Regular checks needed to improve air quality sensor efficiency

Low-cost sensors are sensitive to meteorological conditions and pollutant composition

For Immediate Release

Bengaluru, 23 April 2026

While low-cost air quality sensors offer an affordable and promising way to expand pollution monitoring in developing countries such as India, their readings vary widely unless properly calibrated for local conditions. Bengaluru-based think tank the Center for Study of Science, Technology and Policy's (CSTEP's) latest report, *Performance Evaluation of Multi-pollutant Air Quality Sensors at Indi-SET, Bengaluru, India – First Edition; A Short- and Medium-Term Evaluation*, brings this to the fore.

The report discusses how to improve the testing, calibration, and maintenance of air quality sensors before deploying them. The findings come from an extensive evaluation of 48 multi-pollutant sensor devices from different manufacturers at the India Air Quality Sensor Evaluation (Indi-SET) Facility at CSTEP's Air Quality Lab. The sensors were placed next to a reference monitor and observed for up to 8 months to check their durability and reliability. As part of the study, readings were taken for particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen dioxide, ozone, and carbon monoxide.

During the evaluation, differences in pollutant concentration readings were observed not only between manufacturers but also among devices from the same manufacturer. In some cases, sensors showed inconsistent or faulty readings over time, reinforcing concerns about long-term reliability.

To address these challenges, the study developed locally tailored correction methods that significantly improved sensor performance. This especially held true for key pollutants such as nitrogen dioxide and ozone. Given this, the study recommends that low-cost sensors must be calibrated before deployment. As environmental factors such as weather and pollution patterns differ from place to place, calibration models should reflect these realities to ensure accurate readings.

'Low-cost sensors have the potential for multiple air-quality-related applications if the data can be made reliable. At Indi-SET, we test the performance of sensors, enabling users to assess the reliability of their devices', said Dr Emil Varghese, Senior Associate at CSTEP and one of the authors of the report.

Further, India's diverse climate and pollution conditions require region-specific calibration, calling for the establishment of more testing and training facilities across the country. Sensor accuracy also declines with use, and calibration models may become outdated as conditions change. Thus, regular performance checks—ideally every 3 to 6 months—are essential to maintain data quality.

The study emphasises that while low-cost sensors can play a valuable role in improving air quality monitoring, their effectiveness depends on regular evaluation.

The full report is available here.

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About CSTEP: The Center for Study of Science, Technology and Policy (CSTEP) is one of India's leading think tanks, involved in solving Grand Challenges that the country faces. These include Sustainable and Secure Future, India's Green Energy Transition, Clean Air for All, and Digital Transformation.

About CSTEP's Air Quality Sector: We are working with state pollution control agencies and the Central Pollution Control Board to scientifically identify the sources of pollution for effective and targeted interventions. With the use of emerging technologies such as low-cost sensors, advanced measurements, satellite-based monitoring of air pollution, and comprehensive air quality modelling, CSTEP is looking at ways to make data on air pollution comprehensive, robust, and accessible.