Tribal Air Monitoring Support Center Steering Committee

Guidance for Applications of Low-Cost Air Sensors

The Tribal Air Monitoring Support (TAMS) Center Tribal Steering Committee (Committee) recognizes low-cost air pollution sensors to be in an early stage of technology development, and many sensors have not yet been evaluated to determine the accuracy of their measurements. Next generation low-cost portable air monitoring technology is part of an emerging market and as such, there is likely to be a wide range in the quality, degrees of accuracy and reliability of available devices. The Committee recognizes no low-cost sensor meets regulatory-grade air monitoring requirements and the discussion here is for informational purposes only.

The Committee developed the following guidance to help Tribes determine low-cost air sensor technology best fit for their air pollution sensor monitoring project(s) and application(s).

1. The Committee recognizes planning documents such as Air Monitoring Plans or Quality Assurance Project Plans (QAPPs) are important before beginning any monitoring project. Such planning documents help answer "Questions" as to "*Who, What, When, Why, and How*" to help provide a clear concept of what it is the Tribe is hoping to accomplish through the data collection project. Defining the questions will help identify the pollutant of interest (target pollutant), what are field conditions like, the duration of data collection, the type of measurements needed (i.e., short-term, mobile measurements vs. long-term stationary measurements) and the quality needed for those measurements.

2. Citizen Science Air Monitoring Plans and/or QAPPs targeted for education and outreach can be referenced to support low-cost air sensor monitoring projects. Consult an EPA Regional Project Officer regarding the category QAPP needed for project approval.

3. Consider device specifications like detection range and detection limit, precision and bias, calibration procedures, and others. All these data collection characteristics will determine the sensing equipment that is best suited for data collection purposes or any one project. It is important to note that sensor price ranges may also further influence what sensor is best suited for the project. Sensors with detection ranges and limits with greater accuracy are often more expensive.

4. USEPA has identified air sensors as a class of non-regulatory technology and should not be used in a regulatory context unless those instruments meet all applicable regulatory requirements. USEPA has identified that a primary use of air sensors is for non-regulatory supplemental and informational monitoring (NSIM) applications[1]. Three category NSIM applications have been identified in the Enhanced Air Sensor Guidebook. The Committee recognizes that sensor data streams may likely never meet strict federal monitoring requirements but could still be very useful in NSIM applications such as providing a better understanding of local air quality, helping in the siting of regulatory monitors, or identifying hot spots.

5. Low-cost sensors have a shelf life of less than two (<2) years with many remaining data quality, data interpretation, and data management questions. Applications center around informational measurements and uses such as teaching tools, intended to encourage informal and qualitative awareness. Such measurements can be used for relative comparisons between air pollution levels in two locations or different times, rather than for measurements of absolute or true levels. For example, measurements like these may help address questions regarding air quality during wildland fire events. Although some sensors may not report air quality in traditional concentration units, Tribes may still find measurements made by unitless scales or colors to be useful for making relative comparisons. Furthermore, the use of air sensors in an education setting can help advance learning of science, technology, engineering, and mathematics (STEMs) at various grade levels.

6. Low-cost sensors are screening tools Tribes can use to help provide air pollution data in shorter time increments. For example, sensors can track minute-by-minute changes in pollution levels. As a result, Tribes can become more aware of short-term, peak levels of some pollutants. However, it is important for Tribes to be aware that actual health effects of very short-term elevated levels of most pollutants are not yet well understood and EPA has not established health information defining such short-term pollutant exposures.

7. EPA has established the Air Quality Index (AQI) as a means of translating air pollution measurements into potential health effects. For the AQI, it is very important to remember that the AQI level is based on concentration values averaged over a longer period, (i.e., 8 hours, 24 hours, etc.) not just a single reading taken over the span of a few minutes or hours.

[1] Three (3) NSIM application areas: I) Spatiotemporal Variability, II) Comparison, III) Long-term Trend.

Therefore, Tribes should use low-cost sensors as screening tools to establish air quality awareness and investigation to support more long-term monitoring.

8. Low-cost sensors utilizing light-scattering methods to measure particulate matter (PM) has shown promise in correlations with higher-cost, mass-based PM measurements. Some devices may respond well to various particle distributions (or particle size ranges) than others. For example, a sensor device may underestimate large course particles versus fine particles.

9. Low-cost PM sensors sometimes have correction factors (i.e., the PurpleAir map correction factors) and these correction factors can be very helpful, but their accuracy depends on the emissions mix (i.e., wildland fire smoke vs. windblown dust). A correction factor may be designed well for one emissions mix, but not work well for another emissions mix.

10. Due to uncertainty in sensor data quality and interpretation; if applicable, at least one (1) sensor should augment an existing reference monitor or collocate near an existing air quality station managed by the Tribe or local authority for quality assurance purposes.

11. Low-cost air sensor performance evaluations often only evaluate one pollutant of a multi-pollutant sensor. Findings for the one pollutant cannot be applied to the other pollutants. For example, the South Coast Air Quality Management District (AQMD) Air Quality Sensor Performance Evaluation Center (AQ-SPEC) has found good results for $PM_{2.5}$ for a sensor that measures $PM_{2.5}$, PM_{10}, and Volatile Organic Compounds (VOCs). Seeing good results for $PM_{2.5}$ does not mean the PM_{10}, and VOC sensor components also work well.

12. Low-cost sensor performance evaluations vary between models of the same sensor from the same manufacture. A good evaluation for one model does not guarantee that a different model will work as well, even if it is using the same sensor components and technology.

13. Tribes may have concerns regarding data sovereignty, data privacy and data ownership for sensors that upload to cloud-based data management systems. Sensor manufactures/integrators own the data if it passes through their data management system.

While this guidance is limited in its scope concerning quality and reliability, basic information is provided that should assist Tribes and others in making the most appropriate application of low-cost sensors. USEPA has specific guidelines it must use in establishing regulatory-grade air monitors. Currently, no low-cost sensor meets these strict regulatory requirements nor have been formally submitted to EPA for such a determination. Even though some sensor devices have been tested for measurement performance, durability, and usability, others have not. Therefore, the Committee provides this guidance for applications of low-cost sensors solely for informational purposes.

References:

Clements, A., R. Duvall, D. Greene, AND T. Dye. *The Enhanced Air Sensor Guidebook*. U.S. Environmental Protection Agency, Washington, DC, 2022.U.S.

U.S. Environmental Protection Agency, *Memorandum Air Sensors*, Office of Air and Radiation, June 22, 2020