Environmental Information exchange Network

EN2017

Advanced Monitoring Technologies

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Philadelphia, Pennsylvania

http://www.exchangenetwork.net/en2017

ABSTRACT

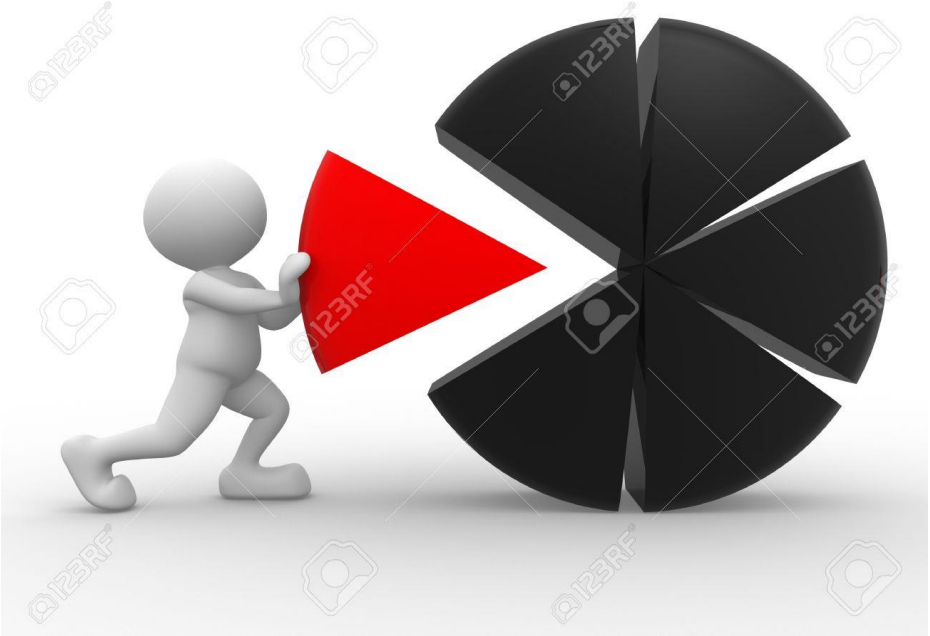
This presentation will cover a broad range of advanced monitoring topics including the collection, use, and application of information from disparate and big data sets. The presentation includes a real-world example of sensor projects occurring in Baltimore, MD, joint EPA/State recommendations on meta data needs and standards for collecting advanced monitoring data, as well as, mock ups for a beta website that provides context and visualization of real-time information from disparate data sets.

Overview

- Introduction
- Sensors: A Real-World Example (Baltimore, MD)
  - SEARCH Project
  - Village Blue Project
  - Smart Cities Air Challenge
- Trends in Sensor Research
- E-Enterprise Advanced Monitoring Team Updates
  - Data Interpretation and Communication
  - Data Standards

Introduction

- Experiencing a shift in…
  - The traditional role of States and EPA as sole resource for collecting, storing, sharing, & communicating air data
  - Large IT and small start-up companies are streaming and storing air quality data
    - It is cheap to collect, provides new methods for analysis, and is often collected now for purposes identified later
- Big Data includes data from traditional data sources (think FRM, FEM) + nontraditional sources (sensors. mobile devices. satellites, Internet of Things)



Introduction

- There’s another Flo in town…
- Meet “Flow”
  - https://www.youtube.com/watch?v=Fs73rh-vNPY

Disclaimer: Video is shown for example purposes only. EPA does not endorse or recommend any particular sensor product.

Introduction

Consumer-oriented turnkey devices:



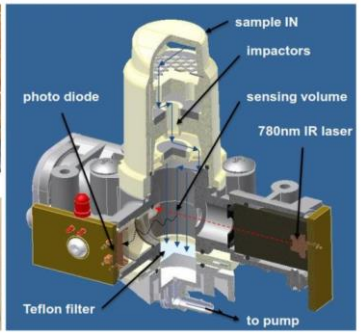

Researcher- or developer-oriented, OEM sensors:






Portable devices for research, advocacy, and screening:





Large-scale air monitoring networks

Sensors: A Real-World Example

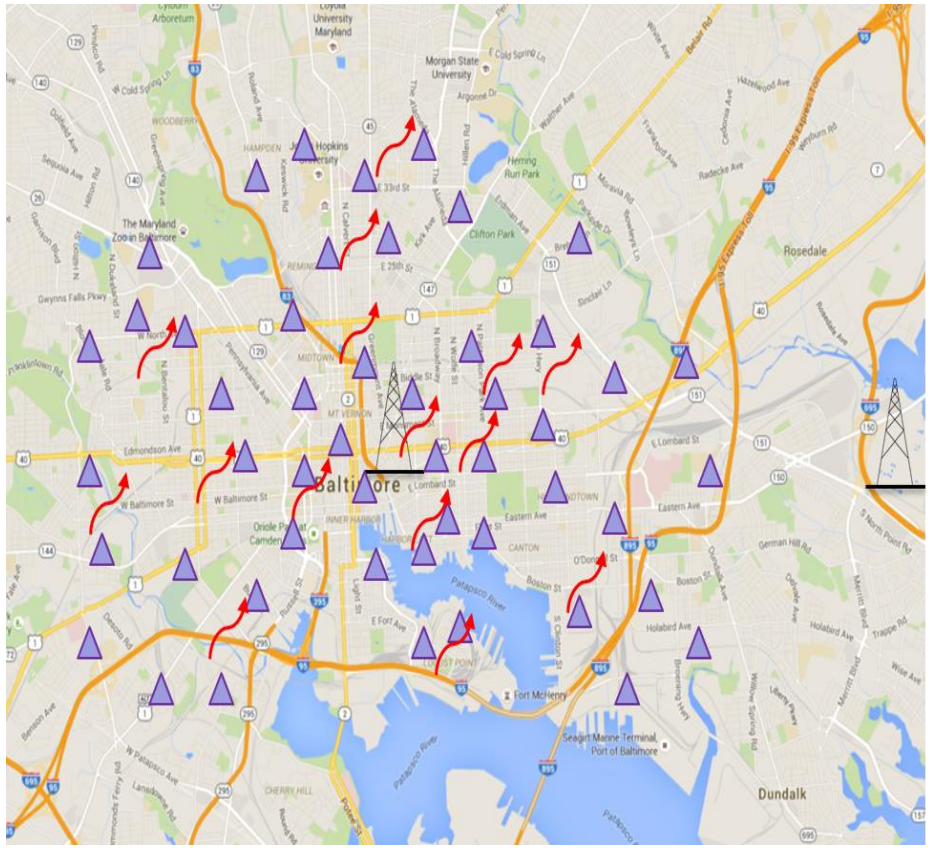
SEARCH (air sensors) + Village Blue (water sensors) + Smart City Air Challenge (air sensors) = Big Data

SEARCH Project

- ✓ **Objective 1: Develop novel online multipollutant monitors**
  - (stationary and portable models) to measure air pollutants and GHGs
- ✓ **Objective 2: Measure pollutants with high spatiotemporal resolution using a multipollutant stationary monitoring network.**
  - ~50 monitors at ~100 locations over three years
- ✓ **Objective 3: Measure temporally resolved personal exposures with detailed time-activity information.**
  - 100 participants (24-hr) with personal multipollutant monitor + GPS

Co-PIs: Drew Gentner (Yale) & Kirsten Koehler (JHU)

SEARCH PROJECT

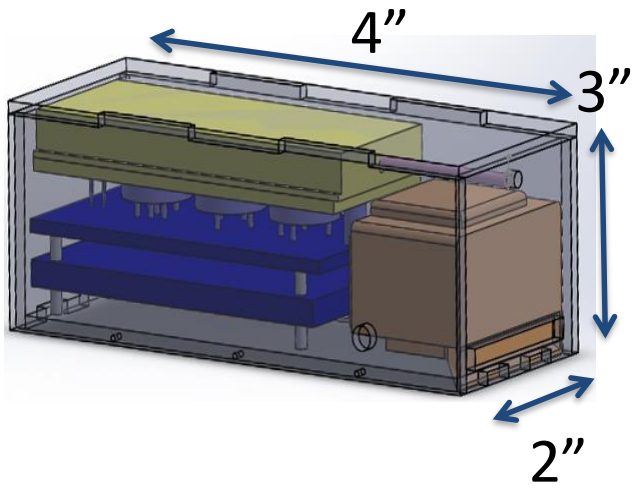


40-50 Stationary monitors with strategic placement across 100 sites in 3 years. Site locations are shown for example only.

EPA Stations
(hourly-weekly data)

Stationary Monitors
(time resolution: hourly+)

Portable Monitors
(time resolution: hourly+)



Measured Air Pollutants
Ozone (Tropospheric)
Particulate Matter ($PM_{2.5}$)
Nitrogen Dioxide (NO_2)
Sulfur Dioxide (SO_2) (stationary only)
Carbon Monoxide (CO)
Methane (CH_4)
Carbon Dioxide (CO_2)
Select monitors with: Size-resolved PM Volatile Organic Compounds Total Oxidative Potential

Village Blue

- EPA and USGS project collecting real-time water quality data using low-cost sensors
- Data to be displayed on interactive website
- Provide insights between water quality and changes that can effect public health and the environment
  - **Example: Make connection between high rainfall and sewer overflows or harmful algal blooms**
- Sensors will measure:
  - Conductivity; dissolved oxygen levels; nitrate levels; pH; temperature; turbidity (water clarity); pigment molecules like chlorophyll and phycocyanin; tidal height; and water flow direction

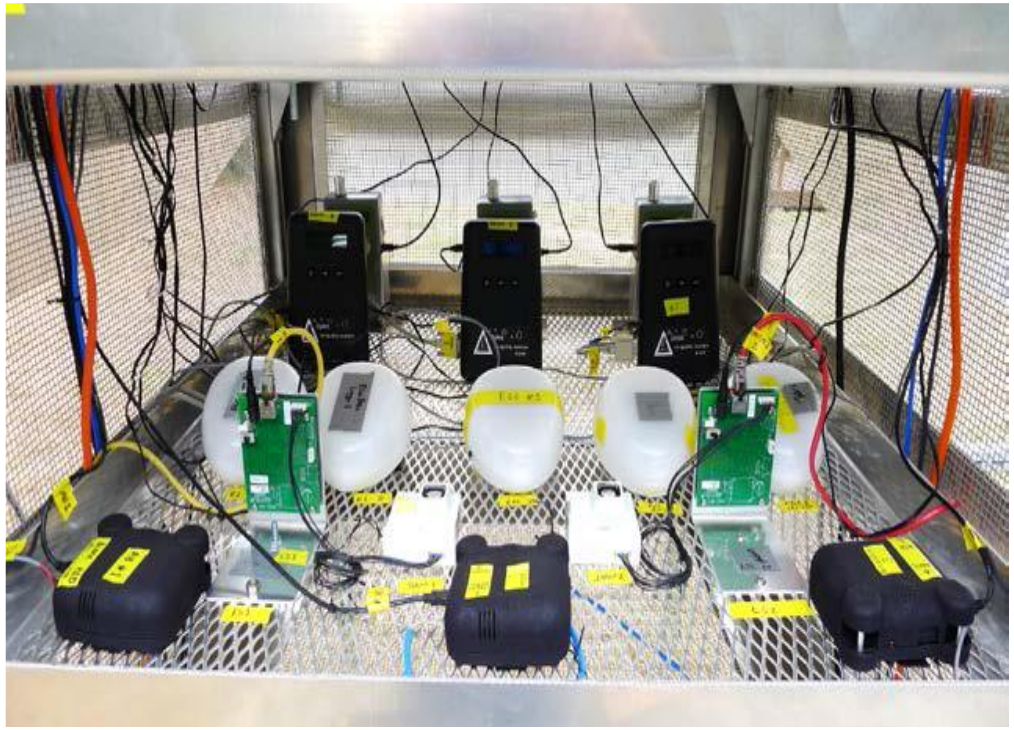
Compliments efforts to make Baltimore Harbor "swimmable and fishable" by 2020

EPA Challenge

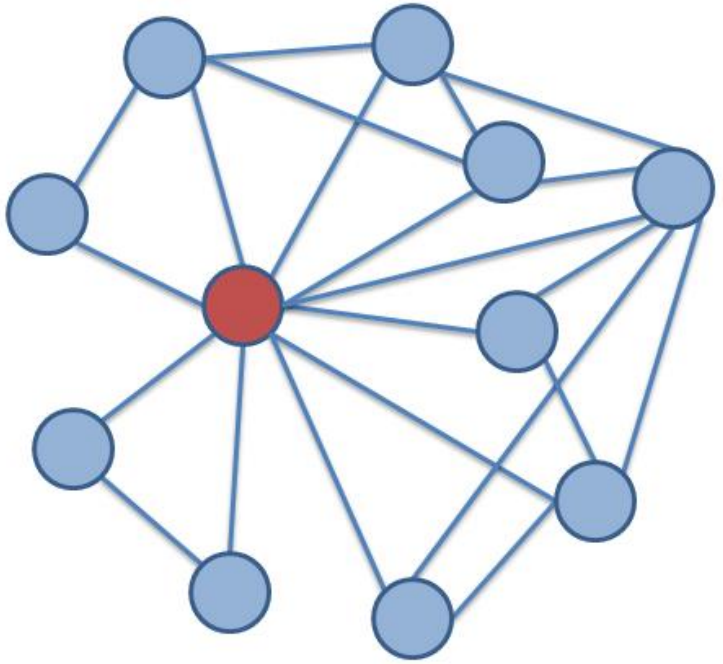
- Smart City Air Challenge
  - A challenge that encourages communities to deploy hundreds (250-500) of air quality sensors and make the data open
  - EPA awarded prizes of $40,000 to two communities based on their strategies, including their plans to share data management methods so others can benefit
  - Prizes awarded to cities of Baltimore, MD and Lafayette, LA
    - Baltimore is measuring O_3 and NO_2 and is using an Amazon web service IoT

Trends in Sensor Research

Performance Evaluations



Sensor Networks



Trends in Sensor Research

NEW: Wildland Fire Sensors Challenge

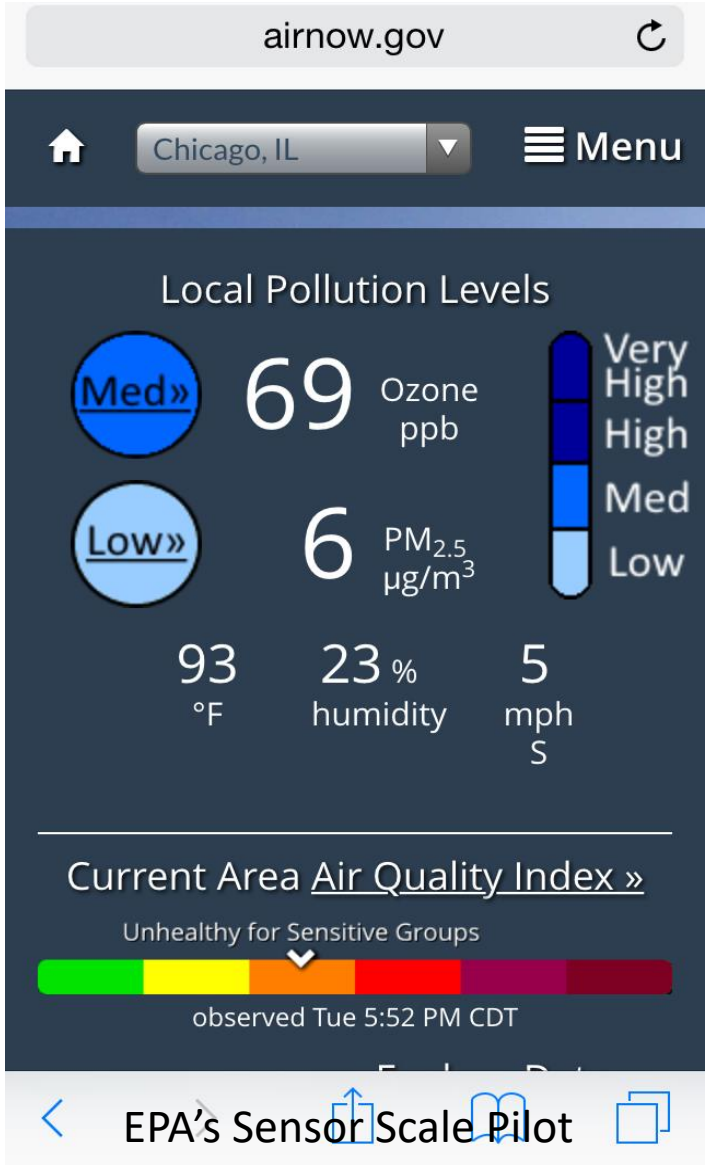
Challenge opportunity to develop a prototype multi-node measurement system capable of rapid deployment and continuous real-time monitoring of highly dynamic air pollution levels during a fire event, including $PM_{2.5}$, O_3, CO, CO_2. Submittal deadline is November 22nd, 2017.

E-Enterprise Advanced Monitoring Team

Recommendations:

1) Explore Development of an Independent Third-Party Evaluation/Certification Program
2) Develop Technology Scan and Screen Procedures
3) Data Interpretation
4) Data Standards
5) Lean Current Technology Approval Processes

Data Visualization



EPA's Sensor Scale Pilot

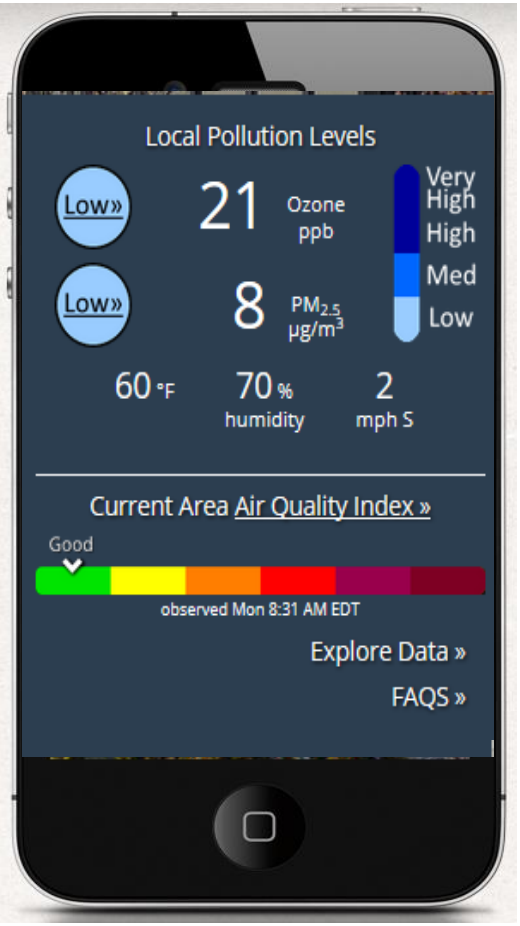
vs

Example of crowdsourced air quality app (not endorsed by EPA)

Team #3 Update

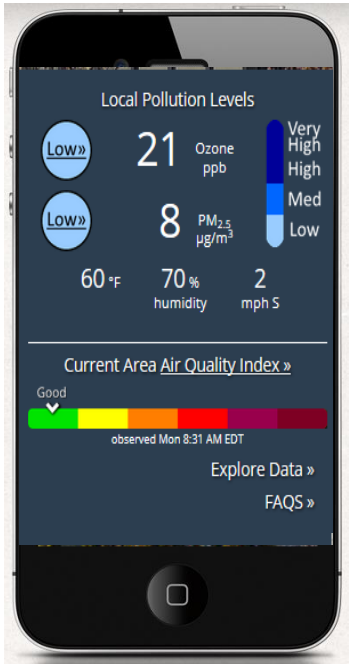
Status

- On May 6th, 2016 EPA launched a new “sensor scale”
  - EPA developed the scale to help the public understand 1-minute data from Village Green stations
  - Messages and cutpoints were supported by robust statistical analysis relating short term measurements to longer term standards
  - Two journal articles on approach have been published (Keating et al., EM 2016 and Mannshardt et al., AWMA 2017)
  - Four focus group studies completed in February 2017
- Pilot appears on existing Village Green data webpage
  - http://bit.ly/VillageGreenPilot
- Next step is to finalize messaging for $PM_{2.5}$ and O_3 in Summer 2017 and draft messaging for CO, NO_2, and SO_2. Messaging for benzene is also under consideration.

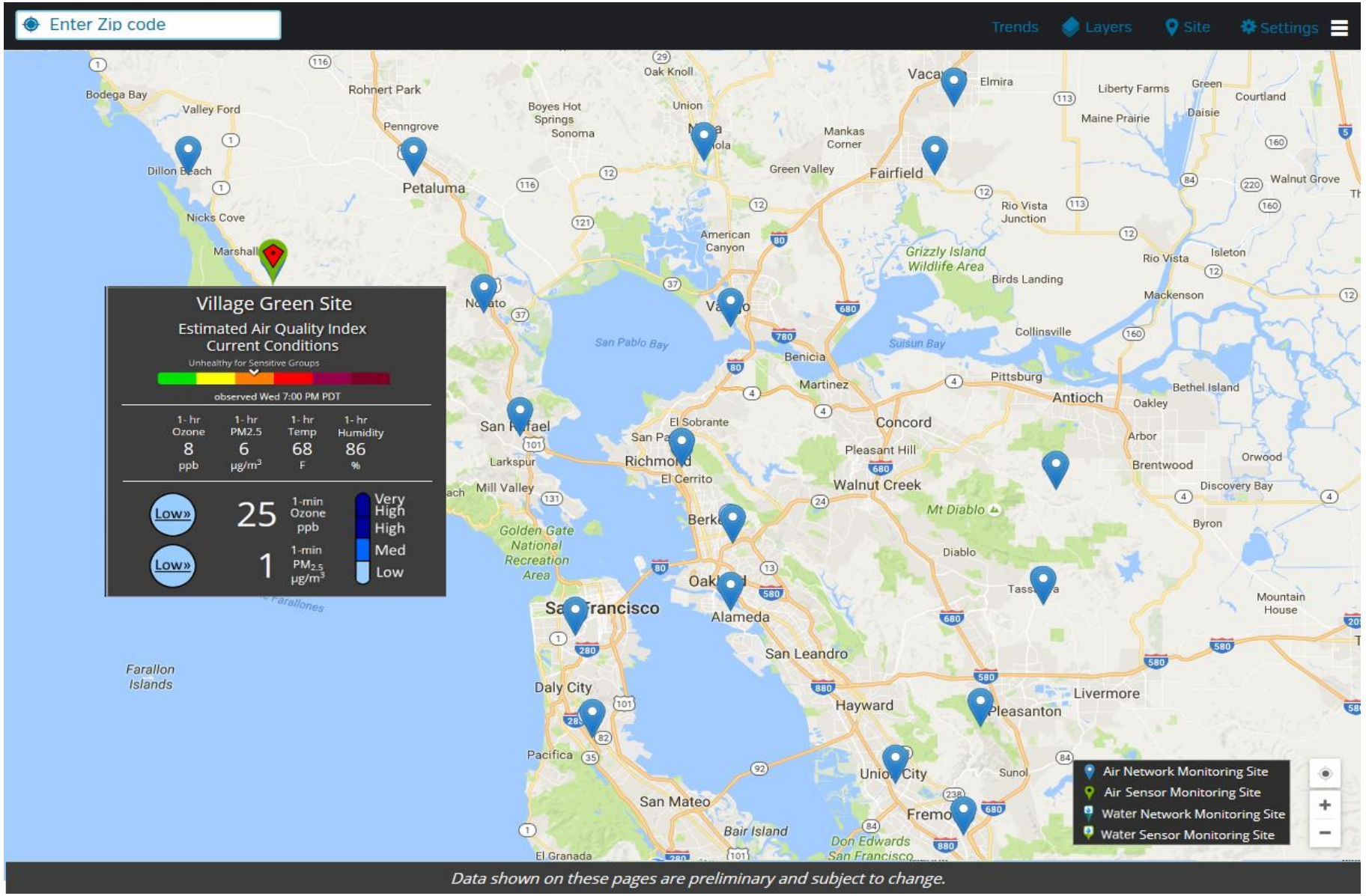


Focus Group Studies

- ✓ Limited general knowledge about air pollutants and measurements
  - ➢ However, there is a recognition of stop light colors and what they mean – red is a “panic” color
- ✓ Confusion between personal and area wide information
- ✓ Desire for customization of website and push alerts when levels changed (esp. to “high”)
- ✓ Specify whether messaging applies indoors, outdoors, or both
- ✓ Use location services and include a map



Data Interpretation – Real-Time Data Display

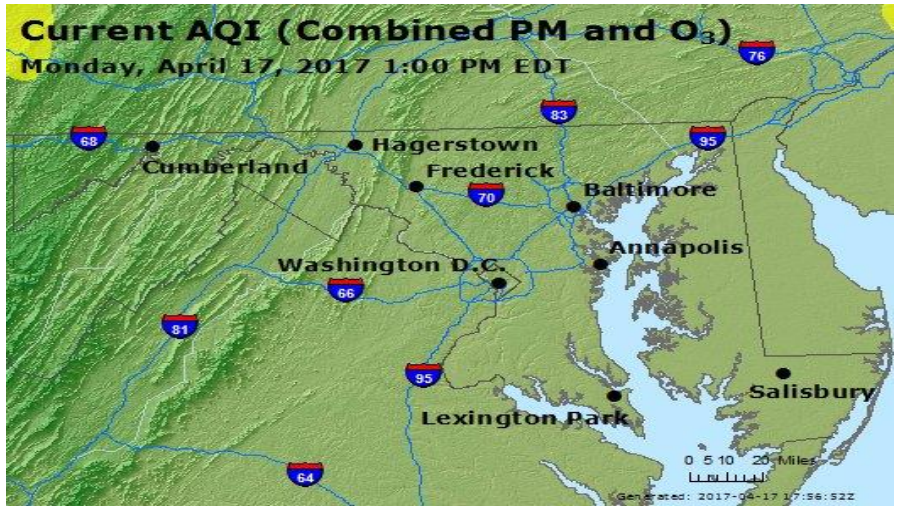


Big Data Providers

- Venturing into environmental data market
- Already streaming regulatory air data
- Willingness to provide “smart city” technologies and data infrastructure
- Desire to team or seeking advice on sensor network research projects
- Providing platforms for end users to merge datasets

AQS Data vs. AirNow

- AQS data is certified by States
- AirNow data
  - Sent to EPA voluntarily by State agencies
  - Real-time (e.g. hourly) data is used in current condition maps
  - Use of NowCast to calculate current conditions
  - $PM_{2.5}$ and ozone are dominant pollutants



Data Standards/Infrastructure Needs

- Data Standards – establishing basic common data elements and formats to simplify ingestion & processing of data.
- Metadata Standards - additional information to help interpret data. Should also include data quality elements (precision & bias), calibration data, as well as standards for time and geolocation.
- Ontology – standardization of terminology and meaning.
- Data Commons – a freely available service for users to upload, analyze, visualize, and share sensor data (should they choose to).

What Would Standardized Sensor Data Enable: **Third-Party Applications**

- Adopting and promoting standards sends a clear signal to the market that there is value in supporting those standards
- Enables the market to develop solutions for data storage, data sharing, and data visualization
- Allows those outside government to develop applications and tools that are valuable to them and meet their specific needs

Team #4 Update

Charge: Evaluate existing data standards for communicating sensor data

Status: Team evaluated several existing approaches:

- Custom solutions for EPA Emergency Response (VIPER)
- EPA's ARS and AirNow system
- USGS's National Stream Information Program (NSIP)
- Open Geospatial Consortium Standards

Charge: Develop a metadata standard as well as a proposed data architecture

Status: The team will leverage lessons learned from a companion E-Enterprise Project: The Interoperable Watershed Network Project which developed a common 'search index' for available sensors and used Open Geospatial Consortium standards to enable the sharing of data

Dwane Young is presenting tomorrow in 3:45pm session on a continuous data pilot project

Questions?