Sensing A Change In The Air

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J.B. and Maurice C. Shapiro Environmental Law Symposium:
Advanced Monitoring, Remote Sensing, and Data Gathering,
Analysis and Disclosure in Compliance and Enforcement

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Environmental Science and Innovative Solutions

Air Quality Monitoring Is Changing


Expensive
Accurate
Few sites
Used by experts

Lower-cost
Less accurate
Many sites (mobile)
Used by everybody

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About Air Sensors

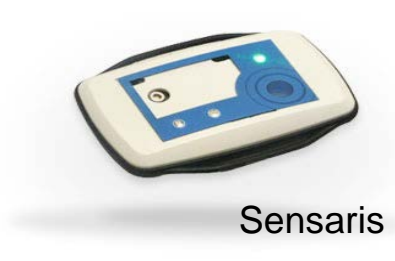- Range in size from small to large

- Range of cost: USD $100–$5,000

- Gas and particles
    - Many gas sensors
    - Some particle sensors
    - Few toxics sensors

- Fixed, mobile, personal

- Components
    - Sensor
    - Data Storage
    - Communications
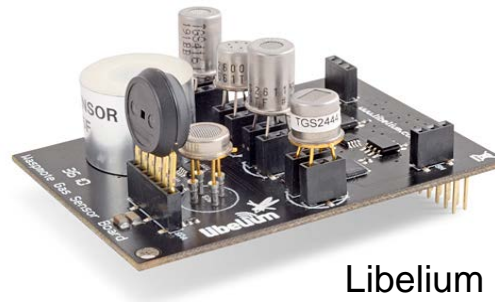   - Display
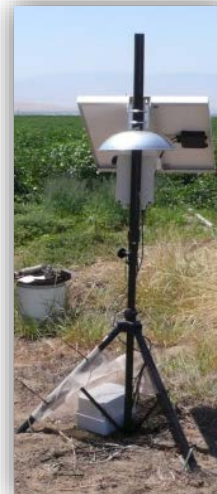
Sensors in the Private Sector
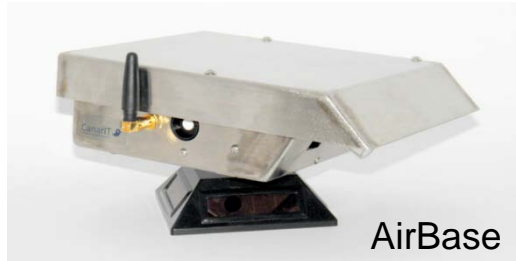
AirBase

Sensaris

Cairpol

Airboxlab
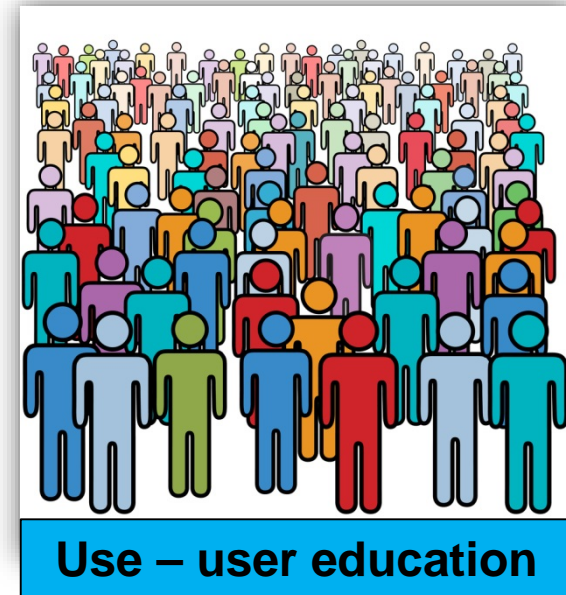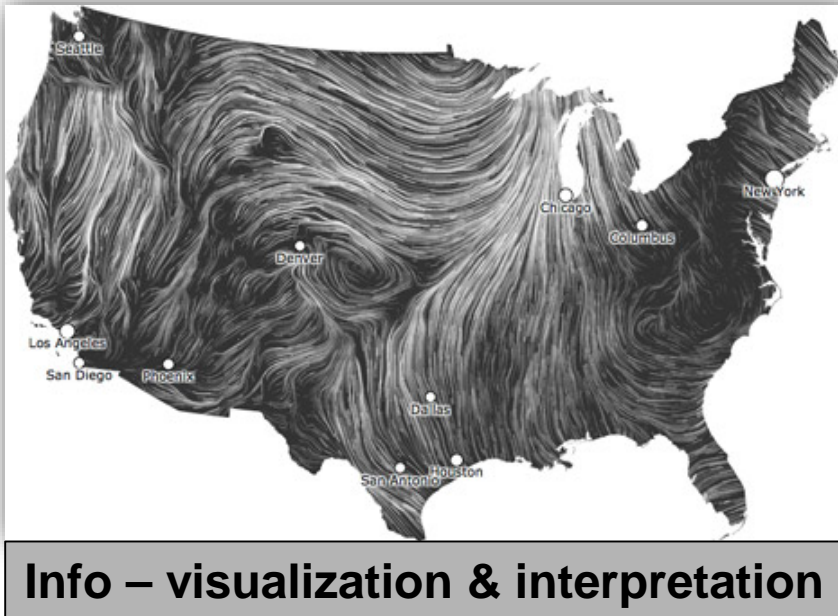

Libelium

Esensors

CubeSensor

Canary

Lapka

Sensordrone

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Three Challenges

Data – quality and quantity

Use – user education

Info – visualization & interpretation

Data – Quality and Quantity

- Quality
  - Accuracy
  - No standards for low-cost devices
  - Many interferences
  - Some perform well; others don't work
- Quantity
  - Storage, processing, and usage requirements
  - Governance, usage rights, privacy

Data – Quality and Quantity

- Are air sensors accurate?

- Example:
  - Study at utility
  - Can PM sensors detect PM_{10}?
  - Field study focusing on quick evaluation

Other Evaluation Studies:

- EPA
- South Coast Air Quality Management District
- EU Joint Research Commission
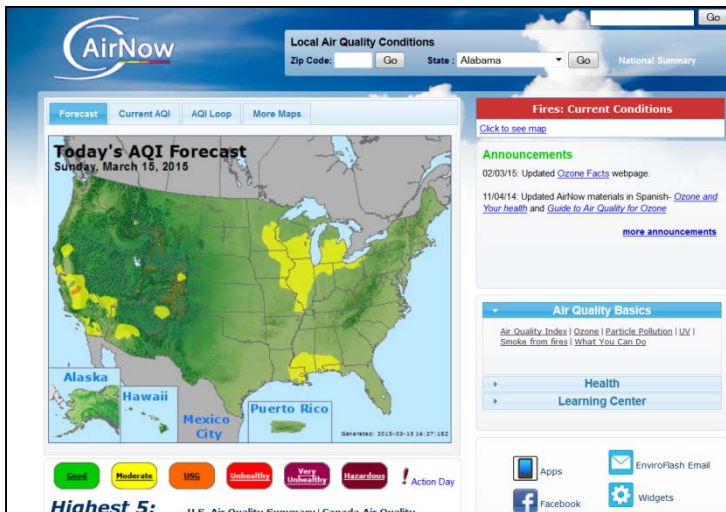- Private sector organizations
- Individuals

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Data – Quality and Quantity

AirNow.gov
2000+ sites
Multiple parameters
Hourly data
24 hr/day 1 year

=

?

Data – Quality and Quantity

AirNow.gov
2000+ sites
Multiple parameters
Hourly data
24 hr/day 1 year

=

1 team
1 sensor system
3 parameters
1-second data
Just 4 hr/day for 1 year

Info – Visualization and Interpretation

- Clear, easy to use, understandable displays
- Integration of other information (weather, sources, activity, pictures, etc.)
- Automation for
  - Adding supporting information
  - Detecting events/issues (indoor/outdoor, local vs. regional source, short-term high value vs. persistent problem)
  - Providing context
- Paradigm shift creating information
  - Fixed → mobile
  - 1-hr data → 1-second data
  - Accurate → may not know
  - Outdoor → unknown

Info – Visualization and Interpretation

- Webcam animations with auto detect and historic query capability
- Coke facility in Pittsburgh, PA

2014-09-19 08:24:01
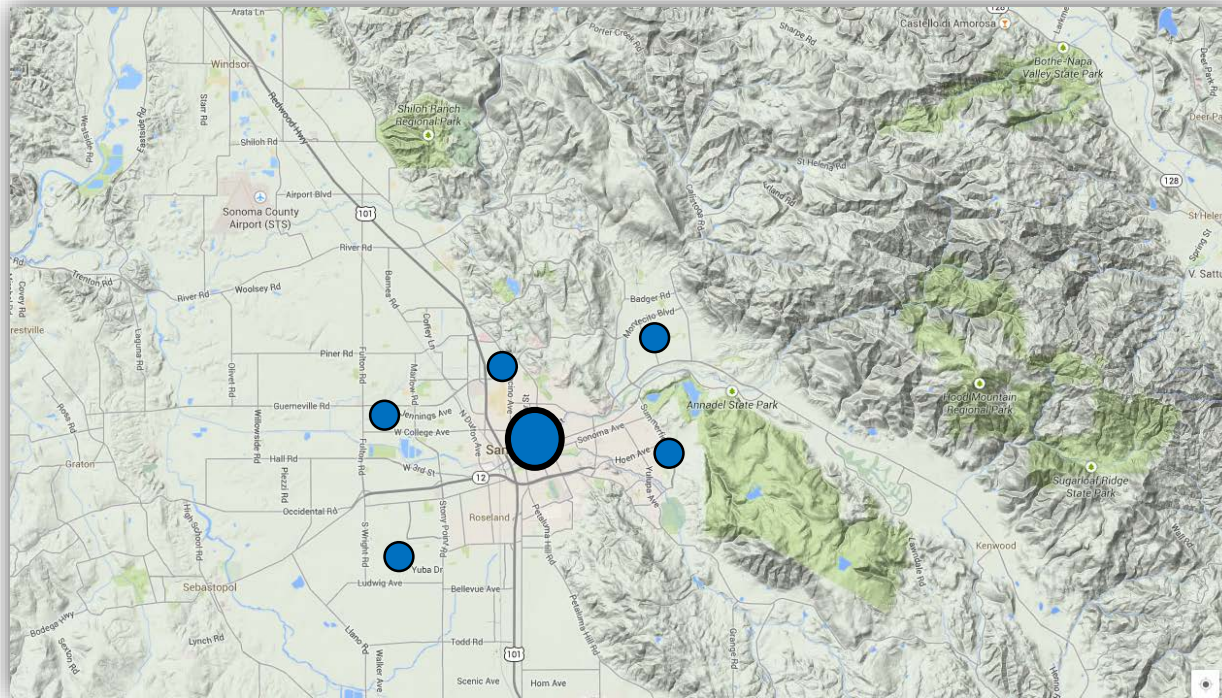
Fast

Share

? Help
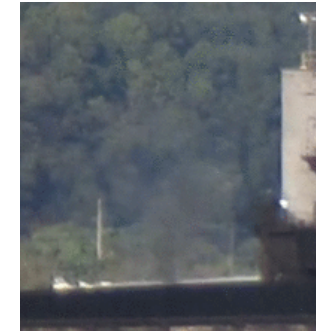
Color with ~60% opacity

Color with ~100% opacity

Credit: CREATE Lab at Carnegie Mellon University

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Info – Visualization and Interpretation

- PM$_{2.5}$ from residential wood burning study in Santa Rosa, CA

Pop: 160,000
Area: 20x15 miles
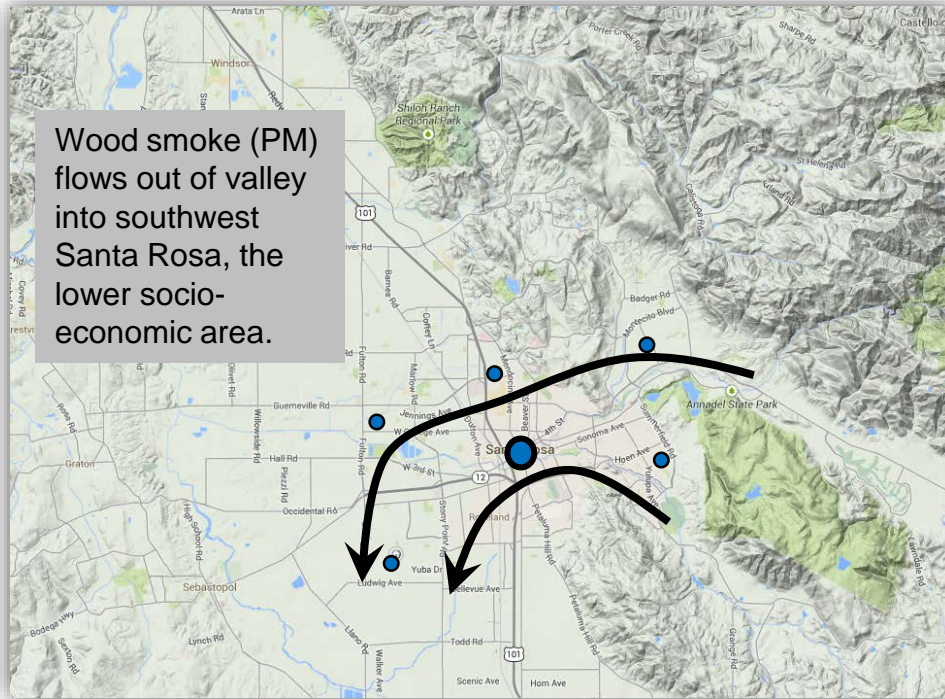
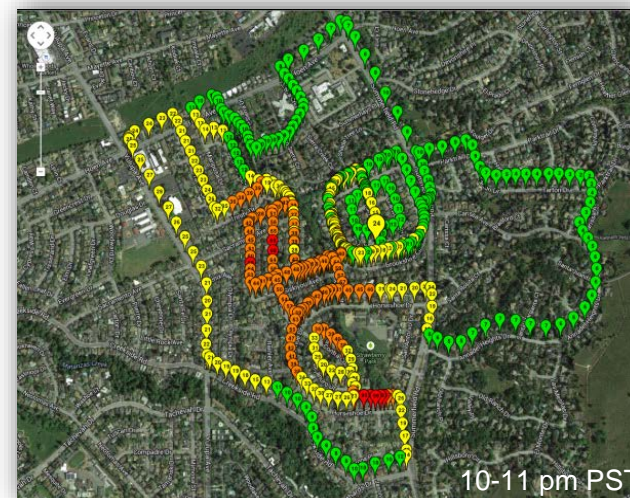# Info – Visualization and Interpretation

Info – Visualization and Interpretation

Fixed Monitors

Mobile Monitor

Wood smoke (PM) flows out of valley into southwest Santa Rosa, the lower socio-economic area.

8-9 pm PST

10-11 pm PST

Large gradients of $PM_{2.5}$ due to local wood burning and light winds.

$PM_{2.5}$ (ug/m3)

150	
65	
35	
12	
0	

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Use – User Education

- Need education about air pollution

- Some questions people are asking:
    - Is sensor working?
    - Do high values pose a health concern now? In the long term?
    - What do the values really mean?
    - How can I lower my exposure?
    - How can I share and connect with others?
    - How does a measurement compare to reference data?
    - Where is the source(s) of this pollution?
    - How does this relate to other risks (smoking, etc.)?
    - How does this relate to other sites and locations that I'm interested in?

- Simple questions. Complex answers.

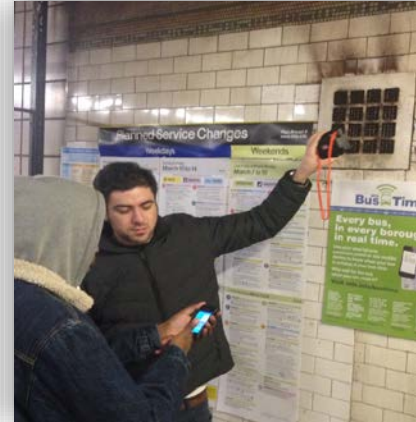# Use – User Education

Kids Making Sense – Teach youth how to measure particle pollution using air quality sensors and to interpret the data they collect.
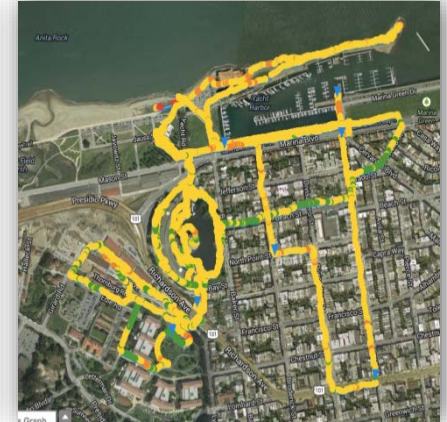
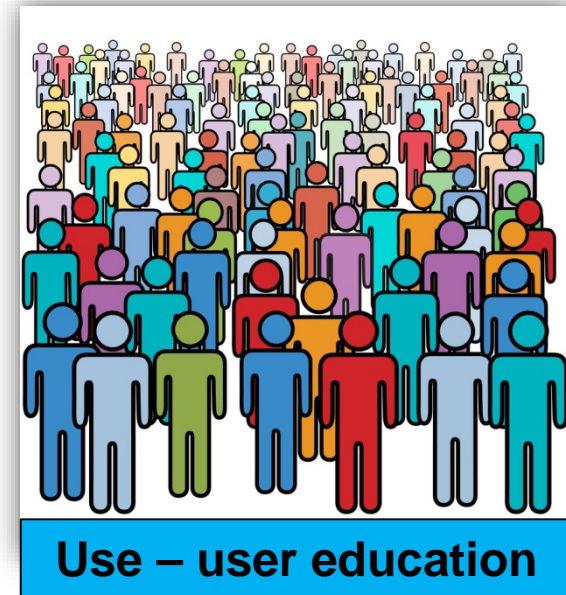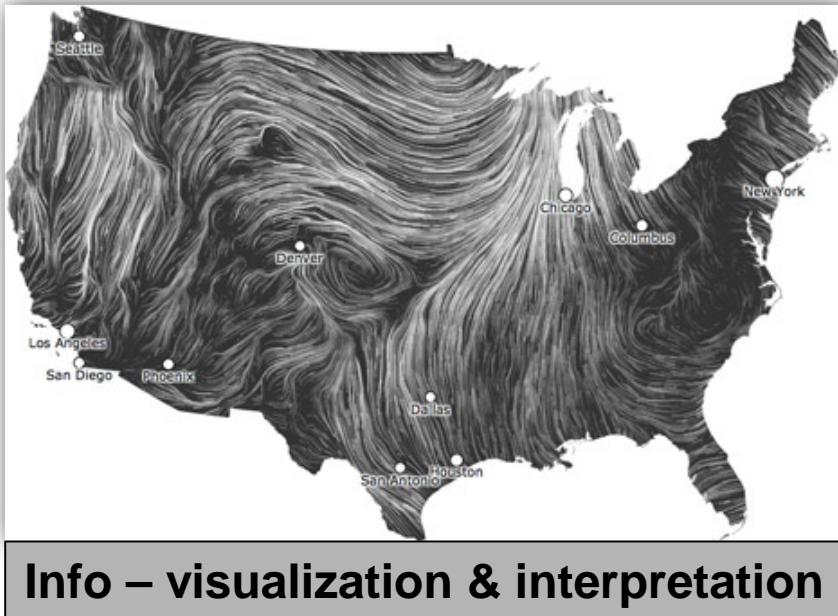

Learn

Measure

Discover

Interpret

Potential Opportunities from Low-Cost Monitoring

- Lower the costs for government, industry, and the public

- Identify problems and areas of clean air

- Engage new people/advocates

- Use power of information to change public policy

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