Championing Liveable urban Environments through African Networks for Air (CLEAN-Air Network)

Kampala Inaugural Workshop Report

(2023)

Workshop **Summary**

Conveners
- AirQo

Convening partners

1. The Health Effects Insitute
2. Stockholm Environment Institute Africa
3. World Resources Institute (WRI) Africa
4. UrbanBetter
5. University of Lagos
6. University of Cape Coast
7. University of Yaounde-I
8. University of Burundi
9. Kampala Capital City Authority
10. National Environment Management Authority (NEMA)

Scientific and programme committee

1. Deo Okure, Air Quality Scientist & programme Manager, AirQo
2. Vanessa Tyaba, Visiting Research Fellow, AirQo, MSc Student, Kings College London
3. Priscilla Adong, Senior Data Sceintist, AirQo
4. Victor Nthusi, Consulting research Fellow, Health Effects Institute
5. Pallavi Pant, Head of Global Health, Health Effects Institute
6. Richard Sserunjogi, Data Science Lead, AirQo
7. Maclina Birungi, Communications Lead, AirQo
8. Gideon Lubisia, International Network, AirQo
9. Martin Bbaale, Lead Software Engineer, AirQo
10. Jennifer Kutesakwe, Senior Environment Inspector, NEMA
11. Gabriel Okello, Visiting Research Fellow, AirQo, Fellow, Cambridge Insitute for Sustaibaility Leadership, University of Cambridge
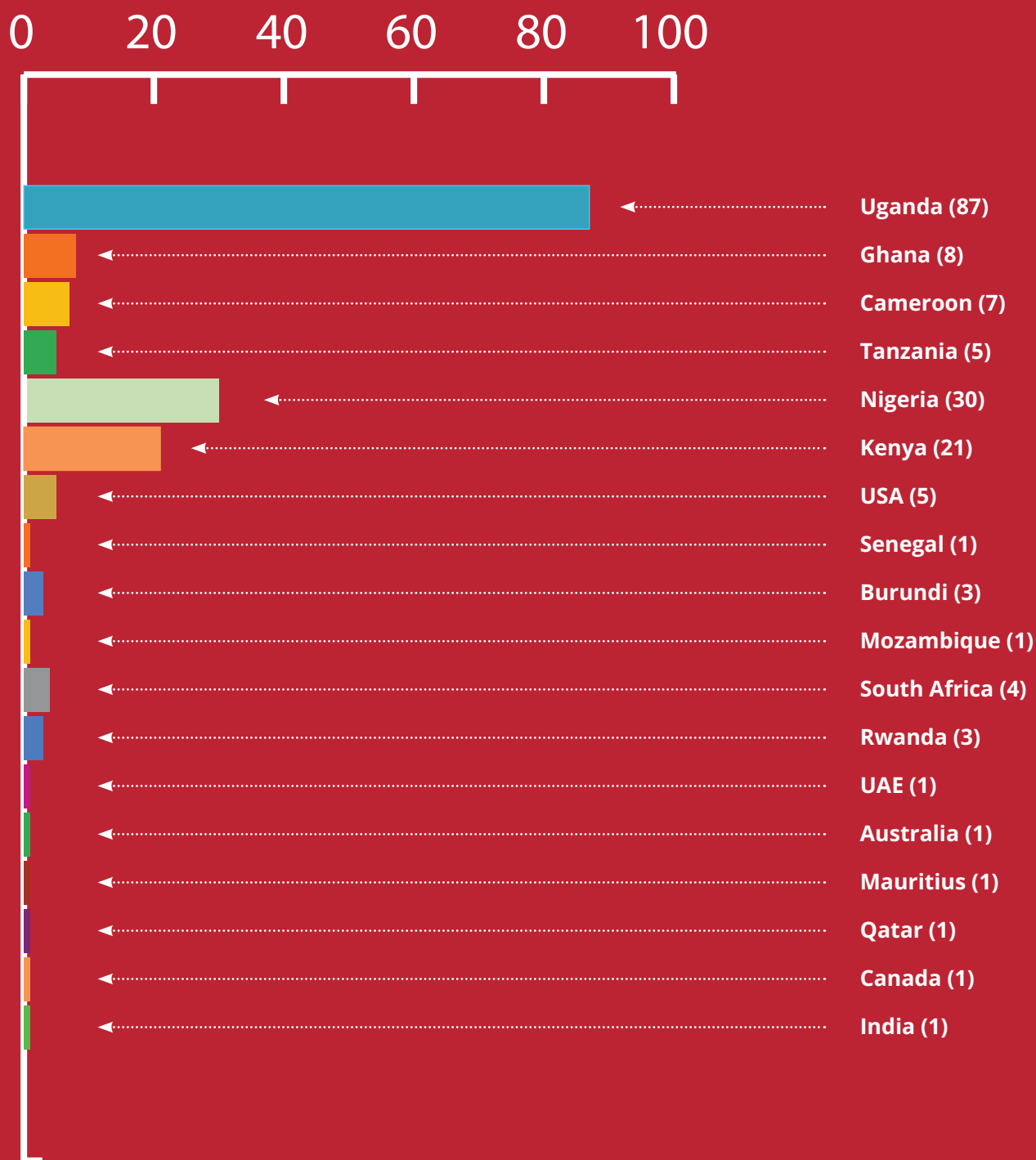
Venue, Kampala Uganda

- **Day 1:**
  Golden Tulip Canaan Hotel
- **Day 2:**
  Makerere University, College of Engineering, Design, Art and Technology
- **Day 3:**
  Sheraton Kampala Hotel

Report authors

1. Deo Okure, Air Quality Scientist & programme Manager, AirQo
2. Monika Kamkuemah, Chief of Staff UrbanBetter, Post Doctoral Research Fellow, University of Pretoria
3. Priscilla Adong, Senior Data Scientist, AirQo
4. Meelan Thondoo,University of Cambridge, IS Global Institute for Global Health, Barcelona
5. Priscah Adrine, Digital Communications Executive, AirQo
6. Ngongang Danube, Research Fellow, Stockholm Environment Institute (SEI) Africa
7. Pallavi Pant, Head of Global Health, Health Effects Institute
8. Martin Bbaale, Lead Software Engineer, AirQo
9. Peter Baranga, Lecturer, Mountains of the Moon University, Uganda
10. Engineer Bainomugisha, AirQo Lead, Head of Department Computer Science

Participants by country

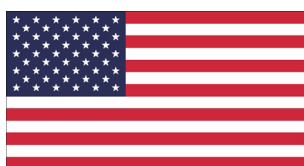| Country	Participants
Uganda	87
Ghana	8
Cameroon	7
Tanzania	5
Nigeria	30
Kenya	21
USA	5
Senegal	1
Burundi	3
Mozambique	1
South Africa	4
Rwanda	3
UAE	1
Australia	1
Mauritius	1
Qatar	1
Canada	1
India	1

Acknowledgement

Convening partners

Participating partners

Funding partners

Acknowledgement

Keynote Speakers

1. **Ms Amy Petersen**, Public Affairs Section, representing the U.S. Ambassador to Uganda.
2. **Hon. Erias Lukwago**, The Lord Mayor, Kampala Capital City.
3. **Mr Abala Wanga**, Kisumu City Manager.
4. **Prof. Barnabas Nawangwe**, Vice-Chancellor of Makerere University.
5. **Ms. Maureen Njeri**, County Executive Committee Member (CECM), Green Nairobi Environment, Water, Food and Agriculture Nairobi City County Government.
6. **Dr Ankwasa Barirega**, Executive Director, National Environment Management Authority, Uganda.
7. **Hon. Albert Aheebwa**, Right Honourable Speaker, Fort Portal City.
8. **Dr Okello Daniel Ayen**, Director Public Health Services and Environment, Kampala Capital City Authority, Uganda.
9. **Dr Adebola Odunsi**, Lagos State Envirobment Protection Agency (LASEPA).
10. **Prof. Tony Oyana**, Principal, College of Computing and Information Sciences, Makerere University.
11. **Prof. Bainomugisha Engineer**, AirQo Project Lead

Guest Moderators

1. **Dr R Subramanian**, QEERI, Kigali Collaborative Research Centre (KCRC)
2. **Dr Anderson Kehbila**-Stockholm Environment Institute (SEI)
3. **Dr Temitope, Sogbanmu**, University of Lagos (UniLag)
4. **Dr Nshakira Nathan**, Kabale University
5. **Dr Mwaniki George**, Head Air Quality, WRI Africa
6. **Dr Nantanda Rebecca**, Makerere University Lung Institute
7. **Christopher Lubega**, U.S Mission, Kampala
8. **Prof. Taibat Lawanson,** Director, Lagos Centre for Housing and Sustainable Development, University of Lagos
9. **Dr Rose Anthony Alani**, University of Lagos (UniLag)
10. **Prof. Rebecca Garland**, Associate Professor, University of Pretoria
11. **Ngongang Wandji Danube Kirt**, Research Fellow, UNEP/SEI
12. **Dorothy Lsoto**, PhD Student, University of Wisconsin-Madison
13. **Dr Ndyabakira Alex**, Kampala Capital City Authority
14. **Prof. Lynn Atuyambe**, East Africa GEOHealth Hub, Makerere University School of Public Health
15. **Patrick Kamara**, Wizarts Foundation and NTV Uganda
16. **Prof. Tolu Oni**, Clinical Professor, University of Cambridge

Breathe
Clean

WORKSHOP REPORT

Contents

Background and Vision for the
CLEAN-Air Network Workshop

Air pollution is a major public health challenge for many African urban spaces, and the dangers of exposure and socio-economic costs surpass other known environmental health challenges, including malnutrition and unsafe sanitation, especially for lower socio-economic strata.[1][2]

1. Brunekreef, B.; Holgate, S. T. Air pollution and health. Lancet 2002, DOI: 10.1016/s0140-6736(02)11274-8
2. Roy, R. The Cost of Air Pollution in Africa; OECD Development Centre, 2016

Africa has one of the fastest growing urban populations in the world, and yet there is an inherent lack of institutional capacity to design and implement targeted interventions to tackle air pollution across African cities.[3][4]

3. Petkova, E. P.; Jack, D. W.; Volavka-Close, N. H.; Kinney, P. L. Particulate matter pollution in African cities. DOI: 10.1007/s11869-013-0199-6
4. Okure, D., Ssematimba, J., Sserunjogi, R., Gracia, N.L., Soppelsa, M.E. and Bainomugisha, E., 2022. Characterization of ambient air quality in selected urban areas in uganda using low-cost sensing and measurement technologies.

The disproportionate impact of air pollution in African cities is instructive for advancing new and collaborative approaches to tackle urban air pollution.

The workshop brought together participants from communities of practice from over 31 cities across the world, as a launchpad for the CLEAN-Air Network to pioneer Africa-led collaborations and multi-regional partnerships that particularly emphasizes the need to strengthen regional networks for sustained interventions.

The CLEAN-Air Network is a broad-based engagement umbrella for the communities of practice for air quality solutions and management across Africa and is envisioned to be:

- Africa-focussed

- Cross region

- Multidisciplinary

- Multi-sectoral: academia, government/policy makers (cities, regulators, etc), citizens, and development partners

- Collaborative and participatory

" *The clean air network will serve as an air quality hub championing clean air in our urban environments in Africa. Through these hubs, we hope to increase the understanding of low-cost air quality monitors and digital solutions and how they can be used as new approaches to air quality management in the African context. Ultimately we want to increase awareness of air quality issues for better health outcomes in Africa.*

Prof Engineer Bainomugisha

This report provides a holistic overview of the key insights and outcomes from the CLEAN-Air inaugural workshop held in Kampala, from 1st to 3rd April 2023.

The CLEAN-Air workshop was a three-day largely in-person engagement that brought together over 200 communities of practice from over 31 cities (18 from Africa) from 18 countries across the world. The workshop was meant to be a launchpad that pioneers Africa-led collaborations and multi-regional partnerships that particularly emphasize the need to strengthen regional networks for sustained interventions. The 3-day engagement was designed around the following core objectives and outcomes

Objectives

1. Establish a forum to foster science - policy dialogue

2. Present the different case studies of participatory air quality management

3. Demonstrate the advances in adapting LCS and opportunities for scaling across Africa

4. Provide a platform for engagement on broader air quality issues

Outcomes

1. Increase the understanding of LCS and digital solutions as new approaches to air quality management in the African context

2. Foster city-city and policy-research collaborations

3. Increase awareness of contextual issues of air quality for better health outcomes

Programme **Outline**

The workshop adopted a single-track format structured around three broad themes delivered through a series of panel sessions as follows:

Session outline	Moderators
Day 1: Participatory Air Quality Management for African Cities	
Session: Strengthening Inclusive and Evidence-Informed Policy Development: Aspirations and Opportunities **Speakers** 1. Martha Mugarura, Ministry of Lands, Housing and Urban Development, Uganda 2. Dr Meelan Thondo, University of Cambridge, Mauritius 3. Dr Felix Assah, University of Yaounde, Cameroon 4. Abala Wanga, Kisumu City County Government, Kenya	1. Dr R Subramanian-QEERI, Kigali Collaborative Research Centre (KCRC) 2. Dr Anderson Kehbila-Stockholm Environment Institute (SEI) Africa
Session: Collaboration and Building Synergies for Collective Urban Air Quality Management Across Africa **Speakers** 1. Mackline Ninsima, Kampala Capital City Authority (KCCA) 2. Prof. Kofi Amegah, Ghana Urban Air Quality Project (GHAir) 3. Nairobi City County Government (NCCG) 4. Dr Monika Kamkuemah, (University of Pretoria) 5. Prof. Robert Mbaike, African Group on Atmospheric Science (ANGA)	1. Dr Temitope, Sogbanmu, University of Lagos (UniLag) 2. Dr Nshakira Nathan, Kabale University
Keynote presentation by NEMA ED	Dr Mwaniki George , WRI Africa
Session: Communicating air quality data and information to the public **Speakers** 1. Maclina Birungi, Effective avenues for communicating air quality data (The AirQo experience) 2. Prof. Tolullah Oni, Communicating health and air quality:	Christopher Lubega (U.S Mission, Kampala)

Session outline	Moderators
Day 2: LCS and digital platforms for air quality management in the African context	
Sustainable Air Quality Monitoring for Africa: Low-Cost Sensors, Networks, Data, and Action **Panelists** 1. Prof Engineer Bainomugisha: Lead - AirQo, HOD Computer Science - Makerere University 2. Dr Rose Alani: Senior Lecturer, University of Lagos 3. Prof Presto Albert: Research Professor, Carnegie Mellon University	**Moderators** 1. Dr George Mwaniki (Head of Air Quality for WRI Africa) 2. Prof Rebecca Garland, Associate Professor, University of Pretoria
Building a low-cost network for smart air quality monitoring in the African context **Panelists** 1. Deo Okure: Air Quality Scientist and Programme Manager 2. Gideon Lubisia, International Network, AirQo 3. Joel Ssematimba: Hardware Engineering Lead	**Moderators** 1. Prof Taibat, Lawanson (UniLag) 2. Dr Rose Anthony Alani (UniLag) 3. Dr Alex Ndyabakira, KCCA
Standardizing data quality assurance protocols for LCS Network in an African Context. The AirQo experience **Panelists** 1. Okedi Deo: Hardware Engineer, AirQo 2. Priscilla Adong: Data Scientist, AirQo	**Moderators** 1. Dr Gabriel Okello 2. Dorothy Lsoto (University of Wisconsin-Madison
Demonstration session: Unpacking the role of custom digital platforms for open data management and sharing **Panelists** 1. Noah Nsimbe, Software Engineer, AirQo 2. Mike Mwanje, Software Engineer (DevOps), AirQo 3. Priscah Adrine, Digital Communications, AirQo	**Moderators** 1. Ngongang Wandji Danube Kirt (UNEP/SEI) 2. Dorothy Lsoto (University of Wisconsin-Madison)

Session outline	Moderators
Day 3: Launching the CLEAN-Air Africa Network	
Multi-disciplinary collaborations for action (lightning talks)	Prof. Lynn Atuyambe, GEOHealth Hub., Makerere University
Integrating air pollution and health data for evidence-based action **Panelists** 1. Dr Daniel Okello: Director Public Health Services and Environment, Kampala Capital City Authority (KCCA) 2. Dr Adebola Odunsi, Lagos State Environmental Protection Agency (LASEPA) 3. Dr Nantanda Rebecca, Makerere University Lung Institute (MLI)	**Moderators** 1. Dr Pallavi Pant, the Health Effects Institute 2. Prof Tolullah Oni; UrbanBetter, University of Pretoria, University of Cambridge
Research commitments • Vice Chancellor, Makerere University	Patrick Kamara
The need for political will • Kampala Lord Mayor, Hon. Erias Lukwago	Patrick Kamara
International collaborations • U.S Ambassador, represented by Ms Amy Petersen	Patrick Kamara

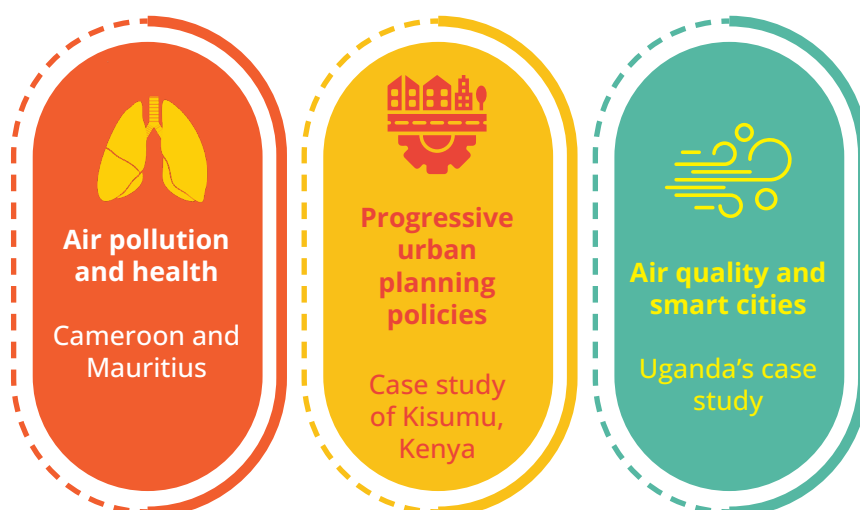# Participatory **Air Quality Management for African Cities**

Opening plenary: Inclusive and evidence-informed policy development: aspirations and opportunities

The opening plenary was a high-level multi disciplinary panel drawing on experts from different contexts in Africa representing different interest groups including Cameroon, Mauritius, Uganda and Kenya. The session was configured to achieve two objectives

- Set the tone for the workshop by presenting the strategic opportunities for data-informed inclusive policy development across Africa.
- Present progressive case studies on participatory and evidence-based policy interventions, research, and action on tackling air quality across African countries.
- Highlight the mulit-faceted nature of air pollution management to build convergence on the optimal model for Africa.

HIGHLIGHTS: OVERARCHING THEMES

Air pollution and health

Cameroon and Mauritius

Progressive urban planning policies

Case study of Kisumu, Kenya

Air quality and smart cities

Uganda's case study

Air Pollution and Health

Dr Meelan Thondo from the University of Cambridge

Dr Meelan Thondoo from the University of Cambridge, discussed the interlinkages between air pollution and health, particularly deaths attributable to air pollution in Low- and Middle-Income Countries (LMICs) compared to Europe. She also discussed the Participatory Quantitative Health Impact Assessment methodology and used a Mauritius case study to illustrate its implementation.

> *Air Pollution is an environmental issue, a justice issue and a gender issue. Reducing air pollution levels in countries has the potential to not only reduce the burden of mortality and morbidity but also contribute toward community and national-level development.*

> *Air Pollution is the most common pathway through which Built Environemt impacts on health. Health Impact Assessment outcomes can help anticipate potential side-effects, unintended consequences, trade-offs, and synergies, and effectively inform policy and planning*

Dr Felix Assah from the University of Yaoundé

Dr Felix Assah from the University of Yaoundé, discussed the ALPhA project's objectives and site, which involves the appropriation of public spaces for physical activity (PA) in Yaoundé, Cameroon, and the risk of air pollution on physical activity.

He also discussed the PM2.5 levels during the Harmattan haze and the increased risk of injuries and diseases associated with exercising in hazardous places.

> *The built environment plays an important role in Physical Activity. There is thus neccessity to go beyond individual sensitivity to a more favorable environment for physical activity*

Progressive Urban Planning Policies

In his presentation, Mr Abala M. Wanga, from Kisumu City County Government in Kenya, discussed Kisumu's unique case of progressive urban policies. He highlighted the environmental challenges facing the city, including unsustainable solid waste management, deforestation, climate change, and environmental pollution. However, he also mentioned the existing enabling policy environment, including several plans at the national and county level to adopt policies, partnerships, collaborations, benchmarking, networking, and compliance with national frameworks. The

impact of these policies has been improved air quality, public health, and a clean, safe, and healthy environment. Air quality observations from Kisumu City Hall monitoring site show that the majority of observed air quality is moderate, with higher concentrations of PM2.5 in February than in other months. The next phase of Kisumu's development plan is creating Kisumu County Integrated Development Plan (CIDP), which will use air quality data from AirQo to inform decision making, attract partnerships and support, enforce action, create awareness, and document best practices.

> **"** Urban planning should take into account air quality. Lack of data makes it difficult to develop tailor-made initiatives to address the pollution challenge, especially planning at policy levels. Use of Smart solutions enhances mitigation potential in the built environment, Looking ahead, there are opportunities to implement green infrastructure projects that can also meet sustainability goals."

Mr Abala M.Wanga, City Manager, City of Kisumu

Air Quality and Smart Cities

Martha Mugarura, Assistant commissioner Urban Development, Ministry of Lands, Housing and Urban Development.

Martha Mugarura, from the Ministry of Lands, Housing, and Urban Development in Uganda, gave a talk titled "Are smart cities the solution to urban health challenges in Africa?" She presented an overview of Uganda's National Urban Policy, which urges functional organization of Uganda's urban areas based on population density, area, and service level. Mugarura explored the concept of smart cities and how they offer a vision for managing the lifecycles of cities, improving economic performance and enhancing city competitiveness. She explained the four pillars of smart cities as: ICT-based urban solutions, better governance and transparency, sustainability, and decent urbanization in emerging countries. She highlighted the importance of air quality management in smart cities, the need to integrate public health into planning, and the use of smart solutions to enhance mitigation potential in the built environment. She concluded by outlining the environmental challenges in an African city context and the aspirations for smart cities in Uganda to offer urban solutions using ICT to provide better urban services and develop the urban economy based on developing ICTs.

" *"Urban planning should take into account air quality. Lack of data makes it difficult to develop tailor-made initiatives to address the pollution challenge, especially planning at policy levels. Use of Smart solutions enhances mitigation potential in the built environment, Looking ahead, there are opportunities to implement green infrastructure projects that can also meet sustainability goals."*

Keynote from NEMA ED

- Dr Akankwasa Barirega formally opened the 3-day workshop
- Updated the audience on the progress on waste regulations in Uganda as a key driver on air pollution
- Highlighted the need to embrace progressive technologies for tackling environemntal pollution
- Empasised the need for research that accelerates behavior change in society
- Acknowledged the shortfalls in scientific research funding but echoed government commitment to funding research
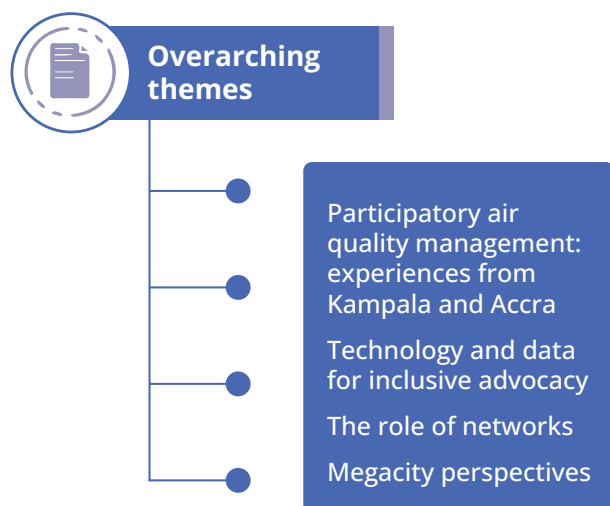

Executive Director, Dr Akankwasah Barirega National Environmental Management Authority

" *"We do not want to import air quality monitoring sensors when we can develop our own and monitor air quality, let us make use of the data and take action to reduce air pollution."*

Collaboration and Building **Synergies for Air Quality Management**

The focus of the session was to highlight city-specific experiences in collaboration and building synergies around tackling air pollution. The objectives of the session were to: present progressive case studies on participatory and evidence-based policy interventions, research, and action on tackling air quality across African countries. The speakers highlighted the mulit-faceted nature of air pollution management to build convergence on the optimal model for Africa.

Overarching Themes

Overarching themes

- Participatory air quality management: experiences from Kampala and Accra
- Technology and data for inclusive advocacy
- The role of networks
- Megacity perspectives

Participatory air quality management

Mackline Ninsiima opened the session on Participatory air quality management experiences from Kampala city, where air quality thresholds, 10-12 times higher than recommended WHO guidelines. She described the process through which ambient air quality monitoring is happening in Kampala with air quality monitors being placed at different locations. Other multisectoral actions include the Kampala Capital City 'Clean Air Action Plan' and the ongoing plan to calculate source

apportionment, led by Makerere University Institute. Training and symposiums have been held on the air quality management strategies and the next step is to increase collaboration and awareness on the topic of air pollution in Kampala.

Similarly Dr. Kofi Amega went on to present the 'Ghana Urban Air Quality project' (GHAir) which aims to bridge air quality data gaps in Ghana. He specifies the different SDGs involved and implied when assessing and monitoring air quality. Household air pollution is still a major problem in Africa and Asia and Amega calls for the need of more data to convince governments that pollution is killing people. There is an urgent need to adapt exposure response functions to African settings and the aim of GHAir to use data to unlock epidemiology research. He also spoke about the Breathe Accra project which is set up in close collaboration with EPA, Ghana Health Service and city authorities. These projects will generate data that will inform local policy making. Accra city so far has been slow in responding to

> " LCS have the potential to advance exposure science by complementing regulatory monitoring to enable better characterization of air pollution exposure
>
> *Dr. Kofi Amega*

health projects due to lack of reliable data and absence of local evidence on human health. Current opportunities lie in the willingness for the environment department in the municipal and sub-metropolitan authorities in Accra to be included in the vision to accelerate AQ improvements in Accra. The objective therefore is to generate hyperlocal air quality data in Ghana and build a technical blueprint that can be shared with other African cities. The activities presented by Amega include a web platform, a training in Health Impact Assessment, providing evidence

to stakeholders and engaging different actors to leverage low-cost data. Amega concluded that low-cost sensors are needed for short and medium term air quality goals and for regulatory and reference instrumentation. It is important now to inspire public confidence in understanding and acting on air pollution data.

Megacity perspectives

Maurice Kavayi presented the state of affairs on air pollution sources and levels in Nairobi City. He raised issues around solid waste management and the pollution caused by different sectors such as industry, transport and energy.

Nairobi has been advancing collective interventions through partnerships and synergies for legislation, planning, monitoring, citizen engagement, and enforcement. Three pillars underpin air quality monitoring programme in Nairobi:

- Steering committee for monitoring
- Ambitious AQ monitoring plans for special areas
- Communication

He highlighted the purpose of Participatory AQ monitoring to include?

- understanding areas that need to be classified as special planning areas
- Contextual approaches for diverse stakeholder needs
- Achieve buy-in of political community on evidence-informed decisions

> " *"Nairobi City is committed to expanding access to air quality data; identifying priority sectors for pollution reduction and increased political buy-in for action. The city also has plans to integrate air quality and climate into city governance structures."*
>
> *Maurice Kavayi*

Technology and data for inclusive advocacy

Dr. Kamkuemah Monika

Aims: How to utilise technology and participatory methods for inclusive advocacy: case study from the City of Cape Town.

- Emphasising air pollution as an environmental and social justice issue
- Youth as the earlier adoptors of technology.
- Case studies of running campaigns using wearable sensors

Technology for Participatory Air Quality Management:

- Importance for promoting PA in cities in terms of criminality, safety
- Use of technology to recruit runners
- Reporting at Different events in Cape Town but also at COP27
1. Showed photos of all the runs including the one where mayor of Cape Town joined

2. Presentation of the interactive data platform with app for geolocation, photos and voice notes
3. Citizens asked for a network of centralized data where they could add their own data added to and submit to some sort of council structure

Challenges

- Accuracy of LCS
- Access and interpretation
- Need for greater collaboration between community and policy stakeholders
- Embrace technology and use it for inclusivity and equity in our cities

"Technology and data can transform the way we approach advocacy, particularly in promoting inclusivity ... It is essential that we embrace technology and data to promote inclusivity and create a more sustainable world."

Dr. Kamkuemah Monika

The Role of Networks

Prof. Mbiake Robert spoke about ANGA introduction of team
Background on AP collaboration and website where people can subscribe and emphasize the benefits of networks in fostering knowledge sharing as the research is not at the same level in Africa – Air pollution knows no border. Reiterated the need to join research networks and the need for establishing contextual linkages between health impacts and air quality data to create health literacy about air pollution. He emphasized the need to evaluate interventions in order to ensure scalability and re-implementation.
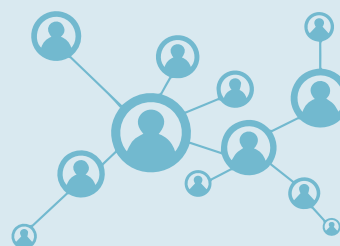
Key Takeaways
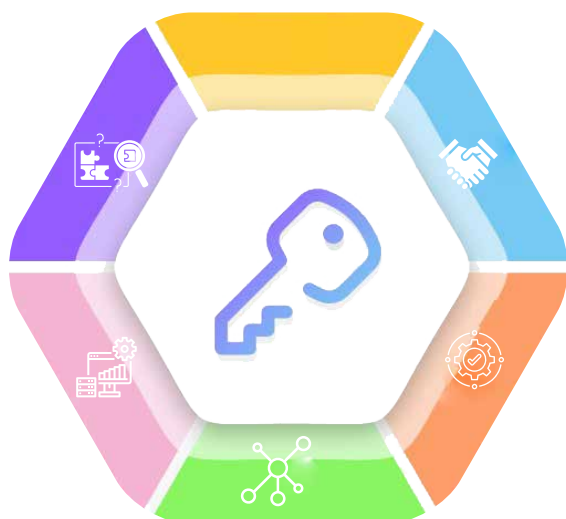
Collaboration
Embracing one-ness across the different sectors and expertise using different stakeholders on their strengths
How do we take care of different competing interests: able understand when to start and complete legislation
Diversity and inclusion (gender, demographics) should be at the centre of participation
Working with existing city authorities

Capacity
There is a lot of potential in the universities, and it is important that they are harnessed

Networks
How do we make networks sustainable: important to sensitise researchers to join the group, convince people for what we are looking for

Technology and data
Effective tool for mobilising different interest groups and bridging the public/citizen-policy interaction. Data drives decisions so important to produce that data!

Research gaps
We need to conduct more air pollution control studies with academics that are leading this effort

Communicating air quality data and information to the public

The panel presented the practicalities on effective ways of communicating and disseminating air quality data to different target audiences including grassroots communities, the media, duty bearers, and research / academic communities among others, based on lived experiences and perspectives on designing effective communication plans, data-driven campaigning, participatory citizen approaches and community-building using available tools and channels. The session was moderated by Christopher Lubega from the U.S Mission Uganda, and was configured around four core objectives:

1. Identify the current gaps and barriers to communicating and disseminating air quality data to different audiences.

2. Determine what kinds of collaborations and partnerships have proved valuable in advancing the fight against air pollution through advocacy, awareness and education

3. Determine how air quality data has been utilized to increase accountability, awareness and evidence-informed actions

4. To explore practical lessons in designing effective air quality communication plans for African cities.

Prof Tolu

"We are all doing different things in our little holes, and not building collaborations. This community of practice is critical to look at how we can better interpret air quality data from different sources" Prof Tolu

Key Highlights

The U.S government commitments to supporting air quality data collection globally while fostering collaborations between the U.S and local governments in Africa

Data from the U.S Embassies facilitating engagement and action

Air quality awareness week has been heavily successful in Kampala through joint stakeholder efforts with the U.S Embassy, AirQo, government entities and other stakeholders in Uganda

Air pollution as an important risk factor for mortality in Africa accounting for 16% of global mortality

There is a need for leveraging health as a strong argument for action

Lack of data being the immediate barrier for communicating data

Primary motivation for communicating: Increase awareness, drive demand for action, demonstrate the impact of intervention

The need for using context and perspectives e.g. the cost of action vs inaction, air pollution vs other health challenges

Air quality data is not yet standardized and there is no integration with routine health data

Understanding the audience and stakeholder mapping is a great tool to segment different audiences

Using contextual data is important to drive the point home when communicating air quality data

Case study of youth advocacy for awareness reaching over 2 million people using digital platforms including social media

Highlighting the role of the media from the beginning through building relationships

The importance of multiple strategies for communicating air quality information to the public to reach different stakeholder segments

Air quality champions can be recruited through existing community structures e.g. local leaders

Low-Cost Sensors (LCS) and Digital Platforms for Air Quality Management in the African Context

The second day of the workshop provided valuable insights into the practical considerations and challenges of developing and deploying low-cost air quality sensors and digital platforms for air quality management in African cities. The sessions covered topics ranging from sensor deployment strategies to data quality assurance, community engagement, and the role of digital platforms in data management and access. The discussions highlighted the importance of collaboration, standardization, and community involvement in ensuring sustainable and effective air quality monitoring initiatives in Africa. Insights from specific sessions are highlighted as follows:

Sustainable air quality monitoring for africa:
low-cost sensors, networks, data and action

The opening plenary sought to provide a comprehensive overview of low cost sensors (LCS) technology and its potential to transform air quality monitoring in Africa, while highlighting the importance of community engagement, data reliability, and policy support for sustainable and impactful solutions.

Objectives of the session including:

1. Introduction to LCS: Design, benefits, and limitations.
2. Large scale sensor deployment strategies and network management.
3. Reliability of LCS data, and the role of standardisation and quality assurance.
4. Impact on local communities: the potential for increased public awareness and engagement for informing policy decisions for improved air quality in African cities

The panel session was expertly moderated by Dr George Mwaniki and Prof. Rebecca Garland, and featured panelists: Prof Engineer Bainomugisha - Lead, AirQo, Dr Rose Alani - Senior Lecturer, University of Lagos, and Prof Albert Presto - Research professor, Carnegie Mellon University. They offered a comprehensive overview of low-cost sensors (LCS) technology, emphasizing its transformative potential for air quality monitoring in Africa. The following key points were highlighted by the panelists.

Key Takeaways

Low-Cost Air Quality Sensors

- LCSs offer cost-effective monitoring solutions, enhancing accessibility to air quality data.

- Your choice of a LCS brand/type should align with your specific monitoring needs. Deployment Considerations include factors such as cost, suitability for local weather conditions, connectivity (whether you have access to WiFi or LoRaWAN e.t.c), ease of use, and other deployment logistics should be carefully considered.

- **Key challenges of using low cost sensors include:**

    - The necessity for ambient collocation sites in a same site you hope to deploy or at least in similar climatic conditions is essential. This is requirement for calibration but reference monitors are scarce.

    - We do not know the lifetime of LCS and how they behave in the course of their lifetime for example low cost NO_2 sensors have a know Ozone interference. Furthermore Ozone depletes the sensor and the decay is non-linear, causing these sensors to stop working abruptly. There is need to understand sensor performance over time.

    - Hopefully in future, LCSs will evolve to measure a wider range of pollutants beyond particulate matter (PM) addressing a broader spectrum of environmental concerns.

Large-Scale Sensor Deployment Strategies and Network Management

- The definition of success in LCS projects should extend beyond short-term deployments and publications. It should include long-term impact in the community, using insights from data to raise public awareness of air pollution, inform policy.

- When designing LCS Networks, Land-use data can inform site selection based on variables like traffic, population density, and neighborhood income (2-4 stratification variables are sufficient). Collaborating with locals is essential for effective network design.

- Preliminary scouting and spot checks before permanent deployment help identify optimal sensor locations and ensure data quality.

- African cities should aim to build local solutions, e.g. increasing LCS production locally can reduce licensing costs.

- Collaboration with stakeholders, grant support, and technology transfer can enhance scalability and sustainability.

- Regular maintenance requires skilled labor and infrastructure for device monitoring and tracking as the network grows. Building local capacity is vital for sustained network upkeep.

- Considering the potential costs of monitoring, hardware alone doesn't contribute significantly. Once the device is installed, the focus shifts to extracting meaningful insights from the collected data. This requires the establishment of a data collection infrastructure, which can involve manual data collection using flash drives or automated methods via wireless networks. The collected data must undergo preprocessing to ensure usability, including calibration.

Key Takeaways

Calibrated datasets are stored and made available for different use cases, e.g. generating insights and presenting these through various visuals, sharing via APIs, developing models e.t.c. It's important to note that the cost of an air quality monitor differs from the expenses associated with data processing infrastructure. In this context, building your own infrastructure tends to be more cost-effective compared to paying for the use of existing infrastructure.

- **Challenges with reference monitors:**
  - Routing data from reference monitors requires network configuration.
  - Cost of replacing parts is higher when compared to low cost monitors
  - They require highly skilled labour.

Reliability of LCS Data

- Co-locate LCS with reference monitors for calibration purposes
- Validate LCS against reference data before deployment.
- Maintain uninterrupted power supply, as power outages can lead to data gaps affecting the quality of results from analyses.

Impact on Local Communities

- Packaging and sharing LCS data with policy makers through reports and visuals empower city planners with valuable insights for informed decision-making.
- Long-term data collection (over years) is crucial for understanding air quality dynamics in over different periods e.g. monthly, weekly, annual trends, e.t.c
- Collaboration with various stakeholders and the incorporation of data into policy-making processes is vital for long term impact
- Its important to note that not all policy decisions are based on scientific evidence, there are other factors that affect decisions of policy makers e.g politics

" *It would be great to see LCSs evolve to measure a wider range of pollutants beyond particulate matter (PM) addressing a broader spectrum of environmental concerns*

Prof. Albert Presto

" *We need to re-define success metrics for monitoring projects to move beyond short-term monitoring, say two weeks, and a publication. We should stretch success to incorporate impact while working with communities and policymakers*

Prof. Bainomugisha

Low-cost network for **smart air quality monitoring** in the african context

The session focused on the practical considerations of establishing and maintaining a smart air quality monitoring network in an African city context, using a large network of LCSs. The session presented a practical case study of participatory sensor placement for a smart network, the practical challenges associated with maintaining a large network of low-cost sensors and optimal strategies for sustained network management.
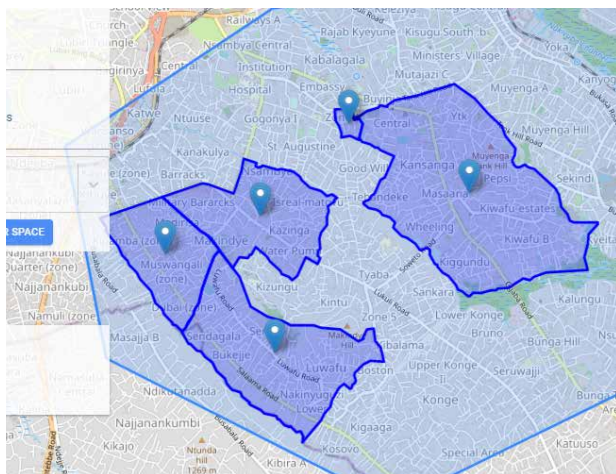
Optimal sensor placement:
The speaker (Deo Okure) presented a practical case study that showcased the implementation of a participatory sensor placement approach for a smart network. The case study highlighted the importance of involving local communities and stakeholders in the sensor placement process to ensure relevant data collection. The presentation emphasized the significance of considering the African context and the unique challenges it presents when designing and deploying action-based air quality networks.

The presentation emphasized the significance of considering the African context and the unique challenges it presents when designing and deploying action-based air quality networks.

Network management: the practical challenges associated with maintaining a large network of low-cost sensors were highlighted. Participants engaged in a lively discussion on the various obstacles encountered, such as sensor calibration, data quality assurance, power supply, and connectivity issues.

> " it is important to engage all the local communities to avoid duplication of efforts
>
> *Gideon Lubisia- International Network Operations Liaison*

> "*Participatory approach is not a substitute for scientific principles but should be guided by the scientific conventions*"
>
> *Deo Okure - Air Quality Scientist & programme Manager, AirQo*

The importance of data validation and quality control measures in ensuring reliable and accurate data was emphasized. Participants shared their experiences and insights on effective maintenance practices, including sensor maintenance schedules, data analysis techniques, and network scalability. The significance of collaboration and knowledge sharing among stakeholders was emphasized as a means to address these challenges collectively.

The discussion further highlighted the importance of leveraging the data obtained from the monitoring network to drive policy changes, raise public awareness, and influence decision-making processes related to air quality management.

In summary, the session established convergence on practical strategies for sustained network deployment and management while highlighting the crucial role of data-driven actions in addressing air quality issues in Africa.

> " *The LCS data is meaningless if it is not reliable... We deploy applications, tools and processes in the management of the network to make the data reliable*
>
> *Quote By Joel Ssematimba, Hardware Engineer.*

Standardising data quality assurance protocols for LCS Network in an African Context. The AirQo experience
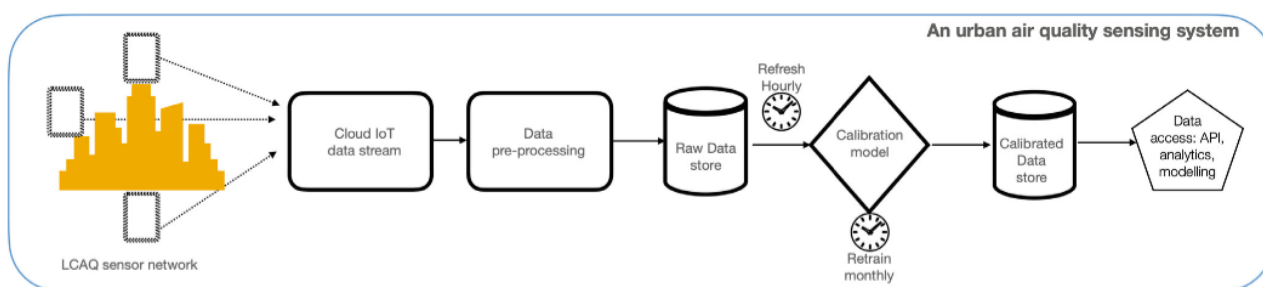
The accuracy of low-cost air quality monitors degrades over time, and can be affected by external factors such as weather changes, i.e. temperature and relative humidity; in addition, low-cost sensors often suffer cross-sensitivities between different ambient pollutants, thereby diminishing their ability to give reliable data. This session provided a holistic view of best practices for quality assurance and applications for large-scale low-cost air quality monitoring networks in urban environments. It was noted that data quality assurance is an important process that focuses on identification and elimination of any data anomalies through data profiling and cleaning. The accuracy of the data that is relayed from the low-cost sensors is paramount for proper decision making by the data consumers.

KEY HIGHLIGHTS AND TAKEAWAYS

Data quality assurance is still a challenge and it requires consolidated efforts from different experts at different stages of the data pipeline

Quality assurance is needed for both the hardware (low-cost sensors) and the software that runs on these sensors. Hardware should function properly through routine and periodic maintenance and the software running on the sensors periodically updated.

The unstable power and internet connectivity affect data completeness, hence the need for innovations that circumvent contextual infrastructural challenges
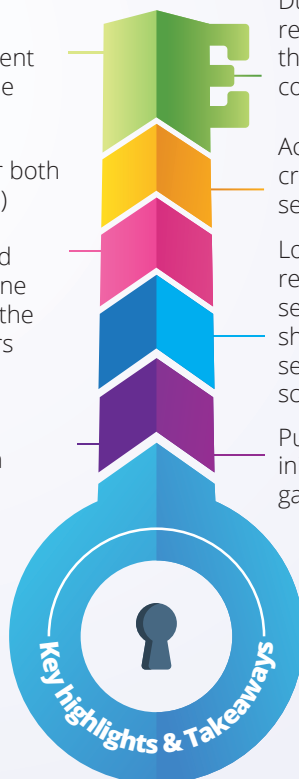
Dual-sensor configuration can reinforce quality assurance through sensor to sensor comparison

Access to reference monitors is critical for supporting low-costs sensor networks.

Localised calibration models reinforces data quality for large sensor networks, but models should be tested against different sensor technologies to support scalability.

Pursing private sector-led initiatives for closing the funding gaps for standard infrastructure

Key highlights & Takeaways

Unpacking the role of custom digital platforms for open data management and sharing

Managing a large network of air quality sensors is complex

AirQo digital platforms during the Africa Climate Summit, Nairobi

Managing a large network of air quality sensors is complex, and there is a need for a robust platform infrastructure for continuous support and management while addressing the associated structural challenges of low-cost sensors.

Ngongang Wandji Danube Kirt and Dorothy Lsoto reiterated the need for Africa-led solutions for tackling air pollution.

The session showcased the AirQo platform, a robust and scalable cloud-native community-aware digital platform for large-scale air quality networks, that attempts to address the data access challenges, with capabilities to become a 'one-stop centre' and regional platform for data access in African cities.

This was preceded by highlighting the contextual data access challenges in African cities, including lack of standardised data formats, complexity in data formats generated by researchers, limited infrastructure for data sharing, variations in the needs and capacity. The audience interacted with the different interfaces of the AirQo platform i.e. web-dashboard and platform, and the mobile application for data access.

There was strong convergence on the need for sustainable funding models for Africa-led initiatives to guarantee stable data pipelines. Pursuing private sector-led initiatives collaborations has the potential to close the funding gaps.

CLEAN-**Air** Network Launch

Multi-disciplinary collaborations for action (lightning talks)

There was a dedicated session on sharing different research and ongoing initiatives by different partners. This was an opportunity to shed light on the multidisciplinarity of air pollution action in different African contexts. The session included presentations from various disciplines and sectors, including public health, the private sector, the social sciences, atmospheric chemistry, civil society, and advocacy, among others,and was led by the East African GEOHealth Hub Uganda. The lightning presentations did not only provide a spotlight for ongoing work but also contributed to setting the tone for the subsequent high-profile deliberations, most especially re-emphasising the need for comprehensive and coordinated efforts from diverse expertise and stakeholder interests. Collaborations have emerged as powerful tools to address the contemporary urban health challenges.

Prof. Lynn Atuyambe, moderating the lightning talks session

Prof. Platas Melina, discussing the nexus of political science and air quality

Experts having a light moment during the CLEAN-Air Launch. L-R, Jovito (Mozambique), Meelan (Mauritius), Monika (Namibia), and Kofi (Ghana)

Integrating air pollution and health data for evidence-based action

Bridging the gap from air pollution sources to health outcomes calls for strengthening the integration of health and air quality data for effective evidence based decision making and planning for urban areas. The 90-min health plenary led by the Health Effects Institute (HEI), was the climax of the 3-day workshop and convened experts representing policy, research, and advocacy from the air quality landscape in Africa. The aim of the panel was to wound up the technical discussions and to build convergence on the core pillars of data-informed and inclusive interventions for better air quality and public health anchored on health considerations in air quality management.

The panel session was configured around the following objectives:

- Highlight the progress made by different African cities on integrating health into air quality decision-making.
- Identify the gaps in integration of air quality and health data for improved city and health planning.
- Define potential pathways, opportunities, and considerations for enabling collaborations for collective and evidence-informed action in African cities.

Prof. Tolu was the session moderator and she highlighted the health risks caused by air pollution on the children and the young population in Africa.

" *Africa is the youngest population in the world but only 6.5% of children reside within 50 km of an air quality monitor....we are always quick to talk about the cost of action due to other competing priorities, but we often forget the cost inaction*

Prof. Tolu. Oni

Commitments and shaping the air quality research agenda for Africa

Professor Barnabas Nawangwe, the Vice Chancellor Makerere University, reaffirmed the role of research in advancing evidence-informed action noting that as a model research-led university in Africa, Makerere University is committed to creating a supportive environment for research entities. This support has spurred high-quality multi-disciplinary research and innovation partnerships for socio-economic transformation of the African continent.

He noted that collaboration between academia, civil society, government, private sector, and development partners will help develop holistic evidence-informed air quality management practices for African Cities. Professor Nawange underscored the importance of embracing research-driven approaches in achieving sustainable improvements in air quality.

" *research plays a critical role in understanding the causes and impacts of some of our social challenges and scientific evidence and data play an important role in informing public education. It is such an honour to see communities of practice coming together to discuss solutions tailored for African cities*

Prof. Nawangwe Barnabas

.

Hon. Erias Lukwago, Lord Mayor Kampala City

> " *As policymakers, we want the air quality data and evidence from the researchers. We understand the data, do not alienate us. We must also involve the population that is impacted by the poor air quality. we are in this together!*

Hon. Erias Lukwago, Lord Mayor Kampala City

The need for political will (Lord Mayor Kampala)

Hon. Erias Lukwago, Lord Mayor attended the launch of the CLEAN-Air Network at Sheraton Kampala, where he highlighted concerns about the city's burgeoning population, that could see half of the country's population residing within the Greater Kampala metropolitan area by 2050, leading to heightened environmental pressures which necessitates proactive planning. The Lord Mayor stressed the importance of policymakers having access to air quality data and research evidence, urging for collaborative efforts and wide dissemination of data to combat air pollution inclusively. He emphasized the need for available data to be accessible to the public, and he advocated for Kampala's initiatives like the Climate Change Action Plan, Green Infrastructure Ordinance, and the Urban Forest Establishment Project to curb pollution.

The mayor's remarks underscored the significance of political will and the importance of CLEAN-Air Africa Network as a platform to amplify the African perspective in the international arena and project the uniqueness of African circumstances in the fight against air pollution.

Descision makers from Kampala interacting with air quality data during the inaugural car-free day ahead of the CLEAN-Air meeting

International collaborations

The U.S Embassy in Kampala represented by Cultural Affairs Officer Amy Petersen officiated the launch of the network and re-echoed commitments by the U.S. Department of State on supporting the air quality agenda in African countries. The U.S. State Department and the U.S. Environmental Protection Agency continue to champion air quality monitoring in African cities through local diplomatic posts, and this has provided continuous datasets, including in cities where air quality monitoring is non-existent. Access to the data have fostered collaborations between African scientists and the U.S scientific community and contributed to capacity building on a range of air quality issues. Uganda is a typical case study that has seen air quality action develop within the last five years from no data to prioritizing air quality at the highest level of governance. The success of Uganda has been driven by international collaborations, and could be replicated in other African countries.

She further highlighted four scalable collaboration areas with the U.S Mission, in part inspired by the collaboration efforts in Uganda:

- **Increasing data access:** Data from over fifteen cities in Africa will continue to be available to support awareness to drive action. Monitoring installations in Kampala and Nairobi are already being used as collocation sites for low-cost sensors and discussions are already underway to have similar infrastructure extended to other African cities including Lagos and Accra

- **Periodic awareness campaigns:** especially during the annual Air Quality Awareness Week, with the aim to disseminate vital information about air quality and promote personal responsibility in reducing air pollution. The awareness campaign has the potential to reach significant number of influential individuals in African cities, and in the case of Uganda, over three million in the last 3 campaigns. Awareness week is a strong collaboration opportunity for the different U.S Mission across Africa

- **Targeted community-led engagement based on the city-specific priorities.** The Ambassador highlighted the ongoing collaborations with AirQo that focus on the transport sector by delivering tailored capacity training for informal automobile technicians to empower them to be ambassadors for attitude and mindset shift towards green mobility, e.g. advocating for better maintenance practices.

- **Targeted institutional support:** the U.S. Mission has also supported capacity development on air quality by leveraging the science fellowship program. In particular, providing direct support to NEMA and the air quality community to develop the first-ever air quality regulations in Uganda, working with KCCA to develop a city-wide emissions inventory, and continuing to provide linkages to the U.S. experts and universities

The Ambassador also launched the AirQo mobile application – the first of its kind in Africa – that provides the public with timely access to air quality information across Africa

Ms Amy Petersen - Cultural Affairs Officer at the American Embassy

> " *Our focus will remain on supporting capacity enhancement for air quality management in various African cities. We are confident that this will be the turning point for air quality in Africa*

Ms Amy Petersen - Cultural Affairs Officer at the American Embassy

The Kampala **CLEAN-Air Plan** for Africa: Summary

Deliberations during the 3-day engagement set-in motion the agenda and the roadmap for the CLEAN-Air plan for Africa

The CLEAN-Air Network

Participation	Roles
Implementing partners	Implementing partners have active interest in air quality work in Africa, have personnel with primary roles on air quality, organize and host activities, participate in CLEAN-Air Network annual meetings and may provide logistical/or funding support to members.
Policy forum	The policy forum provides a platform for engagement for African cities and national governments interested in developing and implementing an air quality management program. The forum includes cities and national governments in Africa interested in developing and implementing an air quality management programme.
Private sector forum	The private sector forum is a platform for engagement with the private sector players interested in contributing to advancing the air quality agenda. Private sector includes regulated industries, commercial media houses, and any private sector entity operating in Africa
Supporting partners	Supporting Partners provide logistical and/or funding support to network members, and may participate in the annual CLEAN-Air Network meetings.
Individuals	Individuals actively involved in air quality work in Africa can join the network as air quality champions

The CLEAN-Air plan for Africa is configured on the following core goals

GOAL 1: Improving the capacity in air quality monitoring, modeling, and data management and access through scaling up of ongoing localized initiatives.

GOAL 2: Expand the understanding, awareness, and appreciation of air quality issues through evidence-informed and participatory advocacy approaches and knowledge sharing for better health outcomes

GOAL 3: Build clean air solutions and frameworks for African cities to support dutybearers on developing and implementing tailored interventions

## These goals will be delivered through the following specific objectives

Objective 1: Strengthen cross-regional air quality networks to enable collective learning, and knowledge sharing.

Objective 2: Increase air quality data access through contextualised low-cost air quality monitoring approaches, data management tools, and modelling.

Objective 3: Co-develop activities to advance participatory, inclusive, and evidence-informed advocacy for improved collaboration, awareness, and education on air quality issues.

Objective 4: Develop targeted city clean air solutions, including templates of clean air action plans for cities, sector-specific clean air toolkits, awareness frameworks, institutional capacity building to facilitate mainstreaming and institutionalising air quality management.

Partnership commitments and initiatives
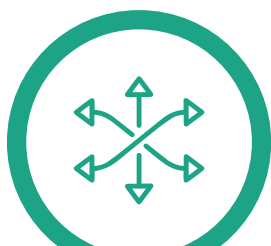
Strengthen cross-regional air quality networks to enable collective learning, and knowledge sharing

1. Peer learning visits and CLEAN-Air annual convenings
2. Stakeholder mapping and analysis across African cities
3. City-focused and targeted capacity training workshops for stakeholders
4. Periodic knowledge sharing through dedicated meetings e.g webinars
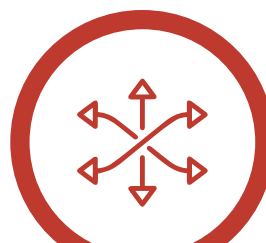
Increase air quality data access through contextualised low-cost air quality monitoring approaches, data management tools, and modelling

1. Identifying and consolidating existing data points
2. Defining the monitoring needs for cities through collaborative mapping of areas of interest
3. Scale up localised calibration models for African cities through collaborative collocation e.g. using reference monitors at the U.S Missions across Africa
4. Increasing data infrastructure in various African countries using low-cost sensors
5. Developing, localising and deploying customisable digital platforms to facilitate engagement e.g. mobile App, websites, including facilitation of localised access using API interfaces
6. Developing spatial and forecasting models for cities
7. Digital platforms e.g. mobile App, and web platforms localized to city needs
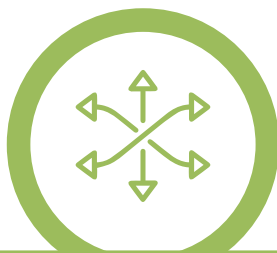
Co-develop activities to advance participatory, inclusive, and evidence-informed advocacy for improved collaboration, awareness, and education on air quality issues.

1. Data and technology youth engagement for increased awareness, capacity and advocacy
2. Targeted awareness campaigns: e.g the annual air quality awareness week
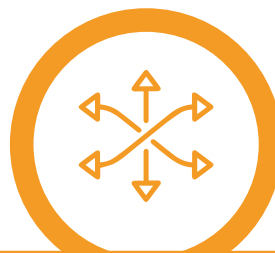
Develop targeted city clean air solutions (templates of clean air action plans for cities, sector-specific clean air toolkits, awareness frameworks, institutional capacity building, and frameworks) to facilitate mainstreaming and institutionalising air quality management

1. Developing and delivering contextualized AQ management toolkits
2. Supporting cities to develop policy outputs e.g. National state of the environment reports, city air quality action plans, etc.
3. Capacity building on air quality and health data integration