



Policy Brief

Air Quality in Uganda: A silent Killer

December 2023



Key points

- Air pollution is a critical global health issue, causing about 7 million annual deaths, with over 90% concentrated in low- and middle-income countries, notably in Africa and Asia. In these regions, both outdoor and indoor air pollutants, including PM_{2.5} and PM₁₀ present substantial risks to human health.
- Urbanization, transportation, industrialization, power generation, and agricultural activities are key drivers of air pollution in Uganda. These contribute to high concentrations of air pollutants including; PM_{2.5} and PM₁₀ that have consistently surpassed the World Health Organization's (WHO) recommended limits. This raises significant human health and environmental concerns.
- Proposed strategies to mitigate poor air quality include enforcing air quality regulations, investing in research and innovations, enhancing monitoring capabilities, promoting sustainable urban planning, developing efficient public transportation systems, implementing cleaner production technologies, encouraging electric and hybrid vehicles, promoting sustainable farming practices, and incentivizing cleaner household energy sources.
- This policy brief proposes several key recommendations to improve air quality in Uganda, including allocating more budgets for air quality monitoring, establishing carbon sinks in urban areas, and promoting car-sharing initiatives to reduce individual vehicle usage.

Introduction

Air pollution is a pressing global concern and is one of the greatest environmental risks to health. By reducing air pollution levels, countries can reduce the burden of disease, including chronic and acute respiratory diseases, including asthma¹. Indeed, air pollution is a silent killer, claiming about 7 million lives a year globally, with over 90% of the deaths being in low and middle-income countries, mainly in Africa and Asia². The consequences of air pollution are particularly prevalent among environmentally vulnerable or sensitive groups including expectant mothers³. Air pollution is caused by a mixture of substances, such as gases, particles, and biological components, found in the atmosphere. Particulate matter (PM) is a composition of liquid and solid particles that are discharged directly into the air³. Extensive studies have been carried out on air pollutants, and indicated particulate matter as the biggest environmental causative

agent of various diseases⁴. The PM is classified by its aerodynamic diameter size as PM₁₀, PM_{2.5}, and PM_{0.1}. Due to their size, they accumulate more, move long distances, and stay in the air for a long time. The WHO recommends the annual mean concentration of PM_{2.5} not exceeding 5 µg/m³ from the previous 10 µg/m³; providing clear evidence of the adverse health effects of air pollution even at reduced concentration⁵. The 24-hour average exposure to PM_{2.5} should not exceed 15 µg/m³.

Both outdoor and indoor air pollutants continue to be of significant concern to public health worldwide and a tough problem confronted by both developed and developing countries⁶. Indoor air pollution (usually as a result of biomass fuel combustion) and outdoor air pollution especially in urban areas have been ranked 10th

¹ WHO 2022: [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)

²WHO. (2016). Ambient air pollution: A global assessment of exposure and burden of disease.

³Wang Z.H, W.H. Zhao, B. Wang, J. Liu, S.L. Xu, B. Zhang, Y.F. Sun, H. Shi, D.B. Guan. Environmentally vulnerable or sensitive groups exhibiting varying concerns toward air pollution can drive government response to improve air quality, *iScience*, Volume 25, Issue 6, 2022, <https://doi.org/10.1016/j.isci.2022.104460>.

⁴ Du Y, Xu X, Chu M, Guo Y, Wang J. Air particulate matter and cardiovascular disease: the epidemiological, biomedical and clinical evidence. *J Thorac Dis.* 2016 Jan;8(1):E8-E19. doi: 10.3978/j.issn.2072-1439.2015.11.37. PMID: 26904258; PMCID: PMC4740122.

⁵Kan H. World Health Organization air quality guidelines 2021: implication for air pollution control and climate goal in China. *Chin Med J (Engl).* 2022 Feb 10;135(5):513-515. doi: 10.1097/CM9.0000000000002014. PMID: 35149640; PMCID: PMC8920460.

⁶ Jiang XQ, Mei XD, Feng D. Air pollution and chronic airway diseases: what should people know and do? *J Thorac Dis.* 2016 Jan;8(1):E31-40. doi: 10.3978/j.issn.2072-1439.2015.11.50. PMID: 26904251; PMCID: PMC4740163.

and 14th, respectively, among 19 leading risk factors for global mortality by the WHO⁷. It has been reported that 55% of the global population lives in urban areas, with this proportion set to reach 68% by 2050⁸.

The situation is not different in Uganda with 24.36% of the total population reported to be living in cities and urban areas⁹. The major pollutants in outdoor air are PM_{2.5} and PM₁₀, ozone, sulfur dioxide, nitrogen dioxide, carbon monoxide, and lead. The indoor air contains all the same pollutants as in the outdoor air, but the concentrations are different, usually lower¹⁰.

In a study on air quality and air pollution exposure in the capital cities of Kampala, Addis Ababa and Nairobi, the results showed that the daily mean PM_{2.5} and PM₁₀ concentrations at roadside and urban background locations were significantly above the WHO daily health-based limits¹¹. Furthermore, Kampala recorded the poorest air quality, where mean daily PM_{2.5} and PM₁₀ concentrations were significantly above the WHO limits on urban background locations by 122% and 69% and at roadside locations by 193% and 215%, respectively. Breathing in unhealthy levels of PM_{2.5} can increase the risk of health problems like heart disease, asthma, and low birth weight¹². Similarly, a study conducted in 2022 in Kampala reported that the 24-hour average PM_{2.5} concentrations 35 µg/m³ were significantly higher, than the recommended WHO limits of 5 µg/m³¹³.

⁷ WHO. (2009). World Health Organization global health risks: Mortality and burden of disease attributable to selected major risks.

⁸ Kundu, D., & Pandey, A. K. (2020). World urbanization: Trends and patterns. *Developing National Urban Policies: Ways Forward to Green and Smart Cities*, 13–49.

⁹UBOS, U. B. O. (2013). Statistical abstract. Kampala: Uganda Bureau of Statistics.

¹⁰ Jiang X, Mei X, Fengategies D. (2016) Air pollution and chronic airway diseases: what should people know and do? *J Thorac Dis.* 2016 Jan; 8(1): E31–E40. doi: 10.3978/j.issn.2072-1439.2015.11.50.

¹¹ Singh A, Ng'ang'a D, Gatari J. M, Kidane W. A, Alemu A. Z, Derrick N, Webster J. M, Bartington E. S, Thomas N. G, Avis W. Air quality assessment in three East African cities using calibrated low-cost sensors with a focus on road-based hotspots. *Environ. Res. Commun.* 3 075007. DOI 10.1088/2515-7620/ac0e0a.

¹² Johnson, N.M., Hoffmann, A.R., Behlen, J.C. et al. Air pollution and children's health—a review of adverse effects associated with prenatal exposure from fine to ultrafine particulate matter. *Environ Health Prev Med* 26, 72 (2021). <https://doi.org/10.1186/s12199-021-00995-5>
¹³ Ninsiima M, Ndyabakira A, Migisha R, Kadobera D, Okello A. D. (2022) Spatio-temporal trends of air quality in Kampala City, 2020–2022. *Quarterly Epidemiological Bulletin: October–December, 2022 Vol. 7 (4).* Article No. 7.

Current trend of air quality in Uganda

Following the analysis of the PM_{2.5} concentrations in various locations in Uganda for the month of July–November 2023, provided by NEMA in partnership with AirQo. The average PM_{2.5} concentrations for July were 43.63 µg/m³ compared to August's level of 37.83 µg/m³. September measured at 35.7 µg/m³, which was lower than July and August. The average PM_{2.5} concentrations in November were measured at 23.93 µg/m³, which is slightly lower than the October reading of 24.94 µg/m³ and better than September's level of 35.7 µg/m³. As observed, the PM_{2.5} concentrations for all the months monitored were highly above the PM_{2.5} WHO limits of 5 µg/m³. Figure 1 presents the trend of air quality in Uganda

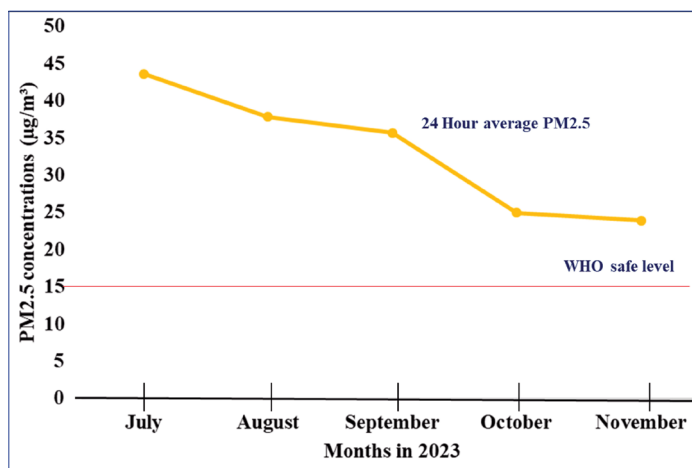


Figure 1: The average PM_{2.5} concentrations for July–November, 2023

Drivers of Air Pollution

Urbanization, transportation, industrialization, power generation, natural phenomena, and agricultural activities are the key drivers of air pollution.

Urbanization

Urbanization is the proportional increase in the number of people living in urban centers and cities. It has been reported that 55% of the global population lives in urban areas, with this proportion set to reach 68% by 2050¹⁴. In Uganda, 24.36% of the total population lives in cities and urban areas, with a population growth rate of 3.3%¹⁵.

¹⁴ Kundu, D., & Pandey, A. K. (2020). World urbanization: Trends and patterns. *Developing National Urban Policies: Ways Forward to Green and Smart Cities*, 13–49.

¹⁵ Kwiringira, J.N., Kabumbuli, R., Zakumumpa, H. et al. Re-conceptualizing sustainable urban sanitation in Uganda: why the roots of 'Slumification' must be dealt with. *BMC Public Health* 21, 992 (2021). <https://doi.org/10.1186/s12889-021-11029-8>

While urbanization brings about several positive aspects, such as increased economic activity and improved access to resources, it also serves as a significant driver of air pollution¹⁶. The rising population is closely connected to the amount of fuel consumed in residential areas. Both urban slums and rural areas around cities rely on biomass for cooking. The increasing population and urbanization levels drive activities like refuse generation. In Kampala, the annual solid wastes generated exceeds 350,000 tons¹⁷ and the improper disposal and management of these wastes contribute to air pollution through the release of harmful substances and the generation of landfill gases including methane, ammonia, sulfides, and carbon dioxide. Furthermore, the growth in population and economy in cities has heightened mobility and transportation needs, leading to increased emissions of air pollutants including PM, Nitrogen Oxides (NO_x), and Ozone (O₃). Additionally, vehicular movement contributes to the re-suspension of dust, further elevating ambient PM concentrations. The poor road network within the urban centers, especially Kampala and the neighboring districts, has led to traffic congestion and delay on the road, elevating the production of PM.

The burgeoning urban population generates substantial amounts of waste, including hazardous materials. Solid wastes burning are very common practices in Uganda which results air pollution¹⁷.

In addition to these, unregulated industrial emissions, waste burning to manage uncollected waste, have contributed to PM in Kampala that has been reported to be higher than the WHO recommended limit of 15 µg/m³ with a mean of 48.4 µg/m³¹⁸

Residential air pollution sources

The combustion of solid fuels and biomass fuels for cooking and heating in households, as well as

16 Wang Z.H, W.H. Zhao, B. Wang, J. Liu, S.L. Xu, B. Zhang, Y.F. Sun, H. Shi, D.B. Guan. Environmentally vulnerable or sensitive groups exhibiting varying concerns toward air pollution can drive government response to improve air quality, *iScience*, Volume 25, Issue 6, 2022, <https://doi.org/10.1016/j.isci.2022.104460>.

17 Muheirwe F, Kihila M.J, Kombe J.W, Campitelli A. Solid waste management regulation in the informal settlements: A social-ecological context from Kampala city, Uganda. *Front. Sustain.*, 2023; Vol 4, <https://doi.org/10.3389/frsus.2023.1010046>.

18 Muheirwe F, Kihila M.J, Kombe J.W, Campitelli A. Solid waste management regulation in the informal settlements: A social-ecological context from Kampala city, Uganda. *Front. Sustain.*, 2023; Vol 4, <https://doi.org/10.3389/frsus.2023.1010046>.

the use of certain household products, including paints, perfumes, and air fresheners continue to contribute to indoor and outdoor air pollution.

A study conducted in kitchens in Mbarara revealed that the mean 24-hour concentration for PM_{2.5} was 449 µg/m³ in the wet season and 526 µg/m³ in the dry season; CO was 41.52 ppm, and all concentrations were higher than the WHO recommendations for PM_{2.5} of 15 µg/m³ and CO of 6.340 ppm¹⁹. Heavy metals in particulate matter were in concentration ranges of 1.012-9.820 µg/m³ Fe, 0.012-0.092 µg/m³ Cr, 0.060-10.750 µg/m³ Zn, 0.048-0.300 µg/m³ Cu, 0.004-0.052 µg/m³ Pb and ND-0.004 µg/m³ Cd. All these mean metal concentrations were lower than recommended exposure levels by the Environmental Protection Agency (EPA), although chronic exposure is a risk to health²⁰.

Industrialization

One of the primary contributors to air pollution in urban areas is industrialization. As urban centers become hubs for economic activities and manufacturing, industries emit a plethora of pollutants into the air. Harmful substances such as particulate matter, sulfur dioxide, nitrogen oxides, and volatile organic compounds are released during industrial processes, leading to the formation of smog and other hazardous pollutants. These pollutants can have detrimental effects on respiratory health, cardiovascular systems, and overall well-being.

Power generation in Uganda has been a crucial factor in the country's economic development, aiming to meet the growing energy demands of its population and industries. Whereas the country heavily relies on hydroelectricity, backup energy sources, which predominantly rely on fossil fuels, have contributed significantly to air pollution. Diesel generators are commonly used in off-grid and backup power systems, and the combustion of this fossil fuel releases a range of pollutants into the air, including a mixture of volatile soluble organic substances, sulphate, nitrate materials, and atoms of soot carbon²⁰. Diesel exhaust contains more than 40 toxic air contaminants, including many known or

19 Muheirwe F, Kihila M.J, Kombe J.W, Campitelli A. Solid waste management regulation in the informal settlements: A social-ecological context from Kampala city, Uganda. *Front. Sustain.*, 2023; Vol 4, <https://doi.org/10.3389/frsus.2023.1010046>.

20 Muheirwe F, Kihila M.J, Kombe J.W, Campitelli A. Solid waste management regulation in the informal settlements: A social-ecological context from Kampala city, Uganda. *Front. Sustain.*, 2023; Vol 4, <https://doi.org/10.3389/frsus.2023.1010046>.

suspected cancer-causing substances, such as benzene, arsenic, and formaldehyde²¹. These pollutants have adverse effects on air quality and public health, contributing to respiratory diseases and other health issues.

Transportation

Motor vehicle traffic is clearly a major contributor to air pollution in Kampala, and this exposes drivers and commuters to poor air quality²². The combustion of fossil fuels in vehicles releases pollutants like carbon monoxide (CO), nitrogen oxides (NO_x), particulate matter, and hydrocarbons into the atmosphere. This situation is exacerbated by the numerous reconditioned vehicles in Uganda, which are estimated to account for 80% of the vehicles in the country²³. These large fleets of motorcycle taxis in Kampala, Uganda, and other cities in low- and middle-income countries (LMICs) emit significant local and global air pollutants²⁴. Kampala metropolitan area has an estimated population of 3.5 million that mainly belongs to the growing middle class. This is responsible for a fast expanding road traffic comprising of second hand and aging reconditioned cars, trucks, buses, and motorcycles that have unregulated exhaust emission limits²⁵.

Agricultural practices

Agricultural activities, such as the use of fertilizers and pesticides, livestock farming, and biomass burning, release pollutants like ammonia, methane, and particulate matter in the atmosphere. Clearing forests for agriculture or urban development reduces the number of trees that can absorb pollutants, leading to increased concentrations of pollutants in the air.

21 Awofeso N. (2011) Generator diesel exhaust: a major hazard to health and the environment in Nigeria. *Am J Respir Crit Care Med*. Vol. 15;183(10):1437. doi: 10.1164/ajrccm.183.10.1437.

22 Singh A, Ng'ang'a D, Gatari J. M, Kidane W. A, Alemu A. Z, Derrick N, Webster J. M, Bartington E. S, Thomas N. G, Avis W. Air quality assessment in three East African cities using calibrated low-cost sensors with a focus on road-based hotspots. *Environ. Res. Commun*. 3 075007. DOI 10.1088/2515-7620/ac0e0a.

23 National State of Environment Report, 2018/19

24 Max Vanatta, Bhavesh Rathod, Jacob Calzavara, Thomas Courtright, Teanna Sims, Étienne Saint-Sernin, Herek Clack, Pamela Jagger, Michael Craig, Emissions impacts of electrifying motorcycle taxis in Kampala, Uganda, Transportation Research Part D: Transport and Environment. Volume 104, 2022.

25 Schwander S, Okello D. C, Freers J, Chow C. J, Watson G. J, Corry M, Meng Q. (2014), "Ambient Particulate Matter Air Pollution in Mpererwe District, Kampala, Uganda: A Pilot Study", *Journal of Environmental and Public Health*, vol. 2014, Article ID 763934, 7 pages, <https://doi.org/10.1155/2014/763934>.

Impacts of air pollution

Air pollution has a wide range of adverse effects on human health and the environment. Long-term exposure to air pollutants can lead to the development or exacerbation of respiratory conditions such as asthma, chronic bronchitis, lung cancer, and heart complications. Air pollutants claim 7 million lives a year globally. People with chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD) and asthma are especially vulnerable to the detrimental effects of air pollutants. Short-term exposure to high levels of air pollution can cause irritation of the eyes, nose, and throat, as well as headaches, dizziness, and nausea. Chronic exposure to air pollutants has been associated with the development of chronic diseases, reduced lung function, and a decline in overall health.

Children in high ambient air pollution sites in Jinja and Kampala had lower lung function than those in Buwenge Sub County with low ambient air pollution²⁶. Among the adolescents in Kampala, it was observed that the combined effects of the Human Immunodeficiency Virus (HIV) and air pollution may amplify the development of cardiovascular diseases²⁷.

Exposure to air pollution, including PM_{2.5}, PM10, SO₂, NO₂, CO, and O₃ is positively associated with an increased risk of stroke, hospital admission incidence, and mortality²⁸. Generally, poor air quality negatively impacts the overall quality of life, leading to discomfort and stress. With its myriad health consequences and other adverse effects, poor air quality stands as a silent killer, demanding urgent and decisive action.

The presence of pollutants such as nitrogen oxides and sulfur dioxide adversely affects plant and animal species, resulting in a significant loss of biodiversity. Furthermore, greenhouse gases

26 Kirenga J. B, Nantanda R, De Jong C, Mugenyi L, Meng Q, Aniku G, Williams S, Tukamuhebwa A. H, Kanya M, Schwander S, Van der Molen T, Mohsenin V. Lung Function of Children at Three Sites of Varying Ambient Air Pollution Levels in Uganda: A Cross Sectional Comparative Study. *Int. J. Environ. Res. Public Health* 2018, 15(12), 2653; <https://doi.org/10.3390/ijerph15122653>

27 1Toe S, Nagy M, Albar Z, Yu J, Sattar A, Nazzinda R, Musiime V, Etajak S, Walyawula F, McComsey GA, Atuyambe LM, Dirajlal-Fargo S. Ambient air pollution is associated with vascular disease in Ugandan HIV-positive adolescents. *AIDS*. 2022 May 1;36(6):863-870. doi: 10.1097/QAD.0000000000003186.

28 Niu, Z., Liu, F., Yu, H. et al. Association between exposure to ambient air pollution and hospital admission, incidence, and mortality of stroke: an updated systematic review and meta-analysis of more than 23 million participants. *Environ Health Prev Med* 26, 15 (2021). <https://doi.org/10.1186/s12199-021-00937-1>

like carbon dioxide (CO₂) and methane(CH₄), contribute significantly to the greenhouse effect and climate change. This leads to global warming and an escalation in the frequency and intensity of extreme weather events, emphasizing the urgent need for comprehensive policies to address this critical issue. Ground-level ozone and particulate matter not only compromise air quality but also inflict damage on crops, posing a direct threat to agricultural productivity.

Strategies to tackle air pollution

Uganda, like many countries across the globe, requires a comprehensive strategy hinged on a multi-sectoral approach to address the issue of air pollution. The following strategic initiatives are proposed to mitigate air pollution and enhance the overall air quality.

Strictly execute the air quality regulatory framework

- Operationalize the Air Quality Regulations (AQR) to limit pollutant emissions.
- Strengthen the enforcement of pollution control regulations, including the National Environment Act, No. 5 of 2019, through increased surveillance and penalties.

Invest in cutting-edge research and innovations

- Foster collaboration between research institutions, industries, and government agencies to develop and deploy state-of-the-art pollution prevention technologies.
- Advocate for the widespread adoption of renewable energy sources to reduce dependence on fossil fuels.
- Encourage energy efficiency practices in industries and households through awareness campaigns and incentives.

Enhance air quality monitoring

- Strengthen air quality monitoring nationwide with improved infrastructure and technologies for accurate and real-time data collection.
- Develop user-friendly platforms for public access to air quality information.
- Enable prompt responses to pollution incidents through expanded monitoring capabilities.

Promote sustainable urban planning

- Encourage sustainable urban planning practices, prioritizing green spaces and

environmentally friendly infrastructure.

- Incentivize the incorporation of green building practices in construction projects to minimize energy consumption.

Develop efficient public transportation

- Establish an efficient, accessible, and environmentally friendly public transportation system to reduce individual vehicle usage and associated emissions.
- Ensure a long term plan to improve road networks and connectivity.

Implement cleaner production technologies

- Enforce stringent emission standards and incentivize industries to invest in pollution control equipment.
- Encourage the adoption of cleaner production technologies across all industries; this includes improvements in technologies that minimize emissions and waste generation.

Promote electric and hybrid vehicles

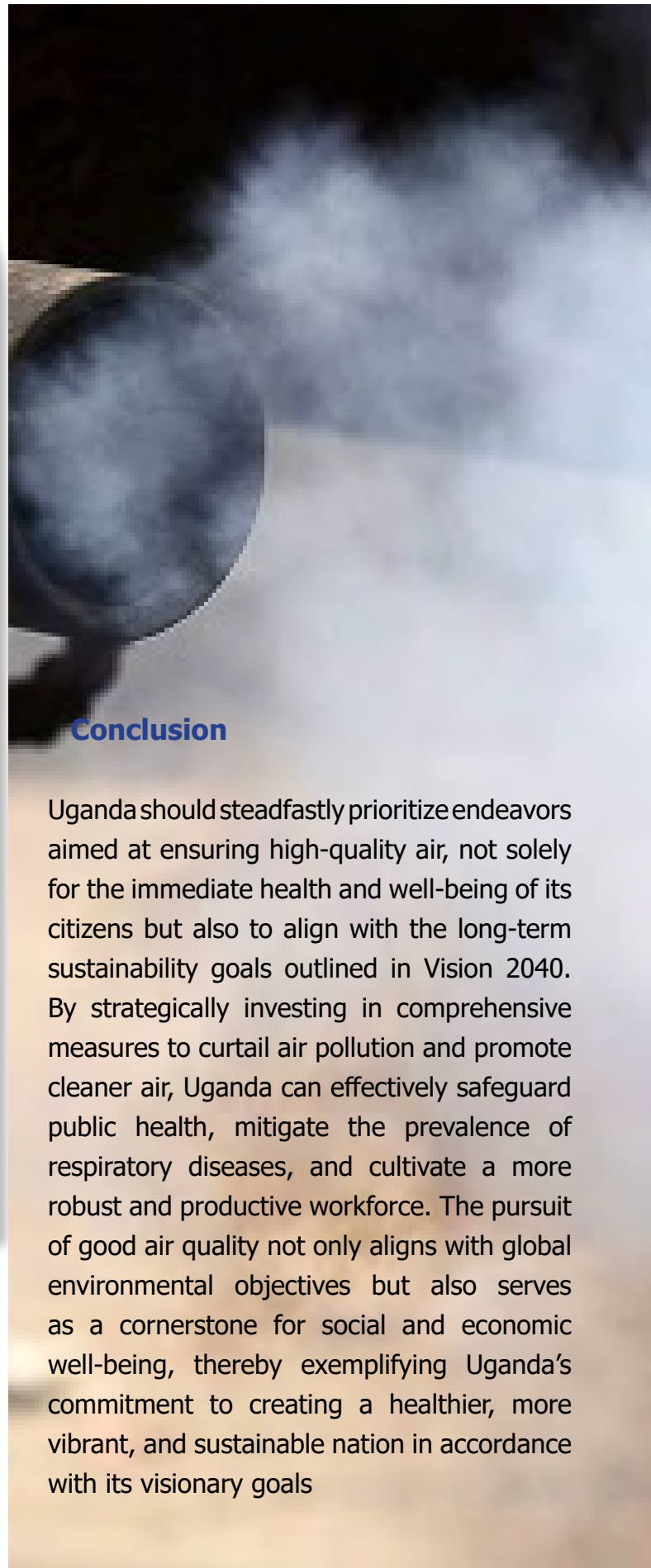
- Promote the adoption of electric and hybrid vehicles through incentives and infrastructure development.
- Enforce strict vehicle emission standards and invest in technologies for monitoring and controlling vehicular emissions.

Encourage sustainable farming practices

- Support farmers in adopting precision agriculture techniques to reduce their environmental impact.
- Minimize the use of chemical fertilizers and pesticides through awareness programs and incentives.

Incentivize cleaner household energy sources

- Provide incentives for households to transition to cleaner energy sources.
- Implement effective waste management strategies and discourage open burning through public awareness campaigns.



Key policy recommendations

- Invest in air quality monitoring equipment for major cities, and municipalities.
- Invest in the creation of carbon sinks (green spaces) in major towns, municipalities, and cities in the country.
- Invest in research and innovations to enhance air quality.
- Facilitating multi-sectoral engagements and sharing initiatives within the city and the use of public means should be highly encouraged.
- Promote the use of electric vehicles and the importation of vehicles as per the AQR with less environmental impact.
- Encourage night time freight delivery systems and carry out vehicle emissions tests.
- The government should construct standard paved roads across the country, especially in urban areas.

Conclusion

Uganda should steadfastly prioritize endeavors aimed at ensuring high-quality air, not solely for the immediate health and well-being of its citizens but also to align with the long-term sustainability goals outlined in Vision 2040. By strategically investing in comprehensive measures to curtail air pollution and promote cleaner air, Uganda can effectively safeguard public health, mitigate the prevalence of respiratory diseases, and cultivate a more robust and productive workforce. The pursuit of good air quality not only aligns with global environmental objectives but also serves as a cornerstone for social and economic well-being, thereby exemplifying Uganda's commitment to creating a healthier, more vibrant, and sustainable nation in accordance with its visionary goals