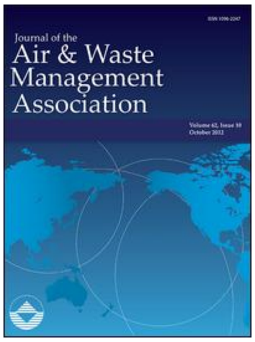

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LETTER TO THE EDITOR

Use of low-cost air sensors to augment regulatory networks

Dear Editor,

The Western US recently had several large wildfires resulting in wide expanses of western states blanketed in smoke. One metric the public used to assess the quality of the air they breathe is the Air Quality Index (AQI), which is the US EPA's method for communicating health-related dangers of ambient air quality to the public (64 FR 42530). The AQI is calculated from the ambient concentration of five "criteria" air pollutants regulated under the Federal Clean Air Act: ground level ozone, particulate matter (PM), carbon monoxide, sulfur dioxide, and nitrogen dioxide and is adjusted to reflect periodic revisions to the National Ambient Air Quality Standards or NAAQS (78 FR 3085). An AQI is calculated for each pollutant and the highest AQI value for the "critical" pollutant is reported. In most locations in the US, the AQI is dominated by ground-level ozone and PM concentrations.

The calculation of the AQI has two important features (64 FR 42530). First, except for particulate matter, AQI values are calculated from concentrations measured by methods that are certified as State/Local Air Monitoring Station (SLAMS) or parts of the SLAMS. Second, the measurements are time averaged (e.g., 24 hours for particulate matter). For particulate matter, either Federal Reference Method (FRM) or Federal Equivalent Method (FEM) monitors can be used to obtain concentration data. The US EPA methodology also allows for the use of monitors with neither FRM nor FEM designations as long as these non-approved data can be related to FRM or FEM measurements by statistical linear regression.

With the recent explosion of Internet of Things (IoT), several low-cost devices have become available for air quality measurements especially in the indoor environment (Chojer et al. 2020). Low-cost sensors were not in wide use for particle measurements when the AQI guidance was written. There are several ongoing efforts (e.g., the US EPA, South Coast Air Quality Management District, and the California Air Resources Board) to compare the measurements of these low-cost air sensors to regulatory instruments and several such comparisons were also presented at the Air Sensor International Conference (ASIC) organized by the Air Quality Research Center of the University of California, Davis (ASIC, 2018). Despite these efforts, low-cost air sensors, with few exceptions, do not yet have FRM or FEM designations. Yet networks of low-cost air sensors publish values labeled as AQIs using different algorithms (e.g. the AirVisual and Purple Air networks). Using the same name gives the impression that they are equivalent to the AQI calculated from regulatory monitoring data, which may confuse the general public. A different moniker would be less confusing.

Low-cost air sensors are certainly useful in non-regulatory or near-regulatory applications. Low-cost sensors empower the public to better understand their local air quality. But accuracy is a concern which must be kept in mind when interpreting and discerning appropriate uses of the sensor data.

Low-cost sensors may exhibit poor accuracy for a number of reasons. A large fraction of them are not sited properly following SLAMS or FRM/FEM guidelines. Most of the sensors that measure particles use light scattering to count particles and assess their size. Estimates of particulate mass less than 10 microns or 2.5 microns (PM10 and PM2.5) are then imputed from these measurements. A number of assumptions go into these measurements including particle density, shape, and refractive index, which are dependent on the particle source (e.g., wildfire, windblown dust). In addition, most low-cost light scattering instruments do not detect small particles, those typically smaller than 0.3 μm, so the mass in those sizes must be inferred. The result is that PM2.5 (and to a lesser extent, PM10) estimates from these sensors can correlate well with those measured by regulatory-grade instruments; however, good accuracy requires adjustment factors based on the source of the particles being measured.

Some current web platforms do not appear to filter sensor data for accuracy. A web platform could be built that would employ quality assurance checks. For instance, the sensor could be periodically brought to a nearby regulatory monitor to adjust its readings and this would be required for the sensor's data to be accepted for posting. Such a web site could also report a number indicating health-related air quality (e.g., HAQ) of the air, instead of AQI, along with a corresponding color bar for ready communication to the public (for an example see https://www.epa.gov/air-sensor-toolbox/what-do-my-sensor-readings-mean-sensor-scale-pilot-project).

In closing, we emphasize the fact that low-cost air sensors can be useful in empowering the public to assess exposure to a few air pollutants in their immediate surroundings (both indoors and outdoors). But since these sensors are not certified as regulatory methods, measurements obtained with them must be treated differently than those obtained using FEM/FRM methods.

Disclosure statement

No potential conflict of interest was reported by the authors.

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