AIJMR
Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

Breathing Inequality: Air Pollution, Urbanization, and Environmental Justice in the Global South

Seema Mehra Parihar[1], Mohammed Baber Ali[2], Vyom Sharma[3], Asmit Soni[4], Yuvraj Singh Sikarwar[5]

[1]Prof. Seema Mehra Parihar, Professor, Department of Geography; Director Himalayan Centre-WCG, Kirori Mal College; and DSPH, Institute of Eminence, University of Delhi.
[2]Dr. Mohammed Baber Ali, Associate Professor, Department of Geography, University of Delhi.
[3]Vyom Sharma, Research Assistant, Kirori Mal College, University of Delhi.
[4]Asmit Soni, Research Assistant, Kirori Mal College, University of Delhi.
[5]Yuvraj Singh Sikarwar, Research Assistant, Kirori Mal College, University of Delhi.

Abstract:
Air pollution has become one of the signature health and equity issues of the urban Global South, and the burden is uneven. It was associated with an estimated 8.1 million deaths worldwide in 2021, second only to high blood pressure among risk factors, and about nine in 10 of those deaths occurred in low- and middle-income countries. This paper interprets that statistic through the lens of environmental justice: who breathes the worst air, why they came to live where the air is worst, and what it would take to change that. Drawing on the Health Effects Institute's State of Global Air, the IQAir World Air Quality Report (2025), the World Health Organization, the World Bank, the International Energy Agency, IRENA and UN-Habitat, we present a data-driven, comparative view of how rapid urbanization, fossil-fuel dependence and household solid-fuel use interact to produce starkly uneven exposure across South Asia, Sub-Saharan Africa, Southeast Asia and Latin America. We posit that exposure mirrors pre-existing inequality so precisely that clean air is now a stand-in for economic and social standing. The paper also resists a fatalism. Over a decade, Beijing reduced fine-particle pollution by 64 per cent, Mexico City reduced its particulate load by about half over a generation, and India's clean-cooking programme reached more than a hundred million households. None of these are complete victories, but they are all proof that the problem is tractable where measurement, financing, and political attention converge. The contribution here is to see the unequal distribution of breathable air not as an unfortunate side effect of growth but as a governable consequence of urban and energy policy.

Keywords: air pollution; PM2.5; environmental justice; Global South; urbanization; household air pollution; clean cooking; informal settlements; clean-energy transition; breathing inequality.

I. INTRODUCTION: THE UNEVEN GEOGRAPHY OF BREATH

There is a particular hour in Delhi in early November when the light turns the colour of weak tea and the streetlights come on at four in the afternoon. Parents keep children home from school; those who can afford it switch on air purifiers and stay indoors; those who cannot keep working in it, because a day not worked is a day not paid. The same air settles over everyone, but it does not weigh on everyone equally. That uneven weight is the subject of this paper.

Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

For this paper breath is taken as a physiological definition where it is defined as a single, complete act of inhaling and exhaling or in other words air drawn into and expelled from the lungs during respiration.
Air pollution is now among the largest environmental health risks the world faces. The Health Effects Institute estimates that exposure to ambient and household air pollution was linked to 8.1 million deaths in 2021, placing it second only to high blood pressure among all risk factors for death, and second among risk factors for the deaths of children under five (Health Effects Institute, 2024). The World Health Organization reports that almost the entire human population, about 99 percent, breathes air that exceeds its 2021 guideline of 5 micrograms per cubic metre of fine particulate matter, the pollutant most consistently tied to early death (WHO, 2024a). What turns these figures into a justice question, rather than merely a public-health one, is their distribution. Roughly nine in ten ambient-pollution deaths occur in low- and middle-income countries, and people in those countries are exposed to fine-particle concentrations between 1.3 and 4 times higher than people in wealthy ones (WHO, 2024a; Health Effects Institute, 2024).
Two forces have sharpened this slope. First, the speed and shape of urbanization. The United Nations predicts that the proportion of people living in cities will rise from 55 per cent in 2018 to 68 per cent by 2050, with almost 90 per cent of the increase in Asia and Africa (United Nations DESA, 2018). Cities in these regions are expanding faster than they are being serviced. Urban land grew up to 3.7 times faster than urban population density between 2000 and 2020, leaving large peripheries with no transit, no paved roads or clean energy (UN-Habitat, 2024). The second force is the energy basis for that growth. Coal still fuels more than 70 percent of India's electricity, solid fuels still provide the cooking fuel for some two billion people, and vehicle fleets in developing cities are expanding faster than emission controls can keep pace (World Bank, 2022a; WHO, 2024b).
These patterns are termed environmental justice. The benefits and burdens of environmental conditions are not evenly distributed, and those who contribute least to a problem often suffer most from its effects. The argument is uncomfortable, but hard to dispute when applied to air: with striking regularity, the populations that breathe the dirtiest air are the poorest, the youngest and the least able to move away from it. Clean air is quietly becoming another thing that money can buy and poverty cannot.
This paper is not an attempt to reargue whether such inequality is found, the data do that. The better question is how the inequality is produced, where it concentrates, and what policy levers have been shown to move it. Section II describes the data sources and the comparative methodology. The aims are stated in section III. Section IV is the literature on pollution, cities and justice. In section V through IX I outline the mechanics: sources of urban pollution, the structure of unequal exposure, the health and human costs, the developmental bind of fast-growing cities, and the tightening link between dirty air and a changing climate. Sections X and XI are about what works. Section XII concludes the argument. The tone throughout is deliberately restrained. The problem is serious but it is also, by the evidence, one of the more solvable environmental problems we face.

II. APPROACH AND DATA SOURCES

This paper is a synthesis. It does not generate new measurements but synthesizes and interprets the best available secondary data, paying particular attention to figures published between 2022 and 2026 and reads them through a comparative, equity-focused lens. Three kinds of evidence are put together.

Exposure and concentration data

The annual average concentrations of PM2.5 and the country and city rankings are based mainly on the IQAir World Air Quality Report 2024, published in March 2025. This report combines ground-based monitoring data from more than 8,900 locations in 138 countries, supplemented where noted by WHO's

Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

air-quality database. These sources have a known limitation discussed in the limitations section; namely, monitoring density is itself unequal so rankings are partly a function of who is measuring rather than only who is polluting.

Health and burden data

Mortality, disability-adjusted life years, and cause-specific fractions are taken from the Health Effects Institute's State of Global Air 2024 (produced with the Institute for Health Metrics and Evaluation and UNICEF), the WHO fact sheets on ambient and household air pollution, the Lancet Commission on Pollution and Health, and the Air Quality Life Index maintained by the Energy Policy Institute at the University of Chicago.

Policy, energy, and urbanization data

Material on clean-energy deployment, electric mobility, and clean cooking comes from the International Energy Agency and IRENA; urbanization figures from UN DESA and UN-Habitat; and national programme data from official Indian government releases and independent monitors such as the Centre for Research on Energy and Clean Air and the Centre for Science and Environment. Table 1 maps each body of evidence to the question it is used to answer.

Table 1. Evidence base and the questions each source addresses

Source	Type	Question addressed
IQAir World Air Quality Report 2024	Exposure	City- and country-level PM2.5 concentrations and rankings
HEI State of Global Air 2024	Health burden	Deaths, DALYs, child mortality, cause-specific fractions
WHO air-quality fact sheets and portal	Health / exposure	Guideline exceedance, ambient vs. household split
Lancet Commission on Pollution and Health	Health / economic	Pollution deaths and welfare losses in LMICs
AQLI (EPIC, University of Chicago)	Health	Life expectancy lost to PM2.5 by region
World Bank cost-of-pollution reports	Economic	GDP and welfare cost of PM2.5 exposure
UN DESA World Urbanization Prospects	Urbanization	Urban growth trajectories for Asia and Africa
UN-Habitat World Cities Report 2024	Urban / equity	Informal settlements, sprawl, climate co-vulnerability
IEA clean-cooking and EV outlooks	Energy / policy	Clean-cooking access, electric-mobility uptake
IRENA Renewable Capacity Statistics	Energy	Regional distribution of renewable deployment

E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

III. RESEARCH AIM AND OBJECTIVES

The aim of this paper is to explain how air-pollution exposure has come to track economic and social inequality so closely across the urban Global South, and to identify the interventions for which there is credible evidence of effect. Five objectives follow from that aim:

(i) to examine the relationship between air pollution and environmental inequality, treating exposure as a distributional outcome rather than a uniform hazard;

(ii) to analyze how the pace and form of urbanization in developing regions have worsened air quality and concentrated it spatially;

(iii) to assess how and why vulnerable populations, the urban poor, women, children, and informal workers, are disproportionately exposed;

(iv) to trace the links between pollution, public health, infrastructure, and socio-economic conditions, with attention to measurable economic cost;

(v) to evaluate sustainable and equitable responses, from clean-energy transition to clean cooking and airshed governance, against the record of what has actually reduced exposure.

IV. LITERATURE REVIEW

This paper is informed by three bodies of scholarship that have not always spoken to one another. The first considers air pollution as an epidemiological problem. Work synthesised in the Global Burden of Disease project established the dose-response relationship between fine particulate matter and cardiovascular and respiratory mortality, and successive State of Global Air reports have refined the estimates to the figures cited above. The literature is rich in quantification and comparatively quiet on distribution; it tells us how many die and of what, less about who and where.

The second body of work is the environmental-justice tradition. It started in North America with research on the clustering of waste facilities and polluting industry near low-income and minority neighbourhoods, and has since migrated to the Global South, where the relevant axis is less often race and ethnicity than income, tenure and informality. Studies of cities in South Asia, Sub-Saharan Africa and Latin America have shown that the urban poor usually occupy the less desirable land such as near landfills, industrial areas and busy roads, mainly because such land is cheap or unowned (Hadi et al., 2023). This results in a double exposure: dirtier outdoor air outside the home and, for households still burning solid fuels, dangerous air inside it.

The third strand is urbanization and sustainable development. The literature and the series of UN-Habitat's World Cities Report (UN-Habitat, 2024) show how the pace of urban growth in developing regions has exceeded the provision of transit, sanitation and clean energy. A similar debate is alive in development economics: can poorer countries follow the same 'pollute first, clean up later' route as today's rich economies, or will they be able to leapfrog to cleaner technologies? The evidence is genuinely mixed and this paper does not present either side as resolved. The cases of China and Mexico City, discussed in Section X, suggest that the curve can be bent earlier than the historical pattern would suggest, but only with deliberate and well-financed intervention.

The paper is an attempt to contribute something at the intersection of the three. The epidemiological literature provides the magnitudes, the justice literature the distributional lens, and the urban-development literature the mechanism. Together they suggest that unequal air is not a natural fact of poverty but a produced outcome of how cities are built and powered, which means it can also be un-produced.

AIJMR
Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

V. AIR POLLUTION AND URBANIZATION IN THE GLOBAL SOUTH

The geography of the world's worst air is not subtle. In the 2024 IQAir ranking, the five most polluted countries were Chad, Bangladesh, Pakistan, the Democratic Republic of the Congo, and India, with national annual mean PM2.5 ranging from about 51 to 92 micrograms per cubic metre, that is, ten to eighteen times the WHO guideline (IQAir, 2025). Only seven countries on Earth met the guideline, and none of them was in the Global South. India alone accounted for twelve of the world's twenty most polluted cities, and the small Indian town of Byrnihat recorded the highest urban PM2.5 measured anywhere, at 128 micrograms per cubic metre. Figure 1 places the most polluted countries against the guideline they all exceed.

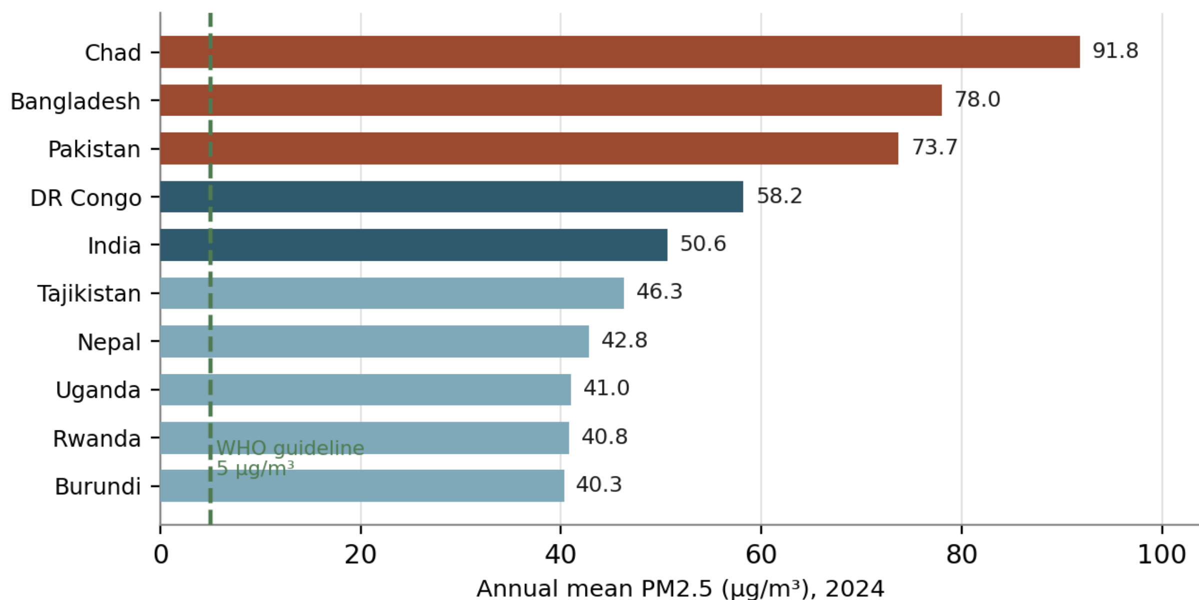

Figure 1. Annual mean PM2.5 in the ten most polluted countries, 2024, against the WHO guideline of 5 µg/m³. Bars in rust exceed 70 µg/m³; the dashed line marks the guideline that all ten breach by an order of magnitude. Data: IQAir World Air Quality Report 2024.

The sources of these figures are broadly similar from one developing megacity to another, although the mix changes. Road transport is the largest local contributor in many places. In Delhi, vehicle exhaust contributes to about half of locally generated winter PM2.5, and vehicle emissions have been estimated at more than 80 percent of poor air quality in Lahore (Down To Earth, 2024; IQAir, 2025). Next layer: industry and coal-fired power. The thermal plants around Delhi emit far more sulfur dioxide than the seasonal crop burning that dominates the headlines. Construction dust, open waste burning, brick kilns and smoke from household cooking fires complete the picture. Figure 2 shows a typical apportionment for Delhi in winter when the sources pile up under a temperature inversion that keeps them close to the ground.

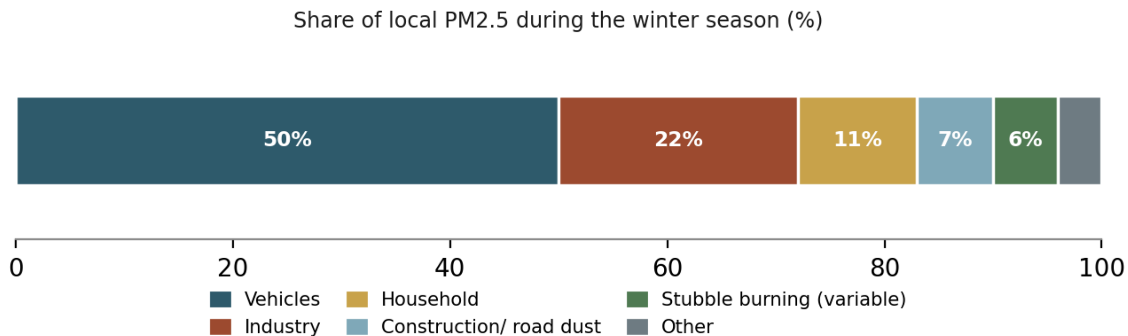

Figure 2. Indicative source apportionment of local winter PM2.5 in Delhi. Shares fluctuate from year to year, especially for crop-residue burning, which peaks for a few weeks each fall but adds only modestly to the seasonal average. Source: Centre for Science and Environment and the IITM Decision Support System, 2024–2025.

The urban growth, in itself, underpins the source mix. In 1950, Asia's urban population was less than a quarter of a billion; today it is over two billion, and Africa's is projected to triple by mid-century (United Nations DESA, 2018). Both trajectories are shown in Figure 3. Every wave of newcomers to cities needs energy, mobility and shelter faster than clean systems can be built to supply them, which is why the pollution problem in these regions is fundamentally an infrastructure-timing problem.

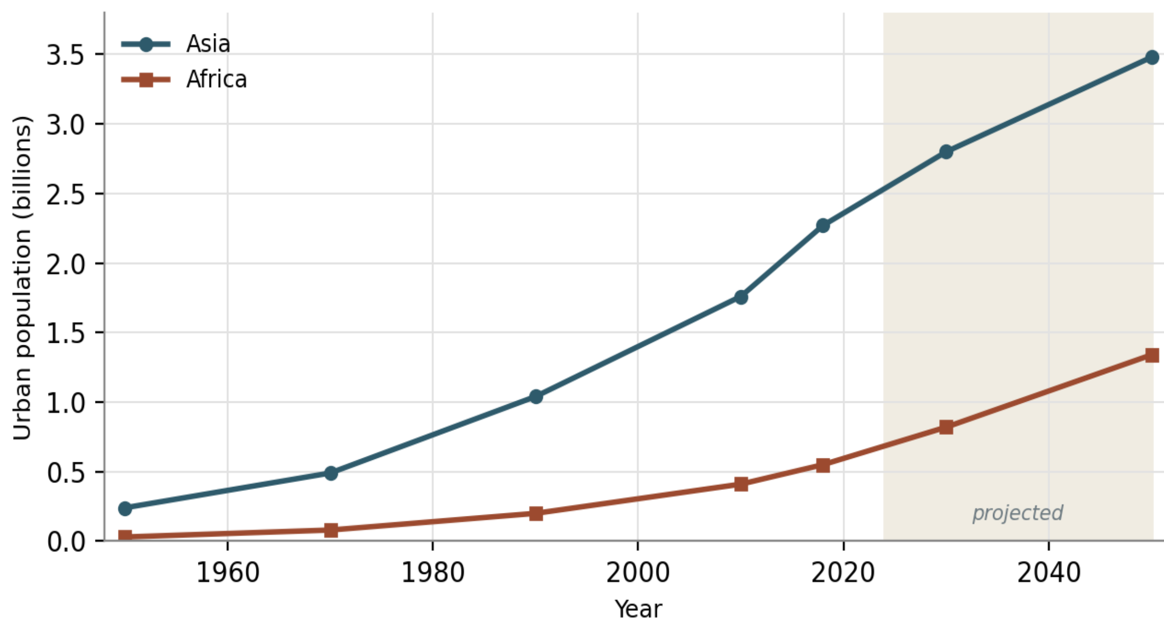

Figure 3. Urban population of Asia and Africa, 1950–2050, in billions. The shaded band marks projected years. Nearly 90 percent of the world's urban growth to 2050 is expected in these two regions. Data: UN DESA, World Urbanization Prospects: The 2018 Revision.

E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

Table 2. Annual mean PM2.5 in selected Global South cities, 2024 (µg/m³)

City	Country	PM2.5	× WHO guideline
Byrnihat	India	128.2	26×
Lahore	Pakistan	102.1	20×
New Delhi	India	91.8	18×
N'Djamena	Chad	91.8	18×
Dhaka	Bangladesh	78.0	16×
Kinshasa	DR Congo	58.2	12×
Islamabad	Pakistan	52.4	10×
Karachi	Pakistan	47.1	9×
Jakarta	Indonesia	41.7	8×

Note. WHO 2021 guideline for annual mean PM2.5 is 5 µg/m³. City figures reflect available monitoring and definitions vary slightly across the New Delhi municipality, the Delhi NCT, and the wider National Capital Region. Source: IQAir (2025).

VI. ENVIRONMENTAL JUSTICE AND UNEQUAL EXPOSURE

If the previous section established where the air is worst, this one asks who is standing in it. The answer, across very different cities, is consistent enough to constitute a pattern rather than a series of local accidents. The people most exposed to polluted air in the Global South are disproportionately poor, and the mechanisms that put them there are structural rather than incidental.

Start with where the urban poor live. UN data put the global slum and informal-settlement population at about 1.1 billion in 2022, with more than four-fifths concentrated in Eastern and South-Eastern Asia, Central and Southern Asia, and Sub-Saharan Africa, the last of which is projected to add some 360 million more informal residents by 2030 on current trends (United Nations Statistics Division, 2024). These settlements rarely sit in clean air. Because the cheapest or most easily occupied land is also the least desirable, informal housing clusters along arterial roads, beside rail yards and ports, downwind of industrial estates, and on or near landfill. The same residents are least likely to have the means of escape that wealthier households take for granted: indoor air filtration, sealed buildings, cars with cabin filters, or simply the option to live somewhere greener.

And then there's a second mechanism that is happening within the home. Households that have not yet climbed the energy ladder cook and heat with wood, charcoal, dung or crop residue, and the resulting indoor smoke is some of the most concentrated pollution any human routinely breathes. It's a gendered burden. The greatest doses are inhaled by women who do the cooking in most of these settings, and the young children often beside them. Household air pollution contributes to a large share of childhood pneumonia deaths, which is discussed in the next section. The unpaid hours spent collecting fuel, often several each day, add to the damage by taking time away from school and paid work, so the same energy poverty that harms lungs also constricts economic horizons.

The third mechanism is informational and infrastructural. Hard to demand clean air if you can't see how dirty the air is. Monitoring is also unevenly distributed: according to the World Bank, low-income countries have about one ground-level PM2.5 monitor per 65 million people and Sub-Saharan Africa about

AIJMR
Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

one per 28 million, compared to one per 370,000 in high-income countries (World Bank, 2022a). Where there are no instruments, there are no data, and where there are no data, there is little public pressure and even less accountability. Green space is on the same gradient. In the cities of the world, less than 44 per cent of people live within easy walking distance of an open public space and in the least-developed countries the figure drops below 30 per cent (United Nations Statistics Division, 2024).
The financing of solutions is matched to the exposure. Between 2015 and 2021, just 1% of international development funding – approximately US$17 billion – was allocated to address outdoor air pollution, and Africa received only about 5% of that funding (Clean Air Fund, 2023). The continent that carries the greatest household and, in some places, ambient burden gets the least money to address it. Diagram 1 illustrates how these mechanisms reinforce each other in a self-reinforcing loop.

Diagram 1: The Exposure–Inequality Feedback Loop
What a low income, settlement choice, energy poverty, and weak monitoring reinforce one another

LOW INCOME / INFORMAL TENURE — limited choice of where to live or work
↓ *cheapest land is the most polluted land*
HIGH-EXPOSURE LOCATION — near roads, industry, ports, landfill; thin green space
↓ *plus, reliance on solid fuels indoors*
DOUBLE EXPOSURE (OUTDOOR + HOUSEHOLD) — women and children absorb the highest doses
↓ *illness, lost school days, lost paid work*
ERODED HEALTH & EARNINGS — medical costs rise; productive time falls
↓ *less money, less political voice, fewer monitors*
WEAK DATA & ACCOUNTABILITY — no measurement → no pressure → no investment
↺the loop closes: weak accountability keeps incomes and exposure where they began

Figure 4. The cycle of exposure and inequity. Each stage makes the next stage more likely, so that exposure to pollution both reflects and reproduces economic disadvantage. To break the loop you must intervene at more than one node at a time. Source: Compiled from UN-Habitat (2024), World Bank (2022a) and Clean Air Fund (2023).

VII. PUBLIC HEALTH AND THE HUMAN TOLL

In the scientific community, the health consequences of polluted air are no longer seriously disputed; it's all about magnitude and attribution, not direction. Fine particles get deep into the lungs and into the blood stream, causing inflammation that has been linked to heart disease, stroke, chronic obstructive pulmonary disease, lung cancer and lower respiratory infection. The State of Global Air 2024 estimates that air pollution accounts for roughly 28 percent of deaths from ischaemic heart disease, nearly half of deaths from COPD and approximately 30 percent of deaths from lower respiratory infections. The total PM2.5 burden is approximately 90 percent attributable to non-communicable diseases (Health Effects Institute, 2024).

Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

Children are the most exposed and the less responsible. In 2021, air pollution caused more than 700 000 deaths of children under five years of age (about 15% of all deaths in this age group), mostly in Africa and Asia and related to household smoke from solid fuels (Health Effects Institute, 2024). The damage starts before birth: the same report links some one-third of preterm births globally to exposure to PM2.5, and a perinatal analysis by the WHO found that exposure above about 20 micrograms per cubic metre increased the odds of low birth weight by over a fifth (Fleischer et al., 2014). Exposure in early life has been linked to impaired lung development and deficits in cognitive performance that persist into school age.
The best way to put the scale in perspective is in years of life. The Air Quality Life Index converts exposure to PM2.5 into lost life expectancy and the numbers for South Asia are dire. The average Indian resident loses some 5.3 years compared to the WHO guideline, while the average resident of Delhi loses nearly 12 (Energy Policy Institute at the University of Chicago, 2024). These are compared to the global average of about 2.3 years in Figure 4.

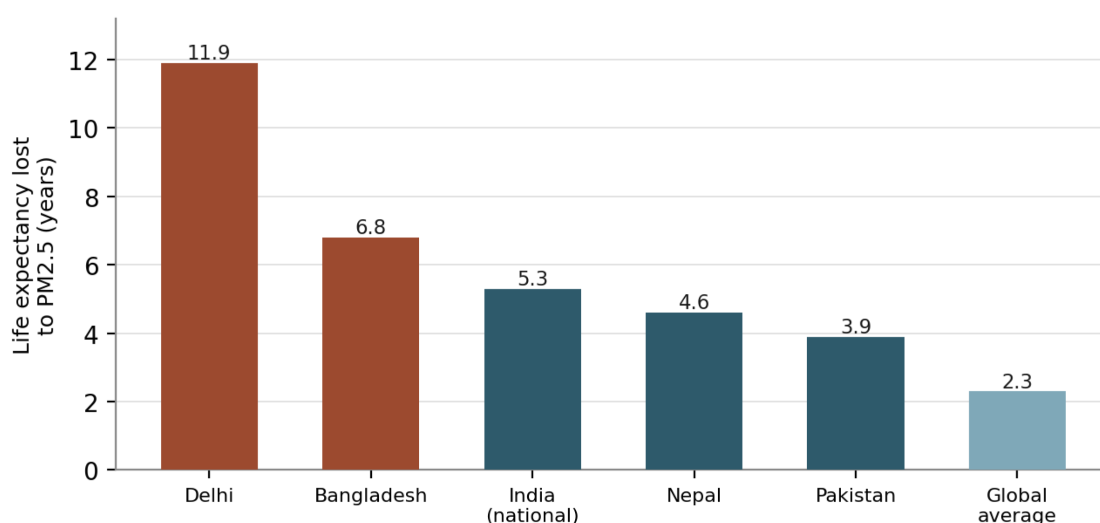

Figure 4. PM2.5 loss of life expectancy relative to WHO guideline, selected South Asian benchmarks and global average. The Delhi figure of almost twelve years is among the highest seen anywhere. Source: Air Quality Life Index, EPIC, University of Chicago, 2024.

This mortality has a large economic shadow. According to the World Bank, the global welfare cost of PM2.5 exposure was around 8.1 trillion US dollars in 2019, or about 6.1 percent of global output, with developing regions facing the most severe relative losses (World Bank, 2022b). Seen from another angle, the Lancet Commission arrives at a similar conclusion, stating that pollution in all its forms is responsible for one in six deaths worldwide, and that 92% of these deaths occur in low- and middle-income countries (Fuller et al., 2022). Lost workdays, higher medical bills, less education and shorter working lives all mean a drain on development not shown on a balance sheet, but just as real for not being so. Table 3 provides a summary of the main health and burden figures.

Table 3. Selected global and regional air-pollution health indicators

Indicator	Value	Source
Total deaths linked to air pollution, 2021	8.1 million	HEI (2024)

E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

Share of ambient deaths in LMICs	~89%	WHO (2024a)
Under-5 deaths linked to air pollution, 2021	>700,000	HEI (2024)
Preterm births linked to PM2.5	~34%	HEI (2024)
Deaths from household air pollution, annual	~3.2 million	HEI (2024)
Population breathing air above WHO guideline	~99%	WHO (2024a)
Life expectancy lost to PM2.5, India	5.3 years	AQLI (2024)
Life expectancy lost to PM2.5, Delhi	11.9 years	AQLI (2024)
Global welfare cost of PM2.5, 2019	~US$8.1 trillion (6.1% of GDP)	World Bank (2022b)

Source: Based on geo-analytics of different reports.

VIII. URBAN DEVELOPMENT AND STRUCTURAL CHALLENGES

There is a developmental bind behind the health figures. It should be stated plainly, not moralised. The now-rich world never managed to industrialize, motorize and house hundreds of millions of new residents while keeping its air clean on far thinner public budgets. But that is what the fast-growing cities of the Global South are being asked to do. There's no fooling anyone here. The tension is real.

The first constraint is the arithmetic of growth. UN-Habitat has found that urban land in many developing regions grew much faster than population density from 2000 to 2020, a pattern of sprawl that lengthens commutes and locks in car and two-wheeler dependence, while pushing the poor to the peripheries with the least transit and the most exposure to road dust and traffic exhaust (UN-Habitat, 2024). The infrastructure is not keeping pace with arrivals. Migrants arrive monthly while it takes years to plan and finance mass transit, paved roads, waste collection, grid-connected clean energy.

And the second constraint is dependence on energy. Coal powers electricity in much of South and Southeast Asia, and the cheapest way to power a growing city is often the dirtiest. Second-hand diesel vehicles exported from rich markets spend their last working years on Global South roads as vehicle fleets grow ahead of emission standards. This is less about apathy and more about the everyday logic of doing the cheap thing under fiscal pressure.

The third constraint is the competition of priorities. A finance minister deciding between investing in clean air or schools, water, and debt service is making a very difficult choice, not a careless choice. This is the significance of the air quality framing. Clean air, considered a luxury good to be afforded after a country is rich, will continue to lose the budget battle. When viewed as the development input it is, a factor in the health and productivity of the workforce, it does much better. The cities making progress, discussed in Section X, are the ones that re-framed it that way.

IX. WHERE POLLUTION AND CLIMATE MEET

Air pollution and climate change are often handled by separate ministries, separate conferences and separate sources of funding, but physically they are two outputs of largely the same activity. Burning coal, diesel and biomass releases the particulate matter which damages lungs as well as the carbon dioxide which warms the planet. Many measures aimed at one problem help the other almost for free (World Bank, 2022a).

AIJMR
Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

There are however some pollutants that fit nicely into both categories. The Climate and Clean Air Coalition names black carbon, methane, tropospheric ozone and hydrofluorocarbons as short-lived climate pollutants which, after carbon dioxide, are the biggest contributors to near-term warming, contributing as much as 45 percent to it, and also to health and crops (Climate and Clean Air Coalition, n.d.). Black carbon, the soot at the heart of much PM2.5, is a good example: reducing it cuts both warming and the particulate load people breathe. The coalition's targets – a 40% cut in methane and up to 70% cut in black carbon by 2030 – are framed squarely around this double dividend.

And pollution makes the climate change worse. Higher temperatures speed up the chemistry that creates ground-level ozone, so heatwaves and smog episodes are arriving together more and more often. Wildfires have become a major and mobile source of particulate pollution, now occurring more often and with greater intensity as the climate warms. In 2023, Canadian fires contributed significantly to the increase in the global annual mean PM2.5, and resulted in an increase of almost half a microgram per cubic metre across Europe through long range transport (Nature, 2025). During the 2024 Amazon fires, PM2.5 quadrupled in some areas of Brazil (IQAir, 2025). The uncomfortable overlap, of course, is that the regions most vulnerable to climate impacts are, with depressing regularity, the same regions already breathing the worst air, so the two burdens compound on the same populations.

X. TECHNOLOGY, POLICY, AND WHAT HAS ACTUALLY WORKED

The case for cautious optimism is based on evidence, not sentiment. A number of large interventions have measurably reduced exposure, and they share a common structure: a clear metric, sustained financing and political attention sustained over more than one electoral cycle. This section reviews the record and the instruments that produced it.

A. The clean-energy and mobility transition

The energy base of cities is the most consequential lever. Renewable deployment is at record levels, with IRENA reporting 473 gigawatts of new renewable capacity in 2023 and a further 585 gigawatts in 2024, the great majority of all new power capacity (IRENA, 2024). However, the distribution continues the inequality this paper has traced: Asia, led by China, accounted for about seven-tenths of 2023 additions, while Africa contributed less than five percent and, in 2024, well less than one percent. Electric mobility tells much the same story. In 2024, global electric-car sales topped 17 million, accounting for more than a fifth of all cars sold, with China alone making up about 60 percent of them (International Energy Agency, 2024, 2025). The heartening outlier is the two- and three-wheeler segment that dominates South Asian streets: India became the world's largest market for electric three-wheelers, and sold over a million electric two-wheelers, the vehicles whose tailpipes are nearest to pedestrians.

B. Closing the clean-cooking gap

The intervention for household air pollution is clean cooking, and the gap is narrowing in one region and widening in another. The number of people in developing Asia who lack clean cooking facilities declined from around 3 billion in 2010 to 2.3 billion in 2022, but in Sub-Saharan Africa the number has continued to grow. Consequently, approximately four out of five households – almost a billion people – still rely on polluting fuels for cooking (International Energy Agency, 2023, 2025). The divergence is shown in Figure 5. The IEA calculates that providing universal access to clean cooking in Africa will cost about $2 billion per year until 2040, a small figure compared to the 815,000 African deaths each year caused by its lack.

E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

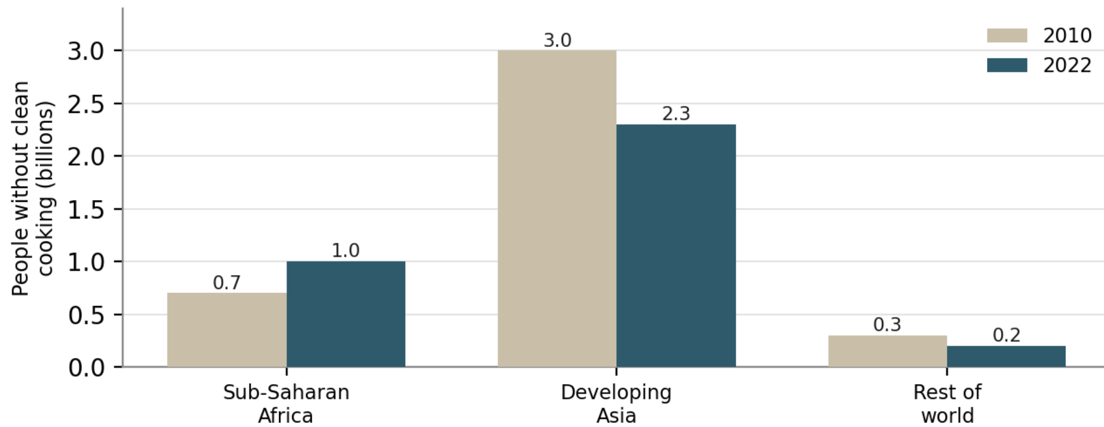

Figure 5. People without access to clean cooking, by region, 2010 versus 2022. Developing Asia has made substantial progress while Sub-Saharan Africa has gone backwards in absolute terms. Data: International Energy Agency, 2023 and 2025.

India's Pradhan Mantri Ujjwala Yojana is the clearest demonstration that the gap can be closed at scale. The scheme had issued more than 103 million subsidised LPG connections by early 2025, mostly in the names of women in poorer households, supported by a per-cylinder subsidy to keep refills affordable (Ministry of Petroleum and Natural Gas, 2025). It is not a finished success, refill rates remain a concern when prices rise, but it shows that a determined programme can move a hundred million households off solid fuels within a decade.

XI. FUTURE OUTLOOK

The next hurdle is not technological, for much of it is at hand, but whether financing and governance come to the right place. The cleaner future is technically feasible — solar and wind are now the cheapest new power in most markets, electric two-and three-wheelers are already competitively priced in South Asia, clean cooking is an engineering solved problem and density monitoring is cheap for the first time possible. The constraints that bind are now money and institutions, not invention.

One must reform the oil price problem as a national problem that can be acted upon. An approach to examine the next ten years is to differentiate between countries according to their exposure and their capacity to respond, as any global shock – a fuel-price spike, a bad fire season, a stalling energy transition – will produce very different outcomes depending on that position. The four quadrants resulting from our conceptual framework have different policy needs.

Diagram 3: Exposure–Capacity Matrix for the Urban Global South

Why the same pollution challenge calls for different responses across regions

	LOW adaptive capacity	HIGH adaptive capacity
HIGH exposure	**Quadrant I — Critical** Northern India, Pakistan, Bangladesh, DR Congo. Severe exposure, thin fiscal space. Needs: concessional finance, monitoring build-out, donor-funded clean cooking.	**Quadrant II — Manageable** China, urban India's better-funded states, parts of Southeast Asia. Needs: airshed governance, accelerated coal phase-down, EV scale-up.

E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

LOW exposure	**Quadrant III — Latent** Lower-income, less-industrial states and smaller African economies. Needs: preventive planning so growth does not lock in dirty infrastructure.	**Quadrant IV — Resilient** Higher-income cities with diversified economies and clean grids. Needs: hold gains, fund cooperation, export what worked.

Figure 8. The exposure-capacity matrix. Global uniform prescriptions are doomed because the four groups have different binding constraints: Quadrant I needs money and measurement; Quadrant II needs governance and speed; Quadrant III needs foresight; and Quadrant IV needs to sustain its gains and finance everyone else's. Synthesis by the authors.

The optimistic view is that you can move between the quadrants. During the last decade, China has moved far into Quadrant II. India is doing this unevenly: fast on clean cooking and electric two-wheelers, slow on the winter air of the Indo-Gangetic Plain. The pessimistic interpretation is that it is not a law of development but a financing gap that the wider world has so far refused to close that has left Sub-Saharan Africa in danger of being held in Quadrant I. What reading is "right" is a question of policy, not of prediction.

If there is one rule for the future, it is that air-quality intelligence should be embedded in economic and urban decision-making, not just tacked on to it. A planning ministry that knows where exposure is concentrated, and a finance ministry that calculates clean air as an investment in productivity rather than an indulgence in environment, will make systematically better choices than one that reads only quarterly growth figures. The tools for clear sight are cheap now. The only question that remains is if they are used.

XII. CONCLUSION

The four claims presented by this evidence are non-rhetorical in nature; they include: (1) Air pollution is both an environmental and social justice problem because the 8.1 million deaths it accounted for globally last year were predominantly felt in low- and middle-income countries with large percentages of these deaths being suffered by the poor, young, and women who have little ability to avoid air pollution or are least responsible for air pollution. (2) Although urbanization in developing nations has allowed many people to earn higher incomes and access more resources, it has done so at the expense of increased amounts of air pollution concentrated in the periphery of cities (urban sprawl) and in informal settlements (poorer neighbourhoods). (3) The way exposure to air pollution is distributed does not reflect the fact that most people living in poverty live near these pollutants but rather the result of how cities are developed, powered, and financed; thus exposure is susceptible to change. (4) The ability to avoid air pollution has been altered with reductions in pollution (e.g., reduction of particulate matter (PM 10) in Beijing by 64 percent, reduction of PM 10 by one-half in Mexico City; the introduction of clean cooking methods for the hundred million households in India) occurring when measurement capacity, funding, and political will align.

None of this is an excuse for complacency. Beijing's cleaner air is still several times higher than the WHO guideline. India's national average improved even as Delhi worsened. The clean-cooking gap in Sub-Saharan Africa continues to grow. The honest position is that the problem is dire, uneven, and incomplete. But the honest position is also that it is one of the more tractable environmental problems of our time, because the technologies are there, and the successes are replicable.

Clean air has become one of those things that only the rich can afford, and the poor cannot. This inequality is what this paper was supposed to describe, and it is not a law of nature. It's policy and geography and policy is what we can change. The job is integration: weaving the clean-energy transition, clean cooking,

electrified mobility, dense monitoring, and airshed governance into a coherent response, and directing the financing to the places, above all in Sub-Saharan Africa and the Indo-Gangetic Plain, where the air is worst and the means are thinnest.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

AUTHORS' CONTRIBUTIONS

S.M. Parihar designed the study, wrote the protocol, and wrote the first draft of the manuscript. M.B. Ali contributed to the regional analysis and literature review. V. Sharma, A. Soni, and Y.S. Sikarwar managed data compilation, table preparation, and reference verification. All authors read and approved the final manuscript.

REFERENCES:

1. Beijing Municipal Ecological and Environmental Bureau. (2024). Beijing achieves national air quality standards for a third consecutive year. Beijing Municipal Government.
2. Centre for Research on Energy and Clean Air. (2025). Tracing the hazy air 2025: Progress report on the National Clean Air Programme (NCAP). CREA.
3. Clean Air Fund. (2023). The state of global air quality funding 2023. Clean Air Fund & Climate Policy Initiative. https://www.cleanairfund.org/resource/
4. Climate and Clean Air Coalition. (n.d.). Short-lived climate pollutants. https://www.ccacoalition.org/content/short-lived-climate-pollutants
5. Energy Policy Institute at the University of Chicago. (2024). Air Quality Life Index: 2024 annual update. EPIC. https://aqli.epic.uchicago.edu
6. Energy Policy Institute at the University of Chicago. (n.d.). Mexico City: ProAire (1990). EPIC. https://aqli.epic.uchicago.edu/post/mexico-city-proaire-1990
7. Fleischer, N. L., Merialdi, M., van Donkelaar, A., Vadillo-Ortega, F., Martin, R. V., Betran, A. P., Souza, J. P., & O'Neill, M. S. (2014). Outdoor air pollution, preterm birth, and low birth weight. Environmental Health Perspectives, 122(4), 425–430.
8. Fuller, R., Landrigan, P. J., Balakrishnan, K., Bathan, G., Bose-O'Reilly, S., Brauer, M., Caravanos, J., et al. (2022). Pollution and health: A progress update. The Lancet Planetary Health, 6(6), e535–e547. https://doi.org/10.1016/S2542-5196(22)00090-0
9. Hadi, A., et al. (2023). Environmental health in informal settlements: Current progress, challenges and perspectives. Frontiers in Public Health, 11.
10. Health Effects Institute. (2024). State of Global Air 2024. HEI, Institute for Health Metrics and Evaluation, & UNICEF. https://www.stateofglobalair.org
11. International Energy Agency. (2023). A vision for clean cooking access for all. IEA. https://www.iea.org/reports/a-vision-for-clean-cooking-access-for-all
12. International Energy Agency. (2024). Global EV Outlook 2024. IEA. https://www.iea.org/reports/global-ev-outlook-2024
13. International Energy Agency. (2025). Global EV Outlook 2025 & Universal access to clean cooking in Africa. IEA. https://www.iea.org/reports/global-ev-outlook-2025
14. International Renewable Energy Agency. (2024). Renewable capacity statistics 2024. IRENA. https://www.irena.org/Publications/2024/Mar/Renewable-capacity-statistics-2024
15. IQAir. (2025). 2024 World Air Quality Report. IQAir. https://www.iqair.com/newsroom/waqr-2024-pr

Advanced International Journal of Multidisciplinary Research
E-ISSN: 2584-0487
editor@aijmr.com
Volume 4, Issue 3, May-June 2026
CrossRef DOI: 10.62127/aijmr.2026.v04i03.1383

16. Ministry of Petroleum and Natural Gas, Government of India. (2025). Pradhan Mantri Ujjwala Yojana: Progress update. Press Information Bureau.
17. Molina, L. T., Velasco, E., Retama, A., & Zavala, M. (2019). Experience from integrated air quality management in the Mexico City Metropolitan Area and Singapore. Atmosphere, 10(9), 512.
18. Nature. (2025). Long-range PM2.5 pollution and health impacts from the 2023 Canadian wildfires. Nature, 644. https://doi.org/10.1038/s41586-025-09482-1
19. Pandey, A., Brauer, M., Cropper, M. L., Balakrishnan, K., Mathur, P., Dey, S., et al. (2019). The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: The GBD Study 2017. The Lancet Planetary Health, 3(1), e26–e39.
20. UN-Habitat. (2024). World Cities Report 2024: Cities and climate action. United Nations Human Settlements Programme. https://unhabitat.org/wcr/
21. United Nations Department of Economic and Social Affairs, Population Division. (2018). World Urbanization Prospects: The 2018 revision. United Nations.
22. United Nations Statistics Division. (2024). SDG Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable. https://unstats.un.org/sdgs/report/2024/Goal-11/
23. World Bank. (2022a). What you need to know about climate change and air pollution. World Bank Group. https://www.worldbank.org
24. World Health Organization. (2024a). Ambient (outdoor) air quality and health [Fact sheet]. WHO. https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health
25. World Bank. (2022b). The global health cost of PM2.5 air pollution: A case for action beyond 2021. World Bank Group.