Commentary
Clean Air COMPASS: An affordable, scalable solution for air quality data management

Gerphas K Opondo[1], Christine Hagerbaumer[2], Nathan R Pavlovic[3], Russell O Biggs[2], Khurshed Alimov[4], Glynda Bathan-Baterina[5], Carlo Bontia[5], Samara Carbone[6], Jennifer L DeWinter[3], Sebastian C Diez[6], Sarah Elkotbeid[7], Dang Espita-Casanova[5], Elizabeth Friedman[8], Everlyn Gayle Tamayo[5], Ikromjon A Mamadov[4], Beto Lugo Martinez[8], Matthew S Tejada[7]

[1]Environmental Compliance Institute , Karen, Nairobi, Kenya
[2]OpenAQ, Washington, DC, USA
[3]Sonoma Tech, Petaluma, CA, USA
[4]Youth Group on Protection of the Environment, Khujand, Tajikistan
[5]Clean Air Asia, Pasig City, Philippines
[6]Allin-Wayra, an International Global Atmospheric Chemistry project - c/o Universidad Del Desarrollo, Las Condes Santiago, Chile
[7]Natural Resources Defense Council, Washington, DC, USA
[8]Science and Community Action Network, c/o Social and Environmental Entrepreneurs, Calabasas, CA, USA

https://doi.org/10.17159/caj/2026/36/1.27331

Across Africa, national and sub-national governments, community-based organisations, and research institutions are responding to the critical need for air quality data–a prerequisite for targeted, evidence-based clean air policy action–by setting up monitoring networks. However, the data generated by these monitoring networks isn't magically ready for analysis and action. Projects need what's called a Data Management System (DMS), the software that handles behind-the-scenes functions, such as data ingestion, aggregation, harmonisation, storage, quality control, validation, sharing, and more, to enable interpretation and application of the data for various use cases. Data management is time- and resource-intensive, requiring air quality, software development, information systems, and operations skills.

Currently, there are two data management options for organisations that measure air pollution: (1) purchase a commercial, proprietary system or (2) develop a bespoke DMS. Each option comes with benefits and limitations that organisations must weigh in order to choose what would fit best for their needs.

Proprietary systems (typically a commercial, subscription-based model where clients are charged a fee regularly) work well for organisations that do not have the time or technical know-how to build their own DMS. Proprietary DMS often come with complementary capabilities that support better user experience, for example, regular and secure software updates. In addition, they come with the benefit of higher optimisation, tuning and testing during development and before market launch. However, proprietary systems have limitations:

- They can be expensive and may deny access to the data once the subscription has run out.
- The methodology behind data quality control or other aspects of data management may be a "black box," therefore unknown.
- They are rigid in most instances and may or may not be customisable by users. When run by the instrument manufacturer, the DMS may be unable to incorporate data from instruments produced by others, thus not able to serve projects using heterogenous instruments. Dr. Collins Gameli Hodoli from Clean Air One Atmosphere in Ghana shared how analysing data from different sources in varying formats has posed an issue for his organisation, saying: ''It has been challenging to develop scripts for varying data formats from varying instruments. One, we have to make sure that all measurement rows and columns, regardless of source, map properly; next, we have to ensure that when two channels are reporting the same measurement, we average them.''
- They may be overly controlling of the data. For example, if the system is run by a manufacturer who claims ownership of the data, the organisation may not be able to share the data beyond project confines. In such cases, the data can't be used for broader purposes, such as air quality forecasting and multi-region public health analyses.

An organisation may, instead, choose to custom-build their DMS. This works well for organisations that have in-house technical expertise and the time needed to develop the DMS or the financial capacity to pay a consulting firm., but not for less-resourced organisations. Without technical know-how, organisations may under- or over-build their DMS. Moreover,

© 2026. The Author(s). Published under a Creative Commons Attribution Licence.

it is inefficient for organisations to 'reinvent the wheel' by developing their own DMSs.

As projects using air sensors to measure air quality have multiplied across the world, philanthropies funding these projects have come to recognise these challenges. They find themselves funding duplicative work in the case of custom-built DMSs, or supporting expensive proprietary systems that limit the data's value in certain other cases. One of these foundations, the Clean Air Fund, posited that making a basic customisable DMS available could help overcome duplication of effort, runaway costs, systems that are not built-for-purpose, and constrained data sharing (Manogaran, Dye & Schwantes, 2023).

The Clean Air Fund commissioned a scoping study in 2023 to test this assumption and to develop recommendations for how to proceed. This study conducted a needs assessment, confirming the value of developing a global, easy-to-use, customisable open-source[1] DMS solution and recommending that it be built with extensive input from a global community of practice (Dye, 2023). Nearly 70% of organisations surveyed said they urgently need a DMS (Dye, 2023).

The study recommended a basic DMS that includes the following core features:

- Be open-source, i.e., the source code running the software be available for free to anyone who would like to view, copy, learn from, alter, or share the code.
- Conduct data aggregation and harmonization, i.e., an automated ability to ingest data from different sources (air sensors, reference monitoring stations, and third-party APIs) and harmonise the data so that it can be easily compared and used and be interoperable with other data sets and platforms.
- Incorporate metadata, i.e., the information that contextualises the data.
- Ensure data security, i.e., the ability to securely store and manage the data on local servers ("on-prem") or in cloud environments.
- Conduct quality assurance and control (QA/QC), i.e. methods to validate and improve the accuracy of the data.
- Include basic visualisation tools, e.g., maps, time series charts.
- Include the option to share the data through public data portals and/or open API access.

When available, the open-source DMS is expected to:

- Reduce duplication of efforts, saving time and money.
- Remove barriers related to licensing fees, proprietary systems, and technical capabilities, making sophisticated data management available to resource-limited organisations and communities.
- Be scalable, supporting single-site community projects to nationwide monitoring networks.
- Enable accessible development and enhancement of advanced data capabilities for visualisation, analysis, quality assurance, sharing and communication, and decision-making.
- Facilitate greater data consistency and coordination among data producers.
- Foster collaboration by providing a shared, transparent foundation for diverse stakeholders to contribute.
- Empower more actors to effectively use air quality data, leading to a more comprehensive and impactful efforts to clean the air.

Based on responses to a Request for Expressions of Interest, the Clean Air Fund chose and has provided initial funding to a small team of organisations to lead development of the open-source DMS (Clean Air Fund, 2024). These organisations: Natural Resource Defense Council, OpenAQ, and Sonoma Technology, are U.S.-based organisations with international scopes and/or experience.

The Clean Air COMPASS project was launched in December 2024 by the project leads, whose first task was to engage a Community of Practice for Air Quality Systems (COMPASS), a network of core partners representing different geographies and data expertise with established credibility to secure the stakeholder feedback needed to build an open-source DMS. Core COMPASS members include: Allin-Wayra, Clean Air Asia, Environmental Compliance Institute, Science and Community Action Network (SciCAN), and Youth Group on Protection of the Environment (YGPE). Additional stakeholders and thought partners are engaged to support the project by providing feedback, and spreading awareness.

The project has so far surveyed the state of existing systems, conducted stakeholder outreach to inform the design of the DMS, developed a system design plan, and developed the DMS prototype with piloting of the prototype happening from January to September 2026. The DMS prototype ensures reliable ingestion, robust quality control, flexible storage, accessible APIs, multilingual and actionable visualisations, and long-term sustainability.

By the end of 2026, the project aims to have successfully piloted and refined the prototype through continued stakeholder engagement and feedback. The team will actively share lessons learned and project outcomes through conferences, publications, and other knowledge-sharing platforms to promote wider awareness and uptake. A stable open-source version of the DMS will be released, accompanied by comprehensive deployment guides, training materials, and

[1]Open-source means that the source code (the code that runs a software program) is available for free to anyone who would like to view, copy, learn from, alter, or share the code.

© 2026. The Author(s). Published under a Creative Commons Attribution Licence.

user support resources to facilitate adoption. In parallel, efforts will focus on securing funding for the project's third year and establishing a long-term sustainability strategy to ensure its continued development, maintenance, and impact.

From 2027 onward, the project will focus on expanding adoption and long-term impact by increasing awareness of the DMS among potential users and stakeholders. Efforts will be directed toward building strong partnerships and fostering active user communities that can support knowledge exchange, collaboration, and continuous improvement of the platform. Interested entities and individuals may get involved or participate in the initiative in different ways, as outlined on the Clean Air COMPASS Website. The project team will maintain and enhance the software, provide ongoing user support, and refine the system based on feedback and emerging needs. Additional features and tools will also be developed to complement the core DMS, expanding its functionality and enabling a broader range of users and organizations to leverage the data for decision-making, research, and public benefit.

Across Africa and beyond, organisations new to air quality monitoring will soon have access to a new resource to cut their data management costs. Instead of spending precious resources reinventing the data management wheel, organisations will be able to focus on analysing and using the data to improve air quality, ultimately saving lives through cleaner air.

An earlier version of this paper was presented at the CLEAN-Air Forum, held in Nairobi (Kenya) in July 2025 and was published in its Proceedings.

References

Clean Air Fund (2024) 'Establishing a global, open-source Data Management System for Air Quality", Clean Air Fund, June. Available at: https://www.cleanairfund.org/wp-content/uploads/Clean-Air-Fund-Open-DMS-EOI.pdf (Accessed: 6 January 2025).

Dye, T. (2023) 'Air Quality Data Management Systems Report our on: Needs Assessment, Ideal Data Management System (People & Software), Next Steps,' Clean Air Fund, [PowerPoint presentation] 6 September. Available at: https://s40026.pcdn.co/wp-content/uploads/Open-DMS-Outcomes-recommendations.pdf (Accessed: 6 January 2025).

Manogaran, S., Dye, T., Schwantes, S. (2023) 'Data management systems: Vital infrastructure needed to inform action on air quality', 20 December. Available at: https://www.cleanairfund.org/news-item/data-management-systems (Accessed: 6 January 2025).

© 2026. The Author(s). Published under a Creative Commons Attribution Licence.