Applications of LCS in air quality management

Dr. Saumya Singh, Postdoc, University of California, Berkeley, USA

Air pollution monitoring is the first step towards effective air pollution management. In India, fine particulate matter (PM2.5) is one of the most relevant pollutants, posing the largest risk for ill health and death. The heterogeneity of air pollution sources in India challenges air quality management despite the continuous effort of government regulatory bodies under a series of policies and programs to expand the air pollution monitoring network across the country. One key factor impeding effective air pollution management is the major data gaps from smaller cities and rural areas which are home to more than 60 % of the population.

The most obvious reason for the data gaps in air quality is the cost associated with traditional continuous reference-grade regulatory monitors. Low-cost sensors (LCS) cost up to three orders of magnitude lower than standard reference instruments, consequently, many avenues for applications have opened up. LCS networks are a promising innovation, particularly when integrated with other monitoring and modelling approaches. Portable, low-cost devices for detecting air contaminants in real-time have a long history, but recent advancements in low-cost air quality sensor technology especially for PM2.5 present a new opportunity to understand and communicate air quality and have captured the imagination of several air quality stakeholders and innovators, including civil society organizations.
With the existing state of PM2.5 LCS, applications can be classified into two major categories – regulatory and non-regulatory applications.

Regulatory applications- Includes compliance with air quality standards, where a precise and absolute determination of air quality is required, low-cost sensors are generally not yet suitable for this. While low-cost PM2.5 sensors can be calibrated to reasonably match official measurements, these calibrations tend to change over time, and many considerations are required such as meteorological effects, especially changes in relative humidity patterns. With careful attention to calibration in research or routine monitoring environment, a low-cost sensor can often provide a moderately precise and accurate (±15-30%) determination of PM2.5. Even with moderate accuracy, one potential application of LCS in this category can be help identifying apt locations for new regulatory monitors.
Non-regulatory applications- Includes enhancing public information about air quality, understanding local emissions events, and exploring spatial and temporal air pollution variability. Low power consumptions, low cost and compact size of LCS facilitates wider, easy deployment and real-time, high-resolution pollution data hence can be useful in such applications. LCS can already provide valuable qualitative information about air quality in settings where other more robust measurements are not available.

Therefore, with the current state of knowledge, the following applications of LCS out of many potential approaches are promising-

1- Strengthening current air quality monitoring- A spatially dense network of LCS can provide complementary measurements to an existing network of monitors in urban areas, highlighting hotspots of pollution in the

region. Broader spatial and temporal coverage helps us to understand the inter and intra urban air quality gradients.

2- Providing new air quality data- Insights about the air quality of remote areas and rural areas where conventional monitoring is not planned in near future. Some preliminary results from our ongoing measurements from North India using LCS showed us that "Rural air quality is not as good as we think" and the urban-rural air quality can be often comparable.

3- Empowering citizens by raising awareness about air quality- LCS is easy to deploy and operate by nature, and are capable of offering useful qualitative information to the public during air pollution events. Timely information can help citizens, especially the most susceptible populations such as children, asthmatics, and the elderly lower their health risk by planning their outdoor activities, hence reducing the short term impacts of air pollution. LCS are ideal monitors for personal exposure monitoring in indoor settings as well, due to the ease of operation.

Integrating LCS in air quality monitoring networks has brought a revolutionary shift particularly, by broadening participation in air quality discussions and disseminating information on air pollution in at-risk communities. However, questions remain about the actual benefits of these technologies considering the time and expertise required for maintenance of the low-cost network and careful calibration to improve their accuracy. With evolving research and development and continuous effort to improve sensor technology and expand the sensors for other pollutant monitoring, LCS seems to be a promising tool in applications such as air quality research, citizen science and regulatory compliances.

******