Civic Science: Building Tools and Platforms for Rigorous Public Research

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Results

All results support the finding that greatest amount of H2S is found in drainage canal, this is scary because it can mix with irrigation and surface water that waters crops and livestock.
How Civic Science Can Address:

- Emerging Health Threats
- Health Disparities/CBPR
- Data Gaps
- Scientific Literacy
Public Lab started through developing a cheap method of making satellite-like maps using helium balloons and digital cameras. The method was used during the BP gulf oil spill by communities to create a public archive maps documenting damage from the spill.

Publiclab.org
Barriers to Community-based Environmental Science and Health Research

- Expensive
- Limited to hands of experts
- Lag in knowledge between experts and people on the ground
- People on ground don’t own the data
- They also don’t understand how scientific knowledge is made
- Industries have far greater capacity to generate data
Public Lab

is a community where you can learn how to investigate environmental concerns. Using inexpensive DIY techniques, we seek to change how people see the world in environmental, social, and political terms.

Join now

Public Lab is made up of:

An open community of contributors
Learn about and help to develop cheaper, more open environmental testing. 
join today »

A set of experimental tools
Browse and freely download the designs, or purchase a kit to get involved today.

A network of local groups
Find a nearby chapter or start one yourself to find local collaborators and support.

A platform to build collaborations
Our online and offline events and systems bring together activists, technologists, scientists, educators, and local residents to solve problems.

An open data archive
A permanent home for environmental data from grassroots groups and individuals.

Free and open source software
From map making and publishing to spectral analysis, with more new tools in development.

publiclab.org
Forum for Public R+D

Balloon & Kite Mapping

How Can I Do This?

Our whole toolkit is linked out below, but really fast:
1) Buy our balloon kit, assemble yourself, or buy/make a kit.
2) Find a good camera.
3) Determine how you will trigger the camera (we suggest a rubber band) or pick out a timelapse app for your smartphone.
4) Build a simple housing from a plastic bottle.
5) Find a site to map that is five miles from an airport and not Washington D.C.
6) Follow the pre-flight checklist (pdf) and quick start guide (pdf) to safely fill up your balloon and fly!
7) Sort your images on your desktop or with Mapmill.
8) Make them into a map with Mapknitter.
9) Print a poster of your map from Mapknitter, see your map join the public record in our archive, and if you'd like, make a poster with our template.

Contributors

PLOTS members who have contributed research notes or added to wiki pages on this topic:

- Jeffrey Warren (283)
- Stewart Long (87)
- Michele Tobias (7)
- Adam Griffith (10)
- Shannon (23)
- Liz Barry (161)
- Mathew (104)
- Cesar Harada (2)
- Jaekyung Lee (3)
- Jeremy Crampton (6)
- Manning (2)

Maps

Open data from balloon and kite photography

Do-It-Yourself "satellite" imagery

These maps were largely made by taking photos from balloons and kites, a technique adapted and refined by Public Lab contributors. Make one yourself and it can be featured here.

A grassroots data archive

This archive represents the collective work of our community to provide an alternative source for aerial imagery, and to highlight issues of environmental and social concern with Do-It-Yourself tools. The archive provides:
- A permanent, backed up archive
- A place to advocate around your data
- A space to discuss and understand the maps
create collaborative workflows

Research notes for balloon-mapping

Quick process notes and field reports
protect openness with viral licensing

CERN Open Hardware 1.0
Share Back with Attribution

Creative Commons
Share Alike with Attribution For Media

GNU Public License 3.0
Copyleft Viral Software Licensing
How can these tools enable scientific rigor?

1. Meta-data gathered constitutively: GPS, time/date stamped.

2. Tools can be standardized: community use standardized kits and can demonstrate tool calibration.

3. Raw data can be shared publicly and modification to the data can be tracked.

4. As communities can build their own tools, experiments can be repeated from place to place.

5. Can be designed to integrate with and potentially improve the quality of “standard” data formats.
How can this improve science?
Discovery of unmapped spring
News Release

EPA Proposes Plan for Cleaning Up Gowanus Canal
Multi-million Dollar Cleanup to Revitalize Polluted Brooklyn Waterway

Contact: John Martin, (212) 637-3662, martin.johnj@epa.gov

For the first and second segments of the canal, the EPA is proposing to dredge approximately 307,000 cubic yards of highly contaminated sediment. In some areas where the sediment is contaminated with liquid coal tar, the EPA is proposing to stabilize the sediment by mixing it with concrete or similar materials. The stabilized areas would then be covered with multiple layers of clean material, including an “active” layer made of a specific type of clay that will remove PAH contamination that could well up from below, an “isolation” layer of sand and gravel that will ensure that the contaminants are not exposed, and an “armor” layer of heavier gravel and stone to prevent erosion of the underlying layers from boat traffic and currents. Finally, clean sand would be placed on top of the “armor” layer to restore the canal bottom as a habitat. The plan also calls for removing contaminated material placed in the 1st Street Turning Basin decades ago.

http://publiclab.org/wiki/new-york-city
Civic Science Approach to Environmental Health Monitoring

- Civic vs. Citizen Science
- Tools developed and owned by communities
- Tools can be adapted and spread in an open source fashion
- Research can be spread and scaled between communities
- Supports public exploration and investigation of environments
- Increases the capacity of regulatory agencies

Institutions for civic technoscience: How critical making is transforming environmental research
SA Wylie, K Jalbert, S Dosemagen, M Ratto The Information Society 30 (2), 116-126
How can this help Agencies?
over 130,000 assessments by over 6000 online individuals in one week.
"Between 15 to 25 percent of natural gas in the U.S. may contain hydrogen sulfide, while worldwide, the figure could be as high as 30 percent.” (Skrtic, 2006)
Background: What is Hydrogen Sulfide (H\textsubscript{2}S)?

- Hazardous, neurotoxic gas
- Smells like rotten eggs
- **Natural sources**: volcanoes, stagnant bodies of water
- **Industrial sources**: sewage plants, CAFOs, pulp and paper mills, oil and gas operations
- Eco-toxic to aquatic life at very low concentrations: 0.0149 ppm – 0.0448 ppm (EPA 2012)
- Human Health Impacts (Acute): **Health effects**: eye irritation, rashes, headaches to serious neurological harm, knock down and/or death (Kilburn, Thrasher and Gray 2010)

<table>
<thead>
<tr>
<th><strong>NIOSH Recommended Exposure Limit (REL)</strong>: 10 ppm, 10-minute ceiling</th>
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<tbody>
<tr>
<td><strong>Concentration considered immediately dangerous to life and health (IDLH)</strong>: 100 ppm</td>
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<tr>
<td><strong>ACGIH\textsuperscript{®} recommends a threshold limit value (TLV\textsuperscript{®}) of 1 ppm as an 8-hour time weighted average (TWA) and a short-term exposure limit (STEL) of 5 ppm.</strong></td>
</tr>
</tbody>
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(Skrtic 2006)
At least 15.3 million Americans lived within a mile of a well that has been drilled since 2000. That is more people than live in Michigan or New York City. *Wall Street Journal* 2013 Oct 25

**Oil and Gas Wells Near Residences, Pavillion Area, Fremont County, WY**

Figure: Residents have health issues they fear are from water contamination caused by oil and gas development. Air sample results in the Pavillion area exceed health-based standards, causing residents to worry that air emissions are also impacting their health. Our data shows high levels of volatile organic compounds coming from production equipment and produced water tanks near their homes and farms.

- Development Site
- Residence

Holes in Data: Existing Stationary Monitors are Insufficient

(Data from FracTracker, US EPA, US Census)

(Matz 2015)
Holes in Data: Brief History of H₂S Regulation

TRI Reporting is not required for downstream oil and gas operations

1990 - Clean Air Act Passed, H₂S on list of extremely hazardous substances (1 of 2 to be struck)
1994 EPA placed an administrative stay on H₂S reporting (lasted 17 years)
2012 Reporting for H₂S is required
   But oil and gas industry is exempt from TRI reporting at downstream facilities (wellheads and impoundments).

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GAO (2012:35): “If oil and gas exploration and production were added to the industries required to report to the TRI, such facilities meeting relevant thresholds would have to report releases of hydrogen sulfide.”
No Protection for Residents

Deb Thomas at the Crosby drill pad near her Wyoming home.

(Warning Signs 2014)
RANCH DEAVER AREA, WYOMING
Research on chronic exposure to H$_2$S

- Respiratory distress
- Headaches
- Depression
- Central Nervous System Disorders
- Fatigue
- Dizziness
- Anxiety
- Sleep problem
- Memory Loss
- Miscarriage

Women employed in rayon textile and paper products jobs in Finland were found to have an increased rate of spontaneous abortions when the mean annual level of hydrogen sulfide exceeded 3 ppb (Hemminki and Niemi 1982).

An increase in spontaneous abortions was also found in women working in petrochemical plants in China as compared to women working in non-chemical plants (Xu et al. 1998).

(Skrtic 2006)
Present \( \text{H}_2\text{S} \) Monitoring tools are inaccessible for communities:

- High-cost
- Designed for expert use
- Designed for Industry to meet OSHA standards
- Designed for emergency situations
- Acute, high does exposures
- To monitor individual exposures

How does the community exposure experience differ?

H$_2$S From Community Perspective:

**Exposure Experience:**
- Low dose
- Chronic exposures
- Community rather than individual exposures
- Environmental and non human health rather than just human health

**Social Exposure Experience:**
- Agency inattention
- No training about risks
- Absence of data
- Lack of regulations
- Low social and economic capital relative to industry
- Ambivalence: a feeling of “being beaten down”
Photopaper Method:
Could this Empower Communities and call Attention to $\text{H}_2\text{S}$ Data Gap?

- Low cost
- Designed and developed with exposed communities
- Easy to use
- Map large areas effectively
- Easy to include controls
- Results are visually compelling
- Results are readily interpreted
- Sensitive to low levels:
  - .03 ppm-2.5 ppm
How Do You Make It?
“When we’ve had oil pipeline breaks, the raw oil smell makes my nose and my eyes burn…”

“…makes my lungs hurt, my chest hurt, makes me real sleepy, and really dummy. You’re kinda’ dizzy and just not all there.”

Family Ranch Deaver, Wyoming

Results After 8 Days

Results After 23 Days

(Image credit: Megan McLaughlin)
Sampled levels of $\text{H}_2\text{S}$ are 735 X’s greater than the intermediate exposure threshold of the Federal ATSDR Standards.

(Macey et. al. 2014)
All results support the finding that greatest amount of H2S is found in drainage canal, this is scary because it can mix with irrigation and surface water that waters crops and livestock.
Publication and Public Lab Results:

Sensing Hydrogen Sulfide from CAFO Emissions in Poweshiek County, Iowa

by sophie | July 16, 2014 15:04 | 630 views | 3 comments

sophie was awarded the Empiricism Barnstar by Shannon for their work in this research note.

Background

In Poweshiek County, Iowa, there are over 45 confined animal feeding operations, and due to their waste management strategies, emissions from the manure, including hydrogen sulfide, often become airborne and reach people living in adjacent communities. The legal limit of hydrogen sulfide in Poweshiek County is 30 ppb for one hour up to seven times per year, and this summer a research group from the University of Iowa is monitoring H2S levels at nearby homes to determine whether levels are in fact within those permitted by the law. As a part of my contribution to this project, I am evaluating whether the DIY photographic paper method of H2S sampling originally designed by Claire Horwitz et al. can be applied to CAFO emissions, specifically at levels at or below 30 ppb. I will deploy my samplers side-by-side with the conventional passive samples in order to calibrate them. It is my hope that, if this method is successful, people living near CAFOs will be able to easily collect reliable data to find out whether they are at any risk from H2S exposure.

Goals

• Determine if and how well this method can be applied to CAFO emissions, especially at or below 30 ppb • Find a relatively easy method of quantifying data • Create maps of H2S emissions, possibly using MapKnitter • Promote method to communities to crowd-source H2S monitoring

Making and Light-proofing the Samplers

To make the samplers, I followed the procedure described by Horwitz et al. and posted on other Wikis. The only alteration I made was that instead of hanging each strip to dry on a clothespin, I left them face-up on a bed of paper towels for >12 hours, due to lack of a private darkroom. I then needed a way to deploy them in the field such that light could not reach them but air could, so I designed an air sampling box that contains a series of baffles that allow air but not light in.
Public Lab Tools Currently In development

Balloon & Kite Mapping
Near-Infrared Camera
Thermal photography
Spectrometer
Indoor Air Quality Mapping
Kite-Balloon Hybrid

Balloon Telemetry Kit
Stereo Camera
Hydrogen Sulfide Sensing
Home Testing for Endocrine Disruptors
Water Quality Sensor
Air Column Monitor

http://publiclab.org/tools
http://publiclab.org/wiki/posters
How Can Public Health Laboratories Support Citizen Science?

• Advise on the development and testing of citizen science tools.

• Support community’s scientific research and planning.

• Act as libraries for low cost citizen science tools
Validate Citizen Science Tools

Sensor Evaluation Report

Air Sensor Guidebook
Support Citizen Science Research
Lending Libraries for Citizen Science Kits
Creating an infrastructure for rigorous, responsive research that supports agencies and the public.

Open Source Research Tools-- low cost, DIY tools, that are in the public domain

Open Source Software--Publicly accessible databases and maps that enable rapid grassroots reporting and analysis across communities

• Study Large Scale Industries and Shared Environmental Health Problems

• From Community to Community

• Fuse Community learning/Advocacy and Academic/Regulatory Analysis

• And Improve Monitoring while Facilitating Basic Research on previously Inaccessible Problems

Emerging Health Threats  Health Disparities/CBPR  Interdisciplinary Collaboration  Scientific Literacy
Thank you!

• Research Team
  - Caitlin Kennedy (Drew University)
  - Megan McLaughlin (RISD)
  - Elisabeth Wilder (Northeastern University)
  - Hannah Gartner (Northeastern University)

• Community Partners and Collaborators
  - Clark Resource Council
  - Powder River Basin Resource Council
  - San Juan Citizen's Alliance

• SSEHRI/Northeastern University

• Public Lab (www.publiclab.org)

• ShaleTest.org