

Civic Science: Building Tools and Platforms for Rigorous Public Research

Sara Wylie PhD

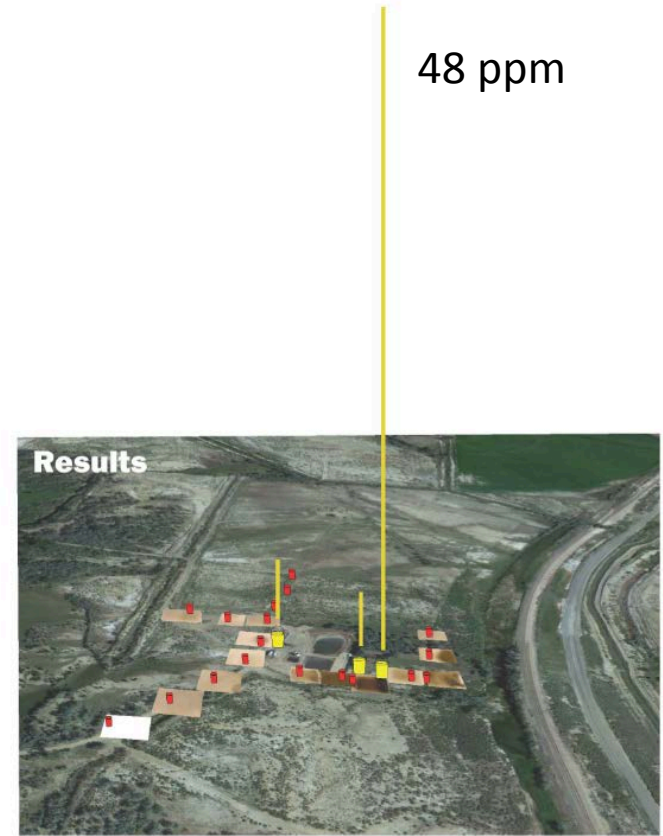
Assistant Professor of Sociology/Anthropology

And Health Sciences

Northeastern University

Publiclab.org co-founder/organizer

JPB Environmental Health Fellow



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's Background



Example of grassroots map



Helium balloon with digital camera attached



Grassroots mapping kit

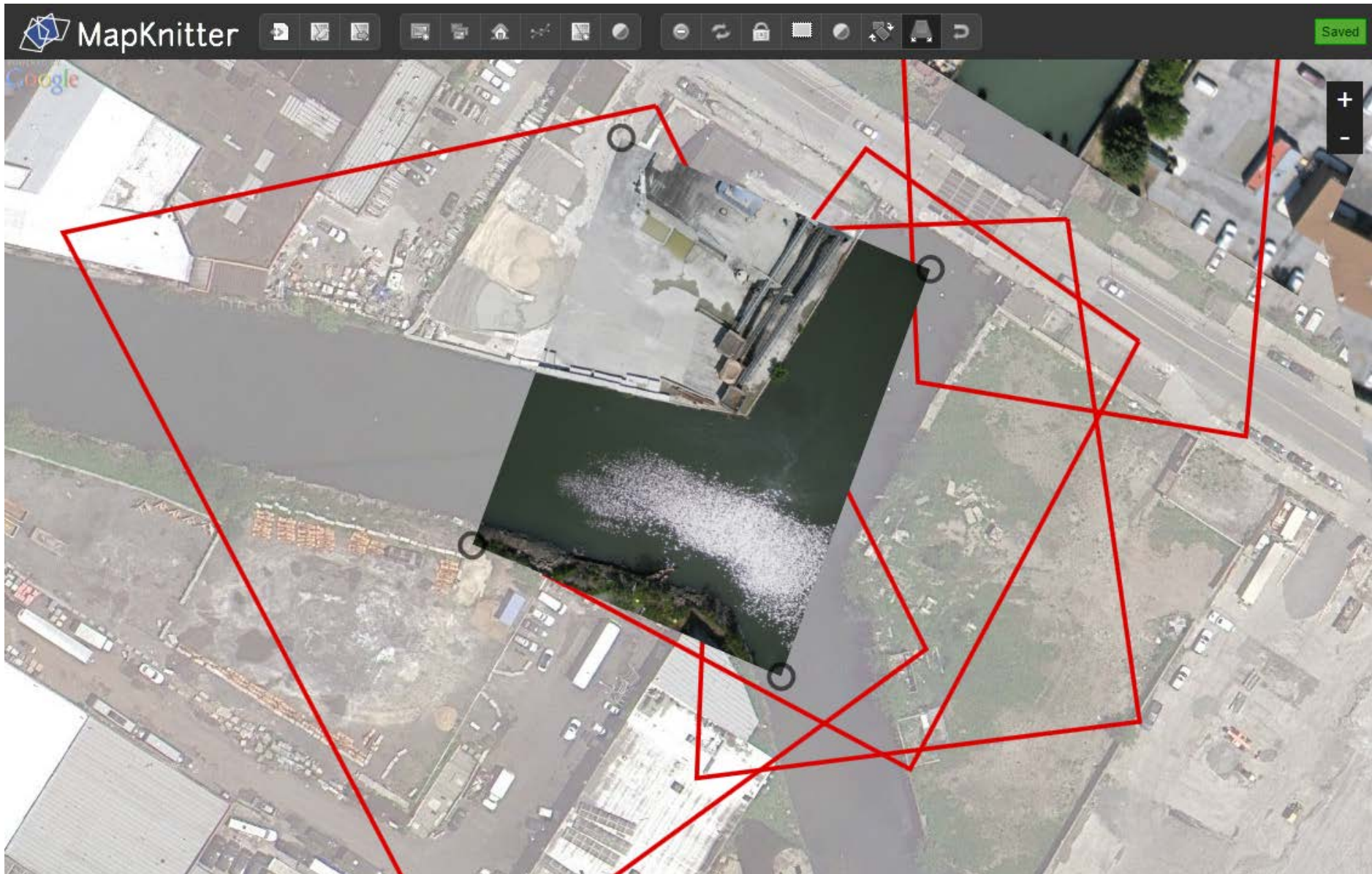
Public Lab started through developing a cheap method of making satellite-like maps using helium balloons and digital cameras. The method was used during the BP gulf oil spill by communities to create a public archive maps documenting damage from the spill.

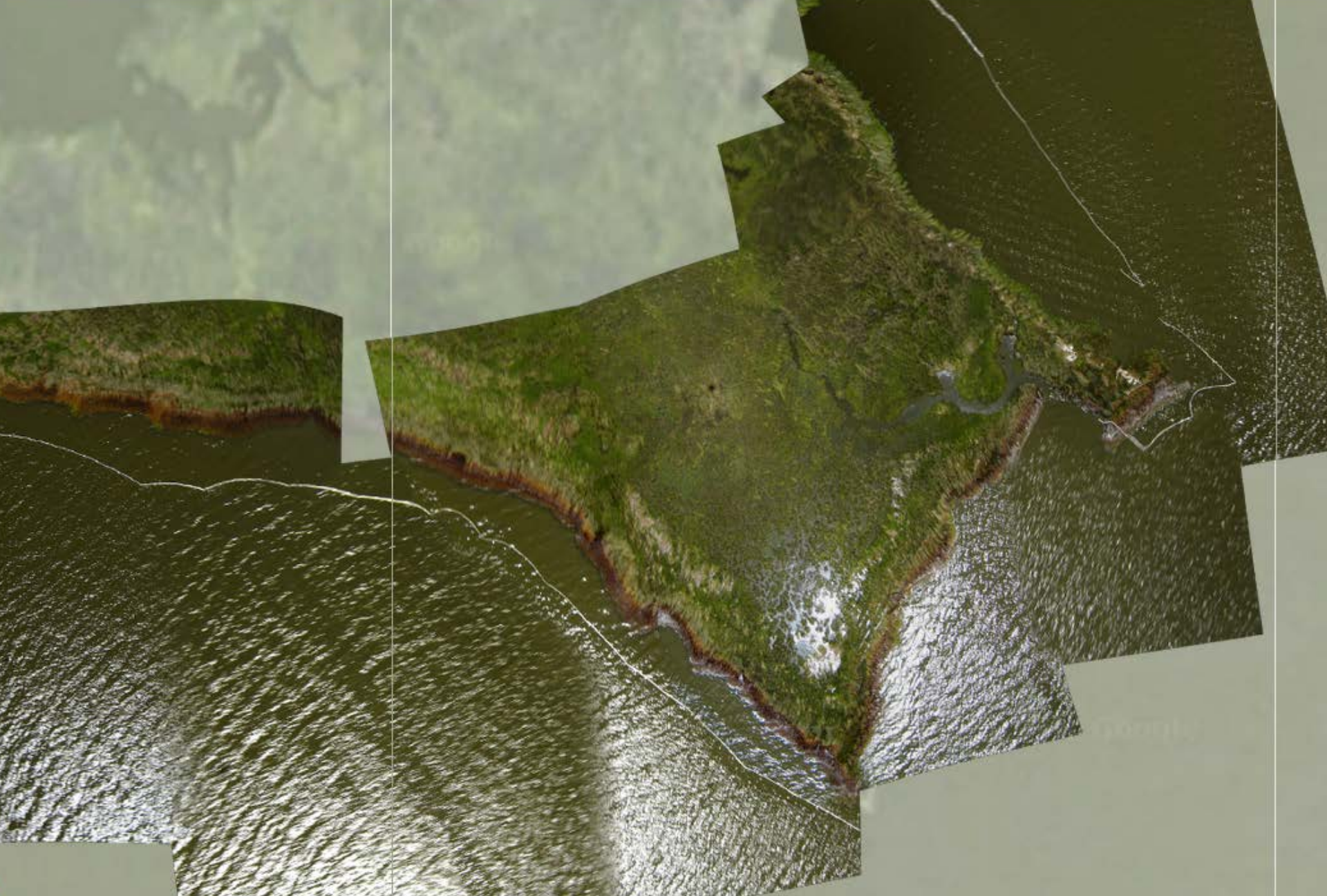
Publiclab.org

Health Disparities/CBPR

Emerging Health Threats

Mapknitter.org





ERMA GULF RESPONSE

Management

Information Help Recent Data Find



Layers Legend Query Tool

BP Deepwater Horizon Oil Spill

Wellhead Surface Location

- Wellhead

18-Jun-12 SCAT Oiling Ground Observations

- Heavy
- Moderate
- Light
- Very Light
- No Oil Observed
- Trace < 1%

7-22-10 Shoreline SCAT Oiling Ground Observations (Date)

- No Oil Observed
- Tar Balls (< 1% cover)
- Very Light
- Light
- Moderate
- Heavy



20 m
100 ft

Imagery ©2012, Map data ©2012 - Terms of Use

Scale: 1: 1693 Zoom Level: 18 Location: 29.47609°,-89.91019°



G070701-002



Can we do better?

Jen Hudon

gomex.erma.noaa.gov/erma.html#x=-89.90833&y=29.47981&z=18&layers=5723+20461+7391

ERMA GULF RESPONSE

Information | Help | Recent Data | Find

Environmental Response Management Application (ERMA)

Layers | Legend | Query Tool | Zoom

BP Deepwater Horizon Oil Spill

Wellhead Surface Location

- Wellhead

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Scale: 1: 1693 Zoom Level: 18 Location: 29.48100°,-89.90991°

publiclaboratory.org/map/wilkinson-bay-northeast-louisiana/2010-07-22

Content management | Site building | Site configuration | Messaging & Notifications | User management | Reports | Advanced help | Help

Scale: 1: 1693 Zoom Level: 18 Location: 29.48100°,-89.90991°

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

Post research

Create wiki page

Mailing lists

Much of our work happens on our mailing lists, which are organized by region and topic. Join one today to get involved.



2 Challenges to solve real-world environmental problems with DIY spectrometry • by Public Lab



Desktop Spectrometry Kit
\$40

Buy Now



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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.



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.



A platform to build collaborations

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

publiclab.org

Forum for Public R+D

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Balloon & Kite Mapping

[View](#) [What links here](#) [Edit](#) [Revisions](#) [Tags](#) [Track](#)



How Can I Do This?

Our whole toolkit is linked out below, but really fast:

- 1) [Buy our balloon kit](#), [assemble your own](#), or [buy/make a kite](#).
- 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 [quickstart 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,



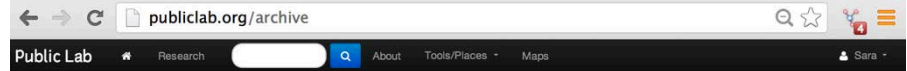
Balloon mapping kits are now available:

[Purchase a kit](#) »

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)
- [maning](#) (2)



Did you know that Public Lab is an open community supported by a nonprofit? [Donate](#) »



Maps

open data from balloon and kite photography

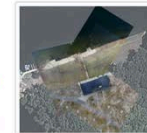
Do-It-Yourself "satellite" imagery

These maps were largely made by [taking photos from balloons and kites](#), a technique adopted 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



Montgomery Bell State Park, Burns, Tennessee

by TNGIC | 4 months ago | [📍](#) | [🌟](#) | [🔍](#)



Rotsoord, Utrecht, Netherlands.

by kelpme, Kelpme de Heer | 3 months ago | [📍](#) | [🌟](#) | [🔍](#)

I just set up a new media lab in Utrecht, the Netherlands called Rotslab. We are geared towards r...



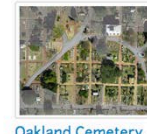
Washington Crossing, Pennsylvania.

by seanmoginnis | 4 months ago | [📍](#) | [🌟](#) | [🔍](#)



Midtown Atlanta, Atlanta, Georgia.

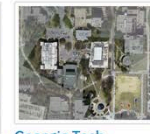
by The Final Five | 3 months ago | [📍](#) | [🌟](#) | [🔍](#)



Oakland Cemetery, Atlanta, Georgia.



Georgia Tech



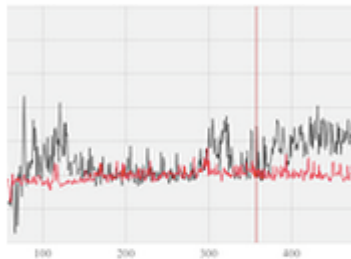
Georgia Tech TV

create collaborative workflows

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Research notes for balloon-mapping

Quick process notes and field reports



[Analytics on aerial images -- using](#)



[Coded ground control points](#)

by: [Jasja](#)
1 week 1 day ago

Ground control point targets are useful to stitch photos on uniform or repetitive landscapes. They...
[Read more](#) »



[3-D Images- Big Branch Balloon Mapping](#)

by: [astoicof](#)
1 week 2 days ago

After the balloon mapping trip at Big Branch National Wildlife Refuge on May 14th 2012, I created...
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Tags: [big-branch](#), [gulf-coast](#), [louisiana](#)

Share your work

Title

B *I* Header Templates Help

##What I want to do

##My attempt and results

##Questions and next steps

Drag & drop to add an image, or [choose an image](#)

balloon-mapping, new-york

[Publish](#) [Preview](#)

By publishing, you agree to [open source your work](#) so that others may use it.

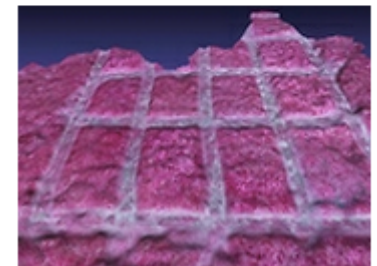
Main image

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[Point plane marsh restoration over time: air vs ground](#)



[FABAoutfit for vertical KAP and BAP](#)
by: [Juan](#)



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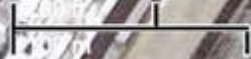
CERN Open Hardware 1.0
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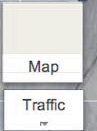
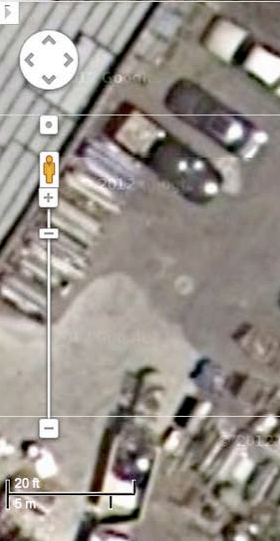
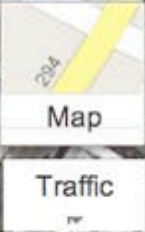
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How can this improve science?



Discovery of unmapped spring



News Release

Region 2 - New Jersey, New York, Puerto Rico and the U.S. Virgin Islands



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.



**Grassroots Community Data Collection
helped focus attention on this site**

<http://publiclab.org/wiki/new-york-city>

Data Gaps

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?



Images from "2011-7-31-brooklyn-gowanus-vis-b"

Sorted best to worst | [sort only this site](#) | [view unsorted from this site](#)

(733 images, 49.5/100 average, ~33.54 votes per image, 100% have votes, >58 participants)

10 out of 10 | 1 reviewers
[Open in Knitter »](#)




± = -

10 out of 10 | 1 reviewers
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± = -

8 out of 10 | 6 reviewers
[Open in Knitter »](#)




± = -

8 out of 10 | 5 reviewers
[Open in Knitter »](#)



± = -

8 out of 10 | 4 reviewers
[Open in Knitter »](#)



± = -

Images from "sandy"

Sorted worst to best | [grid](#) | [sort this site](#) | [view unsorted](#)

(531 images, 64.5/100 average, ~68.71 votes per image, 100% have votes, >106 participants)

« Previous 1 2 3 4 5 6 7 8 9 ... 26 27 [Next](#) »

0 out of 10 | 12 reviewers



0 out of 10 | 13 reviewers



0 out of 10 | 13 reviewers



0 out of 10 | 14 reviewers



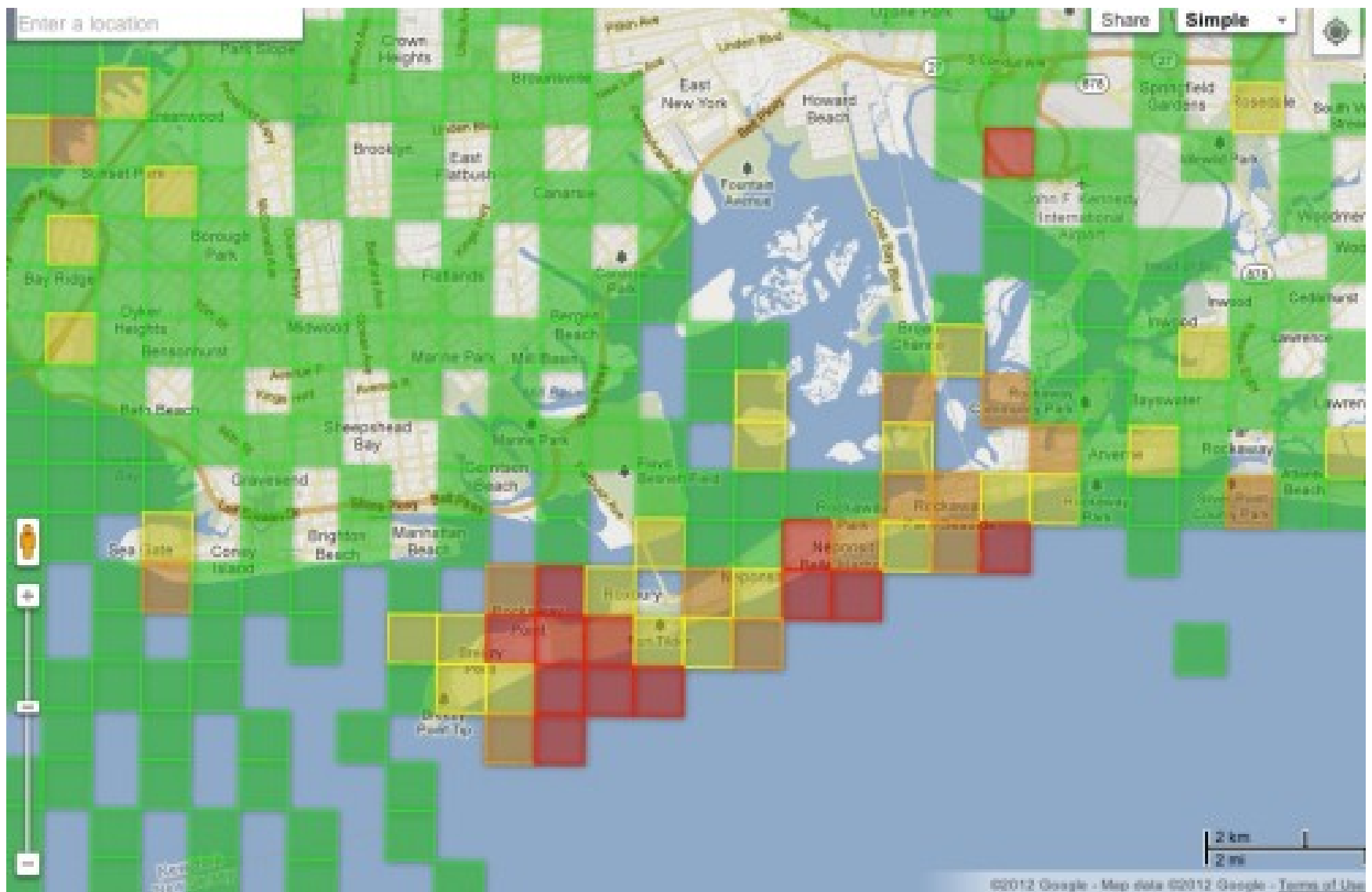
1 out of 10 | 6 reviewers



1 out of 10 | 6 reviewers



<http://queens.brownstoner.com/2012/12/mapmill-adds-crowdsourcing-options-to-the-google-crisis-map-post-hurricane-sandy/>



over 130,000 assessments by over 6000 online individuals in one week.

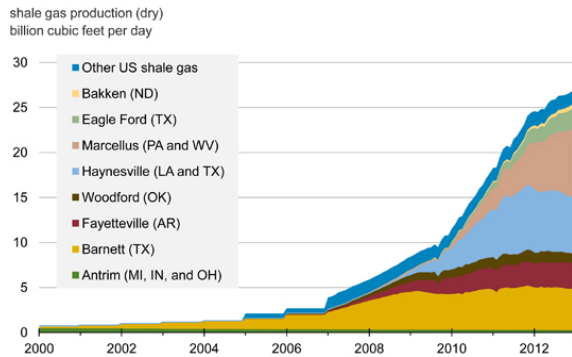
Emerging Health Threats

Data Gaps

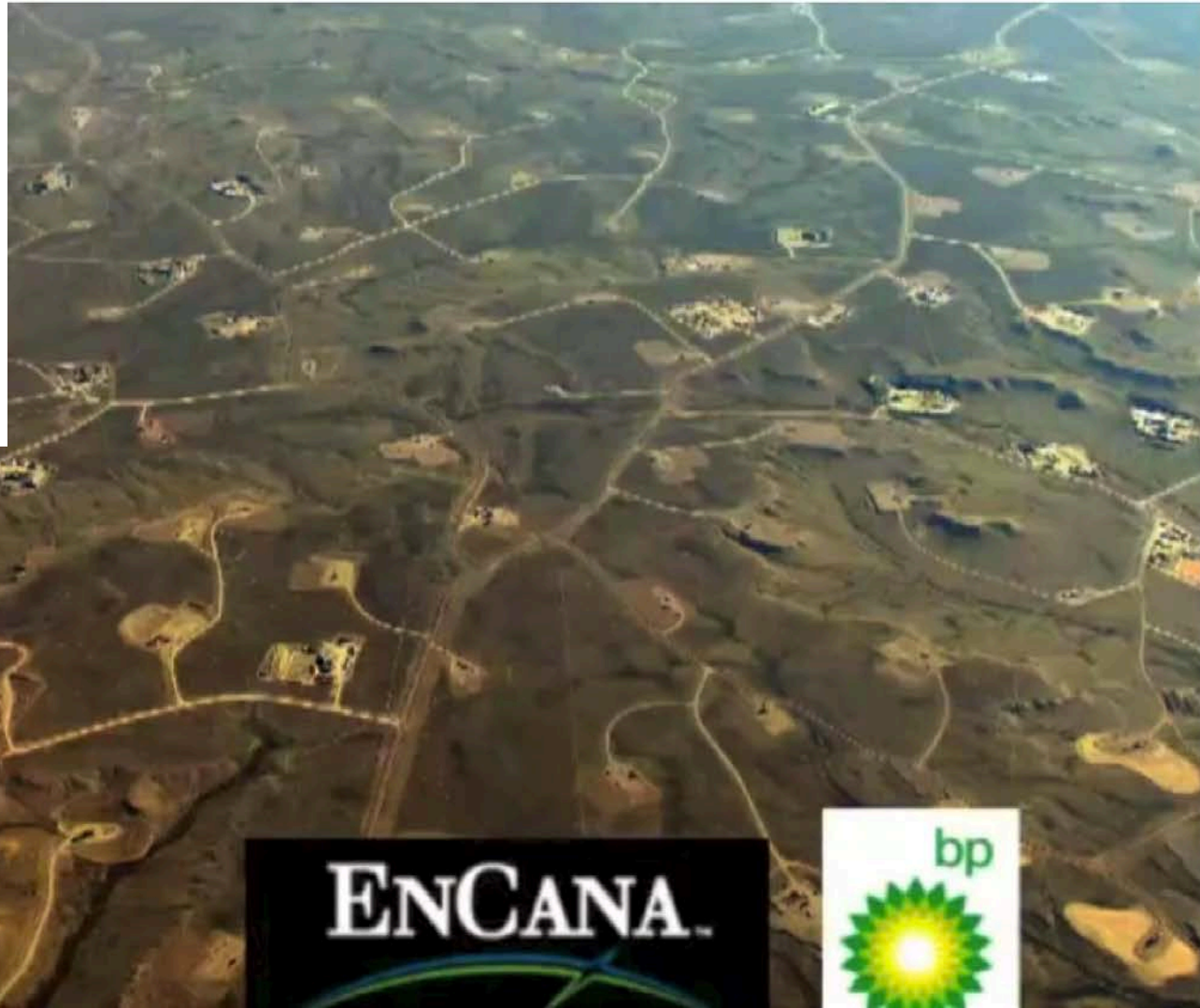
Health Disparities/CBPR

Growth of Unconventional Oil and Gas

"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)



Sources: LCI Energy Insight gross withdrawal estimates as of January 2013 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.



ENCANA.



Background: What is Hydrogen Sulfide (H₂S)?

- 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)

NIOSH Recommended Exposure Limit (REL): 10 ppm,
10-minute ceiling

Concentration considered immediately dangerous to
life and health (IDLH): 100 ppm

ACGIH[®] recommends a threshold limit value (TLV[®])
of 1 ppm as an 8-hour time weighted average (TWA)
and a short-term exposure limit (STEL) of 5 ppm.



(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

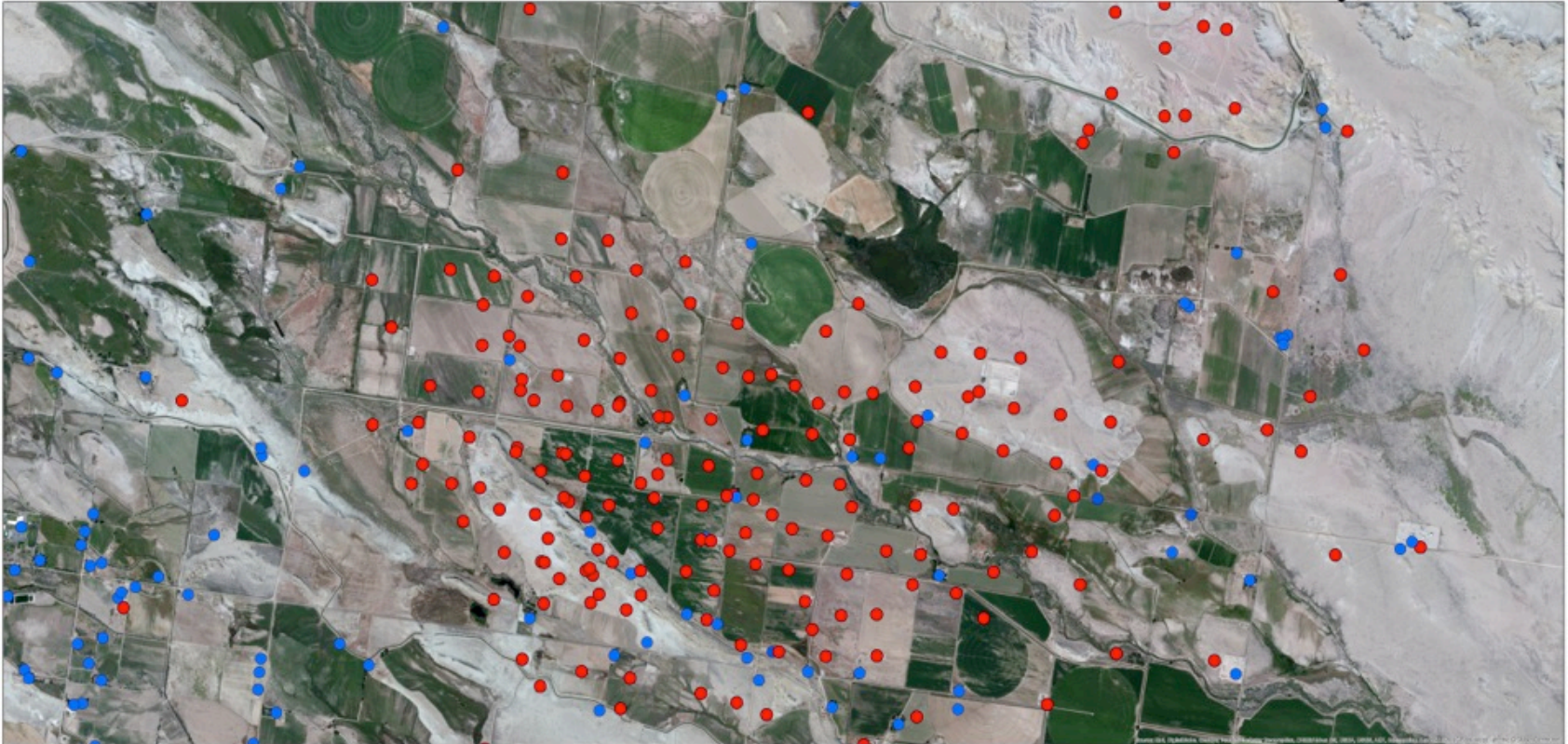
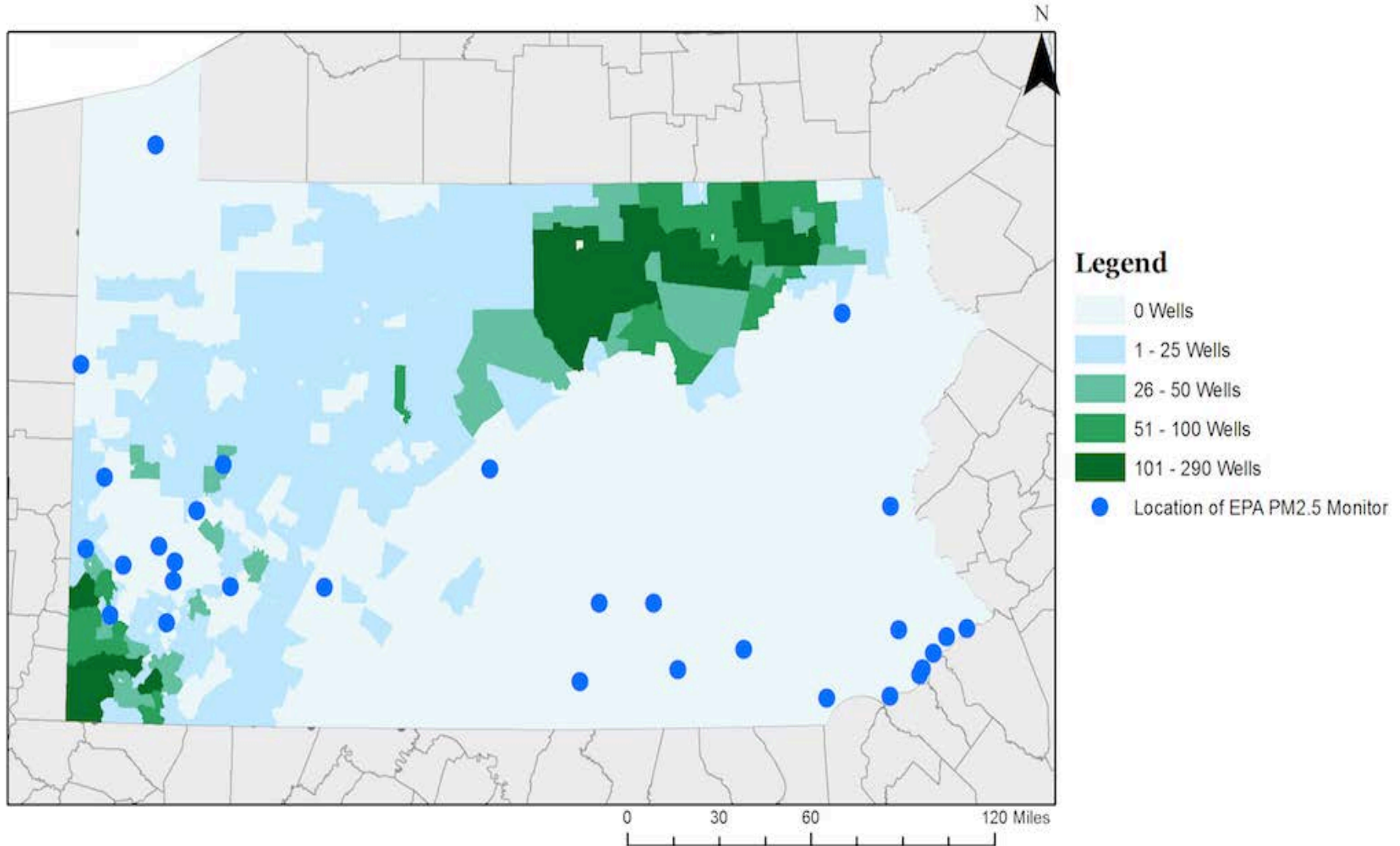


Figure : Residents have health issues they fear are from water contamination caused by oil and gas development. Air sample results in the Pavillion area exceed health based standards, causing residents to worry that air emissions are also impacting their health. Our data shows high levels of volatile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

● Development Site ● Residence 0 0.425 0.85 1.7 Miles



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).

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.”

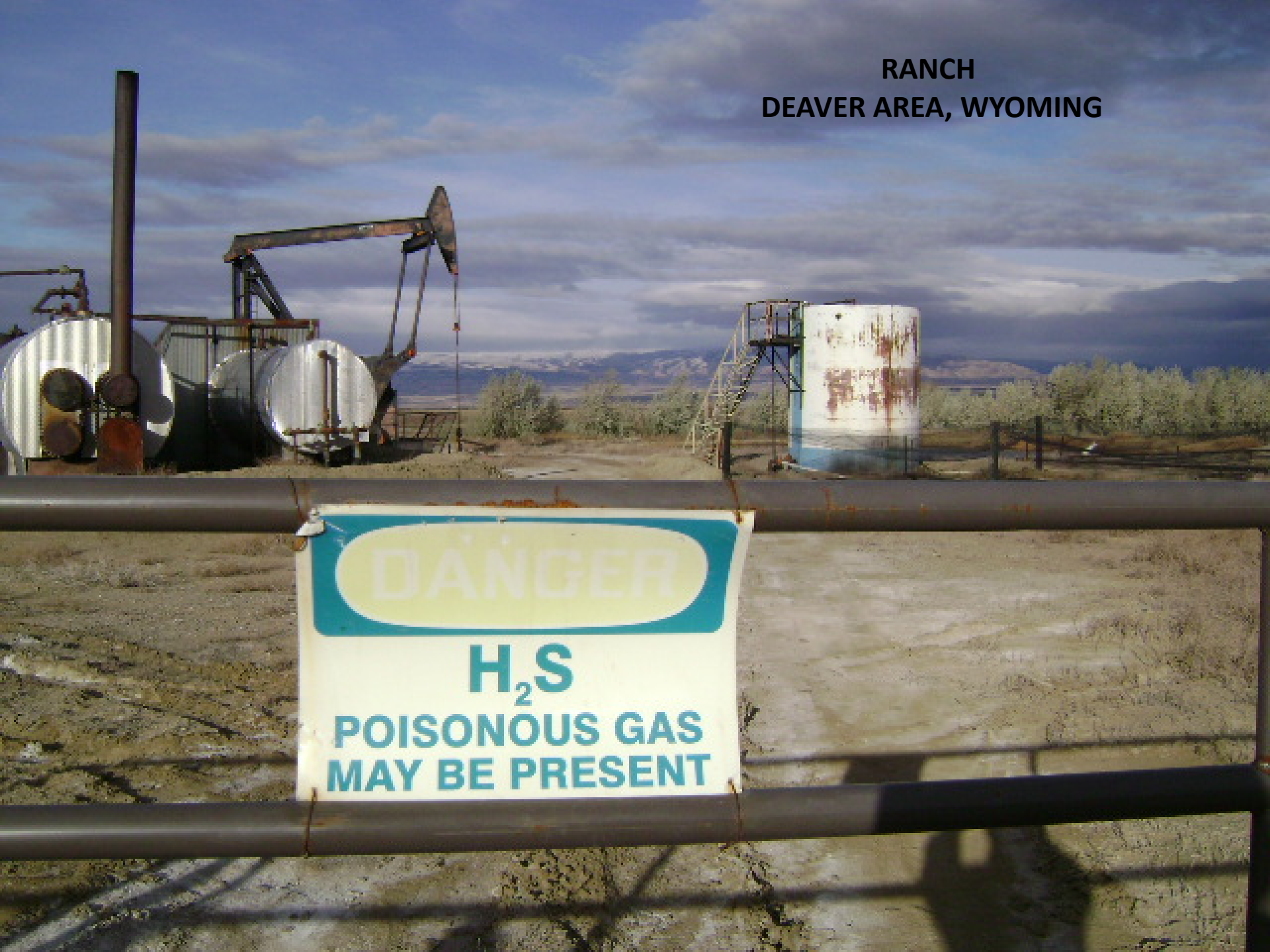
No Protection for Residents



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

(Warning Signs 2014)

RANCH
DEAVER AREA, WYOMING



DANGER

H₂S

**POISONOUS GAS
MAY BE PRESENT**

Research on chronic exposure to H₂S

- 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).

Chronic Exposure	Parti-Pellinen et al. (1996)	Medicine / Public Health	Examined health effects chronic, low-level exposure to sulfur compounds, including H ₂ S, near a paper and pulp mill; administered cross-sectional questionnaire to 336 subjects and to a reference community; increased frequency of eye and nasal symptoms, coughs, and headaches or migraines, and acute respiratory infections.
	Legator et al. (2001)	Medicine / Toxicology / Public Health	Investigate effects of chronic exposure to low levels of hydrogen sulfide; multi-symptom health survey submitted to two exposed communities – Odessa, Texas and Puna, Hawaii, and to control communities; found central nervous system impacts: fatigue, restlessness, depression, short term memory loss, balance and sleep problems, anxiety, lethargy, headaches, dizziness, tremors; respiratory system impacts: wheezing, shortness of breath, coughing; and various ear, nose, and throat symptoms.
	Tarver and Dasgupta (1997)	Chemistry	To determine hydrogen sulfide concentrations near oil fields in Western Texas
	Xu et al. (1998)	Medicine / Epidemiology	To determine effects of exposure to hydrogen sulfide on the reproductive system; conducted a retrospective epidemiological study to assess the association between spontaneous abortion and exposure to petrochemicals in Beijing, China; found an association.
	Kilburn (1999)	Epidemiology	To determine long-term effects of exposure to hydrogen sulfide; examined and submitted a questionnaire to four groups of people that were exposed to hydrogen sulfide (from boreholes in the ground, downwind of a refinery, due to an oil refinery explosion, and a group of people exposed to odors); found abnormal balance, delayed verbal recall, impaired color discrimination and grip strength.
	Schiffman et al. (1995)	Psychiatry	To determine the effect of persistent environmental odors on the mood of people living near the source of odors; submitted a questionnaire to 44 subjects and 44 controls; found more tension, depression, fatigue, and confusion, and less vigor among the exposed subjects.
	Kilburn (2003)	Epidemiology	To measure long term effects of hydrogen sulfide exposure – various lengths of exposure and various concentrations; submitted a questionnaire, and performed neuropsychological and neurophysiological tests on 19 exposed subjects and 202 unexposed subjects; found elevated tensions, depression, anger, fatigue, and confusion, and more prevalent respiratory symptoms among exposed subjects.

(Skrtic 2006)

Present H₂S 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 dose exposures
- To monitor individual exposures

How does the community exposure experience differ?

H₂S From Community Perspective:

Exposure Experience:

- Low dose
- Chronic exposures
- Community rather than individual exposures
- Environmental and non human health rather than just human health

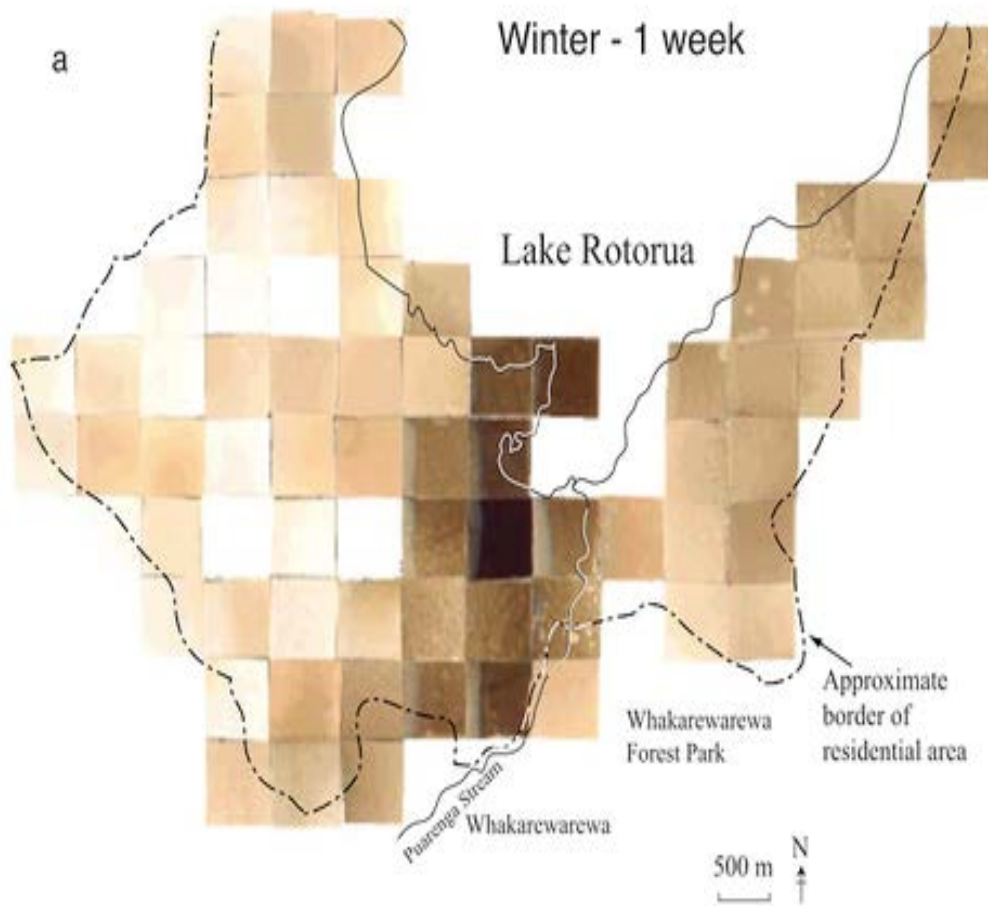
Social Exposure Experience:

- 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 H₂S Data Gap?

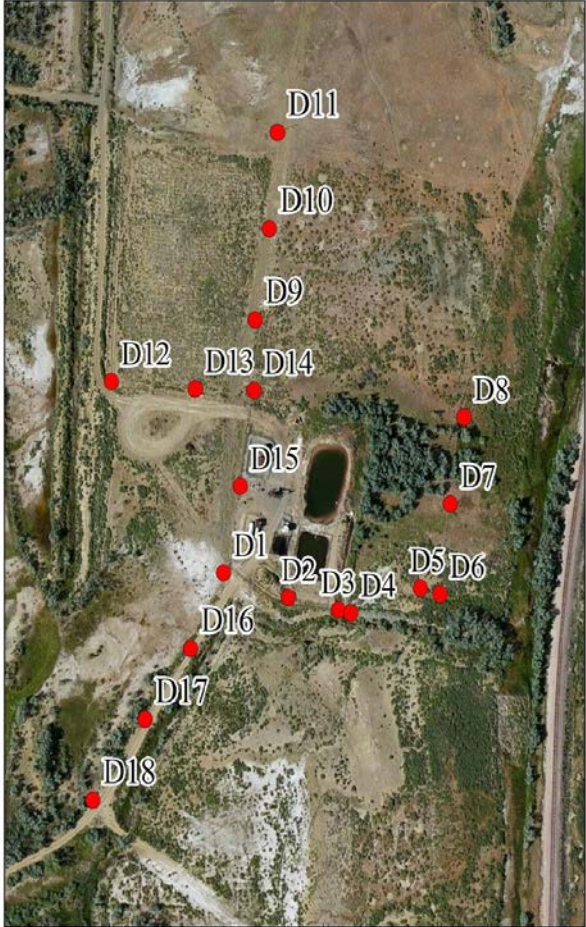
C.J. Horwell et al. / Journal of Volcanology and Geothermal Research 139 (2005) 259–269



- 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



H2S Canisters, McMullan Property, Deaver Area, WY



0 0.02 0.04 0.08 Miles

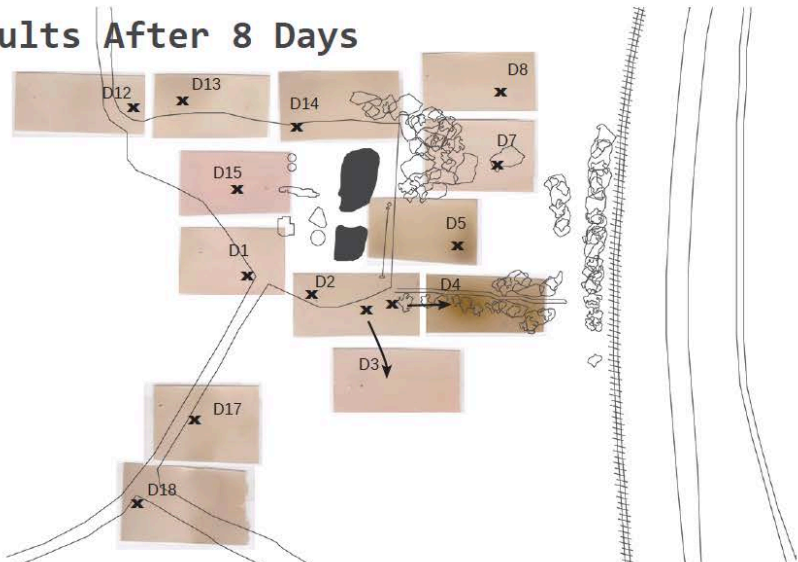
Author: Cait Kennedy Data Frame: NA Equidistant Conic
 Geographic Projection: NAD 1983 Source: Garmin etrex Device
 Date: Summer 2013

How Do You Make It?

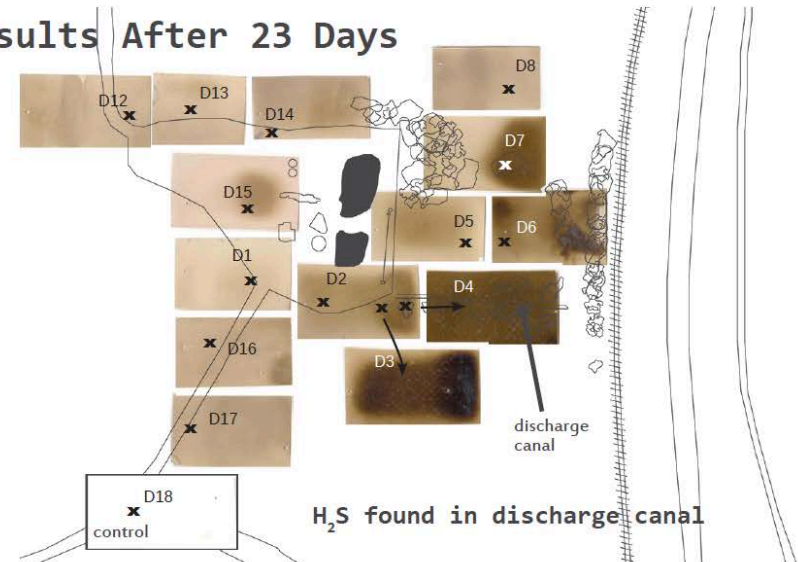




Results After 8 Days



Results After 23 Days



(Image credit: Megan McLaughlin)

48ppm



Sampled levels of H_2S 735 X's greater than the intermediate exposure threshold of the Federal ATSDR Standards

(Macey et. al. 2014)

(Image credit: Megan McLaughlin)



48ppm

Health Disparities/CBPR

Emerging Health Threats

Scientific Literacy

Data Gaps



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.

(Image credit: Megan McLaughlin)

Publication and Public Lab Results:

Public Lab Research About Participate Data Donate

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Sensing Hydrogen Sulfide from CAFO Emissions in Poweshiek County, Iowa

by [sophie](#) | July 16, 2014 15:54 | 630 views | 3 comments

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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 Horwell 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 samplers 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 Horwell 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



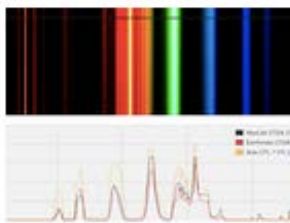
[Balloon & Kite Mapping](#)



[Near-Infrared Camera](#)



[Thermal photography](#)

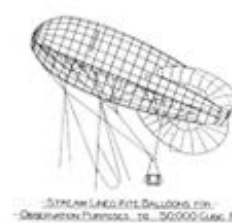


[Spectrometer](#)

Status: [In development](#)



[Indoor Air Quality Mapping](#)



[Kite-Balloon Hybrid](#)



[Balloon Telemetry Kit](#)



[Stereo Camera](#)

Status: [In development](#)



[Hydrogen Sulfide Sensing](#)



[Home Testing for Endocrine Disruptors](#)



[Water Quality Sensor](#)

Status: [Early adopter only](#)



[Air Column Monitor](#)

Status: [In development](#)

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.

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