

**Developing an
mHealth Platform
for Wildfire Disaster
Response Research**



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University of Southern California**

Wildfire seasons are becoming longer and more severe



Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW. Warming and earlier spring increase western U.S. forest wildfire activity. Science 2006;313:940-3

Montana wildfires have burned 1 million acres at a cost of \$300 million

By [Sydney Mook / Forum News Service](#) on Sep 7, 2017 at 7:38 p.m.

[Napa](#) [Sonoma](#)

OCT. 12, 2017, 10:07 P.M.

The Tubbs fire is now one of the five deadliest in California history



Alene Tchekmedyan



Hundreds of firefighters battling largest wildfire ever recorded in B.C.

19 wildfires have merged to create massive fire burning in the province's Interior

By [Mike Laanela, Brady Strachan, CBC News](#) Posted: Aug 22, 2017 8:19 AM PT | Last Updated: Aug 22, 2017 3:47 PM PT

Wildfire smoke in Lower Mainland this summer 'unprecedented': report



JENNIFER SALTMAN

[More from Jennifer Saltman](#)

Published on: September 15, 2017 | Last Updated: September 15, 2017 4:47 PM PDT



Wine Country fires destroyed 8,889 structures

By Sarah Ravani | November 2, 2017 | Updated: November 3, 2017 11:50am

Spurred by winds, Montana fires prompt evacuations, closures

Seaborn Larson, slarson@greatfalltribune.com | Published 6:43 p.m. MT Sept. 3, 2017 | Updated 7:21 p.m. MT Sept. 3, 2017

Canyon Fire 2 has destroyed 6,000 acres and 24 structures, threatening another 5,000

By SCOTT SCHWEBKE | sschwebke@scng.com, ALICIA ROBINSON | arobinson@scng.com, KELLY PUENTE | kpuente@scng.com, JONATHAN WINSLOW | jwinslow@scng.com and NATHANIEL PERCY | npercy@scng.com | Orange County Register
PUBLISHED: October 9, 2017 at 10:38 am | UPDATED: October 10, 2017 at 9:58 am

‘A hell-storm of smoke and ash’: Deadly wine-country wildfires force thousands to flee

By Cara Strickland, Amy B Wang and Lea Donosky | October 10 | [✉](#)

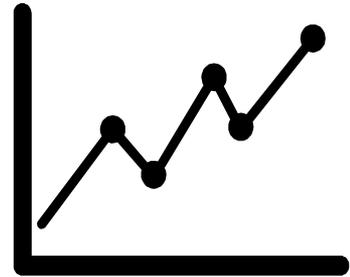
Death toll hits 42 in Wine Country as firefighters hope for rain

Cooler weather should help crews continue their march toward full containment

By PATRICK MAY | pmay@bayareanewsgroup.com | Bay Area News Group
PUBLISHED: October 18, 2017 at 9:06 am | UPDATED: October 18, 2017 at 10:48 am

Factors driving this increase

- Climate change^{1,2}
 - Warmer temperatures
 - Less snow
 - Earlier snowmelt
 - Greater evaporation
 - Increased drought conditions
- Land use changes¹
- Growth of wildland urban interface³



¹Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW. Warming and earlier spring increase western U.S. forest wildfire activity. *Science* 2006;313:940-3

²Diffenbaugh NS, Swain DL, Touma D. Anthropogenic warming has increased drought risk in California. *Proc Natl Acad Sci U S A* 2015;112:3931-6

³Hammer, Roger B., Susan I. Stewart, and Volker C. Radeloff. "Demographic trends, the wildland-urban interface, and wildfire management." *Society and Natural Resources* 22.8 (2009): 777-782

Public health impact of wildfire smoke

Globally, an estimated **339,000 premature deaths** occur each year due to wildfire smoke¹

Wildfire smoke has also been associated with significant **respiratory and cardiovascular morbidity**²

¹Johnston FH, Henderson SB, Chen Y, et al. Estimated global mortality attributable to smoke from landscape fires. Environ Health Perspect 2012;120:695-701
²Reid CE, Brauer M, Johnston F, Jerrett M, Balmes JR, Elliott CT. Critical Review of Health Impacts of Wildfire Smoke Exposure. Environ Health Perspect 2016

Vulnerable populations



- Older adults
- Young children
- Communities of low socioeconomic status
- Individuals with pre-existing conditions (e.g. asthma)

However, results are mixed and/or limited and more research is needed

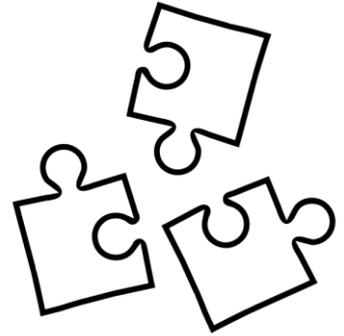
Challenges of researching the health effects of wildfire smoke



- Unexpected onset of wildfire
- Lengthy development process for protocols & questionnaires
- Lengthy IRB approval process

Gaps in the research

- Reliance on administrative data
- Reliance on retrospective analysis
- Lack of real-time data on acute symptoms that don't require immediate medical attention



A "Pyramid of Effects" from Air Pollution

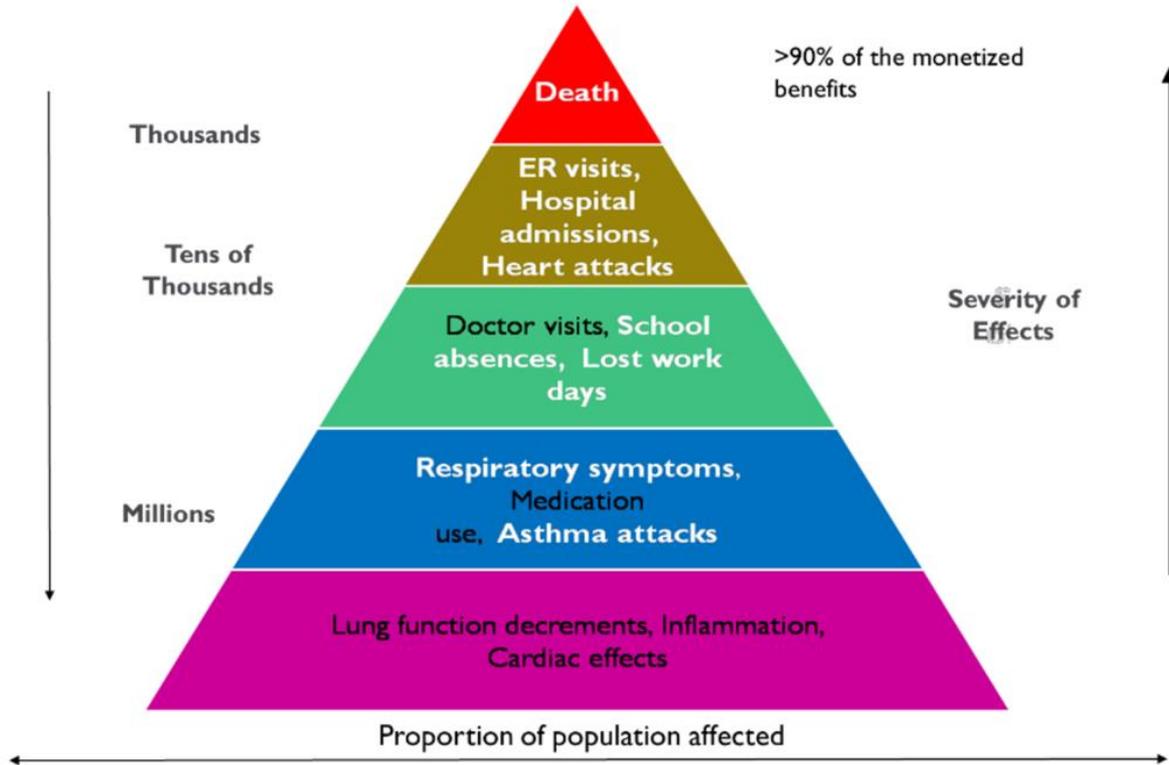
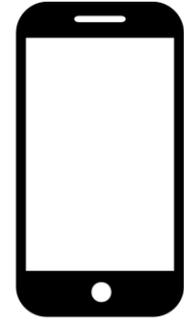


Image courtesy of Dr. Ana Rappold and the EPA Smoke Sense Team

Benefits of mHealth in wildfire research



- Allows rapid data collection
- Can reach large numbers of people
- Can be pre-developed and made available ahead of the fire without significant deployment burden

Collaborative & Complementary Initiatives

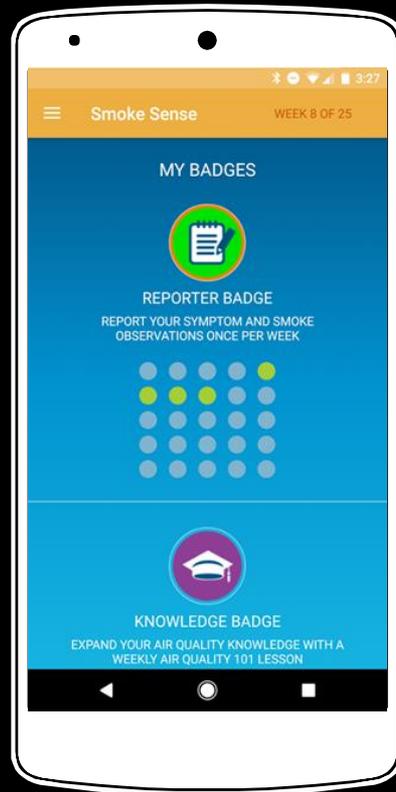
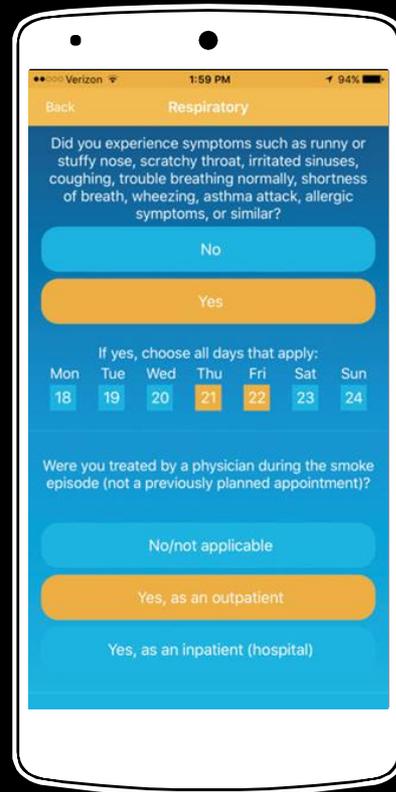
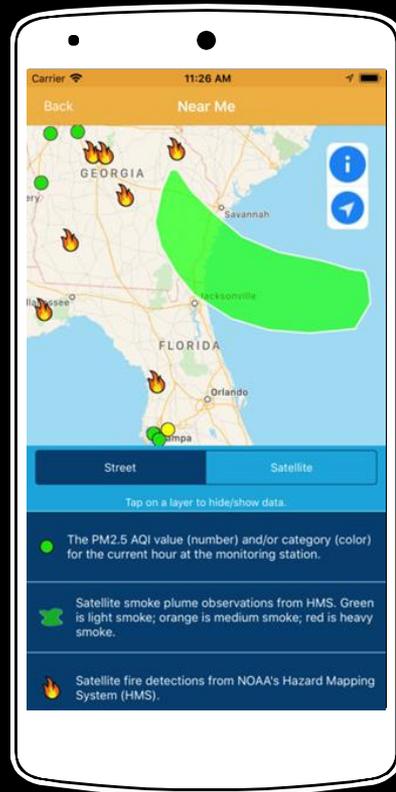
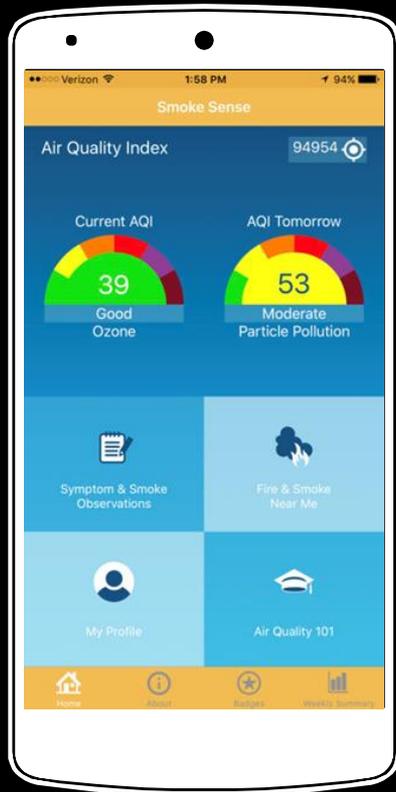
Citizen Science EPA Smoke Sense	mHealth Research USC/EPA Collaboration
Open access	Cohort-based
Limited interaction with users	Close interaction with at risk population
Non-identifiable/broad population level	Detailed assessment of time of exposure to health event

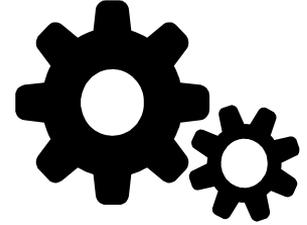
U.S. EPA

SMOKE SENSE

Citizen science study on health
risk and health risk
communication during wildfire
smoke episodes







From citizen science to collaborative science

To advance the knowledge about when and why health outcomes occur and how to reduce the burden during unexpected, acute, or transient wildfire smoke exposures

Advantages for conducting research

- Collect individual-level, highly space- and time- resolved exposure and health data in a real-time and non-intrusive fashion
- Decreased recall bias and exposure misclassification and increased statistical power to detect and quantify effects of wildfire smoke exposure on health

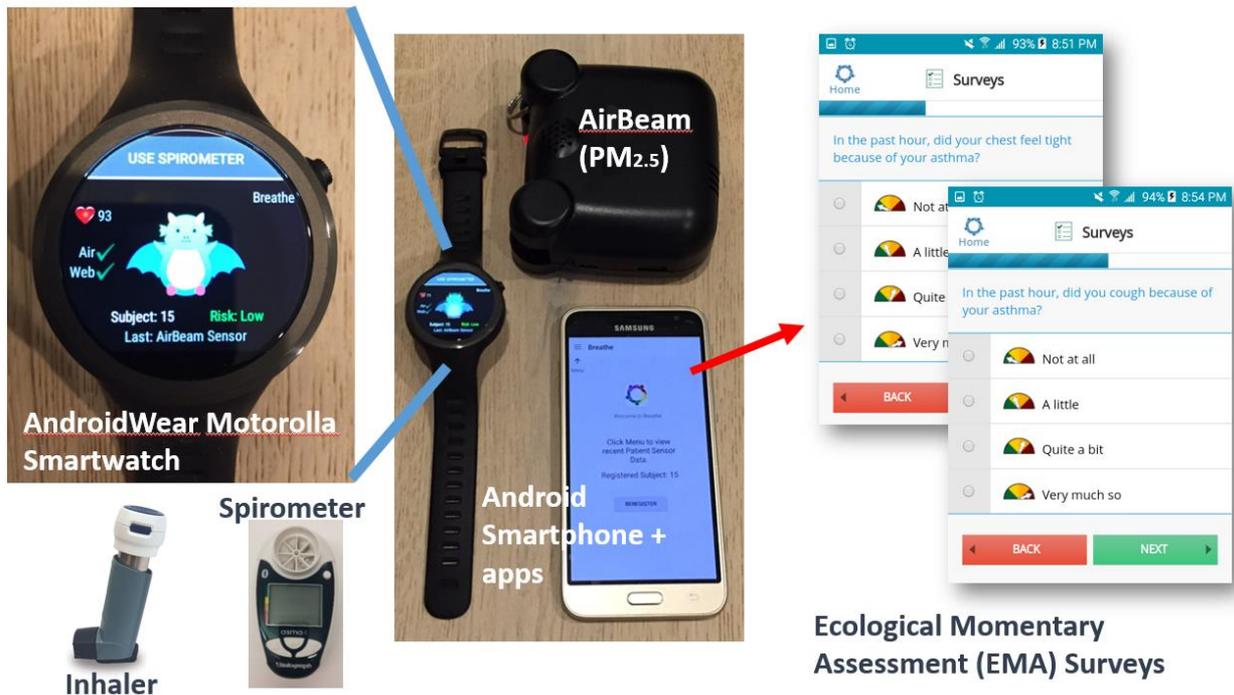
The Los Angeles PRISMS Center

PI Alex Bui, UCLA
NIH/NIBIB U54 EB022002

What if you could
predict ahead of time,
for a given individual,
an asthma attack, and
mitigate if not prevent
it?



BREATHE: Biomedical REAL-Time Health Evaluation Kit



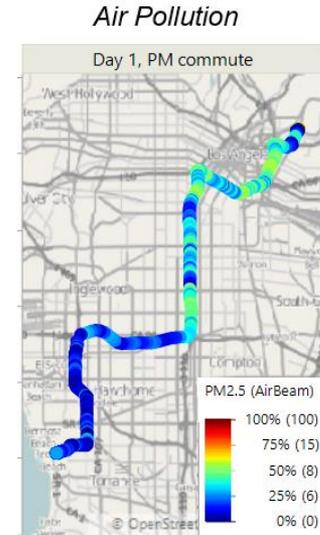
The Los Angeles PRISMS Center, BREATHE Kit

Example Research Questions

- Is smoke exposure associated with acute changes in respiratory health?
- What is the time lag between smoke exposure and asthma exacerbation?
- How do context, mobility, psychology (eg, stress), and exposure interact in relation to health effects?

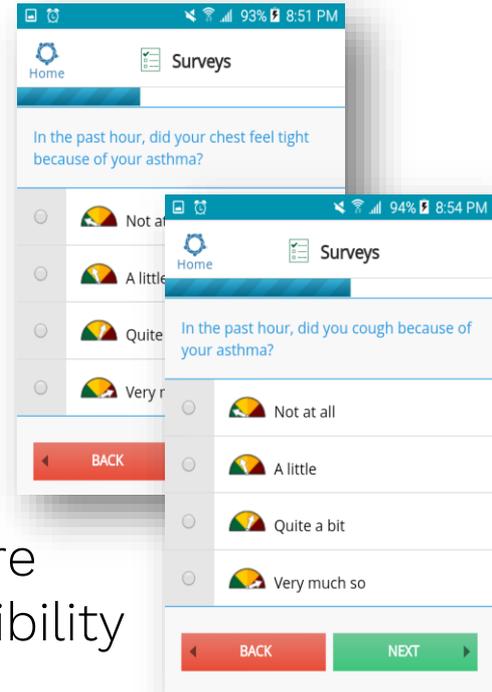
Exposure assessment

- Location tracking (eg, hourly) enabling spatiotemporal exposure assignment
- Customizable frequency of surveys (eg, daily, weekly)
- Collect data on time-activity, microenvironment and exposure avoidance behaviors
- Possibility to extend to personal air pollution and health sensing platform based on our work in the LA PRISMS Center (PI, Alex Bui)



Outcome assessment

- Respiratory health (eg, asthma, acute respiratory infections)
- Cardiovascular health
- Mental health
- Utilization of medication and healthcare
- Acute and subchronic focus with possibility for long term follow-up



Design features

- Web-based recruitment, device agnostic and mobile-friendly
- Ability to customize target populations and data collection frequency according to research questions and wildfire locations
- Ability to interact with participants based on their general area or exposure status (eg, proximity to smoke plumes)
- Ability to customize risk messaging

Conclusion

- Plans to deploy in pilot mode in Summer 2018, ahead of southern California wildfire season
- Findings will help prepare individuals, communities and first responders for future wildfires and capture acute health impacts that are often missed with traditional approaches

Thank You

Dr. Ana Rappold and the EPA Smoke Sense team

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ShihMing Huang and Fred Lurmann, Sonoma Technology Inc.

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USC University of Southern California



Smoke Sense



Los Angeles
PRISMS Center

Credits for graphics and images

Images:

Slide 2: Top image by Tristan Fortsch; bottom image by Noah Berger

<https://www.usnews.com/news/us/articles/2017-09-07/wildfire-weary-western-us-coughs-through-late-season-surge>

<http://www.latimes.com/local/lanow/la-me-ln-central-valley-wildfire-grows-20170717-htlstory.html>

Slide 3: Image by Noah Berger

<http://projects.sfchronicle.com/2017/slideshow-wine-country-fires/#slide-1>

Slide 4:

<http://www.latimes.com/la-me-santa-rosa-slider-20171009-htlstory.html>

Slide 6: Image by Myung J. Chun - TNS

<http://www.startribune.com/thousands-flee-as-california-wildfires-persist/450340823/#8>

Icons from the noun project:

fire warning by Peter van Driel

Family by b farias

Warning by Rockicon

Puzzle by Delwar Hossain

Smartphone by Wahyuntile

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