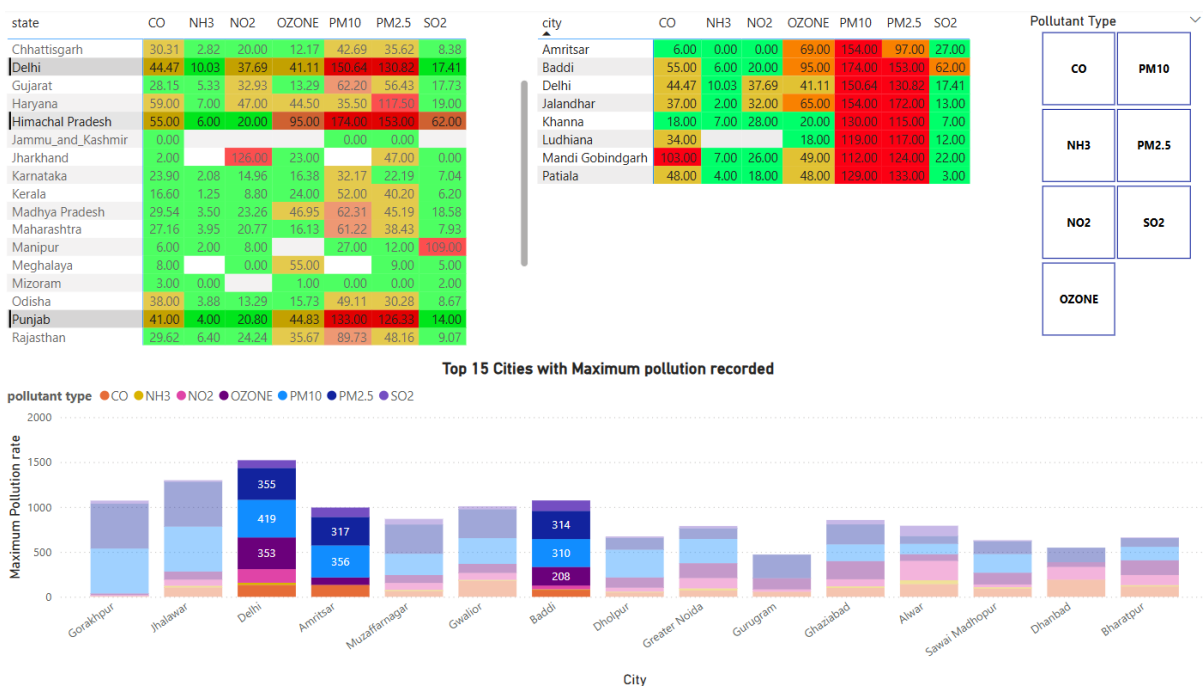
1. Introduction

Air pollution has emerged as one of the most pressing environmental and public health challenges facing India today. With rapid urbanization, industrial expansion, and increasing vehicular emissions, ambient air quality has deteriorated across both urban and rural landscapes. This report provides an in-depth, data-driven assessment of India's Air Quality Index (AQI) on February'19 2024 – 10:00 hours, using real-time pollutant concentration data from monitoring stations nationwide. The analysis focuses on key pollutants—CO, NH_3, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2—that collectively determine AQI values and their spatiotemporal variability. In addition to providing a state-wise and city-level breakdown, the report investigates how pollution patterns differ by city classification (Metro vs. Tier-2), geographical region (Coastal vs. Inland), and monitoring station activity. By synthesizing pollution data across these dimensions, the study aims to identify critical hotspots, evaluate regional disparities, and provide insights to support air quality management, infrastructure planning, and evidence-based policymaking.

2. State-Wise Pollutant Distribution

Key Findings:

- **Delhi, Himachal Pradesh, and Punjab** display **exceptionally high levels** of **PM2.5** and **PM10**, both critical contributors to poor air quality.
- **Jharkhand** exhibits an **unusual spike** in **NO2** (Nitrogen Dioxide) levels (**126 µg/m³**).
- **Chandigarh** records high **OZONE** concentration (68 µg/m³).
- **Chhattisgarh and Bihar** show consistently high pollutant values across multiple categories, including **CO**, **PM10**, and **PM2.5**.
- **Cleaner States**: Andaman & Nicobar, Kerala, and Jammu & Kashmir report **low pollutant concentrations** across all categories.

state	CO	NH3	NO2	OZONE	PM10	PM2.5	SO2
Chhattisgarh	30.31	2.82	20.00	12.17	42.69	35.62	8.38
Delhi	44.47	10.03	37.69	41.11	150.64	130.82	17.41
Gujarat	28.15	5.33	32.93	13.29	62.20	56.43	17.73
Haryana	59.00	7.00	47.00	44.50	35.50	117.50	19.00
Himachal Pradesh	55.00	6.00	20.00	95.00	174.00	153.00	62.00
Jammu_and_Kashmir	0.00				0.00	0.00	
Jharkhand	2.00		126.00	23.00		47.00	0.00
Karnataka	23.90	2.08	14.96	16.38	32.17	22.19	7.04
Kerala	16.60	1.25	8.80	24.00	52.00	40.20	6.20
Madhya Pradesh	29.54	3.50	23.26	46.95	62.31	45.19	18.58
Maharashtra	27.16	3.95	20.77	16.13	61.22	38.43	7.93
Manipur	6.00	2.00	8.00		27.00	12.00	109.00
Meghalaya	8.00		0.00	55.00		9.00	5.00
Mizoram	3.00	0.00		1.00	0.00	0.00	2.00
Odisha	38.00	3.88	13.29	15.73	49.11	30.28	8.67
Punjab	41.00	4.00	20.80	44.83	133.00	126.33	14.00
Rajasthan	29.62	6.40	24.24	35.67	89.73	48.16	9.07

city	CO	NH3	NO2	OZONE	PM10	PM2.5	SO2
Amritsar	6.00	0.00	0.00	69.00	154.00	97.00	27.00
Baddi	55.00	6.00	20.00	95.00	174.00	153.00	62.00
Delhi	44.47	10.03	37.69	41.11	150.64	130.82	17.41
Jalandhar	37.00	2.00	32.00	65.00	154.00	172.00	13.00
Khanna	18.00	7.00	28.00	20.00	130.00	115.00	7.00
Ludhiana	34.00		18.00	119.00	117.00	12.00
Mandi Gobindgarh	103.00	7.00	26.00	49.00	112.00	124.00	22.00
Patiala	48.00	4.00	18.00	48.00	129.00	133.00	3.00

Pollutant Type

CO	PM10
NH3	PM2.5
NO2	SO2
OZONE	

Top 15 Cities with Maximum pollution recorded

pollutant type ● CO ● NH3 ● NO2 ● OZONE ● PM10 ● PM2.5 ● SO2
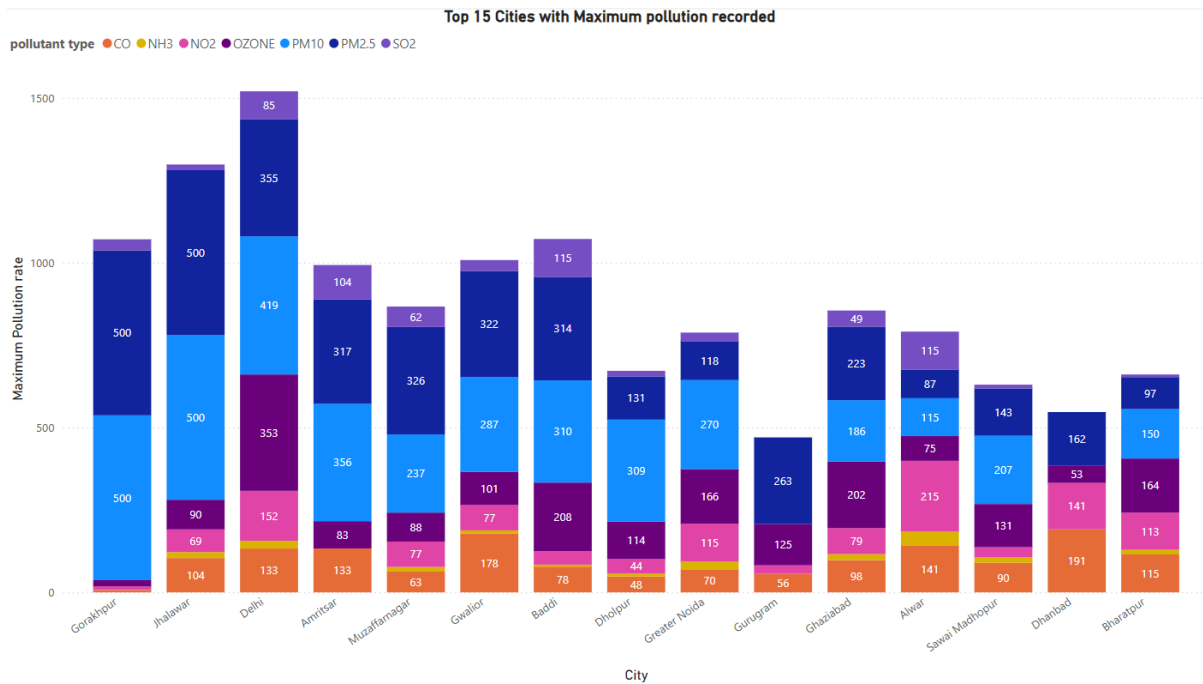
Implication:

Industrialized and densely populated regions (Delhi NCR, Jharkhand, and Haryana) are severely affected. Remote and less industrialized regions remain relatively clean.

3. Top 15 Polluted Cities

Key Observations:

- **Gorakhpur, Jhalawar, and Delhi** top the list with total pollution levels nearing **1500-1600 µg/m³**.
- **Major pollutants** in these cities include **PM10, PM2.5**, and **NO2**.
- Cities like **Amritsar, Baddi, and Gwalior** also report high cumulative pollution levels.
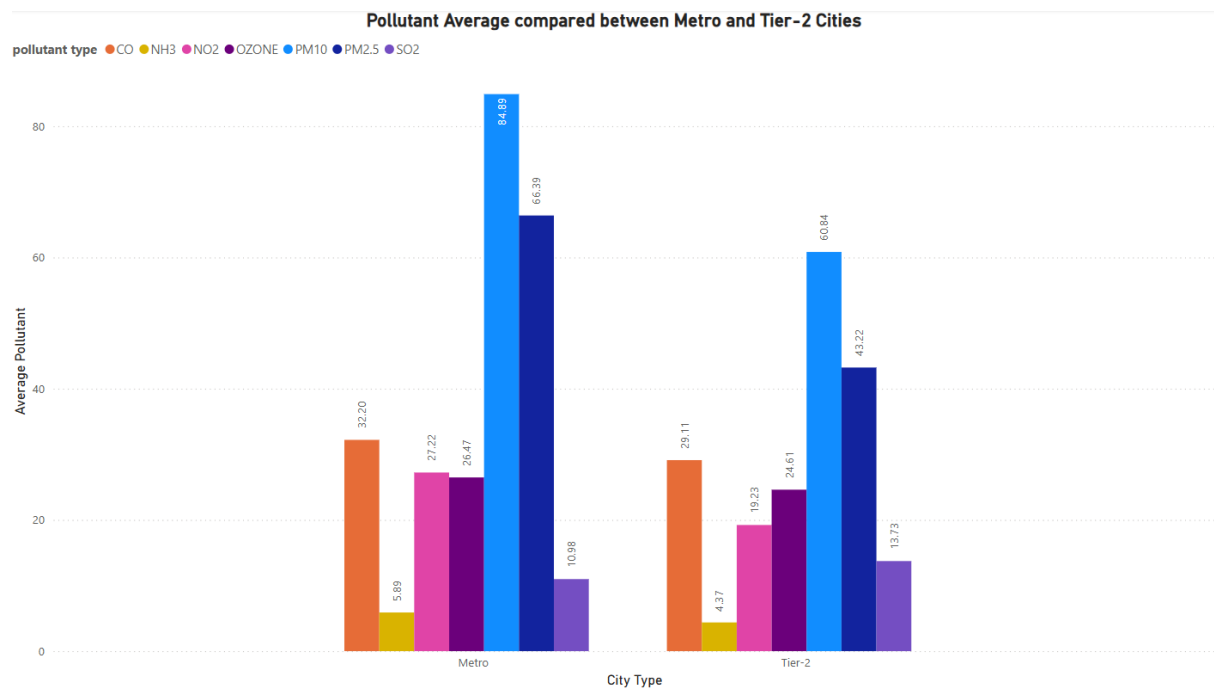

Top 15 Cities with Maximum pollution recorded

Implication:

Urban congestion, industrial emissions, and traffic are major contributors in these cities. Immediate mitigation and monitoring efforts are essential.

4. Metro vs Tier-2 City Pollution Comparison

Pollutant	Metro Avg (µg/m³)	Tier-2 Avg (µg/m³)
CO	32.20	29.11
NH3	5.89	4.37
NO2	27.22	19.23
OZONE	26.47	24.61
PM10	**84.89**	**60.84**
PM2.5	65.39	43.22
SO2	10.98	13.73

Pollutant Average compared between Metro and Tier-2 Cities

pollutant type ●CO ●NH3 ●NO2 ●OZONE ●PM10 ●PM2.5 ●SO2

Insights:

- **Metro cities** show **higher NO2, PM10, and PM2.5** levels due to industrial activities, traffic, and population density.
- **Tier-2 cities** also show concerning pollution levels, but slightly lower on average.

5. Coastal vs Inland City Analysis

Pollutant	Inland Avg (µg/m³)	Coastal Avg (µg/m³)
CO	5.01	4.24
NH3	5.89	4.22
NO2	21.42	21.30
OZONE	29.32	16.36
PM10	**73.25**	**55.01**
PM2.5	**54.78**	**38.15**
SO2	14.95	9.22
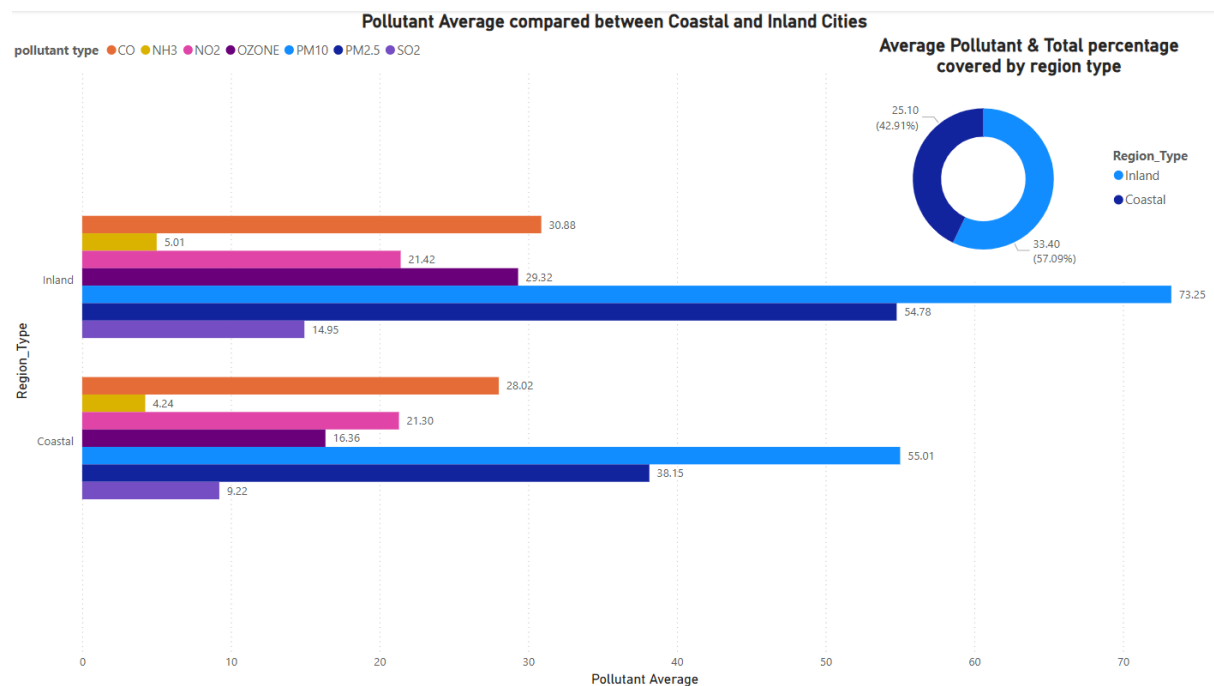
Insights:

- **Inland cities** are **more polluted**, especially in **PM10 and PM2.5**, due to landlocked geography, less ventilation, and higher vehicular concentration.
- **Coastal regions**, benefiting from oceanic air movement, show comparatively **better air quality**.

Overall Region Share:

- **Inland:** 57.09% of pollution levels
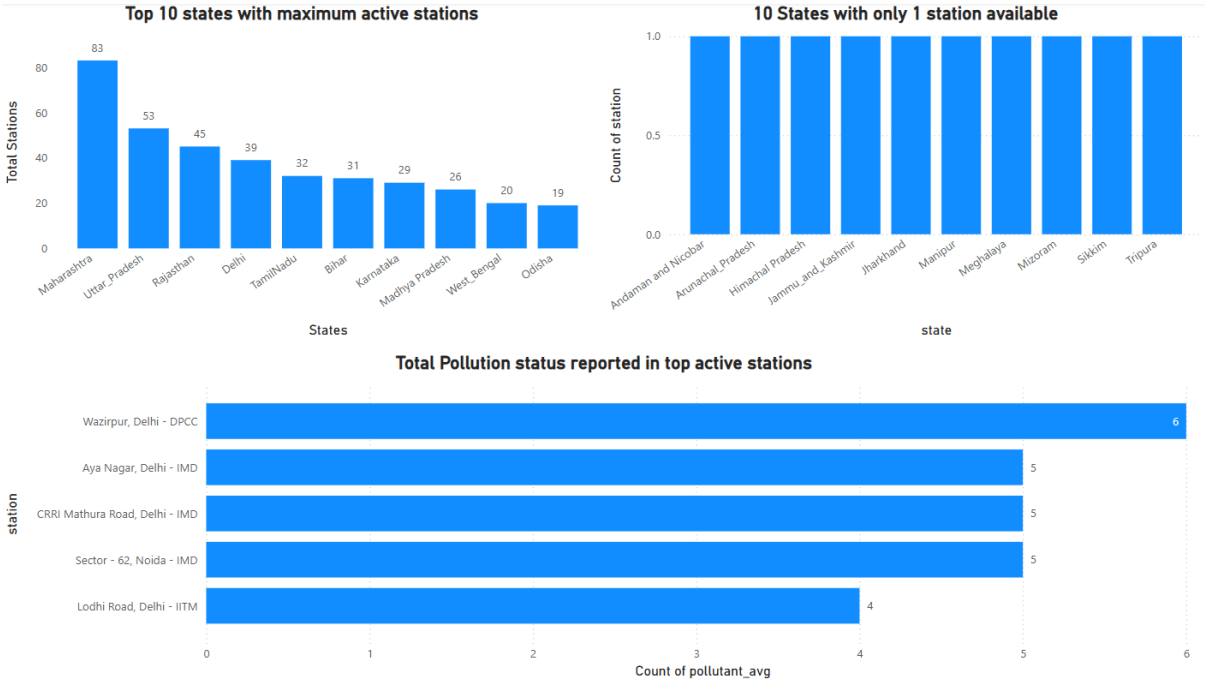- **Coastal:** 42.91% of pollution levels

6. Air Quality Monitoring Stations

States with Most Active Stations:

State	Total Stations
Maharashtra	**83**
Uttar Pradesh	53
Rajasthan	45
Delhi	39
Tamil Nadu	32

States with Only 1 Station:

Includes **Andaman & Nicobar, Arunachal Pradesh, Jharkhand, Manipur, Mizoram, Tripura**, etc.

Top Active Monitoring Stations by Reporting Pollutants:

Station Name	Location	Pollutants Reported
Wazirpur - DPCC	Delhi	6
Aya Nagar - IMD	Delhi	5
CRRI Mathura Road - IMD	Delhi	5
Sector 62 - IMD	Noida	5
Lodhi Road - IITM	Delhi	4

Insights:

- **Delhi** has strong station activity, aiding detailed monitoring.
- **Many states lack adequate coverage**, risking underreporting or blind spots.

7. Key Pollutants Driving AQI

Across all views, the **most dominant pollutants** contributing to poor AQI are:

- **PM10 and PM2.5** – Linked to respiratory and cardiovascular issues.
- **NO2** – Majorly from vehicle emissions.
- **OZONE** – Secondary pollutant formed by chemical reactions; high in areas like Chandigarh.
- **NH3 and SO2** – Spikes in specific regions indicate possible industrial or agricultural emission sources.

8. Recommendations

1. **Expand Monitoring Network** – Especially in north-eastern and hilly states with limited stations.
2. **Mitigation in Urban Areas**:
   - Encourage EV adoption and public transit in metros.
   - Implement stricter industrial emission norms.
3. **Data Transparency** – Real-time dashboards in public spaces and online.
4. **Policy Enforcement** – Penalize excessive emissions, incentivize clean fuels.
5. **Awareness Campaigns** – Educate public on AQI implications and protective behaviour (e.g., masks, avoiding outdoor exercise).

9. Conclusion

The AQI snapshot from 19 Feb 2024 highlights significant regional disparities in air quality across India. While some coastal and remote areas remain relatively clean, urban inland regions face alarming pollution levels, especially from particulate matter (PM10, PM2.5). A coordinated policy response, expanded monitoring, and citizen involvement are crucial to curb rising air pollution and protect public health.