



Leveraging citizen science for research and environmental public health through the Smoke Sense initiative:
Addressing the growing wildfire smoke problem

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Disclaimer: The views expressed in this presentation do not necessarily reflect the views or policies of the U.S. EPA.

Smoke Sense

- There is a gap between the recommended actions and the observed public health outcomes.
- **Smoke Sense:** citizen science outreach and research initiative - understanding the gap between what we know about risk and ways to protect our health and the observed public health outcomes.

Research Objective

- Learn personal motivations in adopting health protective behaviors
- Understanding health risk messaging



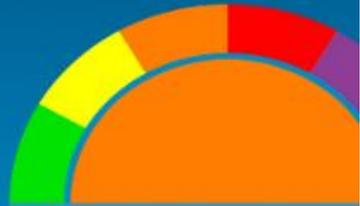
Smoke Sense

Quality Index

27612

Current AQI

AQI Tomorrow



Moderate

Unhealthy: Sensitive Groups

Particle 35

Particle

Ozone 85

Ozone



Symptom & Smoke Observations



Fire & Smoke Near Me



Smoke Smarts



Air Quality 101

Smoke Sense makes smoke and health resources easily available when and where we need them and explores why and how these gaps exist.

Smoke Sense promotes:

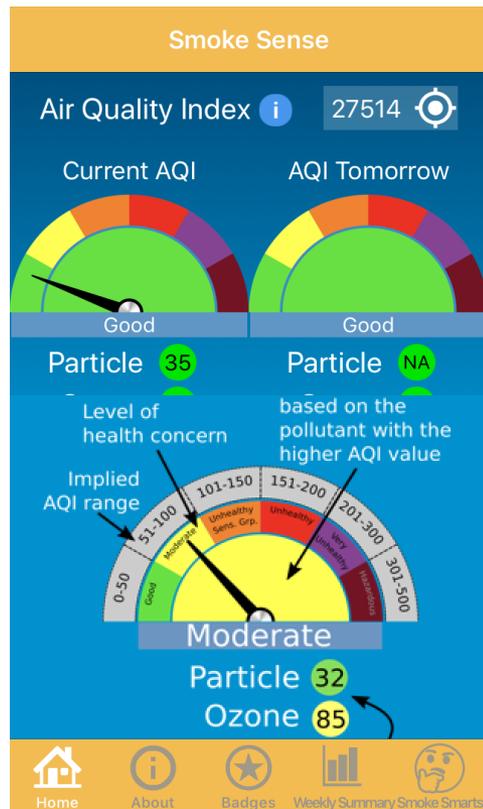
- Issue engagement and education
- Making a personal connection between changes in the environment and our health
- Raising personal awareness about the salience of changing behavior during smoke events.

Mobile application - Available on iOS & Android.

Innovative methodology for learning what personal motivations play role during the smoke episodes; data that is otherwise not available.

This study can inform health risk communication about wildland fire smoke by providing insights into the experiences with smoke, risk perception, self-efficacy, and information needs of individuals who are seeking health risk communication on the topic.

Designed to progression toward adoption of desired exposure-reducing behaviors:
Health Risk Information



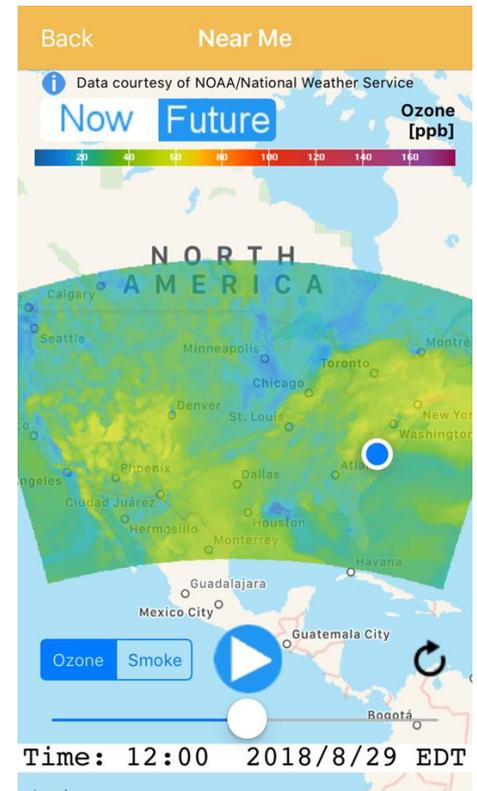
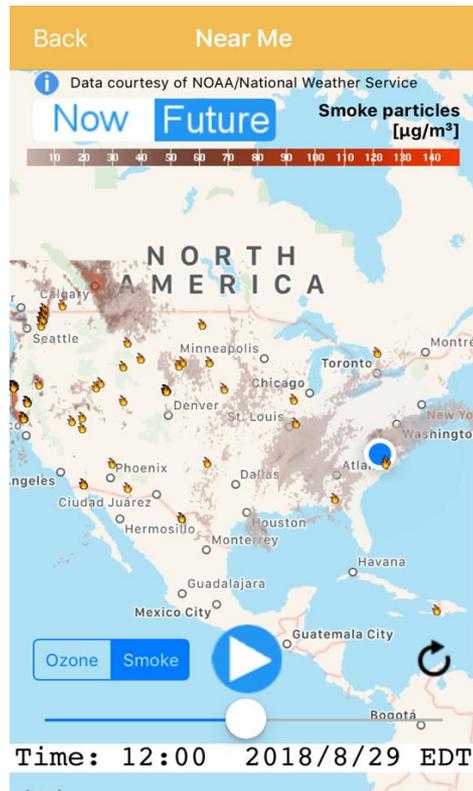
The Smoke Smarts app interface displays the following information:

- Back** (Header)
- Smoke Smarts** (Header)
- Many indoor activities including smoking cigarettes, using gas, propane and wood-burning stoves and furnaces, spraying aerosol products, frying or broiling meat, burning candles and incense, and vacuuming can increase air pollution indoors.** (Text)
- Next** (Button)

The Air Quality 101 app interface displays the following information:

- Back** (Header)
- Air Quality 101** (Header)
- Week 17 (Aug 27 - Sep 02)** (Text)
- Sanjay is creating a clean room for use during a smoke event. The clean room will help his family reduce exposure to particle pollution.** (Text)
- True** (Button)
- False** (Button)
- Save** (Button)

Viewing Smoke & Forecasting Data



Reporting Smoke & Health Symptoms

Back Observations

REPORT YOUR SYMPTOM AND SMOKE OBSERVATIONS

◀ Week 16 (Aug 20 - Aug 26) ▶

 Smoke Observation Yes No

 Health Symptoms Yes No

 Change Reporting Location >

Save

Back Smoke Observations

Did you smell smoke outside your home/workplace/school during this time?

Not at all

1-2 days

3+ days

Did you smell smoke inside of your home?

Not at all

1-2 days

Back Health Symptoms

Have you experienced smoke recently?

Yes, I experienced smoke this week

Yes, I experienced smoke in the last month but not this week

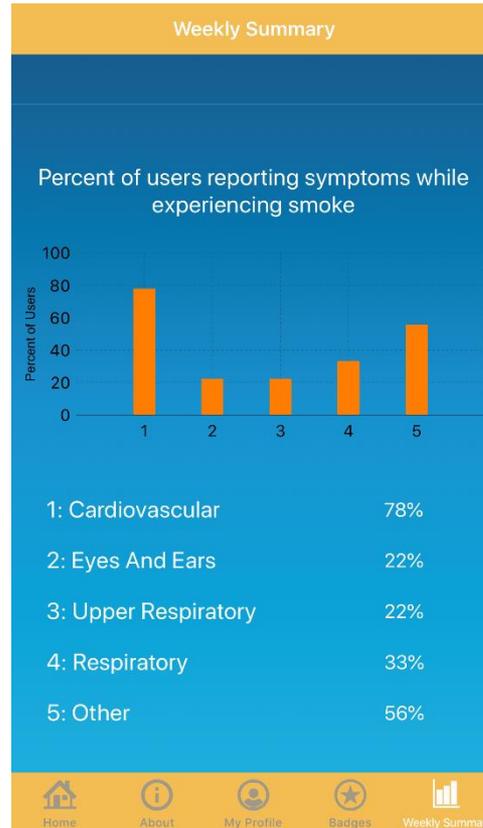
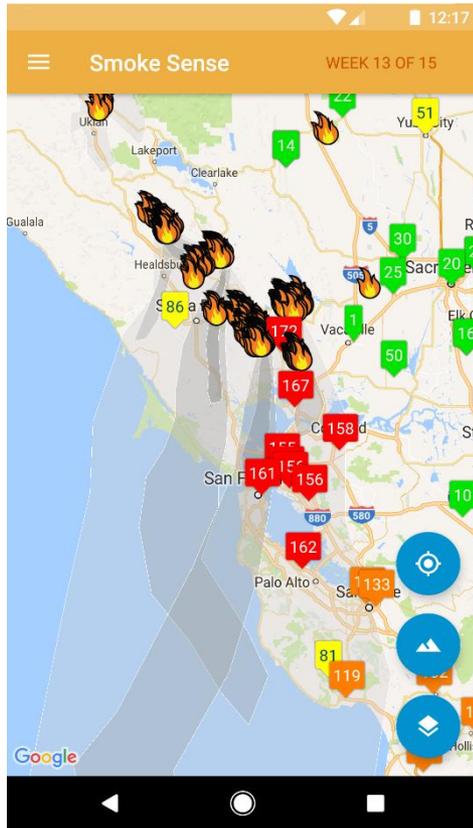
No, I didn't experience smoke

Thinking about the past week, I experienced the following symptoms: (Select all that apply)

Stinging, itching, or watery eyes

Ear or other viral infections

Normative and Social Learning



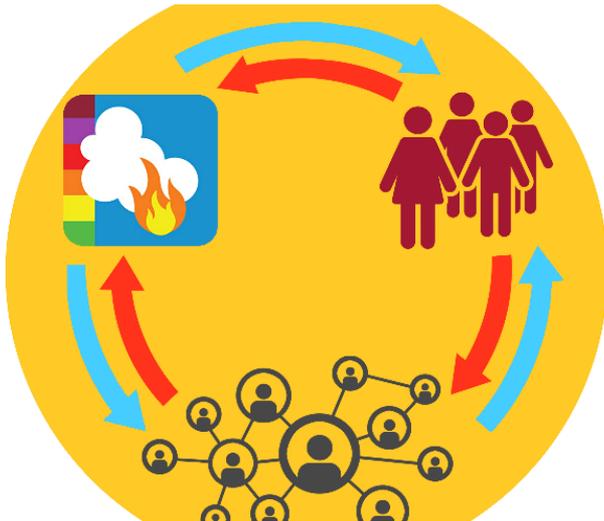
Why Citizen Science?

Develops entry points for members of the public to contribute to research, engage, and access data.

Mutually beneficial – it helps EPA answer questions, and it also serves as an educational/data resource that communities can leverage to address issues related to air quality and health in their communities.

Allows for two-way communication framework in problem formulation and dissemination of knowledge.

Data sharing and fostering change.



Pilot season findings

Participants:

- Clearly recognized smoke as an environmental risk
- Were motivated to participate and report at least in part due to personal health risk factors
- Did not consistently evaluate personal risk.

Exposure Reducing Behaviors



89% reported changing behavior to avoid exposure



Social, physical, or financial barriers



Existing health factors did not determine behavior



Need to mitigate severity of symptoms did determine behavior



Burden barriers are diminished by the number and severity of symptoms

Observations

Two insights regarding ways to make health risk messages more effective in nudging individuals toward engaging in protective health behavior:

1) personal relevance, focusing on health factors and outcomes that individuals identify with, in addition to air quality and susceptibility

2) compelling evidence that behavioral change is beneficial

- Perceived barriers can be significant deterrents to adoption of ERB
 - In the absence of clear message content, behavioral tendencies and weak perceptions of risk lead us to ignore or downplay common risks.

Learning the Audience



Objective: to facilitate their progression toward adoption of desired exposure-reducing behaviors.



Research Question: 1) Do participants' perspectives on the issue of wildfire smoke as a health risk differ, 2) What role do they play in engagement and behavior?



Participant perspectives: health status, experience with wildland fire smoke, risk perception, self-efficacy, access to exposure-reducing resources, information needs, and perceptions on health risk messaging.



Why? Understanding factors which influence this progression may help us understand the nature of health risk messaging needed to achieve better health outcomes.

Learning the Audience:

How were participants similar and how were they different?

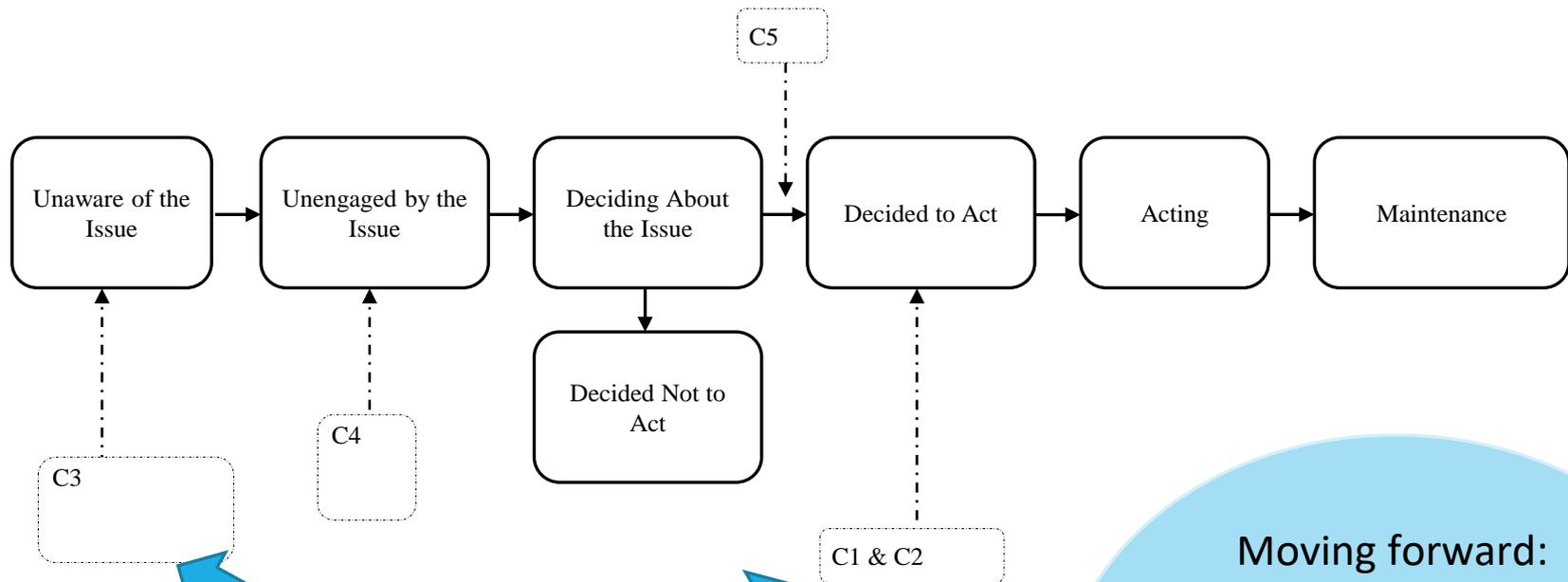
Overall, generally high agreement that wildland fire smoke is a modifiable health risk with high information needs.

High information needs:

- high receptiveness to air quality information alerts related to health
- high value on information from trusted source
- about the impact smoke impacts on health
- specific measures to reduce risk

? Based on these perspectives, where are people on their decision making framework with respect to exposure reducing behavior. We use Precaution Adoption Process Model.

Learning the Audience; decision making framework

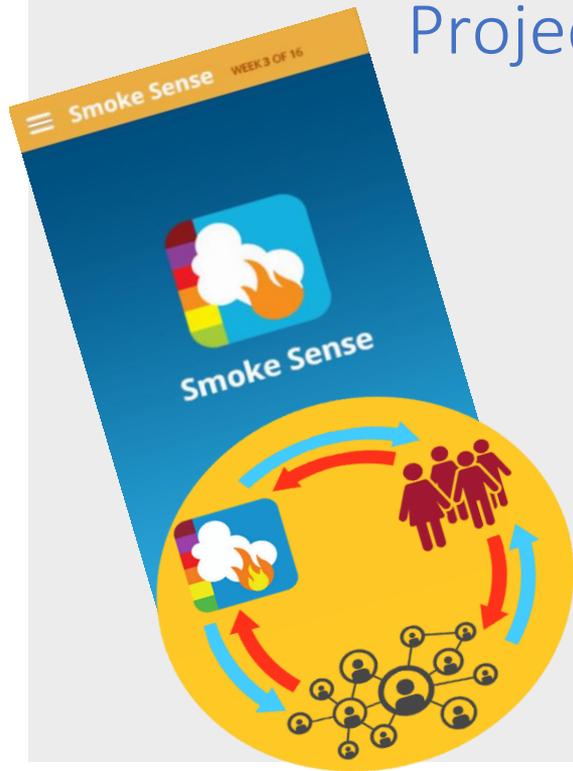


Perspectives: health status, previous experience with wildland fire smoke, risk perception, self-efficacy, access to exposure-reducing resources, information needs, and perceptions on health risk messaging.

Moving forward:

Find a health risk message that meets the people where they are

Additional Projects



- K-12 (Primary Education) Curriculum Project
 - Objective: provide standards-based instructional resources related to the Smoke Sense app that can be incorporated into the classroom
- Smoke Sense is translated to Spanish
- Community of Practice –government and academic partners and collaborators Kansas, Oklahoma, Nebraska, California Public Health, California Air Resources Board, University of Washington, Stanford University, University of Southern California, Canada, US Forest Services, NOAA
- Data Visualization Lab to expand social and normative learning.



VISIT US:



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Smoke Sense

Vision for near term future and expansion of the network

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Communication and Outreach



Study individual and
organizational
engagement



Engaged a
communications
team



Developed targeted
outreach



Building a
community of users

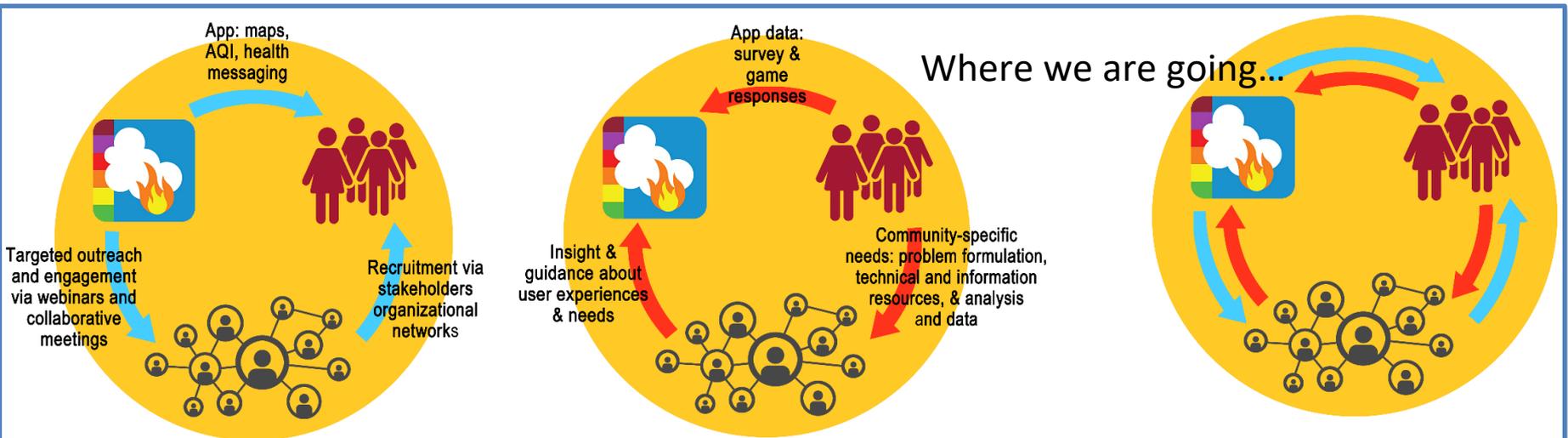


YouTube videos



Data Visualization
Lab

Building a Community of Participants



The end of the pilot year was a good time to stop, check some of our assumptions around community engagement and user needs/experiences by actually assessing our users' experiences – ***what motivates these folks in the network?***

Findings Semi-structured interviews organizational representatives in communities who we worked closely with in the 2017 fire season

RQ1: What factors influence engagement in research that uses a crowdsourcing or citizen science approach?

- Pragmatic reasons
 - Smoke events are increasing in duration and frequency
 - These folks are experiencing this both personally and professionally
 - Individuals in their communities are affected
 - Their organizations are being called upon to respond
 - They are motivated to stay abreast of new tools and resources
- Air quality data is confusing
 - Strong need for interpretation and clarification of air quality data including sensor values and recommended actions

RQ2: What does engagement in citizen science mean for community-led efforts in complex problem domains?

- Smoke Sense is supporting educational campaigns and connects ideas around air quality and health
 - Respondents perceived others in their communities as thinking of these as unrelated concepts
 - Communication tool
 - Linking air quality and health
- Generating new knowledge that can feed back into existing programs
 - Smoke Sense is helping advance what is known

Expanding the Network of Observers

Smoke Sense aims to serve and support on a network of organizations and organizational stakeholders in their work around smoke and health.

All three countries have existing networks of organizations which can be supported by Smoke Sense and that can support the study.

Although we share common goals we do not need to or want to do things the same way. Variable element include formal and informal organizational networks, strength and connectivity of organizations within a network varies, individual level perspectives.

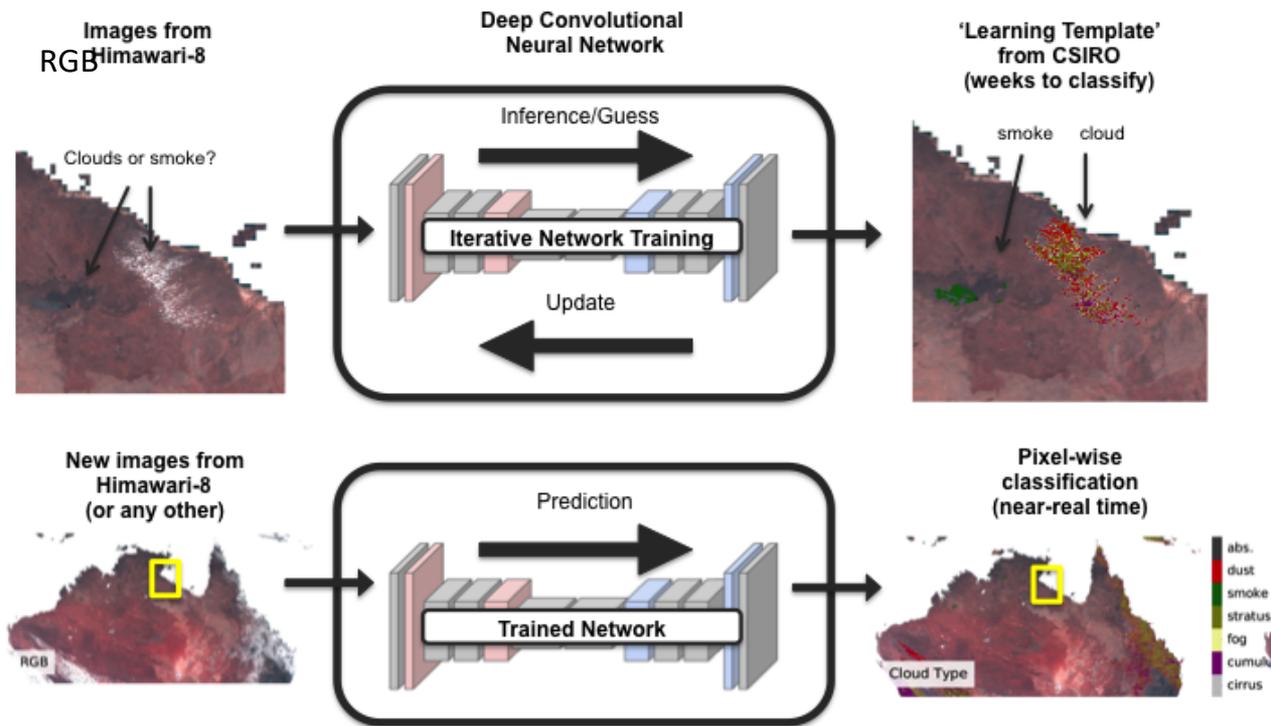
So the goal is to think structurally how we can expand the network in a way that facilitates objectives and strengthens international partnership.

Propose three directions:

- 1) Serving informational needs of users - using new technologies to deliver exposure data and leveraging mobile technology to deliver health risk information.
- 2) Developing health risk messages and shared communication.
- 3) Creating a shared work space, sharing of data and technologies.

Users Have High Information Needs

Machine Learning Automatically Detects Smoke Plumes in Satellite Imagery



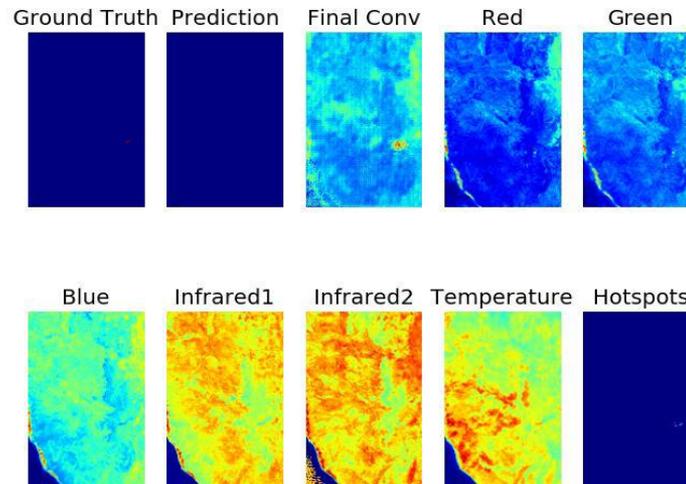
True Colour Satellite Imagery

Advanced Himawari Imager, Himawari-8 geostationary satellite:

6 spectral bands (RGB), top of atmosphere temperature, hot spots,

0.5-2 km resolution at 10 minute intervals

Acc=100.0, IoU=50.0, IoU_TP=0.0(0.0), IoU_TN=100.0(99.9)

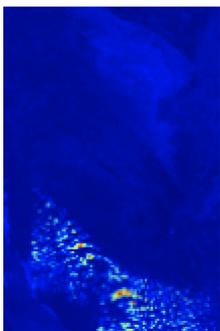


True Colour Satellite Imagery

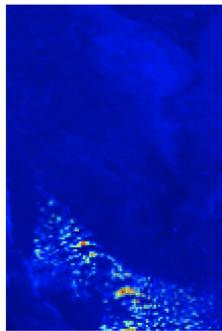
Ground Truth



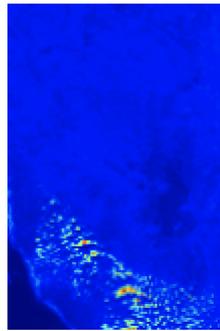
Red



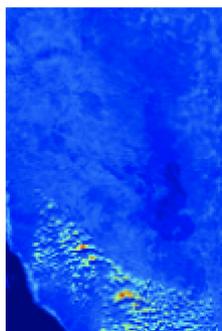
Green



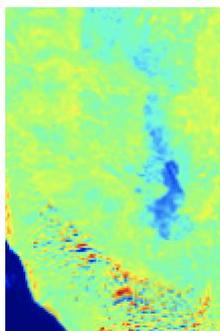
Blue



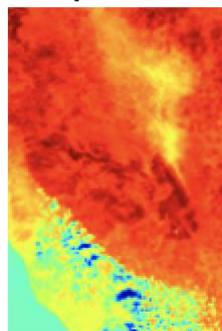
Infrared1



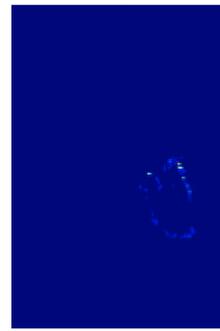
Infrared2



Temperature



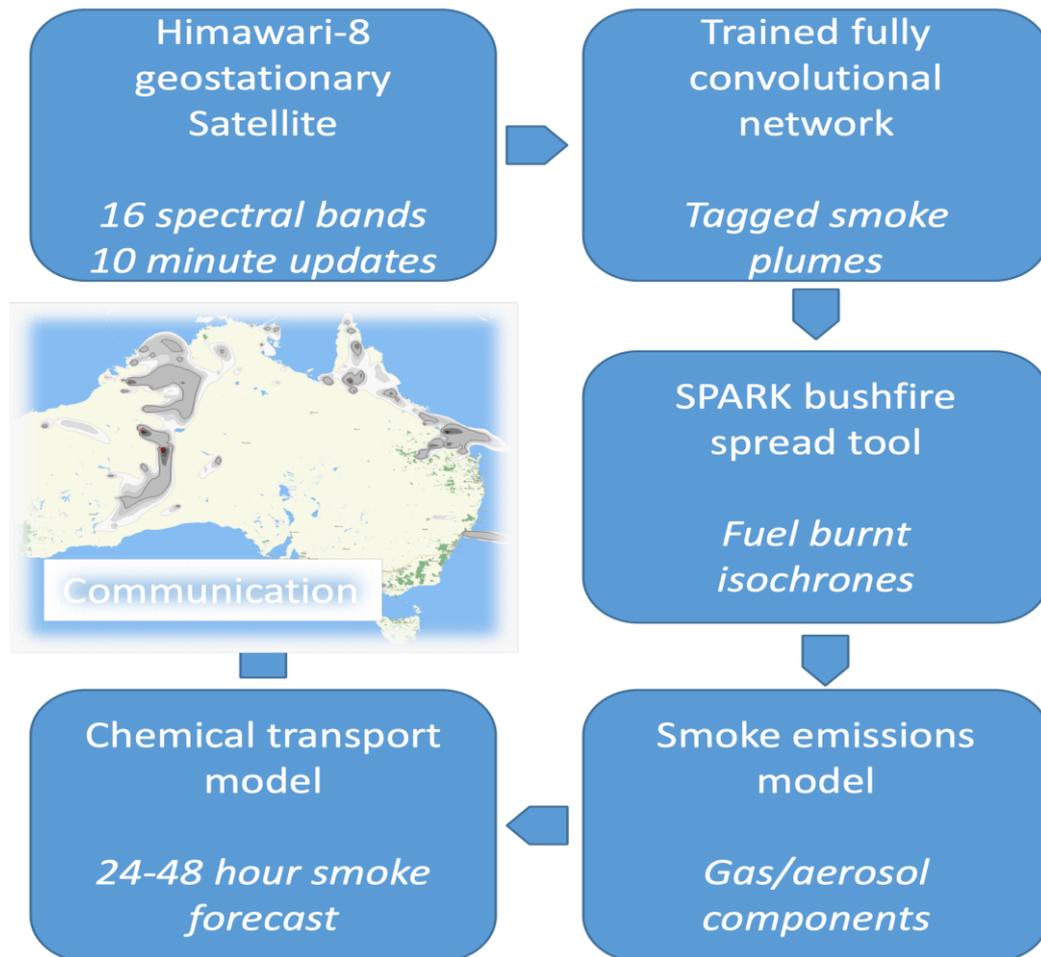
Hotspots



Prediction



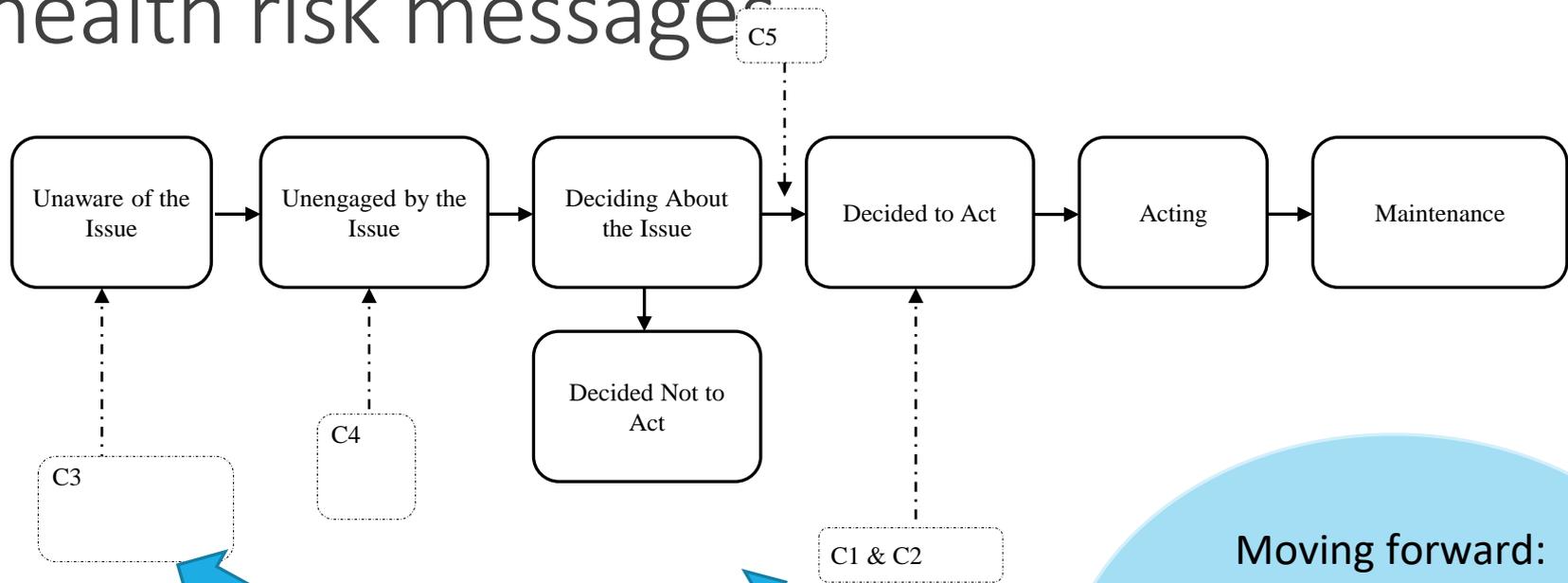
Enhancing Information Needs in Population



The rapid response smoke forecasting framework

Can the real time smoke detection be coupled with Emissions modeling framework and health risk communications in real time for improved health outcomes?

Developing and delivering mechanisms for health risk messages



Perspectives: health status, experience with wildland fire smoke, risk perception, self-efficacy, access to exposure-reducing resources, information needs, and perceptions on health risk messaging.

Moving forward:

Find a health risk message that meets the people where they are

Creating a shared work space, sharing of data and technologies.

Smoke Sense relies on anonymous responses by the participants.

Currently, the app and database are stored on secure server with a limited access.

Anonymity is essential, however other versions of the app have been developed for .

We share code and development with the community of practice.

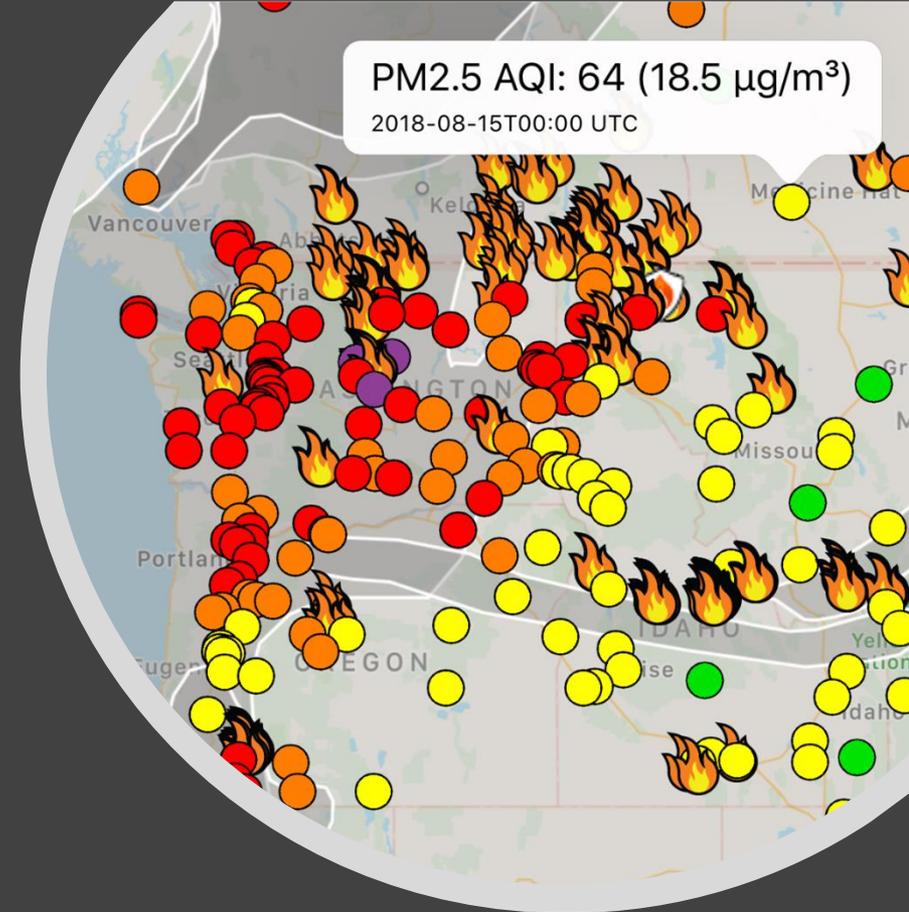
Data sharing is essential for knowledge advancement.

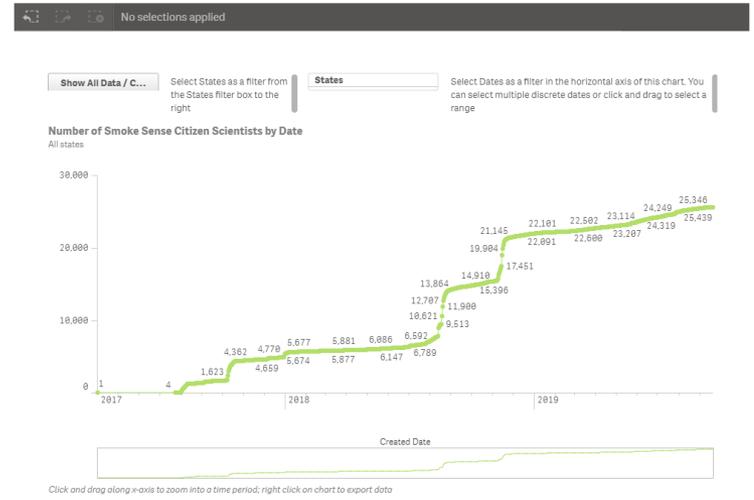
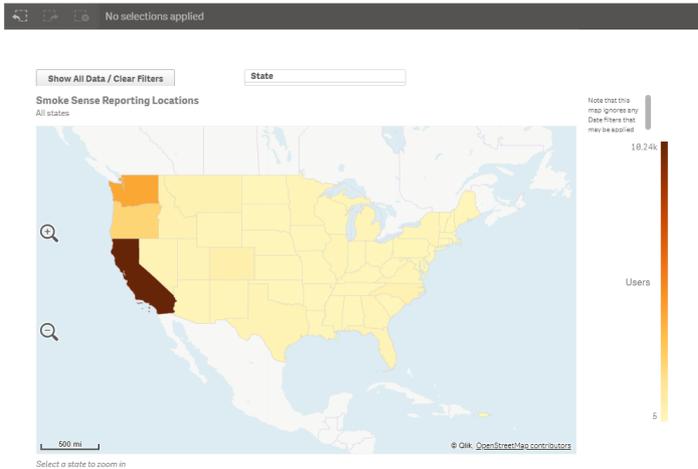
We have to decide on the framework for storing the data.

Developing Targeted Outreach

- Website
- Conferences, web presentations,
- Open collaborations and partnerships
- Github
- Open source, open data
- You tube videos
- Manuscripts with targeted research questions

- Over 25,000+ users and 200,000 sessions!
- Communications and outreach strategy in full effect – local papers Wired, Daily Beast, others
- Featured in Apple App Store





Data Visualization Lab

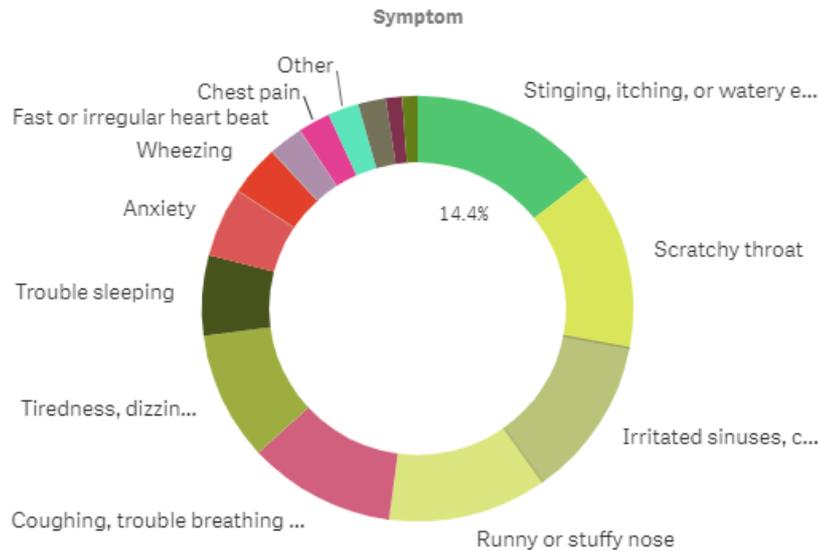
Show All Data / Clear Filters

This sheet contains three charts based on the Health Symptoms Surv...

[Smoke this week](#) Actions Smoke this month

Yes, I experienced smoke this week: Symptoms Reported

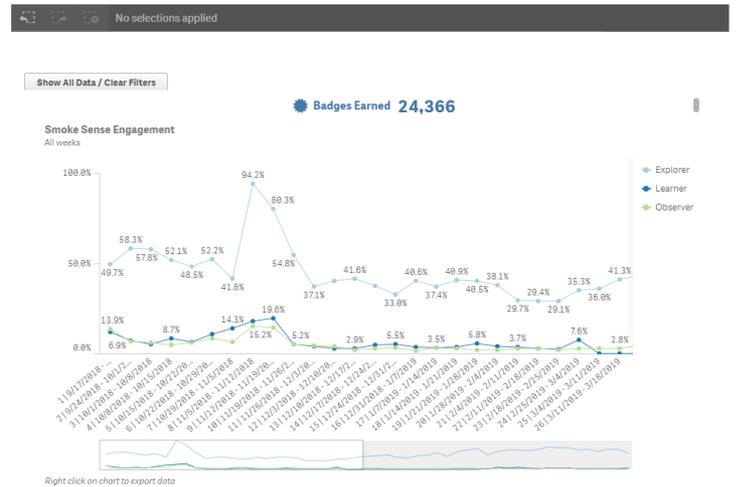
All states / All weeks



Right click on chart to export data

Show Hel...

For some explanation of the filtering of this sheet please click the Show Help notes button above



Right click on chart to export data

Smoke-Ready Toolbox for Wildfires

epa.gov/smoke-ready-toolbox-wildfires

Smoke-Ready Toolbox for Wildfires

Wildland fires produce air pollution that impacts people's health and other aspects of daily life. The increased frequency and intensity of wildfires in the United States are adversely affecting air quality and putting more people at a health risk from exposure to smoke. Public health officials and others can use the resources in the Smoke Ready Toolbox to help educate the public about the risks of smoke exposure and actions people can take to protect their health.

Smoke & Your Health



- [AirNow](#)
- [Smoke Advisories](#)
- [Fires and Your Health](#)
- [Frequent Questions](#)
- [Smoke Sense App](#)
- [Prepare for Natural Disasters and Recovery](#)
- [Before, During, and After a Wildfire \(CDC.gov\)](#)

Wildland Fire
Publications,
Fact Sheets, and
Other Resources

Current Fires



- [Current Fires](#)
- [Current Fire Incident Information System](#)
- [NOAA Smoke Forecast Tool](#)
- [NOAA's Fire Weather Outlook](#)
- [GEOMAC Wildland Fire Support](#)
- [MODIS Active Fire Mapping](#)
- [National Interagency Coordination Center](#)
- [National Interagency Fire Center](#)

For Health
Professionals

Featured Resources

New resource en español now available:

- [Caja de herramientas "Smoke Ready" \(Listo para el humo\) para incendios forestales](#)
- [Blog: Using the Smoke Sense App During the Camp fire in California](#)



VISIT US

So what does this mean for complex problem domains, citizen science, & Smoke Sense?

Citizen science is a useful approach to informing research in complex problem domains

- Increasing our understanding of the issue context and stakeholder insights
- Complementary to translational efforts – moving findings to application

Smoke Sense aims to serve and support on a network of organizations and organizational representatives in their work around smoke and health

The insights gained from systematic evaluation of data and progress support the Smoke Sense team in supporting our stakeholders clarify future directions.

