

Commentary

# **Air Quality Management During the Rush to the Great Indoors**

Sarath Guttikunda  
and Roundtable Discussants at “Air Quality  
in Smaller Towns”, IISER Mohali, 2026-05

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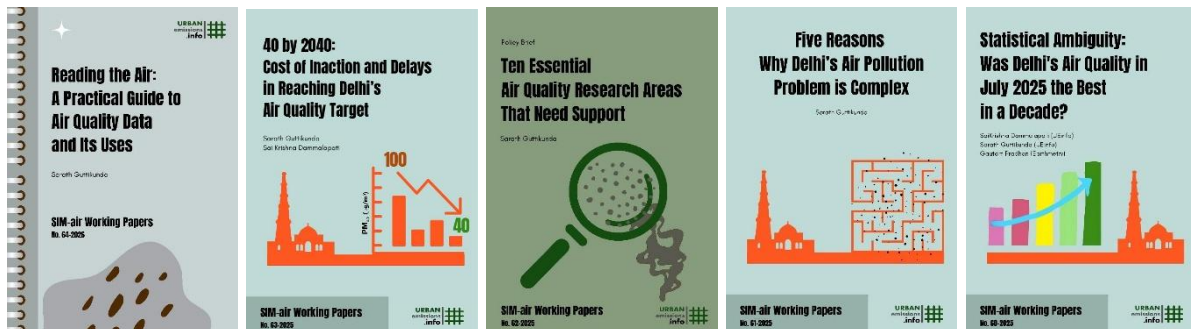
- Sharing knowledge on air pollution
- Providing science-based air quality analysis
- Promoting advocacy and raising awareness on air quality management
- Building partnerships among local, national, and international airheads

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Commentary

## Air Quality Management During the Rush to the Great Indoors



Discussants (left to right): Tarushi Mishra and Anu Sabhlok (IISER Mohali), Satyanan Sarkar (IIT Mandi), Khusdeep Kaur (Ahmedabad University), Awadhendra Sharan (CSDS), Vsundhara Bhojvaid (Shiv Nadar University), Priyanka Rihel (IISER Mohali), Syed Shoaib Ali (IIT Delhi), Priyarat and Chaynika Bhardwaj (MLSM College, Sunder Nagar), and Kanika Makhija (SP University, Mandi), Rama (ASAR), Annanya Mahajan (SFC), Rohit Negi (IIM Kolkata), Kevin Joshi (Respirer), Omish Sharma (Filmmaker), Aalok Khandekar (IIT Hyderabad), Piyush Bharadwaj (CSTEP), and Sarath Guttikunda (Urban Emissions)

This is a collective summary from the discussions carried out at the “Air Quality in Smaller Towns” roundtable gathering at IISER Mohali, co-organized by IIM-Kolkata, May 8-9, 2026.

Broad topics discussed are the following:

1. The Traditional Divide: Ambient vs. Household Air Pollution
2. Reclassifying the Environment: Urban vs. Domestic
3. The Intensity of Exposure
4. Beyond the City: The Airshed Perspective
5. The Rush to Sealed Environments
6. Gated Community Effect
7. Exposure Management vs. Emissions Management
8. Pollution Management vs. Emissions Management



## The Traditional Divide: Ambient vs. Household Air Pollution

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**The conventional framework for understanding air quality has long rested on a binary: what happens outside is ambient pollution, and what happens inside is household pollution.**

This categorization emerged not from a deliberate epidemiological design but from the practical realities of early monitoring infrastructure. Outdoor monitoring stations were built to characterize city-wide or regional air quality, and their readings were treated as representative of general population exposure. Indoor measurements were gathered in contexts where cooking fuels and heating practices were the dominant concern -- particularly in low-income settings where biomass burning was common.



The methodological origins of this divide have had lasting consequences for policy. Because the two streams of data were collected separately, analyzed by different research communities, and reported to different agencies, the conversation about air quality risk became fragmented. Ambient air quality fed into national environmental standards and regulatory frameworks, while household air pollution was largely addressed through development programs targeting cooking and fuel transitions.

This siloed thinking obscured the fact that the human lung experiences pollution regardless of whether the source is a diesel truck or a clay cookstove.

As monitoring technology improved and personal exposure studies became more feasible, researchers began to recognize that the ambient and household binary was an oversimplification. People do not live their lives entirely outdoors or entirely indoors and they move between environments, and their cumulative exposure reflects that movement. The push to integrate these two traditions into a unified exposure science has been slow (GBD), partly because the institutional structures built around each domain are deeply entrenched (and still divided), but it is now widely acknowledged that a human-centered view of pollution exposure is more policy-relevant.

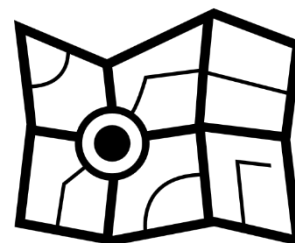


## Reclassifying the Environment: Urban vs. Domestic

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**As the field matured, the framing shifted from a methodological distinction to a spatial one.**

The urban environment became the unit of analysis for one stream of inquiry, encompassing traffic emissions, industrial activity, construction dust, and waste burning alongside weather patterns and urban morphology that govern how pollutants disperse and accumulate. The domestic environment, by contrast, was framed as a closed micro-system in which occupant behavior covering cooking frequency, fuel type, ventilation habits, was the primary lever of intervention.



This spatial reclassification brought new stakeholders. Urban air quality became the concern of city planners, transport authorities, and industrial regulators, with health on the side through epidemiological surveillance. The domestic environment attracted attention from energy ministries, gender-focused development organizations, and public health programs targeting respiratory disease in women and children and groups disproportionately exposed to cooking-related pollution. The result was a rich but diffuse body of knowledge, across the urban and domestic streams.

The practical implication is that interventions were also designed within these silos. Cities invested in emission norms for vehicles and factories; development programs promoted cleaner cookstoves and LPG access. Both sets of interventions are valuable, but neither alone addresses the full arc of a person's daily exposure. A woman who cooks on a clean stove but lives adjacent to a congested road, or a child who attends a school with filtered air but returns to a home filled with coal smoke, illustrates the limits of interventions conceived within a single environmental domain.

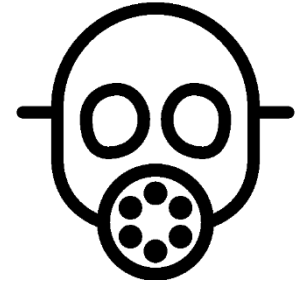


## The Intensity of Exposure

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**Urban areas in South Asia, Sub-Saharan Africa, and parts of Latin America routinely record PM<sub>2.5</sub> concentrations that are multiples of WHO guideline values -- not as occasional spikes but as persistent baselines across seasons and years.**

The health consequences of chronic exposure at these levels are documented, spanning cardiovascular disease, chronic obstructive pulmonary disease, lung cancer, adverse birth outcomes, and neurodevelopmental impacts in children.



The domestic environment compounds this burden rather than offering relief. A traditional solid fuel (biomass and coal) cookstove operating in a poorly ventilated kitchen can generate PM<sub>2.5</sub> concentrations that are orders of magnitude higher than even the most polluted urban street and the person cooking, typically a woman, may spend several hours a day in that microenvironment. The cumulative dose delivered to the respiratory system over a lifetime of cooking on such stoves is enormous. When this indoor exposure is layered onto high ambient outdoor pollution, the total health impact becomes particularly severe, and the distinction between the two sources becomes almost academic from a clinical standpoint.

A framework that treats urban and domestic pollution as separate problems, to be solved by separate agencies with separate budgets, risks leaving large gaps in protection.

Integrated exposure assessments that account for both environments throughout the day are essential for understanding true health risk, and such assessments consistently show that the most exposed individuals in LMICs face a toxic accumulation from multiple simultaneous sources.

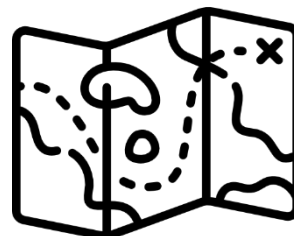


## Beyond the City: The Airshed Perspective

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**The airshed concept is not new, but an unadopted concept in most countries.**

Rather than treating a city or a village as a self-contained pollution system, the airshed perspective recognizes that air masses move continuously across administrative and geographical boundaries, carrying pollutants with them. A factory located outside a city boundary, agricultural burning in peri-urban zones, or dust lifted from degraded land in a district faraway can all contribute to air quality conditions experienced by urban residents and vice versa. Effective management therefore requires governance structures that match the scale of this physical phenomenon.



Empirical evidence increasingly supports the airshed view. Monitoring data shows that rural  $PM_{2.5}$  concentrations are often comparable to urban ones, even in the absence of dense traffic. The sources differ as biomass burning for cooking and heating, agricultural residue burning, and fugitive dust dominate the rural profile, but the resulting concentrations and health risks are similarly elevated. This challenges the assumption that rural populations are relatively protected from air pollution, an assumption that has historically led to under-investment in rural air quality monitoring and intervention.

Embracing the airshed framework also has implications for accountability and policy design. When pollution does not respect administrative boundaries, the question of who is responsible for managing it becomes complex. Regional airshed authorities, cross-boundary emission inventories, and coordinated source-apportionment studies are all tools that can support this broader view, but they require political will and institutional capacity that are often in short supply. The conceptual shift from urban and domestic environments to airshed management is therefore as much a governance challenge as a scientific one.



## The Rush to Sealed Environments

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**In recent years, a behavioral adaptation to deteriorating outdoor air quality has become visible among urban populations with the means to act on their awareness of pollution risk.**

This adaptation takes the form of a deliberate retreat into filtration-equipped, mechanically ventilated, and tightly sealed spaces. For example, homes fitted with HEPA air purifiers, offices and shopping environments with centralized filtration systems, vehicles (big and small) with controllable air filters. This trend accelerated significantly during and after the COVID-19 pandemic, which brought unprecedented public attention to the quality of the air people breathe indoors, and normalized both the monitoring of indoor air and investment in its management.



The epidemiological logic is straightforward: if outdoor PM<sub>2.5</sub> is high and indoor concentrations in a well-sealed, filtered environment are low, time spent indoors translates into reduced personal exposure. Time-activity studies have consistently shown that people in high-income countries spend upwards of 85–90% of their time indoors. The proliferation of low-cost personal air quality monitors has further enabled individuals to make real-time decisions about when and where to spend time, adding a new layer of behavior change to the exposure landscape.

Yet this voluntary enclosure is available only to a segment of the population. For the millions who work outdoors, the sealed environment is not an option -- construction laborers, street vendors, autorickshaw drivers, traffic enforcement officers, agricultural workers. These groups face the highest ambient exposures precisely because their livelihoods require sustained outdoor presence in the most polluted hotspots. The divergence between those who can retreat indoors and those who cannot is therefore not merely a matter of comfort or lifestyle preference; it is a structural determinant of health that maps closely onto existing inequalities of class, occupation, and income.

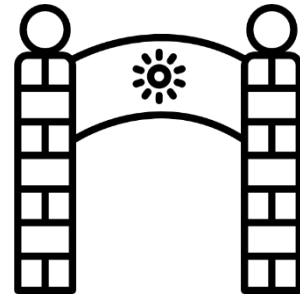


## Gated Community Effect

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**If the affluent segments of a city's population have effectively opted out of the shared air, their political voice in favor of ambitious emission standards may diminish.**

The cost of maintaining a clean indoor environment is non-trivial. A quality HEPA air purifier adequate for a single room cost between INR 5000 to INR 50,000 (market range), with ongoing filter replacement costs and energy consumption adding to the lifetime expense. At the household level, this investment is feasible for upper-middle and high-income families in polluted cities, but it places clean indoor air firmly out of reach for most other residents. Schools and public buildings in high-pollution cities could theoretically deploy filtration at scale, but budget constraints and competing priorities mean this rarely happens.



The affordability question intersects with a deeper behavioral and psychological dynamic. Research on risk perception and protective behavior suggests that the availability of a personal solution, such as an air purifier, a premium air-conditioned car, a filtered office, can paradoxically reduce pressure on individuals to advocate systemic emission reductions.

Understanding the actual distribution of time spent in different environments and the air quality conditions within each environment, is a data gap that remains largely unaddressed, as these studies are resource-intensive, but they are essential for producing accurate population-level exposure estimates. Without such data, policies calibrated to ambient outdoor concentrations alone will systematically misattribute risk and misallocate resources – overstating risk for those who are rarely exposed to outdoor air and understating it for those who have no alternative.

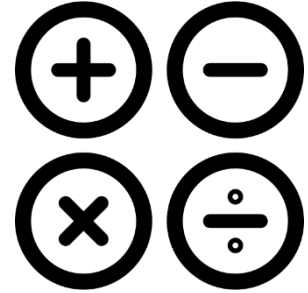


## Exposure Management vs. Emissions Management

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**The tension between exposure management and emissions management represents a new frontier in environmental inequality.**

Emissions management is reducing the quantity of pollutants released at the source through regulation of vehicles, industry, power generation, and agricultural practices, which operates on the premise that the air is a shared resource and that reducing pollution in it benefits everyone who breathes it. This approach is inherently collective and public: it requires regulatory authority, enforcement capacity, and often significant financial adjustment. Its benefits, when achieved, are distributed across the airshed regardless of income or social status.



Exposure management focuses on minimizing the dose received (intake fraction) by individuals regardless of ambient pollution levels. This can involve physical separation from pollution sources (moving homes, changing commute routes), protective equipment (masks, filtration devices), and behavioral adaptation (avoiding outdoor activity during high-pollution episodes).

Exposure management strategies have a legitimate role in bridging the gap, particularly for vulnerable groups such as pregnant women, children, and the elderly, but they are not substitutes for emissions management.

The risk of over-investing in exposure management at the expense of emissions management is that it normalizes poor ambient air quality as an acceptable baseline. Exposure management also shifts responsibility from polluters and regulators to individuals, and it disadvantages those who cannot afford personal protective measures.

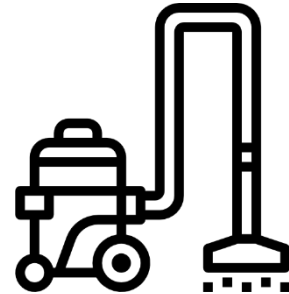


## Pollution Management vs. Emissions Management

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**Integrated air quality management centers on one fundamental objective: controlling emissions at their sources.**

When industries, vehicles, households, and agricultural practices reduce what they release into the atmosphere, pollutants have no opportunity to undergo chemical transformation, disperse across regions, or accumulate to harmful levels. Clean air is the outcome of clean sources -- not of interventions applied after pollution has already entered the atmosphere.



Once pollutants are in the air, they become part of a complex, dynamic atmospheric system that no surface-level intervention can meaningfully undo. Measures such as deploying air purifiers in open spaces, spraying water on roads to temporarily suppress dust, installing mist fountains to increase local humidity, or relocating the monitoring stations to cleaner backgrounds may offer fleeting and localized relief, but they do not reduce the underlying pollution load. More importantly, they risk creating the appearance of improvement where none exists, by manipulating the numbers rather than addressing the problem.

This distinction between pollution managed well and pollution data manipulated to show clean, matters enormously for public trust and policy accountability. Air quality data must reflect reality as it is, not as decision-makers might prefer it to appear. When band-aid solutions are presented as air quality management, they divert attention and resources from the structural changes in energy, transport, industry, and land use, that reduce emissions at these sources.

The goal is not to manage pollution, but to eliminate the conditions that produce it. That requires a sustained focus on emission reduction across all known source sectors, supported by honest monitoring, transparent data, and accountability for results.

Clean air follows from clean sources, and there is no shortcut to that outcome.



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