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The Evolution of Community Air Quality Monitoring

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Disclaimer: Material presented is for informational purposes only and not intended as a recommendation or endorsement of any particular sensor or instrument.

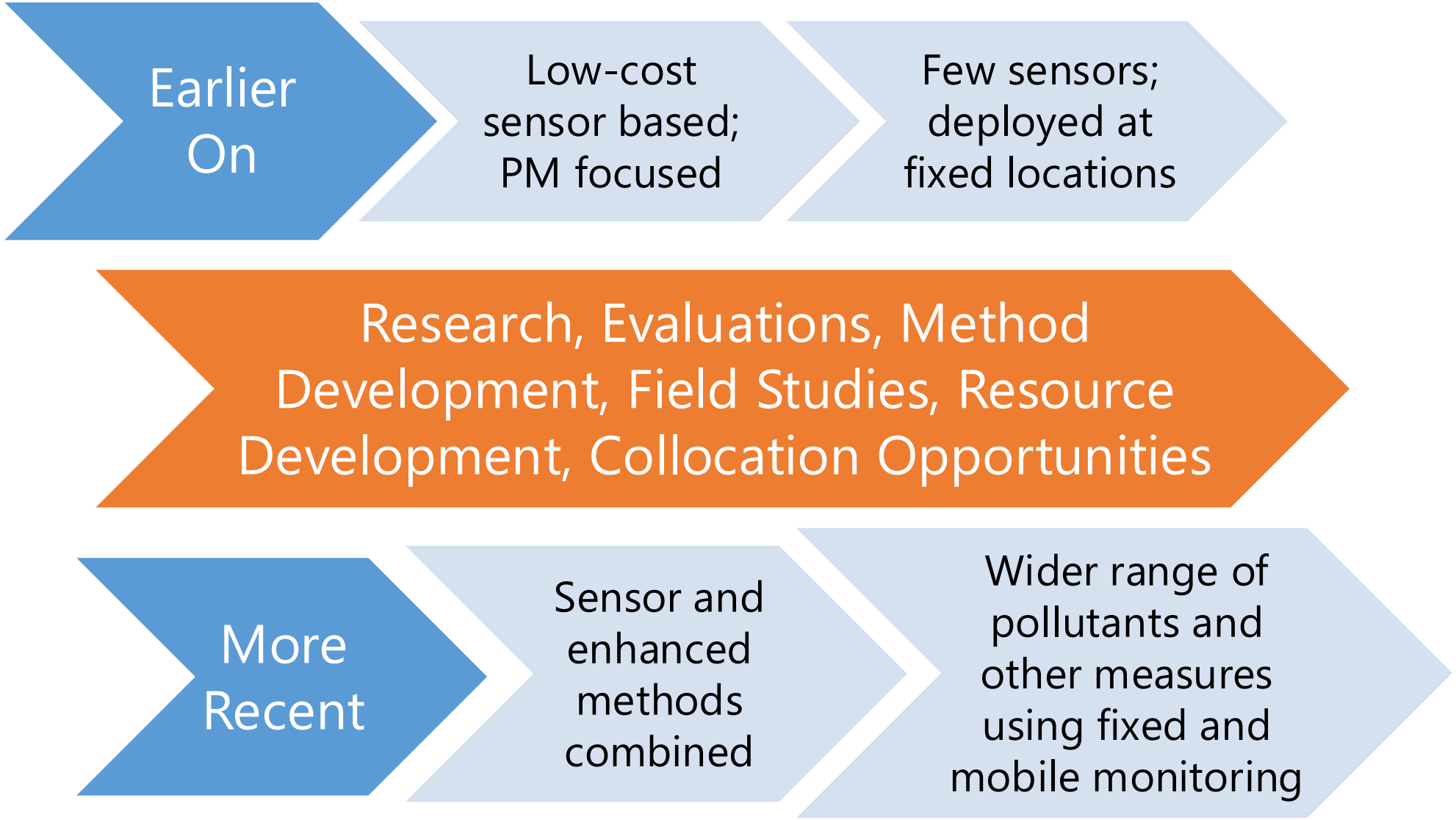
Outline

- A Little History on Community Monitoring
- Community Examples
- Challenges

From Google Scholar

Using the Search Term "Low Cost Air Sensor"

Time Period	Results
2018-2025	101,000
2010-2017	18,200


Earlier On
Low-cost sensor based; PM focused
Few sensors; deployed at fixed locations
Research, Evaluations, Method Development, Field Studies, Resource Development, Collocation Opportunities
More Recent
Sensor and enhanced methods combined
Wider range of pollutants and other measures using fixed and mobile monitoring

What Do Communities Need?

- Ensure they are making actionable and useable measurements
- Select/use/maintain sensors and other measurement methods
- Manage, quality assure, and interpret data
- Understand what supplemental data (e.g., meteorology) best support their study goals

Example Goals

- Produce baseline assessment of pollutants
- Identify air pollution hot spots
- Compare to regulatory monitors
- Compare to other communities
- Assess contributions from specific sources or source types
- Establish trends
- Engage the community with education and outreach support
- Perform health risk and source apportionment

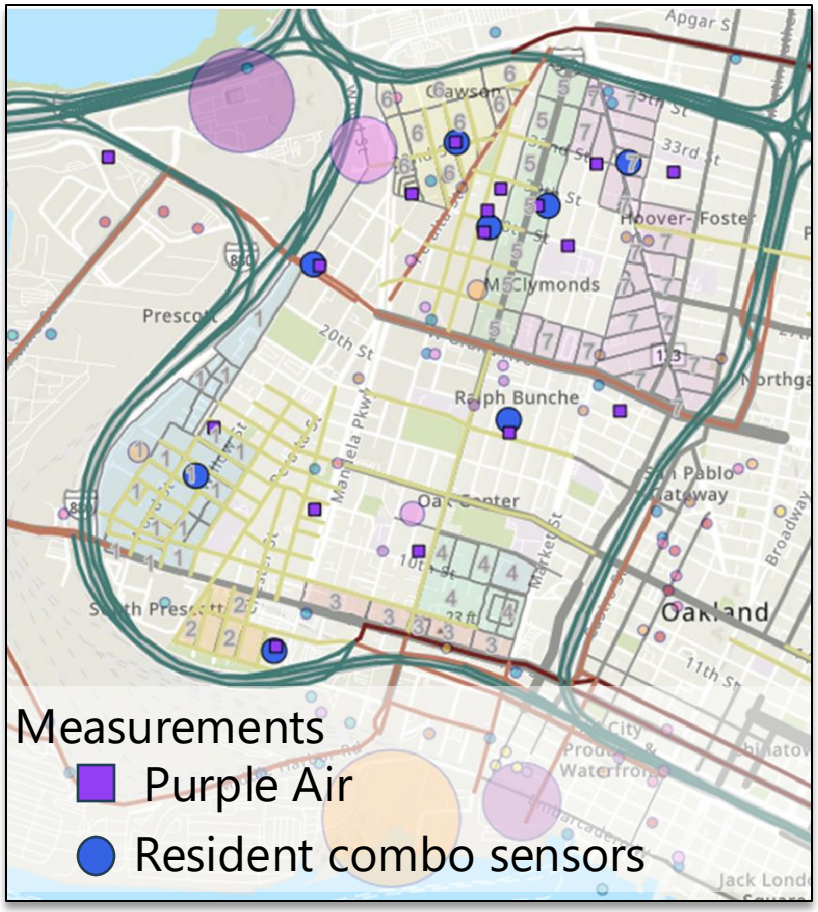
Measurement Types

Pollutant type/Species	Measurement Methods	Notes
Particulate matter	Sensors, regulatory	Well established
VOCs, gaseous air toxics	PID sensors, canisters, field gas chromatographs (GCs)	• Individual species difficult w/o canister • GC sensors used to trigger canisters • Continuous formaldehyde
Metals	Filters, continuous X-ray fluorescence (XRF)	• Costly • Continuous methods useful for source appt.
Smoke markers	Filters, sorbent tubes	Not routinely made
Other gases (ozone, NO_x, CO, CH_4, SO_2…)	Sensors, regulatory, research-grade	Sensors: shelf life, calibration, drift, interference, etc.
Black carbon (BC)	Sensors, research-grade	Not low-cost, but being integrated into lower cost solutions

Other measures: meteorology, noise, vibration, traffic

Recent Community Examples

West Oakland Air Quality Monitoring Network



- Spatially dense speciated $PM_{2.5}$ network, measuring concentrations of black carbon and metals
- Paired with hourly metals measurements
- Resident volunteers host sites

Targeted pollutants	Instruments
$PM_{2.5}$	• PurpleAir sensors • Reference monitor
Diesel PM	• AethLabs Microaeth350 black carbon monitor
Metals and hazardous air particulate pollutants	• Biweekly filters with XRF and gravimetric analysis • Xact (hourly XRF for one year)

Anderson et al., 2024.

PM, BC, and Metals in Maywood, CA

Measurement	Data collected
Continuous metals measurements – Xact 625	1,027 hrs (47 days)
Black carbon – AE33 Aethalometer	1,307 hrs
$PM_{2.5}$ – T640	1,306 hrs
Meteorological data – RM Young	1,307 hrs
Hexavalent Cr filter measurements – BGI sampler	19 filters
$PM_{2.5}$ and PM_1 – Purple Air	3 sensors

Continuous metals sampler – Xact 625

Black carbon sampler – AE33 Aethalometer

Monitoring shelter and particulate matter sampler – T640

Hexavalent chromium sampler – BGI sampler

Purple Air low-cost sensor

DeWinter J. and Aguirre F., 2020

Blue Lake Rancheria Baseline Monitoring

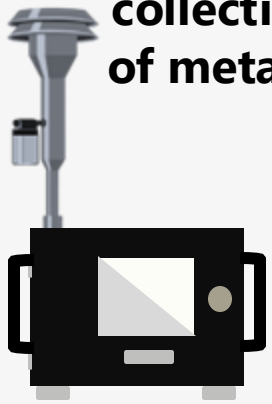
- Monitor $PM_{2.5}$ concentrations with an FEM instrument
- Assess the spatial variability of $PM_{2.5}$ concentrations
- Engage with and educate community members
- Determine the contribution of fossil fuel burning and woodsmoke burning to total BC
- Determine possible sources of metals and BC in the community

Establish regulatory grade air quality monitoring for PM (T640) + met data

Establish a $PM_{2.5}$ sensor network for hyperlocal air quality information

Air quality education for students and community members

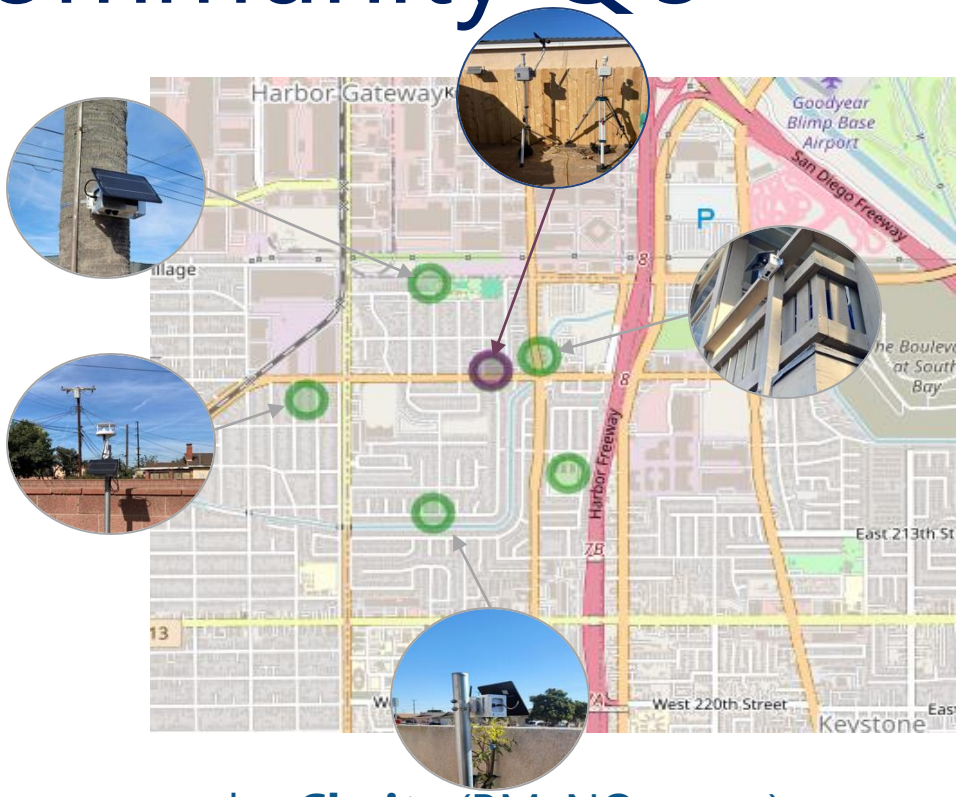
Black carbon and air toxics monitoring (AE33 & filter collection of metals)



Ryder et al., 2024

Del Amo: Air Monitoring Community Q's

- What are the concentrations? Are the levels elevated?
- Are the concentrations changing over time? By season?
- Are concentrations in Del Amo similar to those in nearby communities? What differences exist?
- Are there hot spots within the community?
- What are the likely sources of these pollutants?
- Are these species impacting the health of residents? Should we be concerned?

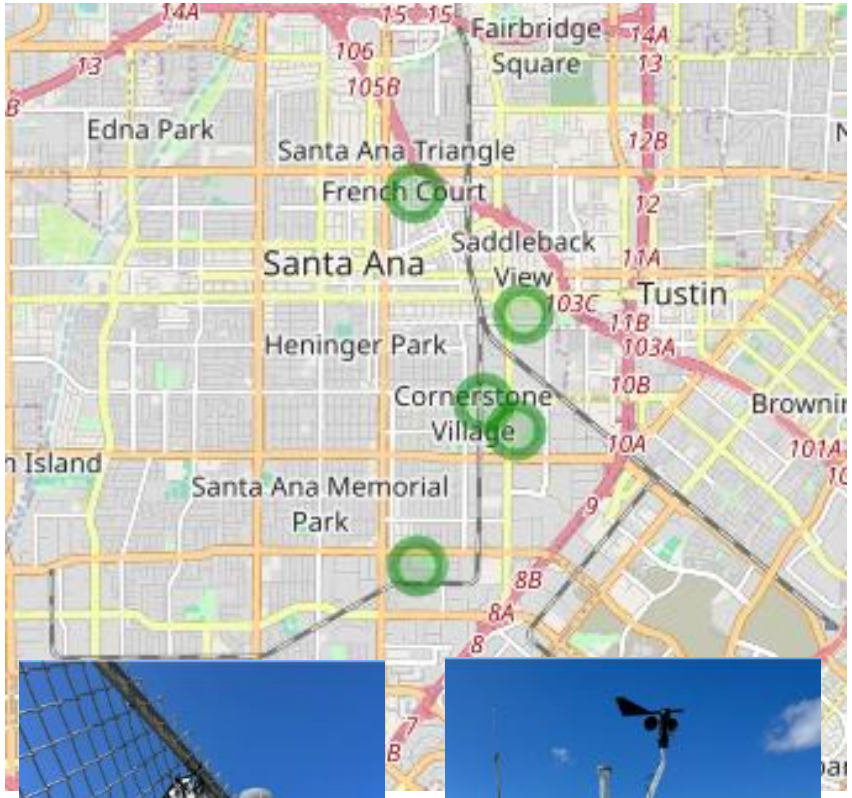


- 5 node sensor network - **Clarity** (PM, NO_2, met)
- Central site equipped with a **Sensit SPOD** (tVOC, PM) and
  - 1-in-6-day samples for metals and VOCs
  - Vibration, traffic, and noise

Madison Park Neighborhood Association GREEN (Santa Ana, CA)

- 5 node sensor network - **Clarity** (PM, NO_2) located at schools within Santa Ana
- Central site equipped with a **Sensit SPOD** (tVOC, PM) and
  - 1-in-6 day filter samples for metals and canister samples for VOC speciation

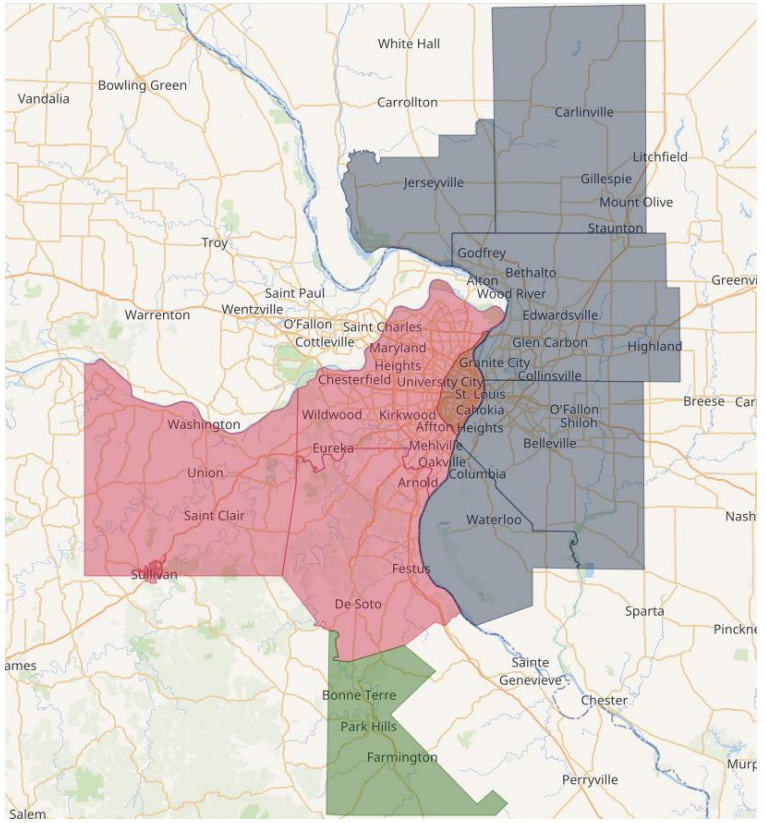
Measurements enhance the community's existing PurpleAir network



United Congregations of Metro East (IL)

- 3 node sensor network – **Sensit RAMPs** (tVOC, SO_2, NO, NO_2, CO) in area heavily impacted by industry
- Central site also collecting 1-in-6 day filter samples for metals and canister samples for VOCs

1. How do hazardous air pollutant concentrations vary across these communities, particularly in places such as community parks and locations with large frequent gatherings?
2. What is the exposure risk for these communities?
3. What are the potential sources of measured pollutants?



Challenges for Communities

- Calibration for the gaseous measurements
- Data management and analysis
- Ease-of-use (or not) of the regulatory grade instruments
- Quality Assurance Project Plans
- Resources – great guidance out there, but $ and technical expertise still needed

https://www.epa.gov/air-sensor-toolbox

https://www.aqmd.gov/aq-spec

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Sources

- Anderson A., Nash L., Cuozo E., and Brown S. (2024) West Oakland, CA: residents drive air quality research for toxics reduction and neighborhood planning. Presentation given at the *Air and Waste Management Association Environmental Justice Conference, December 4-5, Rosemont, IL,* by Sonoma Technology, Petaluma, CA.
- DeWinter J. and Aguirre F. (2020) High-density deployment of $PM_{2.5}$ sensors in the Maywood environmental justice community. Presentation given at the *Air Sensors International Conference, June 18,* by Sonoma Technology, Inc., Petaluma, CA; the Coalition for Clean Air, Sacramento, CA; and Comite Pro Uno, Maywood, CA.
- Ryder O., Gostic C., and Hafner H. (2024) Blue Lake Rancheria's community air quality monitoring projects. Presentation given at the *2024 National Ambient Air Monitoring Conference*, New Orleans, LA, August 15, by Sonoma Technology, Petaluma, CA. STI-8178.