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Regulating Urban Air Pollution: A Legal and Institutional Analysis of Air Quality Governance in Kanpur

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Abstract

Urban air pollution governance in India is a composite of constitutional rights, statutory standards, delegated regulation, and multi level institutional practice. This article offers an expository and analytical account of that composite as applied to Kanpur. It combines doctrinal analysis of key legal instruments, principally the Air (Prevention and Control of Pollution) Act 1981 and Environment (Protection) Act 1986, together with institutional analysis of the mandates and functional roles of the central and state pollution control boards, municipal government, state executive, and environmental adjudicatory bodies. It also synthesizes evidence on ambient air quality conditions, pollution sources, and public health impacts based on official monitoring reports and peer reviewed studies.

Empirically, the paper relies on the national manual monitoring results reported for 2019 for multiple locations within Kanpur, which reveal annual-average PM_{10} concentrations substantially above national standards at many sites. It discusses how these ambient conditions relate to source categories identified by scientific and policy literature (industry, transport, resuspended dust, biomass and waste burning, and secondary aerosol formation), and how they translate into measurable health effects documented in epidemiological work and environmental health assessments.

The article concludes that while the legal framework provides broad authority, standards setting, permitting, inspection, directions (including closure), and penal sanctions, implementation is undermined by capacity limitations, incomplete compliance data transparency, weak inter agency coordination, and insufficiently institutionalized public participation. It proposes a reform package: strengthening statutory anchoring for city airshed plans, expanding and standardizing monitoring and disclosure, integrating municipal service regulation into air governance, and aligning enforcement incentives with "polluter pays" and performance based public finance mechanisms.

Keywords: *Urban Air Pollution Governance, Air (Prevention and Control of Pollution) Act, 1981, Environment (Protection) Act, 1986, Ambient Air Quality Standards (NAAQS)*

Introduction

Kanpur is frequently characterized in policy and research as a high-pollution industrial city where particulate pollution is driven by a mix of industrial activity, transport, dust, and combustion sources. Its air-governance problem is therefore not only technical (emissions inventories, atmospheric chemistry, exposure pathways) but deeply institutional: even where the law grants extensive powers, the effectiveness of regulation depends on monitoring, coordination, enforcement capacity, and credible sanctions.

First, the regulatory state expanded informational instrumentation: the national AQI framework (public-facing index design), the rollout of continuous monitoring systems, and the broad strengthening of the National Air Quality Monitoring Programme (NAMP). Second, environmental adjudication increasingly pushed air governance toward structured planning and compliance reporting for "non-attainment cities," shifting emphasis from episodic enforcement to institutionalized accountability cycles.[1]

This paper addresses three research questions. (a) What do the governing statutes and constitutional doctrine require or permit in regulating urban air pollution? (b) How are governance roles distributed among central, state, and local institutions, and what enforcement instruments are available in principle? (c) Where do key implementation bottlenecks arise in Kanpur, and what reforms follow logically from those bottlenecks?

Methodology

The analysis uses a mixed doctrinal-institutional method typical of environmental governance scholarship. Doctrinally, it synthesizes: (i) statutory mandates and powers under the Air Act 1981 and Environment (Protection) Act 1986, including the boards' functions and "directions" powers; (ii) national ambient standards that define legal "non-attainment"; and (iii) constitutional and Supreme Court jurisprudence establishing environmental rights and governance principles such as "polluter pays" and precaution.[2]

Institutionally, it maps governance actors and decision channels using official descriptions of monitoring programs and oversight mechanisms (e.g., NAMP and continuous monitoring systems) and tribunal records relating to non-attainment oversight. The empirical slice of air quality relies on the published 2019 annual PM_{10} monitoring statistics for multiple Kanpur locations. This is not a comprehensive 2010-2020 trend reconstruction; rather, it is the best publicly extractable city-specific annual monitoring dataset among the sources accessed that remains within the constraint. Missing annual series data are treated as unavailable for the purposes of this paper and flagged as a transparency gap.

For health impacts, the method is evidence-triangulation: it combines peer-reviewed empirical studies with multi-partner environmental health assessment reports conducted with local institutions. The aim is not to compute a new burden-of-disease estimate for Kanpur but to

[1] Central Pollution Control Board, National Ambient Air Quality Status and Trends 2019 (NAMP/NAAQS reporting; station-wise PM_{10} annexure; monitoring network description), 2019.

[2] The Air (Prevention and Control of Pollution) Act, 1981 (functions of boards; statutory structure), Government of India, 1981.

identify what the best available pre-2021 evidence indicates about exposure-health linkages relevant to legal and regulatory design (standards, enforcement thresholds, and vulnerable groups).

Legal Framework

The foundational legal structure for regulating urban air pollution in India consists of constitutional doctrine, statutory mandates, delegated standards, and programmatic governance.

Constitutionalization of clean air: The Supreme Court has treated environmental quality as part of the right to life under Article 21. In Subhash Kumar v State of Bihar (1991), the Court explicitly linked pollution-free water and air to full enjoyment of life, enabling constitutional litigation to compel pollution control.[3]

Statutory mandates and coercive authority: The Air Act empowers the Central Board to improve air quality and prevent/control air pollution, and assigns parallel functions to State Boards, forming the statutory basis for standard-setting support, monitoring coordination, and enforcement through consents and restrictions. The Environment (Protection) Act supplements this with a broad "directions" power; the statute clarifies that directions include closure/prohibition/regulation of industries or processes and stoppage/regulation of electricity or water supply or other services.[4]

A key enforcement lever in air governance is the power to issue directions under the Air Act (commonly discussed as Section 31A), which courts have characterized as conferring "immense powers" on State Pollution Control Boards, including directions that can affect operations of polluting entities. [5]

Indexing, standards, and disclosure architecture: Public dissemination and comparability of air quality were advanced by national AQI initiatives. The national AQI framework was announced in 2014. Official monitoring documents explain that the National Air Quality Index (NAQI) was launched in 2015 and is computed from continuous monitoring data, enabling daily reporting for cities with real-time stations.

Programmatic governance: The National Clean Air Programme (NCAP) (2019) frames targeted reductions, city action plans, and monitoring augmentation as national policy for non-attainment cities, situating city-level measures within a national coordination and funding logic.[6]

Institutional mandates and enforcement powers

The following table summarizes mandates and principal enforcement instruments relevant to Kanpur air governance. It highlights a distinctive pattern: while pollution control boards possess strong legal "command" powers, municipal institutions control many urban services (roads, waste management, construction permissions) that determine emissions of dust and open burning; tribunals and courts increasingly provide compliance oversight but do not replace administrative enforcement.

Institution (Core Actor)	Primary Mandate (Air Governance)	Key Regulatory Tools and Instruments	Enforcement Levers	"Kanpur-Relevant" Implementation Notes and Constraints
Central Pollution Control Board (CPCB)	National coordination of air pollution control; guidance, monitoring, and dissemination of environmental	National Air Monitoring Programme (NAMP) coordination; guidance manuals; national reporting	Standard-setting support; coordination and oversight of state boards; ability to issue directions through delegated	National monitoring and reporting reveal persistent particulate matter exceedances in many Indian cities. NAMP structure demonstrates reliance

[3] Subhash Kumar v State of Bihar and Ors (1991) (Article 21 includes pollution-free air and water), Supreme Court of India.

[4] The Environment (Protection) Act, 1986 (Section 5 directions; closure/utility stoppage clarification), Government of India, 1986.

[5] Goa Foundation v Union of India (2014) (quotation/discussion of Air Act direction power, Section 31A), Supreme Court of India.

[6] National Clean Air Programme (NCAP), Government of India, 2019.

	information; technical support to the central government.	frameworks; coordination directions to State Pollution Control Boards (SPCBs); Air Quality Index (AQI) framework documentation.	mechanisms; support for national compliance reporting and monitoring systems.	on SPCBs/PCCs for monitoring and reporting, meaning that data quality and completeness depend significantly on state-level institutional capacity.
Uttar Pradesh Pollution Control Board (UPPCB)	State-level air pollution regulation and enforcement; implementation of national standards; monitoring, permitting, and compliance supervision.	Consent to Establish (CTE) and Consent to Operate (CTO); inspections; regulatory directions; prosecution support; coordination with district administration and municipal bodies.	Directions under the Air Act and Environment Protection Act including closure orders and utility stoppage; consent conditions; environmental compensation mechanisms influenced by tribunal jurisprudence.	Performance audit findings indicate governance and implementation constraints affecting regulatory capacity. These systemic gaps influence enforcement effectiveness in major urban centres of the state, including Kanpur.
Kanpur Municipal Corporation (KMC)	Urban governance functions influencing emission sources including waste management, road maintenance, and construction regulation.	Municipal bylaws; contracts for mechanized sweeping and water sprinkling; solid waste management systems; permitting and monitoring of construction and demolition activities.	Municipal service enforcement such as waste collection regulation, anti-burning enforcement, local inspections, and penalties under municipal statutes.	Persistent particulate pollution reflects a governance pattern where dust and open burning cannot be controlled by pollution control boards alone. Effective air governance therefore requires integrated enforcement between municipal authorities and environmental regulators.
Ministry of Environment, Forest and Climate Change (MoEFCC)	National environmental policy formulation and rule-making under the Environment Protection Act; coordination of national programmes including the National Clean Air	Notifications under EPA Rules; national policy frameworks; NCAP programme design; inter-ministerial coordination mechanisms.	Policy directives, scheme design, funding mechanisms, and oversight through national committees and monitoring frameworks.	The NCAP framework explicitly identifies city-level action plans and monitoring network expansion as the primary national pathway for improving urban air quality governance.

	Programme (NCAP).			
National Green Tribunal (NGT)	Specialized environmental adjudication; enforcement of environmental principles such as precautionary principle and polluter-pays doctrine.	Original applications; continuing mandamus-style monitoring of environmental compliance; directions to regulators and governments.	Orders requiring action plans, compliance reports, and environmental compensation; binding directions to pollution control boards and state agencies.	NGT proceedings concerning non-attainment cities have significantly pressured regulators to institutionalize monitoring systems and city-level action planning, thereby influencing governance structures even beyond individual disputes.
Supreme Court of India	Constitutional enforcement of environmental rights, particularly through Article 21 jurisprudence; development of environmental governance doctrines.	Public Interest Litigation (PIL) jurisprudence; directions to executive agencies; continuing judicial oversight in pollution matters.	Binding constitutional judgments; continuing mandamus; institutional reform directions to administrative authorities.	Supreme Court jurisprudence has embedded the right to clean air within Article 21 and has driven major urban pollution interventions through continuing litigation, particularly in the **M.C. Mehta** environmental cases.
Allahabad High Court	State-level constitutional oversight of administrative compliance and environmental governance within Uttar Pradesh.	Writ jurisdiction under Articles 226 and 227 of the Constitution.	Judicial directions to state and municipal authorities; contempt jurisdiction for non-compliance.	Detailed documentation of city-specific Kanpur judicial orders is limited in the available sources; therefore, analysis primarily relies on national-level jurisprudence and tribunal oversight when discussing governance implications.

Analysis

Ambient air quality conditions: what can be evidenced. City-specific annual AQI trends for the full 2010-2020 period are not reconstructable from the accessible official compilations used here, because archived annual city AQI series (or year-by-year pollutant averages for 2010-2018 and 2020 at city level) are not present within the extracted pre-2021 sources. This is itself governance-relevant: without publicly accessible annual series, the effectiveness of legal interventions and spending under city action plans becomes difficult to evaluate ex post. [1]

What can be evidenced transparently is that 2019 PM_{10} levels in Kanpur remained far above the annual standard at many monitoring locations. In the NAMP 2019 station list for the city, several locations show annual-average PM_{10} near ~188-228 $\mu g/m^3$,

with one location reported at ~273 µg/m³; even the lowest reported values in the extracted subset (~117-124 µg/m³) are nearly double the national annual standard.

These concentrations indicate that, as of 2019, Kanpur remained a severe particulate non-attainment context under the NAAQS framework. In legal terms, this means that ambient "compliance" is not achievable through isolated control of one sector; it requires cross-sector reforms that reduce both direct particulate emissions (especially dust and combustion) and precursor emissions that form secondary aerosols.

Pollution sources: what the pre-2021 evidence implies. Health- and chemistry-focused studies of Kanpur emphasize multi-source exposure. A GIS-based emissions and health study using 2006 data identifies industries, domestic fuel burning, and vehicles as major emissions sources correlated with respiratory hospital visits. A city-scale environmental health assessment similarly reports strong associations between respiratory disease metrics and outdoor air pollution indicators, and flags measurement-method issues that can affect the reported magnitude of particulate concentrations, important for both compliance determinations and legal proof in enforcement proceedings.

For a quantified "source contribution" snapshot (needed for prioritizing enforcement), the pre-2021 sources accessed do not include the complete official six-city CPCB source apportionment tables for Kanpur (the national summary is referenced in multiple places but was not retrievable in full within this tool session). A peer-reviewed modeling/receptor-analysis summary for North Indian cities including Kanpur reports a $PM_{2.5}$ source split approximately as follows: secondary aerosols (~21.3%), soil dust (~20.5%), vehicle emissions (~19.7%), biomass burning (~14.3%), fossil fuel combustion (~13.7%), industrial emissions (~6.2%), and sea salt (~4.3%). [7]

These relative contributions have direct governance implications: they distribute responsibility across industrial permitting and stack enforcement, transport regulation and traffic management, municipal dust control, prohibition/enforcement against waste burning, and, critically, strategies for secondary aerosol reduction (precursor control) that cannot be fully implemented at city scale without broader airshed coordination.

Public health impacts: legally salient pathways. Empirical health research in Kanpur has documented measurable respiratory harms associated with particulate exposure. A multi-area study (three areas within the city) examined associations between particulate pollution and respiratory health outcomes. A later study using hospital visit data and an emissions inventory found strong associations between residence-area emission strength and pulmonary hospital visits, underscoring how local hotspots translate into health burdens, supporting an enforcement theory grounded in localized risk rather than citywide averages alone.[8] The environmental-health assessment report (India-Norway collaboration) further highlights that measurement and monitoring methods materially affect reported PM_{10} levels; legally, this matters because enforcement and liability (including "polluter pays" compensation) depend on credible and standardized monitoring evidence.

Monitoring infrastructure and compliance visibility. Official monitoring architecture combines manual monitoring (NAMP) and continuous monitoring (CAAQMS). The 2019 national report explains that NAMP operates through collaboration among CPCB, state boards/committees, and research institutions, with data transmission to CPCB for compilation; it also reports growth to 804 monitoring stations covering 344 cities/towns by 31 December 2019. It also explains that real-time data from continuous stations is used to compute daily NAQI values and disseminate information to the public.

At the city scale, the NAMP annexure for PM_{10} provides not only annual averages but also monitoring statistics (minimum/maximum 24-hourly values and sampling coverage), which can

[7] Summary of a PMF-based source apportionment study including Kanpur (indicative $PM_{2.5}$ source contributions: secondary aerosols, soil dust, vehicles, biomass burning, fossil fuel combustion, industry, sea salt), pre 2021 publication cited via public abstract snippet.

[8] Liu H Y et al., "Respiratory Disease in Relation to Outdoor Air Pollution in Kanpur, India" (empirical association using emissions inventory and hospital visits), Archives of Environmental & Occupational Health (2013).

be used to assess data adequacy and potential evidentiary robustness for enforcement. In Kanpur, several locations show very high maximum 24-hourly PM_{10} readings (hundreds of $\mu g/m^3$), indicating episodic extreme exposure in addition to chronic non-attainment.

Enforcement mechanisms and the "law-in-action" gap. Formally, regulators possess strong coercive powers. Under the Environment (Protection) Act, "directions" may include closure/prohibition/regulation of industries and stopping utilities, creating a legal basis for rapid enforcement where violations are persistent or grave. Doctrine around the Air Act's direction power (frequently invoked as Section 31A) similarly supports operational directions against polluting units; Supreme Court decisions have reproduced and applied this direction provision in environmental governance contexts.

However, enforcement effectiveness depends on institutional capacity and administrative routines. A performance audit of Uttar Pradesh Pollution Control Board identifies systemic weaknesses in pollution control administration in the state, an important structural explanation for persistent non-attainment in major cities even when national standards and legal powers exist.

A concrete enforcement illustration in the Kanpur context is the issuance of specific directions by regulators to local industrial units. A 2018 direction document (linked to CPCB enforcement practice) shows use of statutory powers to compel compliance actions in a named Kanpur unit, representing the "case-by-case" enforcement mode that complements broader planning instruments like city action plans. [9]

Judicial and tribunal shaping of governance. Supreme Court jurisprudence supplies constitutional grounding and governance doctrine. In Subhash Kumar, the Court linked pollution-free air to Article 21. In Vellore Citizens Welfare Forum, the Court elaborated the "polluter pays" principle as including restoration/remediation costs and embedded it within sustainable development, establishing a doctrinal basis later used in tribunal environmental compensation approaches. In the long-running M.C. Mehta line of cases concerning urban air pollution, the Court emphasized the duty of the state to protect public health and the environment, and recognized that enforcement failures can persist despite "adequate laws", a crucial observation for institutional reform analysis.

At the tribunal level, the National Green Tribunal has driven structured oversight of non-attainment city planning and accountability. A CPCB report filed in NGT proceedings on non-attainment city governance reflects the tribunal-linked model of regulatory reporting, manpower/monitoring adequacy review, and compliance standardization across states.[10] This governance mode is especially relevant to industrial cities like Kanpur because it formalizes expectations for city action plans, monitoring augmentation, and periodic compliance reporting, though it does not by itself solve municipal service and sectoral fragmentation.

Comparative insights from Delhi as a governance contrast. Delhi is not a perfect comparator, its scale, political salience, and NCR regional governance mechanisms differ, but it is instructive because Supreme Court oversight in the M.C. Mehta vehicular pollution line produced concrete regulatory shifts such as adoption of CNG to reduce diesel-based emissions.[11] The comparative lesson is institutional: sustained judicial attention, coupled with measurable interventions and compliance deadlines, can overcome administrative inertia, but the very need for continuing mandamus also illustrates why executive enforcement capacity and inter-agency integration are indispensable for long-run air quality improvement.

Recommendations

This section proposes reforms designed to strengthen legality, accountability, and effectiveness in Kanpur air governance. The proposals are grouped by statutory design, institutional

[9] CPCB direction document (Kanpur industrial unit compliance direction), 9 Jan 2018.
[10] Central Pollution Control Board, Report filed in NGT proceeding concerning non attainment cities (OA No. 681/2018 reporting and monitoring adequacy discussion), 2019.
[11] Supreme Court of India, vehicular pollution/CNG transition discussion in the M.C. Mehta line (Bhure Lal Committee/CNG), judgment document dated 28 Jul 1998.

architecture, enforcement practice, community participation, and monitoring technology.

Statutory and regulatory strengthening. NCAP-style commitments should be made more legally "justiciable" at the city scale by requiring (i) explicit targets tied to NAAQS attainment timelines; (ii) legally defined responsibilities across municipal and sector departments; and (iii) standardized public reporting obligations (monitoring coverage, spending, enforcement actions, and outcomes). The rationale is that the underlying statutory framework already provides coercive levers; the missing link is enforceable planning and disclosure duties that allow regulators, tribunals, and the public to verify performance.

Institutional integration and accountability. The biggest "structural" reform need is integration between pollution control boards and urban local bodies. Dust control, waste burning prevention, construction management, and traffic congestion are not fully controllable through industrial permitting alone. A city-level "airshed cell" (anchored in state government and linked operationally to the municipal corporation and the state pollution board) should be institutionalized with clear authority to coordinate: (i) road-dust suppression and street mechanization; (ii) construction-and-demolition waste controls; (iii) zero-tolerance enforcement against open waste burning; and (iv) hotspot traffic planning. NCAP already conceptualizes multi-sector city action planning; the reform is to harden coordination as a permanent institutional feature rather than a project.

Enforcement modernization: from episodic to risk-based. Regulators should adopt risk-based enforcement strategies that prioritize locations where monitoring indicates both chronic exceedances and extreme peak events. The NAMP station-level statistics (min/max and annual averages) allow creation of legally defensible hotspot lists for targeted inspection and direction orders. Direction powers under the Environment (Protection) Act (closure/utility stoppage) and Air Act direction authority should be applied in a graduated enforcement ladder: warning → time-bound compliance → environmental compensation → closure/utility regulation for persistent defaulters. This embeds "polluter pays" logic into routine enforcement rather than only post-litigation remediation.[12]

Monitoring and data reforms. Monitoring is not only informational, it is evidentiary infrastructure for law. Priority reforms include: (i) publishing city-level annual AQI and pollutant trend series in machine-readable form; (ii) standardizing monitoring adequacy thresholds and explicitly labeling "inadequate data" locations; (iii) expanding continuous monitoring coverage in industrial and traffic hotspots; and (iv) auditing monitoring equipment and methods for bias and inter-instrument comparability, reflecting prior findings that method differences can produce significant PM measurement differences.[13]

Community participation and legal empowerment. Citizen participation can be made operational through structured local disclosure, grievance channels linked to enforcement actions, and community monitoring partnerships. The legal premise that pollution-free air is part of Article 21 supports public interest litigation and administrative grievance models; however, community participation is most effective when it produces enforceable information (location-specific violations, photographic evidence of burning/dust, and reporting on corrective action) that pollution boards and municipal bodies are obliged to respond to within defined timeframes.

Capacity augmentation of regulators. Finally, state audit findings about institutional gaps should translate into concrete resourcing reforms: staff expansion, laboratory strengthening, training in real-time data analytics and legal drafting of direction orders, and dedicated litigation/compliance units to follow through tribunal and court orders. Without these investments, the gap between formal powers and realized outcomes will persist.

Conclusion

This paper has shown that air pollution governance in Kanpur is legally well-armed but institutionally constrained. The monitoring evidence available for

[12] Vellore Citizens Welfare Forum v Union of India (polluter pays and sustainable development; remediation), Supreme Court of India, 1996.

[13] Norwegian Institute for Air Research et al., Environmental Health Assessment: Respiratory Disease in Relation to Air Pollution in Kanpur, Uttar Pradesh (NILU OR 57/2009), 2009.

2019 indicates severe particulate non-attainment at multiple city locations. Scientific and health evidence links these exposures to meaningful respiratory harms and shows that emissions sources are distributed across transport, industry, dust, and combustion categories, requiring multi-agency integration. Air governance in this city therefore depends less on discovering "new powers" and more on converting existing powers into consistent enforcement, coordinated municipal service regulation, monitoring transparency, and institutional accountability.

The most significant limitations encountered are data limitations: the inability to reconstruct full 2010-2020 city AQI trends and systematic city-level enforcement statistics within accessible pre-2021 compilations. Those limitations are not merely research obstacles; they are governance deficits. Reforms that institutionalize disclosure, standardize monitoring adequacy, and enforce time-bound responsibilities across agencies are therefore central to both legality and effectiveness.

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