6. Air Quality Assesment- Environment

Northern cities are more polluted than southern and western cities in India. A recent analysis reveals that no major Indian city achieved safe air quality levels between 2015 and 2025, with Northern cities like Delhi suffering the most due to landlocked geography and winter inversion, while coastal cities fared relatively better due to natural ventilation.

Report Overview

Source- A new analysis titled "Air Quality Assessment of Major Indian Cities (2015–2025)" conducted by Climate Trends.

Core Conclusion- The report concludes that no major Indian city has achieved "safe" air quality levels over the last decade.

Key Findings of the Analysis

Delhi (Most Polluted)- Delhi recorded the worst air quality among the 11 major cities analyzed.

Trend- The annual mean Air Quality Index (AQI) peaked above 250 in 2016.

Current Status- Despite improvements since 2019, the AQI remains at an unhealthy level of 180 in 2025.

Northern Tier (Lucknow & Varanasi)- These cities began the decade with severe pollution levels (AQI > 200). While they have shown improvement, their levels remain consistently above healthy limits.

Regional Disparity (Coastal & South)- Cities like Chennai, Chandigarh, Visakhapatnam, and Mumbai recorded relatively lower pollution loads.

AQI Range- Fluctuated between 80–140, which is better than the North but still above safe standards.

Bengaluru (Least Polluted)- Bengaluru demonstrated the lowest pollution levels among the analyzed cities. AQI Range- Between 65–90.

Caveat- Even this "best" performance does not fall within the safe range (AQI 0–50).

Analysis- Why Northern Cities Are More Polluted

The high pollution in Northern India is a result of complex interactions between geography, meteorology, and urban planning.

Geographical Factors

Landlocked Basin- Northern cities are situated in the Indo-Gangetic Plain, which acts as a "bowl."

The Himalayan Barrier- The region is bounded by the Himalayas to the north. This massive mountain range acts as a wall, preventing the dispersion of pollutants.

Airflow Obstruction- Due to this enclosure, pollutants cannot escape and tend to **s**tagnate over these cities for extended periods.

Atmospheric Inversion (Winter Phenomenon)

The "Lid" Effect- During winter (December–February), a phenomenon occurs where cold, dense air near the ground gets trapped beneath a layer of warmer air above.

Restricted Mixing- This creates an "atmospheric lid" that prevents vertical mixing.

Result- Pollutants are confined within a thin planetary boundary layer, leading to severe choking in cities like Delhi, Lucknow, and Varanasi.

Seasonal Wind and Rain Patterns

Summer & Monsoon- Strong **westerly winds** and rainfall help wash away and disperse pollutants.

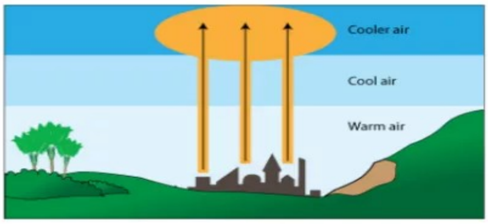
Winter Stagnation- The winter months are characterized by **low wind speeds**, **lack of rain**, and **dry air**. These conditions combine to intensify pollution episodes.

Urban Structure and Wind Resistance

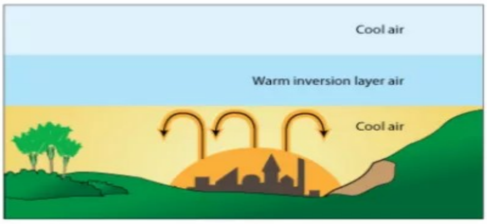
Surface Roughness- The dense urban construction in northern megacities creates friction (surface roughness).

Impact- This friction slows down wind speeds near the ground, further limiting the natural dispersion of pollutants.

Urban Canyons- High built-up density and high-rise clusters create "canyons" that trap particulate matter.



Normal pattern



Thermal inversion

Additional Regional Pollution Burden

The geographical disadvantage is compounded by human-made sources specific to the region-

Crop Residue Burning- Massive contribution from the Punjab–Haryana belt.

Industrial Clusters- High concentration of industries in the National Capital Region (NCR).

Vehicular & Dust Load- High vehicular population combined with dust from extensive construction and mining activities.

Concept- Winter Inversion

Winter inversion is a meteorological phenomenon that significantly exacerbates pollution during colder months.

Definition- A type of temperature inversion where cold, dense air remains trapped near the surface while warmer air sits above it, preventing the normal vertical mixing of the atmosphere.

Characteristics- Creates stable atmospheric conditions with very little vertical air movement. Features a well-defined cold layer at the bottom and a warm layer above. It is strongest during the night and early morning and can persist for days.

Effects on Environment and Health-

Pollutant Trapping- Dangerous pollutants like PM2.5, NOx, SO_2, and ozone precursors get locked near the ground level.

Suspension- Fine particulate matter remains suspended longer, worsening air quality.

Visibility- It promotes dense fog and mist formation and leads to persistent smog, especially in industrial zones.

Health- The trapped pollutants significantly increase the risk of respiratory and cardiovascular illnesses.

Comparative Analysis- Why Southern & Western Cities Fare Better

The following table differentiates the factors helping Southern/Western cities versus the Northern region.

Feature	Southern & Western Cities (e.g., Chennai, Mumbai)	Northern Cities (e.g., Delhi, Varanasi)
Geographical Location	Coastal Influence- Proximity to the sea provides natural ventilation.	Landlocked- Trapped in the Indo-Gangetic plain.
Wind Patterns	Sea Breezes-Daily seabreezes enhance pollutant dispersion.	Stagnant Air- Low wind speeds, especially in winter, cause stagnation.
Physical Barriers	Open Terrain- No major mountain barriers like the Himalayas to block airflow.	Himalayan Barrier- Prevents pollutants from escaping northwards.
Monsoon Impact	Cleansing Effect- Southwest monsoon brings strong westerlies and heavy rain that "cleanse" the air.	Variable Impact- While monsoons help, the long, dry winter reverses benefits.
Pollutant Dispersion	High- Pollutants escape easily due to freer airflow.	Low- Pollutants get trapped due to friction and inversion.

Source- https-//indianexpress.com/article/explained/urban-indian-city-safe-air-quality-10391338/