Advances in adapting low-cost sensors for sustainable air quality monitoring and evidence-informed action in African cities: Scalable experiences from AirQo

Deo Okure, Gideon Lubisa, AirQo | Makerere University

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About AirQo

Founded in 2015 at Makerere University, to close the gaps in air quality management in Uganda and across Sub-Saharan Africa through leveraging technology innovation to influence action through contextual evidence

Vision

Clean air in all African Cities

Mission

To collect, analyse and forecast air quality data to international standards and work with partners to reduce air pollution and raise awareness of its effects in African cities.

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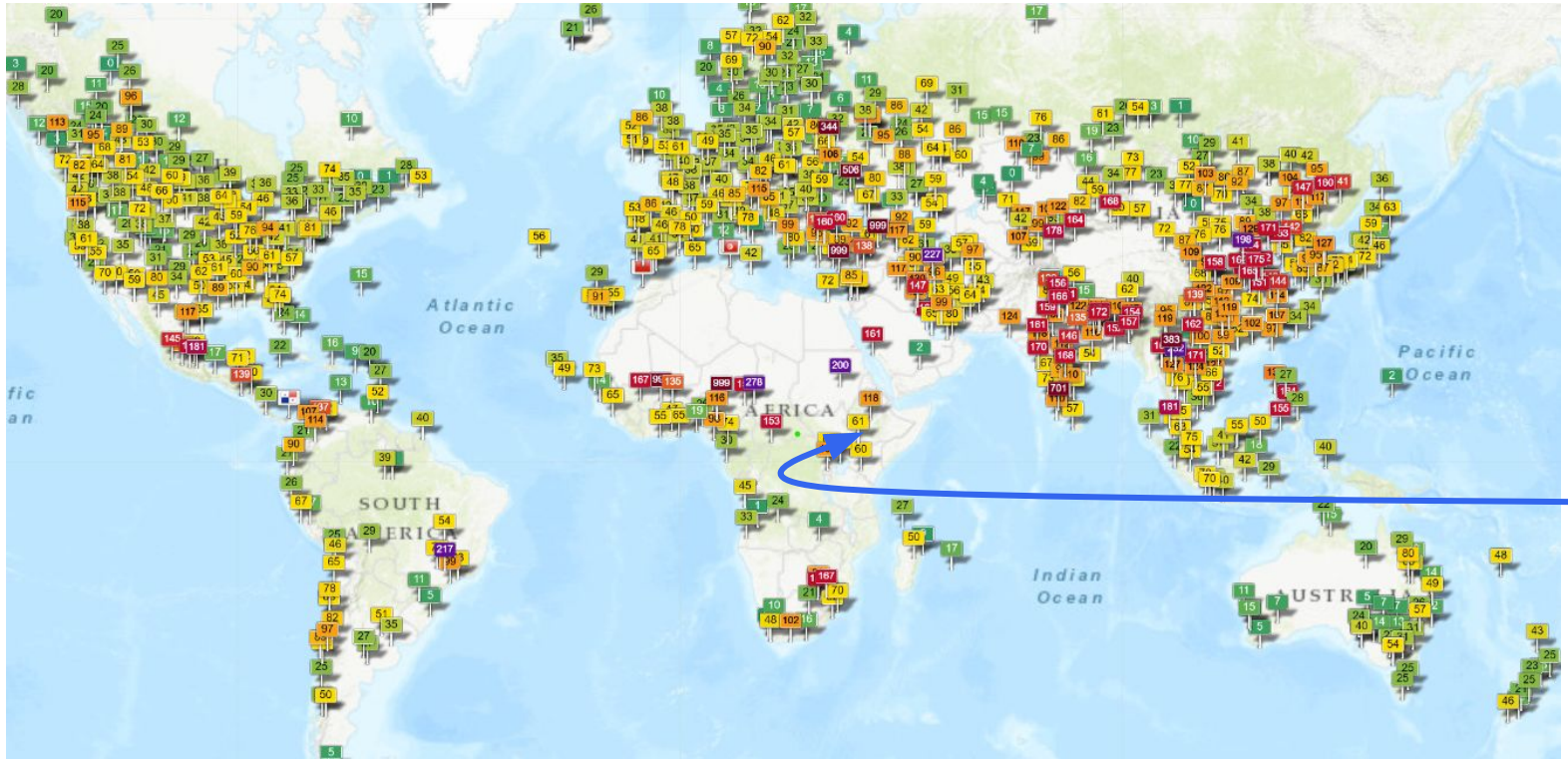
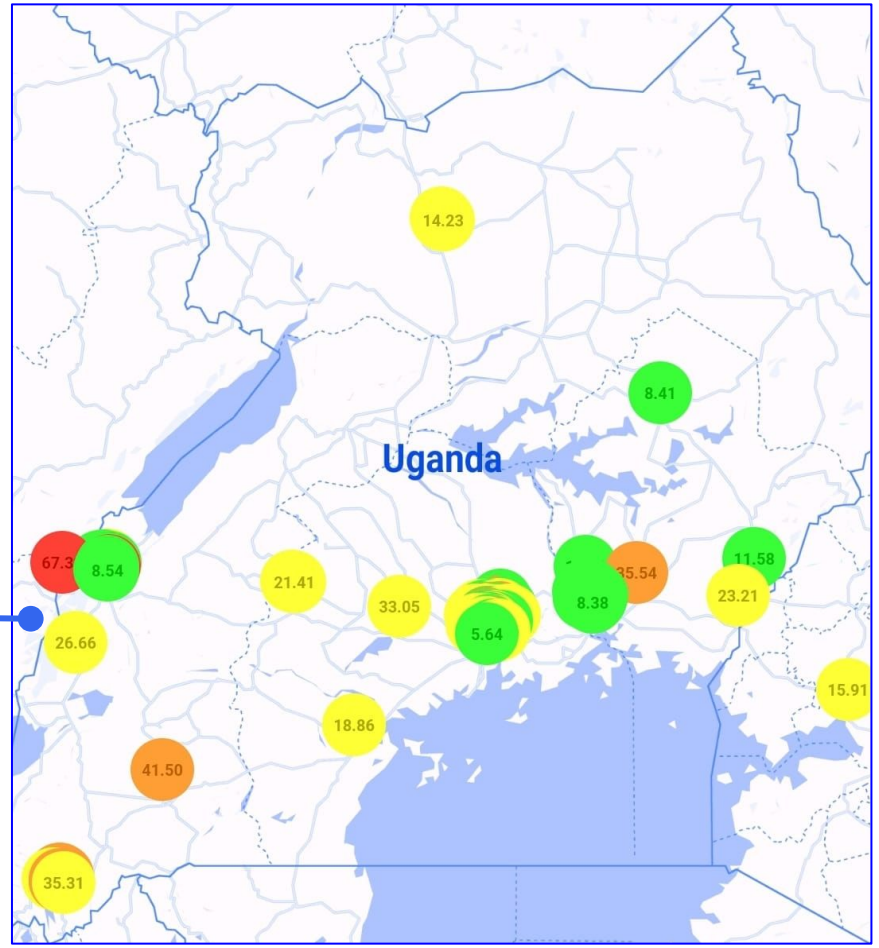
Low-cost sensors are helping close the air quality data gaps in African cities



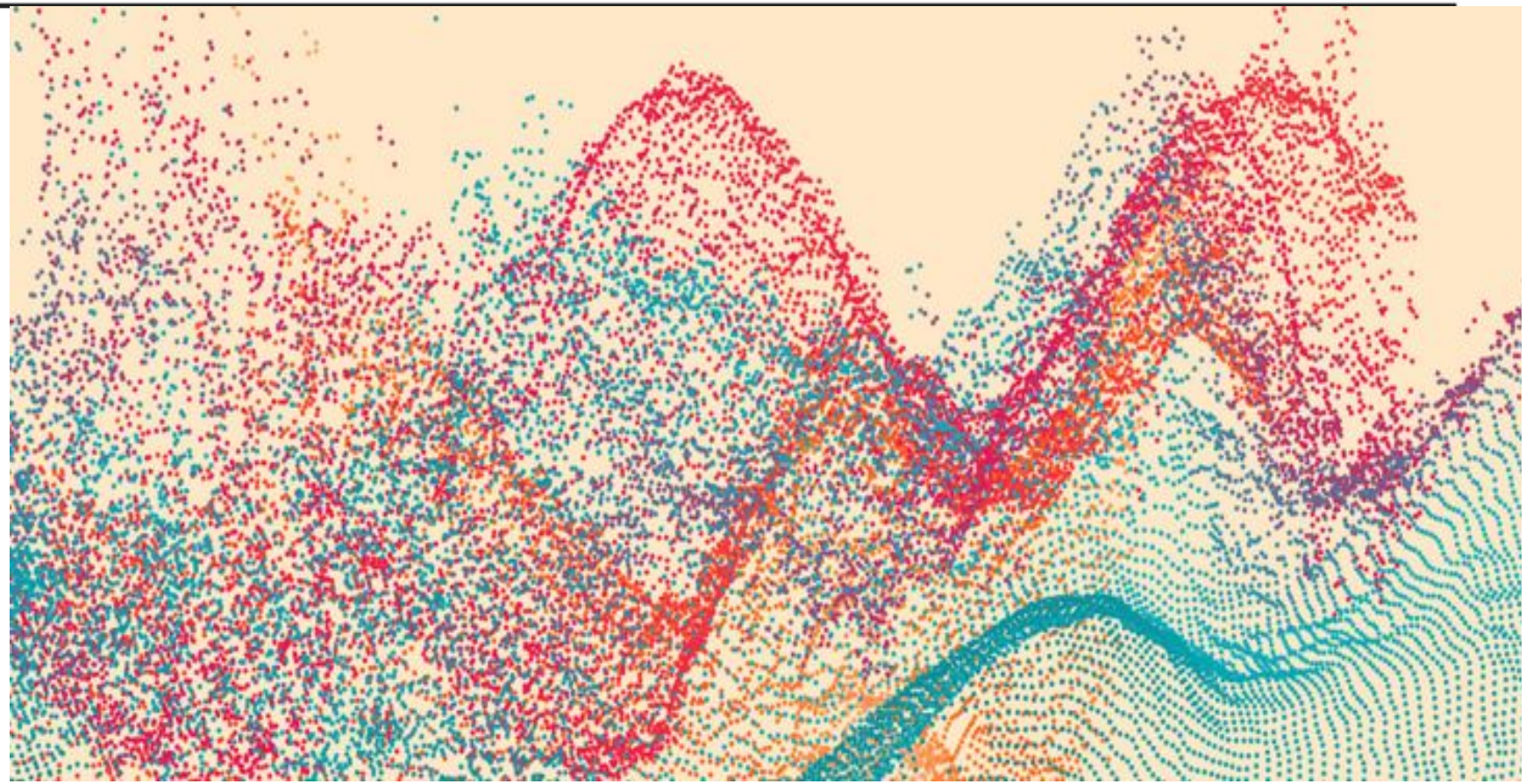
Source:www.waqi.info *(March. 26, 2023: 13:40 EAT)*



www.platform.airqo.net *(March. 26, 2023: 13:40 EAT)*

STEADY GROWTH in AQ data in Africa:

- Low-cost approaches and innovation can close the existing gaps in African cities
- Increasing depth and breadth
- Contextual protocols using existing networks
-
- Integration of data for action



Transition from ‘elaborate’ to portable

What makes it low-cost?

- Purchase cost threshold
  - $100-$2,500 (Jiao et al, 2016; Borrego et al., 2018; Karagulian, 2019; US-EPA, 2020, etc.) vs $30,000 for a single pollutant
  - Limits resolution
- Installation and maintenance
- Data retrieval/access
- Logistics of security and site access

Can LCS be adapted for sustainable smart air quality monitoring in African cities?

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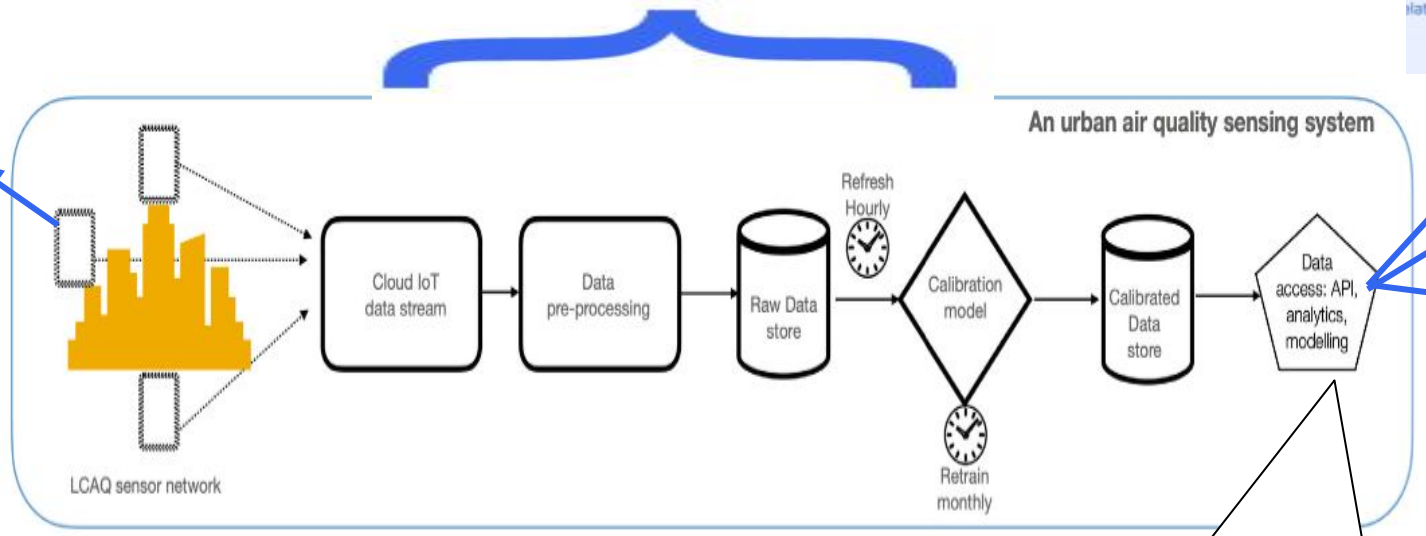
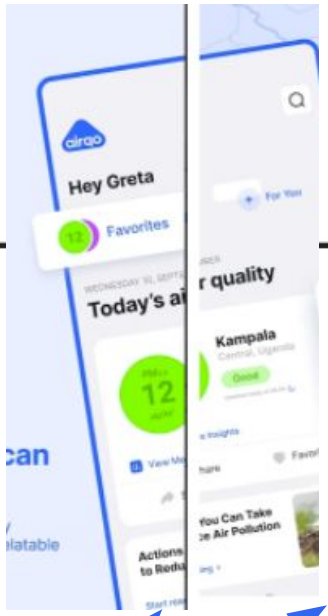
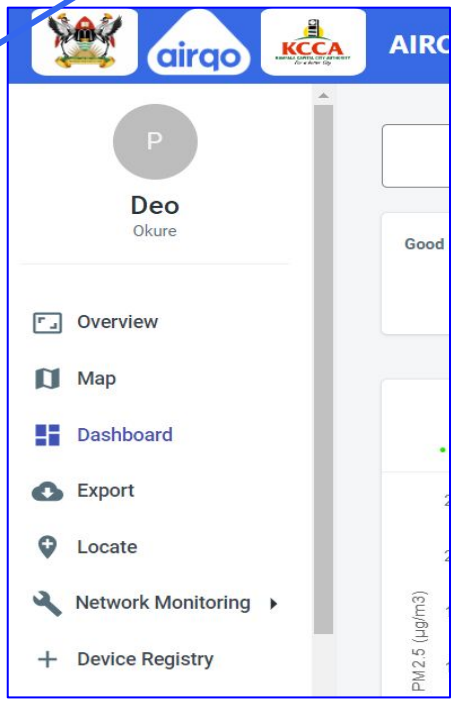
Data Sharing:

Advances from AirQo

- Robust cloud-based infrastructure built for data quality assurance using Machine Learning techniques
- ML prediction models







- Over 160+ locally developed devices deployed across Africa
- Flexible power and data access configurations

- Custom built digital platforms for data access
- Programmatic data access through the API

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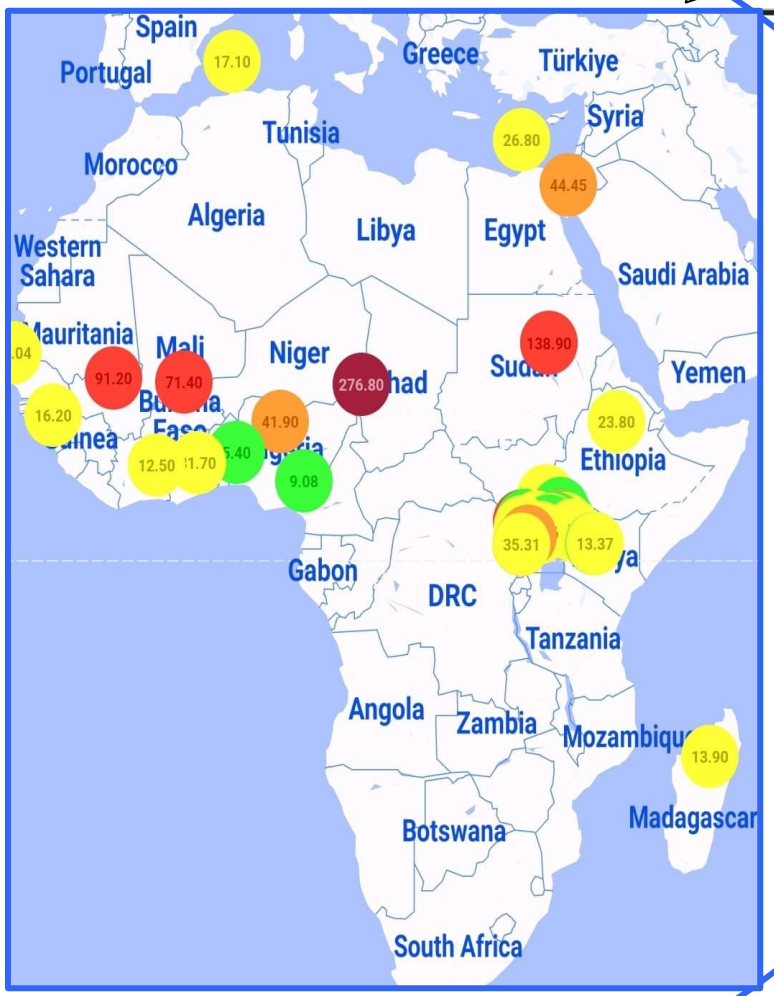
Enabling access through through custom digital platforms and API

Progressively deploying scalable smart networks across Africa

- Uganda
- Kenya
- Cameroon
- Burundi
- Nigeria
- Ghana
- Senegal
- Mozambique
- South Africa



What are the effective avenues for utilising data and novel evidence for (progressive) evidence-informed actions?

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Collaboration synergies as enablers for action

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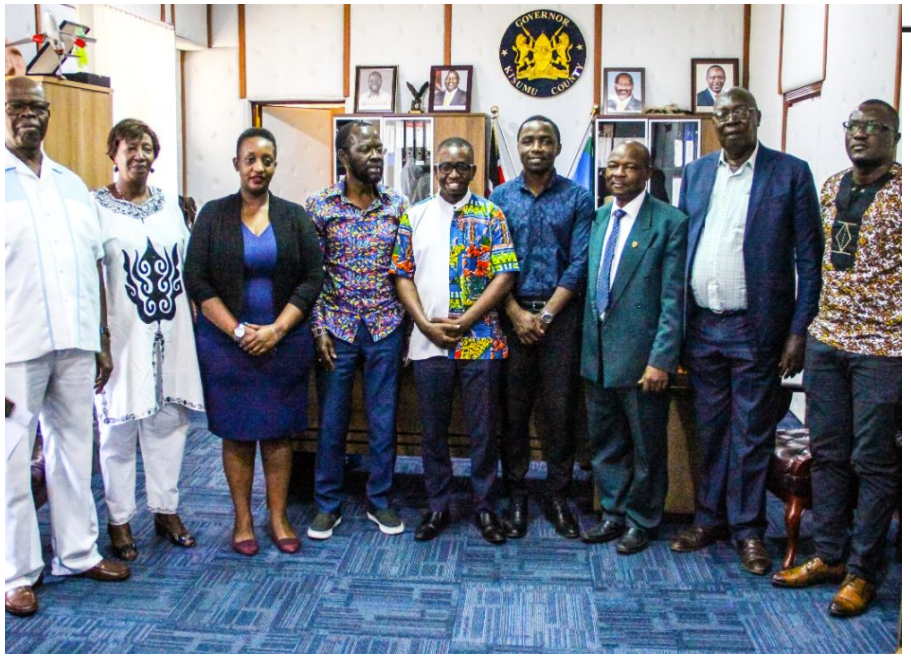


Inclusive and multi-stakeholder approach to building collaborations

- Air quality as a multi-sectoral issue
- Recognising the uniqueness in every collaboration

Contextual data for capacity enhancement

400+

government officials trained on data access

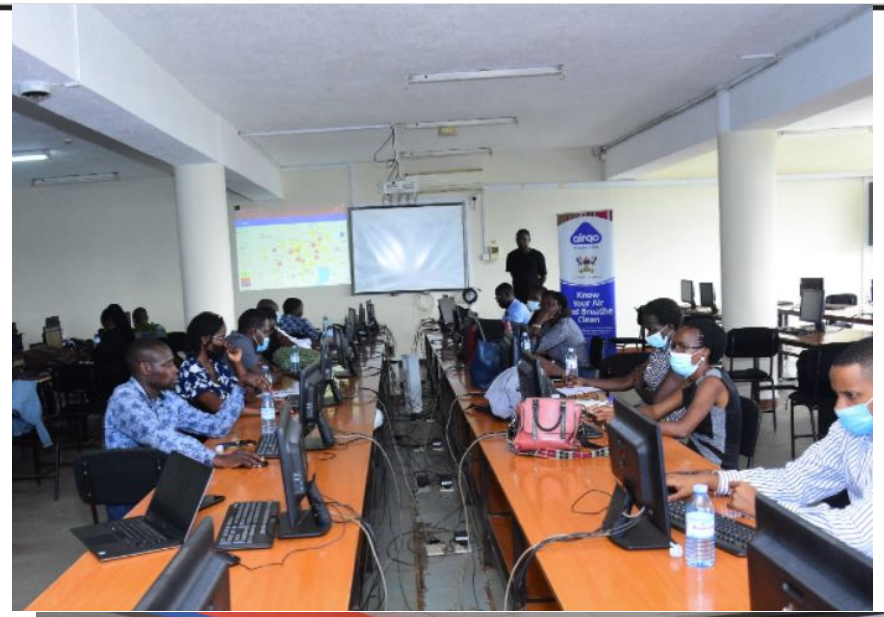
2000+

students and teachers engaged through the science, technology, engineering, and math programme (STEM)

500+

young data scientists across Africa empowered with skills in real air quality datasets and creating data solutions relevant to the African context.

8+ Policy outputs and initiatives



Deo Okure @OkureDo · Dec 21, 2022

Two weeks since our last class with this year's cohort of the @NelsonInstitute Capstone. It was fulfilling to see students appreciate the data management landscape through the @AirQoProject platform. Thanks to @uwmadisonafrica, @Priscillaa_says, @Baalmart . Outputs coming soon!

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Layer.ai Air Quality Prediction Challenge

Can you use Sentinel 5P data to predict air quality in Kampala for AirQo?

Prize $3 000 USD · Time Ended 5 months ago · Participants 236 active · 623 enrolled · Helping Uganda

Good for beginners · Prediction · Safety

Info Data Discussions Leaderboard

Competition Leaderboard

This is the final leaderboard. The competition is officially closed and will not accept any more submissions. Congratulations to all that participated, points were distributed on 20 October 2022.

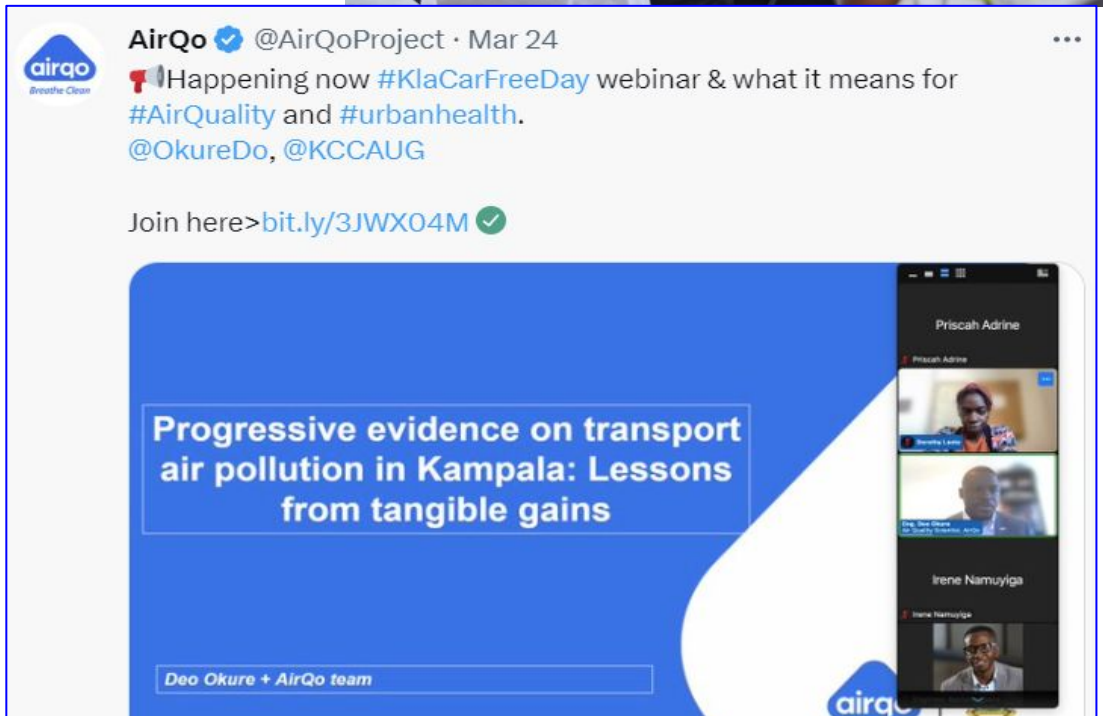
RANK USER PUBLIC SCORE PRIVATE SCORE LAST SUBMISSION

Targeted awareness and inclusive advocacy

Over 500,000+

citizens engaged and educated about air quality and air pollution through our digital platforms

- Different avenues for targeted awareness
- There is need for continuous dialogue



Kampala car-free day: mainstreaming urban health policy initiatives

Reflection: Defining the future of air quality management

STOCK TAKE: 20 years of AQ management in Africa

What AQ management strategies have been (*being*) implemented in Africa for the past 20 years?

Technology	75%
Policy	20%
Education/ Behavioural change	5%

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Review article

Air quality management strategies in Africa: A scoping review of the content, context, co-benefits and unintended consequences

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ABSTRACT

One of the major consequences of Africa's rapid urbanisation is the worsening air pollution, especially in u centres. However, existing societal challenges such as recovery from the COVID-19 pandemic, poverty, i sifying effects of climate change are making prioritisation of addressing air pollution harder.

We undertook a scoping review of strategies developed and/or implemented in Africa to provide a repos to stakeholders as a reference that could be applied for various local contexts. The review includes strat assessed for effectiveness in improving air quality and/or health outcomes, co-benefits of the strategies, pot collaborators, and pitfalls.

An international multidisciplinary team convened to develop well-considered research themes and scope a contextual lens relevant to the African continent. From the initial 18,684 search returns, additional 43 re through reference chaining, contacting topic experts and policy makers, 65 studies and reports were includ final analysis.

Three main strategy categories obtained from the review included technology (75%), policy (20%) an

Gabriel Okello, Rebecca Nantanda, Babatunde Awokola, Meelan Thondoo, Deo Okure, Lambed Tatah, Engineer Bainomugisha, Tolu Oni (2023), Air quality management strategies in Africa: A scoping review of the content, context, co-benefits and unintended consequences, Environment International,Volume 171, 2023, 107709, ISSN 0160-4120,

Selected References

1. Bainomugisha, E., Ssematimba, J. and Okure, D., 2023. Design Considerations for a Distributed Low-Cost Air Quality Sensing System for Urban Environments in Low-Resource Settings. *Atmosphere*, *14*(2), p.354.

2. Okello, G., Nantanda, R., Awokola, B., Thondoo, M., Okure, D., Tatah, L., Bainomugisha, E. and Oni, T., 2022. Air quality management strategies in Africa: A scoping review of the content, context, co-benefits and unintended consequences. *Environment International*, p.107709.

3. Adong, P., Bainomugisha, E., Okure, D. and Sserunjogi, R., 2022. Applying machine learning for large scale field calibration of low-cost PM2. 5 and PM10 air pollution sensors. Applied AI Letters, p.e76.

4. E. S. Coker, A.K. Amegah, E. Mwebaze, J. Ssematimba, E. Bainomugisha (2021). *A land use regression model using machine learning and locally developed low cost particulate matter sensors in Uganda*, in Elsevier Journal of Environmental Research, Volume 199, 2021,111352, ISSN 0013-9351, https://doi.org/10.1016/j.envres.2021.111352.

5. Green, P., Okure, D., Adong, P., Sserunjogi, R. and Bainomugisha, E., 2022. *Exploring PM2. 5 variations from a low-cost sensor network in Greater Kampala, during COVID-19 imposed lockdown restrictions: Lessons for policy*. *Clean Air* Journal, 32(1).

6. Okure, D.; Ssematimba J.; Sserunjogi, R.; Lozano-Gracia, N.; Soppelsa, M. E; Bainomugisha, E. (2022). *Characterization of Ambient Air Quality in Selected Urban Areas in Uganda Using Low-Cost Sensing and Measurement Technologies*. Environmental Science & Technology. ACS. 0.1021/acs.est.1c01443

7. Okure, D.; Bainomugisha, E.; Lozano-Gracia, N.; Soppelsa, M. E.. (2021). *Characterization of Ambient Air Quality in Selected Urban Areas in Uganda : A Low-Cost Approach*. Policy Research Working Paper;No. 9512. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/35035 License: CC BY 3.0

8. Sserunjogi, R., Ssematimba, J., Okure, D., Ogenrwot, D., Adong, P., Muyama, L., Nsimbe, N., Bbaale, M. and Bainomugisha, E., 2022. Seeing the air in detail: hyperlocal air quality dataset collected from spatially distributed AirQo network. Data in Brief, p.108512.

9. World Bank. (2020). *Pollution Management and the Making of Prosperous Cities*. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/34643 License: CC

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