bharat CLIMATE FORUM

Council for International Economic Understanding | Dalberg

Aironomics 2025

Unlocking India's Blue Skies Economy

Date: May 31, 2025 | **Location:** ITC Maurya, New Delhi

AirGPT: Data & Technology at the Heart of Air Quality Management

Context and rationale

India's air quality management (AQM) landscape is undergoing a digital transformation, with advanced technologies increasingly integrated across the full lifecycle—from monitoring and citizen engagement to enforcement and solution deployment. Since the launch of the National Clean Air Programme (NCAP) in 2019, India has expanded its Continuous Ambient Air Quality Monitoring Stations (CAAQMS) network to over 400 stations across 221 cities[1], complemented by mobile monitors, satellite data, and low-cost IoT sensors. Public tools like the SAMEER app and SAFAR forecasts have enhanced citizen access to real-time air quality data and reporting mechanisms. Beyond monitoring, technology is also advancing enforcement and public safety: for instance, the Delhi government's Green War Room integrates camera feeds, air quality data, and on-ground patrols to identify and penalize violators. Meanwhile, innovations such as AI-driven smog towers, automated smog guns, and localized air purifiers are being piloted to actively abate pollution at hotspots. Startups like Ambee and Blue Sky Analytics are applying AI and satellite analytics to map pollution sources and model interventions.

Exhibit 1: Harnessing Tech, Data and AI Across AQM Pillars

- **Low-cost sensors and mobile monitors** enable dense, hyperlocal air quality tracking.
- **IoT-driven mobile systems** map real-time pollution patterns across cities.
- **Integrated data platforms** combine sensor, satellite, and reference data for holistic insights.

- **Real-time apps and alerts** empower citizens with actionable air quality information.
- **Crowdsourced reporting tools** strengthen community participation in compliance monitoring.
- **Citizen-owned sensor networks** democratize access to localized pollution data.

- **IoT-enabled sensors and AI-driven analytics** automate real-time pollution violation detection.
- **Remote sensing technologies** are enhancing large-scale enforcement and surveillance.

- **Sensor-triggered smog guns and localized air suckers** are enabling targeted reduction of airborne pollutants.
- **Building-mounted filtration systems** are emerging as scalable hyperlocal air cleaning solutions.
- **AI-optimized air purification towers** are advancing dynamic and automated pollution control strategies.

India's air quality monitoring landscape is being rapidly reshaped by low-cost sensors (LCS), mobile monitoring units, and AI-powered predictive and diagnostic tools. LCS devices, due to their affordability and compactness, enable dense deployment across urban and rural areas, capturing hyperlocal pollution data. Under the AMRIT project, 1,400 LCS nodes have been deployed across rural Bihar and Uttar Pradesh[2], addressing critical data gaps, with Bihar also equipping all 534 administrative blocks with LCS monitors. Mumbai is building India's densest LCS network with 90 stations. Mobile innovations are also expanding coverage— a few of Mumbai's public buses now carry sensors to capture dynamic pollution patterns, while

---

[1] Urban Lab - Centre for Science and Environment Analysis, Status of air quality monitoring in India: Spatial spread, population coverage and data completeness

[2] Open Gov, Tech Transforming Air Quality Monitoring in India

IIT Madras has developed IoT-based mobile systems for real-time, high-resolution mapping. Comprehensive data integration efforts are consolidating LCS, satellite, and reference station data into open platforms, creating a unified view of pollution dynamics and enabling evidence-based policymaking.
Building on these gains, significant opportunities lie ahead. Expanding dense LCS networks across Tier 2 and 3 cities, peri-urban belts, and industrial hubs can help bridge India's monitoring gaps—currently India meets only 6% of required PM10 monitors and 4% of PM2.5 monitors, with 47% of the population outside a 50-kilometre radius of any station[1]. Embedding mobile sensors in municipal fleets like waste trucks and postal vans can further enhance real-time coverage. Integrating LCS, satellite, and reference-grade monitoring data into open platforms can create a real-time air quality map, supporting hotspot detection. Platforms like OpenAQ and NCAP Tracker already show the impact of integrated monitoring. Globally, countries are advancing approaches India can adapt. South Korea and the United States have deployed dense hyperlocal sensor networks integrated with data fusion techniques like Bayesian inference and Kalman filtering to generate granular pollution maps by combining satellite, drone, and ground data.

Further, new technologies like mobile apps, crowdsourced sensors, and real-time alerts are opening up powerful opportunities to transform citizen engagement and public safety in India's air quality management system. India has taken important early steps: the SAMEER app, developed by CPCB, provides real-time air quality data and violation reporting, with over 1 million downloads to date. Platforms like SAFAR deliver 1–3 day air quality forecasts along with health advisories. In Delhi, the Green Delhi app has enabled citizens to file over 84,000 pollution complaints, achieving an 87% resolution rate through geotagged reporting and digital tracking systems[3].
Building on these initiatives, there is significant potential to deepen citizen-driven action. Expanding hyperlocal exposure alerts through wearables and mobile apps, integrating citizen-reported data into regulatory dashboards, and enabling two-way feedback systems can make public engagement faster, more actionable, and more trusted. Crowdsourced air quality monitoring networks—using low-cost personal sensors—can complement official networks, while automated public safety alerts linked to pollution thresholds can protect vulnerable populations. Real-time citizen engagement is being reimagined globally. London uses AI-driven exposure mapping to deliver personalized air quality alerts and route recommendations for walkers and cyclists. Singapore's "Smart Nation" initiative leverages IoT sensors and open dashboards to crowdsource citizen-reported data, helping authorities respond faster to pollution incidents

Technology is also creating a new enforcement frontier, with tools like IoT-based sensors, automated tracking systems, and AI-powered remote sensing enabling faster, smarter, and more consistent regulatory action. Pilot projects by the Central Pollution Control Board (CPCB) and several State Pollution Control Boards are using drones and satellite imagery to monitor emissions from industrial clusters and detect instances of waste burning and

[3] The New Indian Express, Government records over 84K pollution complaints via Green Delhi App this year

construction dust violations. Gujarat has also pioneered India's first particulate matter emissions trading program, launched in 2019, where industries are required to hold emission permits, with real-time compliance monitored through Continuous Emissions Monitoring Systems (CEMS).

There is significant scope to institutionalize digital enforcement mechanisms nationwide. China's "Blue Sky" program offers a compelling model—it deploys AI-enabled video analytics and satellite surveillance to detect industrial violations and automatically trigger penalties, minimizing human discretion and enforcement delays. India can build on its early pilots by scaling up IoT-based real-time monitoring across high-emission sectors such as construction, small-scale industry, and transport. AI can be harnessed to predict non-compliance hotspots from satellite and drone feeds, while emissions trading markets, linked to dynamic pollution data, can drive cost-effective industry-level action.

Lastly, technology driven pollution abatement is emerging in India, powered by sensor-triggered systems, AI-optimized filtration technologies, and hyperlocal air capture solutions. For instance, In Delhi, smog guns have been actively deployed at construction sites and pollution hotspots, with regulations since 2021 mandating one anti-smog gun for every 5,000 square meters at large construction sites[4]. Startups and research institutions are piloting building-mounted air suckers—compact systems embedded in high-rises that continuously filter ambient air—a concept now being tested in parts of Mumbai and Gurugram. Air purification towers equipped with AI-driven controls are also being explored to optimize performance based on real-time pollution data.

While still at a pilot or early commercialization stage, these solutions present a promising opportunity to scale localized, automated pollution control—especially in dense urban environments where traditional emissions strategies may fall short. Embedding air-sucking units into city infrastructure like flyovers, bus shelters, and metro stations could expand coverage without requiring additional land. AI-enabled optimization can ensure that abatement technologies respond dynamically to pollution peaks, improving cost-effectiveness and operational efficiency. Cities like Rotterdam and Los Angeles are also exploring nature-based and built-environment solutions—including urban vegetation barriers and photocatalytic pavements—to passively absorb pollutants.

This session will bring together leaders across technology, research, entrepreneurship and manufacturing to explore how India can further harness emerging technologies for transformative air quality management. The discussion will focus on highlighting the role of AI, geospatial tools, and digital platforms in enabling smarter air quality monitoring and compliance, showcasing innovations that enhance institutional capacity, and exploring pathways to scale tech-driven solutions across sectors and cities.

---

[4] The Indian Express, Use anti-smog guns at Delhi construction sites, says Commission for Air Quality Management

Potential Opportunities and Challenges

The opportunities that can be realized through the effective integration of data and technology in India's air quality management include:

- **Unlocking a ~$380 million domestic market for air quality monitoring and data solutions:** India's growing demand for granular air pollution data—driven by NCAP mandates, smart city programs, and ESG-linked reporting—can catalyze a domestic market estimated at $380 million by 2030 for sensors, data platforms, and analytics services[5]. This market potential includes localized monitoring networks, mobile monitoring vehicles, emissions monitoring in industrial clusters, and data solutions tailored for government, corporates, and citizens.
- **Enabling real-time regulatory action through digital enforcement infrastructure:** Scaling tools like IoT sensors and Continuous Emissions Monitoring Systems (CEMS) presents a significant opportunity to reduce regulatory lag and improve closure rates of environmental violations. Early adoption in states like Rajasthan—where NB-IoT sensors deployed in Jaipur have improved PM monitoring and triggered timely interventions—demonstrates the potential to institutionalize automated compliance mechanisms across urban centers.
- **Activating neighborhood-level clean air governance through hyperlocal sensor networks:** The deployment of ward-level air quality mapping, as seen in Hyderabad's 49 IoT PM monitors integrated into a mobile-accessible dashboard, showcases the potential for localized interventions in high-risk zones like schools, construction corridors, and transport hubs. Scaling such networks can empower local governments and communities with real-time insights to drive decentralized, targeted clean air actions.
- **Partnering with private players and platforms to integrate air quality information into everyday services:** Collaborations with major tech players like Google and Apple can embed real-time air quality data into widely used platforms such as Google Maps and search engines, enhancing public engagement, driving behaviour change, and increasing demand for localized, credible monitoring networks.
- **Positioning India as a testbed for AI-driven pollution abatement technologies in dense urban zones:** With over 63 Indian cities exceeding national PM2.5 standards by more than 200% , there is a compelling opportunity to pilot and validate localized air capture innovations—such as AI-optimized purification towers, sensor-triggered smog guns, and building-integrated air suckers—in high-density pollution hotspots.

Key challenges would have to be overcome to leverage these opportunities. Some of these challenges include:

- **High costs and limited financing options hinder the scale-up of emerging AQM technologies:** Solutions like AI-optimized purification towers and sensor-triggered smog guns are costly to pilot and deploy, yet dedicated funding instruments—such as

[5] Grand View Research, India air quality monitoring system market size & forecast

innovation grants or green procurement programs—remain scarce. The absence of standardized MRV (Monitoring, Reporting and Verification) frameworks further restricts access to results-based climate finance and hampers large-scale adoption.

- **Fragmented digital infrastructure weakens real-time enforcement:** Despite isolated pilots, there is no unified, nationwide digital backbone for pollution monitoring and compliance. Regulatory bodies often rely on manual or siloed systems, limiting their ability to act on real-time data or coordinate enforcement across agencies.
- **Limited sensor coverage and data quality hinder hyperlocal interventions:** Many cities, especially smaller non-attainment ones, lack dense, calibrated sensor networks. Where low-cost sensors exist, issues with maintenance, validation, and data reliability prevent them from being fully integrated into official planning and response.
- **Institutional capacity gaps stall sector-specific digital compliance:** SPCBs and ULBs often lack the technical capacity, skilled personnel, or IT systems needed to deploy, maintain, and act on digital compliance tools like CEMS, e-logbooks, or automated inspection systems—especially in high-emission sectors like construction or waste.
- **Citizen-facing tools remain underutilized due to poor design and low trust:** Citizen engagement platforms or grievance portals suffer from low uptake and limited two-way communication. Citizens often lack awareness, and without visible government responsiveness to complaints, trust in these tools remains weak.

Key Focus for Discussion

With a focus on identifying challenges and potential unlocks to achieve India's clean air goals, below are the key questions for the panel discussion:

- Where have data and technology made the biggest impact so far across India's air quality management—monitoring, citizen engagement, enforcement, and abatement—and where are the biggest gaps?
- Which emerging technologies—such as AI, geospatial mapping, IoT, and remote sensing—show the greatest potential to transform air quality management in India over the next decade?
- How can India move from fragmented pilots to building a cohesive, scalable digital ecosystem for air quality management?
- What institutional and regulatory reforms are needed to embed real-time digital enforcement and automated compliance monitoring across sectors like industry, transport, and construction?
- How can we design citizen-facing digital tools that not only inform but also activate community action and strengthen accountability in air quality management?
- What best practices and innovations—both domestic and global—can India adapt to enhance hyperlocal monitoring, predictive modeling, and real-time citizen safety advisories?
- How can India build robust, standardized digital Monitoring, Reporting, and Verification (MRV) systems to access results-based financing and climate-aligned investments?

- What role should India's startup, research, and manufacturing ecosystem play in scaling innovative clean air technologies—and how can we catalyze deeper collaboration between government, industry, and civil society?

Session Flow

Panel Discussion - AirGPT: Data & Technology at the Heart of Air Quality Management	
Featured Speech (5 minutes)	The session will open with a featured speech making the case for **data and digital technologies as transformative levers for air quality management**, and positioning India as a global testbed for AI-powered environmental innovation.
Opening Remarks (2 minutes)	• The emcee will provide a **growing role** of data, AI, and digital platforms in India's air quality transformation • The emcee will **invite the panellists** on stage and introduce them. • The emcee will then hand the session over to the **moderator**.
Moderator Opening Remarks (3 minutes)	The moderator will emphasize the need to explore how data, AI, and geospatial innovations can move from fragmented pilots to a cohesive, scalable digital ecosystem for clean air management in India.
Panel: Opening Question (5 minutes)	• Moderator asks each panellist an **introductory question** to address • Panellists give **brief opening statements** from their vantage point
Structured Panel Discussion (25 minutes)	• The moderator asks **pointed questions** to panellists • Each panellist may choose to **build upon or challenge** the view of the previous • Panellists are encouraged to share their **reflections on the featured speech**
Closing thoughts and optional audience Q&A (5 minutes)	• Each panellist concludes with a **closing thought and key takeaway(s)** • They emphasize a **critical call-to-action** for the audience • Time permitting, the panellists may **answer questions** received from the audience