

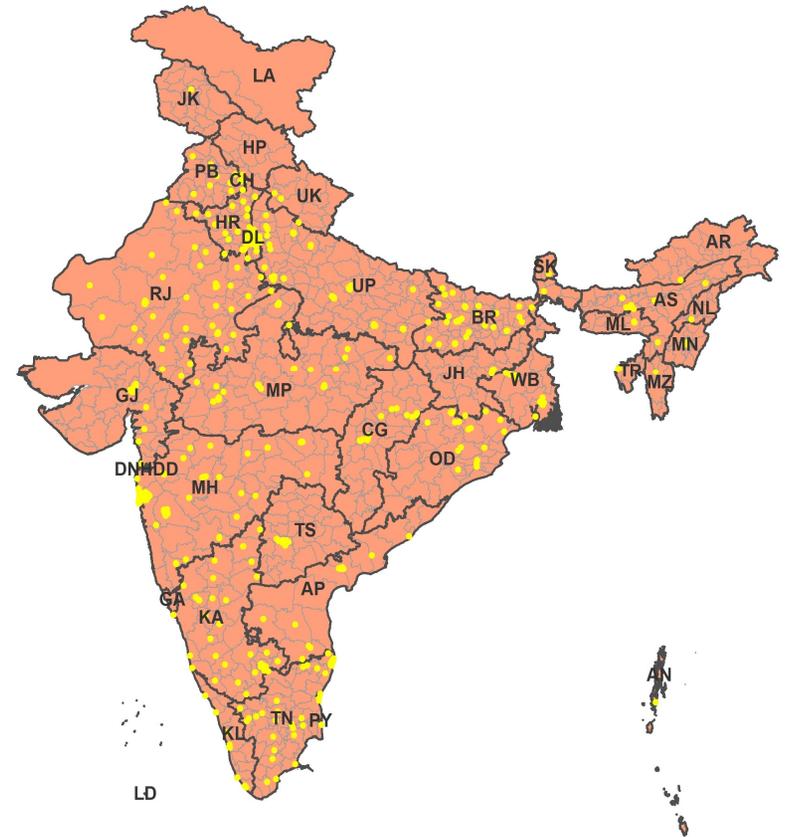
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Mind the Gaps: Monitoring Missteps in India's Air Quality Network

*Understanding Data Shadow regions and their
policy implications*

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Urban Lab, Centre for Science and
Environment
New Delhi, February 26, 2026





Monitoring is the foundation of Air Quality Management

Air quality monitoring is not just a technical exercise; it is the foundation of regulatory action and public health protection.

- It determines what people breathe and how much they are exposed.
- It helps **identify pollution sources** and **high-risk zones**.
- It **enables compliance tracking** and **policy evaluation**.
- It supports funding allocation and performance assessment.

Without continuous, credible and spatially representative monitoring, air quality governance remains incomplete.



India has expanded its Monitoring Network But is it enough?

India's monitoring framework consists of:

1. National Air Quality Monitoring Programme (NAMP)
2. Continuous Ambient Air Quality Monitoring Stations (CAAQMS)

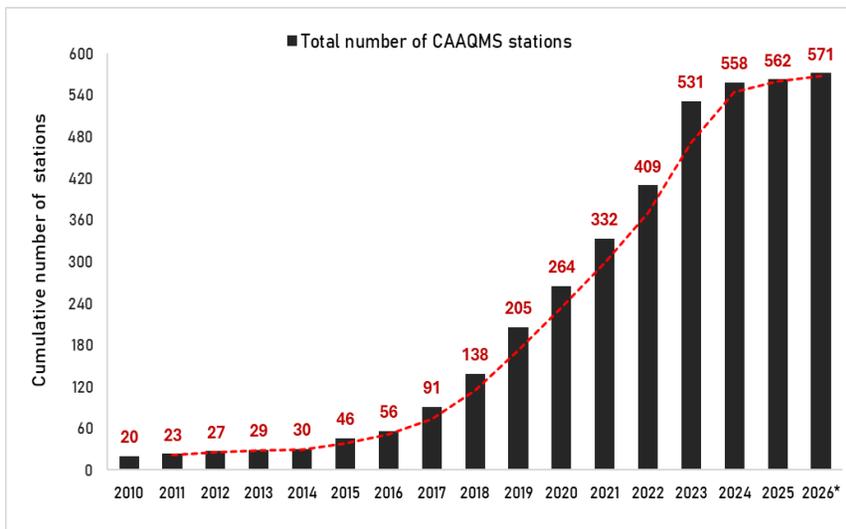
Current status:

- **571 real-time monitors** across 299 cities (as of Feb 2026)
- **966 manual monitors** across 419 cities (as of Nov 2024)

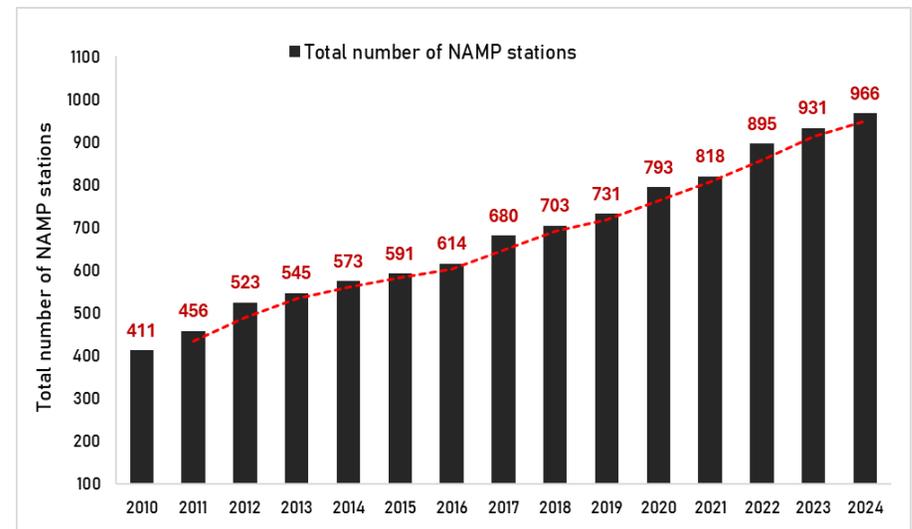


Since the launch of NCAP in 2019, the number of continuous monitors has increased 2.7 times, while manual monitors have grown by 1.32 times.

Growth in Real-time (CAAQMS) stations 2010-2026



Growth in Manual (NAMP) stations 2010-2024



Yet, large parts of the country remain outside the monitoring grid...



The Core Question....

In a country of 1.4 billion where pollution and exposure vary dramatically across regions:

Are we monitoring where exposure is highest, or where it is administratively convenient?

- Monitoring remains concentrated in state capitals and major metropolitan regions.
- Entire districts, industrial belts and fast-growing peri-urban belts remain outside the monitoring grid.



What are Data Shadow Areas??

Data shadow areas are regions where:

- No or very few monitoring stations exist.
- Pollution may be present but remains unmeasured.
- These regions remain invisible in official air quality datasets.

These areas do not feature in regulatory assessments, funding frameworks or performance evaluations — despite potential exposure risks.



How were Data Shadows Identified?

A geospatial assessment was conducted to evaluate monitoring coverage across India.

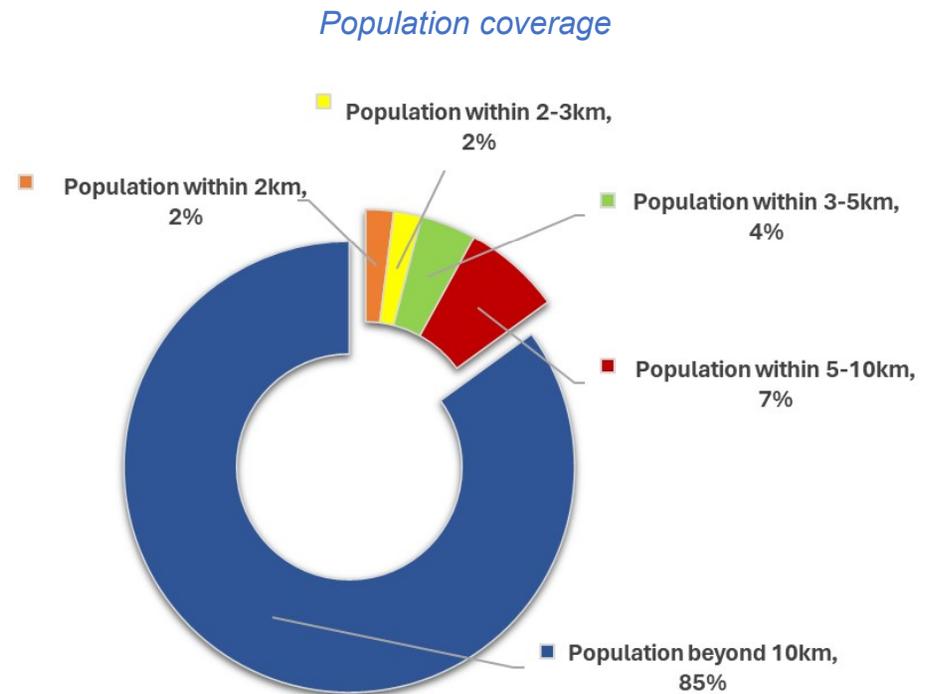
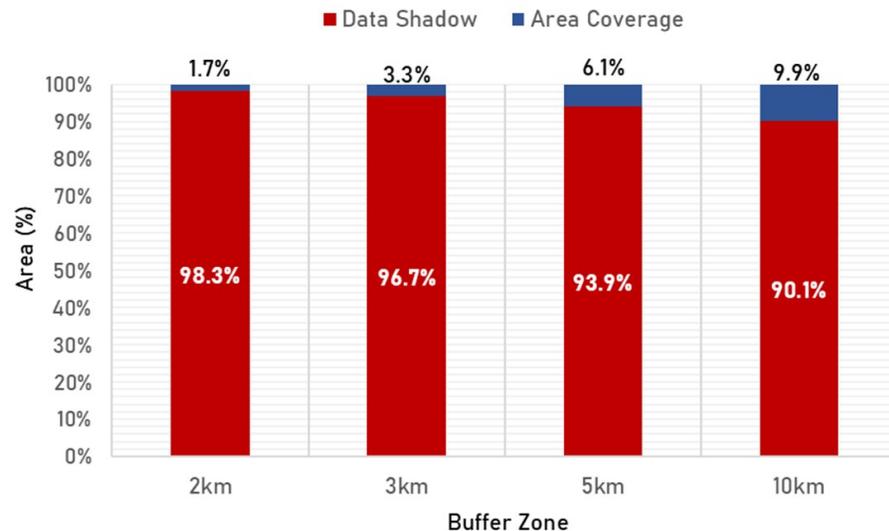
- Each monitoring station was assigned an influence buffer.
- **Buffer distances of 2 km, 3 km, 5 km and 10 km** were used.
- Monitoring buffers were overlaid with high-resolution population data (100m × 100m grid).
- **Land area and population within and outside monitoring influence zones were calculated.**

This approach estimates who is monitored, and who is left out.



Who Lives in Data Shadow Areas? National Monitoring Landscape and Gaps

- Only about 15 per cent of India's population, about 200 million people, live within 10 km of a real-time monitor.
- Over 90 per cent of India's landmass remains outside the 10 km monitoring buffer.



Note: Population estimates are based on the 100mx100m spatial distribution of population in 2020 developed by the Socioeconomic Data and Application Center (SEDAC) - Gridded Population of the World (GPW), version 4, revision 11 (GPWv411) for year 2020. Monitoring locations are approximation based on information available from CPCB website and publications, it is not exact geographical co-ordinate of the stations as that information is not publically available. Source: CSE analysis



How much of India is actually monitored? State-level variation in network coverage

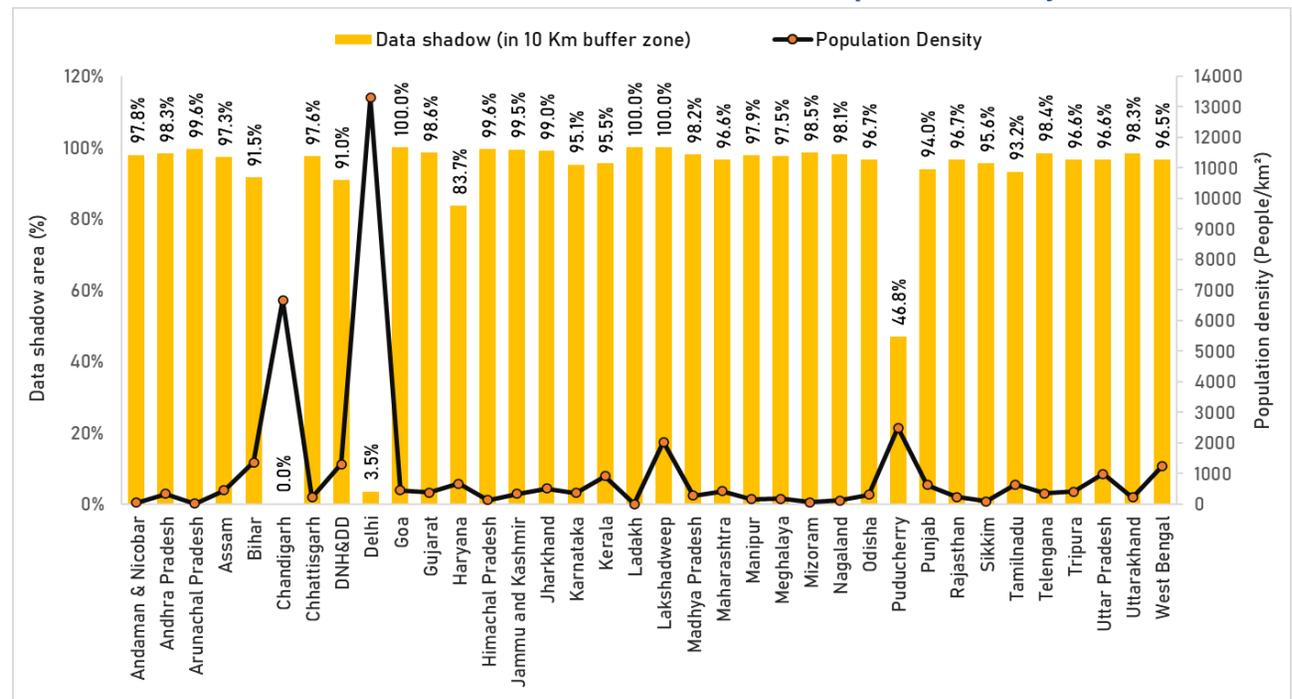
State-Wise Data Shadow Area and Population Density

High coverage: Chandigarh (100 per cent), Delhi (minimal data shadow)

Moderate coverage: Puducherry shows relatively better reach

Very high data shadows (>95%): Uttar Pradesh, West Bengal, Kerala

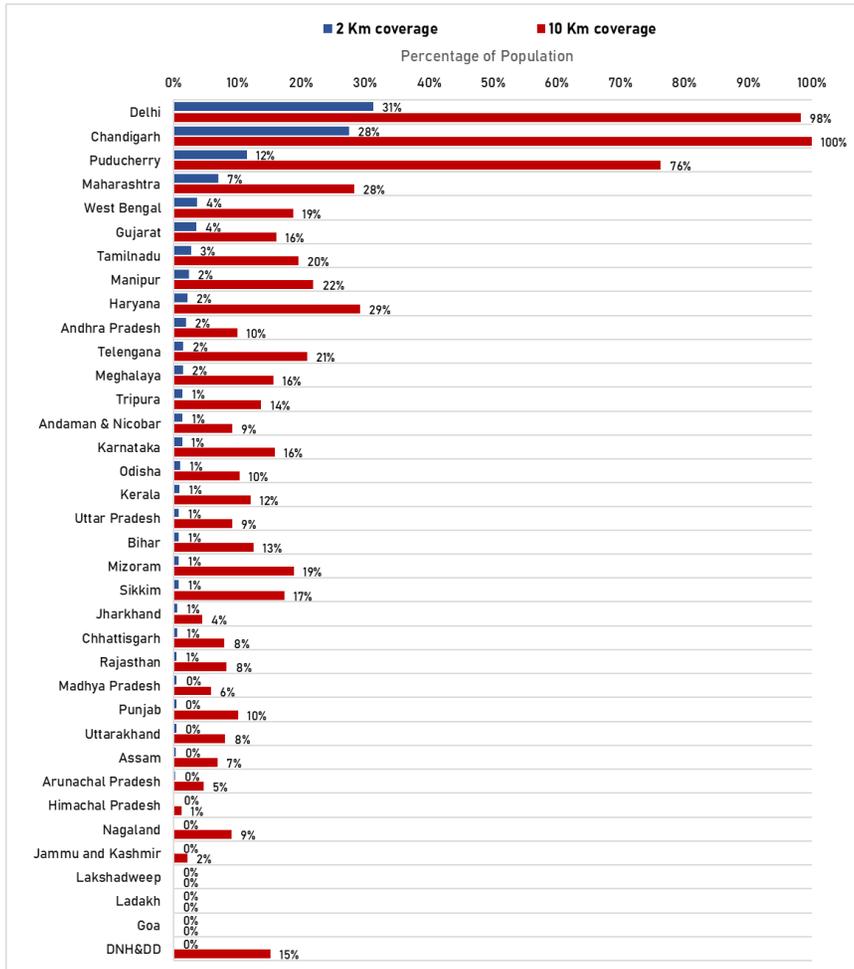
No real-time stations: Goa, Ladakh, Lakshadweep





State-wise population coverage under real-time air quality network

- **Delhi and Chandigarh** shows the highest coverage, with nearly their entire populations covered within 10 km.
- Delhi stands out, with 31% of residents living within 2 km, reflecting a dense monitoring network.
- **Puducherry performs relatively better:** 76% population within 10 km, but only 12% within 2 km.
- **Maharashtra, West Bengal, Tamil Nadu, Haryana, Manipur, and Telangana** show limited reach beyond metros, with **less than 10% population coverage within 2 km, and only 20–30% within 10 km.**
- **Arunachal Pradesh, Nagaland, Assam, Punjab, Madhya Pradesh, Himachal Pradesh, and Uttarakhand** have very poor coverage, with **under 1% population within 2 km and less than 10% within 10 km.**
- **Dadra & Nagar Haveli & Daman & Diu** benefits indirectly, with about **15% population covered** due to proximity to a monitor in Vapi, Gujarat.



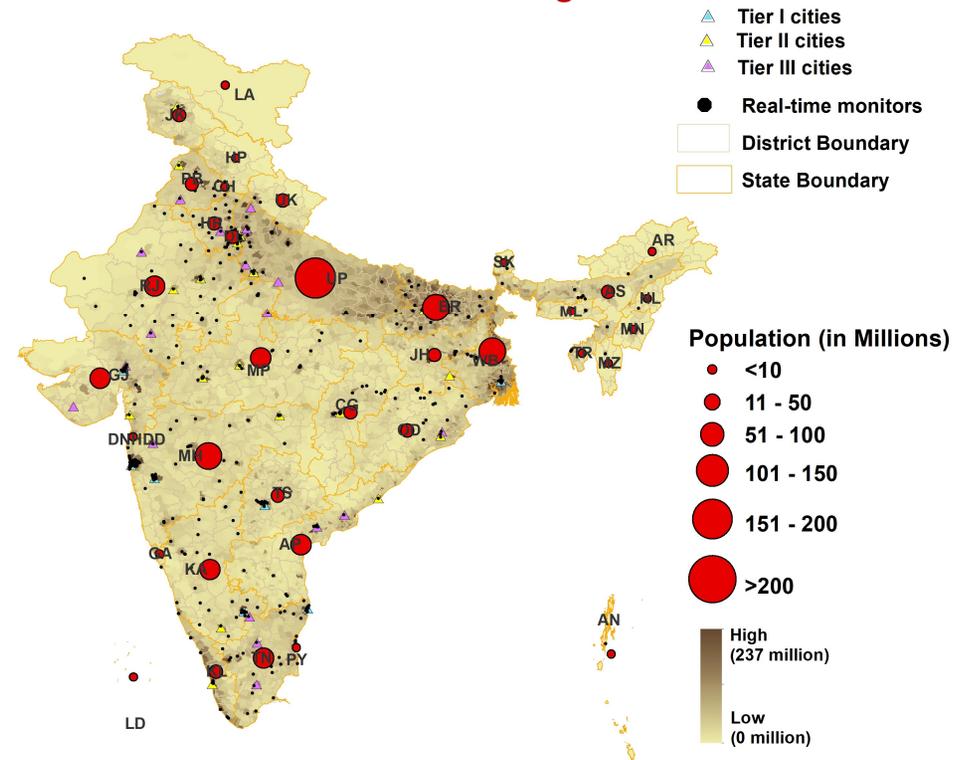
Source: CSE analysis



District-Level Gaps – A Critical Blind Spot

More than 64 percent of India's districts have no continuous monitoring at all.

- 261 high-population districts (>1 million residents) have no continuous monitoring.
- West Bengal districts like Hugli, South 24 Parganas and Murshidabad (6–8 million people each) have no real-time stations
- Uttar Pradesh and Gujarat concentrate monitors in urban cores, leaving many high-density districts uncovered.
- Tamil Nadu, Telangana, Odisha, Jharkhand, Maharashtra, West Bengal and Bihar show large monitoring gaps across peri-urban belts.
- Assam's limited network misses several densely populated towns.
- Jammu & Kashmir and Himachal Pradesh each operate only one station, leaving vast areas in data shadow.

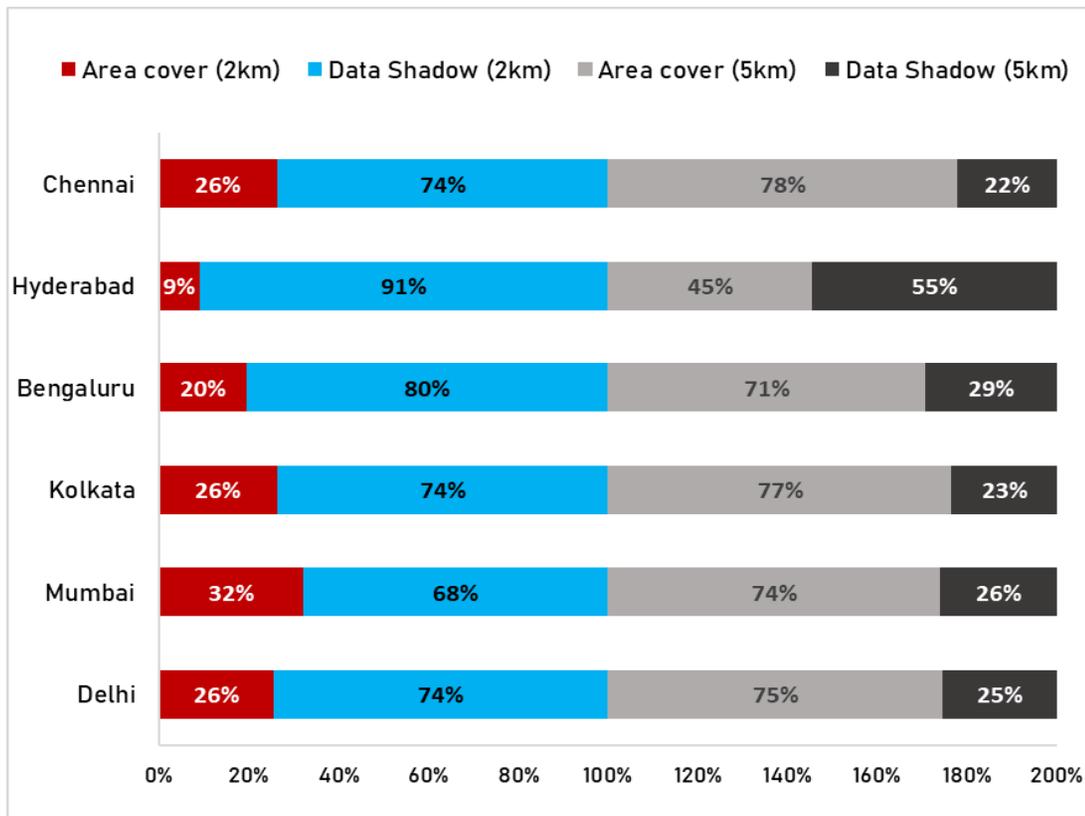


Note: A total of 742 districts, based on the 2022 district shapefile, (approximately 58 more districts added as of today)

Source: CSE analysis



Monitoring coverage and data shadows in India's six megacities



Uneven monitoring within urban core

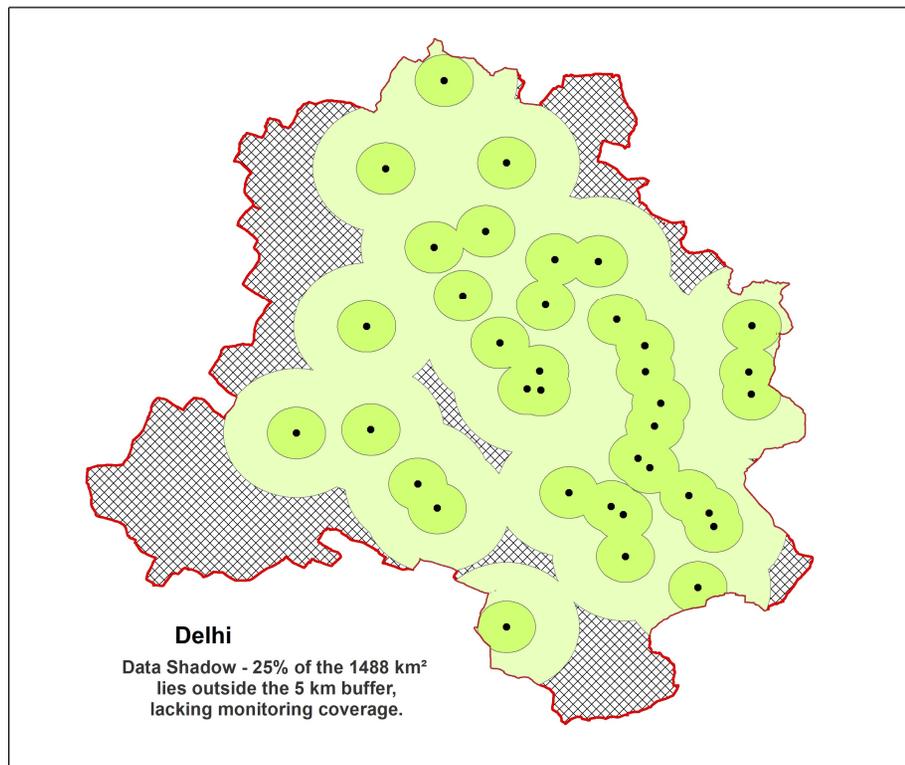
Even in India's six megacities, coverage remains uneven:

- At a 2 km scale, only 9–32% of city area is covered.
- At a 5 km scale, 22–55% of urban areas remain outside monitoring reach.

Monitoring stations are often **clustered in central zones, leaving peripheral and fast-growing regions in data shadow.**



Real time Monitor & 2km Buffer 5km Buffer Data Shadow



Case Study - Delhi

Delhi shows relatively dense monitoring coverage, yet gaps persist:

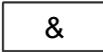
- 31% of population covered within 2 km.
- **Peripheral northwestern and southwestern regions remain under-monitored.**
- **Rapidly urbanizing zones lack proportional monitoring expansion.**
- **Stations must be distributed based on population exposure, emission intensity and representativeness rather than administrative convenience.**

Note: Monitoring locations are approximation based on information available from Central Pollution Control Board website and publications, it is not exact geographical co-ordinate of the stations as that information is not publicly available. Source: Centre for Science and Environment analysis



Case Study - Mumbai & Kolkata

Real time Monitor



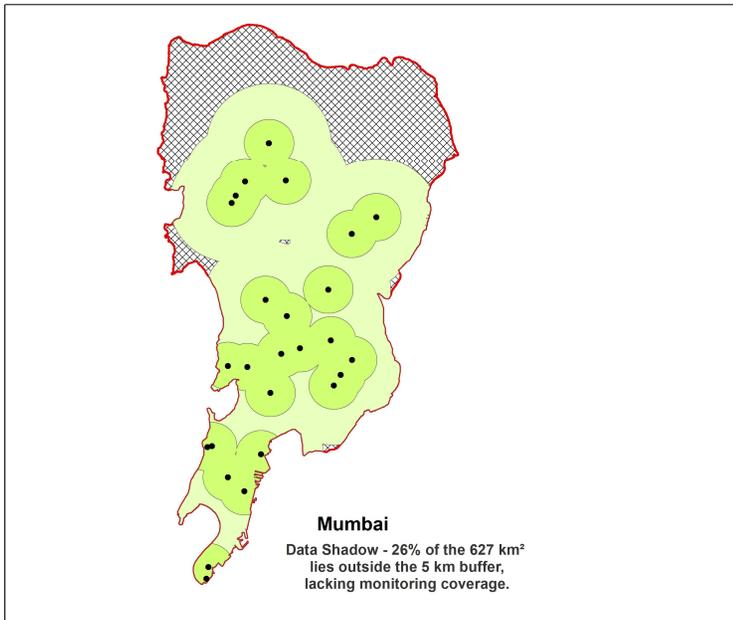
2km Buffer



5km Buffer

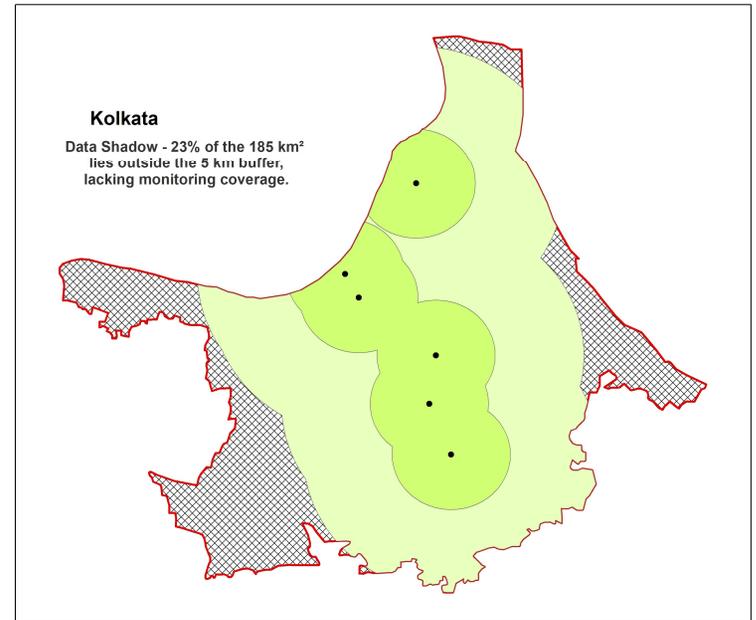


Data Shadow



Mumbai: Strongest 2 km coverage (32 per cent), but northern suburbs remain weak.

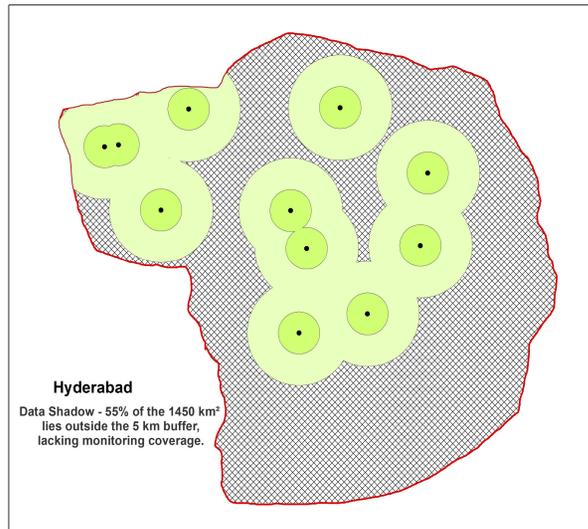
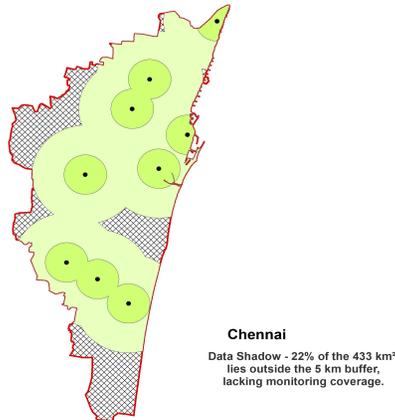
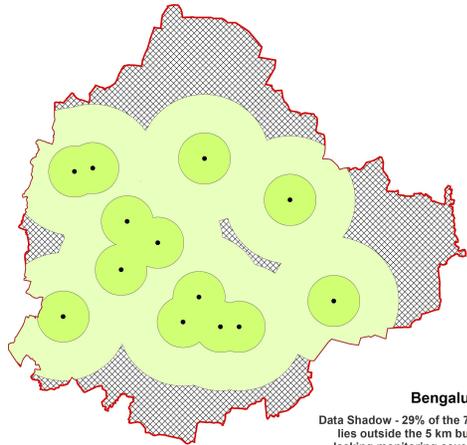
Kolkata: Wider 5 km coverage (77 per cent), yet gaps persist in eastern and western peripheries.



Note: Monitoring locations are approximation based on information available from Central Pollution Control Board website, it is not exact geographical co-ordinate of the stations as that information is not publicly available. Source: Centre for Science and Environment analysis



Case Study - Bengaluru, Hyderabad and Chennai



- **Bengaluru:** Records only 20 percent coverage at 2 km and 71 percent at 5 km, leaving northern, eastern, and southern outskirts in data shadow.
- **Chennai:** Covers 26 percent at 2 km and leads all cities at 5 km with 78 percent, yet southern and central fringes remain under-served.
- **Hyderabad:** Suffers the weakest reach overall, with just 9 percent coverage at 2 km and 45 percent at 5 km, highlighting widespread blind spots across both core and peripheral wards.

Note: Monitoring locations are approximation based on information available from Central Pollution Control Board website and publications, it is not exact geographical coordinate of the stations as that information is not publicly available.

Source: Centre for Science and Environment analysis



Why do Monitoring Gaps Persist??

- **Siting norms prioritize population thresholds over exposure risk**, leading to concentration of monitors in large cities rather than high-emission or high-exposure zones.
- **High capital and operational costs** constrain expansion in smaller cities and rural regions.
- **Operational and maintenance challenges** including equipment breakdowns, calibration gaps, and power/connectivity issues reduce long-term data continuity.
- **Fragmented institutional responsibilities** across agencies hinder coordinated planning, data integration, and accountability.
- **Limited technical capacity** at state and local levels affects installation quality, data validation, and interpretation.



Why Visibility matters?

Implications for Policy and Equity

- Under NCAP, funding allocation, performance assessment, and recognition are tied to measurable air quality improvements.
- Regions without monitors fall into a self-reinforcing cycle of invisibility, exclusion from funding, and delayed action.
- Uneven monitoring coverage represents not just a technical gap, but an environmental justice issue.
- Lack of visibility limits the ability to:
 - ✓ Quantify population exposure
 - ✓ Identify high-risk regions and hotspots
 - ✓ Prioritize interventions and track progress

While action can proceed without local data, since health impacts and solutions are well established - absence of data weakens accountability, prioritization, and equity in policy response.

If you are not measured, you do not matter in policy.



Building a Credible and Equitable Monitoring Framework

Strengthening India's monitoring system requires:

- **A uniform national protocol for data validation and reporting.**
- **Adoption of multi-year rolling averages** for compliance assessment.
- **Clear classification of regulatory, background and exposure monitors.**
- **Redesigning monitoring grids based on exposure risk and vulnerable populations.**



The Way Forward – Bridging the Data Shadow

- Adopt a **hybrid monitoring model** combining reference-grade monitors, low-cost sensors and satellite data.
- Use **satellite-based analysis** to fill spatial gaps.
- Learn from **global best practices in exposure-based network design**.
- **Encourage open data and citizen engagement**.



FACTSHEET

AIR QUALITY MONITORING: ADDRESSING DATA SHADOW REGIONS

Only 15 per cent of India's population lives within 10 km of a real-time monitor, leaving 120 crore people in data shadow. Over 64 per cent of districts lack monitoring networks, including 261 districts with populations of over a million. Even in megacities, 22-55 per cent of urban areas lack monitoring coverage.

India's air quality monitoring has grown rapidly, yet vast regions and millions remain in "data shadows" without reliable information on the air they breathe. This report reveals the scale of these blind spots and their risks to public health and governance. Bridging these gaps is essential not only for accountability under national programmes but also to protect vulnerable communities.

<https://www.cseindia.org/air-quality-monitoring-addressing-data-shadow-regions-12879>