Citizen Science and Government Collaborations: Developing Tools to Facilitate Community Air Monitoring

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Disclaimer: Material presented is for informational purposes only. EPA does not recommend nor endorse any particular sensor product or data management platform.

Low Cost Sensors & Real-time Data

Sensor Applications

- Lower cost sensors → greater access to air pollution data at more local scales
- Potential applications for air monitoring:
  - <u>Personalized health information</u> → Inform individuals about their personal exposures to air pollutants, particularly susceptible populations
  - <u>Empower communities</u> to gather information about exposures
  - <u>Raise awareness</u> and educate individuals and communities about air pollution issues
  - <u>Supplement</u> national, state and local monitoring networks
  - Monitoring during <u>acute events</u>, such as wildfires

Citizen Monitoring of Air Pollution

- Common hurdles:
  - Uncertain data quality
  - Data interpretation
  - Acceptance and application

- How to best address hurdles:
  - Discussions with manufacturers
  - Continued evaluation of sensors
  - Standards for sensor performance
  - Partnerships and engagement with government, academia and the public
  - Pilot efforts

EPA Recognizes Community Interest in Applying Emerging Technologies

- New technologies are advancing and revolutionizing regional, community, fence-line and personal monitoring. Ongoing or recent research includes:
  - Smart City Challenge – 2 communities engaged (Baltimore, Lafayette)
  - STAR Grant Program – 6 academic/community partnership grants
  - Community-specific research opportunities (Village Green Stations)
  - Multiple Region-based community air monitoring projects

Smart City Challenge Locations

Village Green Stations

STAR Grant Program Locations

Questions to Consider when Designing a Citizen Science Study

- Why are we doing this?

- How are we going to do this?

- What type of useful and valid data do we need to collect or use?

- Where should we collect our data?

- What resources (equipment, people, money) do we need to do this?

- What will we do with this information?

Check out EPA's Citizen Science webpage for more information:
https://www.epa.gov/citizen-science

EPA/Community Collaboration Example: Ironbound Community Collaboration

- Overall goal was to characterize urban pollution using portable sensors, especially near roadways
- EPA provided full day of citizen training on air sensor setup and use
- Four sensors were deployed by citizens in the Ironbound community
  - 21 locations over 6 months
- Study results empowered residents to address air quality concerns with local officials

EPA/Community Collaboration Example: DISUR Puerto Rico

DISUR (Desarrollo Integral del Sur)

- Overall goal was to analyze local pollutant levels and determine the area's main sources of pollution
- EPA provided full day of citizen training on air sensor setup and use
- Ten sensors were deployed by citizens in the Tallaboa-Encarnación community

EPA/Community Collaboration Example: Community-led Sensor Evaluation

- Project goals: Help citizen scientists and community groups learn how to use sensors and effectively evaluate their reliability and performance via collocation with reference instruments.

- Project partners: Eastern Band of Cherokee Indians, Clean Air Carolina (CAC)

- Tools from this project are available on Air Sensor Toolbox page
  - Excel Macro to compare data, Training Guide on Sensor Collocation

Training for CAC staff, Mecklenburg County staff, and citizen volunteers

CAC staff and citizen volunteer checking on ozone sensors at deployment site

EPA-Developed Tools and Guidance

Instruction guide for conducting a successful collocation evaluation of air sensors with regulatory grade instruments, provided as a PowerPoint presentation for easy reading and ample visual tools.

Topics covered:

- Background
- Low-cost sensors vs reference instruments
- Introduction to collocation
- Planning collocation
- Making measurements
- Data recovery and review
- Data comparison
  - ➤ **Introduction of Macro Analysis Tool (MAT)**
- Using sensors effectively

Project partners provided feedback on instruction Guide and MAT, which was used by EPA to improve and finalize these products.

EPA-Developed Tools and Guidance

Macro Analysis Tool - MAT
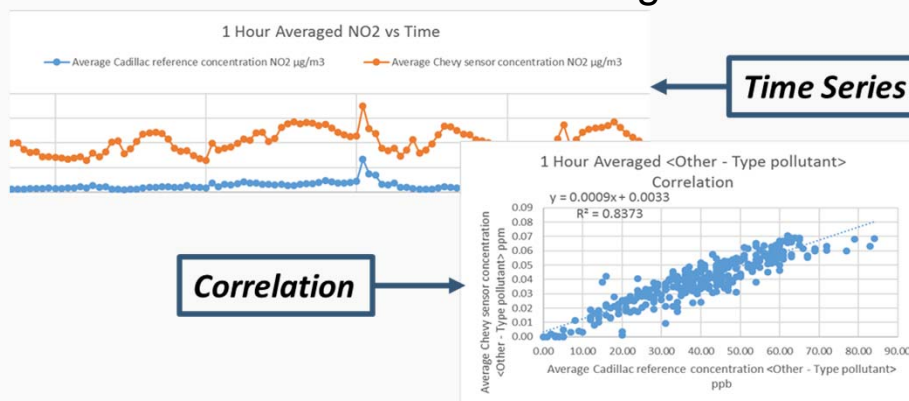*Use this tool to process sensor data, reference data, or both!*

This tool can
- time match the sensor and reference data streams.
- average selected data into longer time averages.
- plot a time series of selected data.
- plot sensor versus reference data and develop a regression equation.

This tool cannot
- process time stamps expressed as fractions.
- process input time intervals that vary.
- run reliably using Excel versions XX and Windows versions XX.

Control Panel

Instructions

Easy-to-use spreadsheet based **macro analysis tool** for performing data comparisons and interpreting the results. Tool tackles one of the biggest hurdles in citizen-led air monitoring projects – working with the data.

Example Outputs:

1 Hour Averaged NO2 vs Time
— Average Cadillac reference concentration NO2 µg/m3 — Average Chevy sensor concentration NO2 µg/m3

Time Series

Correlation

1 Hour Averaged <Other - Type pollutant> Correlation
$y = 0.0009x + 0.0033$
$R^2 = 0.8373$

Lessons Learned

- A number of things could go wrong with a study…
  - Citizen scientists can drop out of a study
  - Data quality could be compromised
  - Sampling and analytical equipment can fail or get damaged
  - Data loss
  - Other unforeseen circumstances
- Always good to have an alternative plan for the "what-ifs"
- Clear roles and responsibilities
- What questions can and can't be answered by the collected data

Air Sensor Toolbox for Citizen Scientists

- Air Sensor Toolbox web page provides citizen scientists and others resources on air sensors
- Air Sensor Guidebook is one of the most popular resources in the Toolbox
- https://www.epa.gov/air-sensor-toolbox

Questions?

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