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Title**:**

From 'Good' to Unjust: Reframing the Air Quality Index through Environmental and Climate Justice

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ABSTRACT

The regulation of air quality is heavily presented to be a success story to the environmental fronts, but this paper contends that even at this point, inequalities are rather severe and enduring. It shows how averages-based compliance measures, unequal geographies of monitoring, and any officially neutral Air Quality Indices (AQIs) are all systematically used to mask disproportionate sufferings by marginalized populations through an environmental justice and substantial equality framework. By comparing India, the United States, and the European Union, the paper demonstrates that design and monitoring density of AQI are not technical decisions but normative and legal decisions on who will be counted in terms of exposure. It also discusses the new role played by machine learning, litigation, and courts in redefining AQI governance to a distributional justice and substantive right to clean air.

INTRODUCTION

The Paradox of Air Quality Progress

Who actually breathes the benefits from Clean Air? Air quality regulation is often presented as a technical success story. In several countries, including Britain and parts of the Global North, average pollution levels have declined[1], and regulatory compliance has improved.

These trends are widely celebrated as evidence that environmental law and policy are effective[2]. Yet beneath this apparent progress lies a structural paradox: air quality governance, while formally neutral, systematically obscures inequality[3]. Environmental improvement has not been shared evenly[4]; instead, it has increasingly coexisted with and in some cases intensified environmental injustice.

This paradox reflects the dominance of the doctrine of formal equality in air quality regulation. Under this approach, fairness is equated with identical treatment through uniform pollution

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[1] Department for Environment, Food & Rural Affairs (UK), 'Air Quality Statistics' https://www.gov.uk/government/statistics/air-quality-statistics accessed 6 January 2026.

[2] Organisation for Economic Co-operation and Development (OECD), 'Environmental Policy Stringency Index' https://www.oecd.org/environment/indicators-modelling-outlooks/policy-instruments/ accessed 6 January 2026.

[3] European Environment Agency, *Unequal Exposure and Unequal Impacts: Social Vulnerability to Air Pollution* (EEA Report No 22/2018) https://www.eea.europa.eu/publications/unequal-exposure-and-unequal-impacts accessed 6 January 2026.

[4] United Nations Environment Programme, *Environmental Inequalities and Air Pollution* (UNEP 2019) https://www.unep.org/resources/report/environmental-inequalities-air-pollution accessed 6 January 2026.

thresholds, standardized Air Quality Indices (AQIs), and aggregate compliance benchmarks[5]. Such regulatory neutrality assumes that pollution poses equal risks to all populations.[6]

However, extensive evidence shows that social vulnerability, shaped by income, race, housing conditions, baseline health, and access to healthcare, fundamentally alters the harm caused by the same level of pollution[7]. When unequal communities are treated the same, formally equal regulation can produce substantively unequal outcomes.

The environmental justice paradigm and the substantive equality principles criticize this assumption. Substantive equality entails consideration of practical disadvantage and disproportion in the case, rather than application of facially neutral principles.

From this perspective, air quality regulation grounded in formal equality risks legitimizing unequal exposure and health burdens by defining regulatory success through averages rather than lived experience.

Air quality inequality can be maintained as a result of the synergy of three governance decisions: the measure of air quality, the location to measure it, and the definition of regulatory effectiveness in statute.

These factors, combined, favour aggregate results rather than distributional ones, and enable pollution costs to be agglomerated in marginalised populations when overall measures are increasing. To comprehend air quality inequality, then, it is necessary to go beyond headline compliance numbers to consider the AQI design, monitoring distribution, and legal standards in the framework of substantive equality and environmental justice.

[5] Sandra Fredman, 'Substantive Equality Revisited' (2016) 14(3) *International Journal of Constitutional Law* 712.

[6] World Health Organization, 'Air Pollution and Health' https://www.who.int/health-topics/air-pollution accessed 6 January 2026

[7] Agency for Toxic Substances and Disease Registry (CDC), *Environmental Justice Index* https://www.atsdr.cdc.gov/placeandhealth/eji/index.html accessed 6 January 2026.

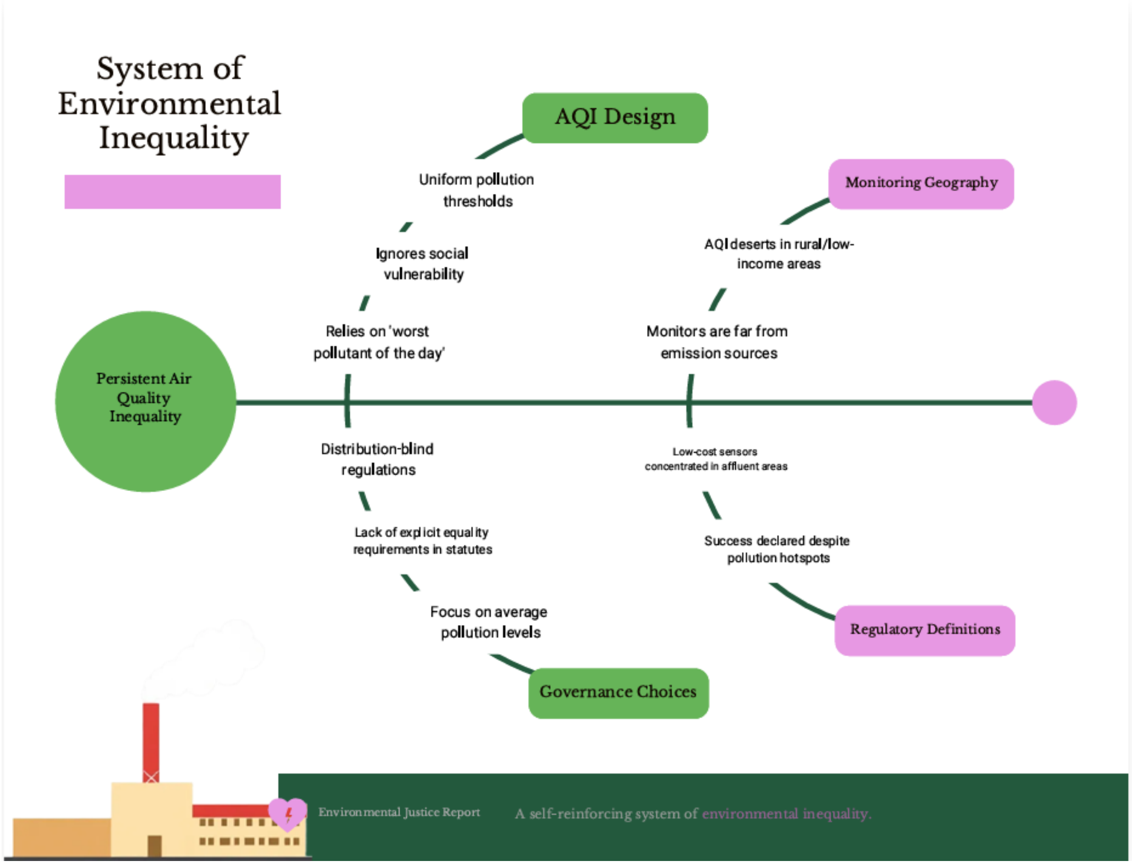

Figure 1: This diagram shows that air quality inequality doesn't happen by chance; it is created by the way air pollution is measured, monitored, and regulated. By ignoring social vulnerability, placing monitors unevenly, and focusing on averages, the system overlooks communities that suffer the most. As a result, pollution hotspots persist, and inequality keeps repeating itself even when policies claim success.

AQI Design and the Illusion of Equal Risk

At the heart of air quality governance lies the design of standard Air Quality Indices (AQIs). Traditional AQIs are built on the assumption that pollution poses equal risks to all populations. They rely on simplified metrics such as the *worst pollutant of the day*.[8] and uniform concentration thresholds, treating air pollution as a homogeneous hazard. This approach ignores substantial scientific and social evidence demonstrating that pollution does not affect all people equally[9]. The

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[8] United States Environmental Protection Agency, *Technical Assistance Document for the Reporting of Daily Air Quality* (EPA 2018) https://www.epa.gov/air-quality-index/technical-assistance-document-reporting-daily-air-quality accessed 6 January 2026.

[9] Richard Fuller and others, 'Pollution and Health: A Progress Update' (2022) *The Lancet* https://www.thelancet.com/commissions/pollution-and-health accessed 6 January 2026.

harm of the same level of pollution is modified significantly by the impact of social vulnerability, which depends upon income, race, housing quality, pre-existing health conditions, occupational exposure, and access to healthcare. As an example, what might be termed as moderate exposure in accordance with the conventional standards of AQI may lead to exceeding health effects in a community that is already at a disadvantage due to poverty or chronic disease.[10] As a result, AQI design does more than describe air quality; it actively determines whose exposure is deemed dangerous and whose is normalized as acceptable[11]. Studies using cumulative hazard indices show that AQI outcomes are highly sensitive to methodological choices. Composite indices that integrate multiple pollutants and benchmark them against health-based guidelines consistently reveal much larger disparities than indices based on regulatory limits[12]. When vulnerability is accounted for, Indigenous, immigrant, low-income, and racially marginalized communities emerge as disproportionately burdened.

This evidence makes clear that injustice is not an accidental discovery; it is an outcome of how air quality indicators are constructed.

Monitoring Geography and the Production of AQI Deserts

The invisibility created by AQI design is reinforced by the geography of air quality monitoring. Large segments of the population live in what may be described as AQI deserts[13], areas without sufficient regulatory or non-regulatory monitors to generate reliable, localized AQI data. Rural regions, low-income neighborhoods, and communities of colour are far more likely to lack monitoring infrastructure, even when they are located near polluting facilities.[14]

Within cities, this inequity takes the form of double marginalization. Marginalized communities often reside closer to emission sources such as highways, industrial zones, and freight corridors,

[10] World Health Organization, *WHO Global Air Quality Guidelines* (WHO 2021) https://www.who.int/publications/i/item/9789240034228 accessed 6 January 2026.
[11] Sheila Jasanoff, 'Technologies of Humility: Citizen Participation in Governing Science' (2003) 41(3) *Minerva* 223.
[12] Rachel Morello-Frosch and others, 'Understanding the Cumulative Impacts of Inequalities in Environmental Health' (2011) 119 *Environmental Health Perspectives* 131.
[13] World Bank, 'Air Pollution: Monitoring and Management' https://www.worldbank.org/en/topic/environment/brief/air-pollution accessed 6 January 2026.
[14] United States Environmental Protection Agency, 'Environmental Justice and Proximity to Pollution' https://www.epa.gov/environmentaljustice accessed 6 January 2026.

yet farther from monitoring sites[15]. In contrast, wealthier and predominantly white neighborhoods tend to enjoy both cleaner air and denser monitoring coverage[16].

The absence of monitoring data compounds the weaknesses of AQI design. Where data is missing, cumulative exposure cannot be measured, inequity cannot be documented, and regulatory intervention becomes less likely. Crucially, the rise of low-cost sensor networks has not automatically corrected these gaps. Studies show that such sensors are disproportionately concentrated in affluent neighborhoods, reproducing old disparities under the language of *smart* or *participatory technology*[17].

AQI deserts, therefore, are not merely technical oversights. They represent a form of informational injustice[18] that denies already overburdened communities the knowledge needed to protect their health, participate meaningfully in environmental decision-making, and hold regulators accountable.

Regulatory Success, Averages, and Distributional Blindness

Failures in AQI design and monitoring directly shape how regulatory success is defined. Traditional air quality law focuses on whether average pollution levels fall within statutory limits. Once compliance is achieved at an aggregate level, regulators often declare success even when pollution remains heavily concentrated in specific neighborhoods.[19]

The British experience illustrates this clearly[20]. While national air quality improved, the greatest benefits accrued to the least deprived areas, while the most deprived communities bore an increasing share of non-compliant air and related health burdens[21]. Globally, similar trends are visible in $PM_{2.5}$, data: average concentrations decline, yet inequality in exposure rises.[22]

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[15] United States Environmental Protection Agency, 'Environmental Justice and Proximity to Pollution' https://www.epa.gov/environmentaljustice accessed 6 January 2026.

[16]ulian Marshall and others, 'Inequities in the Distribution of Air Pollution Monitoring' (2021) *Nature Sustainability* https://www.nature.com/articles/s41893-021-00714-7 accessed 6 January 2026.

[17] United States Environmental Protection Agency, *Air Sensor Guidebook* (EPA 2023) https://www.epa.gov/air-research/air-sensor-guidebook accessed 6 January 2026.

[18] UN Special Rapporteur on Human Rights and the Environment, 'The Right to a Clean, Healthy and Sustainable Environment' (UN Doc A/HRC/43/53, 2020).

[19] Organisation for Economic Co-operation and Development (OECD), *Environmental Inequality* (OECD 2018) https://www.oecd.org/environment/tools-evaluation/environmental-inequality.htm accessed 6 January 2026.

[20] Office for National Statistics (UK), 'Air Quality and Deprivation' https://www.ons.gov.uk/economy/environmentalaccounts/articles/airqualityanddeprivation accessed 6 January 2026.

[21] Office for National Statistics (UK), 'Air Quality and Deprivation' https://www.ons.gov.uk/economy/environmentalaccounts/articles/airqualityanddeprivation accessed 6 January 2026.

[22] Global Burden of Disease Collaborative Network, *Global Burden of Disease Results Tool* https://www.healthdata.org/gbd accessed 6 January 2026.

This raises a fundamental legal and ethical question: can environmental regulation that is blind to distributional outcomes be considered lawful or just? Equality and anti-discrimination principles prohibit not only explicit discrimination but also policies that produce unjustified disproportionate impacts. When air quality strategies consistently benefit privileged populations while leaving pollution hotspots intact, they risk constituting indirect or structural discrimination[23].

Yet most environmental and climate statutes do not explicitly require regulators to assess how improvements are distributed across social groups. This legal silence allows "green inequality" to persist under the appearance of progress[24].

A Self-Reinforcing System of Environmental Inequality

AQI design, monitoring gaps, and distribution-blind regulation together form a self-reinforcing system. Simplified indices underestimate harm in vulnerable populations; sparse monitoring ensures that cumulative exposure remains undocumented; and legal frameworks focused on averages legitimize these outcomes as regulatory success[25]. Each element reinforces the others, embedding inequality into the very structure of air quality governance.

AQI Design as a Legal and Justice Question: India–US Comparison

The US AQI has historical origins in the National Ambient Air Quality Standards (NAAQS), which establish health-based thresholds to criteria pollutants, and is regularly redefined as the scientific understanding advances; the AQI is specifically designed to be a living index, which functions to communicate and protect over time with a change in legal standards.[26] The national AQI of India uses similar categorical bands as the US (Good, Satisfactory, Moderate, Poor, Very Poor, Severe), but not their attachment to explicitly health-based risk functions, and has been criticized as not being strictly enforced under the Air Act.[27]

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[23] European Court of Human Rights, *Guide on Article 14 of the European Convention on Human Rights* (ECtHR 2022).

[24] United Nations Environment Programme, *Environmental Rule of Law* (UNEP 2019) https://www.unep.org/resources/report/environmental-rule-law accessed 6 January 2026.

[25] Harvard Environmental Law & Policy Review, 'Environmental Justice and Regulatory Design' https://eelp.law.harvard.edu accessed 6 January 2026.

[26] S Horn and P Dasgupta, 'The Air Quality Index (AQI) in Historical and Analytical Perspective: A Tutorial Review' (2023) 267 *Talanta* 125260 https://doi.org/10.1016/j.talanta.2023.125260 accessed 1 January 2026.

[27] S Natarajan, P Shanmurthy, D Arockiam, B Balusamy and S Selvarajan, 'Optimized Machine Learning Model for Air Quality Index Prediction in Major Cities in India' (2024) 14 *Scientific Reports* https://doi.org/10.1038/s41598-024-54807-1 accessed 1 January 2026.

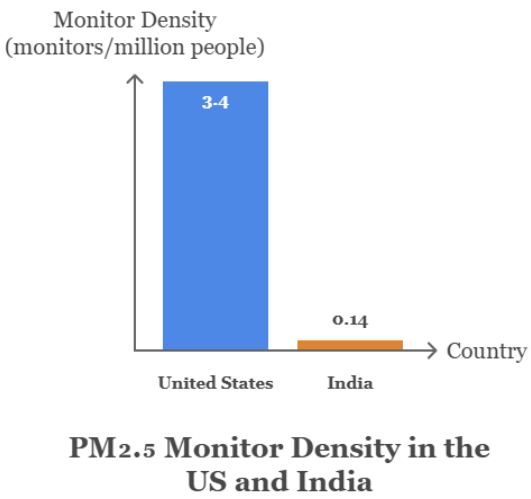

Figure 2: Displays the Monitor Density in the US & India. The Justice Implication is under-monitoring in India as it hides hotspots leading to weakened EJ claims.

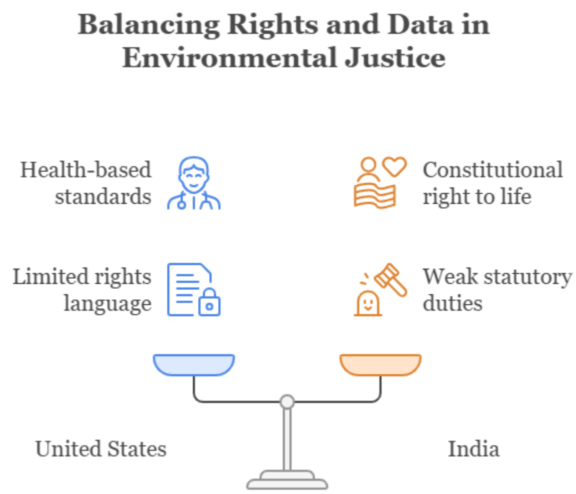

Figure 3: Displays that in the US, though data-rich, but rights-thin. Further, it shows in India, though rights-rich but data-poor.

Globally, AQIs vary in thresholds, average times, and in focusing either on pollution as a single pollutant exposure or a multi-pollutant exposure.[28] Single pollutant indices, as employed in the US and in India, choose the worst contaminant at that point in time, and this may not accurately capture the accumulated risk of many contaminants.[29] Multi-contaminant or health-based indices (e.g., proposed GAQHI) directly associate concentration response functions with local health data and have normative justification insofar as human health is concerned and compared.[30] Recent Indian experiments of city-dependent AQHI of both Delhi and Varanasi have revealed that generic thresholds significantly overstate or understate the health risk when local mortality data, but not pooled indices, are used to derive the classification of *Good/Satisfactory/Poor* days.[31]

Density is also a justice concern to monitor. Traditional networks typically place one station in 100-300 km², and this type does not adequately represent street-level dynamics and mobility

[28] Tan X, Han L, Zhang X, Zhou W, Li W and Qian Y, 'A review of current air quality indexes and improvements under the multi-contaminant air pollution exposure' (2020) 279 *Journal of Environmental Management* 111681 https://doi.org/10.1016/j.jenvman.2020.111681 accessed 6 January 2026.
[29] Ibid.
[30] Ibid.
[31] George F, Joshi P, Dey S, Mall R and Ghosh S, 'A framework for city-specific air quality health index: a comparative assessment of Delhi and Varanasi, India' (2025) 20 *Environmental Research Letters* https://doi.org/10.1088/1748-9326/aded26 accessed 6 January 2026.

routines.[32] It has been demonstrated that better-powered neighbourhoods have higher chances of having a high network of air quality sensors, whereas marginalized communities experience monitoring disparities, which restrict their power to prove and challenge exposure burdens.[33] The machine learning based and high-resolution mapping and low-cost sensors are not only technical enhancements but a key to equal protection as well as in the enforcement of the right to clean air.[34] The US construct is more dynamic in AQI design and well-connected to enforceable standards in comparative perspective,[35] and the jurisprudential elaboration of a substantive right to clean air by the EU with rigid limit value requirements,[36] contrasts with weaker, less health-anchored AQI justifications and enforcement in India.[37] The justice-oriented reform in India would therefore demand: (a) derivation of AQI breakpoints locally based on evidence of health;[38] (b) on statutory minimum requirements on the densities of monitoring with preference to congested regions;[39] and (c) transparent justiciability of exceedances as rights infringements in line with the emerging practice of the EU.[40]

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[32] Jiang F and Ma J, 'Environmental Justice in the 15-Minute City: Assessing Air Pollution Exposure Inequalities Through Machine Learning and Spatial Network Analysis' (2025) *Smart Cities* https://doi.org/10.3390/smartcities8020053 accessed 6 January 2026.

[33] Ibid.

[34] Wen Y, Zhang S, Wang Y, Yang J, He L, Wu Y and Hao J, 'Dynamic traffic data in machine-learning air quality mapping improves environmental justice assessment' (2024) *Environmental Science & Technology* https://doi.org/10.1021/acs.est.3c07545 accessed 6 January 2026.

[35] Horn S and Dasgupta P, 'The Air Quality Index (AQI) in historical and analytical perspective: a tutorial review' (2023) 267 *Talanta* 125260 https://doi.org/10.1016/j.talanta.2023.125260 accessed 6 January 2026.

[36] Misonne D, 'The emergence of a right to clean air: Transforming European Union law through litigation and citizen science' (2020) *Review of European, Comparative and International Environmental Law* https://doi.org/10.1111/reel.12336 accessed 6 January 2026; Bruno W, 'Air Pollution as a Whole: The Court of Justice Strengthens Environmental Standards in the Ambient Air Quality Directive over Contrasting Industrial Emissions Directive Derogations' (2024) 15 *European Journal of Risk Regulation* 465 https://doi.org/10.1017/err.2024.6 accessed 6 January 2026.

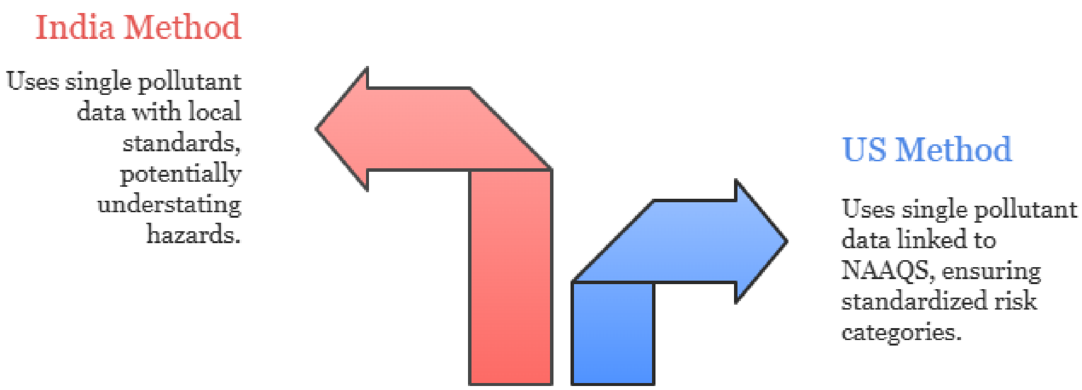
[37] George F, Joshi P, Dey S, Mall R and Ghosh S, 'A framework for city-specific air quality health index: a comparative assessment of Delhi and Varanasi, India' (2025) 20 *Environmental Research Letters* https://doi.org/10.1088/1748-9326/aded26 accessed 6 January 2026; Natarajan S, Shanmurthy P, Arockiam D, Balusamy B and Selvarajan S, 'Optimized machine learning model for air quality index prediction in major cities in India' (2024) 14 *Scientific Reports* https://doi.org/10.1038/s41598-024-54807-1 accessed 6 January 2026.

[38] George F, Joshi P, Dey S, Mall R and Ghosh S, 'A framework for city-specific air quality health index: a comparative assessment of Delhi and Varanasi, India' (2025) 20 *Environmental Research Letters* https://doi.org/10.1088/1748-9326/aded26 accessed 6 January 2026.

[39] Jiang F and J, 'Environmental Justice in the 15-Minute City: Assessing Air Pollution Exposure Inequalities Through Machine Learning and Spatial Network Analysis' (2025) *Smart Cities* https://doi.org/10.3390/smartcities8020053 accessed 6 January 2026.

[40] Misonne D, 'The emergence of a right to clean air: Transforming European Union law through litigation and citizen science' (2020) *Review of European, Comparative and International Environmental Law* https://doi.org/10.1111/reel.12336 accessed 6 January 2026.

Which AQI method should be used for air quality monitoring?



Predictive Environmental Justice: Machine Learning and AQI

Machine learning is now a well-known Indian and other AQI forecasting weapon. A combined model based on the Grey Wolf Optimization and decision trees has been applied to predict AQI in the major Indian cities to be better than the traditional models, with a high accuracy rate in the major cities of Delhi, Bengaluru, Kolkata, Hyderabad, Chennai, and Visakhapatnam.[41] India is a country with an average AQI of 144 and millions of pollution results and related deaths, which explains why such models are driven by the magnitude of air pollution in the country, which is mostly caused by industrial and automobile pollution.[42]

In the US, parallel work uses the deep learning architectures (CNN-LSTM) to estimate AQI based on $PM_{2.5}$ at Jefferson County, Alabama, with explicit demographic information to detect the environmental justice hotspots.[43] This strategy can be implemented by calculating scaled ratios of AQI to racial and socioeconomic factors, which can also be used to make decisions in advance to implement mitigation and deployment of sensors.[44]

Even more advanced exposure models, which combine with dynamic traffic data, greatly enhance community-level measurements of NO_2, ozone, as well as $PM_{2.5}$, and can demonstrate that models

[41] Natarajan S, Shanmurthy P, Arockiam D, Balusamy B and Selvarajan S, 'Optimized machine learning model for air quality index prediction in major cities in India' (2024) 14 *Scientific Reports* https://doi.org/10.1038/s41598-024-54807-1 accessed 6 January 2026.

[42] Ibid.

[43] Maskey A and Shinde R, 'Using Machine Learning for Air Quality Prediction in Alabama: An Environmental Justice Case Study' (2025) *Proceedings of the 2025 ACM Southeast Conference* https://doi.org/10.1145/3696673.3723080 accessed 6 January 2026.

[44] Ibid.

that do not include real-time traffic data are biased in the underestimation of exposures, particularly in poorer neighborhoods.[45] This understatement is important to justice, as it may obscure surpasses in comparisons to legal standards and put the burden of an evidentiary foundation of court or administrative action into question.

Collectively, these researches indicate a new normative task of predictive modeling, not only on predicting the values of AQI, but also on predicting distributional harms. Such models could have a legal role in determining targeted enforcement, where to place the monitors or where to place the monitors in overburdened regions, and theoretically in reviewing ex ante either permitting or transport policies, which would be in line with adaptive governance frameworks that require data-based, active adjustment of legal limits and actions.[46]

Litigation, Courts, and the Emergence of a Right to Clean Air

Civil litigation plays a vital role in the US environmental policy. A review of the almost 30,000 federal environmental cases (1988-2022) reveals that pro-regulatory plaintiffs are more likely to succeed than the anti-regulatory, and pollution and waste are dominant in federal environmental litigation.[47] However, the issues of climate and environmental justice are not explicitly presented in judicial decisions, which suggests that there is a tendency to sideline distributional issues.[48]

The European Union is another example: EU ambient air quality law, as construed by the Court of Justice, has actually created a substantive individual right to clean air, although the legislation on which it is based is not itself cast in explicit rights terms.[49] Limit values according to the Ambient Air Quality Directive are seen as result-based obligations; any exceedance, even at any point of a single sampling, will instigate a legal obligation to implement plans relating to air quality, and litigation has been active in pushing authorities to make and enforce such plans.[50] Recent case law favors ambient air quality requirements more than industry emission derogations and bases

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[45] Wen Y, Zhang S, Wang Y, Yang J, He L, Wu Y and Hao J, 'Dynamic traffic data in machine-learning air quality mapping improves environmental justice assessment' (2024) *Environmental Science & Technology* https://doi.org/10.1021/acs.est.3c07545 accessed 6 January 2026.

[46] Zhao J and Zhang R, 'Legal innovations for balancing environmental protection and public health in urban polluted areas' (2025) 13 *Frontiers in Public Health* https://doi.org/10.3389/fpubh.2025.1557173 accessed 6 January 2026.

[47] Rea C, Merten N and Rife C, 'Outcomes and policy focus of environmental litigation in the United States' (2024) 7 *Nature Sustainability* 1469–1480 https://doi.org/10.1038/s41893-024-01456-x accessed 6 January 2026.

[48] Ibid.

[49] Misonne D, 'The emergence of a right to clean air: Transforming European Union law through litigation and citizen science' (2020) *Review of European, Comparative and International Environmental Law* https://doi.org/10.1111/reel.12336 accessed 6 January 2026.

[50] Ibid.

coordination of legal instruments on tight limit values.[51] Citizen science and low-cost sensors have become an ever more significant part in the sense that they have extended the reach of measurement beyond official networks and have also increased access to information and justice.[52] The introduction of specialized environmental courts in China has been demonstrated to considerably escalate environmental protection spending by firms and improve the air quality of cities, and the courts perform the functions of institutional mechanisms of enhancement and alleviation of local protectionism.[53] This illustrates how the judicial institutions themselves may be subject to measurable environmental effects, not just through the review of the administrative action, but also through tipping the incentive of the entities under regulation. These pieces of evidence suggest a more aggressive role of the courts in AQI-connected justice.

Urbanization, AQI, and Justice in the Global South

A major cause of air pollution is urbanization, which is most prone to low and middle-income countries, in which the process of rapid urbanization may significantly surpass the growth of environmental laws and precautionary measures.[54] An analysis of urbanization and air quality relationships underscores that a significant issue in many Global South cities is that at the point when institutions are the weakest, proactive, preemptive legal action prior to the onset of heavy pollution is important and usually lacking.[55]

In India, the pollution sources are industrialization, growth of vehicles, burning of crops, and domestic use of fuel, with industrial factors being the significant contributors of pollution; about fifty percent of all pollution sources in this country.[56] The laxity in the policing of the current air pollution statute is identified as one of the factors that have led to the negative health effects when formally regulated.[57] Generally, the Global South associates a stronger legal framework and

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[51] Bruno W, 'Air Pollution as a Whole: The Court of Justice Strengthens Environmental Standards in the Ambient Air Quality Directive over Contrasting Industrial Emissions Directive Derogations' (2024) 15 *European Journal of Risk Regulation* 465 https://doi.org/10.1017/err.2024.6 accessed 6 January 2026.

[52] Misonne D, 'The emergence of a right to clean air: Transforming European Union law through litigation and citizen science' (2020) *Review of European, Comparative and International Environmental Law* https://doi.org/10.1111/reel.12336 accessed 6 January 2026.

[53] Ibid.

[54] Zhang X, Han L, Wei H, Tan X, Zhou W, Li W and Qian Y, 'Linking urbanization and air quality together: A review and a perspective on the future sustainable urban development' (2022) *Journal of Cleaner Production* https://doi.org/10.1016/j.jclepro.2022.130988 accessed 6 January 2026.

[55] Ibid.

[56] Zhang Q, Yu Z and Kong D, 'The real effect of legal institutions: Environmental courts and firm environmental protection expenditure' (2019) *Journal of Environmental Economics and Management* https://doi.org/10.1016/j.jeem.2019.102254 accessed 6 January 2026.

[57] Ibid.

efficient enforcement of environmental laws with lower carbon emissions, whereas the opposite is true, i.e., economic growth below institution strengthening leads to poor environmental quality.[58] Urban environmental justice literature also reveals that the availability of monitoring infrastructure and data is unevenly distributed in cities: wealthier areas are likely to enjoy massive sensor networks, with marginalized neighbourhoods being expected to *suffer smart city inequity* in monitoring, preventing them from recording and challenging exposure.[59] Findings of mobility-conscious, high-resolution measurements of $PM_{2.5}$, exposure in the *15-minute city*, New York City environment, show high levels of exposure to Black people and low-income earners in practice within their accessible walking distance, than would be indicated by traditional census tract-based studies.[60]

Such results help underscore the fact that in the Global South, injustice of urban air quality is not based solely on poverty, but rather through a combined effect of the rapid urbanization, ineffective environmental institutions, and the inequalities in the infrastructure to monitor and transportation infrastructures.

CONSLUSION

Potential Resolutions: Towards Effective and Just Air Quality Governance.

To conclude, the unequal air quality burden necessitates the provision of solutions to the current disparate situation between the regulatory framework and the actual justice solutions. The accomplishment of AQI design and monitoring should be reformed, with the major aspects of substantive equality, in which local healthcare risk thresholds and high-resolution sensor networks are introduced to underserved communities. The exposure to local pollution can be minimized by local technological and nature-based interventions, like, but not limited to, the creation of more extensive green spaces, carbon sequestration initiatives, community-based assessment, and monitoring to build resilience. Cases such as *GoGreen Filter,* founded by Rohan Kapoor and Jack Reichert, are examples of how useful innovation can help reduce emissions at the foundation. Their algae-powered exhaust filter lowers the carbon emissions in vehicles by turning CO2 into oxygen,

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[58] Alola A, Dike G and Alola U, 'The role of legal system and socioeconomic aspects in the environmental quality drive of the Global South' (2022) 163 *Social Indicators Research* 953–972 https://doi.org/10.1007/s11205-022-02920-x accessed 6 January 2026.

[59] Jiang F and Ma J, 'Environmental Justice in the 15-Minute City: Assessing Air Pollution Exposure Inequalities Through Machine Learning and Spatial Network Analysis' (2025) *Smart Cities* https://doi.org/10.3390/smartcities8020053 accessed 6 January 2026.

[60] Ibid.

and this low-cost, scalable technology can be used to ensure that the goals of controlling emissions and sustainable environmental health are aligned. Such grassroots solutions should be promoted through policy and law by providing incentives to use clean tech, ensuring that an even spread of coverage by the monitoring process, and by making the distributional implications of the regulator accountable.[61] When combined, these plans will be able to turn enhanced headline air quality into clean-air fairness across the board.

[61] *GoGreen Filter* (GoGreenFilter.com) https://www.gogreenfilter.com/ accessed 6 January 2026.