Series 2 – Social Pillar: Environment, Water, Sanitation and Regional Development

Enhancing Our Care for the Urban Air We Breathe

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Key Messages

The harm caused by air pollution in Kenya's urban areas is estimated to be high but documentation is at infancy.

Air Quality Management (AQM), a pillar in green growth, is hindered by limited measurements. There is need to Investment in AQM.

Coordinated systems thinking interventions are needed in AQM, institutional capacity strengthening, bolstering the legal and regulatory framework, climate change knowledge

Urban sustainability indicators are useful for policymakers to gauge the socio-economic and environmental impacts, including air quality, of policies and practices.

Context

Living in a city or a metropolitan area is a great promotion for human well-being, given its convenient mode of life and efficient way of working. This is so for Kenyan cities, Nairobi included. However, concerns are emerging from residents and scientists that the unprecedented development of cities has caused a range of environmental problems and exerts huge pressure on natural ecosystems that we rely on (UNEP, 2016; Asian Coalition for Housing Rights 2004; Muthama, 2019a). Several parts of Kenyan cities continue to experience overwhelming solid waste challenges and air pollution impacts among other environmental concerns.

The 2017 Kenya Economic Survey estimated that 19.9 million Kenyans, representing 38.3% of the population, suffered from respiratory ailments that are exacerbated by poor air quality. The 2019 Kenya Economic Survey estimated that 21.8 million Kenyan, representing 39.3% of Kenyans, suffered from the respiratory ailment, indicating a 1% increase of the ailments at the national level. This is a pointer that the air pollution problem may be increasing.

Current trends, including industrialization and urbanization, suggest that air quality in Kenya cities will worsen over time unless targeted interventions are adopted in the short, medium, and long term and the institutional and technical capacity of organizations responsible for Air Quality Management (AQM) is strengthened. The 2019 Kenya Economic Survey indicated that the total number of environmental crimes reported to the Kenya National Environment Management Authority (NEMA) rose within the period 2014 to 2018. For example, 97 crimes were reported in 2017, rising to 156 in 2018. The increase in reporting may be attributed to the introduction of equipment for checking air quality. This further confirms the need for continuous monitoring of indoor and outdoor air pollution in Kenya

However, the efforts by the national and county governments, to enforce existing regulations is hampered by a lack of high-quality and continuous air quality monitoring data (Muthama, 2019b). Without an understanding of the baseline air quality in Kenya and how it varies across the country as well as over time, the NEMA Standards and Regulations cannot be effectively enforced..

Study Approach and Results

The African Agenda 2063, Kenya's vision 2030 and the Sustainable Development Goal number 11 emphasises on the importance of paying closer attention to city's environmental dynamics for the well-being of its residents, the city of Nairobi included. The theoretical perspective taken for this study was based on systems theory. Systems theory states that there is a relationship between structure and behaviour. Cities are created by social systems and rely on complex networks of human-made systems to supply them. Also, this study used the approach of incorporating core concepts of urban metabolism in assessing urban system sustainability in the context of

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energy and water use, with a focus on the City of Nairobi. The concept of metabolism mimics human metabolism: a process by which the human body converts what he/she eats and drinks into energy. Practically, the study of urban metabolism involved 'big picture' quantification of the inputs, outputs and storage of energy, water, nutrients, materials and wastes for an urban region.

Urban sustainability indicators were used. They are tools that allow city planners, city managers and policymakers to gauge the socio-economic and environmental impact of, for example, current urban designs, infrastructures, policies, waste disposal systems, pollution and access to services by citizens. They allow for the diagnosis of problems and pressures, and thus the identification of areas that would profit from being addressed through good governance and science-based responses. Understanding the relationship between resource consumption and the production of products and wastes is the key to understanding how urban ecosystems persist.

Satellite data is increasingly being employed to address problems arising from inadequate air-quality monitoring data. Satellite sensors such as MODIS (Moderate-resolution imaging spectroradiometer) and MISR (Multi-angle imaging spectroradiometer) can provide aerosol retrievals that are suitable for studying air pollution trends (Muthama, 2019a).

In this study, MODIS data were used. Satellite-based ariel averaged monthly data for four parameters, over Nairobi, as a case study, were downloaded from the MODIS website. Analyses and visualizations used in this study were produced with the Giovanni online data system, developed and maintained by the NASA GES DISC (Acker and Leptoukh, 2007). Sulfur dioxide (SO2) surface mass concentration and carbon dioxide (CO2) in free troposphere were obtained. Monthly data for the period January 1980 to July 2017, for the two parameters were collected and subjected to time series analysis.

Air pollutants that cause negative health and environmental impacts include Particulate Matter (PM), ozone (O3), carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), and volatile organic compounds (VOCs). The key pollutants analysed in this study, namely SO2, is a by-product of burning fossil fuels such as crude oil, furnace oil, diesel, and coal. SO2 can be transformed in the atmosphere into sulfates that appear as fine particles.

Data analysis revealed that the air quality over Nairobi has deteriorated in the period 1980 to 2017 as depicted by the temporal pattern of the SO2. From around 1998 there is a marked increasing trend of SO2. The annual increase is estimated at 0.08 micrograms per cubic meter (µg/m3) per year. There is a clear seasonal pattern with the December to February season having the highest values and trend. The month of February has the highest trend of 1.09 µg/M3 per year. Apart from marked seasonality, there are also seasonal spikes which beg for further understanding as regards the well-being of the City residents. Kenya's air quality regulations (GoK, 2014) provide for an ambient tolerance limit of 50 µg/m3. This implies that in a couple of decades Nairobi will experience severe SO2 pollution if business as usual continues. Energy waste over Nairobi in the form of SO2 is increasing drastically. As the nation of Kenya industrialises in line with Kenya's vision 2030, the situation will only grow worse if concerted mitigating measures, by way of policy and practice, are not initiated and maintained. This calls for measures to ensure that AQM systems are operationalized across the country. Also, a systems-thinking approach in solving the problem will bear fruits (Muthama 2019b).

Analysis of CO2, a greenhouse gas, showed an increasing trend from 1980 to 2017. The warming is likely caused by both urbanisation and human activities. This is in agreement with other studies in many cities around the world (Zhang 2013; Barnes 2009). This begs for further understanding of the sustainability of Kenyan cities under changing climate..

Policy Recommendations

Short-Term

- County Governments should make cities and urban areas more compact thus more energy efficient
- Green spaces should be created that help remove particulate matter
- Ministry of Environment and Forestry (MoE&F), together with county governments, should work towards improving urban waste management, including the capture of methane gas emitted from waste sites as an alternative to incineration
- National and County governments should create and maintain spaces for safe walking and cycling
- National and County governments and other key stakeholders should operationalize cost-effective air quality monitoring systems
- Public, Private partnership should be instituted to entrench citizen science in monitoring and reporting air quality
- Stakeholders should embrace and implement Systems thinking approach and Urban metabolisms concept in Air quality management and Governance

Medium-Term

- MoE&F should foster institutional collaboration among public officials, researchers, private sector and civil society in advancing the use of lower-emission cookstoves and/or cleaner fuels in place of traditional household solid fuel including firewood
- Line ministries should promote the use of low-emissions fuels and renewable combustion-free power sources, such as solar, wind or hydropower
- MoE&F should strategising to move way completely from kerosene
- Line ministries and other stakeholders should improve the energy efficiency of homes and commercial buildings through insulation and passive design principles such as natural ventilation and lighting
- Set up robust Air quality monitoring systems for each urban area in Kenya
- Research institutions should pursue targeted studies to enhance our understanding and quantification of health effects of air pollution in Kenya under changing climate.

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References

Asian Coalition for Housing Rights. (2004). Negotiating the right to stay in the city. Environment and Urbanization, 16(1): 9–26.

Acker, J. G. and G. Leptoukh, (2007). Online Analysis Enhances Use of NASA Earth Science Data. Eos, Trans. AGU, 88(2) 14 -17.

Muthama, N. J., (2019a). Sustainable Urban Metabolism: The Case of Air Quality in the City of Nairobi. In Sustainable Development in Africa Ed. by M. Nagao, J. Masinja & A. Alhassan, Spears Media Press

Muthama NJ. (2019b). Sub-National Policy Readiness as Regards the Planet's Carrying Capacity and Environmental Sustainability in Kenya. *Journal of Sustainability, Environment and Peace* 1(1) 6-11

UNEP (2016) GEO-6 Regional Assessment for Africa. UNEP, Kenya.

GoK(2014) Environmental Management and Coordination (Air-quality) Regulations, Government Press

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