Rapid Review: AQ-MNCH Data, Actors and Advocacy Activities

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CLEAN AIR FUND

RCPCH Royal College of Paediatrics and Child Health *Leading the way in Children's Health*

Paediatric Association of Nigeria (PAN)

NEPAL PAEDIATRIC SOCIETY 1981

South African Paediatric Association

Contents

Background

World Health Organisation (WHO) data suggests that 99% of the world's population reside in a locality where air quality guidelines are unmet, as of 2019.[1] Globally, 3.7 million deaths are attributed to ambient air pollution per year. About 88% of these deaths occur in low- and middle-income countries (LMICs), which represent 82% of the world's population. It is also estimated that outdoor air pollution is responsible for approximately 1.4% of total mortality, 0.5% of all disability adjusted life years (DALYs) and 2% of all cardiopulmonary disease.[2]

There is substantial global evidence and research on climate change, air quality (AQ), and air pollution, with some focus on air pollution's impact on health.[3,4] However, there is less emphasis on the specific effects on child health and even less on the continuum of air quality's impact on maternal, newborn, and childhood health (MNCH). Additionally, the volume of research in LMICs is inversely related to the significant impact of poor air quality on MNCH faced in these countries.[5,6]

Air Quality and Maternal, Newborn & Child Health

Exposure to air pollution during pregnancy poses significant risks to maternal health. Studies have linked exposure to particulate matter ($PM_{2.5}$ and PM_{10}) with an increased risk of gestational hypertension, preeclampsia, and eclampsia.[7,8] These conditions can lead to severe complications for both the mother and the fetus. Emerging evidence suggests a possible association between maternal exposure to ambient air pollutants, particularly $PM_{2.5}$ and NO_2, and an increased risk of postpartum depression,[9] and an increased risk of placental abruption in mothers.

Furthermore, research has shown that exposure to poor air quality during pregnancy can have adverse effects on newborns, including low birth weight, premature birth,[10] and infant mortality.[11] $PM_{2.5}$ exposure, due to its small size, can cause inflammation, oxidative stress, and damage to the cardiovascular and respiratory systems, increasing the risk of conditions like asthma, pneumonia, and heart problems in children.[12,13] Children have more porous respiratory systems and a less mature immune system, making them less effective at detoxifying and expelling pollutants.[12] $PM_{2.5}$ can also cross the blood-brain barrier, causing neuroinflammation, oxidative stress, and abnormalities in neurodevelopment. Prenatal and perinatal exposure to $PM_{2.5}$ can cross the placental barrier.[14-16] Exposure during pregnancy can harm vital developmental processes needed for life. It may impact the cardiovascular and central nervous systems and hinder lung growth.[15] This may suggest a link between $PM_{2.5}$ exposure and perinatal and neonatal mortality. The severity of these effects can vary depending on the exposure duration and the foetus' vulnerability, themselves relating to underlying social and economic inequalities.[12]

Measurables: Air Quality – Maternal, Newborn & Child Health

Air quality

Other air pollutants of significance that could be measured include carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), and sulphur dioxide (SO_2).[17]

i. Carbon monoxide (CO): High CO levels can reduce the blood's oxygen-carrying capacity, which is primarily emitted from vehicular exhaust and generators, leading to various health issues.

ii. Nitrogen dioxide (NO_2): Mainly from vehicular emissions and industrial activities, NO_2 can inflame the airways and increase susceptibility to respiratory infections.

iii. Ozone (O_3): A secondary pollutant formed from the reaction of nitrogen oxides and Volatile Organic Compounds in sunlight; ground-level ozone can irritate the respiratory system.

iv. Sulphur dioxide (SO_2): Released from industrial processes and the combustion of fossil fuels, SO_2 can irritate the respiratory system and exacerbate conditions like asthma.[18,19]

Maternal, Newborn & Child Health

Table 1 highlights several pregnancy outcomes, maternal conditions and childhood illnesses associated with ambient air pollution, based on a review of global literature.

Pregnancy outcomes with a *strong* association with ambient air pollution
Preterm labour[20]
Stillbirth[20]
Intrauterine growth restriction (IUGR)
Low birthweight[20,21]
Gestational diabetes[20-24, a]
Pregnancy outcomes with an association with ambient air pollution
Spontaneous abortion[20]
Congenital anomalies[a]
Neonatal morbidity[20]
Foetal growth restriction
Foetal/neonatal thyroid function[a]
Foetal brain development[25, a]
Foetal lung development[25, a]
Childhood illness with an association with ambient air pollution
Asthma[12,13]
Pneumonia[12,13]
Maternal conditions with a *strong* association with ambient air pollution
Vasodilation and hypertension[21,24]
Maternal conditions with an association with ambient air pollution
Post-partum depression[9]
Placental abruption[8]

Table 1. Maternal, newborn and child health outcomes associated with ambient air pollution, identified from a literature review.

[a] These outcomes are noted as being difficult to measure, or difficult to link specifically to poor air quality

Inception: global paediatric partnership on air quality advocacy

This project aims to connect extensive epidemiological data with the experiences and observations of paediatricians in selected areas of countries facing severe air pollution challenges: Kathmandu Valley, Nepal; Lagos State, Nigeria; and Johannesburg, South Africa. We build on existing collaboration between RCPCH and sister paediatric associations in these partner countries; The Nepal Paediatric Society (NEPAS), The Paediatric Association of Nigeria (PAN), and the South African Paediatric Association (SAPA).

The availability of health data and meteorological sources is significantly influenced by the economic status of a country. In poorer countries, monitoring sources are often weaker and less reliable. To address these challenges, a UK Reference Group consisting of experts from Imperial College London, the Grantham Research Institute on Climate Change, and the Royal College of Paediatrics and Child Health was established to explore potential solutions and strategies.

One of the primary challenges identified is the geographical distribution of meteorological monitoring stations.[26] In Nepal, for example, monitoring is predominantly clustered around US embassies, leading to uneven data coverage. This clustering makes it difficult to use a geographical model for analysis (although more recent expansion of monitoring sites may mitigate this somewhat). Instead, the UK Reference Group discussed the feasibility of focusing on seasonal variations, which was deemed a more practical approach given the current limitations. Other methodological challenges include issues related to the access, continuity, and ownership of both air pollution monitoring and hospital records data.

Through further consultation with the UK Reference Group, it was agreed that meteorological and biological relationships between air quality and health outcomes have been well documented in the global literature,[26] allowing us to infer that the same mechanisms exist in all countries. This project therefore does not seek to prove causality between AQ and MNCH, but to encourage clinicians specialised in maternal/perinatal, newborn and paediatric health, considered one of the most trusted professions in the world and powerful agents for systemic change,[27,28] to share their own experiences. These firsthand observations can create an

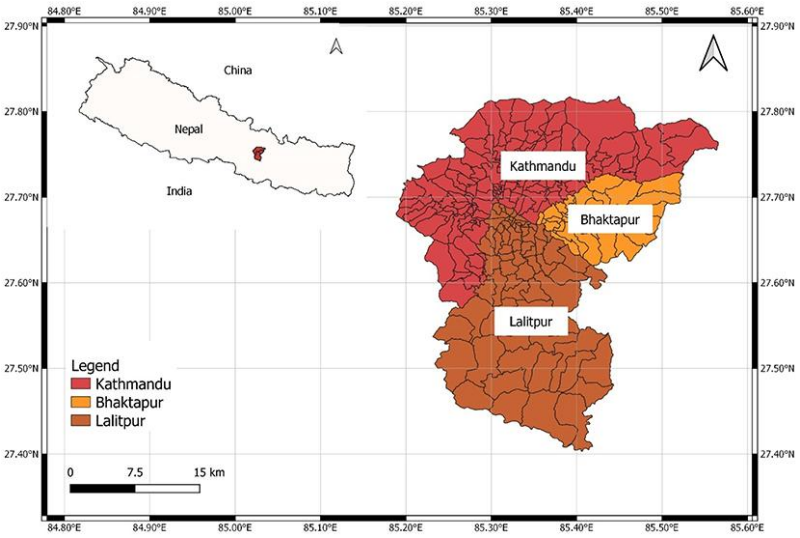
impactful advocacy strategy and encourage policy change, by providing concrete examples of how air pollution can impact health globally, in particular where senior clinicians at the head of national professional bodies often enjoy strong lateral linkages with their senior peers in political and policy-making circles.

This foundational report — the first in a series — has been developed by the paediatric association partners NEPAS, PAN and SAPA, to deliver:

1. A rapid synthesis of country-specific data on the intersections between air quality and maternal, newborn, and child health (AQ-MNCH).
2. A preliminary audit and mapping of ongoing AQ-MNCH advocacy interventions and campaigns within each country.
3. A structured landscape review identifying key stakeholders, initiatives, and forums relevant to AQ-MNCH at the national level.

Nepal: Kathmandu Valley

Evidence

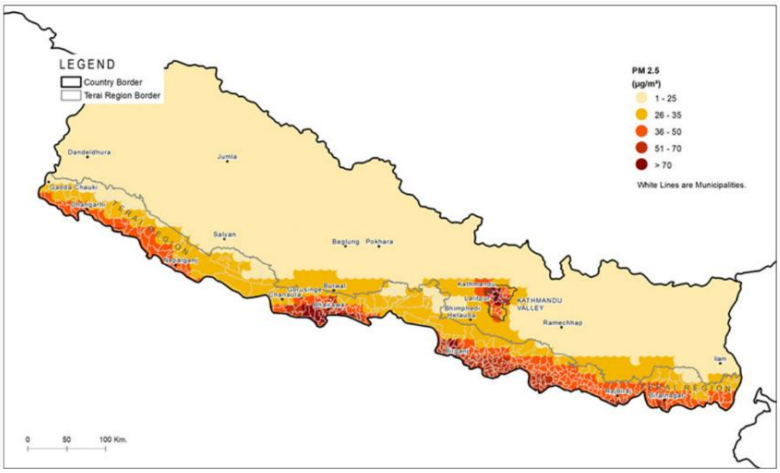


According to the 2020 World Air Quality Report, 37 out of the 40 most polluted cities globally are located in South Asia.[29] There has been a significant upward trend in greenhouse gas emissions, particularly methane and nitrous oxide, from 1990 to 2020.[30] Among South Asian countries, Nepal recorded the highest increase in particulate matter ($PM_{2.5}$) concentrations, rising from 87.6 $\mu g/m^3$ in 1990 to 99.7 $\mu g/m^3$ by 2017.[31]

Figure 1. Map of Kathmandu Valley.[32]

Nepal also has the highest rate of premature deaths attributable to air pollution among South Asian countries, with 222 premature deaths per 100,000 persons. The total number of deaths attributable to air pollution in Nepal was 42,100 cases in 2019, a reduction of less than 1 percent over the last 30 years (1990–2019). Despite significant improvements in indoor air quality (which experienced a 42 percent reduction), the increase in deaths caused by exposure to ambient $PM_{2.5}$ and ozone resulted in an average loss of three years in life expectancy per resident.[33]

Kathmandu Valley is surrounded by four mountain ranges: Shivpuri Hills, Phulchowki, Nagarjun, and Chandragiri.[34] The valley is comprised of three districts: Kathmandu, Bhaktapur, and Lalitpur. It has a population of approximately 3 million, with an average population density of 10,189 individuals per km^2.[35]



Severe air pollution levels are observed in Kathmandu Valley (see Figure 2), typically under the influence of its bowl-shaped topography which restricts wind movement and retains pollutants in the atmosphere. This is especially problematic during the winter season (November-February, see Figures 3 and 4 and Table 2) when thermal

Figure 2. Annual average air pollution levels for $PM_{2.5}$ in Nepal for 2021 with Kathmandu Valley highlighted.[36]

inversion occurs in the valley during late night and early morning. Cold air flowing down from the mountains is trapped under a layer of warmer air which acts as a lid. As a result, the pollutants are trapped close to the ground for extended periods of time.[33]

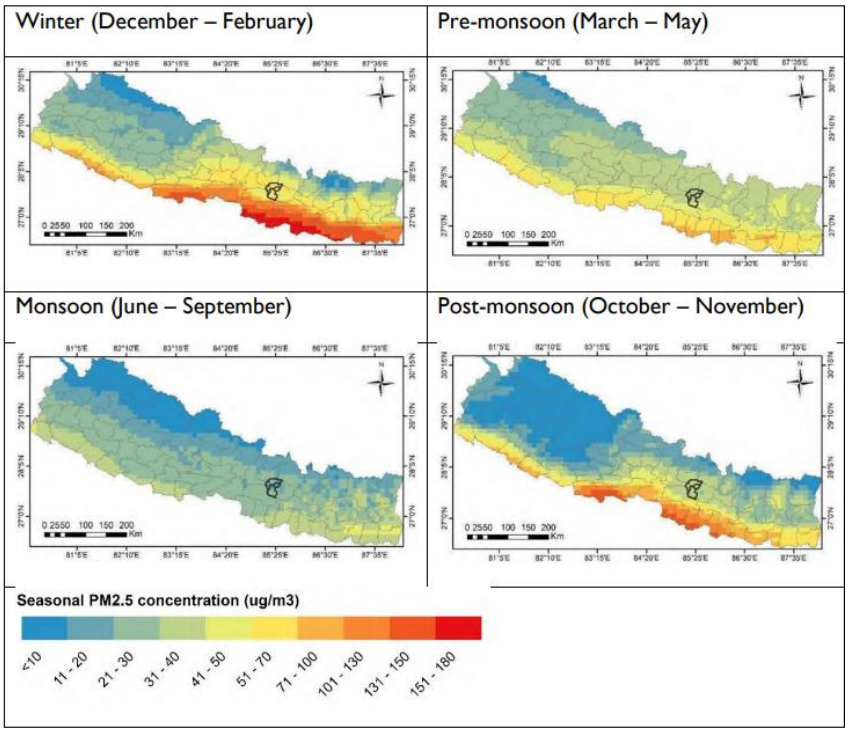


Figure 3. Spatial distribution (grid 0.1o x 0.1o) of seasonal $PM_{2.5}$ concentration (μg/m^3) in Nepal, 2020. Three districts of Kathmandu Valley, Kathmandu, Lalitpur, and Bhaktapur are highlighted.[33]

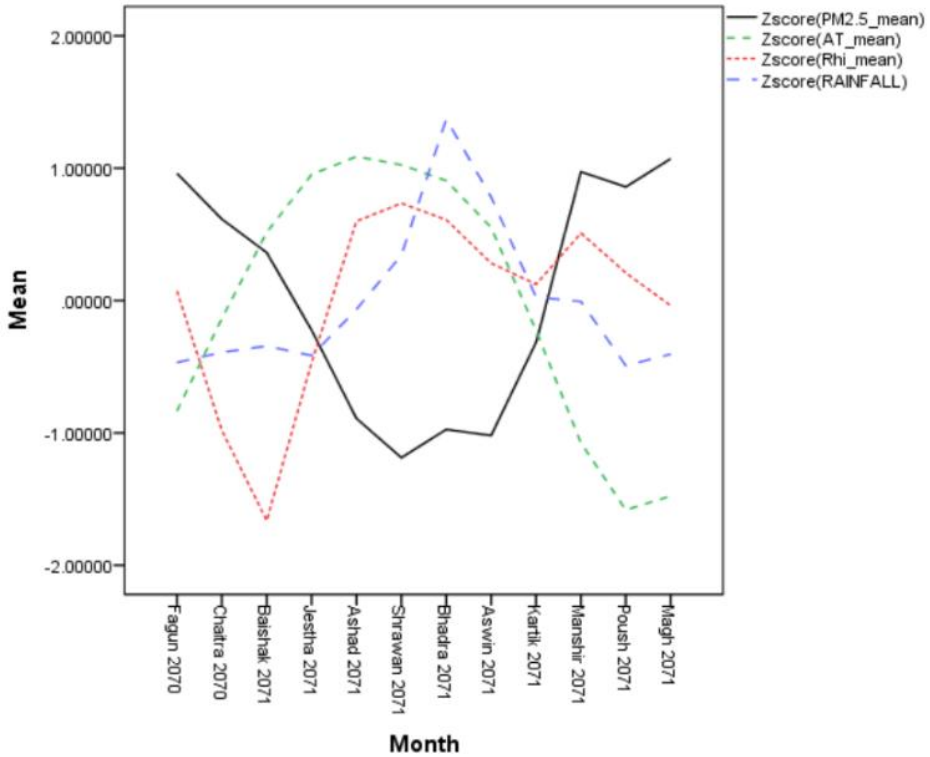


Figure 4. Graph illustrating the average $PM_{2.5}$ concentration (black), average temperature (green), average humidity (red) and average rainfall (blue) in Kathmandu valley in 2013.[b,2]

[b] Data obtained from three air quality monitoring stations.

Season	Month
Spring/Pre-monsoon	Falgun-Baishak
Summer/Monsoon	Jestha-Shrawan
Autumn/Post-monsoon	Bhadra-Kartik
Winter	Manshir-Magh

Table 2. Seasons and corresponding months in Nepal.[2]

The Kathmandu Valley region includes the country's main urban centre and has the greatest population density as well as associated traffic congestion and urban development activities. This feeds high levels of air pollution. Within the valley basin, pollutants are not dispersed and can remain for extended periods of the year, especially during the dry winter months. Nagarjun and Chandragiri experience the greatest $PM_{2.5}$ concentrations. The lowest concentrations are found at Bagmati. Concentrations of $PM_{2.5}$ are lower on the outskirts of Kathmandu, around Lalitpur and Bhaktapur.[33] According to Nepal's Department of Environment, air quality monitoring data shows that for 2021 and 2023 the average annual $PM_{2.5}$ concentrations across 16 monitoring sites in Kathmandu Valley and the Terai are far higher than the WHO's recommended 5µg/m³ (see Figure 5).[36]

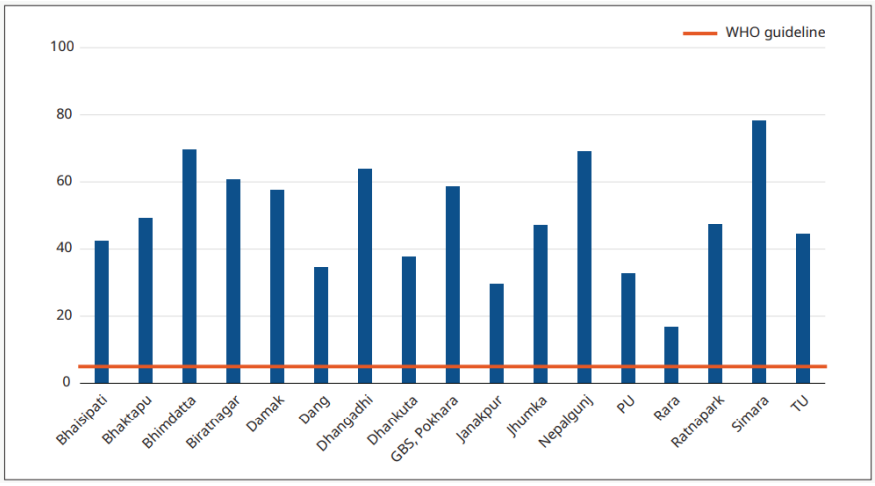


Figure 5. Annual average PM2.5 concentrations for 2021 and 2023 in the Kathmandu Valley and the Terai.[36]

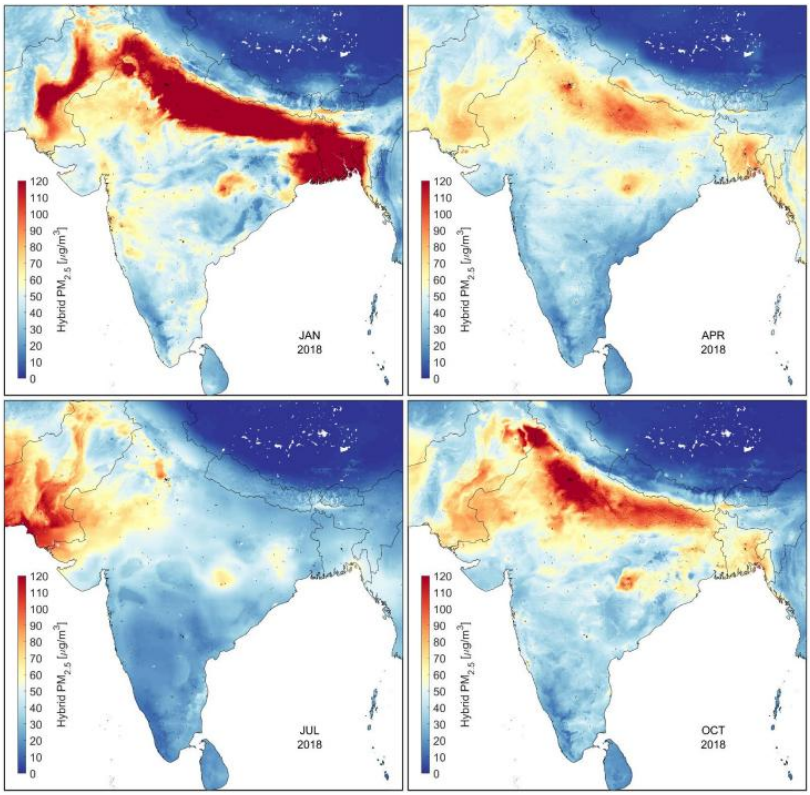


Figure 6. Monthly mean $PM_{2.5}$ over Bangladesh, India and Nepal for January, April, July and October 2018. Circles correspond to ground monitor locations.[37, c]

Vehicular emissions are major sources of air pollutants in Kathmandu Valley, in addition to brick and marble factories and other industrial sources (e.g. Chirag Foam Industry, Guheswori Rolling Mills, Nepal Gas Industry, Ratna Feed Industry, Paper and Pulp Industry, and the Nepal Biscuit Company).[38]

Nepal has several air quality monitoring stations:[33]

- Department of Environment (Nepal): 30 monitoring stations measuring PM_1, $PM_{2.5}$, PM_{10} and total suspended particles, stations in Pulchok and Sauraha measure O_3, and stations in Ratnapark, Dhulikhel, Khumaltar and Lumbini measure CO, SO_2, NOx and O_3.
- US State Department: Two monitoring stations in Kathmandu Valley, highlighted in Figure 7.
- Dristhi (a citizen's group): Ten sensors in Kathmandu.
- Academic and One-off Studies: Various sensors used for specific research purposes.

[c] South Nepal experiences some of the worst air pollution in the country due to forest fires concentrated in the southern Terai region, and the sharing of a long boundary with India, where transboundary pollution from industrial activity, crop burning, and vehicular emissions is significant. Two-thirds of $PM_{2.5}$ exposure in the Terai originates across international borders, particularly from the Indo-Gangetic Plain–Himalayan Foothills region, known for its dense agricultural and industrial emissions.[34]

However, Kathmandu Valley was chosen as our study site due to its high population density, significant vehicle use, and more developed air quality monitoring infrastructure. The Valley is affected by regional pollution transport, with ~25% of its pollution coming from outside the Valley—over half of that from outside Nepal—carried in by prevailing wind patterns and atmospheric conditions.[26]

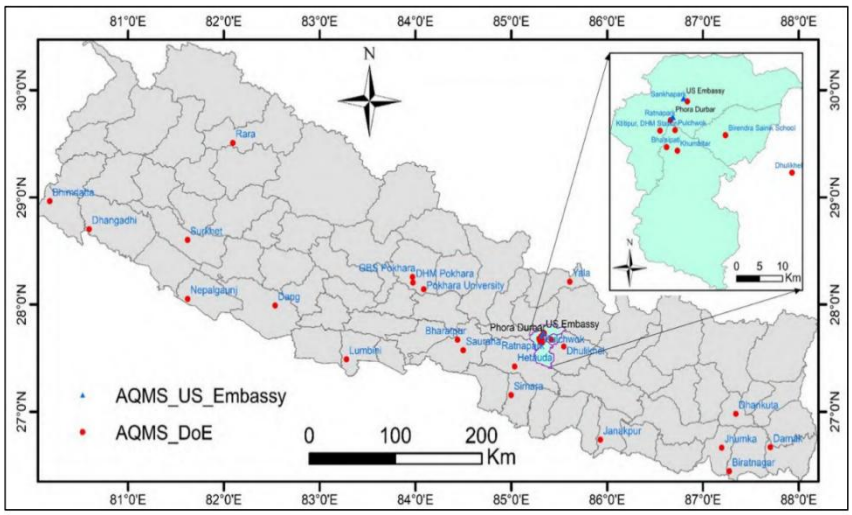


Figure 7. Locations of ambient air quality monitoring stations managed by the DoE, Nepal (red circles) and by the US State Department (blue triangles).[33]

There is a need for more air quality monitoring stations with greater geographical coverage. A significant concern is the use of different types of sensors by various actors (The International Centre for Integrated Mountain Development (ICIMOD), Dristhi, Department of Environment), which hinders comparative analysis and trend determination.[39]

Government data is considered the most valid and authentic by many stakeholders within the air pollution sphere. However, there is a reluctance from the government to make their air quality data fully accessible. Real-time air quality measurements are publicly available on the Department of Environment website, but historic data is not shown. This limits the ability to determine past trends and conduct predictive analysis. Additionally, the data is shared only as text and graphs (over a period of a week), rather than in a downloadable format for analysis and reuse.[40]

Air Quality and Maternal, Newborn & Child Health

A systematic literature search in PubMed and Scopus was conducted using keywords related to population (pregnant women, newborns, infants, and children), exposure (air pollutants, air quality, particulate matter $PM_{2.5}$ and PM_{10}), outcomes (maternal, newborn, and childhood health), and region (Nepal, Kathmandu, Kathmandu Valley). The search revealed a limited number of published articles addressing the relationship between air pollution and maternal, newborn, and child health in Nepal.

One case-control study reported a significant association between indoor air pollution exposure and preterm birth among pregnant women, with an odds ratio (OR) of 2.95 (95% CI: 1.50–5.79) compared to controls.[41] Additionally, the prevalence odds for small-for-gestational-age (SGA) infants were reported at 5.4 (95% CI: 4.9–6.9) among 4,000 pregnant women exposed to air pollution during pregnancy.[42]

A cohort study conducted in Kavre district, Bagmati Province, assessed pregnant women exposed to precipitation, temperature, and $PM_{2.5}$. This study found no statistically significant association between exposure to these environmental factors and adverse pregnancy outcomes, including preterm birth, low birth weight (LBW), and stillbirth.[43]

Apart from the published scientific literature, a report published by Save the Children found that respiratory illness and skin disease are the primary health issues in Kathmandu and Saptari, respectively.[44] The majority of respondents from both districts reported that air pollution had impacted their living and quality of life. The report also highlighted a knowledge gap among women regarding air pollution's impact on health. A policy review revealed disparity in air pollution policy formulation and implementation, underscoring a lack of ownership and commitment.

Advocacy

Environmental protection is the joint authority of local and central government according to the constitution of Nepal. Federalisation in Nepal has authorised provinces and local governments to mobilise resources for developing local responses to climate change. However, local governments struggle to directly and indirectly access international funds earmarked for climate change, and lack mechanisms to prioritise climate change within their own budgets.[45] Local government has been investing negligible amounts on air pollution control except for a few metropolitan cities like Kathmandu, which has increased investment into air quality monitoring.

Although environmental and air pollution issues in Nepal can be addressed by key polices, such as the National Environment Polices, 2019; Environmentally Friendly Vehicle and Transportation Policy, 2014; Industrial Policy, 2011; Civil Aviation Policy, 2006; National Transport Policy, 2002; National Climate Change Policy, 2019; the implementation of these policies are feeble, outcomes are unmeasurable, and some of these polices do not align with the current context. In addition, vertical and horizontal coordination between concerned ministries, departments and local governments remain weak.

Our partner, NEPAS, highlight a pressing need for targeted research initiatives and the sharing of lived experiences, particularly that of children and women who are disproportionately affected by air pollution. To mitigate air pollution through encouraging behavioural changes, advocacy campaigns should involve diverse stakeholders to effectively inform, educate and motivate individual and communities.

Key actors, initiatives and forums

Clean Energy Nepal (CEN)	One successful example of a public awareness campaign is the Maskmandu campaign conducted by Clean Energy Nepal (CEN), where activists placed masks on public statues and laid on the streets to draw attention to air pollution issues. This campaign effectively engaged the government, media, and public.[46]
Cleanup Nepal (EPIC Project)	Cleanup Nepal's EPIC project focuses on measuring $PM_{2.5}$ levels in 40 schools across Kathmandu, generating real-time air quality data, and raising awareness among students and teachers. The project also advocates for evidence-based policy interventions to improve air quality, aiming to create a replicable model for other cities.[47]
Department of Environment (DoE), Ministry of Forest and Environment	The DoE is a government apex body involved in air quality policy formulation, coordination, and the monitoring and evaluation of all stakeholders.

	• Kathmandu Metropolitan City Office, Department of Environment: local government body of Kathmandu Valley involved in the monitoring and control of air pollution.
Family Health International 360 (USAID Clean Air Project)	FHI 360 is leading a consortium of partners, including the Asian Institute of Technology, the Environment and Public Health Organisation, the Energy Policy Institute of the University of Chicago, and One to Watch Pvt. Ltd., in implementing the USAID Clean Air project (2021-2026). The project aims to improve air quality in Kathmandu Valley by installing air quality sensors, conducting community listening tours, and providing technical support to municipalities. It focuses on reducing air pollution and improving health and educational outcomes.[48]
International Centre for Integrated Mountain Development (ICIMOD)	ICIMOD works closely with the National Planning Commission and the DoE.
Nepal Environmental & Scientific Services (NESS)	NESS provides innovative engineering, environmental, social and other scientific services with a focus on sustainable development and environmental stewardship. NESS, through its first private sector accredited laboratory is providing a wide range laboratory services to government, development partners, academia, the private sector, NGOs/INGOs, and communities.[49]
Nepal Forum of Environmental Journalists (NEFEJ)	NEFEJ is an organisation that brings together journalists and environmental experts to raise public awareness and advocate for environment-friendly public policies. They focus on sustainable development and have been instrumental in lobbying for sound environmental policies through public debates, hearings, and media platforms.[50]
Save the Children	Save the Children, through its "Generation Hope" campaign, uses a mascot named Saathi the Air Bear to raise awareness about air pollution among children and young people in Nepal. This initiative aims to empower children and youth to engage in dialogue with policymakers and advocate for climate action.[51]
Social Welfare Council	The Social Welfare Council is a government apex body that coordinates the activities of NGOs and INGOs.[52]
World Bank Nepal	The proposed Nepal Clean Air for Prosperity (NCAP) project aims to reduce $PM_{2.5}$ and precursor emissions from industrial and commercial sources in Kathmandu Valley and the Terai region. These objectives will be achieved through a combination of Performance Based Conditions and project activities through: Component 1: Accelerating Cleaner Production in Targeted Enterprises.

	Component 2: Air Quality Monitoring, Policy Setting, Enforcement Capacity, and Regional Cooperation. Component 3: Project Management, Monitoring, and Capacity Building. Component 4: Contingency Emergency Response Component (CERC).[53]
World Health Organisation (WHO)	WHO is involved in air quality advocacy in Nepal through initiatives like the Urban Health Initiative. They work on building the capacity of key stakeholders, performing joint multisector data analysis, and supporting the establishment of air quality monitoring networks. WHO's efforts are aimed at mitigating the health impacts of air pollution and informing policy changes.[54]

Table 3. Key actors, initiatives and forums engaged with advocacy for better air quality in Nepal.

Nigeria: Greater Lagos

Evidence

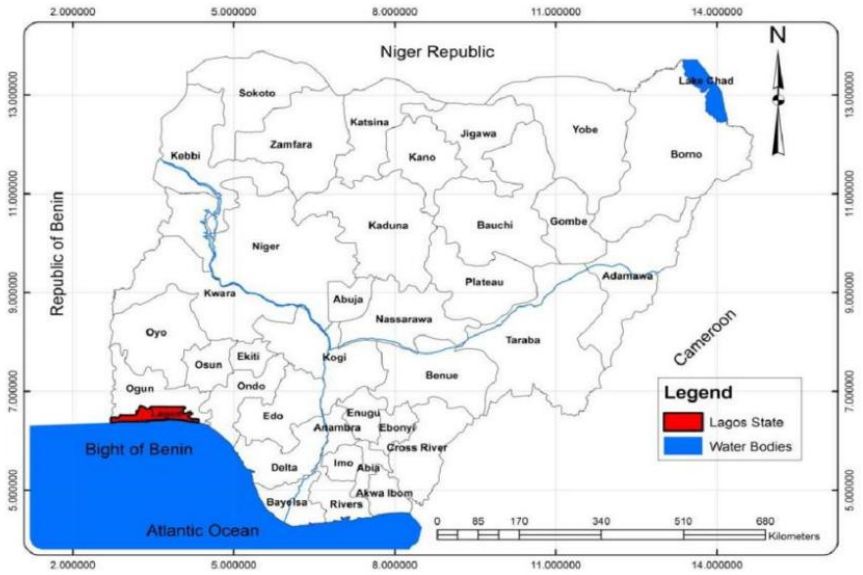


Figure 8. Map of Lagos State

With a population estimated at over 22 million,[55] Lagos is Africa's biggest megacity and is projected to be the continent's fastest-growing city.[56, 57] It accounts for 12% of Nigeria's total population and 30% of its GDP. Despite Lagos state being Nigeria's economic hub, its health indices are as poor as the next state in Nigeria, with a maternal mortality ratio of 555 per 100,000 live births.[58] Lagos State has a concerning neonatal mortality rate, reported as 25 deaths per 1,000 live births in 2023 – equivalent to the average of the world's least developed countries in 2022.[59,60,d] This is the third highest in southwest Nigeria. A significant proportion of these deaths are considered preventable.[61] The under-five mortality rate in Lagos State was also reported as 46 deaths per 1,000 live births.[62]

[d] There is always some uncertainty around definitive mortality rates. WHO cites a neonatal mortality rate range of 22.6-50.7 deaths per 1000 live births for Nigeria in 2023.[60]

According to the State of Global Air data, in 2021 Nigeria recorded over 71,000 newborn deaths attributable to air pollution.[63] Lagos' densely populated urban areas experience high pollution levels from various sources such as vehicular emissions, industrial activities, and waste burning (see Figure 9).[64] An estimated 30% of Lagos' $PM_{2.5}$ air pollution concentrations are attributable to road transport.[56]

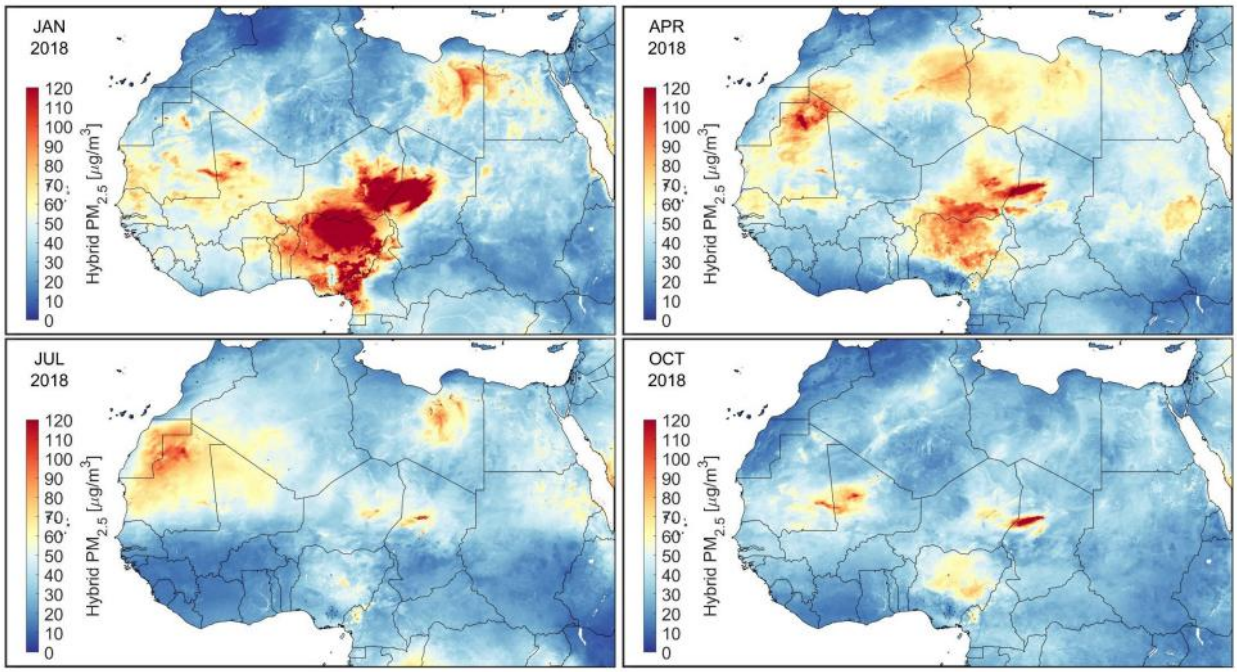


Figure 9. Monthly mean PM2.5 over North Africa for January, April, July and October 2018[37]

Partly because of the operation of the Harmattan wind, blowing north-easterly across the Saharan desert towards West Africa between late November and early March, there is a distinct seasonal pattern to air pollution intensity, including over Greater Lagos (see Figure 10). This, with district-by-district ambient urban pollution differentials, offers an additional option for comparative assessment of AQ impact on health at Lagos maternal and child facilities.

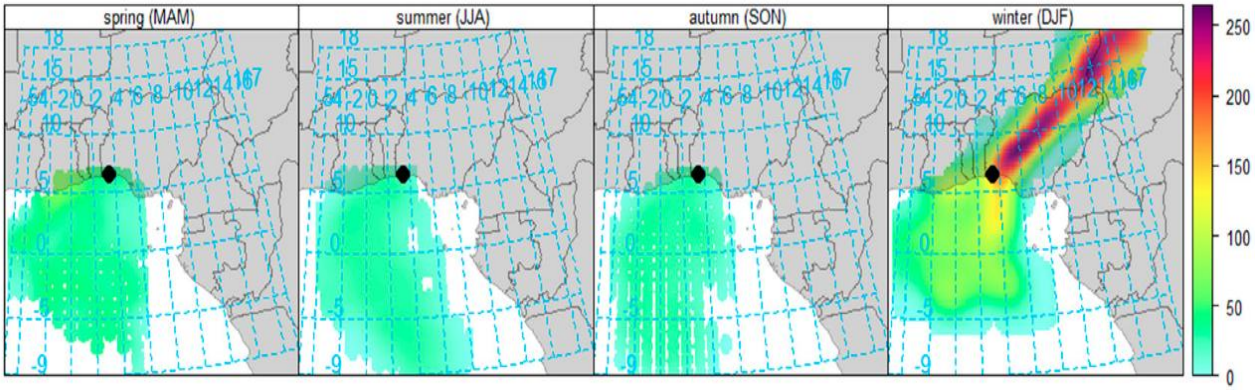


Figure 10. Gridded and smoothed back trajectory concentrations showing mean PM_{10} concentrations in Admiralty Way, VI, Lagos, Nigeria, using the concentration-weighted trajectory methodology grouped by three months (MAM = March, April, May, JJA = June, July August, SON = September, October, November and DJF = December, January, February).[65]

WHO Air Quality Guidelines stipulate that the annual concentration of $PM_{2.5}$ should not exceed 15 µg/m^3.[19] Lagos frequently exceeds these guidelines, recording values up to 38.6 $PM_{2.5}$ (µg/m3),[19,66] Historical data in specific locations often show much higher concentrations,

especially in industrial and traffic-congested areas. Data from Lagos State Environmental Protection Agency (LASEPA) show average $PM_{2.5}$ in 2024 for Lagos State was significantly outside recommended levels in individual districts, as noted in Tables 4-7 and Figures 11-14.

These graph and tabular data offer actionable insight into both seasonal patterns of air pollution and quality (for example Banana Island), and focal districts within the metropolis where poor air quality is concentrated.

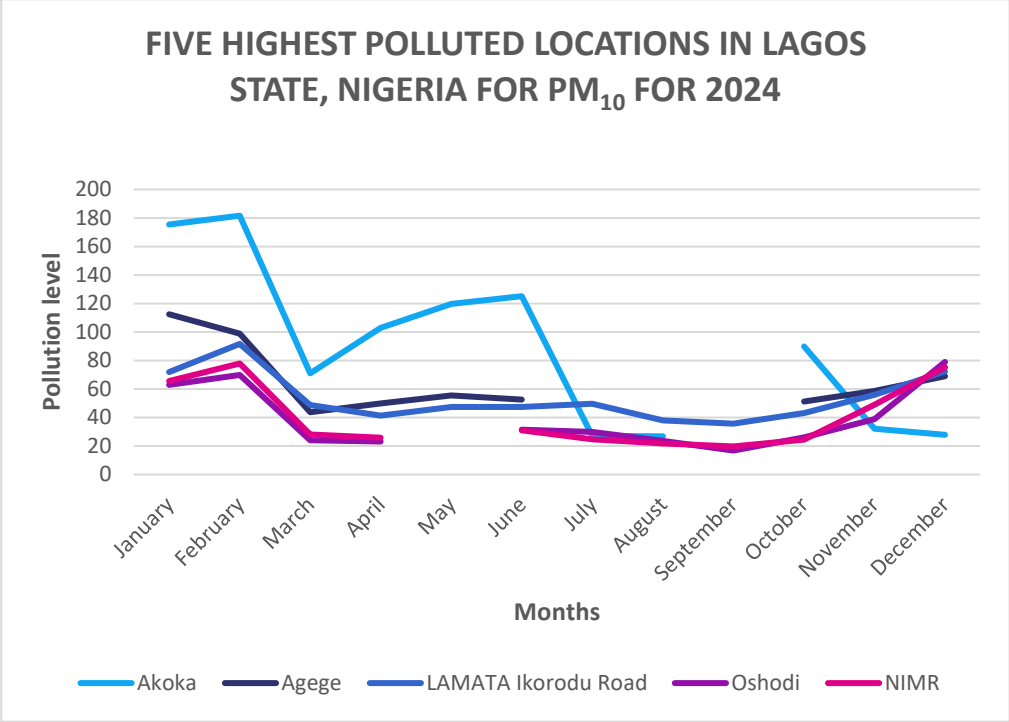


Figure 11. Top five highest polluted locations in Lagos State, Nigeria for PM_{10} in 2024

S/N	Location	Value	Month (2024)
1	Akoka	181.61	February
2	Agege	112.45	January
3	LAMATA Ikorodu Road	91.66	February
4	Oshodi	79	December
5	NIMR	77.9	February

Table 4. Top five highest polluted locations in Lagos State, Nigeria for PM_{10} in 2024

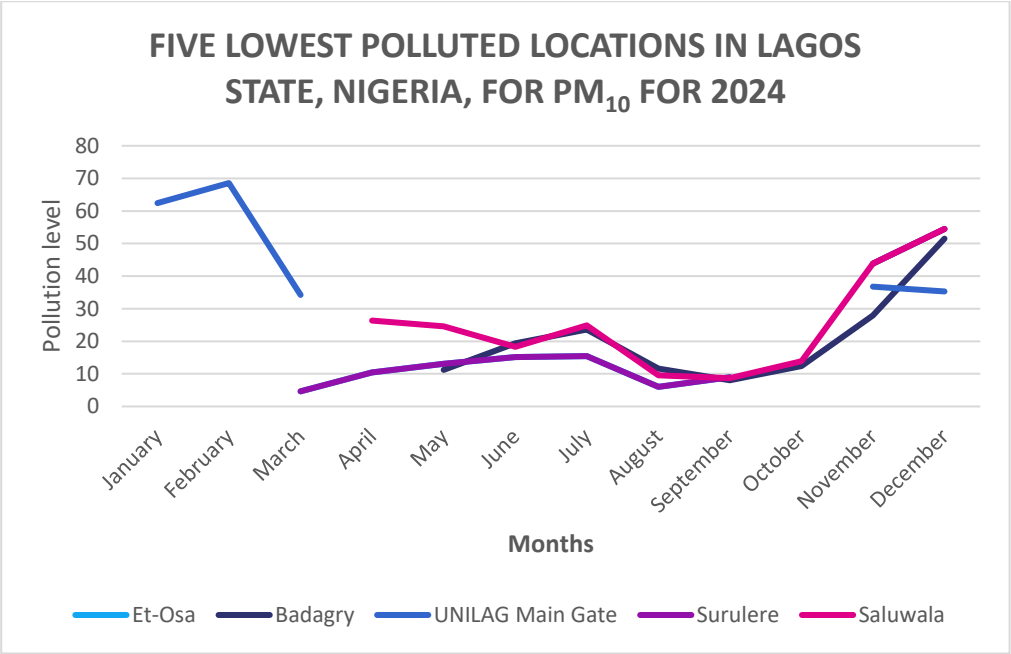


Figure 12. The five lowest polluted locations in Lagos State, Nigeria for PM_{10} in 2024

S/N	Location	Value	Month (2024)
1	Eti-Osa	4.64	March
2	Surulere	4.64	March
3	Badagry	8.04	September
4	UNILAG Main Gate	8.4	September
5	Saluwala	8.86	September

Table 5. The five lowest polluted locations in Lagos State, Nigeria for PM_{10} in 2024

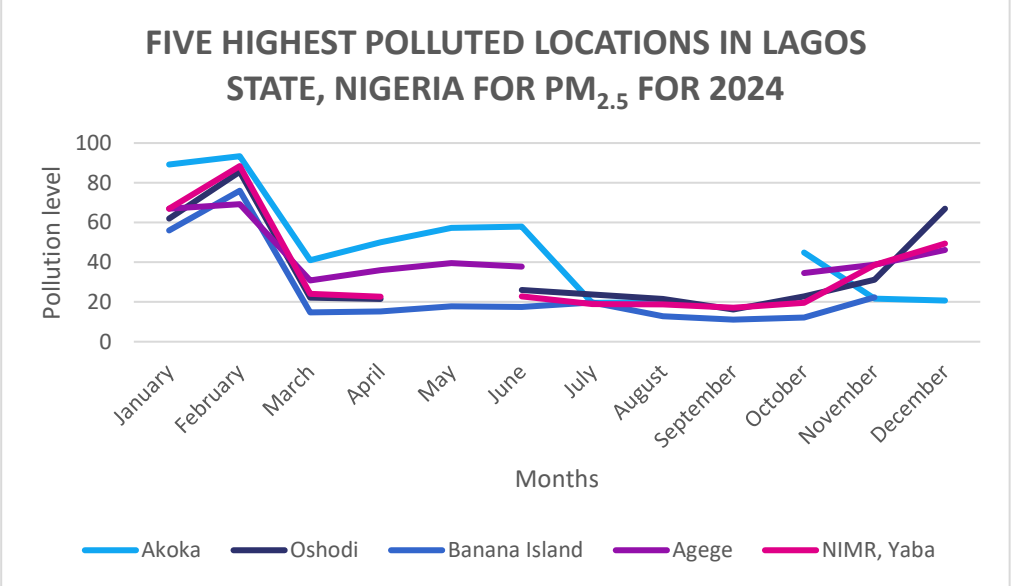


Figure 13. Top five highest polluted locations in Lagos State, Nigeria for $PM_{2.5}$ in 2024

S/N	Location	Value	Month (2024)
1	Akoka	93.38	February
2	NIMR, Yaba	88.42	February
3	Oshodi	83.54	January
4	Banana Island	76.00	February
5	Agege	69.23	February

Table 6. Top five highest polluted locations in Lagos State, Nigeria for $PM_{2.5}$ in 2024

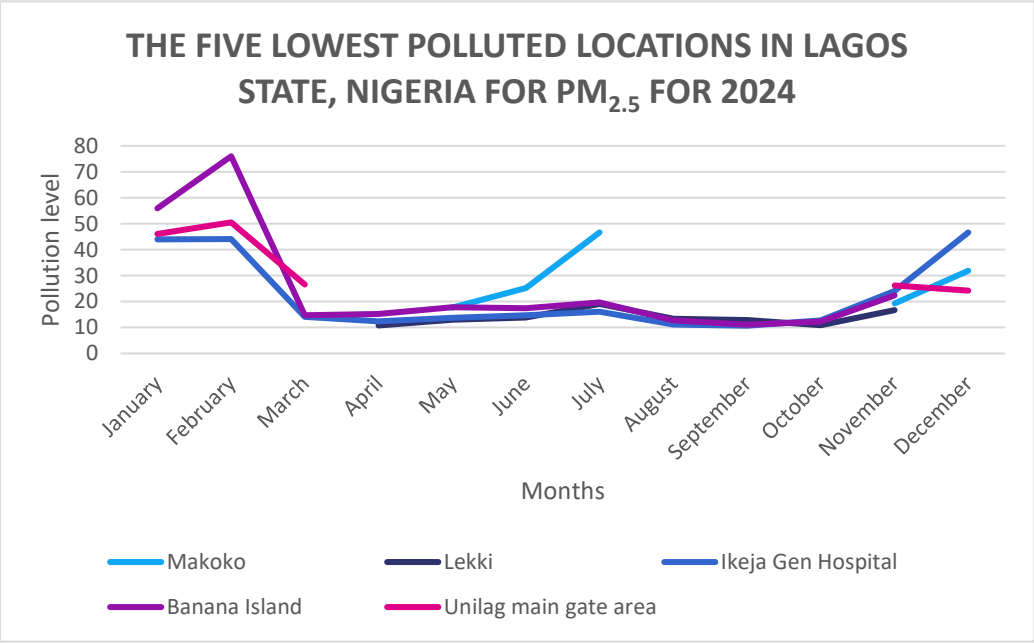


Figure 14. The five lowest polluted locations in Lagos State, Nigeria for $PM_{2.5}$ in 2024

S/N	Location	Value	Month (2024)
1	Makoko	9.69	September
5	Unilag main gate area	9.54	September
2	Lekki	10.08	July
3	Ikeja General Hospital	10.69	September
4	Banana Island	11.11	September

Table 7. The five lowest polluted locations in Lagos State, Nigeria for $PM_{2.5}$ in 2024

Other air pollutants of significance in the Greater Lagos region:

- Monitoring has shown CO levels ranging from 1.00 to 6.0 ppm in residential areas and higher in transport sector locations.[17]
- While some studies reported levels below detection limits, others indicate the presence of NO_2, particularly at traffic intersections.[67]
- Real-time levels of ozone have been reported to be around 14 ppb.[68]
- Sulphur dioxide levels have been measured up to 0.20 ppm in residential areas and higher near transport hubs.[67]

Sources of ambient air pollutants in Lagos are multifaceted but offer clearly demarcated factor-areas for focused policy intervention advocacy.

Transportation: Approximately 2.5 million vehicles are on the Lagos roads daily.[69] With a high density of old and poorly maintained vehicles using fuel with high sulphur content, vehicular emissions are a dominant contributor to air pollution in Lagos. Traffic congestion exacerbates this issue, leading to prolonged periods of idling and increased emissions.[67]

Industries: Industries such as cement, chemicals, furniture, refineries, and steel factories release significant amounts of pollutants into the air.[68]

Power Generators: Private generators meet a large proportion of Lagos's energy demand due to the unreliable public power supply. In fact, 60% of Lagos' energy comes from gasoline/diesel generators.[70] The combustion of gasoline and diesel in these generators is a significant source of air pollution.

Waste Burning: The open burning of municipal and industrial waste is a common practice, releasing harmful particulate matter and other toxins into the atmosphere.[71]

Despite this context, policy and action on AQ and MNCH in Nigeria remains limited. Much of the AQ research done in Nigeria has been on indoor air pollution, where a significant increase in stillbirths was found among mothers exposed to unclean cooking fuels.[72] Using the 2018 Nigerian Demographic and Health Survey data, researchers found that mothers exposed to biomass fuel gave birth to babies with lower birthweight than mothers in lower-polluted households.[73] Another study compared the highly-polluted crude oil refining Eleme community in Rivers State with the non-oil refining community of Ubakala-Umuahia, noting that adverse birth outcomes were twice as high in the pollution-exposed community than in the non-exposed, with a 89% higher risk of low birthweight and a six-times higher chance of congenital abnormalities in the exposed community.[74] No similar studies have been conducted on AQ and MNCH in Lagos State.

AQ is routinely monitored at different strategic places in Lagos and coordinated by the University of the Lagos State Environmental Protection Agency (LASEPA) and the Air Quality Monitoring and Research Group (AQMRG) of the University of Lagos. Readings are published

online in real time, categorised according to WHO thresholds into three levels: highly polluted, moderately polluted, and low pollution.

Our partner, PAN, highlights that the evidence on the health impacts of air pollution globally and in similar urban settings strongly suggests that poor air quality contributes to the adverse pregnancy outcomes, increased infant and child mortality, respiratory illnesses, and possibly other long-term health problems in Lagos State.[e] Addressing these critical issues requires a multi-pronged approach to document causality, pathways to mitigating them, advocacy to policymakers, and public awareness campaigns to educate the population about the health risks of air pollution and ways to reduce exposure.[75]

Advocacy

Nigeria is a multi-ethnic and culturally diverse federation made up of 36 states. The political landscape consists of three tiers of government: Federal, State and Local, and is headed by the President who holds executive power. The country's political landscape is characterised by security challenges and a weakening economy which threaten progress made in its democratic development. Insecurity from kidnapping and banditry in the Northwest and separatist agitations in the Southeast continue to pose serious challenges to democracy. Fuel subsidy removal and naira devaluation have resulted in rising costs of living and unprecedented inflation. Despite these challenges, Nigeria remains a key player in the Economic Community of West African States (ECOWAS) and the African Union, influencing decisions on regional security. Nigeria maintains strong ties with global powers such as the United States, United Kingdom and China in terms of trade, security and economic cooperation.

Nigeria has made considerable strides in technology particularly in its rapidly growing tech ecosystem, with Lagos State as a leading hub. Nigeria is growing technologically especially in areas like Fintech, Tele-Health, Artificial Intelligence (AI), block chain and telecommunications. Nigeria has a strong Fintech sector with many companies offering digital financial services. Telecommunication is widely available across the country. Artificial intelligence (AI) is increasingly being used in various sectors in Nigeria, particularly finance and health care. The government is actively promoting digital transformation across various sectors, to improve productivity and economic growth. Nigeria still has some challenges to her technological development such as limited access to reliable internet; poor electric power supply in most parts of the country, particularly the rural areas; brain drain of skilled tech professionals; and a lack of funding for “start-up” businesses.

The Nigerian healthcare system faces serious challenges such as inadequate healthcare financing, poor health policy implementation and the emigration of essential workers. Nigerian healthcare financing relies heavily on out-of-pocket payments. In 2025, about 5% of the Nigerian budget was allocated to health care which falls grossly short of the 15% benchmark set by the Abuja declaration. With inadequate funding for health and poor health insurance Nigeria has witnessed a massive exodus of healthcare personnel, leading to a low healthcare worker-to-population ratio. The withdrawal of major pharmaceuticals from Nigeria due to insecurity and an adverse economic environment has led to limited availability of essential medications and the skyrocketing of the prices for the few available ones. Therefore,

[e] While gathering evidence on the AQ situation and monitoring in Lagos State, it was noted by the AQMRG, University of Lagos, that the AQ in a community close to the University campus was very poor. Their investigation led them to visit the location, and they found that it was a fishing community whose residents engaged in fish smoking.

most of the populace cannot afford essential medications. The fallout of this scenario is increased visits to alternative health practitioners, late presentation to biomedical healthcare, and higher childhood morbidity and mortality from preventable causes.

The primary healthcare centres (PHC) make up 85% of the nation's healthcare infrastructure and are the first port of call for most Nigerians. However, currently only 20% of these facilities meet basic operational standards due to inadequate funding, insufficient staffing, and limited essential medical supplies. Nigeria is working to advance its healthcare system by strengthening the PHCs through the National Primary Health Care Development Agency (NPHCDA) which focuses on improving access and quality of services. Through the establishment of the Basic Healthcare Provision Fund (BHCPF), the Government aims to improve access to essential health services at the primary level.

PAN

The Paediatric Association of Nigeria (PAN) is the largest body of child advocates in Nigeria and a major voice for children on matters involving maternal and child health in the country. Currently, PAN has a workforce of 1186 members across the 36 states of Nigeria and the Federal Capital Territory. As of April 2025, there are a total of 755 Paediatricians in Nigeria, of which 91 (12.0%) reside in Lagos State (see Figure 15).

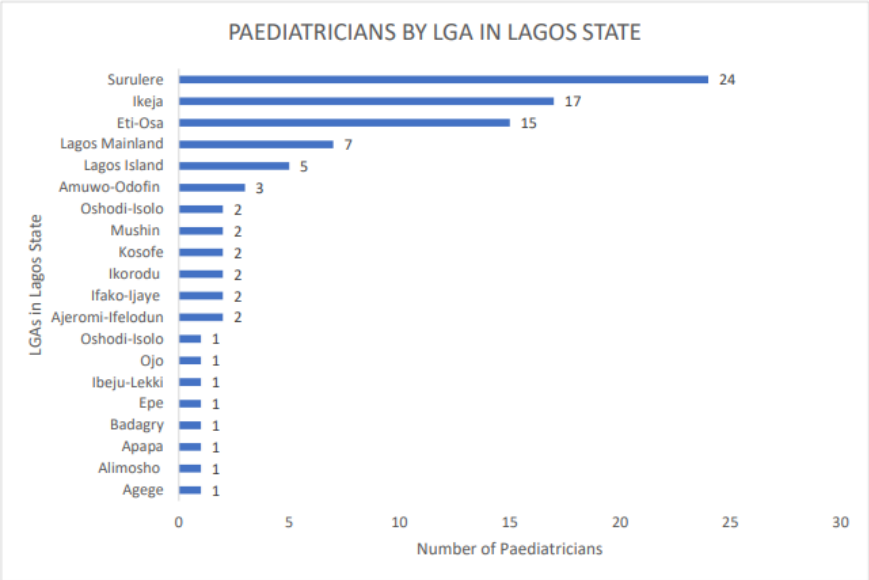


Figure 15. Distribution of paediatricians in various local government areas of Lagos State.

Paediatricians and Paediatric trainees are Ordinary and trainee members, respectively. Nurses and any other medically qualified practitioners in the field of paediatrics and child health can join PAN as associate members. PAN conducts the following activities:

i. Educational training to members and the public through monthly educational webinars in collaboration with sub-specialty societies and committees
ii. Engagement in strategic partnerships with relevant governmental and non-governmental bodies at national, sub national and global levels to promote child health in Nigeria
iii. Partnerships with other international organisations to execute grants on programmes that positively impact on child health

The affairs of the association are managed by an elected PAN Executive Council headed by the President. PAN is a member of the Union of African Societies and Associations of Paediatrics (UNAPSA) and the International Pediatric Association (IPA). PAN notes that while no AQ-MNCH activities have been undertaken by the association, PAN has the capacity to carry out robust advocacy activities in Lagos State, Nigeria and beyond.

Key Actors, Initiatives and Forums in Air Quality, Child Health, Pulmonary Health in Nigeria

S/N	Key Actors	Functions	Organization	Sector	Location
1.	Lagos State Environmental Protection Agency (LASEPA)	Agency focused on safeguarding the environment and promotion of sustainability within Lagos State. They ensure that the air, water and wildlife is protected and improved on by assisting organizations, industries and businesses to comply with environmental regulations.	Government	Environment	Lagos
2.	Lagos State Waste Management Authority (LAWMA)	Agency which ensures the effective collection, transportation and disposal of municipal and industrial waste. The are also responsible for promoting and recycling waste through various programs. They enforce sanitation and environment rules and improve environmental sustainability.	Government	Environment	Lagos
3.	Federal Ministry of Environment and Ecological Management	Agency responsible for addressing environmental issues, coordinating all environmental matters, and implementing policies for issues like desertification, deforestation, pollution, waste management, climate change and clean energy. They raise public awareness about environmental issues and enforce environmental laws, guidelines and regulations.	Government	Environment	Nigeria
4.	National Council on Climate Change	A national designated authority responsible for combating climate change and its impact in Nigeria.	Government	Environment	Nigeria
5.	Environmental Health Council of Nigeria (EHCON)	Agency that promotes the development and advancement of environmental health practices and research	Government	Environment	Nigeria
6.	Nigerian Environmental Society (NES)	Agency that advocates for environmental protection, sustainable development and environmental professionalism	Government	Environment	Nigeria
7.	Nigerian Conservation Foundation (NCF)	Agency that ensures nature conservation and sustainable development and works to preserve biodiversity and promote sustainable use of natural resources	Government	Environment	Nigeria
8.	Environmental Rights Action (ERA)	Agency that focuses on environmental rights and promotes responsible governmental, commercial and individual practices in Nigeria.	Government	Environment	Nigeria
9.	Office of Climate Change & Circular Economy, Ministry of	Agency that aims to solve climate change issues and create circular economy by reducing the increasing carbon emission from waste and turning them into resources	Government	Environment	Nigeria

	Economic Planning and Budget				
10.	National Environmental Standards and Regulations Enforcement Agency (NESREA)	Agency that enforces environmental laws, guidelines, policies, standards and regulations in Nigeria and is charged with establishing air quality standards and enforcing the maintenance of this standards.	Government	Environment	Nigeria
11.	Urbanbetter	An Africa-led global social enterprise which aims to build healthy, climate-resilient urban spaces through data-driven advocacy.	Non-governmental Organization	Environment	Lagos
12.	RAD Environmental and Climatic Protection (RENACLIP)Foundation	A foundation which seeks to maintain a sustainable environment by creating awareness of environment threatening activities, sensitizing the public on promotion of healthy environment, involvement in research and capacity building.	Non-governmental Organization	Environment	Lagos
13.	BlakMoh Wellbeing Foundation	A foundation that fosters environmentally conscious practices, climate change awareness and sustainable livelihoods to ensure a healthy planet.	Non-governmental Organization	Environment	Lagos
14.	African Cycling Foundation	A foundation that advocates for a more inclusive, livable and sustainable Lagos.	Non-governmental Organization	Transportation	Lagos
15.	SustyVibes	A youth group focused on environmental and climate action by making sustainability relatable and actionable for young people in Africa. They carry out various initiatives aimed at promoting environmental sustainability through projects like waste management and supporting youth-led innovative solutions for climate change.	Non-governmental Organization	Environment	Lagos
16.	Lagos Urban Development Initiative (LUDI)	An organization that advocates for a more inclusive, livable and sustainable environment and supports the monitoring of air quality in Lagos State	Non-governmental Organization	Environment	Lagos
17.	Society for Environmental Health of Nigeria (SEHON)	A professional body that conducts research, advocates for policy changes and raises awareness about environmental issues which contributes to the protection of the environment.	Non-governmental Organization	Environment	Nigeria
18.	Nigerian Society for Neonatal Medicine (NISONM)	A professional body whose mission is to consistently contribute to the acceleration in the reduction of newborn death rates in Nigeria	Non-governmental Organization	Health	Nigeria
19.	Society of Gynaecology and Obstetrics of Nigeria (SOGON)	A professional body whose members are committed to improving women's health and rights and reducing maternal and newborn mortality in Nigeria.	Non-governmental Organization	Health	Nigeria
20.	Nigerian Thoracic Society (NTS) - Paediatric Assembly	A professional body whose mission is to improve respiratory health in Nigeria through research, training and advocacy. The World Day of Pneumonia and World Day of Asthma celebrations by the NTS are avenues for advocacy on air quality.	Non-governmental Organization	Health	Nigeria
21.	Air Quality Monitoring Research Group (AQMRG) group University of Lagos	A research hub consisting of researchers, policy makers and advocacy groups from Nigeria, Ghana and Cameroon who work with other organizations to ensure air quality monitoring and modelling by using low-cost censors and reference monitors.	Research Group	Research	Lagos

22.	Nilayo Sports	A sports management and marketing firm which aims to promote sporting activities at all levels. They also collaborate with other organizations like World Athletics. In May 2024, they supervised the installation of an Air quality sensor at the National Institute for Sports (NIS) in Lagos State.	Sports company	Sports	Lagos
23.	Savenhart Investment Limited	An automobile company that promotes green energy transportation by providing electric bikes made specially for the Nigerian terrain.	Automobile company	Technology	Lagos
24.	Center for 21st Century Issues	A group whose aim is to promote the voices of the socially disadvantaged groups into policy processes and implement interventions that seek to promote social justice and eliminate inequality in areas of Health, Environment, Education, water and sanitation.	Civil Society Organization	Health	Lagos
25.	Gbagada General Hospital	A health care centre situated in Akoka, one of the five highest polluted locations in Lagos State for PM10 for the year 2024	Secondary Health facility	Health	Lagos
26.	Orile-Agege General Hospital	A health care centre situated in Agege, one of the five highest polluted locations in Lagos State for PM10 for the year 2024	Secondary Health facility		
27.	Lagos State University Teaching hospital (LASUTH)	A health care centre situated in Ikeja, one of the five lowest polluted locations in Lagos State for PM10 for the year 2024	Tertiary Health facility	Health	Lagos
28.	Eti-Osa Maternal and Child Centre	A health care centre situated in Eti-Osa, one of the five lowest polluted locations in Lagos State for PM10 for the year 2024	Secondary Health facility	Health	Lagos
29.	World Health Organization (WHO)	United Nations Agency with an interest in clean air; regularly monitors air quality and publishes air quality guidelines.	International Organisation	Health	Internatio nal
30.	United Nations International Children's Emergency Fund (UNICEF)	United Nations Agency which aims to protect the rights and well-being of children globally. They advocate for clean air and health environments.	International Organisation	Health	Internatio nal
31.	United Nations Environment Programme (UNEP)	United Nations Agency which focuses on environmental issues including air quality and establishes international frameworks for cooperation on air quality.	International Organisation	Health	Internatio nal
32.	International Union of Air Pollution, Prevention and Environmental Protection Associations (IUAPPA)	Global organisation focused on prevention of air pollution by development and implementation of policies for air pollution prevention and control, environmental protection and sustainable development.	International Organisation	Health	Internatio nal
33.	Climate and Clean Air Coalition (CCAC)	United Nations Environment programme which promotes actions to reduce short-lived climate pollutants which impact on air quality.	International Organisation	Health	Internatio nal

Table 8. Key actors, initiatives and forums engaged with advocacy for better air quality in Nigeria.

South Africa: Johannesburg

Evidence

Figure 16. Map of South Africa.[76]

South Africa is increasingly recognising the public health implications of outdoor air pollution, particularly among vulnerable groups such as children. While there is a growing body of research on this topic, available epidemiological data remains fragmented and geographically limited. Much of the evidence comes from localised studies in pollution hotspots and tends to focus on respiratory health outcomes. The need for nationally representative, longitudinal data remains a pressing gap in the literature. Air quality data in South Africa is primarily gathered through the South African Air Quality Information System (SAAQIS), a platform managed by the South African Weather Service in collaboration with the Department of Forestry, Fisheries and the Environment. SAAQIS monitors pollutants such as PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, and ozone using a network of over 100 monitoring stations across the country. However, data quality and coverage vary widely; most reliable data comes from urban and industrial areas like Gauteng, Mpumalanga's Highveld region, and parts of KwaZulu-Natal.[77]

The WHO provides stringent guidelines for safe concentrations of air pollutants to protect human health. South Africa's National Ambient Air Quality Standards (NAAQS) are less rigorous.[78] This discrepancy is partly due to contextual factors such as veld fires, seasonal dust, and the dry winter conditions prevalent in regions like the Highveld. These natural and anthropogenic conditions make adherence to WHO $PM_{2.5}$ guidelines less feasible in the South African setting.[79]

Major contributors to ambient air pollution in South Africa (Figure 17) include industrial emissions, vehicular traffic, and household fuel burning. The Highveld and Vaal Triangle regions are home to coal-fired power plants and petrochemical industries, making them significant sources of SO_2, NOx, and particulate matter. The highveld priority area, declared in 2007 due to concerning levels of air pollution, is one of the most heavily polluted regions in South Africa. It includes parts of the Mpumalanga, Gauteng and Free State Provinces. It is characterised by intense industrial activity, including coal mining and combustion, which

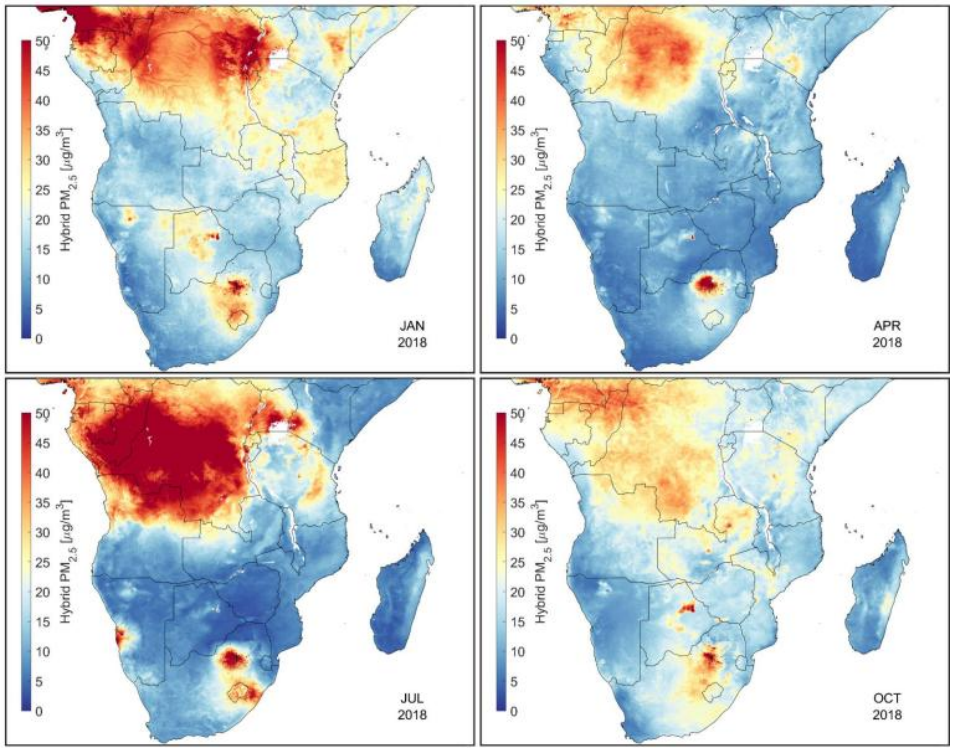


Figure 17. Monthly mean $PM_{2.5}$ over southern Africa for January, April, July and October 2018.[37]

contributes significantly to ambient concentrations of sulphur dioxide (SO_2), nitrogen oxides (NOx), and fine particulate matter ($PM_{2.5}$).[80] In urban areas, vehicular emissions—particularly from minibus taxis and vehicles—contribute to high NO_2 levels. Meanwhile, in many low-income communities, indoor and outdoor air pollution are exacerbated by the burning of coal, wood, and paraffin for domestic use. Other contributors include waste burning, poorly regulated landfills, and seasonal biomass burning during winter months.[80]

Outdoor air pollution was linked to over 22,000 deaths in South Africa in 2019, due to diseases such as ischaemic heart disease, stroke, lower respiratory infections, and chronic obstructive pulmonary disease.[81] Children are particularly susceptible to the health effects of air pollution due to their developing respiratory systems and high exposure rates per body weight.

In children, both outdoor and indoor air pollution have been associated with adverse health outcomes. Studies in Durban found links between indoor $PM_{2.5}$ exposure and poor birth outcomes - including prematurity and low birth weight, particularly in low-income households.[82] Additionally, early-life exposure to household air pollution and environmental tobacco smoke has been shown to increase the risk of wheezing and lower respiratory tract infections in infants.[83] Among school-aged children, those living in heavily polluted regions such as the Highveld Priority Area have reported chronic respiratory symptoms, including coughing and asthma-like conditions.[82] In a recent study done by the South African Medical Research Council, there was some evidence that pneumonia case fatality rates in children under 5 years of age were greater in district municipalities with coal fired power stations (CFPS) compared to those without CFPSs.[80] However, these findings were not statistically significant. There was statistically significant evidence that the birth outcome orofacial cleft lip and palate occurred more in district municipalities with CFPSs compared to those district municipalities without CFPSs.[80]

A 2022 study by deSouza et al. examined the association between in-utero exposure to fine particulate matter ($PM_{2.5}$) and stunting among children across 32 African countries. The study found that higher levels of prenatal $PM_{2.5}$ exposure were significantly associated with

increased odds of stunting, with an odds ratio (OR) of 1.016 (95% CI: 1.002–1.030) per 10 µg/m³ increase in $PM_{2.5}$ concentration.[84] Although South Africa was not included in the country specific analysis due to a limited sample size, the findings suggest that prenatal exposure to air pollution may contribute to undernutrition and stunting in children. These results underscore the importance of addressing air pollution as a modifiable risk factor to improve child health outcomes in South Africa. While both under-five and school-aged children are vulnerable, more literature currently exists on the health outcomes of older children. This gap underlines the need for further research targeting younger age groups, who may experience different patterns of exposure and susceptibility.

Although several studies have explored the effects of air pollution in South Africa, a major limitation remains the absence of long-term cohort studies and the weak integration between environmental monitoring systems and health surveillance data. Much of the current evidence is derived from cross-sectional or ecological studies, which provide limited insight into causality or the progression of health impacts over time. To strengthen the evidence base, future research should prioritise longitudinal designs with more precise exposure assessments, standardised health outcome measurements, and policy-relevant indicators. In addition, incorporating qualitative research methods, such as interviews, focus groups, or ethnographic approaches can provide a valuable and contextualised understanding of how air pollution affects individuals and communities, particularly in vulnerable settings. These perspectives can uncover lived experiences, behavioural adaptations, and perceptions of risk, helping to shape interventions that are both evidence-based and socially responsive.

Johannesburg is home to several key public hospitals, each playing a vital role in the city's healthcare system:

- Chris Hani Baragwanath Academic Hospital (CHBAH), located in Diepkloof, Soweto, is the largest hospital in Africa and a major teaching facility linked to the University of the Witwatersrand
- Rahima Moosa Mother and Child Hospital (RMMCH), situated in Coronationville, specialises in maternal and paediatric care, offering essential services for women and children while also serving as a training site
- Charlotte Maxeke Johannesburg Academic Hospital (CMJAH), found in Parktown, is a central tertiary referral and teaching hospital offering a wide range of specialist services, including oncology, cardiology, and infectious diseases

Several reliable sources provide air quality data near Chris Hani Baragwanath, Rahima Moosa, and Charlotte Maxeke hospitals in Johannesburg. AQI.in offers real-time data for nearby areas like Diepkloof and Davidsonville. SAAQIS (South African Air Quality Information System) operates local monitoring stations such as Jabavu (near Soweto), Davidsonville (near Coronationville), and Observatory (close to Parktown), which track pollutants like $PM_{2.5}$ and PM_{10}. IQAir also covers greater Johannesburg, offering user-friendly data on air pollution and health advice. These platforms help monitor environmental risks around key hospitals and support public health and research. Additionally, the South African Consortium of Air Quality Monitoring (SACAQM), have developed low-cost AI-powered air quality sensors that have been deployed in the Gauteng/Highveld area.

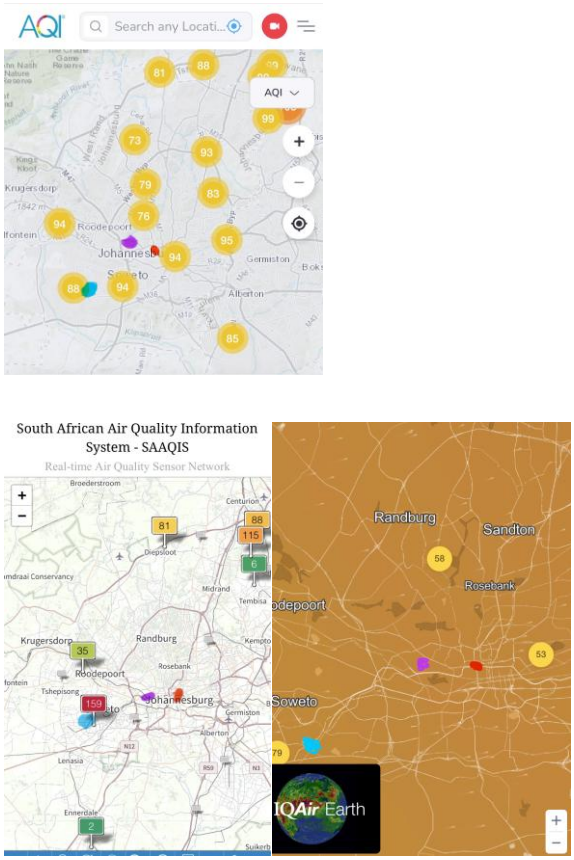


Figure 18a, b and c. Three sources of air quality monitoring data in Johannesburg, with Chris Hani Baragwanath Academic Hospital, Rahima Moosa Mother and Child Hospital, and Charlotte Maxeke Johannesburg Academic Hospital highlighted in blue, purple and red, respectively.

Advocacy

SAPA

The South African Paediatric Association (SAPA) is a non-profit organisation committed to ensuring that all children in South Africa thrive by fostering collaboration among paediatric professionals, families, and both public and private healthcare sectors. As of 2024 it is comprised of 450 active paid members and 2,692 health professionals on its mailing list. SAPA is an advocate for children's rights, particularly those of the most vulnerable, and works to influence health policy and research through partnerships with local and international stakeholders. The association also emphasises continuous professional development by organising conferences, webinars, and workshops that facilitate knowledge sharing and networking among healthcare providers. SAPA has grown into an inclusive and influential body, notably hosting the first International Pediatric Association Congress in sub-Saharan Africa in 2010. Through its multifaceted efforts, SAPA remains a cornerstone of paediatric care and advocacy in the region.

Key actors, initiatives and forums

Research Units	
University of Cape Town	• Paediatric Pulmonology, Department of Paediatrics and Child Health • Centre for Child and Adolescent Lung Health, the Lung Institute includes an allergy and immunology unit • Centre for Environmental and Occupational Health, School of Public Health • Drakenstein Child Health Study • Environmental Humanities South • SA-CARES- South Africa: Climate Air-emissions and Respiratory Health Early Sensing project • African Centre for Cities • African Climate Development Initiative
University of the Witwatersrand, Johannesburg	• Wits Planetary Health Research, Infectious Diseases and Oncology Research Institute
KwaZulu-Natal/ University OF Kwazulu-Natal	• African Health Research Institute • Occupational Health Programme
MACE – Mother and Child in the Environment	Birth cohort longitudinal study examining the effects of environmental exposures on the health and development of a cohort of women attending ante-natal clinics in the South Durban Basin, in comparison to a cohort of women from the less industrially polluted community north of the city. The women will be of similar socio-economic status. Priority outcomes will be indicators of respiratory development, as well as adverse respiratory outcomes. Risk factors to be investigated will include ambient and indoor pollution, dietary impacts, particularly reduced intake of antioxidants, genetic polymorphisms, epigenetic changes and adverse birth outcomes. The proposed investigation will address the hypothesis that asthma risk may be influenced by environmentally induced epigenetic changes. This is cutting edge research, which is gaining momentum in the USA and UK, but still in its infancy in Africa. The MACE study has the advantage of repeated measures of specific environmental exposures, collection of biological specimens over time (as children will be followed from before birth to six years of age), and comprehensive clinical outcomes assessment. This will contribute to a wealth of information on specific environmental triggers and critical time windows of susceptibility. Additionally, an African population will, for the first time, be evaluated in a study of environmental epigenomics.

South African Medical Research Council	The South African Medical Research Council has several notable studies relevant to AQ-MNCH: • **Estimating the Health Impacts Among Communities Living Close to Coal-Fired Power Stations in South Africa** This study, funded by the Foreign, Commonwealth, and Development Office (FCDO), aims to review and summarise global research on the health effects of coal-fired power stations (CFPS), with a specific focus on South Africa. The objectives include analysing mortality and morbidity rates (specifically tuberculosis and pneumonia prevalence), in districts with CFPS and comparing them to similar regions without CFPS. The findings will be shared at a workshop in Gauteng. • **Heavy metals and children's respiratory symptoms and asthma in low socio-economic homes** This project aims to explore the impact of heavy metals on respiratory symptoms and asthma in children participating in the "Mother and Child in the Environment (MACE)," cohort study investigating the effects of ambient and indoor air pollution and the development of adverse respiratory outcomes in children of women living in highly industrialised communities of south Durban and less industrialised communities of north Durban. The findings of this study will have the potential to influence spatial planning policy and ultimately reduce potential exposure to multiple environmental pollutants related to the increase in the prevalence of respiratory symptoms and the burden of asthma. • **Investigating Environmental Exposures in Early Childhood Development (ECD) Centres in Gauteng Province** The South African Medical Research Council's Environment and Health Research Unit is partnering with DataDrive2030 on the Thrive by Five Index 2024 - the second round of the national survey of preschool child development. In a sub-sample of early childhood development (ECDs) in Gauteng Province, the study will monitor temperature variations in the classroom and metal exposure in dust and soil in various areas of the school. This research will investigate how environmental factors may impact young children's health and learning conditions in ECD. • Leveraging Environmental Air Pollution data for Epidemiological Studies (LEAP-Epi) Funded by the Royal Society of Engineering and in partnership with the University of Leicester, the University of the Witwatersrand and North-West University, this project involves testing and implementing low-cost sensors that measure air pollution in two South Africa sites, Soweto (Gauteng province) and Agincourt (Mpumalanga province). The project aims to understand how low-cost sensors fare compared to high grade instruments when collecting air quality data, as well as how they are received by communities and households when implemented in the dwellings and at schools. • **Mining Intervention study**

	A before and after intervention study is conducted in Soweto, Snake Park, a community situated at the base of the Durban Roodepoort Deep Mine. The study aims to evaluate the impact of an educational and domestic hygiene intervention on exposure to indoor dust lead levels. If the interventions lead to a reduction in indoor dust lead levels, the study will inform the development of an awareness campaign to reduce lead exposure in communities located near gold mine dumps. The study holds the potential for a cost-effective measure to reduce exposure to mining-associated toxic substances for hundreds of thousands of households living in the shadow of mining operations and other sites of elevated exposure to toxic substances from industrial sources.
Drakenstein Child Health Study, Western Cape	Drakenstein Child Health Study (DCHS) is a multi-year birth cohort study following 1,000 mother-child pairs to investigate the epidemiology, aetiology and risk factors for childhood lower respiratory illness and the impact on child health, including the development of chronic respiratory disease. The study aims to investigate the role and interaction of potential risk factors covering 7 areas (environmental, infectious, nutritional, genetic, psychosocial, maternal and immunological risk factors) that may impact on child health. Mothers are enrolled at 20-28 weeks gestation and children followed until they reach five years of age. This approach will provide an innovative, longitudinal assessment of a range of clinical, molecular, environmental and socioeconomic variables impacting on childhood respiratory illness and the evolution of chronic disease in a low and middle-income country setting. This study takes place at three sites in the Drakenstein sub-district near Cape Town, South Africa.
Africa Health Research Institute, KwaZulu-Natal	The Africa Health Research Institute (AHRI) is an independent, transdisciplinary scientific research institute based across two campuses in the province of KwaZulu-Natal in South Africa. AHRI's research combines population, basic, social, and medical sciences to understand and intervene in the health and well-being of South African communities. AHRI works in partnership with local communities and South African academic, governmental and other policy stakeholders. AHRI collaborates with over 60 institutions globally, consisting of ~500 scientists, students and staff members.
University of the Witwatersrand, Planetary Health Research, Gauteng	A leading research institution part of the division of Infectious Diseases and Oncology Research Institute (IDORI) at the University of the Witwatersrand, the team conduct cutting-edge globally relevant research into planetary health, with a focus on the effects of climate change on public health. Although based in Johannesburg, the group has a footprint across South Africa, the United Kingdom and Ireland. Projects include: the NIH-funded HE2AT Centre which explores the effects of heat across Sub-Saharan Africa, and the Wellcome funded Bio-HEAT project which looks at the biological mechanisms of the impacts of heat in pregnant women in children in South Africa.

Government	
National Department of Health (DoH)	Primarily responsible for internal / domestic air quality including its impact on health. Regularly hosts an air quality focus group of scientists, health professionals, and air quality officers, although the group is largely concerned with adult health.
Department of Forestry, Fisheries and the Environment (DFFE)	Responsible for enforcing and implementing: 1. Regulatory framework: • National environmental management: Air Quality Act (AQA) which aims to prevent pollution, protect the environment, and promote sustainable development. • Setting national standards: DFFE establishes national norms and standards for air quality monitoring, management, and control that apply to all levels of government. • Atmospheric emissions licensing: The DFFE regulates atmospheric emissions through licensing, ensuring that industrial and other activities meet environmental standards. 2. Monitoring and Reporting: • Ambient air quality monitoring: The DFFE maintains a national air quality monitoring network to track various pollutants and ensure compliance with air quality standards. • State of Air report: An annual report that assesses the state of air quality across the country is compiled by DFFE. • Compliance monitoring and enforcement: The DFFE monitors compliance with regulations and takes enforcement action against those who violate air quality standards. 3. Policy and Planning: • Air Quality Management Plans: The DFFE supports the development and implementation of Air Quality Management Plans (AQMPs) at the provincial and municipal levels. • Strategy development:

	They develop strategies and policies to address specific air quality issues, e.g. the brown haze in Cape Town. • Capacity building: Providing technical assistance and support to provincial and local authorities to build their capacity in air quality management. 4. Collaboration and Partnerships: • Provincial Air Quality Officers forum: The DFFE facilitates collaboration among provincial air quality officers. • South African Weather Service: The DFFE collaborates with the South African Weather Service to ensure real-time reporting of air quality data to the South African Ambient Air Quality Information System (SAAQIS). • Multi-stakeholder forums: The DFFE engages with various stakeholders, including government, industry, and civil society, to address air quality issues
Department of Mineral Resources and Energy	The Department of Mineral Resources and Energy (DMRE) is responsible for regulating the mining and energy sectors in South Africa, with a focus on ensuring health, safety, and environmental compliance. The DMRE also plays a role in managing the broader just energy transition. Role in Air Quality: • Compliance with the AQA: The DMRE must ensure that mining and energy operations comply with the Air Quality Act (AQA). This includes monitoring emissions, approving environmental impact assessments, and enforcing regulations. • Environmental Management Programmes (EMPs): The DMRE approves EMPs for mines, which must address potential air quality impacts. • Monitoring and enforcement: The department conducts inspections and audits to ensure that mining and energy companies comply with air quality regulations and their approved EMPs. • Collaboration: The DMRE collaborates with other government departments, like the DFFE, and other stakeholders to address air quality issues.

	• Focus on industrial emissions: The DMRE also supports regulating industrial emissions from large emitters, such as Eskom and Sasol. Key Areas of Responsibility: • Mining Sector: The DMRE oversees the entire mining lifecycle, from exploration to closure, including environmental management. • Energy Sector: The department regulates the energy sector, including electricity generation, distribution, and the use of liquid fuels. • Just Energy Transition: The DMRE is also involved in the just energy transition. • Mine Health and Safety: The department ensures the health and safety of mine employees and nearby communities. • Sustainable Development: The DMRE promotes sustainable development in the mining and energy sectors, balancing economic and social development with environmental protection.
Professional societies and associations	
Allergy Society of South Africa (ALLSA)	Professional society for medical practitioners and other allied health care workers and scientists involved in the research, diagnosis, treatment and management of allergic diseases. Patient education and CPD training occurs through its foundation, the Allergy Foundation of South Africa.
South Africa Thoracic Society (SATS)	Representative society for pulmonologists, paediatric pulmonologists, cardiothoracic surgeons and respiratory therapists in South Africa. SATS has three key focus areas: • Education and training, including National Asthma Education programme • The development of national guidelines for asthma, COPD & pneumonia • Research and advocacy, including links to the African Thoracic Society
Public Health Association of South Africa	Includes Special Interest Groups on Occupational and Environmental Health, and Climate, Energy and Health.

Working group on climate change and child health	Initiated by members of the UCT, DPCH Advocacy Committee and Child Health Priorities Committee to raise awareness and mobilise paediatric and child health community to address impacts of climate change on child health.

Civil society/environmental/climate change NGOs	
UNICEF	
Greenpeace	Greenpeace emphasises the urgent need for action against air pollution in South Africa, calling for stricter regulations and enforcement to protect public health.
Centre for Environmental Rights	i. Deadly Air Case in Supreme Court of Appeals: Legal Battle for Clean Air: The case involves social and environmental justice groups challenging the South African government for failing to implement regulations to improve air quality in the Highveld Priority Area. The Supreme Court of Appeals heard the case, focusing on the government's obligation to enforce air quality standards. ii. Court Rules No New Coal-Fired Power: Landmark Ruling: The North Gauteng High Court ruled against the South African government's decision to procure new coal-fired power, citing insufficient consultation and consideration of environmental and health impacts. The ruling emphasises the need to protect children's rights and future generations. iii. Eskom's Attempts to Bypass Air Pollution Laws Challenged: Legal Challenge: civil society organisations are challenging Eskom's attempts to postpone compliance with minimum emission standards at several coal-fired power stations. The case highlights the ongoing health impacts and the need for a just transition to cleaner energy.
Deadly Air Court Case	Summary of judgement: The case addresses the severe air pollution in the Mpumalanga Highveld area, arguing that the government's failure to enforce air quality standards violates constitutional rights. The judgement emphasises the need for immediate action to protect public health.
GroundWork	GroundWork is a non-profit environmental justice organisation focused on climate and energy justice, coal use, environmental health, global green and healthy hospitals, and waste. They partner with various organizations including EarthLife Africa, SA Waste Pickers Association, WIEGO, South Durban Community Environmental Alliance, and VEJA.
Vaal Environmental Justice Alliance (VEJA)	VEJA runs campaigns on water pollution, air quality, and energy & climate change. They facilitate school monitoring programs supported by the Bench Marks Foundation to monitor environmental impacts.
South Durban Community Environmental Alliance (SDCEA)	SDCEA has a system for logging pollution complaints. Community members can report pollution issues via a dedicated phone line and WhatsApp.

EarthLife Africa	EarthLife Africa campaigns against coal, advocating for the transition from coal to renewable energy. They focus on preventing new coal-fired power stations and mines and promoting the early retirement of existing coal infrastructure.
Cityzens for Clean Air Campaign	This campaign involves young citizens monitoring air quality in cities like Cape Town, Accra, and Lagos. It integrates physical activity and citizen science to advocate for healthier urban environments.
Life After Coal	Life After Coal is a joint campaign by Earthlife Africa, GroundWork, and the Centre for Environmental Rights. It aims to discourage fossil fuel developments, reduce emissions from existing coal infrastructure, and enable a just transition to sustainable energy.
Policy frameworks	
• UCT library, South African Government Policy: Air quality Includes a list of national, provincial and municipal policies, frameworks and plans. • National Environmental Management Act – Air Quality	

Table 9. Key actors, initiatives and forums engaged with advocacy for better air quality in South Africa.

Conclusion

The inception phase of this project (as presented in this report) has demonstrated a number of positive features relating to the feasibility of a longer-term programme development:

- Successful establishment of partnership between RCPCH Global and Paediatric Partner Organisations in Nepal, Nigeria and South Africa, as well as establishment of Project Reference Group
- Development of a viable methodological model (adaptable in different country contexts) for generating granular data directly from clinical experience in selected sites on the interaction between air pollution and maternal, newborn and child health, to bind with and amplify larger epidemiological datasets and research, with the potential to strengthen the leverage of advocacy domestically within partner LMICs and at regional and global levels
- Mapping and identification of key government and nongovernment actors in the climate change/air quality and MNC health spaces, domestically within partner countries, as the basis for strategising longer-run advocacy engagement, networking and coalition-building around the imperatives of maternal and child health for air quality policy action.

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