ABSTRACT BOOK

EPIC | Clean Air Program

About the Africa Clean Air Forum 2026

The Africa Clean Air Forum is the flagship event of the Africa Clean Air Network (AfriCAN). It serves as a platform to convene policymakers, academia, industry, media and civil society organisations to foster knowledge sharing, collaboration, and cross-border partnerships to address air pollution across Africa.

In 2026, the Forum was organised by the Africa Clean Air Network in partnership with the Department of Forestry, Fisheries and the Environment (South Africa), Gauteng Provincial Government, the City of Tshwane, University of Pretoria, Clean Air Fund, Climate and Clean Air Coalition, C40 Cities, Health Effects Institute and AirQo.

The full programme, list of attendees, and slides are available on the website.

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LIST OF ABSTRACTS

Only accepted abstracts are included in the abstract book.

The scientific contents of the abstracts contained within this book are the intellectual properties of the authors.

Environmental Noise and Particulate Matter Exposures and their Association with Cognitive Performance in Junior High School Students in the Greater Accra Region

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Urbanization in the Greater Accra Region has led to significant increases in environmental noise and particulate matter ($PM_{2.5}$), both of which pose risks to cognitive development in children. Existing studies indicate that noise and $PM_{2.5}$ negatively impact memory, attention, and executive functioning, yet research in Sub-Saharan Africa remains limited. This study investigates how environmental noise and $PM_{2.5}$ influence cognitive performance among Junior High School (JHS) students within two locations, Adabraka (urban) and Asutsuare (rural).

The study assessed the association between environmental exposures (noise, $PM_{2.5}$) and cognitive performance, measured using the Kaufman Assessment Battery for Children (KABC- II). A cross-sectional study design was employed, involving 277 students from Adabraka and Asutsuare. Noise levels and concentrations were monitored over 5 days and 6 months. Cognitive performance was assessed using KABC-II subtests combined into the Fluid- Crystallized Index (FCI).

Data were analyzed using regression models to identify predictors of cognitive performance, adjusting for confounders. Environmental Noise: Indoor noise negatively impacted planning and sequential processing abilities (Adjusted OR: 1.11 [1.02– 1.14], p=0.008). Outdoor noise showed marginal effects on attention and planning. $PM_{2.5}$ Concentrations: Both short-term (5–day) and long-term (6–month) $PM_{2.5}$ exposures were significantly associated with lower FCI scores. Indoor $PM_{2.5}$ levels had the most substantial effect on cognitive performance, particularly on learning and knowledge subscales.

The findings emphasize the need for interventions such as improved indoor air quality and noise reduction in school environments. Policymakers should prioritize strategies to mitigate these environmental stressors, particularly in urbanized regions like Greater Accra, to enhance student cognitive outcomes and academic success.

Keywords: environmental exposures, particulate matter, cognitive performance

Enhancing Climate Data Accessibility in Africa through the Development and Deployment of Miri Air Monitoring Stations

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Africa faces an acute climate data deficiency despite high climate vulnerability, operating with less than one-eighth of the WMO-recommended monitoring station density. Satellite-based observations, while valuable, lack the ground-truth validation necessary for accurate environmental assessment. Miri Africa addresses this gap through Miri Air: solar-powered, modular monitoring stations manufactured in Lagos, Nigeria. Each unit measures environmental parameters, which include meteorological variables, particulate matter ($PM_{2.5}$, PM_{10}), gaseous pollutants (CO_2, SO_2, CO, O_3), and noise levels. Sensors undergo calibration against certified reference standards following WMO-No. 8 guidelines. IoT-enabled cellular connectivity enables real-time data transmission to a cloud platform supporting visualisation, threshold-based alerts, and data export. In partnership with Lagos State Environmental Protection Agency (LASEPA), 100+ stations have been deployed across Lagos State, establishing an open-access dashboard (air.lasepa.gov.ng) that provides public real-time air quality information. Preliminary analysis demonstrates improved spatial-temporal resolution when ground-based measurements are fused with satellite datasets, validating the critical role of surface observations in climate data infrastructure.

Keywords: Air Pollution, Air Quality, Low-cost Sensors, Earth Observation

Advancing Low-Cost Air Quality Sensors for Policy Action in Africa: The Role of Philanthropy

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Air pollution remains a major but under-measured public health and development challenge across Africa. Despite rapid urbanisation and growing exposure to harmful pollutants, many African cities lack reliable, accessible, and policy-relevant air quality data. Reference-grade monitoring infrastructure is expensive and sparse, limiting governments' ability to design effective interventions. Low-cost air quality sensors (LCS) offer a promising pathway to close these data gaps, but their impact depends on validation, contextualisation, and integration into decision-making systems.

This abstract presents lessons from philanthropic investments that have accelerated the development, deployment, and use of LCS across African contexts. Drawing on initiatives in West and East Africa—including city-wide monitoring in Accra, youth-led citizen science in Nairobi and Cape Town, and the establishment of regional sensor evaluation and training centres—the paper highlights how risk-tolerant capital can de-risk innovation, strengthen local capacity, and build trust in LCS data. These efforts demonstrate the importance of evaluating sensors under African environmental conditions, supporting African-led calibration and manufacturing, and prioritising demand-side use of data by city authorities, health professionals, and communities.

The findings emphasise a strategic shift away from hardware-centric approaches toward open data systems, regional collaboration, and policy-relevant applications such as hotspot identification, source attribution, and urban air quality management. By aligning technical innovation with local institutions and governance needs, philanthropic actors can help transform low-cost sensor data into actionable evidence—supporting cleaner air, healthier cities, and climate-resilient development across Africa.

Estimation and Modelling of $PM_{2.5}$ Concentrations in Kinshasa (2022–2024) from MODIS MAIAC Satellite AOD and Meteorological Parameters

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This study aims to estimate surface $PM_{2.5}$ concentrations in Kinshasa, the capital of the Democratic Republic of Congo, using satellite data on aerosol optical thickness (AOD), given the lack of a ground-based monitoring network in the city.

First, $PM_{2.5}$ concentrations were estimated using a semi-empirical physical model based on AOD, horizontal aerosol dispersion, and certain microphysical characteristics of the aerosols. Then, these satellite estimates were compared with the limited in-situ measurements taken between 2022 and 2024 at two sites: the U.S. Embassy (Site 1) and the University of Kinshasa (Site 2).

Two regression models were applied: a simple linear regression (SLR) directly linking AOD to $PM_{2.5}$, and a multilinear regression (MLR) incorporating meteorological parameters illustrating the vertical dispersion of aerosols as well as external influencing factors, namely temperature, wind direction, and precipitation.

The results show that the MLR model improves performance compared to the SLR model. At Site 1, the coefficient of determination increases from $R^2 = 0.51$ to $R^2 = 0.57$, and at Site 2 from $R^2 = 0.65$ to $R^2 = 0.73$, with a reduction in MAE and RMSE.

Seasonal analysis highlights better performance during the rainy season than during the dry season. These results offer significant potential for strengthening air quality monitoring and supporting the development of more effective environmental and health policies in regions where ground-based measurement capacity remains limited.

Keywords: $PM_{2.5}$*; AOD; horizontal and vertical dispersion of pollutants.*

Open-Source Hardware Air Quality Monitors as Infrastructure for Local Capacity Building and Sustainable Monitoring Networks

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Reliable air quality monitoring remains limited in many African cities due to the high cost and operational complexity of conventional monitoring infrastructure. While low-cost sensors have expanded opportunities for distributed air quality measurements, many commercially available monitoring systems remain proprietary, restricting transparency, repairability, and long-term local ownership of monitoring networks.

This presentation explores the role of open-source hardware air quality monitors as a foundation for more sustainable and locally operated monitoring infrastructure. Open-source hardware provides complete documentation of electronic designs, firmware, and system architecture, allowing universities, research institutions, city agencies, and community organizations to fully understand and adapt monitoring technologies.

In many African contexts, where access to specialized equipment and vendor support can be limited, these characteristics are particularly important. Open hardware designs enable local repair, modification, and technical training, reducing dependency on proprietary vendors and lowering the risk that monitoring networks become inactive when devices fail or project funding ends.

Beyond enabling data collection, open-source hardware can support the development of local technical ecosystems around environmental monitoring. Engineering students, researchers, and technical communities can study, modify, and improve monitoring devices, strengthening long-term capacity for air quality management.

The presentation shares examples from projects in Africa utilizing AirGradient's open-source hardware monitors and illustrates how open designs support local deployment, technical learning, and community engagement. These experiences suggest that open-source hardware can play an important role in building resilient and locally owned air quality monitoring networks while expanding access to reliable environmental data.

Keywords: open-source hardware, air quality monitoring, capacity building, sustainable monitoring networks, environmental technology

Designing Sustainable Hybrid Air Quality Monitoring Networks: Enabling Hyperlocal Observations and Local Capacity Building

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Urban air pollution can vary significantly over short distances due to traffic patterns, urban morphology, and localized emission sources. Conventional regulatory monitoring networks, which typically consist of a limited number of reference-grade stations, often lack the spatial resolution needed to capture these hyperlocal variations. As a result, important pollution hotspots and exposure differences within cities may remain poorly understood.

Hybrid monitoring networks that combine reference-grade instruments with distributed low-cost sensors (LCS) provide a promising approach to address this challenge. Reference stations provide high-quality baseline measurements and calibration anchors, while dense networks of lower-cost sensors can significantly increase spatial coverage and enable hyperlocal observations of pollution patterns.

However, the effectiveness and sustainability of hybrid monitoring networks depend heavily on the design of the supporting data and software infrastructure. Systems that rely on proprietary platforms or subscription-based services can create long-term dependencies that limit flexibility and make it difficult for cities and research institutions to sustain monitoring networks once initial project funding ends.

This presentation discusses approaches for designing open and interoperable hybrid monitoring networks that support long-term operation and local capacity development. Particular attention is given to calibration strategies, data integration between reference and sensor networks, and software tools that ensure transparency and data quality.

The presentation also highlights deployments that combine reference monitors with networks of low-cost sensors to study urban air pollution at high spatial resolution, including projects in African cities. These examples illustrate how hybrid networks designed with capacity building, interoperability, and local ownership in mind can provide hyperlocal insights while supporting sustainable monitoring infrastructure.

The Open Air Foundation: Empowering Communities With Air Quality Data to Drive Clean Air Action

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Across many African cities, the true scale of air pollution remains poorly understood due to limited monitoring infrastructure and restricted access to reliable data. Without accessible air quality information, it is difficult for communities, policymakers, and investors to quantify health impacts, prioritize interventions, and build the investment case for cleaner air and healthier cities.

The Open Air Foundation is a newly established philanthropic initiative designed to address this gap by supporting communities in deploying open-source, low-cost air quality monitoring networks. The foundation, which is based in Switzerland, builds on years of experience working with communities facing severe air pollution but lacking the resources and technical capacity to measure it.

By combining affordable monitoring technology with open data platforms, training, and technical support, the foundation helps local partners generate reliable, real-time air quality data that can inform public awareness, policy discussions, and urban planning. Another aim of the foundation is to help communities make their air pollution communication more impactful, translating complex environmental data into messages that resonate with the public, decision-makers, and media.

Over the next five years, the Open Air Foundation aims to donate and deploy 5,000 low-cost air quality monitors with local partners, with many deployments expected in African cities where monitoring infrastructure remains limited.

The foundation was initially established and sponsored by AirGradient, an open-source air quality monitoring company, but aims to expand through support from philanthropic organizations as well as crowd-sourced contributions from environmentally engaged global citizens.

By combining open technology, community partnerships, and scalable philanthropic support, the Open Air Foundation aims to strengthen local capacity and generate the evidence needed to support investment in cleaner and healthier cities.

Keywords: community air quality monitoring, open-source hardware, low-cost sensors, capacity building, clean air investment

The Burden of Ambient Air Pollution on Respiratory Infections in Low- and Middle-Income Countries: Evidence from a Systematic Review and Meta-Analysis

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Exposure to ambient air pollution increases the risk of respiratory tract infections (RTIs). This systematic review and meta-analysis quantified the association between ambient air pollution and RTIs in low- and middle-income countries (LMICs).

We searched Ovid Medline, PubMed, Embase, grey literature and related databases for studies published between January 2000 and December 2024 reporting on ambient air pollution and RTIs in LMICs. Studies reporting odds ratios (ORs) were included in a random-effects meta-analysis.

From 2,201 records, 111 full texts were assessed, with 19 studies included in the systematic review and 8 studies for the meta-analysis. Among the 19 studies, 42% focused on pneumonia, 37% on acute RTIs, 11% on lower RTIs, and one study each on tuberculosis and upper RTIs. The pooled OR for RTIs associated with ambient air pollution was 1.31 (95% CI: 1.09–1.57), with high heterogeneity ($I^2 = 70.4\%$, $p < 0.0001$). Subgroup analyses showed stronger associations among African studies (OR: 2.02, 95% CI: 1.58–2.58) than in Asian studies (OR: 1.16, 95% CI: 0.92–1.45), in studies including all age groups ((OR: 1.68, 95% CI: 1.30–2.18) compared to those focusing on children (OR: 1.20, 95% CI: 0.99–1.46) and for pneumonia (OR: 1.83, 95% CI: 1.49–2.24) compared to other RTIs. PM2.5 was the most consistently associated pollutant (OR: 1.38, 95% CI: 1.08–1.77). Cross-sectional studies showed stronger associations (OR: 2.11, 95% CI: 1.50–2.96) than cohort studies (OR: 1.08, 95% CI: 0.86–1.36). Meta-regression revealed a declining trend in the strength of the association over time from 2018 to 2024.

Ambient air pollution, particularly $PM_{2.5}$, is significantly associated with increased RTI risk, with stronger effects in African settings and for pneumonia. The association appears to weaken in more recent studies, potentially reflecting changing exposure patterns or research methodological advancements

Adoption and Implementation of Air Pollution Control Policies and Legislative Frameworks to Control Air Pollution: A Case Study of the East African Community Member States

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East African Countries experience increasing air pollution trends exceeding World Health Organisation recommended levels. This study examines the extent to which existing climate and environmental policy and legal frameworks among East African countries aim to reduce air pollution and discusses the implementation challenges at the regional and national levels among member states.

The study employed a qualitative approach to review and analyze the existing empirical evidence to examine existing laws and policies that either directly target or indirectly contribute to the control of air pollution using legal and policy content analysis. A narrative literature review was used to identify challenges to the implementation of the frameworks at levels.

Thirty-seven (37) policies and legal frameworks were reviewed, with 54% (20/37) being policy frameworks and 43 % (16/37) being legal frameworks. 16% (06/37) of policies reviewed were at the East African Community regional level, 30% (11/37) from Uganda, 22% (08/37) from Kenya, 16% (06/37) from Tanzania and 16% (06/37) from Rwanda. (65%, 24/36) directly targeted air pollution, while the rest (32%, 13/36), if implemented, would contribute to the control of air pollution. The study did not find any frameworks that address adaptation to air pollution health and non-health effects. Challenges identified include financial limitations, limited accountability and enforcement, low community involvement in the policy process and implementation and limited data availability for decision making.

We demonstrate that the existence of frameworks is not enough to ensure the effective mitigation of air pollution, due to challenges such as financial constraints, lack of government commitment, limited engagement of the communities and availability of data to inform decision-making. Amidst those limitations, we identify that the major gap in the current legislative and policy frameworks is the absence of laws and policies for identifying and prioritizing adaptation strategies.

Key words: Air pollution, Policies, Laws, Frameworks

Particles Pollution in a City in West Africa: Case Study of Urban Ouagadougou

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Nowadays, ambient air pollution is a serious public health issue. Thus, Western African cities are not excluded from this phenomenon. These cities are characterized by rapid and uncontrolled growth with limited means to support this growth, thus contributing significantly to sanitary risks. Indeed, this demographic growth generates a strong need for transportation, which leads to an increase in road traffic emissions and air pollution due to the great rate of poorly maintained engines, unpaved roads, important number of imported second hand vehicles that do not respect emission standards and poor fuel quality. This study assesses particulate and carbon monoxide air pollution levels in the streets of a West African city (Ouagadougou, Burkina Faso). A total of 16 classified measurement sites were selected in the city of Ouagadougou with a uniform spatial distribution. Of these sites, four were traffic proximity sites . The average $PM_{2.5}$ concentrations measured ranged from 18 to 32 µg/m^3 and PM_{10} ranged from 147 to 268 µg/m^3.

Quantifying the Health Burden of Ambient $PM_{2.5}$ and Source-Specific Contributions in Ghana

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Ambient fine particulate matter ($PM_{2.5}$) is a serious health risk factor, contributing substantially to cardiovascular, respiratory, and metabolic diseases burden globally. In sub-Saharan Africa especially in Ghana there is limited understanding of nationally resolved $PM_{2.5}$ attributable morbidity and mortality constraining evidence-based air quality management.

This study presents a 20–year (2005–2024) national assessment of $PM_{2.5}$-attributable mortality and morbidity in Ghana using CAMS reanalysis exposure fields and Global Burden of Disease (GBD 2019) cause-specific concentration-response functions. Health impacts were estimated using a Health Impact Function framework and disaggregated by cause, gender, and region.

Outcomes assessed include ischemic heart disease, stroke, chronic obstructive pulmonary disease, lung cancer, diabetes, respiratory diseases, and child acute respiratory infections. Spatial and seasonal risk patterns were evaluated using normalized health risk scores across administrative regions.

Total annual $PM_{2.5}$-attributable mortality increased from 14,567 deaths in 2005 to 25,417 deaths in 2024, representing a 74.5% rise ($R^2 \approx 0.7$). The most pronounced relative increases were observed for diabetes (+179%), ischemic heart disease (+134%), lung cancer (+122%), and cardiovascular disease (+121%). Seasonal analysis reveals extreme nationwide risk during harmattan months, with January recording mean concentrations of 95.7 µg/m³, while wet-season months (July-September) show substantially lower exposure (~15–17 µg/m³). Northern Ghana consistently experiences higher seasonal risk compared to southern coastal regions.

These findings demonstrate a rapidly escalating and seasonally amplified $PM_{2.5}$ health burden in Ghana, with pronounced spatial disparities. Strengthened national air quality management and targeted regional mitigation strategies are urgently required to curb the growing chronic disease burden associated with ambient air pollution.

Air Quality Measurement: Case Study of Indoor Air Pollution in a Tertiary Institution Library in Nigeria

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The investigation described in this article seeks to identify the current levels of indoor air quality (IAQ) in the Federal College of Agriculture, Akure (FECA) library in Nigeria. The study was conducted in a reading room without a cooling system. The accuracy of the sensor was confirmed before the study by collocating the sensor with a reference monitor at the National Agency for New Technologies, Energy, and Environment (ENEA) reference facility in Italy. The results revealed that the library reading room had various internal thermal conditions, such as temperature, relative humidity (RH), CO_2, PM_1, $PM_{2.5}$, PM_{10}, NO_2, O_3, etc. The temperature levels (28.4–36.30 °C), relative humidity (47.7–67.80 %), PM_1 (0–80 µg/m^3), $PM_{2.5}$ (0–103 µg/m^3), PM_{10} (0–106 µg/m^3), NO_2 (153–276 ppb), O_3 (24–78 ppb), and the concentration of CO_2 (453–6158.1 ppm). The criteria of the World Health Organisation (WHO) and the National Environmental Standards and Regulations Enforcement Agency (NESREA) were not met for PM levels. This shows that there is a relationship between PM and weather. There is a moderately negative correlation between the CO_2 and NO_2 of the location ($r = -0.061$, $p = 0.000$). Similar loadings were seen in the values of PM_1, $PM_{2.5}$, and PM_{10} in the first component (PC1). This shows that all sizes of particles are equal in their contribution to the change in indoor air quality. All parties must make every effort to reduce the effects of pollutants on individuals and library materials, even though they do not pose any potential hazard to library users.

Keywords: Library, SentinAir, pollutants, meteorological parameters, NESREA

Environmental Exposure Disparities in Urban Markets: A Comparative Air Quality Assessment in Lusaka, Zambia

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[1]Levy Mwnawasa Medical University, Zambia [2]University of Michigan, USA

Background: Urban areas exhibit stark infrastructure disparities; unpaved, high-traffic facilities versus paved, enclosed structures. The study quantified $PM_{2.5}$ and PM_{10} exposure differences between market infrastructure types and characterized temporal patterns.

Methods: Conducted in two marketplaces, in Lusaka, Zambia, located 20 km apart, representing paved (control) and unpaved (exposed) environments. Two low-cost PurpleAir sensors were installed at each market to continuously monitor $PM_{2.5}$ and PM10 concentrations, May 25–July 9, 2025. Measurements were recorded every 2 minutes between 7 am and 7 pm, corresponding to market operating hours. Data analysis used synchronized monitoring periods when all sensors were active to minimize temporal confounding. Welch's two-sample t-tests were conducted to compare pollutant concentrations between the two site types, statistical significance set at $p<0.05$.

Results: There were 16,079 observations. Exposure sites recorded significantly higher mean concentrations of $PM_{2.5}$ (32.7 versus 27.6 µg/m³; 95% CI: 3.9–6.2; $t = 8.63$, $p < 0.001$) and PM_{10} (44.4 versus 33.3 µg/m³; 95% CI: 9.7–12.6; $t = 15.05$, $p < 0.001$) compared to control site; increases of 18.5% and 33.3%, respectively. $PM_{2.5}$ levels at exposure sites exceeded the WHO 24–hour guideline value (15 µg/m³) by 118%. Exposure and control sites demonstrated weekday elevations irrespective of infrastructure type for temporal patterns. Control sites revealed weekend-to-weekday; 214% to 228%, whereas exposure sites showed smaller increases of 102% to 105%. Diurnal patterns were observed at both locations, peak concentrations occurring mid-afternoon (15:00–16:00), during maximum market activity and traffic.

Conclusion: $PM_{2.5}$ concentrations were significantly higher in unpaved, high-traffic market environments. There is a need for targeted urban infrastructure improvements such as paving, dust control, and traffic management to reduce air pollution exposure and protect the health of open market vendors.

Key words: $PM_{2.5}$ *, women vendors, exposure*

Financing Clean Cooking Through Carbon Instruments

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This presentation will provide an example of recent clean cooking financing initiatives by presenting the Efficient Cookstoves Project in Uganda.

The Efficient Cookstoves Project in Uganda addresses critical health, environmental, and social challenges by promoting access to cleaner and more efficient cooking technologies. This initiative reduces harmful indoor air pollution, combats deforestation, and empowers local communities, particularly women and children, by alleviating the burden of fuel collection.

This project provides access to locally manufactured, cleaner, and more efficient cookstoves, which use 50% less firewood than traditional stoves. These innovative stoves not only reduce harmful smoke emissions but also alleviate the pressure on Uganda's forests, combating deforestation and contributing to climate change mitigation.

Anthesis collaborates with local organisations to support the manufacturing, distribution, and sales of efficient cookstoves. By purchasing carbon credits, Anthesis helps ensure that these improved stoves are widely accessible to Ugandan households, delivering measurable health, environmental, and social benefits.

This initiative is certified under the Gold Standard, guaranteeing rigorous monitoring, reporting, and verification of its impacts. As a member of the International Carbon Reduction and Offset Alliance (ICROA), Anthesis ensures its projects meet the highest standards for reliability and climate compensation.

The presentation will also invite discussion of the pros and cons of this initiative compared to other clean air financing mechanisms.

Building Open-Source Air Quality Infrastructure for African Cities: Lessons from AirQo

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Access to reliable air quality data across African cities remains constrained by fragmented monitoring systems, siloed technical solutions, and limited regional collaboration in environmental data infrastructure. AirQo, an air quality monitoring initiative based at Makerere University, Uganda, addresses this challenge through a community-driven, open-source approach that prioritises replicability, shared ownership, and local relevance across multiple African countries.

This presentation shares evidence and lessons from AirQo's experience developing and scaling open-source tools, spanning low-cost sensor hardware, data pipelines, calibration algorithms, and web and mobile applications, deployed across cities in Uganda, Kenya, Nigeria, Zambia, South Africa, and beyond. We demonstrate how openly shared infrastructure enables African institutions to build on each other's work rather than recreating solutions in isolation, accelerating collective progress on clean air action.

Central to this work is a model of regional collaboration that connects universities, city governments, national environment agencies, and civil society organisations around shared data infrastructure. By making tools, code, and lessons learned openly available, AirQo has fostered a growing ecosystem of institutions capable of deploying, adapting, and contributing back to air quality monitoring solutions suited to African contexts.

We reflect on both the technical and cultural dimensions of sustaining such collaboration, including governance of shared platforms, community contribution models, and the importance of building systems that outlast individual funding cycles.

Our findings affirm that regional investment in open, collaborative air quality infrastructure yields compounding returns: reducing duplication, expanding monitoring coverage, and strengthening the evidence base needed to drive clean air policy across Africa.

Keywords: open-source, regional collaboration, air quality monitoring, shared infrastructure, African cities

Assessment of Lead (Pb) and Other Heavy Metals Levels in the Ambient Environment in Accra, 2018–2022

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[1]Environmental Protection Authority, Ghana

This study assessed the concentrations of lead (Pb) and other heavy metals in airborne particulate matter across selected EPA monitoring locations in Accra from 2018 to 2022. The objective was to determine the levels, spatial distribution, seasonal variations, and temporal trends of selected heavy metals in the ambient environment at roadside and non-roadside locations.

Airborne particulate matter samples were collected following the ASTM D4096–17 standard method using MiniVol and High-Volume Air Samplers fitted with quartz filters. The collected samples were analyzed using Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF), employing the Amptek Experimenter's Kit Spectrometer with Amptek DPPMCA and bAxil software (version 1.7.0) to identify and quantify the concentrations of heavy metals.

Results from the seven monitoring locations showed that annual mean concentrations of Pb, Mn, As, and Hg were within their respective guideline limits of 0.5 µg/m³ (GS 1236), 0.15 µg/m³ (WHO), 6 ng/m³ (USEPA), and 1 µg/m³ (WHO). However, cadmium (Cd) and chromium (Cr) exceeded the recommended limits of 5 ng/m³ (WHO) and 12 ng/m³ (USEPA) during the assessment period. Aluminum (Al) had no available standard for comparison. Among roadside sites, Amasaman recorded the lowest concentrations for most metals, while Mallam recorded the highest. At non-roadside locations, Dansoman had the lowest concentrations, whereas the North Industrial Area recorded the highest levels.

Median concentrations across roadside locations ranged from 0.02–0.05 ng/m³ for Pb, 3.35–7.38 ng/m³ for Cr, 0.18–0.35 ng/m³ for Mn, and 13.95–22.22 ng/m³ for Cd. Statistical analysis showed significant spatial differences in several metals across monitoring locations and between Harmattan and non-Harmattan seasons. Trend analysis also indicated increasing concentrations of Cd at all locations and rising levels of Pb, Mn, Cr, and Al at selected locations over the monitoring period.

Keywords: Heavy metals, Airborne particulate matter, Ambient air quality, Accra, Seasonal variation.

Assessment of Air Quality Around Selected Factories in Aba and Umuahia Metropolis, Abia State, Nigeria

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This study meticulously examined the ambient air quality surrounding selected industrial establishments in the metropolises of Aba and Umuahia. Ambient concentrations of air pollutants were systematically monitored in proximity to these factories to evaluate the ramifications of industrial activities on local air quality. Five strategically chosen sampling points were established, with measurements conducted during both dry and wet seasons to capture seasonal fluctuations. Sampling was performed three times daily over a span of fourteen consecutive days per season, employing a space-time approach to ensure the representativeness of the data. The pollutants analyzed included NO_2, CO, VOCs, CO_2, $PM_{2.5}$, and PM_{10}, accompanied by various meteorological parameters. The gathered data were juxtaposed with national and international standards, and the Air Quality Index values were computed. Statistical analyses, encompassing ANOVA and correlation, were executed utilizing SPSS software. The findings unequivocally demonstrated a pronounced influence of industrial activities on air quality, with pollutant concentrations consistently elevated at industrial sites in comparison to control locations. PM_{10} levels remained below the NESREA limit of 150 µg/m³ in both seasons, with the peak mean recorded at Pfizer Feed (94.85 µg/m³ during the dry season; 72.42 µg/m³ during the wet season), while control sites exhibited significantly lower values (19.06–22.21 µg/m³ dry; 15.05–16.35 µg/m³ wet). Conversely, $PM_{2.5}$ concentrations surpassed the NESREA standard of 40 µg/m³ at the majority of sites during the dry season (reaching 67.88 µg/m³ at Pfizer Feed) and remained above the permissible limit. Notable correlations were observed, including PM_{10}-$PM_{2.5}$ ($r=0.987$) and CO-CO_2 ($r=0.95$). In light of these findings, it is concluded that industrial facilities significantly contribute to the degradation of air quality, with $PM_{2.5}$, NO_2, and VOCs presenting the most pressing regulatory and health challenges, particularly during the dry season, while CO and PM_{10} predominantly remained within acceptable limits.

KEYWORDS: Air quality, Pollutants, Factories, Air emissions

Using Machine Learning Models to Predict Daily PM_{10} Concentration in the Wet Savanna of Lamto Station in Côte d'Ivoire

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Despite its significant impacts on climate, environment, and public health, air pollution monitoring in Africa is still sparse. This study developed a machine learning framework of four models—namely SARIMAX, Random Forest, XGBoost, and LightGBM—that were trained on a daily basis using 25 meteorological variables from ERA5 reanalysis to reproduce daily PM_{10} surface concentrations in Lamto, Côte d'Ivoire. A total of 2225 daily recorded concentrations from 2017 to 2023 were used, with 80% (1780 days) allocated to training the models and 20% (445 days) for prediction. An assessment of ERA5 reanalysis data against in-situ measurements highlighted its ability to reproduce the pattern of meteorological variables such as temperature and relative humidity, despite some biases. Results show that all models were able to reproduce the observed PM_{10} variations, although they slightly overestimated concentrations during the main wet season (March-April-May-June-July) and underestimated high pollution events in the main dry season (November-December-January-February). Finally, performance analysis revealed that the Random Forest model outperformed, with an R^2 of 0.78 and RMSE of 23µg/m^3, outperforming the other models. This framework successfully demonstrates the utility of machine learning for air quality prediction in West Africa, with potential for future improvements through bias correction and model combination.

Keywords: Lamto, Prediction, PM_{10}, Machine Learning, Air Pollution

Perceived and Measured Ambient Air Quality in a Traffic-Dominated Urban Corridor in Accra, Ghana

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Air pollution represents a major environmental and public health hazard in rapidly urbanising cities, yet the ways in which residents perceive air quality in their daily environments often differ from scientifically measured conditions. Understanding this relationship is important for effective risk communication and public engagement in air quality management. This study examined perceptions of ambient air quality among residents and road users in the Shiashie-La Bawuleshie area of Accra, Ghana, and compared these perceptions with measured particulate matter ($PM_{2.5}$) concentrations. A convergent mixed methods design combined questionnaire surveys (n = 131) with secondary $PM_{2.5}$ periodic data obtained from a MiniVol air quality monitor between January and December 2022. Descriptive statistics, inferential analysis, and thematic content analysis were used to examine patterns in perception and exposure. Results showed that average $PM_{2.5}$ concentrations exceeded the World Health Organization annual guideline value by more than 9.7 times. Qualitative findings revealed that the perception-measured gap is largely explained by reliance on sensory cues and the visibility of pollution. Despite these elevated pollution levels, many respondents perceived morning air quality as good, indicating a notable divergence between perceived and measured conditions. Socio-demographic characteristics were not significantly associated with perceived air quality, whereas road use frequency was significantly associated with perceived morning air quality ($p = 0.03$). These findings highlight the need to integrate public perception with monitoring data to strengthen risk communication and support more effective urban air quality management.

Keywords: Risk perception; Traffic-related emissions; Urban Hazards

Adaptive Optimization of Urban $PM_{2.5}$ Sensor Networks Using LOCATE-Guided Spatial Design and Machine Learning Diagnostics: Case Studies of Kampala Metropolitan Area and Nairobi City

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Rapid urban growth in African cities creates strong within-city variation in particulate pollution, while monitoring networks are often expanded without systematic spatial design. We present a data-driven framework to optimize low-cost $PM_{2.5}$ sensor networks in the Kampala Metropolitan Area (KMA) and Nairobi City by combining spatial statistics with machine-learning diagnostics. Global Moran's I confirmed non-random spatial structure (0.48 in KMA; 0.10 in Nairobi), and Getis-Ord Gi* identified persistent hotspot corridors associated with transport and industrial activity. Distance-decay modeling showed that $PM_{2.5}$ can be predicted reliably within an effective sensing radius of 6–8 km; within this range, Gradient Boosting achieved mean R^2 values of 0.85 in KMA and 0.88 in Nairobi. Redundancy analysis within the inferred radius identified 62–67% of sensors in KMA and 33–64% in Nairobi as candidates for redeployment, while preserving spatial representativeness and Air Quality Index (AQI) risk visibility. Reallocation toward underserved peripheral areas improved exposure equity without compromising exceedance detection. Because optimization emphasizes redeployment of existing devices rather than replacement, the approach supports operational cost savings and sustained evidence generation for public health decision-making. The proposed framework is scalable for adaptive, equitable, and cost-effective air-quality network management across rapidly changing Sub-Saharan African cities.

Spatial Modeling of Ambient $PM_{2.5}$ and Population Exposure in Addis Ababa Using Land Use Regression

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Rapid urban expansion across Africa is increasing air pollution in many major cities, yet limited monitoring networks hinder accurate assessment of pollution levels, spatial patterns, and population exposure. This study developed a land-use regression (LUR) model to estimate annual concentrations of fine particulate matter ($PM_{2.5}$) and to assess population exposure in Addis Ababa, Ethiopia. Our estimated annual mean $PM_{2.5}$ concentrations show significant spatial variation, ranging from 5.9 to 47.9 µg/m³, with a citywide average of 17.3 µg/m³. No part of the city met the World Health Organization (WHO) guideline of annual $PM_{2.5}$ below 5 µg/m³, and 77% of the area exceeded the Interim Target-3 (IT-3) threshold of 10 µg/m³. The highest $PM_{2.5}$ concentrations surpassing the least stringent level (IT-1, 35 µg/m³) were mainly observed in the sub-cities of Arada, Addis Ketema, Lideta, and Kirkos, particularly around dense urban centers and major road corridors. The LUR model performed well, with an adjusted R^2 of 0.74 and an RMSE of 1.85 µg/m³. Key predictors of $PM_{2.5}$ levels included distance to the city's waste dump site, local vegetation coverage, and the lengths of primary and secondary roads, capturing both major pollution sources and land-use features associated with lower emissions or improved pollutant dispersion. Model diagnostics indicated good reliability, with low multicollinearity and no spatial autocorrelation in the residuals. We also estimated population exposure to $PM_{2.5}$ by calculating population-weighted concentrations at both the city and Kebele (the smallest administrative unit) levels. The city-level population-weighted mean exposure was 21.3 µg/m³, while Kebele-level estimates ranged from 13 to 30 µg/m³, indicating significant spatial differences in the pollution burden across the city. Our findings highlight the urgent need for policy measures and targeted interventions to protect public health and advance environmental justice in urban areas.

Keywords: Ambient air pollution, land use, particulate matter, urban air quality, health risk assessment

Air Quality and Public Health Benefits Associated with Waste Management Transition in Casablanca, Morocco

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Poorly managed landfills are important sources of atmospheric pollutants that can affect environmental quality and public health in rapidly growing urban areas. In Casablanca, Morocco, the Mediouna landfill historically represented a major emission source due to waste decomposition, open burning, and related combustion processes. This study evaluates changes in air quality associated with the transition in waste management practices and the progressive closure of the landfill.

Atmospheric data from the CAMSRA reanalysis were used to analyze variations in methane (CH_4), fine particulate matter ($PM_{2.5}$), and carbon monoxide (CO) during two periods: before the landfill crisis and management transition (2015–2018) and after the closure decision and rehabilitation phase (2020–2023). The analysis was conducted within two spatial buffers around the landfill: 50 km (zone 1) and 100 km (zone 2).

Results show a significant decrease in $PM_{2.5}$ surface concentrations in both zones, from 24.3 to 15.3 µg/m³ in zone 1 and from 21.9 to 12.0 µg/m³ in zone 2. Carbon monoxide mass mixing ratios also decreased from 2.55×10^{-7} to 2.13×10^{-7} kg/kg in zone 1 and from 2.57×10^{-7} to 1.92×10^{-7} kg/kg in zone 2. In contrast, methane total column values showed a slight increase, likely reflecting regional methane sources and atmospheric transport.

Using the BenMAP model with the Krewski concentration-response function, the reduction in $PM_{2.5}$ corresponds to an estimated 56 avoided deaths from lung cancer and 117 from ischemic heart disease, highlighting the public health benefits of improved waste management.

Keywords: $PM_{2.5}$ exposure , Methane emissions, BenMAP health assessment, Urban air pollution, Landfill emissions

Air Pollution and Hospital Admissions in Urban The Gambia

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Ambient air pollution is a major contributor to global morbidity and mortality, yet evidence linking particulate matter exposure to health outcomes in West Africa remains scarce due to limited ground-based air quality monitoring. We examined seasonal patterns in particulate matter concentrations and their relationship with hospital admissions in urban areas of The Gambia.

We conducted a 12–month ecological study across the Greater Banjul Area (Banjul, Kanifing, and Brikama), which comprises approximately 64% of the national population. Monthly mean concentrations of fine particulate matter ($PM_{2.5}$) and PM_{10} were obtained from a national network of ground-based air quality sensors deployed through the Clean Air Initiative. Monthly hospital admission counts were obtained from the national Demographic and Health Information System (DHIS). Seasonal differences in $PM_{2.5}$ concentrations were assessed using the Wilcoxon rank-sum test, and monthly patterns in particulate matter and hospital admissions were examined descriptively.

Mean $PM_{2.5}$ concentrations were significantly higher during the dry season than the rainy season (43.3 ± 16.0 vs 19.8 ± 6.9 µg/m³; $p < 0.001$). Across urban areas, mean $PM_{2.5}$ ranged from 27.8 µg/m³ in Banjul to 37.5 µg/m³ in Brikama, with monthly values ranging from 8.0 to 101.1 µg/m³. Monthly trends showed that periods of higher particulate matter concentrations—particularly during the dry season—coincided with increases in hospital admissions.

Using newly available ground-based air quality monitoring data, this study provides some of the first evidence from The Gambia that seasonal variation in particulate matter concentrations may correspond with patterns in hospital admissions. These findings highlight the importance of expanding air quality monitoring and integrating environmental exposures into health system planning in climate-vulnerable regions.

Low-Cost Measurements, High-Value Insights: Source Apportionment for Effective Air Quality Management in African Cities

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This presentation demonstrates how source apportionment can directly support effective air quality management in African cities. By combining traditional filter sampling with spatially distributed PM monitoring, we identify major pollution sources and their temporal and spatial variability. The results demonstrate that cost-effective measurement strategies yield detailed, policy-relevant source information. Such evidence is essential for prioritizing interventions and designing targeted abatement strategies.

Keywords: source apportionment, low-cost sensor networks, chemical analysis, evidence-driven planning and abatement

Building the Evidence for Clean Air: The Gambia's National Clean Air Initiative and Pathway to Regulatory Reform

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Air pollution is a leading global health risk, responsible for millions of premature deaths annually and disproportionately affecting low- and middle-income countries 1. Despite this burden, sub-Saharan Africa has had limited regulatory-grade monitoring infrastructure, constraining evidence-based policymaking.

The Gambia, like many West African countries, has historically lacked continuous, nationwide air quality data. However, in 2024–2025, the Government of The Gambia, through the National Environmental Agency (NEA) in partnership with the Permian Health Lung Institute, and funding from the University of Chicago Energy Policy Institute, launched the country's first coordinated Clean Air Initiative to establish a national air quality monitoring network.

Objectives for this work are: to establish the first nationwide $PM_{2.5}$ and PM_{10} monitoring network in The Gambia; to generate baseline exposure data to inform public health and regulatory decision-making; to support the revision of The Gambia's National Ambient Air Quality Standards (NAAQS); and to identify structural, policy, and legal barriers to achieving sustainable national impact.

Between February and August 2025, $PM_{2.5}$ concentrations were monitored across using calibrated low-cost sensors anchored to a Beta Attenuation Monitor (BAM) reference instrument. Sites included Banjul, Kanifing, Brikama, Farafenni, Soma, Basse, Kartong, Gunjur, Bakoteh dumpsite, and others. Data were analyzed to assess seasonal trends, spatial disparities, and the magnitude of exceedances relative to WHO air quality guidelines (15 µg/m³ daily mean).

Policy impact and regulatory reform include the ongoing revision of The Gambia's National Ambient Air Quality Standards, updates to national vehicle emission policies and transport regulations and review processes for the Waste Bill, and Forestry Bill. Structural, policy, and legal barriers include institutional fragmentation, technical capacity gaps, legal harmonization needs, and resource constraints.

These findings confirm that ambient $PM_{2.5}$ levels in The Gambia frequently exceed WHO recommendations and pose significant risks for global health especially respiratory, cardiovascular, and pediatric health

A Policy Assessment of Gender Equality, Disability, and Social Inclusion (GEDSI) Integration in Uganda's National Waste Management Policies, Air Quality and Pollution

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Uganda's waste management in cities is increasingly marked by environmental degradation and significant public health risks to those who are exposed, particularly due to air and chemical pollution. While policy frameworks exist, they often overlook the intersectional vulnerabilities created by gender, disability, socioeconomic status and age. This study assesses how national policies can reduce marginalised groups' disproportionate exposure to pollutants. The resulting health disparities, and investigated the integration of Gender Equality, Disability, and Social Inclusion (GEDSI) principles into Uganda's waste management and pollution control policies. Specifically, identifying policy gaps that exacerbate the vulnerability of women, youth, and persons with disabilities to chemical and air-borne contaminants. A qualitative desk review of primary and secondary sources, including national regulatory frameworks and international human rights instruments. The analysis was conducted using a GEDSI-responsive framework and a human rights-based approach, including a systematic assessment of policy responsiveness to pollution's differential effects on vulnerable populations, stakeholder consultations to validate findings against lived realities. The findings reveal a dual reality: while Uganda has a strong theoretical policy foundation that acknowledges women's roles in production and sustainable practices, implementation is uneven. Significant gaps remain in the absence of gender responsive budgets, scarcity of GEDSI-disaggregated data, and inadequate accountability mechanisms, thus exposing women, informal waste workers, and people with disabilities to disproportionately high levels of toxic pollutants. The absence of GEDSI lenses in policy enforcement excludes those affected by air and chemical pollution from policy benefits. The study calls for the immediate implementation of GEDSI-responsive budgeting and collection of disaggregated data to track health outcomes, improving government capacity and regulatory enforcement to protecting vulnerable populations from pollution and advocates for a Multisectoral coordination mechanism that aligns waste management with international human rights standards, ensuring environmental justice and equitable health outcomes for all.

Keywords: Policy, Uganda, Gender equality, Air pollution, Waste management

Low-Cost Sensors for Measuring Health Co-Benefits in Climate-Financed Clean Cooking Programs

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Clean cooking programs supported by climate and carbon finance often claim health benefits based on simple adoption surveys or health symptom questionnaires without directly measuring whether air quality has improved. Although improving health is often a priority for clean cooking initiatives, substantial funding for implementation comes through climate finance mechanisms. These mechanisms typically reward fuel switching and/or increased energy efficiency, and do not directly incentivize reducing household air pollution. This misalignment creates a gap between reported health co-benefits and the strength of supporting evidence.

Here, we present a practical approach that uses lower-cost sensors to demonstrate potential health co-benefits of clean cooking programs from reduced air pollution exposure. The approach is intended to improve the credibility of health-related claims while remaining feasible for large-scale implementation. The approach centers on measuring kitchen $PM_{2.5}$ concentrations together with direct energy-use monitoring to strengthen the interpretation of health co-benefit beyond simpler adoption or symptom questionnaires, while remaining more practical than intensive personal exposure measurements.

Applying low-cost sensors in this context requires consideration of methodological and technical challenges. Sensor performance must be appropriate for high and variable $PM_{2.5}$ concentrations often found in biomass-using kitchens, while deployment protocols must address environmental conditions, power constraints, field durability, data integrity, and installation protocols. $PM_{2.5}$ sensor calibration and correction procedures are essential, whether based on prior evidence or project-specific co-location with reference methods. Sampling designs must also capture variation in housing, ventilation, cooking behavior, and fuel stacking, among other factors. Combined with appropriate sampling, low-cost sensors provide an opportunity to embed air quality measurement within digital monitoring, reporting, and verification platforms, helping quantify air quality improvements and strengthen the credibility of health co-benefit claims.

Keywords: Carbon finance, SDGs, $PM_{2.5}$, cookstoves, carbon credits.

Quantifying the Spatiotemporal Patterns of Atmospheric Methane Emissions and Their Associations with Environmental Factors in Bihar, India

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Methane (CH_4) is a potent greenhouse gas with a global warming potential approximately 80 times greater than carbon dioxide over a 20–year timescale. Its atmospheric concentration has increased significantly due to anthropogenic activities such as agriculture, fossil fuel extraction, and waste management. Understanding the spatial and temporal variability of CH_4 emissions is crucial for effective mitigation strategies. This study examines the spatiotemporal distribution of atmospheric CH_4 over Bihar, India, using satellite observations from the Sentinel-5P TROPOspheric Monitoring Instrument (TROPOMI) between 2018 and 2023. We integrate CH_4 concentration data with meteorological variables and vegetation indices, including the Normalized Difference Vegetation Index (NDVI), Enhanced Vegetation Index (EVI), and Gross Primary Productivity (GPP), to assess emission drivers and identify regional hotspots and coldspots. Our findings reveal a 2.8% increase in annual mean CH_4 levels over the study period, with concentrations ranging from 1887.6 to 1939.9 parts per billion. Peak CH_4 emissions occur during the monsoon and post-monsoon seasons (August-October), coinciding with rice cultivation, wetland emissions, and flooding. Spatial analysis identifies hotspots over the mid-Gangetic plains, driven by intensive agriculture, livestock farming, and population density, while coldspots are found in forested and less urbanized southern and northern regions. Statistical analyses show positive correlations between CH_4 and vegetation indices (NDVI, EVI, GPP) and relative humidity ($r \approx 0.4$, $p < 0.01$), while wind speed exhibits a negative correlation ($r = -0.33$, $p < 0.01$), highlighting the role of biomass productivity, moisture availability, and atmospheric mixing in CH_4 variability. Anomaly analyses confirm agricultural and hydrological factors as key drivers of CH_4 emissions. These findings highlight the need for targeted mitigation strategies in flood-prone and agriculturally intensive regions, aligning with India's climate action goals and contributing to global CH_4 reduction efforts.

Keywords: Methane; Spatiotemporal; TROPOMI; Hotspots; mid-Gangetic plains

From the Saharan Oscillation Index to Urban PM10 Extremes: Bridging Dust Dynamics and Air Quality in Morocco

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Sand and dust storms are a growing environmental and public health concern, with North African cities particularly exposed to dust-influenced particulate pollution episodes. Casablanca and Marrakech frequently exceed PM10 air-quality guidelines due to local emissions and Saharan dust transport, yet large-scale circulation's role remains insufficiently quantified. This study develops the Saharan Oscillation Index (SaOI), capturing the Azores High-Saharan depression pressure dipole, and assesses its relevance for PM10 variability and extremes in Morocco.

Using ERA5 sea-level pressure, SaOI is the daily difference between normalised pressure at the Azores High grid point and Niamey, Niger (Saharan low proxy), analysed seasonally. Daily PM10 data (2013–2016) from Casablanca and Marrakech stations are city-averaged, with extremes at the 95th percentile (STARDEX/ETCCDI). Relationships with seasonal SaOI, NAO, and MO are quantified via Spearman correlations; synoptic contexts use ERA5 pressure maps.

Annual PM10 averages correlate significantly and negatively with SaOI, strongest in winter (SaOI positively with NAO, negatively with MO). Extreme PM10 composites show northeasterly-southwesterly flows over Morocco from North Atlantic anticyclones and deepening Saharan troughs, favouring dust advection/stagnation (Casablanca) and southerly transport (Marrakech spring-summer). SaOI complements NAO/MO as a simple indicator for dust-related PM10, aiding North African early-warning/mitigation strategies.

Spatial Mapping of Exposure and Vulnerability to $PM_{2.5}$ and Environmental Parameters Affecting Respiratory Health in Morocco

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This study examines the spatial profiles of environmental exposure and vulnerability to fine particulate matter ($PM_{2.5}$) and key meteorological factors in Morocco from 2017 to 2023. Temperature, relative humidity, and wind speed, were obtained from the ERA5 and ERA5–Land reanalysis datasets. While $PM_{2.5}$ concentrations were obtained from the Copernicus Atmosphere Monitoring Service. Spearman rank correlations were used to identify associations between environmental variables, contributing to the construction of composite exposure indices. The variables were normalized and weighted to generate synthetic exposure scores, then interpolated using kriging in ArcGIS Pro. A vulnerability index was developed by integrating the exposure index with sociodemographic indicators (poverty and illiteracy). Age-standardized mortality rates for chronic respiratory diseases (CRDs), attributable to selected available environmental risk factors, were extracted from the Global Burden of Disease database.

The spatial results indicate that southern and southeastern Morocco experience the greatest exposure and vulnerability. Wind speed plays a major role in these areas by influencing the dispersion of naturally occurring $PM_{2.5}$. The combination of $PM_{2.5}$ and temperature also increases environmental pressure in these regions, characterized by high temperatures, as well as in urban areas heavily exposed to anthropogenic $PM_{2.5}$. Furthermore, relative humidity exerts significant pressure in coastal areas. Northern regions are characterized by a generally higher population adaptive capacity, resulting in lower vulnerability. Statistical analysis shows that mortality from CRDs was highest for ambient particulate matter, followed by suboptimal and low temperatures. These results identify areas where the coexistence of high $PM_{2.5}$ concentrations and environmental conditions is likely to amplify the risk of CRD mortality. This highlights the need for integrated public health strategies that address air pollution and weather conditions, including targeted interventions and enhanced pollution monitoring.

Keywords: Meteorological parameters, $PM_{2.5}$, environmental exposure, vulnerability, chronic respiratory disease risk.

Concurrent Heat and Ozone Episodes in Morocco: A Composite Index Framework

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Concurrent heat and ozone extremes have become more frequent, long-lasting, spatially extensive, and associated with larger health impacts. To operationalize the detection of risk communication, we configured a three-level composite index. The index combined daily summer Universal Thermal Comfort Index (UTCI) and maximum daily 8–hour average (MDA8) for O3 on a 0.1° grid from June to September, standardized each grid cell to a baseline period, forming one-sided upper-tail p-values. Using Fisher's method, we calculated a joint-tail intensity (INT) [0,1] and set three alert levels: L0: INT <0.90, L1: INT ≥ 0.90 and <0.95, and L2: INT >0.975 + 10% of grid cells with INT ≥ 0.975. We identified 287 L1 and 123 L2 days at the national level. The UTCI and ozone showed a statistically positive trend with +0.49 °C and +0.49 ppb/decade, respectively. L2 episodes increased by +1.9 days/decade, while L1+L2 days increased by +10 days/decade. The analysis of the spatiotemporal structure of L1 and L2 events indicated that most days were concentrated under moderate intensity and low coverage, while L2 days were clustered in the high-intensity and high-coverage quadrant, which was consistent with the escalation configuration of our index. The lengths of the L2 events indicated a predominance of short-lived events, with 60% of the L2 days having an L1 day within the previous two days, which supports the configuration of L1 as an early signal. The empirical validation showed consistent thresholds and combination method choices. Integrating health data and forecasting are essential for enhancing risk attribution.

Toward a Universal Air Quality Index: Rationale and Global Implications

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Air pollution is a major global risk factor for premature morbidity and mortality, much of which is preventable. To inform the public, many countries use the Air Quality Index (AQI), which integrates data from selected pollutants into a single metric for specific locations and time periods. AQI systems translate pollutant concentrations into numerical values and color-coded categories that convey potential health risks and guide protective actions. However, current AQI frameworks have notable limitations, including insufficient incorporation of emerging evidence on pollutant toxicity and chemical composition. For instance, metrics such as the oxidative potential of fine particulate matter are not routinely considered, despite their relevance to health outcomes.

In addition, risk communication remains inconsistent, as AQI values and category thresholds vary significantly across countries for the same pollutant concentrations, often leading to public confusion. Communication also tends to emphasize numerical values over intuitive color-based messaging. This paper argues for the development of a Universal Air Quality Index (UAQI) that establishes a consistent relationship between pollutant concentrations, toxicity, and standardized color-coded risk categories. It further recommends prioritizing universal color-based communication to improve public understanding. Establishing a global policy framework to support such harmonization would enable regulatory authorities and policymakers to communicate air pollution risks more effectively and reduce population-level exposure worldwide.

Keywords: Universal AQI, Color coding, Risk information, Citizen science, Influence of media

The Saharan Oscillation Index (SaOI) as a Forecasting Framework for Transboundary Dust and Compound Climate-Health Extremes in Africa

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Africa is disproportionately vulnerable to compound environmental extremes, including severe heatwaves and hazardous particulate matter (PM_{10}) exposure. Standard global climate indices often fail to capture the regional atmospheric mechanisms driving these overlapping hazards. To address this, we characterize the Saharan Oscillation Index (SaOI), a regional atmospheric pressure dipole between the Azores High and the Saharan Low, as a primary synoptic driver.

Utilizing 75 years (1950–2024) of ERA5 meteorological reanalysis and Copernicus Atmosphere Monitoring Service (CAMS) data, we reconstructed the long-term SaOI time-series. We conducted seasonal spatial correlation analyses to map its teleconnections with PM_{10}, dust aerosol optical depth, and surface temperatures across the continent.

Our analysis reveals a post-1990 regime shift toward sustained positive SaOI phases. These phases act as a "climatic pump," simultaneously suppressing regional rainfall and amplifying surface warming (+2°C anomalies). Crucially, the intensified pressure gradient drives massive transboundary uplift of Saharan dust, correlating strongly with hazardous PM_{10} concentrations across North and West Africa. This creates a synchronized "compound exposure" event, significantly elevating the risk of cardiovascular and respiratory morbidity in vulnerable urban populations.

The SaOI provides a unifying framework linking macro-scale climate variability directly to local air quality and health impacts. By validating the predictability of the SaOI, we propose an operational SaOI-based Early Warning System (S-EWS). Forecasting these phase shifts 1–3 months in advance offers a highly cost-effective investment for healthy cities, enabling proactive resource allocation and anticipatory public health defense against transboundary air pollution across Africa.

Regional Modelling and Characterisation of $PM_{2.5}$ Pollution across Southern Africa

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Fine particulate matter ($PM_{2.5}$) is a major air pollutant with significant implications for human health and environmental sustainability. Understanding its spatial distribution and temporal variability is particularly important in regions such as southern Africa, where ground-based monitoring networks remain limited. In this study, the Comprehensive Air Quality Model with Extensions (CAMx) is used to simulate $PM_{2.5}$ concentrations across southern Africa and to investigate their spatial and temporal characteristics. Model outputs are analysed to examine the regional distribution, validate with in-situ observations and to characterise its temporal variability. The results reveal clear spatial heterogeneity in $PM_{2.5}$ concentrations across the southern Africa region, with high levels of concentrations associated with areas influenced by anthropogenic emissions, industrial activities, and regional transport processes. Temporal analysis further highlights the influence of seasonal meteorological conditions and emission patterns on $PM_{2.5}$ variability.

Summarily, the study provides a regional perspective on $PM_{2.5}$ pollution across southern Africa and demonstrates the usefulness of the CAMx modelling framework for understanding air-quality dynamics in data-sparse regions. The findings contribute to improved regional air-quality assessment and provide information that can support future environmental management and policy discussions.

Association Between Ambient Fine Particulate Matter Exposure and Birth Outcomes in Nigeria

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While the association between exposure to ambient fine particulate matter ($PM_{2.5}$) and birth outcomes is well established, evidence from developing countries and the extent of the effects remains insufficient. This study aims to address this gap by analyzing this association in Nigeria and evaluating any potential effect modification.

Employing a fixed-effect logistic regression model and adjusting for potential confounders, including other air pollutants, we explored the association among preterm birth (PTB), low birthweight (LBW), and stillbirth (SB) in Nigeria using data from the 2018 Nigeria Demographic and Health Survey, along with in-utero exposure determined at the household level based on satellite-derived $PM_{2.5}$. Based on the derived exposure-risk functions, we assessed the health benefits of meeting clean air targets.

We found that for every 10µg/m^3 increase in in-utero $PM_{2.5}$ exposure, the odds of LBW, PTB, and SB were 1.08 (95% CI:1.00–1.16), 1.12 (95% CI:0.97–1.29) and 1.09 (95% CI:0.98–1.13), respectively. Sensitivity analysis indicated that first-trimester exposure was more critical for the delivery of preterm and LBW babies, while the third-trimester was critical for SB. A significant p-value trend suggested an increase across exposure quartiles for LBW and PTB; however, the quartile-specific estimates for SB indicated a non-monotonic pattern, with elevated risks observed in the second and highest quartiles. The poorest households had a higher effect on LBW than their counterparts. For PTB, cooking fuel type and maternal BMI were key effect modifiers. Capping $PM_{2.5}$ levels at the Nigerian Air Quality Standard of 20µg/m^3, could decrease the estimated prevalence of LBW, PTB and SB from 1.88%, 1.22%, and 1.64% to 1.41%, 0.78%, and 1.34%, respectively.

Our study provides the first local evidence of this association in Nigeria, which will be pivotal in driving health-centric clean air policies in the country.

Keywords: Particulate matter, Birth outcomes, Health benefits

Bottom-Up Emission Inventory and Future Projections of Particulate Matter and Gaseous Pollutants from Road Transport in Nairobi County, Kenya: Dominance of Two-Wheelers and Diesel Fleets

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Road transport is the dominant source of urban air pollution in rapidly motorizing cities of sub-Saharan Africa. This study presents a comprehensive, bottom-up emission inventory for key gaseous and particulate pollutants from the road transport sector in Nairobi County, Kenya. Vehicle activity data were obtained through extensive 12–hour traffic counts, origin-destination surveys, GPS-derived mileage measurements, and questionnaire-based fleet characterization across major road classes. Emissions of organic carbon (OC), non-methane volatile organic compounds (NMVOC), ammonia (NH_3), carbon monoxide (CO), nitrogen oxides (NO_x), and particulate matter (PM_{10} and $PM_{2.5}$) were quantified using locally adapted Euro IV-consistent emission factors.

The road transport sector emits approximately 5,361 tonnes/year of OC, 1,328 tonnes/year of NMVOC, 191 tonnes/year of NH_3, 9,382 tonnes/year of CO, 6,645 tonnes/year of NO_x, and 149.5 tonnes/year of PM_{10}/$PM_{2.5}$. Two-wheelers (boda bodas) dominate OC (48.2 %), NMVOC (77.3 %), and CO (85.5 %) emissions, while diesel buses account for the largest share of NO_x (72.5 %) and significant PM (27.5 %). Diesel cars and SUVs are the leading source of NH_3 (56.8 %).

Using a compound-growth bottom-up model, business-as-usual projections indicate 3–7–fold increases by 2030 and 6–17–fold increases by 2050 across all pollutants. Moderate and ambitious mitigation scenarios demonstrate that targeted electrification of two-wheelers, modernization of diesel bus and truck fleets, and improved traffic management could reduce emissions by 40–95 % by 2050.

This high-resolution inventory provides the first detailed, locally grounded scientific basis for prioritizing air-quality and climate actions in Nairobi and offers a replicable framework for other East African cities.

Breathing Deadly Air at Home: Evidence from Mavoko and Machakos, Kenya, as an Investment Case for Clean Air

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Household Air Pollution (HAP) from cooking fuels remains a leading environmental health risk in Sub-Saharan Africa, disproportionately affecting urban and rural communities. Despite this burden, detailed chemical characterisation of personal exposures in real household settings is scarce, limiting the evidence base for targeted clean cooking interventions.

Community Health Promoters recruited households within Community Health Units. Personal exposure (cook) and stationary (cooking area) monitoring was conducted in peri-urban Mavoko and rural Machakos sub-counties over 24 hours using UPASv2+ devices. A total of 15 filter samples were analysed by energy-dispersive X-ray fluorescence (EDXRF), with elemental concentrations (ng/m³) corrected for filter area and sampled air volume. Contrasting cooking environments, including charcoal and kerosene use in peri-urban and predominantly firewood use in rural settings was captured.

EDXRF analysis identified two dominant elemental clusters consistent with major source types. The first dominant cluster included K, S and Br; was strongly correlated with PM2.5 (R^2=0.63–0.99), classical biofuel combustion tracers confirming solid fuel burning as the primary driver of indoor pollution. Cu, P, and Se associate with this cluster indicating contributions from high-temperature combustion. The second cluster made of Si, Ca, Ti, Fe, and Mn had weak correlation with PM2.5 (R^2= -0.10–0.22) but strong within the cluster (R^2=0.38–0.99), are consistent with soil resuspension and flyash. Trace Pb levels were detected in one sample (69 ng/m³), indicating occasional exposure to toxic metals.

These findings provide direct chemical evidence linking household fuel use and environmental exposures underscoring the toxicological significance of these exposures beyond mass concentration. While the limited sample size constrains quantitative source apportionment, the results clearly identify dominant exposure sources. The study strengthens the case for investment in clean cooking technologies and improved household energy systems in these settings.

Comparison Between Real-Time Low-Cost Sensor and Gravimetric Sampling Methods of $PM_{2.5}$ in an Urban Background in Lusaka, Zambia

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Gravimetric methods serve as the standard reference for measuring $PM_{2.5}$ [1,2], while real-time low-cost sensors (LCS) offer continuous, immediate readings through light scattering or beta attenuation [3], making them ideal for tracking short-term fluctuations, source identification, and exposure dynamics in dynamic environments like urban areas [4,5]. The study aimed to compare these two methods for PM2.5 data collection in Lusaka, Zambia.

The sampling site was on the roof of the Academic Building Block, Levy Mwanawasa Medical University, representing an urban background location. This is an ongoing, one-year observational environmental monitoring study. The gravimetric measurement applied a GilAir-5 pump (calibrated flow rate 4 L/min) fitted with a $PM_{2.5}$ cyclone to collect PM2.5 on 37 mm Teflon (PTFE) membrane filters for 24 hours (9 am to 9 am) every fourth day. Sampling was conducted from September to November in 2025 (20 days). PM2.5 gravimetric analysis was conducted at the Air Quality Laboratory, SHSPH, University of Pretoria. A PurpleAir LCS continuously collected real-time PM2.5 data during the same study period.

Across the monitoring period, the LCS method consistently reported substantially higher $PM_{2.5}$ concentrations than the gravimetric method. The LCS measurements ranged from 20.82 to 76.2 µg/m³, with an average of 40.19 µg/m³. In contrast, the gravimetric method recorded markedly lower concentrations, ranging from 0.41 to 19.21 µg/m³, with an average of 3.25 µg/m³. Compared with the WHO 24-hour $PM_{2.5}$ guideline of 15 µg/m³, the LCS method generated data exceeding it on several sampling days, whereas the gravimetric method data did not exceed it at any point during the study period.

Conclusion: Preliminary findings indicate that LCS substantially overestimates $PM_{2.5}$ concentrations relative to gravimetric measurements in an urban background setting in Lusaka, underscoring the need for site-specific calibration before LCS data are used for regulatory or health risk assessments.

Portable Air Cleaners as a Targeted Intervention for Reducing Household $PM_{2.5}$ Exposure in Uganda: Early Findings from an Optimization Study

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Exposure to $PM_{2.5}$ is a major contributor to respiratory, cardiovascular, cerebrovascular, and other adverse health outcomes, with disproportionate burdens in low- and middle-income countries. In these settings, reducing indoor exposures to levels approaching World Health Organization guidelines has proven difficult, even when households transition to cleaner cooking fuels, because exposures often reflect multiple sources, including ambient pollution, waste and agricultural burning, and other household activities. The persistence of elevated indoor $PM_{2.5}$ exposures indicates a need for complementary interventions that can further reduce exposure. We evaluated portable air cleaners (PACs) as a potential supplemental intervention in Uganda, with a particular focus on their potential relevance for homes with high-clinical-risk members. The study includes three phases, beginning with controlled experiments on PAC placement and speed setting in homes (Phase I, n=2; Phase II, n=6), followed by a larger user-directed phase (Phase III, n=20). In Phase I, PACs were rotated between multiple rooms at varying speeds for 72–hour periods. In Phase II, PACs were operated at medium speed and rotated between two rooms for one-week periods. PM2.5 was measured continuously indoors and outdoors using nephelometric monitors. Early results indicate that PAC use lowered indoor $PM_{2.5}$ concentrations by an average of 7.2 µg/m3 (95% CI: 4.0–10.3) across 88% of experimental conditions. In Phase II, reductions were observed across all experimental conditions, with an average indoor $PM_{2.5}$ reduction of 4.1 µg/m^3 (95% CI: 1.6–6.6). Results from the first two phases suggest potential for PACs as a targeted clinical or public health option for high-risk households, although more data are needed to evaluate effectiveness, feasibility, and broader applicability. PACs could be particularly relevant in African settings as a targeted measure to protect clinically vulnerable household members while broader air quality policies continue to address the multiple sources contributing to indoor exposures.

Keywords: Filter, household air pollution

Empewo Bwe Bulamu (Air is Life): Kingdom of Buganda Clean Air Action

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Air pollution is an emerging public health and environmental challenge in rapidly urbanizing African cities, yet awareness remains low among the public. Survey results from Kampala, Uganda in 2025 show 95% of respondents had never heard of Air Quality Index (AQI), 94% had never actively searched for air pollution information and 90% underestimated the number of deaths associated with air pollution. Despite low public awareness, the results showed a strong willingness to support interventions such as improved waste management, regulation of old vehicles and increased environmental sensitization.

The Kingdom of Buganda, through its Ministry of Environment, Water, Gender, and Bulungibwansi, is playing a key role in raising awareness about air pollution through *"Empewo Bwe Bulamu" (Air is Life)*—an air quality project funded by the EPIC Air Quality Fund through the University of Wisconsin-Madison. The project has installed 15 real-time low-cost air quality sensors across Kampala. In partnership with New York University Abu Dhabi, a public-facing air quality dashboard displaying sensor data was installed at Bulange, the Kingdom's administrative headquarters. To date, more than 73 air quality ambassadors from all 18 counties of the Kingdom have been trained to use this data to promote awareness across communities. A newly signed Memorandum of Understanding between the National Environment Management Authority and the Kingdom focuses on environmental conservation, under which air pollution management falls, elevating the Kingdom's clean air actions. Together, these initiatives help close the air quality awareness gap contributing to cleaner air for all.

Keywords:Awareness, Kingdom of Buganda, Low-cost sensors, Air quality dashboard

Seasonal $PM_{2.5}$ Sources in Accra, Ghana: Evidence from a Year-Long Measurement Campaign

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Air pollution in rapidly growing West African cities remains poorly characterized, limiting effective mitigation strategies. We present results from a year-long measurement campaign of fine particulate matter ($PM_{2.5}$) in central Accra, Ghana, based on daily 24–hour filter samples collected between September 2024 and September 2025. Filters were analyzed for elemental composition using energy-dispersive X-ray fluorescence (ED-XRF) and for black carbon (BC) using optical transmissometry, providing a comprehensive dataset for receptor modelling.

Preliminary findings reveal persistently elevated $PM_{2.5}$ concentrations, with daily mean value consistently exceeding local permissible level of 35 µg/m^3 and annual mean values exceeding international health guideline of 5 µg/m^3 thresholds. The data also demonstrate pronounced seasonal variability, largely driven by Harmattan dust intrusions, which significantly amplify particulate levels during the dry season. Elemental and carbonaceous analyses reveal a complex mixture of crustal material and combustion-related species, including markers of traffic emissions, biomass burning, and waste combustion. Positive Matrix Factorization (PMF) resolves multiple major sources, including mineral dust, vehicular emissions, biomass burning, secondary/aged aerosol, waste burning, and marine influence.

A key strength of this study is the ability to quantify source contributions across an entire annual cycle, capturing both wet and dry seasons. Such temporally resolved source apportionment remains rare in Accra and, more broadly, in West Africa, where previous studies are largely limited to shorter campaigns conducted over a decade ago. Given the rapid urbanization, increasing motorization, and evolving waste practices in Accra, updated source profiles are critically needed.

The results highlight the dual importance of regional and local sources: while Saharan dust dominates seasonal peaks, local emissions from traffic, household energy use, and waste burning contribute substantially to year-round exposure. These findings provide an evidence base for targeted air quality management in Accra and similar urban environments.

Keywords: Source apportionment, West Africa, Air quality policy

Mainstreaming Clean Air Action for Prosperous, Vibrant and Healthy African Cities

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Mainstreaming clean air interventions across multiple policy focus areas is critical for effective air quality management. For resource constrained cities, the initial challenge is to make the case that cleaning up the air will also result in a myriad of other benefits to the economy, public health and well-being. In addition, enabling policy frameworks should be designed to reduce investment uncertainty and lower financing costs. In this paper, we will present recommendations for the development of legislative frameworks for Clean Air Zones (CAZ), using the City of Johannesburg (CoJ) as a case study. This includes an account of legal pathways for implementation and alignment with the CoJs energy, climate and air quality legislation. The recommendations are based on an assessment completed for the ongoing project to develop a CAZ policy for the CoJ. It is important for cities to understand that supporting regulatory frameworks that enable the declaration of CAZs can be done while also stimulating green growth. There will be immediate and localised benefits to communities but to achieve substantial benefits, CAZ's should ideally be implemented at scale. This is especially important when considering the air quality dynamics of the Greater Johannesburg area, which also includes the City of Tshwane and the City of Ekurhuleni. The recommendations could potentially be used by other African cities to create enabling legislative frameworks and contextualise them to the specific needs of their communities.

SAMSA – Sustainable Atmospheric Monitoring Service for Africa

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Air pollution is a leading risk factor for premature mortality and disability in Sub-Saharan Africa, yet air quality monitoring and forecasting remain sparse, fragmented and project-based. SAMSA (Sustainable Atmospheric Monitoring Service for Africa) introduces a scalable, interoperable atmospheric monitoring and decision-support service tailored to African realities, integrating modelling, observations, health analytics and policy-relevant scenario assessment into a sustained system.

SAMSA combines emission inventories, meteorological data and land-use information with low-cost sensor observations to model the historical, current and near-future state of the atmosphere. Using TNO's open-source chemical transport model LOTOS-EUROS, SAMSA delivers source-apportioned air quality information—both sectoral and geographic—covering particulate matter, ozone and reactive gases.

SAMSA allows to link air pollution and heat exposure to burden-of-disease assessments. Its scenario assessment component (LE-Go) enables policymakers to evaluate mitigation measures and quantify health, social and economic co-benefits, directly supporting evidence-based air quality management, climate action and investment prioritization.

TNO acts as system orchestrator, transferring and adapting over a decade of experience from its leading role in the European Copernicus Atmospheric Monitoring Service (CAMS). This orchestration role spans open-source model stewardship, methodological harmonization, capacity building and governance design, ensuring scientific robustness while enabling local ownership.

SAMSA is co-created with African institutions, including the Ministry of Health (Kenya), the University of Nairobi (CEMA), KEMRI and Air Quality Systems East Africa (AQS), embedding the service within national and regional decision processes. Collaboration with ICPAC enables scaling across the Greater Horn of Africa, with a clear pathway towards continental deployment.

By moving beyond isolated pilots, SAMSA demonstrates how system orchestration can transform air quality monitoring into a locally led, decision-ready infrastructure that supports policy, climate finance, innovation and public health protection across Africa at scale and over the long term sustainably globally.

Source Apportioned Air Pollution Monitoring for Nairobi

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The air pollution levels in Nairobi structurally exceed the WHO limit values, posing a substantial health risk to the city's residents. In 2022, Nairobi City County (NCC) adopted the Nairobi City County Air Quality Act, a legal framework for comprehensive air quality management that is operationalized by the Nairobi City County Air Quality Action Plan (2025–2029). To fulfil this obligation, action perspective is required that is based on detailed insight into the origin of pollution. NCC and TNO have teamed up to monitor the air quality in the city using a source apportioned modelling approach. This presentation shows the results of a first demonstration over Nairobi that has been made by NCC and TNO.

Source apportionment simulations provide insight into the source specific contributions to air pollution and the geographical origin of the pollution. Using a local emission inventory, labelled runs with TNO's chemical transport model LOTOS-EUROS are set up. The priority emission sources, such as transport, waste management, construction, and industry, as well as the geographical origin (the different counties in and around Nairobi) are labelled.

NCC operates reference-grade monitoring equipment alongside a distributed network of low-cost sensors across the city. Through a data assimilation approach, the observational information is enriched by making it continuous in time and space while acknowledging the uncertainties in both model predictions and observation/measurements. This approach ensures an optimal result with the best available information.

The resulting calibrated, source-specific exposure information offers NCC clear action perspectives. It allows the city to prioritize interventions on the most impactful source types and origin, evaluate the effectiveness of policy options, and build a pathway for progressive reduction of PM and NO_2 concentrations. In addition, the exposure information provides a robust basis for conducting health impact assessments that can quantify the benefits of cleaner air for Nairobi's residents.

Hybrid Deep Learning and Signal Decomposition Algorithm for Forecasting Temporal $PM_{2.5}$ from Low-Cost Sensors: Johannesburg, South Africa

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Forecasting air pollution is essential for reducing health risks and informing policy measures, especially in metropolitan regions with inadequate monitoring systems. This study examines the efficacy of hybrid deep learning and signal decomposition methods for predicting $PM_{2.5}$ concentrations recorded by low-cost sensors in the City of Johannesburg (CoJ), South Africa. Three methodologies were evaluated: a Long Short-Term Memory (LSTM) network, a CEEMDAN-LSTM hybrid model that combines Complementary Ensemble Empirical Mode Decomposition with LSTM, and a Random Forest-enhanced CEEMDAN-LSTM (RF-CEEMDAN-LSTM) model. CEEMDAN was utilized to decompose the noisy and non-stationary $PM_{2.5}$ time series into intrinsic mode functions, while Random Forest was employed for feature refinement and model input optimization. The evaluation of model performance through standard error metrics indicated that the hybrid frameworks significantly surpassed the standalone LSTM, with the RF-CEEMDAN-LSTM providing the most precise and consistent predictions. The results illustrate the efficacy of integrating signal decomposition with deep learning and machine learning methodologies to enhance short-term $PM_{2.5}$ predictions from low-cost sensors, offering significant insights for urban air quality management and decision-making in Johannesburg.

Cloud Cost Optimisation: A Practical Framework for Cloud Infrastructure Cost Optimisation in African Air Quality Monitoring Networks

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Cloud computing has transformed how environmental monitoring organisations manage technical infrastructure offering flexibility and scale previously out of reach. But in resource-constrained settings, cloud services introduce a different problem: costs that quietly spiral beyond what programmes can sustain. For air quality monitoring networks across Africa, this is not theoretical. When infrastructure becomes unaffordable, data stops and so does the investment case for clean air.

This paper examines how monitoring organisations can achieve long-term infrastructure sustainability without sacrificing data continuity or performance, presenting a practical, replicable cloud cost optimisation framework for cost-sensitive environments across African cities. Drawing on empirical results from AirQo, Uganda, we present a framework built on five core pillars: rightsizing of virtual machines to match workload requirements, strategic deployment of Spot VMs for compute savings, resource labelling and usage analytics for cost visibility, automated budget alerts and expenditure reporting, and alignment of infrastructure provisioning with real demand. These strategies were applied across a cloud-native platform supporting containerised microservices, automated orchestration pipelines, and distributed data processing for one of Africa's most extensive low-cost air quality monitoring networks.

The results delivered a sustained reduction in monthly cloud expenditure exceeding half the original cost while maintaining system stability, data continuity, and platform performance. These findings demonstrate that significant infrastructure savings are achievable without compromising scientific output, offering a replicable model for environmental monitoring organisations across the continent.

Keywords: *cloud cost optimisation; infrastructure sustainability; air quality monitoring; low-resource settings; African cities; FinOps*

Scaling Clean Cooking Transitions in Urban Africa: Lessons from the "Abuja Breathe Clean Air" Initiative

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Indoor air pollution from biomass cooking fuels remains one of Sub-Saharan Africa's most persistent yet under-prioritized public health emergencies. Its burden falls disproportionately on women and children in peri-urban settlements, who endure daily $PM_{2.5}$ concentrations exceeding WHO thresholds by several multiples. Despite the scale of this crisis, municipally led, evidence-based responses remain rare across the continent.

This session presents the Abuja Breathe Clean Air Initiative, among the first municipally led clean cooking transition programs in West Africa to integrate rigorous household air quality monitoring into its design. Led by the Federal Capital Territory Administration (FCTA), the initiative transitioned 5,000 low-income households from biomass fuels to Liquefied Petroleum Gas (LPG) within six months, deploying an integrated model combining targeted financial subsidies to dismantle affordability barriers, behavioural science techniques to drive durable habit change, and continuous $PM_{2.5}$ monitoring to track real-world health outcomes.

Pre-intervention baseline data recorded average ambient concentrations of 40.1 µg/m³ ($PM_{2.5}$) and 68.3 µg/m³ (PM_{10}), dramatically exceeding WHO guideline thresholds of 5 µg/m³ and 25 µg/m³ respectively. Preliminary findings indicate meaningful reductions in indoor particulate matter across transitioned households, alongside improvements in women's respiratory health, cooking-related time burdens, and household economic productivity. Comprehensive quantitative outcomes will be presented live during this session, offering participants direct access to emerging real-world implementation evidence.

The Abuja model demonstrates that municipally led clean cooking transitions are financially viable and institutionally replicable across rapidly urbanizing cities. Its architecture, integrating public financing, private-sector LPG supply chains, community health engagement, and rigorous monitoring is designed for adaptation and scale beyond the FCT.

Participants will leave with a practical policy and partnership framework for designing, financing, and scaling comparable interventions in their own urban contexts, advancing cleaner air, improved public health, and gender equity.

Keywords: Household Air Pollution, $PM_{2.5}$ *Monitoring, Clean Energy, Public Health, Climate Action*

Bridging Science and Youth Advocacy by Translating Air Pollution Research into Community Action in Nigeria

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Air pollution is a pressing public health challenge in rapidly urbanising cities, driven primarily by vehicular emissions that severely compromise air quality and pose serious health risks. To close this gap, this initiative integrates experimental research with community-based advocacy. Laboratory investigations using mice exposed to traffic-related air pollution revealed significant biomarker responses, indicating physiological stress and potential long-term health implications linked to pollutants such as $PM_{2.5}$ and carbon monoxide. To translate these findings into real-world impact, they were deployed through the Project Save the Planet Initiative and the EcoGenius platform. Through youth-centered engagement, environmental education, and advocacy campaigns, over 5,000 young people have been sensitized across Lagos. In collaboration with CMA-CGM, over 1,000 trees were planted in urban public schools to mitigate air pollution exposure. Additionally, targeted workshops with transport workers focused on reducing emissions through improved vehicle maintenance, behavioral change, and the adoption of cleaner mobility alternatives, including electric vehicles and low-emission transport systems.This integrated approach shows a scalable strategy that connects scientific knowledge with grassroots action, enabling youth and important stakeholders to spearhead sustainable solutions for air quality in urban areas.

Air Pollution Exposure and Cardio-Respiratory Health Outcomes: Evidence from a Case Crossover Study in Urban area

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Fine particulate matter ($PM_{2.5}$) pollution is a critical public health challenge recognized by the World Health Organization (WHO) and the Health Effects Institute (HEI) as a leading risk factor for cardio-respiratory morbidity and mortality. In Ghana, as in many sub-Saharan African countries, $PM_{2.5}$ concentrations often exceed WHO guideline limits, yet local epidemiological evidence remains limited, constraining targeted interventions. This study employed a time-stratified case-crossover design with conditional logistic regression (CLR) to investigate the relationship between $PM_{2.5}$ exposure and cardio-respiratory health outcomes in Accra, Ghana, focusing on the University of Ghana community as a microcosm of the urban environment. Additionally, source apportionment was conducted using Non-Negative Matrix Factorization (NMF) alongside conditional bivariate probability function (CBPF) analysis. Air quality and meteorological data (temperature, relative humidity, wind speed, wind direction) were collected between January 2023 and December 2024 using low-cost sensors (Quant-AQ, Kunak Pro) alongside a reference-grade monitor (Teledyne T640). Health records on upper respiratory infections, hypertension, asthma, and pneumonia were obtained from the University Hospital. Exposure analysis revealed $PM_{2.5}$ concentrations consistently exceeding national and international guidelines, particularly during the dry season (November-March), with mean values ranging from 19.99 ± 7.92 µg/m³ to 67.88 ± 66.06 µg/m³. Source apportionment identified vehicular emissions and regional transport as major contributors to particulate matter pollution within the study area. CLR showed that increasing $PM_{2.5}$ levels were associated with elevated cardio-respiratory outcomes (OR=1.032, 95% CI [1.015, 1.050]), with youthful age group at greater risk. Findings demonstrate the link between elevated $PM_{2.5}$ and adverse health outcomes, while highlighting how low-cost sensors can complement epidemiological studies. This evidence reinforces the urgent need for enhanced air quality monitoring and interventions to mitigate health burdens and accelerate progress toward SDG 3.

Keywords: Air Pollution, Source Apportionment, Epidemiological Studies

Passive Sampling as a Tool for Low Cost Source Apportionment

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Transport-related activities such as vehicular emissions, road dust resuspension, and wear from engines, brakes, and tires contribute significantly to the release of trace metal elements into atmospheric particulate matter. Although many air quality studies focus on measuring concentrations of fine particulate matter ($PM_{2.5}$), understanding the elemental composition of particulate matter and identifying pollution sources is critical for assessing potential health risks such as organ damage, cancer, allergic reactions, and neurological disorders. This study evaluates the use of passive sampling as a low-cost approach for source apportionment of trace metal elements in particulate matter within Kampala City.

Atmospheric deposition samples were collected from 20 locations across Kampala, selected based on high traffic density and frequent congestion during rush hours. Passive samplers based on the Bergerhoff device were deployed for 30 days to collect particulate deposits. The samples were separated into liquid and solid fractions and analyzed for trace metal content using inductively coupled plasma mass spectrometry (ICP-MS/MS).

The most abundant elements detected in the liquid fraction were Ca > Fe > Zn > Mn > Al, while Fe > Al > Na > Mn > Zn > Ba dominated the solid fraction. Source apportionment using the EPA Positive Matrix Factorization (PMF 5.0) model identified vehicular emissions, road dust, and tire wear as major contributors to the liquid fraction, while vehicular emissions, road dust, and crustal materials dominated the solid fraction. The findings demonstrate that passive sampling can provide valuable insights into particulate matter composition and pollution sources at relatively low cost, making it suitable for air quality monitoring in resource-limited urban environments.

Keywords: Passive sampling; source apportionment; particulate matter; trace metal elements; vehicular emissions

Urban Leaves as Cost-Effective Biomonitors of Traffic-Related Trace Metals in Kampala, Uganda – A Feasibility Study

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Air pollution is a growing concern in rapidly urbanising areas. Trace metals in particulate matter are potentially toxic and can accumulate in the environment, yet data on their occurrence and distribution remains limited. This is especially true in resource-constrained urban settings, where conventional monitoring infrastructure is often too expensive. This study investigates the use of plant leaves as a low-cost sampling approach for monitoring trace metal pollution in Kampala, Uganda.

A total of 44 leaf samples from ten plant species and 22 locations were collected, classified as either traffic-exposed or background sites. At each location, both mature and immature leaves were sampled. Following microwave-assisted acid digestion, eight metals associated with vehicle emissions (Ba, Cr, Cu, Fe, Ni, Pb, Sb, and Zn) were analysed using inductively coupled plasma mass spectrometry (ICP-MS).

Significantly higher mass fractions of Fe, Pb, and Sb were observed in mature leaves at traffic-exposed sites, indicating accumulation of airborne particles over time. Cu mass fractions varied significantly between plant species. No consistent overall differences were found between traffic and background locations, suggesting strong variability within the sample set and highlighting the sensitivity of sampling design and plant species selection in heterogeneous urban environments.

This study provides baseline data on trace metal pollution in Kampala and demonstrates the potential of leaf-based biomonitoring as a cost-effective and scalable approach for air quality assessment. Overall, this approach presents a promising complementary tool to support low-cost air quality monitoring strategies in Sub-Saharan Africa.

Keywords: Trace metals; Traffic emissions; Biomonitoring; Urban air quality; Low-cost monitoring

The Missing Link in Clean Air: Empowering Informal Mechanics to Reduce Transport Emissions in African Cities

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Road transport emissions are an increasingly significant contributor to urban air pollution in many African cities, where aging vehicle fleets, weak regulatory enforcement, and informal vehicle maintenance practices pose major environmental and public health challenges. In Uganda, over 90% of vehicles are imported used vehicles, and maintenance activities are largely performed within an under-regulated informal sector, often compromising emissions control systems and contributing to excessive pollutant emissions. This paper presents a case study of Autosafety Uganda, an award-winning community-driven initiative working to address transport-related air pollution at its source through a combination of emissions monitoring, mechanic capacity building, and community engagement. Since 2022, the initiative has trained over 1,600 mechanics on environmentally responsible vehicle maintenance practices aimed at preserving emissions control systems and improving vehicle efficiency. At the same time, field-based vehicle emissions monitoring activities have been conducted to generate real-world data on pollutant levels from in-use vehicles, contributing to ongoing policy discussions on transport emissions management. Recent community-focused interventions around schools in Kampala further explored the intersection between transport emissions and children's exposure to air pollution. These activities combined vehicle emissions testing, community awareness programs, and collaboration with academic partners to improve understanding of local air quality challenges and practical mitigation measures. The findings demonstrate that integrating technical emissions monitoring with grassroots capacity building and public engagement can provide a practical and scalable pathway for reducing transport-related air pollution in rapidly urbanizing cities with large informal automotive sectors. The paper highlights lessons learned, policy implications, and opportunities for scaling similar approaches across African cities seeking locally grounded solutions to transport-induced air pollution.

Breath of the Pastoralists: Culture-Driven, Gender-Inclusive Air Quality Solutions in Northern Kenya

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Air pollution in semi-arid pastoralist communities of Northern Kenya poses significant health risks yet remains under-recognized. Seasonal droughts, strong winds, dusty roads, and livestock movements increase particulate matter, compounded by open fires with no ventilation and charcoal or biomass burning for cooking and heating. A recent household survey of 150 families in Samburu County found that 78% of women and 65% of children under five are regularly exposed to smoke, leading to chronic respiratory illnesses and eye irritation. Men and youth are often excluded from household and community decision-making, reinforcing gender and generational inequities.

This intervention demonstrates deep personal and organizational engagement. ICAN mobilized community members to participate in air quality monitoring ($PM_{2.5}$ and PM_{10}), documenting dust and smoke exposure, and co-designing culturally appropriate solutions. Ministry of Health staff, including Milina Lenyarua, provided guidance on respiratory health mitigation and medical follow-up. Youth engagement was led by Valarie Loloju, facilitating participatory forums and awareness campaigns. Together, this multisectoral collaboration integrates health expertise, local leadership, and youth voices to implement sustainable strategies.

Key approaches include promoting cleaner cooking technologies, improved ventilation, participatory decision-making, and gender-sensitive awareness campaigns, all grounded in pastoralist cultural practices. Preliminary results indicate a 40% increase in safer stove adoption, enhanced inclusion of men and youth in discussions, and strengthened community understanding of air pollution sources such as dust storms, open fires, and charcoal combustion.

This evidence-driven, culture-centered approach underscores that effective clean air interventions require trust, collaboration, and gender equity. By bridging local knowledge, youth engagement, and health sector expertise, our model is replicable across pastoralist regions and offers actionable insights for policymakers, funders, and civil society actors seeking to address air quality and health disparities in Africa.

Keywords: Air pollution, Pastoralist communities, Gender equity, Youth engagement, Biomass smoke, Dust storms, Open fires, Cleaner cooking technologies

What Drives Air Pollution in Lagos? Year-Long Evidence on $PM_{2.5}$ Sources in a Rapidly Growing Megacity

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Lagos, Nigeria, is one of the world's fastest-growing megacities, yet its air pollution remains poorly characterized due to limited long-term monitoring. We present results from a year-long measurement campaign of fine particulate matter ($PM_{2.5}$) at an urban background site at the University of Lagos (January 2025–February 2026), based on daily 24–hour filter sampling combined with chemical analysis and receptor modelling.

Filters are analyzed for elemental composition using energy-dispersive X-ray fluorescence (ED-XRF) and for black carbon using optical transmissometry, providing a detailed basis for source apportionment. Initial analyses from the early phase of the dataset, now extended to a full annual cycle, indicate persistently elevated $PM_{2.5}$ concentrations, with strong seasonal variability and highest levels during the dry season. Mean concentrations in general exceed WHO guideline values, highlighting a substantial urban pollution burden.

Receptor modelling identifies multiple major sources, including mineral dust, vehicular emissions, petroleum-related combustion, regionally formed secondary aerosol, biomass and waste burning, marine aerosol, and industrial emissions. In contrast to many smaller cities, Lagos shows a strong influence of combustion-related sources linked to its energy deficit, extensive use of backup generators, heavy traffic congestion, and large industrial and port activities.

A key strength of this study is the daily sampling over a full annual cycle, enabling quantification of seasonal source contributions in a rapidly evolving megacity. Such datasets are extremely scarce for Lagos and scarce in Africa.

The findings highlight clear priorities for intervention, particularly cleaner transport systems, improved energy infrastructure, and better waste management. This work provides an evidence base for targeted air quality policies in Lagos and offers insights relevant to other African cities facing similar challenges.

Keywords: Source apportionment, Elemental composition, Black carbon, Megacity air pollution, Air quality policy

Air Quality Data Generation in the City Of Douala Using Low Cost Sensors

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A recent assessment by the Energy Policy Institute at the University of Chicago ranked Cameroon among the countries with the most limited air quality infrastructure, including gaps in monitoring systems, open data access, and regulatory standards. In Douala, the absence of continuous air quality data constrains evidence-based policy and public health action. Low-cost sensors offer a scalable solution to improve data generation. This study aimed to generate fine particulate matter ($PM_{2.5}$) data using low-cost sensors in Douala.

Five PurpleAir-II-SD sensors were deployed across strategically selected sites in Douala from January 2023 to December 2024. Site selection prioritized security and reliable electricity supply. Sensors were installed approximately 6 feet above ground and positioned away from major pollution sources to ensure representative ambient measurements. $PM_{2.5}$ concentrations were recorded at 120–second intervals. Data were collected both online and via SD cards, with monthly downloads for backup and quality control. Cleaning procedures included removal of missing and erroneous values. Descriptive and temporal analyses were conducted to characterize pollution patterns.

The overall mean 24–hour $PM_{2.5}$ concentration across the study period was 31.38 µg/m³, exceeding World Health Organization air quality guideline limits. Annual averages were higher in 2023 (34.57 µg/m³) compared to 2024 (28.19 µg/m³) ($p < 0.001$). Seasonal trends showed elevated concentrations (40.03 µg/m³) during the dry season (November to April), compared with lower levels (21.48 µg/m³) ($p < 0.001$). in the rainy season between May and October. Data gaps occurred due to intermittent internet connectivity and power outages.

The findings provide critical baseline evidence to support public awareness, guide environmental policy, and inform future air quality monitoring initiatives.

Keywords: $PM_{2.5}$, air quality monitoring, PurpleAir

From Footpaths to Finance: How Run Leader-Generated Air Quality Data Can Unlock Investment for Healthy African Cities

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African cities lack the granular air quality data needed to attract clean air investment. Monitoring infrastructure remains limited, leaving investors and policymakers without verified baselines to assess risk, identify priority areas, or design targeted interventions. Community-generated data presents an opportunity to fill this evidence gap.

This abstract presents a community-led data generation model implemented by UrbanBetter, where Run Leaders deploy wearable sensors and structured observation to generate hyperlocal air quality and urban heat data. The model demonstrates how community data can produce investment-relevant evidence, identify priority intervention zones, and provide a replicable pathway for African cities to unlock clean air financing.

As a Run Leader in Nairobi, I coordinate quarterly data collection activations where community members wear portable air quality and heat sensors during designated routes. We document features of the natural and built environment using structured observation tools. Routes are designed to identify pollution sources, map heat variation, and capture temporal patterns. Findings are reviewed at the Cityzens Hub and translated into recommendations, which are compiled into quarterly reports shared with government and civil society stakeholders. The model operates across multiple hubs across the continent, enabling cross-learning and scalability.

Recurring hyperlocal data provides verified baseline data that supports investment decision-making and urban planning. The data identifies pollution and heat hotspots, enabling targeted interventions and reducing uncertainty for investors and city planners. Community participation strengthens local accountability and sustainability of interventions.

Community-led data generation transforms grassroots monitoring into a practical tool for investment planning, urban policy, and climate resilience. This work demonstrates a low-cost, scalable approach for building the evidence base needed to support clean air investment in African cities and contributes to the forum theme, *Investment Case for Clean Air and Healthy Cities*.

Keywords: Air Quality Monitoring, Community-Based Data Collection, Clean Air Financing

Making Air Pollution Visible: Linking Emissions to Health and Economic Costs

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Air pollution is often invisible and difficult to relate to everyday experience. While measurements of pollutant concentrations are essential, they can be abstract and disconnected from the concerns of policymakers and communities. Framing air pollution in terms of its impacts on health, livelihoods, and economic outcomes makes these risks more immediate, tangible, and actionable.

In this presentation, we will demonstrate how integrating air quality data with health and economic analysis can strengthen advocacy and decision-making. We present a practical, generalisable framework for moving beyond pollutant concentrations by translating air quality data into health and economic impacts, which is applicable to outputs from models, satellites, and ground-based sensors.

These impacts span a wide range of outcomes, including preterm and low birth weight births, childhood asthma incidence and emergency visits, chronic diseases such as COPD and diabetes, work absences, and premature mortality. Translating these health burdens into economic costs, such as healthcare expenditure and lost productivity, makes the scale of harm explicit and directly relevant to policy, investment, and development decisions.

The presentation also highlights how this approach has been applied in South Africa to support civil society advocacy and litigation, including work undertaken by Greenpeace Africa. These examples illustrate how connecting air quality data to human and economic impacts can strengthen public narratives, inform legal strategies, and support more effective policy engagement.

Real-World Vehicle Emissions and Policy Insights from Johannesburg

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Johannesburg, the most densely populated city in the Gauteng Province, frequently experiences air pollution levels exceeding the World Health Organization (WHO) guidelines and motor vehicles are a major source of toxic air pollutants, such as nitrogen oxides (NO_X), carbon monoxide (CO), and particulate matter (PM) (Gauteng Department of Agriculture and Rural Development, 2017). The city also bears the highest transport-related health burdens in South Africa, driven by a large passenger car fleet and the widespread use of old, poorly maintained vehicles (Jin et al., 2025). Against this backdrop, understanding real-world vehicle emissions is critical to inform effective policies to reduce air pollution and associated health risks.

Between July to September 2025, The Real Urban Emissions (TRUE) Initiative collected over 250,000 real-world emission measurements in Johannesburg and the Greater Gauteng Region using remote sensing technology. Conducted in partnership with the City of Johannesburg, the University of Johannesburg's Process, Energy and Environmental Technology Station (UJ PEETS), and OPUS RSE, as part of the Breathe Cities Initiative, the TRUE Johannesburg project represents the first large-scale remote sensing study in the region. In addition to generating and increasing access to real-world data, the project further supports future monitoring activities by developing expertise in vehicle emissions measurement techniques within South Africa.

Remote sensing is a non-intrusive technique that uses spectroscopy to measure tailpipe emissions from vehicles in real traffic. Thus, the collected data reflect representative fleet composition and emissions under real-world conditions, addressing an important data gap in the region. We present policy-relevant insights from the analysis of multiple pollutants — including NO_X, CO, PM, and hydrocarbons (HC) — across major vehicle classes including passenger cars, trucks, and minibus taxis. Based on these findings, we suggest tailored interventions at both national and local levels to reduce on-road vehicle emissions while ensuring equitable outcomes.

Examining Data-Driven Approaches for Clean Air Advocacy in a Changing Climate: A Scoping Review

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Air pollution remains a global public health and climate challenge, causing millions of premature deaths annually and disproportionately affecting marginalised communities. This scoping review examines how data-driven approaches have been used to advocate for clean air in the context of climate change, what methods exist for data mobilisation, enabling conditions, limitations, and whether there were any equity or health considerations.

Recent advances in low-cost monitoring, satellite data, and digital platforms have transformed the availability and granularity of air-quality data. However, how these diverse data sources are mobilised and used to influence policy, shape public discourse, and support community action remains poorly understood.

Fifty studies from 41 countries and over 100 cities were included. Five categories of data-driven approaches were identified. These included sensor-based monitoring, modelling, digital platforms and data visualisation, community-centred approaches, and lived-experience assessments. Most studies (86%, n=43) combined multiple data approaches; Data advanced advocacy by increasing awareness, informing policy, exposing inequities, fostering collaboration, and mobilising action. This review highlights the need to embed community co-production within monitoring efforts, align funding with long-term governance systems, and standardise open data platforms to ensure that clean-air initiatives are equitable, durable, and responsive to climate and health priorities.

Keywords: Clean air, Advocacy, Data-driven approaches, Community action

Air Quality Co-Benefits of Net-Zero Transitions: A Sectoral Analysis in South Africa

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Air pollution and climate change are driven by overlapping emission sources, creating important opportunities for integrated, sectoral interventions that deliver both environmental and public health benefits. This paper evaluates evidence-based interventions aligned with net-zero transition pathways, focusing on their potential to generate air quality co-benefits in South Africa.

Using a mitigation assessment matrix, the study analyses priority emitting sectors, including energy, transport, industry, agriculture, and waste. It assesses the effectiveness of sector-specific mitigation strategies and examines the extent to which climate-focused interventions can yield measurable improvements in air quality. The analysis identifies enabling conditions, trade-offs, structural barriers that influence outcomes, and highlights factors that support the achievement of mitigation targets.

Findings indicate that the scale and distribution of air quality co-benefits vary significantly depending on policy design, technological pathways, and regional socio-economic contexts. To achieve sectoral mitigation targets set, additional support is needed including financial instruments, policy interventions and human capital. Interventions in the energy and transport sectors demonstrate the greatest potential for substantial and near-term co-benefits, particularly where fossil fuel use is reduced or eliminated. In contrast, other sectors present more complex or uncertain outcomes, often requiring complementary, air quality-specific measures.

This paper situates insights on air quality co-benefits of net-zero transitions within South Africa's climate policy and governance landscape, highlighting the importance of regulatory coherence, institutional capacity across different levels of government, and the role of private sector participation in implementation. While climate mitigation strategies offer significant opportunities to improve air quality, the effectiveness thereof depends on deliberate policy interventions, financial and economic instruments, availability of data, available technical capacity, and strengthened governance.

Key considerations are identified to guide the development of sectoral interventions that maximise synergies between climate and air quality objectives, supporting equitable pathways toward clean air and net-zero emissions.

Keywords: net zero, air quality, co-benefits

Role of Air Quality Modelling in Policy Development: Clean Air Zones for City of Johannesburg

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In the last few decades, significant strides have been made in air quality modelling, and expertise within Africa has been developed towards running models to describe current pollutant distribution and investigate the impact of mitigating emissions. However, it is more recent that the use of models has been applied to drive policy more directly. Be it in creating the evidence-base to designing the specifics of a policy.

Air quality model simulations of a baseline and intervention scenarios were used to develop a Clean Air Zone policy for the City of Johannesburg by providing the context and extent of the air pollution problem within the city and potential means to reduce emissions within very specific zones in the city. The idea being that at the policy development phase to identify immediate and feasible actions that also align with ongoing non-air quality related interventions (e.g. provision of electricity using decentralized renewable energy infrastructure). Greater success is anticipated if interventions are focused to small key areas and aligned to planned or ongoing actions happening within the departments responsible for source sectors.

In addition to air quality modelling, the determination of a baseline was supported by use of the city's existing air quality monitoring network. A comprehensive high-resolution emissions inventory formed input into the air quality model and was key to identifying major source sectors as well as their spatial distributions. The modelling exercise also highlighted the need for development of robust rapid assessment tools to regularly support policy makers, thereby enhancing the science policy interface.

Key words: Policy, emissions, clean air zones

Long-Term Air Quality Trends in Coastal West African Cities Inferred from Airport Visibility Records

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Long-term air quality trends remain poorly constrained in many African cities due to the lack of sustained ground-based monitoring, particularly during periods of rapid urban growth. Here, we use historical horizontal visibility observations from major airports in Accra (Ghana), Lomé (Togo), and Lagos (Nigeria) to reconstruct multi-decadal trends in particulate air pollution in coastal West Africa, extending in some cases back to the 1940s.

Visibility measurements, routinely recorded for aviation, are converted to aerosol extinction coefficients (β_{ex} $\propto$ 1/visibility), which serve as a proxy for fine particulate matter concentrations. The extinction coefficient is primarily sensitive to submicron anthropogenic aerosols, with limited influence from gases and coarse particles except during Harmattan dust events. To isolate urban pollution signals, analyses focus on non-dust periods and exclude high-humidity conditions.

All three cities exhibit a clear long-term increase in aerosol extinction, with the most pronounced rise occurring from the 1980s onward. The observed trend likely reflects intensifying anthropogenic emissions, urbanization, population growth, increasing motorization, and changes in regional aerosol processes. This period coincides with the emergence of satellite-based aerosol products, enabling direct comparisons. In Lagos, trends derived from visibility closely track independently estimated $PM_{2.5}$ from reanalysis data, lending confidence to the observed long-term trends.

A particularly striking result is observed in Accra, where diurnal patterns have evolved over time: early records show weak variation, while recent data exhibit pronounced morning peaks consistent with traffic emissions, reflecting the emergence of urban transport as a dominant pollution source.

By extending observational records across decades of urban development, this approach provides a rare opportunity to link environmental change with the growth of cities. Airport visibility data thus represents a valuable and underutilized resource for reconstructing long-term air pollution trends in data-scarce regions.

Keywords: long-term air pollution trends; urban air quality; historical data; traffic emissions; West Africa

Respiratory Health impacts in Mpumalanga, South Africa: Evidence from the 2016 South African Demographic and Health Survey to Inform a Just Transition

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Communities in Mpumalanga Province, South Africa, face chronic exposure to air pollution from coal-based industries, increasing the risk of respiratory illnesses. However, population-level evidence on associated health outcomes and healthcare access remains limited. This study assessed respiratory health patterns and determinants among adults in Mpumalanga and explored implications for health system strengthening within a Just Transition framework.

Data were drawn from the 2016 South Africa Demographic and Health Survey. A subsample of 1410 individuals aged 15–59 years was analysed. Descriptive statistics estimated the prevalence of respiratory symptoms, and multivariable logistic regression identified socio-demographic, environmental, and healthcare- related predictors.

The prevalence of self-reported respiratory symptoms was 37.9%. Significant predictors included a diagnosis of chronic bronchitis [aOR = 13.55, 95% CI= 3.10–59.17, p< 0.001] and visiting a health facility in the past year [aOR = 5.37, 95% CI= 2.40–12.08, p< 0.001]. Use of private [aOR = 3.98, 95% CI = 1.85–8.58] or public [aOR = 7.80, 95% CI = 4.91–12.40] treatment facilities was also strongly associated with reported symptoms [p< 0.001]. Being sent away from a clinic without medication increased the odds of reporting symptoms [aOR = 2.51, 95% CI = 1.40–4.54, p=0.002]. Lower odds were observed among middle- and higher-income households and younger adults.

Respiratory symptoms are common among and shaped by socio-economic disadvantage and barriers to healthcare access. These findings highlight the need for a health-focused Just Transition approach that prioritises air quality improvements, equitable healthcare delivery, and strengthened surveillance systems to protect vulnerable populations.

Impact of West Africa Convective Systems on Seasonal Variability of PM2.5 Concentrations

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Air quality in West Africa exhibits pronounced seasonal variability driven by complex interactions between meteorological processes, emission sources, and regional climate systems. This study investigates the influence of the West African Convective Systems on air pollutant concentrations, with a particular focus on fine particulate matter ($PM_{2.5}$), across dry and wet seasons. The Convective Systems plays a critical role in shaping atmospheric circulation, rainfall distribution, and wind patterns, which in turn regulate pollutant transport, dispersion, and removal processes.

Satellite-derived aerosol optical depth (AOD) and reanalysis data from ERA5 were integrated to derive ground-level $PM_{2.5}$ concentrations and characterize atmospheric dynamics over the region between 2000 and 2023. Spatial and temporal analyses were conducted to evaluate seasonal patterns and their relationship with key meteorological variables, including precipitation, wind fields, boundary layer height, and relative humidity.

Results show a marked seasonal contrast in $PM_{2.5}$ concentrations across large parts of the Sahel and coastal West Africa. Elevated concentrations during the dry season are associated with intensified Saharan dust transport, increased biomass burning, and reduced atmospheric mixing under stable conditions. In contrast, wet season reductions in $PM_{2.5}$ are strongly linked to precipitation scavenging and enhanced vertical mixing driven by convective systems. Statistical analysis reveals a significant negative correlation between $PM_{2.5}$ and precipitation, and a positive association with low boundary layer heights and weak wind speeds.

This study contributes to a deeper understanding of climate-air quality interactions in West Africa and provides valuable insights for improving air quality forecasting, supporting climate-sensitive environmental policies, and strengthening regional strategies for pollution mitigation and protecting public health.

Keywords: Climate, $PM_{2.5}$, Convective Systems, Dispersion, Atmospheric circulation

The Status of Ambient Air Quality in Kampala Capital City, Uganda During Public Holidays and Non-Public Holidays: Time Series Analysis 2017- 2025

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Ambient air quality in urban cities continues to be poor especially in urban cities of LMIC. According to WHO, 99% of the global population breathing air exceeds WHO limits, causing over 4.2 million annual premature deaths from diseases like stroke and lung cancer.

This study aimed to characterize diurnal and holiday-specific patterns of ambient $PM_{2.5}$ concentrations during public holidays and non-public holidays in Kampala City and quantify exceedances of WHO air quality guidelines to inform public health risks and policy in Uganda

This study was conducted in Kampala Capital City, Uganda. Ambient $PM_{2.5}$ concentrations were measured using Beta Attenuation Mass Monitor BAM 1022 and Modulairs.

New Year's Peak: Max 250 µg/m³ (ConcS, December 31); avg 74–85 µg/m³ daily fireworks likely culprit. Liberation Day: Moderate peaks ~100 µg/m³ mornings; daytime lows ~15–30 µg/m³. Public Holiday (Jan 15): Cleanest (avg 31–39 µg/m³); mins 8–12 µg/m³ afternoon. ConcS highest (mean 79 µg/m³); exceeds WHO PM2.5 24h guideline (15 µg/m³) 80% of time, but lower than typical Kampala (50–100+ µg/m³).

The peak $PM_{2.5}$ concentration reached 250 µg/m³ (ConcS, December 31), representing a sixteen times exceedance of WHO 24–hourly $PM_{2.5}$ guideline 15 µg/m³. The observed high $PM_{2.5}$ concentrations during New year's eve could be attributable to fireworks and celebrations, far exceeding typical Kampala daily averages of 50–100 µg/m³. Festive holidays (New Year's: 74–102 µg/m³ daily avg) showed two to three times higher ambient air pollution than quieter observances (Jan 15: 31–39 µg/m³; Liberation Day: 32–40 µg/m³), with daytime relief possible (<20 µg/m³ mid-afternoon).

Household Air Pollution and Respiratory Health among Primary School Children in Kampala, Uganda

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Household air pollution (HAP) from indoor cooking with solid fuels and biomass contributes to over 4 million premature deaths globally each year and affects more than 80% of the African population, disproportionately impacting women and children. HAP is a major driver of acute and chronic respiratory diseases, with more than half of pneumonia-related deaths among children under five linked to inhaled particulate matter (PM2.5). In Kampala, Uganda, most households continue to rely on biomass fuels, exposing children to harmful indoor air pollutants. Despite established links between air pollution and respiratory illness, evidence on chronic respiratory conditions among African children remains limited. This study assessed the association between HAP exposure and respiratory health among primary school children in Kampala.

We conducted a cross-sectional survey of 845 parents/caregivers of primary school children in Kampala. Data were collected using structured questionnaires in REDCap and analyzed in STATA and R. Modified Poisson regression was used to examine factors associated with respiratory symptoms and diseases.

Results were obtained from 845 caregivers of parents/primary school children from 10 primary schools in the five divisions of Kampala city. Within the past 12 months from the date of the survey, 2.4% of children suffered wheezing, 6.1% suffered bronchitis, cough or phlegm (BCP), and 12.8% suffered rhinitis. Children living in high-polluting households were significantly more likely to experience rhinitis (IRR=1.93; 90% CI: 1.12–3.30) compared to those in moderate- or low-polluting households. In Addition, children born prematurely were significantly more likely to experience rhinitis (IRR: 2.22; 95% CI: 1.35–3.65), while parental history of asthma was also associated with Asthma and rhinitis (IRR: 2.92; 95% CI: 1.03–8.28; IRR: 3.41; 95% CI: 2.16–5.38), respectively.

HAP exposure is associated with respiratory illness among children aged 9–11 years in Kampala. Findings underscore the need for cleaner cooking technologies, improved ventilation, and targeted public health interventions to reduce the risk of long-term respiratory disease.

Air Quality Assessment of Rwanda's Nationally Determined Contribution Scenarios

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Rwanda faces climate-related vulnerabilities and has developed strategies to mitigate these impacts through its Nationally Determined Contributions (NDC) report. The NDC document includes policy measures that cover energy, waste, agriculture, and industry sectors, many of which will yield significant health co-benefits by reducing $PM_{2.5}$ concentrations. Here, we aim to estimate the air quality benefits of the NDC scenarios using the REACH model. REACH is an air quality policy assessment model that applies a Gaussian plume framework with simple chemistry. The main outputs of the REACH model are ambient $PM_{2.5}$ concentrations and a policy impact metric ($PM_{2.5}$ mortalities per tonne). The REACH model domain for this project covers Rwanda, Burundi, Tanzania, Uganda, Kenya and Ethiopia. This work first estimates emissions reductions from the NDC policy scenarios that have air quality relevance. Then, REACH is used to estimate changes in $PM_{2.5}$ concentrations and mortalities from these emission reduction scenarios. Some of the scenarios analyzed are efficient cookstoves, vehicle emission standards, electric vehicle deployment, and hydropower implementation. The efficient cookstove scenario assumes a 68 % reduction in biomass consumption among households transitioning from traditional stoves, affecting 33 % of all households in Rwanda. The results indicate that the efficient cookstove scenario yields the largest $PM_{2.5}$ benefits in Rwanda, with an estimated 95 lives saved annually. Integrating air quality co-benefits into Rwanda's NDC assessment can help strengthen the case for policy actions, as demonstrated here by the REACH model application.

Data Analysis and Implications of Relocating the Radnor Air Quality Monitoring Station in the Cato Ridge Area in KZN

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Air pollution poses a significant environmental and public health threat globally, with developing regions such as South Africa facing challenges due to limited monitoring infrastructure. In the Cato Ridge area of KwaZulu-Natal, the Radnor Air Quality Monitoring Station has served as a critical node for tracking particulate matter (PM10) concentrations, fulfilling both environmental compliance and community health assessment functions. However, in 2022, a surge in trucking activity, emissions from unpaved roads, and frequent power outages led to equipment damage and compromised data quality. These disruptions resulted in elevated PM10 exceedances and prompted the relocation of the Radnor station 520 metres closer to the primary emission source.

This study investigates the implications of this relocation by analysing historical and current PM_{10} data from the previous and new station sites, alongside comparative data from a nearby background station. Using R, time-series trends, seasonal variations, and meteorological influences are analysed. Microsoft Excel is also employed for supplementary graphical visualisation, particularly where large datasets and multiple variables are assessed. This study aims to determine whether the new station location offers improved representativeness of pollution exposure and compliance monitoring, especially during high-risk periods in winter. Findings are expected to inform siting strategies for monitoring stations in semi-rural industrial areas, contribute to improved air quality management practices, and support regulatory compliance under the National Environmental Management: Air Quality Act (Act 39 of 2004). The study also highlights the value of statistical tools like R in ensuring reliable and reproducible air quality assessments in resource-constrained settings.

Keywords: Air quality, PM_{10}, Seasonal Variation

The Impact of the Micro-Scale Environment on Cyclists' Exposure to Air Pollution on Car-Free Routes in Nairobi

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Urban cyclists are often exposed to air pollutants, particularly Particulate Matter ($PM_{2.5}$), which increases their vulnerability to health risks. This is worse in Sub-Saharan cities such as Nairobi, where there is insufficient cycling infrastructure coupled with rapid urbanisation growth, resulting in increased exposure to urban air pollution. This study explores cyclists' personal exposure to $PM_{2.5}$ along a pre-mapped route during a car-free cycling event in Nairobi. An assessment of the surrounding built and natural environments (200m buffer) around the cycling route was done to understand the variability in $PM_{2.5}$ personal exposure. GPS-enabled portable $PM_{2.5}$ sensors were mounted on selected cyclists' bicycles to provide a spatial identity to each 10-second pollutant measurement that enabled pollutant mapping and hotspot identification. We employed a hybrid method that included exposure, spatial, and statistical analyses that allowed us to characterize the surrounding microenvironments. Exposure comparison before, during, and post-event shows that cyclists experienced the highest exposure during the event (few spikes> 400 µg/m³, and a mean of 113.4), before (few spikes > 300 µg/m³, and a mean of 57.0), and post (fewer spikes > 200 µg/m³). This showed several incidences that exceeded the WHO guidelines (15 µg/m³), meaning that cyclists were often exposed above the WHO limits across all the sessions. PM2.5 exposure also varied across different microenvironments, with industrial segments having the highest exposure and relatively widespread, followed by commercial segments with elevated concentrations, but less variability, and lastly, residential segments that showed the lowest median exposure with several episodic high-exposure events. The study demonstrates the importance of understanding cyclists' air pollution exposure in urban microenvironments, which is critical in supporting decision-making, policy planning, and targeted interventions for mitigating the negative impacts of air pollution in support of healthy, physically active modes of transportation such as cycling.

Keywords: $PM_{2.5}$ *exposure, cyclists, microenvironment exposure*

Rapid Policy Review and Landscape Analysis of Air Quality Standards of African Countries

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Air pollution remains a major health risk in Africa with the continent experiencing 1.1 million deaths annually from air pollution. The World Health Organization recommends countries enact a wide range of regulations, policies, and air quality standards for controlling emissions from major pollution sources such as transportation, anthropogenic biomass burning and industry in order to bring national air quality levels in line with values set by the WHO.

The study aims to conduct a rapid policy review and landscape analysis of National Ambient Air Quality Standard (NAAQS) across African countries, using the WHO air quality database and peer reviewed published evidence. Literature was retrieved online from the government's document repository, PubMed, and Google Scholar.

There are 21 African countries (39%; n=21/54) at different stages in formulating a NAAQS. One-third (n = 7) are located in West Africa, and another one-third (n = 7) are in Southern Africa, indicating a regional concentration of progress in air quality standard development.

The majority of African countries (77%; n = 45/54) have a defined legal mandate supporting the role of government agencies in ensuring environmental health and safety compliance. However, only a small proportion (n = 9) have established specific national air quality standard targets, indicating a significant gap between general environmental governance frameworks and the implementation of targeted air quality regulations.

Many countries in the African have established environmental health agencies with the required legal framework for monitoring, compliance and enforcement. However, only a limited number have country specific, enforceable standards in place with most adopting the WHO interim targets as national benchmarks.

Keywords : Air Pollution; Air Quality; National Ambient Air Quality Standards

A Perception Study on Air Pollution in Plastic City, Brakpan, Johannesburg: Community Attitudes and Experiences

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Air pollution poses a significant environmental health burden in South African informal settlements, where structural inequality, inadequate service provision and proximity to emission sources intensify residents' vulnerability. While air-quality research has largely prioritised monitoring and regulation, comparatively little is known about how residents of informal settlements perceive air pollution and how these perceptions shape awareness, concern and coping behaviour. This study examines community perceptions of air pollution in Plastic City, an informal settlement located adjacent to the Weltevreden Landfill Site in Brakpan, Gauteng, within a broader environmental justice framework.

A cross-sectional quantitative survey was conducted with 43 adult residents using a structured questionnaire adapted from a validated air-pollution perception instrument.

Results indicate that perceptions of air pollution are primarily grounded in sensory experience, with 79% of respondents reporting high or very high levels of dust, smoke or odour in their environment. Although only 47% of participants reported high awareness of pollution sources and health impacts, concern was widespread, with 81% expressing high or very high concern about local air quality. A statistically significant association was observed between awareness and concern (χ^2, $p < 0.05$), indicating that greater awareness corresponds with heightened perceived risk. However, no significant relationship was found between awareness and protective behaviour ($p > 0.05$), reflecting a persistent knowledge-behaviour gap. Coping responses were largely short-term and reactive, including staying indoors, covering the mouth and increased cleaning, highlighting the structural constraints that limit residents' capacity to reduce exposure.

The findings demonstrate that air-pollution perception in informal settlements is shaped by embodied experience, uneven access to information, and limited behavioural agency. The study underscores the limitations of awareness-based interventions and emphasises the need for structurally grounded governance and infrastructural responses to address environmental injustice and reduce exposure in marginalised urban communities.

Keywords: Air pollution; informal settlements; environmental justice; perception; community awareness

From Emissions to Equity: Multi-Hazard Pathways for Urban Health and Resilience

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In South Africa, air pollution in a changing climate already presents challenges to public health. The impacts of air pollution from transport, power generation and industry are intensified by compounding climate hazards such as heatwaves, droughts, wildfires, and flooding. These environmental and health burdens are disproportionately borne by residents of low-income and informal settlements, particularly those located adjacent to major emission sources such as transport corridors and industrial zones.

This paper applies a vulnerability lens, via a structured impact pathway framework, to systematically explore linkages between elements ranging from multi-hazard sources and prevailing environmental conditions through to population exposure, adverse health impacts, and broader equity outcomes—simultaneously surfacing potential trade-offs, including economic affordability burdens and disruptions to local livelihoods. Drawing on the development of a clean air zone policy for the City of Johannesburg as a case study, we apply this integrated approach to identify high-risk areas where pollution exposure intersects with social vulnerability and climate threats. This will allow for the implementation of targeted measures and inform the prioritisation of interventions. To maximise effectiveness, multi-stakeholder collaboration is essential, as is embedding transparent risk assessments within impact pathway models.

The application of a multi-hazard vulnerability lens shows that improvements in ambient conditions, reductions in exposure pathways, and protections for downstream health can deliver tangible benefits. This includes lowered incidences of respiratory and cardiovascular diseases, strides toward greater equity, enhanced urban liveability, co-benefits in greenhouse gas reductions, and bolstered overall city resilience. Johannesburg's clean air zone interventions transform from mere technical controls into comprehensive, justice-oriented strategies that foster sustainable urban futures—providing actionable, scalable insights for cities across South Africa.

Keywords: air pollution, climate hazards, equity, impact pathways, stakeholder integration

Development of Reduced-Complexity Air Quality Models for Evaluating Environmental Policies in West Africa : Case of REACH

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Air pollution is a major public health and environmental issue worldwide. In West Africa, rapid urbanization and population growth, along with the resulting economic activities, are contributing to rising emissions of air pollutants. These pollutants have significant impacts on human health, ecosystems and the climate. Despite the growing importance of issues related to air pollution, West Africa still suffers from a lack of air quality monitoring networks. Furthermore, the use of chemical transport models remains limited, hampered by several challenges, including data scarcity, technical constraints and the high cost of infrastructure. Thus, this study aims to develop the Rapid Estimation of Air Concentrations for Health (REACH) model to estimate marginal social costs for the analysis of environmental policies in West Africa. Despite disparities in observational data from West Africa, we were able to evaluate the REACH model using data from some international air quality program and projects in West Africa. The analyses indicated that the model reproduces the observed levels of particulate pollution fairly well, despite some persistent biases; these could be improved by including certain local sources in the inventories. Beyond performance evaluation, REACH was used to estimate the health impacts associated with exposure to $PM_{2.5}$ precursors in 2018. Estimates revealed that approximately 15,483 deaths were attributed to the emission of 1 tonne of primary $PM_{2.5}$ and 9,591 to other precursors (SO2, VOCs, NOx). The spatial distribution of these deaths showed that most occurred in areas with high population density and human activity. By identifying areas with high health impacts and the pollutants contributing most to them, the REACH model provides a decision-support tool for prioritizing emission reduction strategies in the region.

Keywords: West Africa, REACH Model, $PM_{2.5}$, Performance, Marginal social costs

Mobile Sensing of Urban Air Pollution: Evidence from Motorcycle-Based Monitoring in Nairobi

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Accurate measurement of air pollution is critical for designing, targeting, and evaluating environmental policy. Most urban pollution data rely on static monitoring stations, which provide high-frequency temporal data but can have limited spatial coverage. Yet pollution can vary sharply within cities, particularly along streets and across neighborhoods, creating important gaps in understanding exposure and its determinants. This paper demonstrates a scalable approach to collecting high-resolution, street-level pollution data using mobile sensors. We equip ten motorcycle taxis (bodas) in Nairobi, Kenya with pollution monitors and collect data over a six-month period. Despite the small fleet, we achieve broad spatial coverage across most of the city, but identify gaps in peripheral areas. We document coverage patterns and implement incentive mechanisms to encourage drivers to traverse under-sampled locations, improving representativeness. We leverage these data in two main applications. First, we analyze spatial variation and contributors of urban pollution by integrating the mobile measurements with a number of public and private sector geospatial datasets, capturing congestion, road characteristics, land use, building density, industrial activity, vegetation, among other factors. Second, we examine exposure disparities for two key groups: pedestrians and residents across neighborhoods. We estimate pedestrian exposure by identifying high-footfall corridors using street-view imagery and computer vision algorithms, revealing that some of the most heavily trafficked pedestrian routes coincide with elevated pollution levels. We also assess residential exposure across income groups using geocoded survey data, finding that lower-income areas experience systematically higher pollution. Overall, the paper shows that a small, mobile sensing network can generate granular, citywide pollution data at relatively low cost. This approach enables new insights into both the sources of pollution and inequalities in exposure, offering a valuable complement to traditional monitoring systems.

Keywords: pollution measurement, mobile sensing, intra-urban pollution variation

Air Pollution Burdens and Governance Gaps in Hyderabad: Evidence from a Multi-Year Mixed-Methods Assessment

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Rapid urbanisation and industrial growth continue to intensify air pollution in many South Asian cities, yet the policy and governance dynamics shaping these trends remain poorly understood. Hyderabad, one of India's fastest-growing urban centres, now faces particulate and gaseous pollution levels that pose substantial risks to public health. This study integrates five years of continuous air quality measurement (2019 to 2023) with qualitative insights from key stakeholders to assess both atmospheric trends and the systemic barriers to mitigation.

Ambient concentrations of $PM_{2.5}$, PM_{10}, NO_2, and SO_2 were analysed from five Continuous Ambient Air Quality Monitoring Stations (CAAQMS) between 2019 and 2023. Quantitative data were integrated with meteorological parameters, while qualitative insights were obtained through in-depth interviews with 10 key stakeholders from government, industry, and civil society.

Particulate matter levels frequently exceeded WHO daily guidelines by over ninefold, particularly in industrial-residential zones like Zoo Park $PM_{2.5}$ (48.4±22.6 µg/m³) and PM_{10} (107.5±46.7 µg/m³), while Central University consistently reported the lowest, $PM_{2.5}$ (32.0±18.0 µg/m³) and PM_{10} (78.8±39.0 µg/m³). Elevated NO_2 levels were observed in traffic-heavy locations such as IDA-Pashmylaram (36.1±18.1 µg/m³), Central University (35.5±13.5 µg/m³), and Zoopark (35.4±17.5 µg/m³), over seven times the WHO daily limit, and SO_2 remained within permissible ranges. Seasonal patterns revealed peak pollution during winter temperature inversions. Stakeholders identified weak interdepartmental coordination and inadequate enforcement of construction dust protocols as primary barriers to effective mitigation.

Despite the existence of air quality regulations, our findings reveal sustained exceedances of health-based standards and limited institutional capacity to implement them. Addressing Hyderabad's pollution burden will require shifting from reactive, fragmented measures to coordinated, data-driven policies that integrate seasonal action plans and green infrastructure into long-term urban development.

Keywords: Air pollution, Hyderabad, Urban Governance

The Role of Media in Raising Awareness About Air Quality Issues

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The rapid urbanization in Ghana has exacerbated air quality issues, posing significant health risks, particularly to vulnerable populations such as children. The media plays a crucial role in raising awareness and informing the public about the dangers of air pollution. This paper explores how newspapers, television, radio, and digital platforms in Ghana contribute to public awareness about air quality and solutions that advocate for cleaner air. It examines the strategies by media outlets to disseminate information, including investigative journalism, public service announcements, and collaborative campaigns with non-governmental organizations (NGOs).

Through detailed case studies, the paper highlights successful media initiatives that have brought air quality issues to the forefront of public discourse. For instance, investigative reports in leading newspapers have uncovered sources of pollution and held industries accountable, while television and radio programs have educated the public on the health impacts of poor air quality. Social media has also emerged as a powerful tool, enabling real-time information sharing of some sources of air pollution and community engagement.

However, challenges such as media censorship, funding constraints, and limited access to scientific data are identified as barriers to effective advocacy.
The paper concludes with recommendations for enhancing the media's role in environmental health advocacy. These include training programs for journalists, increased collaboration between media and environmental scientists, and leveraging digital platforms to reach a wider audience. By strengthening these strategies, the media can continue to play a vital role in promoting cleaner air and protecting public health in Ghana.

Seasonal Variability Analysis of Air Quality in Lahore

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The state of air quality in Lahore, as observed and analyzed through this study has been found to be alarming. Particularly, the particulate pollution is usually higher than the WHO's maximum exposure limit almost throughout the year. There are only a few days in the entire study period when the daily average values of $PM_{2.5}$ have remained within the maximum exposure limit. These days are during the high rain days during the 2nd quarter during the months of July and August. The 3rd Quarter is the worst period of the entire year with daily average values of $PM_{2.5}$ reaching as high as 10 times the WHO maximum exposure limits. The air quality is good on the US EPA scale for one-third of the one year study period. This points out that the population is exposed to alarmingly high levels of pollution for 67% of the time each year. The concentration of ammonia is the highest in the winters during smog period. It is known to contribute to the haze and smog. Visible pollution is also at its peak during November and December in Lahore. Methane, also a known greenhouse gas, is highest during the summers and monsoon. This can be attributed to agriculture areas and a landfill site in the study area.

- Air quality in Lahore has been found to be hazardous throughout the year, peaking in the winter season.
- Heavy precipitation in the months of July and August improves the air quality tremendously. Similarly, the prevailing smog in the months of winters is swept by reasonable showers in the months of December and January.
- Health risk has been found to be alarmingly high for all age groups in the period from October through February.

Burden of Cardiovascular Diseases Attributable to Particulate Matter Pollution across African Union Member States: A Systematic Analysis for the Global Burden of Disease Study 2023

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Cardiovascular disease is the leading cause of mortality in the African Union (AU), yet environmental risk factors—specifically particulate matter—remain under-addressed in regional prevention strategies. This study evaluated the impact of both ambient and household particulate matter on CVD across all AU Member States from 1990 to 2023.

We analyzed mortality and Disability-Adjusted Life Years (DALYs) for CVDs attributable to particulate matter using the GBD 2023 Comparative Risk Assessment framework.

In 2023, particulate matter pollution was responsible for an estimated 682,400 (95% uncertainty interval [UI]: 541,200–823,600) CVD deaths across the AU. While absolute mortality has increased by approximately 42% since 1990, the age-standardized death rates revealed significant regional disparities. North Africa recorded the highest age-standardized mortality at 86.6 (95% UI: 65.4–108.2) per 100,000, followed by Central Africa at 54.9 (95% UI: 41.2–70.5), Western Africa at 51.5 (95% UI: 38.6–66.1), Eastern Africa at 36.9 (95% UI: 27.8–48.4), and Southern Africa at 28.5 (95% UI: 21.4–37.2).

Household air pollution remains the dominant driver of CVD in regions with high reliance on traditional biomass use, such as Central, Western, and Eastern Africa. However, ambient particulate matter is a rapidly growing threat, accounting for nearly 31% (95% UI: 24.5–38.2) of the total PM-attributable CVD DALYs in the AU. This outdoor burden is most concentrated in urbanizing regions, such as North Africa, where it has overtaken indoor smoke as the primary environmental CVD risk.

Particulate matter is a primary modifiable driver of the CVD epidemic in Africa. The transition from indoor to outdoor exposure necessitates a dual policy approach: accelerating clean energy transitions to reduce household smoke and implementing strict industrial and vehicular emission standards to control ambient pollution. Integrating these environmental interventions is essential for the AU to meet global cardiovascular health targets.

Keywords: Cardiovascular Diseases, Particulate Matter; African Union

Local Air Quality Impacts of Informal Tipper Truck Parks in a West African City: Evidence from Measurement, Health Risk Assessment, Dispersion Modelling, and Air Mass Trajectory Analysis

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This study examines local-scale particulate emissions and associated respiratory health risks from tipper truck parks in Oke-Baale, Osogbo, Nigeria, where heavy-duty diesel vehicles operate in close proximity to residential and commercial zones. Gravimetric sampling during the rainy season quantified $PM_{2.5}$, PM_{10}, and total suspended particulates (TSP). Hourly mean concentrations ranged from 30.67–91.21 µg/m³ ($PM_{2.5}$), 101.65–217.28 µg/m³ (PM_{10}), and 3333–7333 µg/m³ (TSP), while corresponding daily averages were 22.03±11.00 µg/m³, 64.26±22.40 µg/m³, and 1985.05±720.08 µg/m³. Dispersion modelling using AERMOD indicated that 24–h mean concentrations of $PM_{2.5}$ (5.88 µg/m³) and PM_{10} (7.28 µg/m³) complied with WHO, USEPA, and NESREA guideline limits, whereas TSP (305 µg/m³) exceeded the USEPA threshold (260 µg/m³) by 1.17–fold. Model outputs further revealed elevated ground-level concentrations in close proximity to emission sources. Air mass trajectory analysis using HYSPLIT showed pollutant transport originating from the Gulf of Guinea, traversing the Lagos-Ogun-Oyo corridor before dispersing northward. Respiratory deposited dose (RDD) assessment demonstrated that total respiratory deposited doses (TRDDs) for individuals at the tipper parks ranged from 0.05–0.36 µg/min ($PM_{2.5}$), 0.04–1.20 µg/min (PM_{10}), and 5.09–39.15 µg/min (TSP). Deposition of TSP was predominant in the extrathoracic and tracheobronchial regions, whereas $PM_{2.5}$ exhibited deeper alveolar penetration, indicating greater long-term health implications. Age-stratified analysis showed the highest RDDs in the elderly, followed by adults, children, and infants. Overall, the study highlights substantial health risks linked to fine particulate exposure and integrates AERMOD dispersion modelling with ICRP-based deposition modelling to elucidate pollutant transport and deposition dynamics, underscoring the urgent need for targeted emission control strategies.

Spatio-Temporal Assessment of Classroom Air Quality and Thermal Comfort as Determinants of Respiratory Health Risks in Urban Pre-Tertiary Institutions

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Poor indoor environmental quality (IEQ) remains a significant driver of pediatric morbidity, yet data on the interplay between particulate matter (PM), building design, and health in tropical schools are sparse. In this study, the spatio-temporal dynamics of classroom air quality and thermal comfort were investigated to identify the key environmental determinants of respiratory health risks among primary and secondary school students in Benin City, Nigeria. IEQ parameters ($PM_{2.5}$, PM_{10}, CO, and CO_2) and thermal indices were monitored across six schools for ten weeks. Health data were collected through modified BMR questionnaires and analysed using descriptive, inferential, and multivariate logistic regression. To estimate non-carcinogenic health risks, the hazard quotient (HQ) was calculated using the United States Environmental Protection Agency (US EPA) framework. The $PM_{2.5}$ and PM_{10} concentrations ranged from 11.2–81.4 µg/m³ and 20.1–138.6 µg/m³, respectively. The CO_2 concentration peaked at 729.3 ± 28.4 ppm, while high temperature–humidity index (THI) values (28.3–30.1) indicated severe heat discomfort. Health risk assessment revealed that all HQ values for $PM_{2.5}$ and PM_{10} remained below unity (HQ < 1), suggesting that students were not at immediate risk of chronic non-carcinogenic effects; however, respiratory symptoms were highly prevalent: coughing (58.2%), phlegm (32.5%), and chest pain (26.7%). Multivariate analysis revealed that high PM risk was a near-perfect predictor of coughing ($p < 0.001$) and significantly increased the odds of chest pain (Crude OR = 2.74; $p = 0.001$). Poor sanitation was the strongest predictor of phlegm production (AOR = 5.54; 95% CI: 1.35–22.80; $p = 0.018$) after adjustment for confounders, including age, sex, and socio-economic status. These findings suggest that targeted spatio-temporal interventions, such as improved cleaning protocols and air quality policies, are essential for mitigating health risks and optimizing the learning environment.

Hyperlocal Air Quality Monitoring in Urban Sports Events: The "Running for Clean Air" Initiative

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Air pollution remains one of the leading environmental health risks globally, with particularly severe impacts in rapidly developing regions such as some regions in Africa, where air quality data gaps and limited monitoring infrastructure hinder effective policy responses.

In this context, innovative, data-driven and community-oriented approaches are essential to support evidence-based interventions and investment in clean air solutions.

The "Running for Clean Air" initiative, led by World Athletics and supported by the Clean Air Fund, represents a novel cross-sectoral model integrating sport, environmental monitoring, and public engagement.

The project deploys advanced air quality sensors (Kunak AIR Pro) in urban environments associated with major marathon events, such as Lagos (Nigeria) and Warsaw (Poland), to collect high-resolution data on pollutants (e.g., $PM_{2.5}$, NO_2, O_3) and thermal stress over extended periods. Monitoring is conducted both prior to and during events, combining fixed and mobile measurements along the racecourse to capture spatial and temporal variability in exposure. These data are complemented by awareness campaigns, stakeholder engagement activities, and collaboration with local governments and organisations.

Results demonstrate the feasibility of hyperlocal air quality monitoring in urban sports contexts, revealing clear temporal pollution patterns (e.g., higher exposure during specific days and peak daytime hours) or specific areas particularly affected by air pollution aimed at providing actionable insights for safer physical activity planning. The initiative also successfully engages communities, leveraging marathon events as platforms to disseminate real-time data and raise awareness about the health and performance impacts of air pollution.

In conclusion, "Running for Clean Air" illustrates the potential of integrating sensor-based system networks, citizen engagement, and high-visibility public events to address urban air pollution. This approach contributes to closing data gaps, fostering behavioural change, and supporting policy development, offering a scalable model particularly relevant for African cities seeking cost-effective, evidence-based clean air solutions.

Open Air Quality Monitoring and Transparent Data Sharing in Malawi: The Malawi Initiative for Clean Air Solutions (MIfCAS)

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Air pollution is detrimental to health in Malawi but Malawi currently lacks a national policy on air pollution mitigation to protect public health due to limited air quality monitoring capabilities. The Malawi Initiative for Clean Air Solutions (MIfCAS), an interdisciplinary collaborative funded by the Energy Policy Institute at the University of Chicago Air Quality Fund sought to bridge this gap. We established a hybrid network for quantifying fine particles using a Beta Attenuation Monitor (BAM) 1022 (MetOne Instruments Inc., Oregon, USA), AirGradient OpenAir (AirGradient, Chiang Mai, Thailand) and IQAir AVO (IQAir, Zurich, Switzerland) instruments in addition to periodic mobile monitoring with OpenSeneca (Zurich, Switzerland) mobile monitors. We present here a preliminary analysis of the reported data from this hybrid network to make a case for a long-term high-density ground-based air quality monitoring in Malawi to support the development, implementation, and tracking of a national policy on air pollution mitigation. Hourly measurements ranged between 1–433 µg m^{-3} (raw air sensor measurements). These relatively low hourly levels (i.e., between 1–35 µg m^{-3}) agree well with hourly measurements from the BAM 1022 requiring further investigation. Diurnal patterns were bimodal, consistent with anthropogenic activities with peaks at 06:00 hr (50 µg m^{-3}) which drops between 07:00 and 17:00 hr and peaks again at 6:00 pm. The highest observations were recorded on Thursdays (35 µg m^{-3}) and the lowest, Sundays (32 µg m^{-3}). With the mobile monitors, observations near Lilongwe, the capital city were >50 µg m^{-3}, moderate to high (i.e., 20–25 µg m^{-3}) along the route from Mzuzu to Lilongwe, and relatively low near the lake regions (15–20 µg m^{-3}). These preliminary findings are presented as foundational evidence to support a national discourse on air pollution management and control through district-specific and community engagement efforts with regulators and in-country research institutions.

Respiratory Health Effects of Traffic-Related Air Pollution Exposure in Urban Cameroon: A Comparative Study in Yaoundé, Cameroon

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Air pollution is a growing public health concern in rapidly urbanizing African cities. In Yaoundé, road traffic represents a major source of particulate and gaseous pollutants, yet local evidence on associated health effects remains limited.

Objective: To assess the impact of traffic-related air pollution exposure on respiratory health among residents in Yaoundé. Methods: A comparative cross-sectional study was conducted over three months (July-August 2025) in two urban neighborhoods with differing traffic exposure levels (Mvan and Ngoa Ekelle). Ambient concentrations of $PM_{2.5}$ and PM10 were measured, and a structured questionnaire was administered to residents who had lived or worked in the area for at least one year to assess respiratory symptoms and health perceptions. Data were analyzed using SPSS, R, and Excel.

$PM_{2.5}$ and PM_{10} concentrations were significantly higher in Mvan compared to Ngoa Ekelle ($p < 0.001$). Residents in the high-exposure area reported higher prevalence of respiratory symptoms, including cough, nasal congestion, throat irritation, and shortness of breath, as well as more frequent respiratory infections. Despite limited formal diagnoses, 85.5% of participants perceived air pollution as having a negative impact on their health. Adoption of personal protective measures was higher in Mvan (74.3%) compared to Ngoa Ekelle (47.3%).

Increased exposure to traffic-related air pollution is associated with greater respiratory health burden among urban residents in Yaoundé. These findings highlight the need for strengthened air quality monitoring, policy interventions, and community-level risk reduction strategies in rapidly growing African cities.

Keywords: Air pollution; Traffic emissions; Respiratory health; $PM_{2.5}$; PM_{10}; Yaoundé

The Interplay between Air Quality and Climate Challenges in Africa

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In this presentation, I will examine the two-way relationship between climate change and air quality in Africa. Many air pollutants that directly affect human health are co-emitted with climate forcers such as greenhouse gases and aerosols, creating strong linkages between air quality management and climate mitigation. I will explore how these relationships may evolve as energy systems change and combustion becomes a less dominant source of emissions.

The relative importance of different emission sectors, including industry, transport, and agriculture, will be discussed, alongside the contribution of naturally occurring pollutants. Attention will also be given to how climate change could alter natural sources, for example through increased temperatures, land degradation, and potential changes in desert dust emissions. Socio-demographic trends will also play a central role. Africa's rapid population growth and urbanization are powerful drivers that will shape both air pollution trajectories and climate resilience pathways across the continent's cities and regions.

Finally, I will consider the interaction between air pollution, climate change, and the Sustainable Development Goals (SDGs). While climate action is addressed explicitly through SDG 13, air pollution is embedded across multiple goals related to health, cities, and energy. I will argue that for the SDGs, and their post-2030 evolution, to become more effective, climate must be the central lens through which all goals are viewed. Furthermore, air pollution must be more fully recognized within development agendas, as it remains the leading environmental risk factor for human health across many African countries and is likely to remain so for the foreseeable future.

Keywords: Climate Change, Air Pollution, Sustainable Development Goals, SDGs, Emissions

Investment Priorities for Urban Air Quality: Evidence from Acid Rain Monitoring in Addis Ababa, Ethiopia

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Addis Ababa experiences rapid expansion because of its industrial growth and rising vehicular traffic, which has created worries about the city's air pollution problems and their resulting environmental impacts, including acid rain. This research study examines the spatial distribution of acid rain together with its potential sources in Lemi Kura Sub-City, which is located in Addis Ababa, Ethiopia. Rainwater samples were collected from three representative locations: the Hayat Residential Area, Goro Traffic Congestion Area, and Lemi Industrial Zone over three months (February-April 2025). The researchers used pH analysis to evaluate the acidity of the samples, which helped them determine the environmental damage potential of the samples.

The study results demonstrate that pH levels across all study locations reached an average of 6.95, which shows that rainwater maintained a neutral to slightly alkaline state. The Lemi Industrial Zone had an average pH of 6.93, which indicated that the area experienced very low acid deposition. The Goro Traffic Congestion Area showed a gradual decrease in pH, which began at 6.44 and ended at 6.24 because of increasing acidification caused by rising NO_x and SO_2 emissions from heavy traffic. The Hayat Residential Area maintained a stable pH level, which stayed close to neutral.

The observed spatial and temporal pH variations demonstrated urban air pollution growth, which particularly stemmed from transportation-related emissions, even though none of the pH measurements reached the acid rain threshold (pH ≤ 5.6). The results highlight the need for ongoing air quality monitoring together with active management efforts, which protect the environment and urban systems and safeguard public health in cities. The research results will assist local government officials by providing data for sustainable urban and clean air investment initiatives, which benefit Addis Ababa and other African cities.

Keywords: Acid rain, Lemi Kura Sub-City, Addis Ababa, air pollution, pH measurement

COSMO-MUSCAT Simulated Aerosol-Cloud Interactions and the Impacts on Climatic Parameters over West Africa

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Dust and convective systems are two (2) significant systems associated with the two major seasons over West Africa: the dry and cold harmattan season and the warm and wet/rainy season. However, studies have shown that aerosols are ubiquitous in the atmosphere and significantly modulate, interact, and modify atmospheric processes. Several works have attributed the changing climate to extreme convective rains. The study period was between August 25th to September 5th, 2009, which made it 12 days; with a focus on the convective rain over Ouagadougou on September 1st, 2009. However, the impacts or effects of the interactions between clouds and aerosols on convective rain were yet to be examined. This work also examined the ability of the TROPOS-developed, ICON-driven COnsortium for Small-scale MOdelling - MUltiScale Chemistry Aerosol Transport (COSMO-MUSCAT) coupling model to accurately simulated heavy rainfall event of September 1, 2009 over Ouagadougou. The radiative feedback and non-feedback of this interaction was carried out in order to determine its impact on temperature and relative humidity (at both the upper level and the surface), convective precipitation, and cloud cover over West Africa. It can be deduced from the outputs that COSMO-MUSCAT performed well in simulating these scenarios. The cloud was light and towering under non-feedback but thicker under the feedback scenario. The temperature and relative humidity analyses showed different outputs under different scenarios and levels.

Keywords: Aerosols; COSMO-MUSCAT; Cloud; Climatic Parameters; West Africa

Air-Pollution Exposure and Health Risks among Waste Pickers and Residents around the Pugu Dumpsite, Dar es Salaam, Tanzania: Air-Pollution Dispersion Modelling Using Survey Data

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Urban waste management in rapidly growing cities such as Dar es Salaam poses critical environmental and public health challenges, primarily through air pollution generated by open burning, illegal dumping, and inefficient collection systems. Despite increasing evidence of severe air quality deterioration, limited research has quantitatively assessed exposure pathways and health risks among vulnerable populations, such as informal waste pickers, who are central to urban recycling systems. This study addresses this gap by evaluating air pollution exposure and associated health outcomes among waste pickers and nearby residents around the Pugu dumpsite. By integrating a Gaussian plume dispersion model with cross-sectional survey data from 130 respondents, the research demonstrates that particulate concentrations ranging from 12–130 µg/m^3 for $PM_{2.5}$ and 14–184 µg/m^3 for PM_{10} significantly exceed World Health Organization 24-hour safety guidelines for a radius exceeding 5 kilometers.

The results reveal a significant dose-response relationship, with 63% of waste pickers operating within the high-intensity source zone reporting chronic respiratory distress compared to 34% of residents. These findings indicate that waste pickers experience the highest risk due to prolonged interaction with waste and proximity to open burning activities. Furthermore, leachate analysis identifies both environmental contamination risks and potential opportunities for resource recovery within a circular economy framework. Ultimately, these results highlight the urgent need for integrated waste management strategies, consistent air quality monitoring, and targeted exposure mitigation to protect vulnerable populations and inform sustainable urban policy in rapidly urbanizing contexts.

Air Quality, Microbial Contamination and Antibiotic Resistance in an Urban Abattoir in Lagos, Nigeria

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Airborne microbial contamination and pollutants in abattoir environments may create selective pressures that favor the persistence and dissemination of antimicrobial-resistant (AMR) microorganisms with public health implications. This study assessed air quality parameters, microbial load, and antimicrobial resistance profiles in a Lagos abattoir.

Air sampling was conducted at three locations (L1 and L2 within the abattoir, and L3 outside the abattoir). Passive settle plate method, and appropriate microbiological media was used for bacterial and fungal isolation. Air quality parameters were measured using portable sensor devices (DM601 Air Quality Monitor), while meteorological parameters were obtained using a mobile air monitoring system (Weather Forecast app). Antimicrobial susceptibility testing was performed using the Kirby-Bauer disk diffusion method.

CO_2 levels ranged from 1029 ppm to 2847 ppm. The highest pollution level was recorded outside the abattoir (L3), with an AQI value of 500 (very unhealthy), and elevated TVOC (1.394 mg/m³). Particulate matter concentrations were relatively consistent across locations, with $PM_{2.5}$ ranging from 150–230 µg/m³ and PM_{10} from 190–310 µg/m³, while gaseous pollutants such as O_3 (37 µg/m³) and NO_2 (30 µg/m³) showed minimal variation across sampling points. The relative humidity (89%) and temperature conditions (32°c) supported microbial persistence with a total of 400 colonies recorded for the three locations. Antimicrobial susceptibility testing showed high levels of resistance to multiple antibiotics, with several isolates demonstrating multidrug resistance across locations.

The presence of elevated gaseous pollutants, particularly outside the abattoir may be attributed to vehicular emissions, nearby waste accumulation, and open burning practices commonly associated with abattoir surroundings. The detection of multidrug-resistant organisms highlights potential public health risk in the work environment. These findings underscore the need for improved environmental sanitation, integrated microbial air quality monitoring, and implementation of One Health-based interventions.

Keywords: Antimicrobial-resistant, Gaseous pollutants, Particulate matter

Air Quality Measurement, Modelling and Forecasting

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Air pollution is an escalating environmental and public health concern in rapidly urbanizing African cities, including Nairobi, Kenya. However, limited availability of high-resolution air quality data continues to constrain effective policy development and intervention strategies. This study investigates urban air quality dynamics using low-cost sensor networks deployed across selected locations in Nairobi to generate localized, real-time data on particulate matter (PM2.5 and PM10).

The study analyzes spatial and temporal variations in pollution levels, with a focus on identifying pollution hotspots and peak exposure periods. Data were complemented with meteorological parameters to better understand the influence of weather conditions on pollutant dispersion. Findings indicate that particulate matter concentrations frequently exceed recommended international guidelines, particularly in areas characterized by high traffic density and informal economic activities.

The use of low-cost monitoring technologies demonstrates significant potential in bridging data gaps in resource-constrained settings by enabling scalable and continuous air quality assessment. Additionally, the study highlights the importance of integrating data-driven insights into urban planning, environmental regulation, and public health interventions.

By providing context-specific evidence, this research contributes to the growing body of knowledge on air quality monitoring in Africa and supports the development of targeted, evidence-based strategies to mitigate air pollution and its associated health risks. Strengthening local monitoring capacity and fostering cross-sector collaboration will be critical for sustainable air quality management in the region.

Keywords: air quality, Nairobi, low-cost sensors, $PM_{2.5}$, urban pollution

Ambient $PM_{2.5}$ and PM_{10} across Five Monitoring Sites in Port Harcourt, Rivers State, Nigeria: Concentrations, Diurnal Patterns, and WHO Guidelines Exceedance

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The Niger Delta cities have extremely limited data on particulate matter (PM) pollution. Port Harcourt, Nigeria's primary petroleum and industrial center, endures persistent exposure to combustion aerosols, gas flaring byproducts, and vehicular emissions; yet quantitative evaluations of ambient PM with sufficient temporal resolution are mostly lacking in the literature. This study characterises ambient $PM_{2.5}$ and PM_{10} concentrations at five monitoring locations in Port Harcourt, quantifies exceedances of WHO and USEPA air quality standards, elucidates diurnal and monthly concentration trends, and identifies inter-site variations attributable to local source influences. Hourly $PM_{2.5}$ and PM_{10} data were obtained from AirQo Binos low-cost sensors at five locations — Collins Owhondah Drive, Peter Odili Road, Rumuchita, Trans-Amadi Road, and UST Road — from 14 January to 15 March 2026. Kruskal-Wallis tests with Bonferroni-adjusted Mann-Whitney pairwise comparisons evaluated inter-site differences, while Spearman rank correlations examined $PM_{2.5}$-meteorological relationships. Mean $PM_{2.5}$ concentrations ranged from 23.7 µg/m³ at UST Road to 34.6 µg/m³ at Trans-Amadi Road, all exceeding the WHO annual guideline of 5 µg/m³ severalfold. Between 76.5% and 97.2% of monitoring days exceeded the WHO 24–hour $PM_{2.5}$ guideline (15 µg/m³) across all sites. Mean PM_{10} concentrations ranged from 31.3 µg/m³ at UST Road to 48.6 µg/m³ at Collins Owhondah Drive; the WHO 24–hour PM_{10} guideline (45 µg/m³) was exceeded on 17.6% to 54.0% of monitoring days. Trans-Amadi Road demonstrated a distinctive afternoon $PM_{2.5}$ peak (15:00) consistent with industrial activity, whereas four sites exhibited morning peaks (05:00–07:00) driven by rush-hour traffic and nocturnal boundary layer compression. Inter-site differences were highly significant (Kruskal-Wallis $H = 303.0$, $p < 0.001$). The air quality in Port Harcourt represents a severe and ongoing public health challenge, necessitating urgent policy interventions, including the regulation of vehicular emissions and open burning and the expansion of ambient monitoring networks.

Keywords: Air pollution; Port Harcourt; Nigeria; $PM_{2.5}$; PM_{10}; low-cost sensors

Bankable Breath: Citizen Science as a Catalyst for Multistakeholder Air Quality Financing in African Cities

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Every day, millions of people in African cities inhale air that threatens their health. Yet funding for clean air fell by twenty percent in 2023, leaving urban areas with less than one percent of international resources. Traditional short-term donor approaches struggle to tackle systemic pollution, especially in high-density cities with large informal economies. In line with the 2026 Forum's theme, this submission from the UrbanBetter Cityzen Hubs presents a community-driven model that turns citizen-generated data into actionable, investable evidence.

Led by UrbanBetter Cityzens Hubs in Johannesburg and Nairobi, with insights from Lagos, Cityzens capture high-resolution P.M 2.5 data using wearable sensors. This data is paired with geotagged photographs documenting pollution sources and infrastructure gaps. The dual-evidence approach makes previously invisible exposure visible (e.g daily risks faced by informal workers). Lessons from all three hubs inform the model, highlighting urban challenges and opportunities across Sub-Saharan Africa and reinforcing its broader applicability.

By transforming hyper-local data into verified, risk-reducing evidence, the model creates a clear pathway for investment. Climate financiers, ESG investors, and philanthropic partners can co-invest in interventions like low-emission transit corridors or alternatives to open waste burning while tracking measurable urban health outcomes in real time. Linking citizen-collected data to financial instruments makes the impact tangible, the risk quantifiable, and the investment case undeniable. This approach turns clean air initiatives into replicable, bankable opportunities that appeal to both private and institutional funders.

This session will show how citizen science is not a mere advocacy exercise; it is a critical financial instrument that enables scalable, equitable, and investment-ready air quality interventions. By connecting grassroots data collection with institutional expectations, this model bridges local realities and global funding structures, helping build breathable, healthy, and resilient cities across Sub-Saharan Africa.

Keywords: Multistakeholder financing, Citizen science, ESG investments, Air quality data, Informal economy

Schools as Sentinels for Operationalizing National Air Quality Legislation through School-Based Monitoring Hubs in Uganda

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Children in rapidly urbanizing African cities often experience disproportionate exposure to air pollution, yet schools remain underused as sites for evidence generation and policy action. This abstract presents the Uganda Clean Air Schools Initiative (UCASI) as a practical model for transforming schools into stationary air quality monitoring hubs that generate localized $PM_{2.5}$ evidence for health protection, climate literacy, and regulatory action.

The initiative is grounded in Uganda's National Climate Change Act, 2021 and the National Environment (Air Quality Standards) Regulations, 2024, and responds to a critical implementation gap, the absence of routine, publicly accessible school-centered data that can inform enforcement, awareness, and urban planning. By combining stationary monitoring at school sites with complementary mobile and community-level measurements, the model strengthens understanding of pollution exposures affecting children as a vulnerable population.

The proposed approach positions schools as both learning spaces and environmental sentinel sites. It demonstrates how school-based monitoring can support the translation of air quality legislation into practice through three pathways, generating open-access exposure baselines, informing "clean air school zone" protections, and embedding air quality evidence within education and public health conversations. It also highlights the role of multi-stakeholder collaboration among civil society, academia, technical monitoring partners, and public institutions in building scalable, locally relevant monitoring systems.

This session contributes to the Africa Clean Air Forum theme by showing that investment in school-based monitoring is not only a technical intervention, but also a governance tool for addressing exposure inequities, protecting children's health, and advancing evidence-driven urban resilience in African cities.

Sensirion SPS30 and SEN55 $PM_{2.5}$ Validation Under Extreme Indoor Biomass Concentrations

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While low-cost sensors (LCS) are increasingly utilized, validation remains limited for indoor environments characterized by high-concentration biomass burning. Sensirion SPS30 and SEN55 OEM sensors show promising precision and accuracy under ambient conditions. Manufacturer specifications define a measurement range of <1000 µg/m^3, but for applications in low-resource settings their performance under extreme loading is critical. This study evaluates these sensors through collocation with gravimetric measurements in kitchens and a residence in Arba Minch, Ethiopia, where concentrations regularly exceeded 1,000 µg/m^3 and reached levels of 10,000 µg/m^3.

Sensor precision was consistently high, with coefficients of variation (CV) ranging from 1.4% to 7.7%, well within the threshold of <10%. Crucially, precision remained stable during low-concentration periods following repeated high-exposure events, suggesting no significant sensor degradation. The sensors showed high linearity with gravimetric measurements ($R^2 \geq 0.96$). After correcting for significant slopes (1.14 and 1.15), the sensors met performance criteria with accuracy errors (AE) of 14–22% (below the <25% limit).

Values beyond the specified measurement range were essential: truncating any values beyond 1000 µg/m^3 led to AE >25 %. A SEN55 digital truncation at 6553.4 µg/m^3 did not lead to excessive errors. Occurrences of this truncation were significantly matched to SPS30 measurements beyond this level, showing that these high concentration measurements were meaningful rather than random.

While on-site validation is necessary to determine correction factors, the SPS30 and SEN55 proved capable of handling concentrations far beyond their rated range. This resilience is not universal among OEM sensors, many of which show non-linear responses after high-exposure events. We recommend that system designers preserve raw data rather than using pre-averaged outputs to better interpret truncation effects. For low-income country contexts, selecting sensor types that "hold out" under high, variable concentrations is vital for reliable indoor monitoring.

Keywords: low-cost sensors; biomass burning; indoor air quality; high-concentration validation; SPS30; SEN55

Participatory Approach to Development of Air Quality Action Plans (AQAPs) for Ghana

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Air pollution is responsible for about 28,000 early deaths every year, making it the second biggest risk factor for death and disability in Across Ghana, this pollution causes. The levels of fine particulates ($PM_{2.5}$ and PM_{10}) as well as NO_2, SO_2, and ozone frequently exceed those recommended by the world health organization. In recognition of the adverse impacts of air pollution the government of Ghana and private funders, including the Clean Air Fund have stepped up mitigation measures to reduce pollution levels and promote cleaner and safer air for all. In this study, we adopt a participatory approach to develop air quality action plans for 15 local assemblies within the Greater Accra Metropolitan Area (GAMA). We setup air quality action plan teams in each assembly responsible for identifying pollution hotspots and mitigation measures that could be implemented to improve air quality. To obtain a baseline understanding of current pollution levels, we installed reference grade air quality monitors across 60 locations, selected in conjunction with assembly officials, to monitor concentrations of $PM_{2.5}$, PM_{10}, NO_2, and SO_2. Each participating assembly was guided to design three air quality scenarios: Business as Usual (no changes to emissions), Best Case (emission reduction percentage determined by the assembly), and Worst Case (emissions increase relative to current levels by at least 25%). We used the AERMOD model to model concentrations of air pollutants under each scenario to guide planning by the assemblies. Our monitoring data shows that air pollution levels of all pollutants exceed WHO guideline values across all assemblies, especially in areas with bus terminals, road construction sites, and markets. The levels of SO_2 often exceeded 200ug/m^3, exceeding WHO guideline values by more than 500%. Each assembly produced an action plan to reduce air pollution by 2030 based on monitoring and modelling results

Keywords: Air-Quality, Action-Plans, Air-Pollution

Multistakeholder Financing and Air Quality Interventions: Emerging Trends, Challenges and Opportunities for Low- And Middle-Income Countries in Africa

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Air pollution has emerged as a critical environmental and public health challenge in low-income countries, particularly in Africa, where rapid urbanization, industrial expansion, biomass dependence, and weak regulatory enforcement increase exposure risks. Although its socioeconomic and health impacts are increasingly recognized, financing for air quality interventions remains inadequate because of constrained public budgets, declining international development assistance, and competing priorities. Integrating air quality into national climate finance strategies is therefore essential for long-term sustainability and equitable development across the continent. This study examines the role of blended finance and public-private partnerships (PPPs) as innovative financing mechanisms for air pollution mitigation in Africa within an evolving funding landscape. Conventional public financing alone is insufficient to meet investment needs associated with just energy transitions, transport modernization, emissions control, and air quality monitoring infrastructure. The paper adopts a mixed-methods approach combining a systematic review of financing models applied in environmental and climate-related interventions, comparative evidence from Global South countries, and stakeholder analysis involving governments, development finance institutions, private investors, and civil society actors. Secondary data from policy reports, investment portfolios, and international financing databases will be analysed to identify resource mobilization patterns, institutional arrangements, and implementation barriers. Blended finance can reduce investment risks and attract private capital when supported by guarantees, concessional funding, and policy incentives. The study identifies opportunities for designing integrated financing models that address air pollution while generating co-benefits for climate resilience, public health, and clean energy in low-income countries. However, weak institutional capacity, regulatory uncertainty, limited project pipelines, and inadequate measurement of air quality co-benefits remain major barriers to scaling PPPs in African contexts. The study provides actionable policy entry points for strengthening policy coherence, developing investment-ready interventions, expanding domestic fiscal instruments, and fostering regional cooperation to mobilize multistakeholder financing.

Keywords: Blended finance, PPPPs, air pollution mitigation, low-income countries

Bridging Ground and Satellite Data for Methane Emission Quantification in Unmanaged Dumpsites: A Case Study of Dandora, Nairobi

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Accurate quantification of methane (CH_4) emissions from unregulated dumpsites remains a critical challenge in developing countries, where limited monitoring infrastructure constrains effective climate mitigation. This study presents a field-based assessment of methane emissions at the Dandora dumpsite in Nairobi, Kenya, combining in-situ gas measurements with satellite observations. Methane concentrations were measured using a portable gas analyzer across multiple sampling points within and around the dumpsite. The downwind (inverse dispersion) method was applied to estimate emission fluxes by analyzing methane plumes at varying distances from the source. To enhance robustness, ground-based measurements were compared with coincident satellite-derived methane observations acquired one day apart.

Results indicate significantly elevated methane concentrations at the site, exceeding 500 ppm in several sampling locations, highlighting the dumpsite as a major emission hotspot. Emission estimates downwind showed strong spatial variability but consistently aligned with elevated concentration gradients observed downwind. Comparison with satellite data demonstrated general agreement in identifying emission hotspots, although discrepancies in magnitude were observed due to differences in spatial resolution and atmospheric conditions.

The study underscores the reliability of integrating ground-based measurements with satellite observations for quantifying methane emissions from unmanaged waste sites. Furthermore, it highlights the complementary role of satellite observations in validating and scaling localized measurements. These findings contribute to improving emission inventories and support the development of targeted mitigation strategies for landfill methane in tropical urban environments.

Keywords: Modelling, Methane emissions, hotspot, satellite validation

Tracking Personal $PM_{2.5}$ Exposure Across Travel Environments using Portable Sensors: Evidence from an East Africa Journey

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Traditional static air quality monitors often fail to capture dynamic personal exposure to fine particulate matter ($PM_{2.5}$) as individuals move across environments. With increasing global travel and mobility in African cities, understanding how PM2.5 exposure varies in transit, such as in airports, aircraft cabins, and urban areas, is critical for informing public health interventions.

The objective was to quantify and compare personal $PM_{2.5}$ exposure across multiple travel-related and urban environments during an international trip between Douala (Cameroon) and Mombasa (Kenya).

Over a 10–day period (February 26– March 7, 2026), we tracked $PM_{2.5}$ exposure using a portable sensor (Atmotube). Measurements were taken across multiple settings, including aircraft cabins (four flights, 1–4.5 hours each), airport terminals (six locations), urban outdoor areas and indoor spaces such as conference venues and restaurants.

Exposure to $PM_{2.5}$ varied widely depending on the environment. Aircraft cabins consistently had low levels, averaging 2.03–5.86 µg/m³, with occasional peaks up to 38 µg/m³. Airports showed higher and more variable exposure, reaching a mean of 30.12 µg/m³ at Douala International Airport, with peaks up to 91 µg/m³ in Nairobi during transit. In Mombasa, urban outdoor exposure was relatively low (mean: 5.76 µg/m³), and indoor conference venues also showed low levels (mean: 4.36 µg/m³). However, short-term exposure spiked dramatically in a semi-enclosed restaurant with active biomass grilling, where $PM_{2.5}$ reached a mean of 186 µg/m³ and a peak of 447.2 µg/m³.

Short-duration, high-exposure environments can significantly contribute to overall personal exposure, particularly in African urban contexts. Portable monitoring provides insights that complement stationary networks, enabling more responsive risk communication, targeted interventions, and improved urban air quality management. These findings can inform policy, urban planning, and public awareness strategies to reduce exposure in high-risk environments across African cities.

Keywords: Personal exposure; $PM_{2.5}$; travel; portable sensors; Africa.

Agricultural Exposure Pathways and Clean Air Challenges in Peri-Urban West Africa: Insights from Senegal

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Air pollution is a major health concern in Africa, yet exposure assessment remains limited outside established monitoring systems, particularly in data-sparse regions. In West Africa, peri-urban agricultural zones are closely linked to growing cities but are not commonly considered within air quality management discussions.

This work presents insights from field-based research and observations conducted in Senegal's Niayes horticultural zone, a key production area supplying urban markets. Monitoring studies have documented widespread pesticide use and gaps in compliance, while occupational health approaches, including acetylcholinesterase activity, highlight exposure risks among workers.

Beyond direct occupational exposure, this case illustrates airborne pathways relevant to clean air strategies. Inhalation during spraying and pesticide drift can affect nearby settlements, especially in densely populated peri-urban areas. These exposures may occur alongside ambient air pollution, creating combined environmental exposure situations that are not well captured in current monitoring approaches.

In data-sparse contexts, these challenges are further compounded by limited integration between environmental monitoring, agricultural practices, and health surveillance systems.

This contribution highlights a practical gap in air quality management and discusses opportunities for better coordination between agriculture, health, and environmental sectors. It emphasizes the need for integrated and context-adapted approaches to better understand and address exposure risks in rapidly urbanizing regions of West Africa.

Keywords: Peri-urban exposure; Air quality; Pesticide drift

From Air Pollution Monitoring to Driving Policy Action for Clean Air in DR Congo

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Democratic Republic of the Congo (DRC) has the highest air pollution level in Africa. The average resident of the DRC is losing three years of life expectancy - according to the AQLI - because of pollution levels that are ten times higher than WHO guideline. Yet, for years, air pollution has not been a priority for the DRC Government which lacks air quality monitoring systems, has weak environmental health data, and is facing increasing respiratory disease risks. To address the DRC air pollution crisis, we established WASARU - a nonprofit organization working at the intersection of urban resilience, environmental health, and community-driven data systems, with a strong focus on vulnerable populations. WASARU flagship initiative is the Kinshasa Air Quality Project, funded by EPIC.

At the Africa Clean Air Forum 2026, we will present how we turn data into clean air policy change through our clean air interventions focused on:

- launching the Kinshasa Air Quality Project, a particulate pollution monitoring network providing the only open, real-time air quality data in DRC;
- providing science evidence with new scientific data on air quality and health effects of air pollution;
- engaging with national government to influence and support decision makers to act on air pollution;
- informing health policy & prevention strategies - strengthening the implementation of the National Action Plan for Health Security;
- engaging local community and increase public awareness;
- open data capacity building;
- establishing national and regional partnership to support awareness, policy dialogue, and strengthen the air quality agenda in DRC and East Africa.

How Lessons Learnt from Pilot Air Quality Monitoring were Translated into Building Grassroots Support for Air Quality Policy in Nigeria

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Lagos, Nigeria, one of Africa's most populous cities, faces significant challenges in understanding and mitigating the population health impacts of air pollution due to limited air monitoring infrastructure. To address this gap, four low-cost sensors were deployed to measure fine particulate matter ($PM_{2.5}$) across Lagos between July 2023 and December 2024 in a pilot project. Strategically deployed to capture variations in population socioeconomic status and emission sources, the sensors provided critical insights into spatial and temporal air quality patterns.

Challenges emerged during deployment, including optimizing sensor placement to accurately capture ground-level TRAP. Collaborative efforts with local stakeholders were essential for sensor placement and data collection. These learnings were used to improve a full project titled Air Quality for Collective Public Health Action, funded by the EPIC Clean Air Program. This project is deploying advanced low-cost $PM_{2.5}$ sensors across Lagos, Abuja, and Ibadan to bridge critical gaps in air quality data within Nigeria.

For the pilot project, the 24–hour overall median $PM_{2.5}$ concentration was 20.6 µg/m^3 (IQR=16.3, 29.8), indicating poor air quality throughout the city. $PM_{2.5}$ levels were significantly elevated in December (mean=43.1 µg/m^3), January (mean=62.1 µg/m^3), and February (mean= 68.3 µg/m^3) at all study sites. The dramatic elevations in $PM_{2.5}$ levels from December to February highlight the unique challenges of air pollution research in SSA, where distinct $PM_{2.5}$ sources and meteorological conditions shape seasonal variations. This study's marked spatial and temporal variability underscores the need for tailored, context-specific approaches to air pollution monitoring and exposure assessment in SSA.

Learnings from the pilot project were translated into the full project by raising awareness and spurring grassroots involvement by educating them how to make use of publicly available data. The project is on a journey to ensure that air quality data is not only accessible but also actionable at the local level.

Indoor Air Quality and its Effects on Children's Health and Academic Performance in Schools in Mfou, Cameroon

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Indoor air quality (IAQ) in schools affects students' health, and academic performance. Major sources of indoor pollution include poor ventilation, cleaning products, and building materials. This study assessed IAQ in schools in Cameroon, and examined its effects on pupils' health and learning outcomes.

A cross-sectional study was conducted in 2025 across ten primary schools in Mfou, Cameroon. IAQ was measured using BOSEAN portable monitors for CO_2, $PM_{2.5}$, PM_{10}, temperature, humidity, and volatile organic compounds (VOCs). Observation grids documented ventilation, occupancy, and cleaning practices. Structured questionnaires were administered to 350 pupils. Data were analyzed with IBM SPSS 25.0, using descriptive statistics, chi-square tests, and Pearson correlation analyses, with significance set at $p < 0.05$.

Average CO_2 concentrations reached 1,200 ppm, exceeding the 1,000 ppm threshold in 70% of classrooms. $PM_{2.5}$ averaged 45 µg/m³ and PM_{10} 80 µg/m³, both above WHO guidelines. VOCs, including formaldehyde, were detected in 40% of classrooms. Observation grids revealed poor ventilation in 65% of rooms, overcrowding, and frequent use of chemical cleaning products. Mean temperatures were 29°C and relative humidity 72%, conditions that worsened pollutant persistence. Health outcomes were significantly associated with exposure: respiratory symptoms (42%, $\chi^2 = 12.6$, $p = 0.004$), ocular irritation (28%, $\chi^2 = 9.8$, $p = 0.012$), headaches and concentration difficulties (35%, $\chi^2 = 14.2$, $p = 0.002$). Academic performance was reduced, with pupils in polluted classrooms scoring 12% lower in attention and memory tests (Pearson $r = -0.31$, $p < 0.01$).

Indoor air pollution in schools is a public health concern, impairing children's well-being and learning. Poor ventilation and chemical product use intensify exposure. Practical measures like improved natural ventilation, safer cleaning practices, and awareness campaigns are needed, in compliance with current regulations, to protect pupils.

Keywords: Indoor air quality, schools, children's health, academic performance, Cameroon.

Linking Air Pollution, Climate Change, and Health in Africa: A Bibliometric and Knowledge Mapping Review

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Globally, the challenges of air pollution, climate change, and health are interconnected. However, the evidence available in Africa remains underdeveloped and fragmented. This study presents a comprehensive bibliometric and knowledge mapping of the intersection of air pollution, climate change, and health in Africa. We utilized science mapping and performance analysis techniques to process and retrieve peer-reviewed documents from the Web of Science Core Collection (2000 - 2024). The bibliometric analyses, VOSviewer and Bibliometrix, were used to study the trends in publications, authorship, institutional contributions, and collaboration networks. Findings showed a remarkable increase in the number of studies from 2015. The research studies were concentrated in a few countries, especially South Africa, Nigeria, and Kenya, depicting the unequal distribution of research capacity across African countries. The analyses of keywords and the co-occurrence and co-citation analyses revealed three main theme clusters. The first revolves around household air pollution and the associated risks of exposure. The second includes climate-sensitive air pollution, dust, and temperature variability. Thirdly, the health impacts from air pollution, with a focus on respiratory and cardiovascular diseases. Despite the growing attention, significant gaps still exist. These include the underrepresentation of rural settings and vulnerable populations, limited data for long-term monitoring, and the weak integration of health and climate data. This review highlights the importance of interdisciplinary and regionally coordinated research efforts to understand and tackle the complexities of air quality, climate change, and health in Africa. The results of this review are instrumental in defining research gaps, formulating policies, and designing specific interventions to mitigate the health impacts of air pollution in the region.

Keywords: Air Quality, Africa, Health, Climate change, Bibliometric

Combining Temporal Interpolation and Inverse Distance Weighting to Estimate $PM_{2.5}$ Pollution in Unmonitored Areas in Yaounde

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Accurate assessment of urban air quality in sub-Saharan Africa is limited by sparse monitoring networks and data gaps from sensor failures, power outages, and platform malfunctions. In Yaounde, Cameroon, monitoring stations are few and not in all key neighbourhoods, leaving large areas without measurements. This study estimates daily PM2.5 concentrations in unmonitored Yaounde neighbourhoods using a combined temporal and spatial interpolation framework with data from the AirQo CleanAir4Africa network from February to October 2024.

A two-step interpolation was used. Linear interpolation reconstructed short temporal gaps (< 5 days) using available data before and after missing values, within each station's series, reducing missing data to about 6%; then, Inverse Distance Weighting (IDW) spatial interpolation estimated daily PM2.5 concentrations in 10 neighbourhoods not directly covered by stations, using distance-weighted contributions from surrounding stations.

Most neighbourhoods had 200 to 215 days of successful predictions. Mean $PM_{2.5}$ concentrations varied, from 26.6 µg/m³ in Cité Verte to 45.8 µg/m³ in Nkomo, all exceeding the WHO 2021 daily average guideline of 15 µg/m³. Peak concentrations exceeded 90 µg/m³, reaching up to 109 µg/m³. A consistent 14–day data gap, likely from a platform failure, couldn't be recovered by linear interpolation, affecting spatial interpolation. Nkolondom had no predictions as it was too far from any 3km range station, highlighting a spatial interpolation limitation. PM2.5 concentrations showed a seasonal decline from 70–90 µg/m³ in mid-February to 20–45 µg/m³ by October, consistent with the dry-to-wet season transition.

These findings show the feasibility of combined interpolation to characterize air quality in data-scarce urban settings, highlighting constraints imposed by sparse and unreliable monitoring infrastructure in sub-Saharan African cities.

Keywords : $PM_{2.5}$, Interpolation, unmonitored neighbourhoods, Yaounde

Building Liberia's First Air Quality Monitoring System: Low-Cost Sensing, Regional Collaboration, and Pathways to Reference-Grade Integration

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The Clean Air Liberia project, funded by the EPIC Fund, is a pioneering initiative and the first of its kind in Liberia, aimed at establishing a foundational air quality monitoring and capacity development framework in Monrovia. The project is implemented through a collaboration between the Kigali Collaborative Research Centre (KCRC), Rwanda, and the Afri-SET initiative at the Department of Physics, University of Ghana, combining regional expertise in low-cost sensing, data analytics, and environmental capacity building. Central to the project is the deployment of AirGradient low-cost air quality sensors, generating real-time, location-specific data on key pollutants in a city where such measurements have historically been absent. Importantly, data from the deployed sensors is publicly accessible through the OpenAQ platform, enhancing transparency, visibility, and global data integration.

The project has had a measurable impact in Monrovia by generating the first localized, continuous air quality datasets, addressing a critical data gap that has long hindered environmental management and public health research. The availability of real-time, openly accessible data has strengthened public awareness of pollution exposure and provided an empirical basis for emerging policy discussions.

Despite these gains, the project faces notable challenges. The use of low-cost sensors introduces uncertainties related to accuracy, calibration, and long-term stability, necessitating robust quality assurance protocols. Infrastructure constraints, including unreliable power supply and intermittent internet connectivity, affect data continuity, while limited regulatory frameworks constrain policy uptake and long-term sustainability.

Collaboration remains central to the project, enabling cross-country knowledge transfer and local institutional engagement. The next phase will include the installation of a reference-grade air quality monitor in Monrovia to strengthen calibration and data validation. This positions the project for scale-up, policy integration, and long-term contributions to air quality management and public health in Liberia.

Keywords: Air Quality Monitoring, Low-Cost Sensors, Urban Air Pollution, Capacity Building, and Open Data

A GIS-Based Analysis of Air Pollution and Exposure Risk in Kampala 2025

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Rapid urbanization in Kampala has led to deteriorating air quality, driven primarily by domestic fuel combustion, vehicle emissions, and industrial activity. This study utilized data from ten low-cost sensors for the year 2025 and GIS-based interpolation to map the spatial distribution of PM2.5 and PM10 across Kampala.

To identify pollution drivers and pollution patterns, the study integrated spatial datasets including road networks, settlement patterns and population distribution data was obtained from Geofabrik and WorldPop and key analyses were performed like Kernel and line density to map population, road and settlement density. A hotspot analysis was performed to identify statistically significant clusters of high PM concentrations across Kampala. All these spatial variables were standardized and integrated using a Multi-Criteria Decision Analysis (MCDA) weighted overlay model that combined pollution levels and pollution drivers to generate a comprehensive exposure risk map, highlighting areas of Kampala with the highest potential air pollution exposure to be used for policy and intervention activities.

The results confirmed that Kampala's air quality significantly exceeds WHO guidelines of 5 µg/m³ for $PM_{2.5}$ and 15 µg/m³ for PM_{10}. In the Kawempe and Rubaga divisions, $PM_{2.5}$ averaged 30.1 µg/m³and PM_{10} reached 30.5 µg/m³. These areas are defined by high population density and a landscape that is 91.5% built-up. Similarly, Central Kampala recorded high PM_{10} levels averaging 30.5µg/m³, driven by intense road density and urban activity within an environment that is 95.4% built-up with only 3.1% tree cover

Keywords: Particulate Matter, Multi-Criteria Decision Analysis, Exposure Risk Map

Operational Air Quality Forecasting Systems for Three African Cities

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While significant progress is being made in the installation and operation of pollution sensors, analytical space remains a critical weakness in Africa. The number of groups capable of performing emissions and atmospheric pollution modeling is limited, primarily due to computational constraints and a shortage of trained personnel who can translate raw data into modeled insights. Advancing this modeling effort remains a priority for the community, and we aim to create a pilot platform that demonstrates the modeling framework for three cities -- Kampala, Accra, and Ouagadougou. By moving beyond simply measuring "how much" pollution exists to identifying "where" it originates from, the locally hosted system can provide the essential evidence base needed to build a powerful and effective local policy narrative. The integrated emissions and pollution modeling system (using WRF and CAMx models, coupled with data from extensive monitoring networks in the cities) will go beyond simple compliance and AQI analytics to hotspot mapping, source identification, source apportionment, policy scenario analysis, and short-term forecasts as health alerts. In this presentation, we will provide an overview of the modeling architecture and preliminary results from the operational system.

Air Quality and Its Health and Economic Impacts in Dakar, Senegal

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In this work, we used data from the Dakar air quality management center, data from the Simeon FONGANG ocean physics laboratory, and data from Dakar's four medical districts. We also used data from the measurement campaign organized as part of the Dakar Air Quality Management PlanA network of 17 measurement sites, spread across all the arrondissement communes, has been temporarily set up to characterize air pollution in Dakar. Average annual concentrations of regulated pollutants far exceed the 2005 World Health Organization (WHO) standards, as well as the 2003 and 2018 Senegalese Air Quality Standards, with exceedances of 2 to 7 times for $PM_{2.5}$. Spatial distribution shows maximum concentrations in the Plateau commune, the capital's business center, heavily impacted by intense economic activity due to the presence of many of the country's major infrastructures and institutions.
The total number of premature deaths attributable to air pollution in 2022 is 751. This total mortality could increase by around 40%, to 1049 deaths by 2035, if no action is taken to reduce current and projected emission levels. In economic terms, health-related costs are significant and could rise in the years to come, if nothing is done. From 442.6 billion CFA francs in 2022, these costs are expected to rise to 645.7 billion CFA francs in 2035.

Spatial Variability of $PM_{2.5}$ Concentration and CO_2 Emission over Selected Districts of Malawi

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This study investigates the spatial variability of $PM_{2.5}$ concentrations and CO_2 emissions from nine areas in Malawi. Fixed low-cost sensors from AirGradient were used for real-time $PM_{2.5}$ and CO_2 monitoring between September 2025 to March 2026. The study employed four-quadrant spatial analysis to characterize pollutant distribution patterns across different urban types and regions. Four machine learning models (XGBoost, CatBoost, Random Forest, and PyTorch DNN) were constructed to quantify $PM_{2.5}$ and CO_2 levels in relation to meteorological factors and population density. The findings reveal visible spatial variation of $PM_{2.5}$ and CO_2 across Malawi. $PM_{2.5}$ concentrations averaged 25.9 µg/m^3 (range: 23.5 - 55.1 µg/m^3), while CO_2 levels averaged 428.56 ppm (range: 415 - 444 ppm). The weak correlation between $PM_{2.5}$ and CO_2 ($r = 0.274$) suggests different emission source profiles and atmospheric transport mechanisms for each pollutant. Regional analysis identified the central region of Malawi as the most polluted (55.1 µg/m³), while the northern region demonstrated the lowest pollution levels (18.9 µg/m³). Urban type analysis revealed that institutional sites consistently achieved the lowest pollution levels (20.9 µg/m³), while residential areas showed the highest variability (17.9 - 32.1 µg/m³). Residential areas in the central region emerged as priority intervention zones, while institutional sites demonstrated effective local emission management practices. While the Random Forest model showed the best performance on the test set for $PM_{2.5}$ and CO_2 predictions, with the lowest MAE (3.4) and RMSE (5.66), and the highest R-squared value (0.957), the PyTorch DNN struggled to learn the prediction patterns. This real-time ground-based dataset represents the first comprehensive assessment of the spatial patterns of air quality in urban Malawi. The research demonstrates strong potential for targeted emission-reduction strategies by urban type and regional characteristics, for advancing sustainable urban development in Malawi.

Keywords: Air pollution, Particulate matter, Carbon dioxide, Malawi, Machine learning models

Population Centric Optimization of Low Cost Sensor Networks in Data Sparse Urban Cities: An Unsupervised Machine Learning Framework

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Particulate matter ($PM_{2.5}$) monitoring networks using low-cost sensor technology in the Global South are often challenged by data scarcity and resource limitations, hindering effective air quality management. Our methodology tackles this by optimizing the spatial distribution of $PM_{2.5}$ monitoring stations based on population exposure using unsupervised machine learning algorithms, particularly, K-Medoids clustering.

Building upon existing literature, our approach integrates high-resolution population data at a 100m resolution with population-weighted K-medoids to capture the geospatial extent of where people live. To ensure equitable representation, we adopt a two-tier framework that separately optimizes high- and low-density population zones. In high-density zones, monitors are iteratively added to maximize population coverage within a fixed service radius, ensuring that at least 95th percentile of residents in densely populated cores fall within the effective monitoring range. This rule prioritizes uniform exposure representation and prevents redundant clustering in already well-covered areas. In low-density zones, a distance-based spatial fairness rule governs placement so that most residents remain within an acceptable service distance (default set as 10 km) of at least one monitor, maintaining equitable geographic access even where population counts are sparse. We hypothesize that together, these constraints produce compact and demographically representative networks.

We evaluate our configurations against two benchmarks: (i) a greedy exposure-maximization method and (ii) a uniform geometric baseline. Across the four South Asian cities, namely Lahore, Karachi, Delhi, and Dhaka, our approach yields balanced, exposure-relevant monitoring networks that better reflect the spatial distribution of urban populations. Furthermore, the framework is scalable and provides a foundation for future integration of emissions, meteorological, and other contextual data layers in network design.

Keywords: Air quality monitoring, K-medoids clustering, Population exposure, Network optimization, Low-cost sensors, Urban air quality

Strengthening Air Quality Governance Through Regulation and MRV Systems: The Lagos Greenhouse Gas Registry as a Policy Model for African Cities

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The Lagos State Environmental Protection Agency, in collaboration with private sector partners, is developing the Lagos Carbon Registry—also known as the Lagos Greenhouse Gas Registry (LGHGR)—as a centralised digital system to strengthen emissions management in Lagos State. With carbon emissions projected to reach up to 73 million tonnes by 2050 and associated social costs estimated at between USD 10.5 billion and USD 21.9 billion, Lagos requires a robust framework to drive measurable emissions reductions and unlock climate finance. The LGHGR is designed as a comprehensive measurement, reporting, and verification (MRV) platform that enables organisations to track, report, and verify carbon and air pollutant emissions across key sectors—energy, transport, industrial, waste, commercial, and agriculture. It supports the development of a reliable emissions inventory, sectoral baselines, and a functional carbon trading ecosystem. By providing high-quality, verifiable data, the registry positions Lagos-based entities to access green finance and participate in emerging carbon markets. Aligned with the Lagos Climate Action Plan, national climate policies, and international frameworks, the LGHGR enhances transparency, accountability, and evidence-based policymaking. Its development has followed a structured, consultative process, including regulatory reviews, multi-stakeholder engagements, and validation exercises to define governance arrangements and ensure implementation readiness. The system integrates sector-specific data templates, a user-friendly digital MRV platform for emissions reporting and third-party verification, and a carbon credit and trading exchange. This approach transitions Lagos from fragmented reporting practices to a standardised, bottom-up emissions management system with improved data completeness, consistency, and accuracy. Ultimately, the LGHGR strengthens regulatory decision-making, supports climate policy implementation, and contributes to Nigeria's compliance with global reporting obligations under the Paris Agreement. It establishes a scalable model for subnational carbon governance, enabling Lagos to lead climate action and sustainable development in Africa.

Keywords: Greenhouse Gas Registry; Measurement, Reporting, and Verification; Carbon Markets/Emissions Trading; Climate Policy and Regulation

From Awareness to Practice: Gaps in the Integration of Air Pollution into Clinical Care among Healthcare Workers in Lagos State, Nigeria

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Air pollution is a major environmental determinant of health, with disproportionate impacts in low- and middle-income countries. Healthcare workers (HCWs) are critical to translating environmental health knowledge into clinical practice, yet gaps persist between awareness and application. This study assessed the knowledge, attitudes, and integration of air pollution considerations into patient care among healthcare workers in Lagos State, Nigeria.

A cross-sectional KAP survey was conducted among 354 healthcare workers across six population-dense Local Government Areas in Lagos State, Nigeria, selected using the Lagos State Primary Healthcare Board district structure. A structured questionnaire assessed knowledge of air pollution sources and health effects, attitudes toward air quality action, and clinical practices regarding respiratory care. Data were analysed using descriptive statistics and chi-square tests ($p < 0.05$).

Awareness of air pollution sources (96.3%) and health impacts (98.0%) was high, and most respondents expressed strong concern about pollution and climate-related health risks. However, only 28.6% demonstrated understanding of the Air Quality Index (AQI), and 46.7% lacked knowledge of where to access air pollution data. Although 88.7% had recently managed respiratory cases, only 39.3% reported some use of air pollution data in clinical practice. Overall integration into patient care remained low, with 40.7% classified as having low integration. Integration was significantly associated with profession ($p = 0.001$), specialty training ($p = 0.011$), knowledge level ($p < 0.001$), and level of concern ($p < 0.001$).

Despite high awareness and positive attitudes, a critical gap between environmental health knowledge and clinical application persists, limiting the health sector's response to air pollution-related disease. Strengthening healthcare worker capacity, improving access to air quality data, and integrating environmental health into clinical systems are necessary priorities for advancing clean air and building healthier urban populations in Africa.

Keywords: Air pollution; Knowledge, Attitudes, and Practices (KAP); Respiratory health

A Multi-Scale Air Quality Exposure Index for Municipal Prioritization and Monitor Network Design in Honduras

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Honduras lacks a national air quality monitoring infrastructure, making evidence-based prioritization essential for resource allocation. We present a multi-scale framework that combines a municipal-level Air Quality Exposure Index with an intra-urban monitor placement optimization methodology to guide strategic deployment of monitoring networks across the country.

At the national scale, we construct a composite exposure index for 265 Honduran municipalities by integrating satellite-derived $PM_{2.5}$ concentrations from intense and recent years, population density and demographic exposure metrics, wildfire density as a proxy for biomass burning emissions, and greenhouse gas emission inventories from of CO_2 and CH_4. Variables are normalized and combined through a weighted scoring system where air quality indicators receive dominant weighting , with supplementary greenhouse gas capturing broader pollution source profiles. Municipalities are ranked to identify priority areas where population exposure intersects with elevated pollution levels, revealing that northern corridor municipalities in Yoro, Cortés, and Santa Bárbara departments consistently rank highest due to the convergence of industrial activity, agricultural burning, and dense population centers.

For the two highest-priority urban areas identified, Tegucigalpa and San Pedro Sula, we apply a Weighted K-Means clustering algorithm with adaptive Voronoi tessellation to optimize intra-city monitor placement. Using WorldPop gridded population data, the algorithm classifies urban zones by density, assigns monitor quantities proportional to population thresholds (35,000, 50,000, and 70,000 inhabitants per monitor for high, medium, and low-density areas), and generates population-weighted service areas. The resulting networks propose 29 monitors for Tegucigalpa (serving 1.34 million) and 18 for San Pedro Sula (serving 825,000).

This integrated approach provides a replicable, data-driven framework applicable to other low- and middle-income countries seeking to establish air quality monitoring networks with limited resources.

Keywords: air quality monitoring, exposure index, geospatial prioritization, low-cost sensors, Honduras

Air Quality Policy Landscape in Cameroon: Gaps, Challenges and Opportunities

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Air pollution is an increasingly urgent public health concern in rapidly urbanizing settings across sub-Saharan Africa, including Cameroon. The main sources of air pollution include road traffic emissions, household biomass use, industrial activities, and open waste burning. These exposures contribute to the national burden of non-communicable diseases like respiratory infections and cardiovascular diseases. Evidence from studies conducted in Cameroon indicates that particulate matter and other gaseous pollutants frequently exceed World Health Organization guidelines, exposing populations to harmful levels of pollution.

This study analyzes the policy landscape for air quality management in Cameroon, focusing on regulatory frameworks, institutional arrangements, and implementation gaps. A qualitative document review was conducted, drawing on national legislation, sectoral strategies, and international guidelines, complemented by a review of scientific literature on air pollution sources, exposure, and health impacts.

Findings indicate that Cameroon has established several policy instruments relevant to air quality, including the 1996 Framework Law on Environmental Management, the 2011 Decree on atmospheric protection, and the Cameroon Standard NC 2856 (2021), which defines ambient air quality limits for key pollutants. However, the absence of a comprehensive national air quality strategy limits the coherence and effectiveness of current efforts. Institutional responsibilities are distributed across multiple sectors-environment, health, transport, and urban development-resulting in coordination challenges. In addition, air quality monitoring remains limited, with available evidence largely derived from short-term or research-based measurements rather than routine, nationwide monitoring systems. This constrains the availability of consistent data to inform evidence-based decision-making and effective policy implementation.

Overall, the analysis highlights that the challenge is not the absence of policies, but their limited implementation and the insufficient integration of public health considerations. Strengthening air quality governance in Cameroon requires the development of a dedicated national strategy, improved monitoring systems, and enhanced multisectoral coordination.

Keywords: Air pollution, Policy analysis, Environmental governance, Cameroon

Building Capacity and Monitoring of $PM_{2.5}$ Across Bhutan Through a Low-Cost Sensor Network

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The project titled "*Building Capacity and Monitoring of $PM_{2.5}$ Across Bhutan Through a Low-Cost Sensor Network*" was awarded to Bhutan in 2025. The main objectives of the project are to monitor $PM_{2.5}$ concentrations across the country and to make real-time data available online. As part of the project, 15 low-cost sensors (Air Gradient) were procured and installed in both sensitive and mixed-use areas across Bhutan. These sensors were primarily deployed in industrial areas and major urban centers to assess and compare $PM_{2.5}$ concentrations in different regions. Prior to installation, the sensors were validated using advanced field monitors. The installation process proved more challenging than initially anticipated, particularly due to issues related to Wi-Fi connectivity and access to remote locations across the country. Nevertheless, after approximately 8–9 months from the commencement of the project, all sensors were successfully deployed. Preliminary data collected over several months indicate that industrial areas occasionally recorded $PM_{2.5}$ concentrations exceeding 500 µg/m³. Urban and border areas showed concentrations in the range of 50–55 µg/m³, while rural areas recorded lower levels, typically between 25–30 µg/m³. Distinct diurnal patterns were observed, with urban sites exhibiting bimodal peaks during the early morning (06:00–08:00) and evening hours (17:00–19:00). Industrial zones also showed additional nocturnal enhancements, with peaks occurring during late-night to early morning hours (01:00–03:00). These findings highlight the complex interplay of emission sources and atmospheric dynamics influencing $PM_{2.5}$ variability in Bhutan and provide an empirical basis for targeted air quality management and the expansion of high-resolution monitoring networks.

Keywords: Bhutan, AirGradient, $PM_{2.5}$*, industrial, diurnal*

Operational $PM_{2.5}$ Estimation in Data-Sparse Environments Using Multi-Source Remote Sensing and Machine Learning: Evidence from Pakistan

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Many countries facing severe air pollution still lack dense regulatory monitoring, limiting their ability to generate reliable daily$PM_{2.5}$ information for decision-making. We present a machine-learning air quality estimation framework designed for data-sparse environments with an operational deployment in Pakistan and a cross-border extension to India. The system produces daily gridded $PM_{2.5}$ estimates by fusing multi-source remote sensing, meteorology and ground observations within a unified modelling pipeline.

In Pakistan, the framework is deployed operationally to generate nationwide daily $PM_{2.5}$ maps at 0.1° resolution. A version of the model designed to operate even in areas without recent local monitor data achieved a held-out 2025 test MAE of 22.9 µg/m³ and R^2 of 0.730, outperforming both station climatology and GEOS-CF. When recent local observation history was available, an extended version of the model reduced MAE to 14.3 µg/m³ while maintaining stable performance in poorly monitored areas.

We then extended the same framework to India, where larger geographic scale, a more heterogeneous monitoring network, and greater climatic diversity provide a harder test of transferability. In India, the base model achieved a test MAE of 19.3 µg/m³, while the version using recent local observations reduced monitored-location MAE to 9.21 µg/m³. Joint India-Pakistan training further improved India's variance explained, raising R^2 by 2.6% in monitored areas and 12.6% in unmonitored areas, suggesting that cross-border learning captures shared atmospheric structure across contiguous airsheds, though with a modest calibration tradeoff.

This work provides new scientific and operational evidence that multi-source machine-learning systems can deliver actionable $PM_{2.5}$ estimation even where monitoring is sparse or delayed. The framework is relevant for African clean air planning because it offers a practical pathway for national-scale estimation support in low-data environments.

More Research Needed on People's Responses to Air Quality Data

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Air pollution poses significant health risks globally, especially in rapidly growing cities of the Global South, with South Africa's Johannesburg exemplifying severe pollution issues. Access to real-time, localized air quality data is seen as a key strategy for reducing pollution, aiding regulators in source identification and enabling communities to adopt protective behaviors. However, despite existing monitoring infrastructure, public awareness and use of air quality data remain limited, particularly in lower-income areas where most exposure occurs. The effectiveness of data-driven approaches depends not only on technical monitoring but also on how well information reaches and influences the public, shaped by perceptions of trust, fairness, and efficacy. A survey of 1,255 residents in Johannesburg, South Africa, revealed most people do not know where to access air pollution data (36% accessed data), despite the city having multiple monitoring stations. Few individuals regularly seek out air quality information; younger and more educated respondents are more aware but still rarely access data. Furthermore, satisfaction with government communication about air pollution is low, and proximity to monitors does not correlate with increased knowledge or satisfaction. Public preferences for monitor placement are split between pollution hotspots and population centers, with residents favoring locations like factories, residential areas, and hospitals over schools or roads. Most respondents believe more air quality data would pressure governments and polluters to act and help individuals protect themselves, indicating perceived utility of increased monitoring. Taken together, these findings, although limited to Johannesburg and descriptive and correlational, raise important questions about AQM campaigns. While it is often postulated that more air quality data would increase public awareness and pressure on policymakers to curb air pollution, the case of Johannesburg shows that setting up monitors and making the data available online does not suffice for the information to reach the population

Keywords: AQM, Perceptions, Monitoring

Seasonal Patterns and Health Risks of Particulate Matter ($PM_{2.5}$ and PM_{10}) in Yaoundé, Cameroon

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This study provides a comprehensive one-year assessment of particulate matter ($PM_{2.5}$ and PM_{10}) and associated health risks in Yaoundé, from February 2025 to January 2026, based on measurements from seven monitoring sites using AirQo Binos Low-Cost Sensors. Daily mean concentrations were 6.90 ± 1.10 - 127.74 ± 15.24 µg/m³ for $PM_{2.5}$ and 1.59 ± 0.50 - 401.15 ± 20.35 µg/m³ for PM_{10}. Annual mean concentrations were 25.01–31.33 µg/m³ for $PM_{2.5}$ and 33.54–42.47 µg/m³ for PM_{10}, exceeding WHO guideline values. Exceedance rates of WHO daily thresholds were 91.21% for $PM_{2.5}$ and 26.49% for PM_{10}, indicating frequent pollution episodes and sustained exposure, particularly to fine particles. The combined exposure index (IE > 1) and elevated time-weighted averages (TWA: 27.79 ± 13.84 µg/m³ for $PM_{2.5}$5; 38.22 ± 21.17 µg/m³ for PM_{10}) highlight chronic exposure and increased risks of respiratory and cardiovascular diseases. Spatial analysis revealed higher $PM_{2.5}$ concentrations at Rond Point Express (31.33 ± 13.69 µg/m³) and higher PM_{10} at Ekounou Market (42.47 ± 18.89 µg/m³), compared to lower levels at Ecole Publique Bastos ($PM_{2.5}$: 25.01 ± 13.25 µg/m³; PM_{10}: 33.54 ± 19.73 µg/m³), reflecting localized emission sources. Strong positive correlations between $PM_{2.5}$ and PM_{10} (r^2 = 0.76 - 0.96) suggest common emission sources. Moreover, 75.56% of $PM_{2.5}$/PM_{10} ratios exceeded 0.7, indicating the dominance of fine particles. Seasonal variations were pronounced, with higher exceedance rates during the dry season ($PM_{2.5}$: 97.55%; PM_{10}: 50.71%) compared to the wet season ($PM_{2.5}$: 74.85%; PM_{10}: 4.06%), highlighting meteorological influence on particulate pollution. These findings demonstrate persistent exposure to harmful particulate matter and emphasize the dominance of fine particles in urban air pollution. Urgent mitigation strategies and improved air quality management are required to reduce health risks, particularly during the dry season.

Keywords: $PM_{2.5}$, PM_{10}, combined exposure index, time-weighted average, health risk

Air Quality Monitoring and Identification of Pollution Hotspots using Low Cost Sensors in Faisalabad, Pakistan

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Air pollution has become one of the most pressing environmental challenges in Faisalabad, Pakistan, driven by rapid industrialization, vehicular growth, and agricultural activities. This study aims to monitor ambient air quality, identify pollution hotspots, and explore potential contributors across the city.

To achieve this, ten low-cost AirGradient air quality monitors were installed at strategically selected locations representing varied land-use types. Data collected from these sensors, combined with readings from publicly available sources on the OpenAQ platform, underwent a rigorous process of screening and cleaning to ensure accuracy and consistency alongside removal of outliers. Comprehensive data analysis was carried out to spatially and temporally characterize air pollutant levels, enabling the identification of high-pollution zones and determining associations with major sources such as industrial clusters, traffic corridors, and agricultural residue burning.

Based on these findings, targeted recommendations were developed for improving air quality management and policy intervention. This study provides actionable insights that can support Faisalabad authorities in formulating evidence-based strategies to mitigate air pollution and promote cleaner urban environments. The results are expected to strengthen local capacity for air quality monitoring and inform long-term sustainable air management plans.

Determinants of Household Air Pollution (HAP) Exposure: 24-hour $PM_{2.5}$ and Carbon Monoxide (CO) Measurements in Bukavu, Eastern Democratic Republic of Congo (DRC)

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Household air pollution (HAP) from biomass fuel combustion is a major environmental health challenge and a significant contributor to ambient air pollution globally. However, data on indoor carbon monoxide (CO) and $PM_{2.5}$ concentrations in urban sub-Saharan Africa (SSA) remain limited.

The objective was to inform research priorities, policy development, and targeted interventions addressing HAP in urban SSA.

This sub-study of the ongoing MUTOTO cohort investigated determinants of HAP in Bukavu, eastern Democratic Republic of Congo. Pregnant women were recruited from three municipalities at Bukavu Referral Hospital. Questionnaire data assessed household characteristics and exposure patterns. Personal CO and household $PM_{2.5}$ concentrations were measured over 24 hours using LASCAR EL-USB-CO loggers and PurpleAir Zen sensors (March 2025–January 2026). $PM_{2.5}$ data were corrected using the ALT-CF-CF3 method. Households were stratified according to WHO air quality guidelines. Descriptive analyses were conducted, with variable sample sizes due to missing data.

A total of 483 households were included. Mean 24-hour concentrations were 5.3 ppm (SD 8.7) for CO and 53.8 µg/m³ (SD 34.2) for $PM_{2.5}$; medians were 2.1 ppm (IQR 0.5–6.2) and 43.8 µg/m³ (IQR 30.6–63). Maximum values reached 65.1 ppm and 224.3 µg/m³, respectively. Households in extreme exposure groups had significantly higher concentrations than low exposure groups (22.15 ppm [SD 14.71] vs. 2.20 ppm [SD 2.65]; 112.13 µg/m³ [SD 35.38] vs. 21.79 µg/m³ [SD 2.35]; $p < 0.001$). Frequent cooking (≥2 times/day), biomass fuel use, and concrete roofing were associated with higher exposure, while most kitchens lacked chimneys (96%) and indoor smoking was rare (1%). Socioeconomic factors were not significantly associated with exposure.

Biomass-based cooking in poorly ventilated homes substantially increases HAP exposure in Bukavu urban setting. Interventions promoting clean cooking and improved ventilation are urgently needed to protect women and children.

Keywords: Household air pollution; $PM_{2.5}$; carbon monoxide; biomass combustion; sub-Saharan Africa.

Establishing a Real Time Air Quality Monitoring Network in Zimbabwe: The Journey

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Air pollution remains a leading environmental-health challenge affecting both developed and developing countries including Zimbabwe. For developing countries, the situation is even made worse by the prohibitive costs of monitoring equipment leading to data scarcity. To bridge this data gap, with support from the EPIC Air Quality Fund we are on a journey to establish the first real time monitoring network in Zimbabwe. Here we chronicle our journey. Currently, our network is composed of 20 low-cost air quality monitoring sensors distributed across the country and is feeding real time air quality status for 20 sites. The monitors have been measuring particulate matter 2.5 ($PM_{2.5}$) and particulate matter 10 (PM_{10}). This far, the main users of the network include local municipalities, local communities, academics and policy makers. In this presentation we showcase the preliminary results derived from the network, the lessons learnt, challenges and the journey ahead.

Keywords: Air pollution, air quality network, low-cost sensors, data scarcity, $PM_{2.5}$

Spatiotemporal Dynamics of Air Pollution in Faisalabad, Pakistan: Integrating Air Quality Data with Policy Reform for Public Health

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Faisalabad, a major industrial and commercial hub in Pakistan, faces significant air quality challenges that threaten public health. As part of the Energy Policy Institute at the University of Chicago (EPIC) program, this study investigates the temporal and sectoral variations of air pollutants using a strategic network of ten low-cost Air Quality monitors. These sensors, deployed across industrial, commercial, residential, educational, and high-traffic public zones, provide high-resolution data on $PM_{1.0}$, $PM_{2.5}$, PM_{10}, and CO_2, alongside meteorological parameters including Relative Humidity (RH) and Ambient Temperature. This study focused on data collected from November 2025 through May 2026, capturing the transition from the high-pollution winter season (Nov-Feb) to the pre-monsoon period (Mar-May). Preliminary findings highlight distinct pollution profiles across sectors, with industrial and heavy-traffic residential areas showing the highest concentrations of $PM_{2.5,}$ approximately 20–50 times and 7–17 times higher than the annual permissible World Health Organization (WHO) and National Environmental Quality Standards (NEQS) limits of 5 μgm^{-3} and 15 μgm^{-3}, respectively. Additionally, the magnitude of "high pollution events" was analyzed, and US EPA protocols were applied to conduct health impact assessments, correlating pollutant levels with health risks for the local population. Furthermore, beyond data collection, a core objective of this project is translating evidence into national-level policy impact. Following high-level consultations with the Environmental Protection and Climate Change Department (EPCCD), Punjab, Pakistan, our team successfully submitted a comprehensive policy paper. This document provides expert commentary and evidence-based best practices regarding the utility of low-cost sensors that are currently being utilized by the government to revise and approve the official "Guidelines for Low-Cost Sensors." By bridging the gap between emerging sensor technology and regulatory frameworks, this project serves as a scalable model for strengthening air quality standards and informing public health policies in rapidly urbanizing regions.

Keywords: Air Quality, $PM_{2.5}$, Health Impact

Afri-SET: A Scalable Model for Low-Cost Sensor Evaluation, Capacity Building, and Evidence Based Air Quality Management in Sub-Saharan Africa

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Expanding air quality monitoring across sub-Saharan Africa is critical to addressing rapidly increasing urban pollution, yet persistent challenges with sensor reliability, technical expertise, and local environmental adaptation continue to limit progress. Over the past three years, Afri-SET - The Air Sensor Evaluation and Training centre for West Africa has been established at the University of Ghana as the region's first dedicated low-cost sensor evaluation and training facility. In this presentation, we will share practical lessons from designing, implementing, and operating a real-world sensor hub in a resource-constrained environment. A major achievement of Afri-SET is the establishment of Africa's first independent sensor evaluation hub, where reference-grade instruments assess sensor performance under high temperatures, humidity, and dust. Each year, a minimum of 10 different sensor types were evaluated, alongside the publication of at least one peer-reviewed article annually, demonstrating scientific acceptance and the generation of new insights. The facility is now internationally recognized and serves as an official test site for the Airlab Microsensor Challenge 2025. Afri-SET has generated trusted evidence supporting national air-quality decision-making. Its evaluations and calibration outputs have guided monitoring strategies, including sensor selection by the Ghana EPA, demonstrating that locally validated sensors can reliably inform urban air-quality management. Equally important is Afri-SET's regional capacity-building impact, with more than 193 practitioners, researchers, and students trained in sensor deployment, data analysis, and interpretation. By sharing experiences from Afri-SET, this presentation aims to guide other regions seeking to develop similar facilities, accelerate the adoption of reliable low-cost sensors, and enhance local capacity to tackle air pollution effectively.

Keywords: Low-cost air quality sensors, Sensor evaluation, Capacity building, Sub-Saharan Africa, Urban air pollution monitoring, Policy-relevant data

Secondary Organic Aerosol Formation in Kigali, Rwanda

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Understanding the mechanisms of secondary organic aerosol (SOA) formation is crucial for improving our understanding of air quality, haze, and cloud formation. This study examines SOA formation mechanisms in Kigali, Rwanda, using a 12-month dataset of real-time PM_1 chemical composition, as measured by an aerosol chemical speciation monitor (ACSM). We investigated the roles of aerosol liquid water content (ALWC), relative humidity, and atmospheric oxidants along with aerosol chemical composition in SOA formation during dry and wet conditions. Unlike in heavily polluted megacities such as Delhi and Beijing, we did not observe a significant relationship between ALWC and SOA formation. However, we observed a positive correlation between oxygenated organic aerosols (OOA) and particulate nitrate (pNO_3^-) ($R^2 = 0.57$, $p < 0.001$). SOA mass yield rapidly increased with the rate of increase of particulate nitrate, which could be linked to nitrate chemistry. Diurnal patterns of aerosol chemical composition, oxidants, and meteorological parameters linked to enhanced SOA concentrations in the morning, which could be driven by nocturnal NO_3 radical reactions followed by continued production during the day via photochemical oxidation. These results suggest that SOA formation in Kigali is primarily governed by NO_3 and OH radical photochemistry processes rather than by bulk aqueous-phase chemistry. The results highlight a unique SOA formation process and emphasize the importance of local chemistry and meteorological conditions in shaping aerosol processes in rapidly urbanizing regions.

Keywords: Air Pollution, Kigali, Secondary Organic Aerosol, Nitrate, Oxidants

Data to Action: Integrating Low-Cost Sensor Networks for Air Quality Management and Health Risk Assessment in Pakistan

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Pakistan remains among the countries with the worst air quality according to the IQAir World Air Quality Report 2025. Despite the critical situation, the country's air monitoring infrastructure is limited and fragmented. The study assesses the effectiveness of low-cost sensors (LCS) with reference-grade monitors for air quality management and health risk assessments. The Urban Unit, with support from the EPIC Air Quality Fund, deployed a network of 160 sensors across 14 major cities in Pakistan, later expanded to 24 cities with an additional 14 units deployed at schools and key locations. $PM_{2.5}$ data were analyzed from June to December 2025 to examine spatial and temporal trends, showing Faisalabad, Kasur, Gujranwala, Lahore, and Peshawar as the most polluted cities. For performance assessment, validation was performed at two reference-grade monitoring sites in Lahore from November 2025 to February 2026. Results showed strong correlations, with Pearson correlation (r) of 0.92 and 0.88, and coefficient of determination (R^2) of 0.84 and 0.79, respectively, for Kahna Hospital and the Foot and Mouth Disease Research Center (FMDRC), indicating the reliability of LCS in a real-time scenario. The health risk assessment (HRA) revealed the highest age-standardized mortality in Lahore (8,468), followed by Faisalabad (7,195) and Peshawar (2,967), with the highest exposure burden of 51% in Faisalabad. The results indicate that LCS networks provide reliable, high-resolution data and offer a scalable, cost-effective alternative for improving air quality monitoring in Pakistan, which will also be instrumental in supporting data-driven policy decisions.

Keywords: $PM_{2.5}$, Low-Cost Sensors (LCS), Pearson correlation (r), Coefficient of determination (R^2), Health risk assessment (HRA)

Exploratory and Comparative Assessment of Personal Exposure to Fine Particulate Matter ($PM_{2.5}$) in Nassau, The Bahamas and Nairobi, Kenya

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Fine particulate matter ($PM_{2.5}$) is a key metric for air quality and well-established public health risk factor. The challenge in personal exposure assessments is that air pollution concentrations constantly change over space and time, and individuals also move through various microenvironments in their daily routines. Fixed reference monitors, which are sparse and often report hourly averages, cannot capture short-term, high-concentration spikes, such as those an individual may be exposed in specific microenvironments. GPS-enabled personal sensors, on the other hand, capture personal exposure in different microenvironments at high temporal resolutions in addition to location data. The objective of this study was to determine personal exposure to geo-referenced fine particulate matter ($PM_{2.5}$) through participatory assessment using portable GPS-enabled sensor. To achieve this objective, Ultrasonic Personal Air Sampler (UPAS v2.1 Plus; AccessSensor Technologies, USA) was used for quantifying time-integrated personal exposure to $PM_{2.5}$ among participants. Measurements were conducted in Nassau and Nairobi between 24th April 2024 to 9th May 2025 and 5th December, 2025 to 11th January, 2026. Daily exposure values ranged from 0.14 mg/m^3 to 602.35 (mean = 4.6 ± 2.098 mg/m^3) in Nassau (April 2025). In Nairobi the values ranged from 4.16 mg/m^3 to 4246.12 mg/m^3 (mean = 41 ± 18.01 mg/m^3). Nassau daily exposure ranged from 0.47mg/m^3 to 212.39 mg/m^3 (mean = 6.8 ± 3.021 mg/m^3, April 2025). In Nairobi the values ranged from 1.23 mg/m^3 to 5035.86 mg/m^3 (mean = 66.95 ± 6.52 mg/m^3, Dec 2025 to January 2026). All the mean daily value for Nassau were below the WHO daily mean guideline of 15mg/m^3 while the mean daily exposure values in Nairobi were above the WHO guideline except for two days. Physico-chemical characterisation of the particles is recommended (and planned for the study) to enable source apportionment and the particulate matter.

Keywords: $PM_{2.5}$, personal exposure, Nassau, Nairobi

From Better Air to Better Health, What Is Needed?

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Air quality in Sub-Saharan African (SSA) cities has deteriorated with the situation driven by increased ownership of vehicles with poor emission ratings, poor vehicle maintenance culture, influx of two-stroke engines, use of biomass fuels for cooking, poor waste management practices, and industrial expansion. In Africa, air pollution is the second leading risk factor for deaths with air pollution contributing to 1.1 million deaths in 2019. Of these, more than 63% were linked to household air pollution exposure. Although the burden of disease (BOD) attributable to air pollution exposure in Africa is growing, estimates of its magnitude and impact are possibly underestimated due to lack of air quality monitoring capacity and limited air pollution epidemiological studies. There is therefore an urgent need to bridge the huge air quality data gaps in Africa to enable the conduct of robust epidemiologic studies to inform the integrated exposure response functions for better quantifying the BOD attributable to air pollution exposure on the continent and provide a solid evidence base for investments in air pollution control for public health protection. The proliferation of low-cost air quality sensors in recent times represents an excellent opportunity for bridging these data gaps and is gradually being leveraged in African countries. In this talk, I will highlight the extent of the air pollution problem in Africa, identify the driving factors and diverse sources, pinpoint the thriving monitoring networks, and showcase the limited exposure health effects studies conducted in the region. I will proceed to outline how the Ghana Urban Air Quality and Breathe Accra Projects which have deployed low-cost sensors interspersed with reference grade monitors in metropolitan areas of Ghana is facilitating a data-driven solutions to the air pollution problem in Ghana as well as helping bridge the epidemiologic evidence gaps in the country for improved population health

Challenges and Drivers for Building an Air Quality Network Ecosystem in Mozambique – The Case of BLAZE Project

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Establishing an air quality monitoring network in Mozambique is both an urgent public health necessity and a complex institutional undertaking. Drawing on the BLAZE initiative, this brief summary highlights principal challenges and drivers shaping the creation of an open air quality ecosystem centered on $PM_{2.5}$ monitoring, data sharing, and policy engagement. The findings indicate that Mozambique possesses important enabling conditions for network development, including an existing reference-grade monitoring base, growing low-cost sensor deployment, emerging collaborations among the Manhiça Health Research Center, Eduardo Mondlane University, the National Institute of Meteorology, and strong interest from the Ministries of Health and Environment in using air quality data to inform standards, environmental governance, and health research. Additional drivers include the integration of monitoring within health facilities, the use of open-data platforms such as AirQo and OpenAQ, and the project's contribution to local capacity building, student research, and public awareness.

However, the establishment of a robust network is constrained by persistent operational and governance barriers. These include lengthy procurement and customs procedures, financial and administrative bureaucracy, delays in licensing and maintenance of sensors, limited availability of data loggers for real-time transmission, and continued dependence on external technical support for calibration and quality assurance. Further challenges arise from insecure installation environments marked by theft and vandalism risks, uneven institutional coordination across national and subnational levels, and tensions surrounding data ownership, attribution, and the transition from proprietary to open-access models. Although progress has been made in deploying monitors and expanding stakeholder engagement, our progress shows that sustained success will depend on strengthening local technical autonomy, formalizing inter-institutional governance, improving data infrastructure, and securing long-term financing. Overall, the Mozambican case demonstrates that building an air quality network ecosystem is not only a technical exercise, but also a strategic process of institutional alignment, trust building, and evidence-to-policy translation.

Leveraging Low-Cost Sensor Networks to Assess Diurnal and Seasonal Variability of Ambient $PM_{2.5}$ in an African Peri-Urban Environment

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Air pollution remains a critical global challenge, posing severe risks to both public health and the environment. While recent research underscores the growing impact of ambient air pollution, particularly in rapidly urbanizing regions, air quality monitoring in Africa remains limited due to the cost of conventional monitoring infrastructure. This study investigates the diurnal and seasonal variability of ambient $PM_{2.5}$ concentrations in Juja, Kenya, using a network of low-cost sensors as a cost-effective alternative to traditional monitoring stations.

Data was collected from five monitoring sites between November 2019 and April 2022, employing PurpleAir PA-II-SD sensors to measure $PM_{2.5}$ levels on a 24-hour cycle. Data was then calibrated against a BAM-1022 reference monitor using simple linear regression to enhance accuracy and reliability. The results indicate that $PM_{2.5}$ concentrations were significantly elevated during the dry season (June-August 2020), with a mean reduction of 5–10 µg/m³ observed in the wet season (March-May 2020). A strong correlation between PM2.5 concentrations and vehicular emissions was identified, with peak levels occurring at 5 AM and 5 PM, coinciding with commuter traffic patterns. Notably, a comparative analysis of April 2021 and April 2020 revealed a decline of 5–10 µg/m³, attributed to Covid-19 lockdown measures.

These findings demonstrate the efficacy of low-cost sensor networks in capturing spatial and temporal air pollution trends. The study highlights the potential of statistical calibration techniques, such as simple linear regression, in mitigating sensor biases, thereby enhancing the applicability of low-cost monitoring solutions in data-scarce regions. This research underscores the necessity for expanded air quality monitoring networks across Africa to support evidence-based policy interventions aimed at mitigating urban air pollution.

Keywords - Air Pollution, Ambient $PM_{2.5}$, Low-cost Sensors, Fine Particulate Matter

A Data-Driven Framework for Real-Time Monitoring and Health Risk Prediction of Indoor Air Quality in Resource-Constrained Environments using Machine Learning and Low-Cost Sensor Networks.

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Indoor Air Quality (IAQ) remains a critical public health challenge in low-income communities, where reliance on solid biomass fuels for cooking and heating, combined with inadequate ventilation, leads to hazardous concentrations of pollutants like and Carbon Monoxide (CO). Traditional high-precision monitoring equipment is often cost-prohibitive for these resource-constrained environments, creating a significant data gap in the populations most at risk. This research proposes a data-driven framework utilizing Machine Learning (ML) to enable accurate, real-time monitoring and health risk prediction through Low-Cost Sensor (LCS) networks. The study investigates the deployment of an Internet of Things (IoT) infrastructure integrated with advanced ML algorithms, specifically focusing on Random Forest and Long Short-Term Memory (LSTM) networks. These models are employed to calibrate noisy sensor data against environmental variables and to provide short-term forecasting of pollution spikes. By implementing "TinyML" (Edge AI) directly on microcontrollers, the system ensures real-time anomaly detection and health risk stratification without requiring continuous high-speed internet connectivity. Preliminary results suggest that ML-enhanced low cost sensors can achieve over 85% accuracy in classifying indoor air safety levels compared to reference grade monitors. The findings provide a scalable, affordable solution for environmental justice, empowering marginalized households with actionable insights to mitigate respiratory risks. Ultimately, this framework bridges the gap between sophisticated atmospheric science and the practical socio-economic needs of vulnerable urban and rural settlements.

Combining Optical Spectroscopic Sensors with Low-Cost Sensors to Improve Spatial Coverage while Maintaining Data Quality

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Advanced optical spectroscopy instruments provide highly accurate measurements of atmospheric trace gases but are typically expensive and limited in spatial coverage. In contrast, low-cost sensor networks can provide dense spatial information but often suffer from calibration drift and lower accuracy. This presentation will discuss strategies for combining high-quality optical spectroscopic measurements with networks of low-cost sensors to improve spatial coverage while maintaining measurement reliability. Examples from field campaigns and environmental monitoring systems will illustrate how such hybrid approaches can strengthen air-quality and climate observations, particularly in regions where monitoring infrastructure is still developing.

Breathe2Change Xpand: Integrating Air Quality Science and Diplomacy for Sustainable Development in Northern Argentina

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Air pollution remains one of the most critical global public health challenges, particularly in regions with limited monitoring infrastructure. In Argentina, the province of Tucumán faces significant air quality issues driven by structural factors such as biomass burning and industrial activities. In response, the Breathe2Change initiative was established as a successful model of science diplomacy and technical cooperation between the scientific sector, led by the Atmospheric Studies Laboratory (LEA) and the Government of Tucumán, with the support of the Alexander von Humboldt Foundation.

This initiative implemented the first hybrid air quality monitoring network in the region, integrating EPA-certified reference instrumentation with a dense network of 30 low cost sensor modules for particulate matter (PM). The resulting data revealed a clear seasonality, with $PM_{2.5}$ levels tripling during peak months and exceeding WHO daily guidelines approximately 40% of the year.

By making this information accessible through real-time interactive platforms, the project has transformed scientific data into a vital management tool for policymakers and an awareness resource for the public. Based on this success, the network is currently expanding to other provinces in Argentina's North region. These territories face similar atmospheric challenges, and the goal is to replicate this framework of participatory governance to drive evidence-based environmental policies and sustainable development.

Keywords: Air quality monitoring, Biomass burning, Science diplomacy, Citizen engagement, Northern Argentina

Creating a Database of Informal Sources of Air Pollution Using AI and Satellite Imagery Air Pollution Asset-Level Detection (APAD)

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[1]APAD

Urban air pollution in developing countries is often driven by varied formal and informal emission sources such as brick kilns, waste burning sites, and small-scale industry. We have implemented a high-throughput geospatial pipeline that integrates satellite imagery, multimodal AI models, and cloud-native processing to systematically detect and map pollution-linked infrastructure at scale. Designed for large-area coverage, the system processes thousands of satellite tiles in parallel, enabling rapid, cost-efficient analysis across entire regions. To date, it has identified over 50,000 assets across Pakistan, India, and Bangladesh, and produced a near-complete industrial asset map of Kampala, Uganda through automated segmentation, geolocation, and validation workflows. By improving the completeness and spatial accuracy of emissions inventories, these pipelines enable targeted inspections, monitoring expansion, and prioritised interventions, demonstrating how scalable digital infrastructure can potentially inform investment-ready targeted strategies for clean air.

When Heat Meets Air Pollution: Assessing Indoor Environmental Quality in Ghana and South Africa

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Background: An estimated 2.9 million people die prematurely from illnesses attributable to exposure to household air pollution annually, which is only surpassed by premature mortality due to hypertension. A recent global burden of disease study found that particulate matter ($PM_{2.5}$) is the most significant air pollutant contributing to adverse health outcomes. Likewise, exposure to excessively high temperatures are also a significant environmental health hazard with an increased burden of both morbidity and mortality. There is growing evidence that the combined effects of heat and air pollution pose a greater risk to public health than either factor alone. Furthermore, indoor environmental quality (IEQ) is a critical determinant of health as some vulnerable individuals spend approximately 90% of their time indoors. However, there is a lack of evidence regarding these exposures from longitudinal studies in African residential settings.

Methods: The Heat Adaptation Benefits for Vulnerable groups In Africa study (HABVIA) contributes to building this evidence base by monitoring IEQ in low-resourced communities in Ghana and South Africa. Hourly temperature, humidity and $PM_{2.5}$ measurements were collected in 250 homes during summer months from rural and urban sites in both countries using low-cost sensors. Pearson correlation and multivariable linear regression models were used to assess associations between these environmental variables, housing characteristics, household practice and fuel sources as key components of IEQ. $PM_{2.5}$ concentrations will also be compared against World Health Organization guidelines and national standards to identify potential health risks.

Outcomes: Our findings will provide local insights into how IEQ exposures are shaped by housing, household practices and energy use. The overall goal is to inform integrated interventions that address both air pollution and heat exposure simultaneously to reduce environmental health inequalities and promote healthier homes in Africa.

Heat, Air Pollution, and Vulnerability: Lived Experiences of Older Adults in Zimbabwe for Policy and Action

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Older adults in Zimbabwe face increasing health risks from environmental risk factors including climate change related extreme heat, and exposure to both indoor and outdoor air pollution. Age-related vulnerability, combined with existing chronic conditions, increases their sensitivity to environmental risks such as ambient heat and poor air quality. Despite this, their lived experiences are often overlooked in environmental health research and policy targeting older people. This qualitative study explored how older adults in Zimbabwe perceive, experience, and respond to these environmental risks in both rural and urban settings. Sex-specific focus group discussions (FGDs, N=4) were conducted in Murewa (rural) and Harare (urban), with 10 participants each and all aged 60 years and above. Discussions were conducted in Shona, transcribed into English, and analysed thematically. Participants described noticeable changes in weather patterns, including more intense heat, as well as increasing concerns about indoor/outdoor? air quality. Urban participants highlighted pollution from improper domestic waste disposal, sewage, traffic emissions, and industrial activities as key contributors to poor air quality, often linking these exposures to respiratory illnesses such as allergies and diseases that affect the lungs. Rural participants, while less likely to explicitly identify air pollution, raised concerns about pesticides and environmental changes, such as reduced tree cover, affecting air quality and their health. Across both urban and rural settings, older adults reported that heat and poor environmental conditions negatively affected their health and reduced their ability to carry out daily activities. Limited access to healthcare, social support, and adaptive resources, such as reliable, affordable energy, further increased their perceived vulnerability. This study highlights how heat and air pollution jointly shape the health and wellbeing of older populations in Zimbabwe. It underscores the need for context-specific interventions, including improved waste management, cleaner energy use, and heat-health action plans that are inclusive of older adults. By centering lived experiences, this research contributes to building Africa's evidence base on environmental risks and supports more equitable and locally-relevant policy responses.

Clean Cooking Transitions and Household Air Pollution Monitoring in Sub-Sahara Africa: The SHINE Project

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Background: Household air pollution (HAP) is a leading environmental health risk in sub-Sahara Africa, largely driven by the heavy reliance on biomass fuels for cooking. Growing electricity access has not translated into a mass clean cooking transition, leaving many households at risk of harmful pollutants. Addressing this challenge goes beyond technological solutions and requires a deeper understanding of the socio-economic and behavioral drivers of fuel use. This work is part of the Sustainable, Holistic and Inclusive Energy Systems for Well-being (SHINE) project and presents the project protocol and baseline evidence on fuel use, and subsequent linkages between air pollution exposure and individual and household wellbeing. Setting: Based in The Gambia and Ghana, we present baseline work conducted in Ghana, a country with high electrification (89% national and 77% rural) yet with only 0.4% of households using electricity for cooking. The sample consisted of 416 households from 12 communities in three regions of Ghana: Ashanti, Oti and Greater Accra. These sites represent diverse energy contexts (grid connection, areas with unreliable electricity, off-grid island communities that rely on solar microgrids). Description: Using a mixed methods approach, baseline quantitative household surveys and qualitative approaches were used to understand energy access and usage, cooking practices and lived experiences. Building on this, SHINE is initiating air pollution monitoring to generate empirical exposure data. This will be integrated with a pilot intervention on electric cooking. Initial Findings: Use of firewood and charcoal is remarkably high (82% and 10% respectively), contributing significantly to HAP and associated health risk. Women continue to bear a disproportionate burden due to their primary roles in cooking (84%) and collecting fuel. 83% of participants reported that household members often experience coughs and eye irritation with biomass use, indicating substantial HAP exposure. There is a high awareness (82%) of clean cooking technologies but low adoption of electric cooking, constrained by cost, reliability and support. 63% and 74% of participants expressed strong interest in cleaner alternatives and willingness to participate in clean cooking programs respectively. Lessons learned: Access to electricity alone does not guarantee a reduction to HAP exposure and although there is mitigation through clean cooking efforts, affordability and reliability are also important factors to consider. Exposure to HAP is influenced by technical, social and cultural factors and require community-centered approaches and solutions. Baseline findings highlight the importance of integrating exposure monitoring with intervention design to further understand the cooking transition and impact on wellbeing. Conclusions: This study highlights HAP risk and shows strong community readiness for transition. It also provides a foundation for ongoing air pollution monitoring and intervention within SHINE. Addressing HAP in Sub-Sahara Africa requires people-centered, interdisciplinary strategies that address technical and socio-cultural barriers.

Short-Term Air Pollution and Mortality in South Africa's Priority Areas: Evidence from Adapted Case-Crossover Analyses

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Background: South Africa's Air Quality Priority Areas (Highveld, Vaal Triangle Airshed, Waterberg-Bojanala) experience persistently high pollution levels, yet quantitative evidence linking exposure to health outcomes remains limited. This study addresses that gap using epidemiological methods adapted for real-world data constraints. Key Findings: Across all Priority Areas, short-term exposure to ambient air pollution was consistently associated with increased mortality. The strongest and most consistent effects were observed for particulate matter (PM_{10}, $PM_{2.5}$) and sulphur dioxide (SO_2), with clear spatial and seasonal patterns. At the district level, the highest risks were observed in industrialised regions. In Nkangala, PM_{10} exposure was associated with a 38% increase in weekly mortality in spring (OR = 1.38; 95% CI: 1.15–1.64), while SO_2 in autumn increased mortality by 34% (OR = 1.34; 95% CI: 1.12–1.59). Similar magnitudes were observed in Fezile Dabi and Sedibeng, where both PM_{10} and SO_2 showed consistent, statistically significant effects across seasons. When results were pooled across districts, the pattern remained robust. PM_{10} in spring was associated with a 30% increase in mortality nationally (OR = 1.30; 95% CI: 1.18–1.43), while SO_2 in autumn showed a 27% increase (OR = 1.27; 95% CI: 1.15–1.41). Effects were strongest in the Highveld and Vaal Triangle Priority Areas, reflecting both higher exposure levels and population vulnerability. Conclusions and Policy Relevance: This study provides clear, consistent evidence that air pollution is contributing to short-term increases in mortality across South Africa's Priority Areas, with the largest impacts observed in industrialised districts and during high-exposure seasons.

Longitudinal Environmental Air Sampling for Enhanced Pathogen Detection and Antimicrobial Resistance Surveillance in Resource-Limited Healthcare Settings

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Airborne transmission of pathogens and antimicrobial-resistant microorganisms, such as Staphylococcus spp. and Legionella spp., fungi including Aspergillus and Penicillium spp., respiratory and enteric viruses, Mycobacterium tuberculosis, remain a major concern in healthcare settings, particularly in low-resource environments where overcrowding, poor ventilation, high humidity, elevated particulate matter, and inadequate infrastructure can facilitate aerosol generation and persistence. Although environmental surveillance is increasingly recognized as an important component of infection prevention and control (IPC), current surveillance systems often rely on costly and highly specialized equipment that is inaccessible in many low- and middle-income countries (LMICs). Therefore, there is a critical need for scalable and cost-effective alternatives. This study proposes the use of portable air cleaner (PAC) filters as environmental sampling tools for monitoring airborne pathogens and antimicrobial resistance (AMR) markers.

We aim to assess the feasibility of using portable air cleaner filters for longitudinal environmental air sampling to detect airborne pathogens and monitor AMR-associated genetic determinants in healthcare facilities in Mozambique and South Africa.

This prospective longitudinal study will be conducted in four hospitals across Mozambique and South Africa, including TB/HIV care areas, waiting rooms, inpatient wards, and dormitories. Portable air cleaners (PACs) equipped with filters will be deployed for air purification and environmental sampling over a 12–month period covering seasonal variation. Filters will be sampled and replaced quarterly, generating approximately 768 environmental air samples. Additional Air Cub units will operate alongside PACs to compare sampling efficiency and microbial recovery between systems. Samples will undergo DNA extraction, targeted qPCR, and metagenomic sequencing using the Illumina MiSeq platform to identify airborne pathogens and AMR genes, including blaCTX-M, mecA, vanA, and carbapenemase genes. Data analysis will use mixed-effects and longitudinal modelling approaches in R, Stata, and Python to evaluate detection rates, temporal trends, environmental associations, and comparative performance of sampling systems.

Knowledge, Attitudes and Practices Towards Particulate Matter Pollution Among Urban Residents in Nairobi, Kenya: Implications for Targeted Investment in Community Health Interventions

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Particulate matter ($PM_{2.5}$) poses a growing public health threat across African cities, yet community-level behavioural responses to this exposure remain poorly understood. Designing effective clean air interventions requires evidence on what communities know, believe and do, as well as the key drivers of protective actions. This study assessed knowledge, attitudes and predictors of practices regarding $PM_{2.5}$ pollution among residents of Embakasi Sub-County, Nairobi, Kenya.

A cross-sectional study was conducted among 309 household heads in Embakasi selected using systematic household sampling. KAP scores were computed and categorised using Bloom's cut-off criteria. Descriptive analyses, chi-square tests and ordinal logistic regression were applied to identify distributions, associations and independent predictors of protective practices at a significance level of $p \leq 0.05$.

While 71% of respondents demonstrated high knowledge and 62% held positive attitudes towards $PM_{2.5}$ pollution, 61% reported poor protective practices revealing knowledge-practice and attitude-practice gaps. Knowledge was significantly associated with education level ($p < 0.001$) while attitudes were associated with both education level and length of stay ($p < 0.001$). At the bivariate level, protective practices were associated with length of stay ($p = 0.003$), perceived income ($p = 0.017$) and living with a vulnerable person ($p < 0.001$). In the ordinal logistic regression model, living with a vulnerable individual was the only independent predictor of protective practices (PPO OR = 2.29, 95% CI: 1.34–3.93, $p = 0.001$).

High awareness of $PM_{2.5}$ risks does not translate into protective actions in the majority of urban households. Investments in clean air health interventions must go beyond awareness campaigns to address the practical and structural barriers to behaviour change. Prioritising households with vulnerable members including children, elderly persons and individuals with chronic illness, represents a high-impact, evidence-based entry point for scalable urban health investment across African cities.

Integration of Satellite and Surface Measurements to Map Speciated $PM_{2.5}$ in Africa as part of the Multi-Angle Imager for Aerosols (MAIA) Investigation

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While many epidemiological studies have focused on the adverse health effects of exposure to $PM_{2.5}$ mass concentration, the relative toxicity of different compositional mixtures is less well understood, in part due to the sparseness of surface monitors that measure chemical speciation. To bridge this gap, NASA's Multi-Angle Imager for Aerosols (MAIA) investigation will examine how different types of airborne particulate matter (PM) affect human health. The MAIA satellite instrument, an ultraviolet-visible/near-infrared/shortwave infrared multi-angle imaging spectropolarimeter, will be launched into Earth orbit in the 2027–2028 timeframe in partnership with the Italian Space Agency. The investigation focuses on 12 globally distributed Primary Target Areas (PTAs), including two African PTAs centered near Addis Ababa/Bishoftu/Adama, Ethiopia and Johannesburg/Pretoria, South Africa. Retrieved aerosol properties will be combined with ground-based PM measurements and WRF-Chem chemical transport model outputs to generate daily, 1–km-resolution maps of near-surface PM_{10}, $PM_{2.5}$, and speciated $PM_{2.5}$ (sulfate, nitrate, organic carbon, elemental carbon, and dust). MAIA's surface-based PM measurement network is currently operational, and the data are publicly available free of charge. The MAIA project leverages the SPARTAN speciation network and has deployed additional filter-based $PM_{2.5}$ speciation samplers in various locations within the African PTAs along with two AethLabs microAeth MA350 black carbon (BC) monitors in Addis Ababa. A network of PurpleAir sensors has also been deployed in the Addis Ababa-Adama corridor and is calibrated using Beta Attenuation Monitors operated by the US State Department.

This poster highlights findings from the first three years of operation of MAIA's PM monitoring network. Annual average $PM_{2.5}$ levels of approximately 30 and 25 μg/m³ are observed near Addis Ababa and Johannesburg, respectively. While high levels of elemental carbon are observed in both PTAs, a greater proportion of sulfate is seen in South Africa in contrast with elevated dust levels in Ethiopia. Complementary source apportionment of MA350 BC measurements and FTIR spectra from SPARTAN filters provides insights into the sources of carbonaceous PM. In Addis Ababa, BC was dominated by fossil fuel combustion while organic matter was dominated by charcoal; in Pretoria, organic matter was primarily associated with fossil fuel combustion and seasonally varying biomass burning/biogenic secondary organic aerosol. In addition to the full PM product suite to be produced during the MAIA flight mission over the two African PTAs, acquisition of MAIA satellite imagery and generation of column-integrated aerosol products are also planned for Secondary Target Areas (STAs) encompassing the cities of Dakar, Accra, Lagos, and Cape Town.

SPECTRA: Transforming low-cost sensor and GPS data into personal air pollution exposure intelligence for African health research

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Ambient air pollution is a major environmental health risk, yet personal exposure remains difficult to characterize because individuals move through diverse microenvironments over time. Although low-cost wearable sensors now generate high-resolution GPS and pollutant data, scalable analytical tools are needed to transform these data into meaningful exposure profiles for health risk assessment.

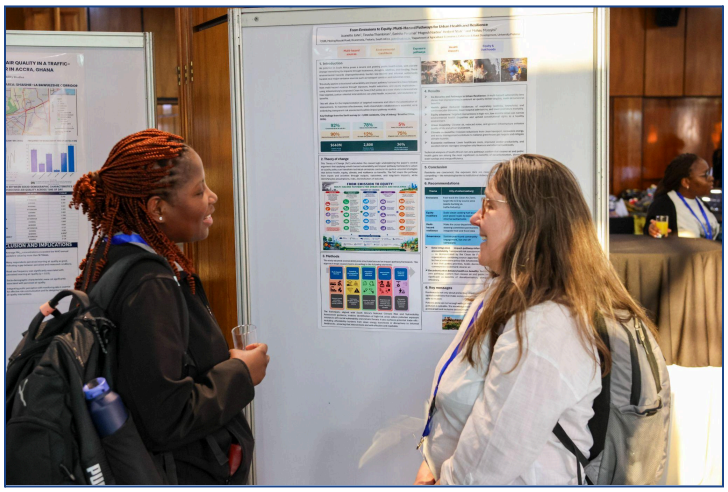
To address this gap, we developed SPECTRA (Spatiotemporal Personal Exposure Characterization and TRAjectory Analyzer), an open-source web-based platform designed to characterize personal air pollution exposure trajectories and generate contextual exposure profiles for health risk assessment. SPECTRA (https://portal.placealert.org/apex/) was developed using R and deployed through an interactive web-based architecture. SPECTRA applied a four-stage indoor/outdoor classification pipeline using GPS speed and displacement, OpenStreetMap building footprints, misclassification detection, and confidence-scored correction. Time-weighted pollutant concentrations are aggregated across spatial grids to identify exposure hotspots and characterize patterns by time, mobility, duration, and environmental context.

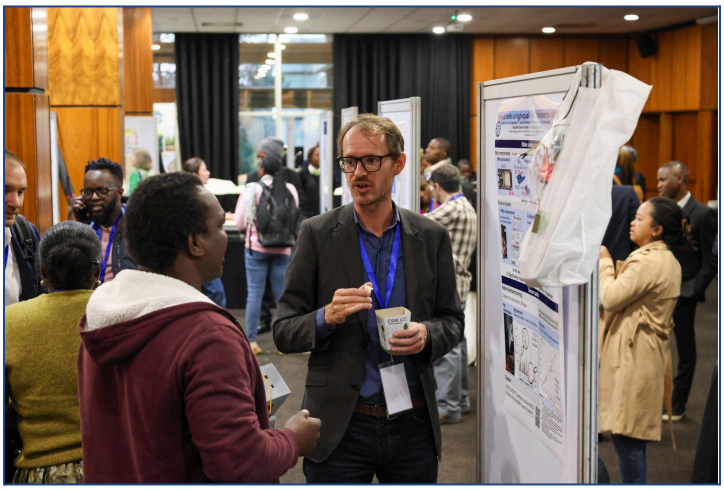
SPECTRA was applied to personal $PM_{2.5}$ exposure datasets collected through the PRECISE-DYAD study in Kenya, Mozambique, and The Gambia. The platform successfully processed large-scale multidimensional datasets comprising GPS trajectories and pollutant measurements collected from 343 pregnant and postpartum women. A demonstration analysis conducted using 571,040 observations from Mozambique revealed pronounced diurnal variation in $PM_{2.5}$ exposure, with concentrations peaking during afternoon periods (60.72 µg/m³ at 15:00) and declining overnight (11.90 µg/m³). Climate-stratified analyses showed higher mean $PM_{2.5}$ concentrations under hot and humid conditions (32.85 µg/m³) compared with cooler and drier environments (22.01–22.58 µg/m³), highlighting the influence of meteorological conditions on personal exposure.

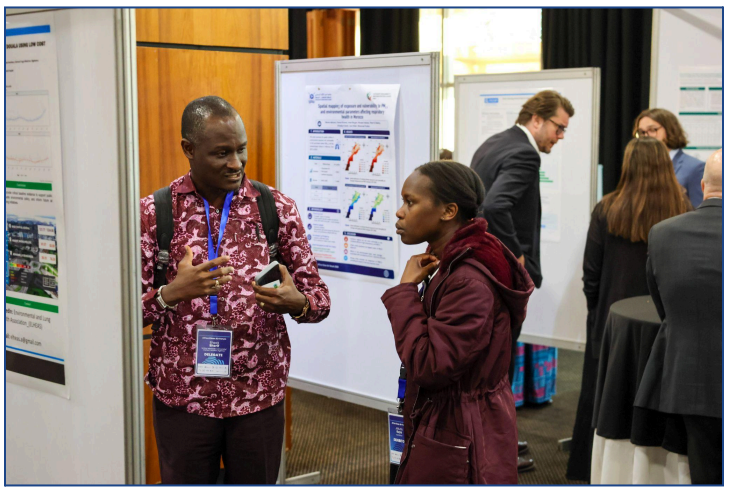
Mobility-informed classifications further distinguished exposure across stationary, perimeter movement, and travel contexts, while spatial aggregation identified 577 exposure grid cells with an overall time-weighted mean $PM_{2.5}$ concentration of 21.81 $\mu g/m^3$.These findings demonstrate the value of integrating mobility, environmental context, and geospatial analytics into personal exposure assessment.

Keywords: Air pollution exposure, low-cost sensors, $PM_{2.5}$, GPS trajectories, personal exposure assessment, Health , Sub-Saharan Africa.

Photo Gallery







About Africa Clean Air Network (AfriCAN)

The Africa Clean Air Network (AfriCAN) is an Africa-based collaboration platform bringing together partners across borders, disciplines and sectors; it was configured on the philosophy of strengthening Africa-led efforts towards evidence-driven clean air action. Launched in 2023, the network is building a shared framework to connect people, data, and solutions. Learn more.

For any questions, please write to us at network@cleanairafrica.org.