



KEY MESSAGES

- ★ Air pollution is a global health challenge listed by the WHO as a major silent killer responsible for the observed respiratory, cardiovascular and cancer illness and deaths.
- ★ Air pollution is linked to more than 18,000 premature deaths in Kenya every year.
- ★ The Air quality of the Nairobi Metropolis is continually deteriorating with both indoor and ambient air pollution levels exceeding World Health Organization (WHO).
- ★ Despite the global calls and the evidence of the deteriorating air quality in Nairobi metropolis, there has been minimal effort to address the situation.
- ★ The Nairobi metropolis counties currently have inadequate capacity in terms of expertise, budgets, equipment and regulatory framework to effectively manage air pollution.
- ★ This Policy brief highlights the drivers of air pollution within the Nairobi Metropolitan area and recommends policy and programmatic interventions to address this major environmental risk.

INTRODUCTION

Air pollution is emerging as one of the major environmental concerns in Nairobi Metropolitan area which covers Nairobi county and parts of Kiambu, Machakos and Kajiado Counties. Although there is no continuous and robust air quality monitoring system in Nairobi metropolitan area, random studies undertaken show that there is deteriorating air quality with measurements exceeding the World Health Organization (WHO) standards¹. This situation raises concerns on its current and potential impacts on the populace in the metropolis. It is therefore necessary to develop and implement regulations and policies, strategies, plans and frameworks including establishment of a robust air quality monitoring system in the metropolis besides².

Controlling air pollution requires a collaborative management approach by national and county governments. The Kenyan constitution 2010 stipulates in Article 42 that every Kenyan is entitled to a clean and healthy environment.

The Fourth schedule of the constitution assigns county governments the function of controlling air pollution within their jurisdiction³. The Air Quality Regulations of 2014 prohibits several forms of air pollution by giving guidelines on the exact levels of permissible emissions. However, The Air Quality Regulations of 2014 do not provide for the control, prevention as well as abatement of all forms of air pollution to ensure that there is a clean and a healthy ambient air quality⁴.

A rapid assessment undertaken by NETFUND in January 2020 on the status of policy and programmatic interventions relating to air pollution management in Nairobi metropolis counties revealed that there was very limited undertaking by counties on this matter. Generally, the metropolis counties have inadequate capacity and framework to regulate air pollution and to design and implement appropriate air quality intervention and management programmes⁵.

This policy brief explores the major drivers of air pollution in the Nairobi metropolis and highlights the impacts on human and environmental health.

CONTENT

- INTRODUCTION
- POLLUTANT EMISSION IN THE NAIROBI METROPOLITAN
- DRIVERS OF AIR POLLUTANTS IN NAIROBI
- IMPACTS OF AIR POLLUTION.
- BARRIERS AND CHALLENGES TO EFFECTIVE AIR POLLUTION MANAGEMENT IN NAIROBI METROPOLITAN COUNTIES
- CONCLUSION AND RECOMMENDATIONS

AUTHORS

Michael. O. Okok,
National Environment Trust Fund
(NETFUND)

Tom Randa,
African Centre for Technology Studies
(ACTS)

Donatos Mengich,
National Environment Trust Fund
(NETFUND)

¹ Pope, F. D., Gatari, M., Ng'ang'a, D., Poynter, A., and Blake, R. (2018). Airborne particulate matter monitoring in Kenya using calibrated low-cost sensors. *Atmospheric Chem. Phys.* 18, 15403–15418.

² Amegah, A.K., and Agyei-Mensah, S. (2017). Urban air pollution in Sub-Saharan Africa: Time for action. *Environ. Pollute.* 220, 738–743

³ Kenya Constitution 2010

⁴ Air quality Regulations 2014

⁵ NETFUND Air quality control and management in Nairobi metropolis rapid assessment report

Borrowing insights from various studies on air quality of the city and its environs, the brief points out the barriers to effective air quality management and makes comprehensive recommendations to improve air quality in Nairobi metropolis. The policy brief aims to incite deliberation and subsequent strategic actions among stakeholders including Metropolis residents, Private sectors, County and national government, NGOs and International Partners.

POLLUTANT EMISSION IN THE NAIROBI METROPOLITAN

The main pollutants emitted from different sources within the Nairobi metropolitan area include particulate matter (PM₅ and PM₁₀), Ozone (O₃), black carbon, nitrogen oxides (NO_x), carbon monoxide (CO), Methane (CH₄), Sulphur Oxides (SO_x), Ammonia (NH₃) and hydrocarbons/volatile organic compounds (hydrocarbons -HCs/VOCs) all of which have adverse health and environmental impacts. While some of these pollutants are emitted due to inefficiency of combustion processes, many others are generated due to fuel properties, chemical reactions, and lack of tailpipe controls. Particulate matter emissions at national scale are dominated by industrial emission, tailpipe emission from the transport sector and residential combustion. However, their concentration is much higher on the outskirts of the central business district and industrial areas of the city because these are the areas where emission occurs daily. Spatial distribution of emissions of PM_{2.5} shows that emission intensity is highest around Kariokor Market, Baba Dogo and Donholm in the outskirts of Nairobi Central Business District. The activities at these identified hotspots in Nairobi are replicated in several areas in the Metropolis.

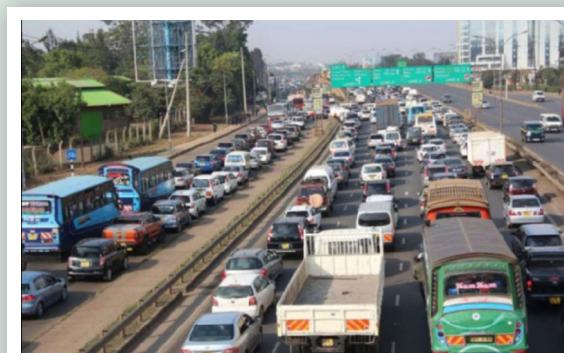
In 2016, Kenya's air contained more than two times as many of the deadly PM_{2.5}s relative to the WHO guideline for outdoor air pollution limits. The measured 25.8 micrograms per cubic metre (ug/m³) of ultra-fine particles of 2.5 micrometres or less in diameter which can penetrate and lodge deep inside the lungs clearly shows Nairobi's air breaches all limits set by the WHO.

The measured pollutants included PM_{2.5}, Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), and Ozone (O₃)⁶.

The dangers posed by the high levels concentrations of the pollutants cannot be over emphasized. The lack of continuous and robust monitoring systems and research make it difficult to precisely explore the scope of impacts and roll out effective interventions⁷.

DRIVERS OF AIR POLLUTANTS IN NAIROBI.

- Rapid urbanization, transportation, energy consumption, industrialization, increased commercial activities and waste disposal operations are the key drivers of air pollution by contributing significantly to air pollution sources⁸.
- Main sources of air pollution in Nairobi metropolis are the increasing traffic activities and congestion, unpaved earth surfaces and construction activities, secondary aerosols, industrial emissions and combustion. The traffic and vehicular sources alongside the mineral dusts are contributing a significant amount (74%) of pollutants⁹.
- **Rapid population growth** in the metropolis is a significant driver to both indoor and ambient air pollution. The population of the Nairobi metropolitan counties has rapidly grown over the years with the area currently hosting about 9,354,580 residents according to the 2019 Population and Housing Census. Nairobi county is the most populated of the four counties with its population having grown from approximately 3,138,369 in 2009 to 4,734,881 in 2019. As at 2018 Urbanization level was at 27.03% and mainly driven by rural to urban migration¹⁰. There is a direct link between growing population and other drivers of air pollution such as energy consumption, waste generation, mobility and transport demand.
- **Fossil fuel** poses a threat to the quality of the air due to resulting emissions from combustion. As at 2017, about 34.4% of Kenya's installed electricity generation capacity (802.56 MW) was still based on fossil fuels¹¹. Some industries around the metropolis also use biomass fuel (wood) for steam generation and diesel driven generators thus contribute to the overall air pollution. About 58% of the Nairobi metropolis population live in the informal settlements and 69.7% use paraffin and charcoal as the primary source of cooking energy¹². Studies have indicated that average levels of fine particulate matter within households are



⁶ UNEP 2017

https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf

⁷ Rajé, F., Tight, M., & Pope, F. D. (2018). Traffic pollution: a search for solutions for a city like Nairobi. *Cities*, 82, 100-107.

⁸ Rajé, F., Tight, M., & Pope, F. D. (2018). Traffic pollution: a search for solutions for a city like Nairobi. *Cities*, 82, 100-107.

⁹ Gaita, S. M., Boman, J., Gatari, M. J., Petterson, J. B., & Janhäll, S. (2014). Source apportionment and seasonal variation of PM 2.5 in a Sub-Saharan African city: Nairobi, Kenya. *Atmospheric Chemistry and Physics*, 14(18), 9977-9991.

¹⁰ KNBS 2019 <https://www.knbs.or.ke/?wpdmp=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county>

¹¹ KPLC 2017 Annual Report

approximately 76 $\mu\text{g}/\text{m}^3$, which is three times more than the WHO recommended maximum level of 25 $\mu\text{g}/\text{m}^3$ and thus the observed increasing respiratory health complications and deaths in the Metropolis¹³.

- **Ineffective Waste management is another driver to air pollution.** Open waste burning and organic waste in landfills release harmful dioxins, furans, methane and fine particulate matter like black carbon into the atmosphere. In the metropolis, it is estimated that 40 percent of waste is openly burned thus releasing harmful elements into the atmosphere which is even more harmful since wastes are usually not segregated. These wastes come from household and commercial activities as well as industrial processes in the following proportions: domestic sources (68%), industrial (14 %), roads (8%), hospitals (2%), markets (1%), and other sources (7%)¹⁴.
- Vehicular emission has been cited as a major source of air pollution especially within Nairobi metropolis due to increasing vehicle population and traffic jams¹⁵. As at August of 2018, the vehicular population in Kenya stood at 3,135,573 units with about 940,672 of these being in the Nairobi Metropolitan area¹⁶. The vehicular number in the metropolitan area is projected to reach about 1.4 million by 2025, and is likely to exacerbate the already existing traffic and pollution challenges. Other than emission from fuels, movement of vehicles causes resuspension of dust, which adds to the ambient air pollution.
- Kenya's Industrial development has generally been on the rise and was contributing up to 16.39% of the country's Gross Domestic Product (GDP) by 2018¹⁷. Cement manufacturing, cigarette production, incinerators, ferrous and non-ferrous metal manufacturing and recycling facilities, thermal power plants, sugar factories, galvanized steel production and agricultural products processing are some of the major emission sources. Most of the industrial operations are concentrated in the Metropolis and thus contribute to air pollution.



IMPACTS OF AIR POLLUTION

Air pollution is now widely known to have impacts over human health, agriculture, ecology, buildings and climate. In humans, it affects the respiratory, cardiovascular, cardiopulmonary, and reproductive systems and can also lead to cancer¹⁸. The International Agency for Research on Cancer (IARC) has classified outdoor air pollutants as carcinogenic to humans¹⁹. Globally, a WHO report shows that air pollution causes about 24% of all adult deaths from heart disease, 25% from stroke, 29% from lung cancer and 43% from chronic obstructive pulmonary disease²⁰. In Kenya, it is linked to more than 18,000 premature deaths every year with the mortality rate from air pollution in the country rising from 60 for every 100,000 deaths in 2012 to 78 for every 100,000 deaths in 2016²¹.

The risks from air pollution are now far greater than previously thought or understood. Recent studies have even indicated that it has a direct link with the infections and fatalities associated with the Corona Virus Disease of 2019 (COVID-19) which is a more recent pandemic. Air pollution causes or aggravates conditions such as asthma, lung and heart diseases and people with such underlying conditions are more likely to experience severe illness or even death from COVID-19²². Furthermore, short-term exposure to higher concentrations of PM_{2.5}, PM₁₀, CO, NO₂ and O₃ is associated with an increased risk of COVID-19 infection²³.

Other than ambient pollution, use of biomass and unclean cook-stoves in informal settlements and peri-urban areas of the metropolis for cooking and kerosene for lighting is associated with indoor air pollution which is linked to different health complications and diseases such as Chronic Obstructive Pulmonary Disease, tuberculosis, cataract and adverse

¹² Kenya National Bureau of Statistics Population Distribution by Age, Sex and Administrative Units 1C (2010) Nairobi

¹³ Dianati, K., Zimmermann, N., Milner, J., Muindi, K., Ezeh, A., Chege, M., ... & Davies, M. (2019). Household air pollution in Nairobi's slums: A long-term policy evaluation using participatory system dynamics. *Science of the Total Environment*, 660, 1108-1134.

¹⁴ NEMA 2003 Nairobi and its Environment report.

¹⁵ Gaita, S. M., Boman, J., Gatari, M. J., Pettersson, J. B., & Janhäll, S. (2014). Source apportionment and seasonal variation of PM 2.5 in a Sub-Saharan African city: Nairobi, Kenya. *Atmospheric Chemistry and Physics*, 14(18), 9977-9991.

¹⁶ KNBS, Kenya key economic indicators, 2015,2016,2017 and 2018

¹⁷ Kenya: Share of economic sectors in the gross domestic product (GDP) from 2008 to 2018 <https://www.statista.com/statistics/451143/share-of-economic-sectors-in-the-gdp-in-kenya/>

¹⁸ Global burden of disease 2019 http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf

¹⁹ IARC 2013 Air pollution and cancer <https://publications.iarc.fr/Book-And-Report-Series/Iarc-Scientific-Publications/Air-Pollution-And-Cancer-2013>

²⁰ Global burden of disease 2019

²¹ WHO 2016 https://www.who.int/gho/publications/world_health_statistics/2016/EN_WHS2016_TOC.pdf

²² Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., ... & Guan, L. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The Lancet*.

²³ Yongjian, Z., Jingu, X., Fengming, H., & Liqing, C. (2020). Association between short-term exposure to air pollution and COVID-19 infection: Evidence from China. *Science of the total environment*, 138704.

²⁴ Cohen, A. J., Brauer, M., Burnett, R., Anderson, H. R., Frostad, J., Estep, K. ... & Feigin, V. (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *The Lancet*, 389(10082), 1907-1918.

pregnancy outcomes²⁴. Health Effect Institute and Institute of Health Metric and Evaluation 2016 reports recorded more than 20,000 air pollution related deaths annually in Kenya with more than half of these deaths resulting from inhaling black carbon from solid fuels such as charcoal and wood burned in inefficient cook-stoves at the urban household level²⁵.

Some of the air pollutants such as black carbon, ozone, and methane also have warming potential hence are short-lived climate pollutants. Aerosols reduce the light and heat reaching the Earth's surface, causing heating of the atmosphere and cooling of the Earth's surface. This changes evaporation rates and precipitation efficiency of the clouds and can eventually impact the rainfall patterns in a region which has implications over several aspects including rain-fed agriculture, floods and extreme droughts. Apart from these impacts, there could be larger regional impacts over the cyclones along the coastal lines. In 2019, Kenya meteorological department revealed that tropical cyclone known as "IDAI" delayed the rains in Kenya which significantly reduced moisture influx into the country leading to continued sunny and dry weather conditions that negatively affected the Agricultural sector²⁶.

BARRIERS AND CHALLENGES TO EFFECTIVE AIR POLLUTION MANAGEMENT IN NAIROBI METROPOLITAN COUNTIES

- Lack of continuous and robust air quality monitoring system. This has led to the existing data gap to effectively determine the scope and extent of the adverse impacts of air pollution in the metropolis and for policy action.
- Inadequate air quality management policies and guidelines. Most of the Counties have no air quality management regulations, policies and strategies to effectively guide air quality management at the local level.
- There exists ambiguity in the roles of the national and county government in managing air pollution. Both National Environment Management Authority (NEMA) and County governments have certain functions in air pollution but there is no clear distinction on their specific roles and scope.
- The budgetary allocation by the county governments to departments responsible for environmental management is inadequate to cover all the environmental challenges. The department has therefore to prioritise which challenges to address and most of the counties seem to prioritize the visible solid waste management and ignore or side-line the invisible silent killer, air pollution.
- Most of the counties are under-staffed in the environment department with very few or no air quality experts or officers with air knowledge on air pollution and management.
- Lack of equipment to continuously monitor and measure air quality in the counties makes it difficult to monitor emissions and compare with existing standards, enforce the existing air pollution laws and assess the health impacts of air pollution through research.

CONCLUSION AND RECOMMENDATIONS

Air pollution remains a big threat to human health, the environment and economic wellbeing in Nairobi Metropolitan area. The situation is likely to deteriorate as long as the drivers are not controlled. It is essential therefore that various stakeholders including National Government, relevant county governments, private sector and civil society organization work together to undertake policy and programmatic actions to arrest air pollution in the metropolitan area. The recommendations set below should ensure the actualization of effective Air quality management in the Metropolis:

- Establish a robust air quality management system that involves monitoring, data collection and dissemination to bridge the gap that has seen the metropolis lack air quality inventory. The system will enable monitoring of trends and inform the designing and implementation of appropriate interventions.
- As the human and vehicular population of the metropolis is projected to increase as urbanization continues, the counties should plan how to effectively manage the always congested traffic and settlements and have a strategic plan on handling and disposing of the different wastes generated. This will significantly contribute to reducing air pollution from the sources.
- Development of National air quality management framework. This will clearly stipulate the roles and responsibilities of National and County governments in managing air pollution and thus reduce conflicts and duplications.
- Mainstream air quality in planning at county level by formulating and implementing air quality regulations, policies, strategies and programs.
- Promote the use of clean energy technologies at household level to reduce indoor air pollution. This can be achieved through incentives, developing guiding policies and increasing the access to clean energy technologies in the metropolis informal settlements.
- Enhance public awareness creation on air pollution and associated risks.
- Clearly define settlement and industrial zones to minimize direct exposure to harmful gaseous effluents from the industrial operations.
- Enhance the capacity of existing staff and ensure adequate staffing in the environment departments at county level to effectively manage air pollution implement the strategic actions.

²⁵ Global burden of disease 2019 http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf

²⁶ Ministry of Environment Metrological department 2019 http://www.meteo.go.ke/pdf/seasonal_update.pdf