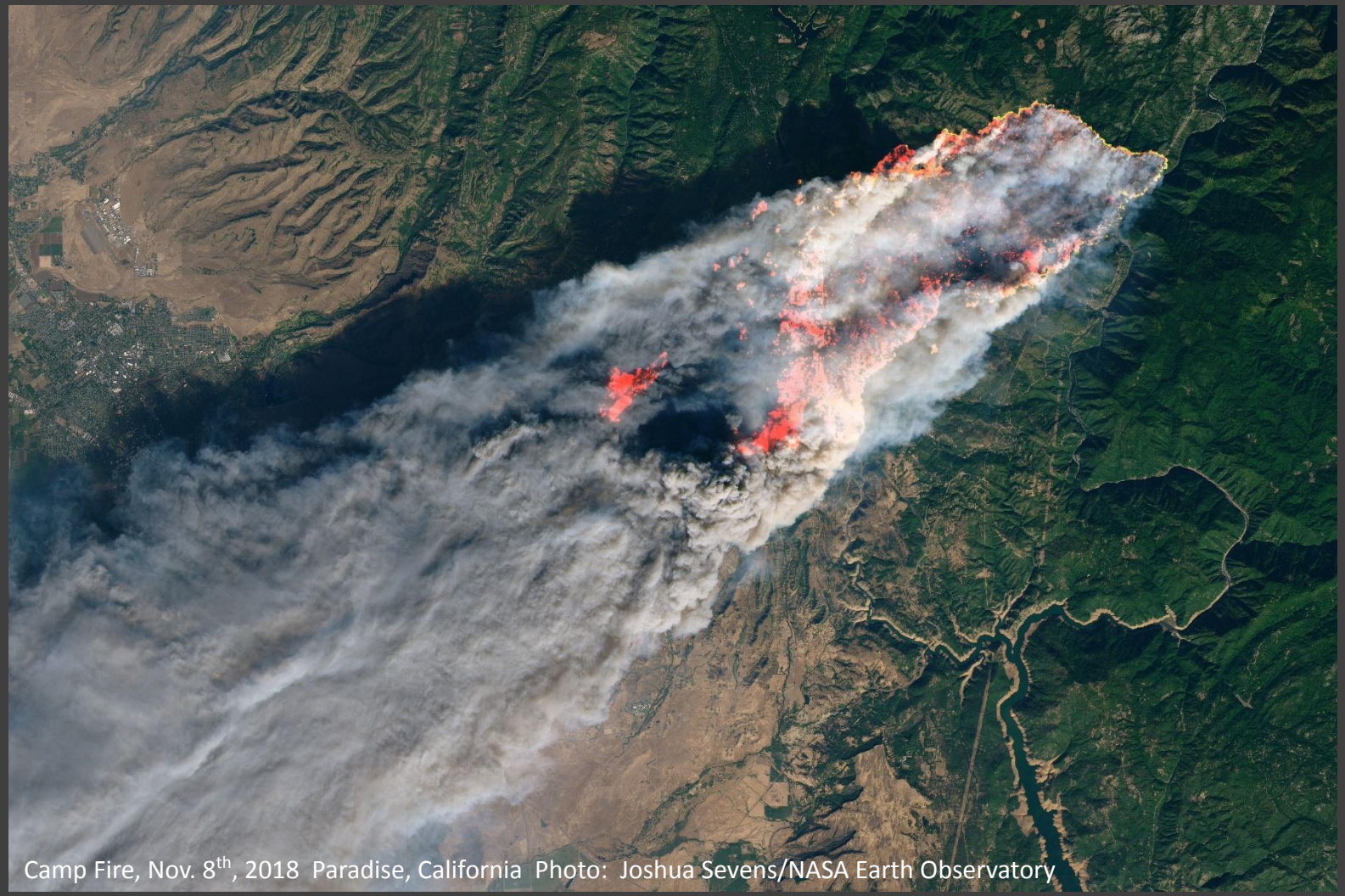
Sensing From All Angles: Building Water Security for Wildland Urban Interface (WUI) Communities

Jenna Tilt, Eliza Amstutz, Andres Schmidt, Mike Gough, Lisa Ellsworth, Erica Fischer, Brad Wham, & Amy Metz



Camp Fire, Nov. 8th, 2018 Paradise, California Photo: Joshua Sevens/NASA Earth Observatory

Oregon State University

University of Minnesota

University of Colorado Boulder

Alfred P. Sloan Foundation

Geospatial Modeling

What areas are most vulnerable to future water contamination?

Pipeline and Sensor Testing

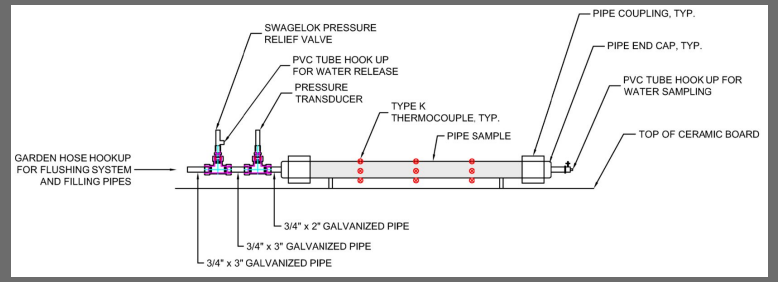
What environmental and pipeline conditions do the sensors need to withstand?

Adaptive Capacity

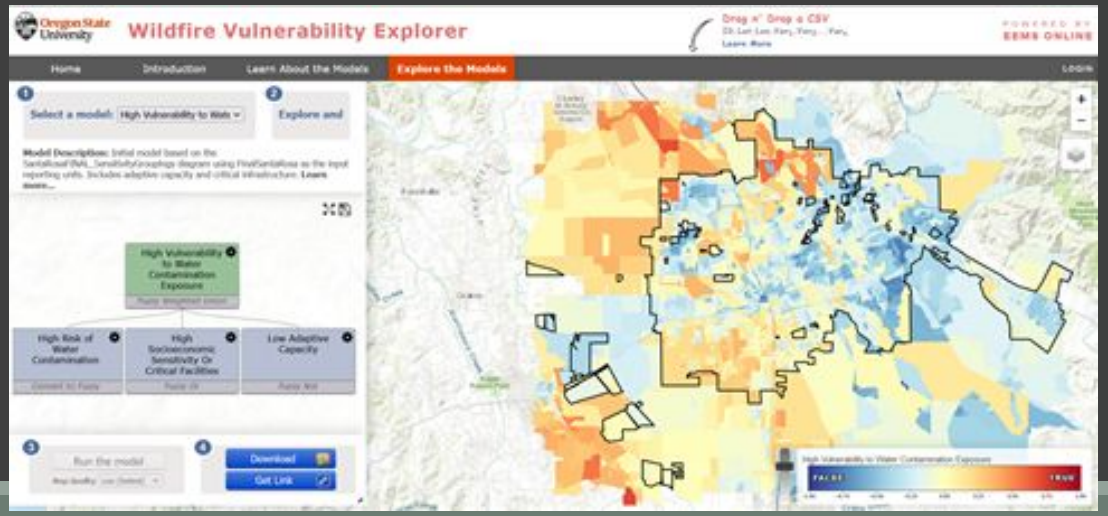
Socio-Economic Sensitivity

Water Contamination Exposure

Pipeline Material Testing

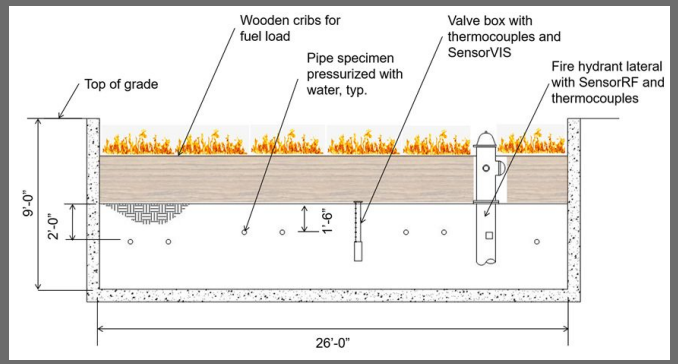


WILDFIRE VULNERABILITY EXPLORER

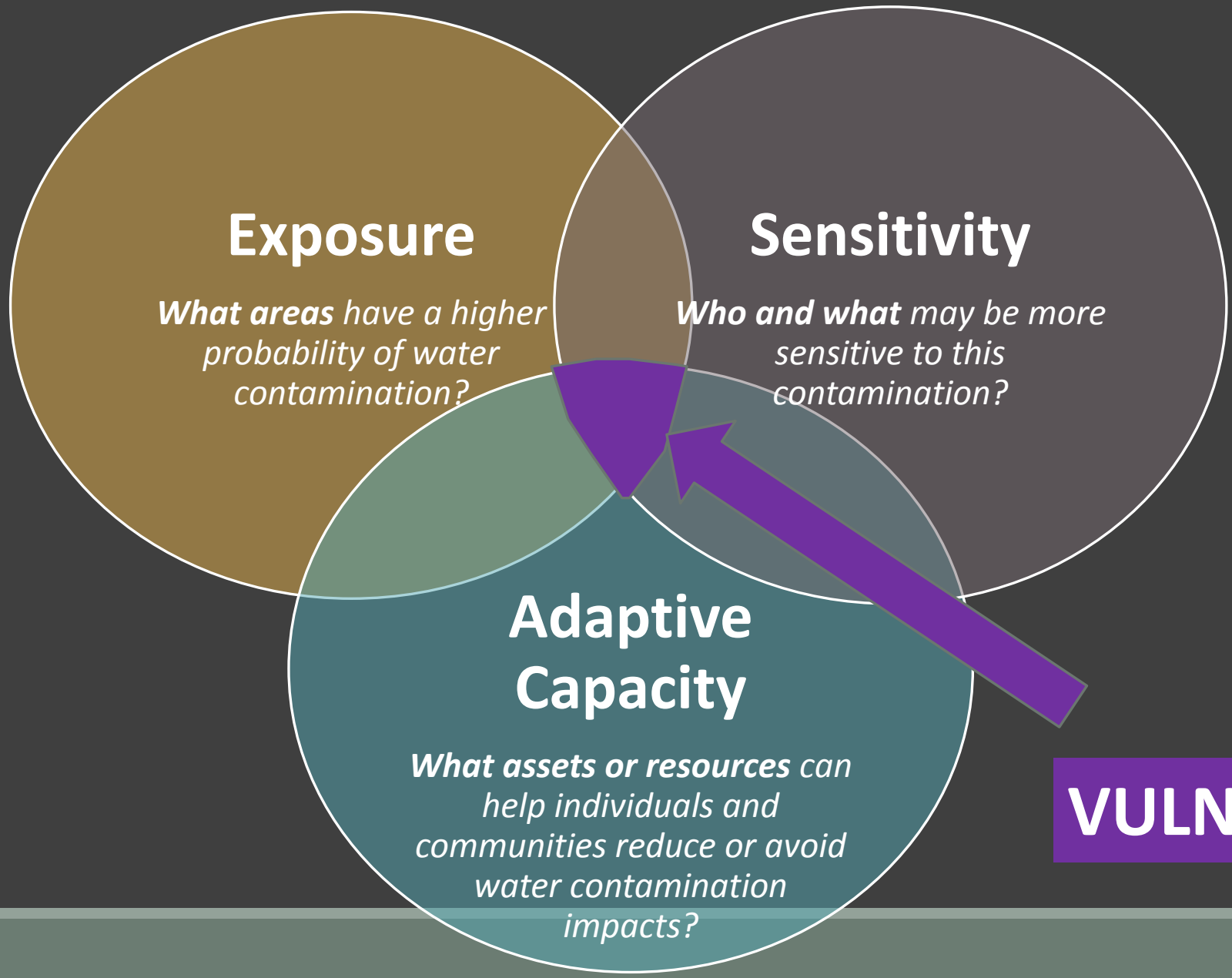


Sensor Development

Large-scale Wildfire Testing

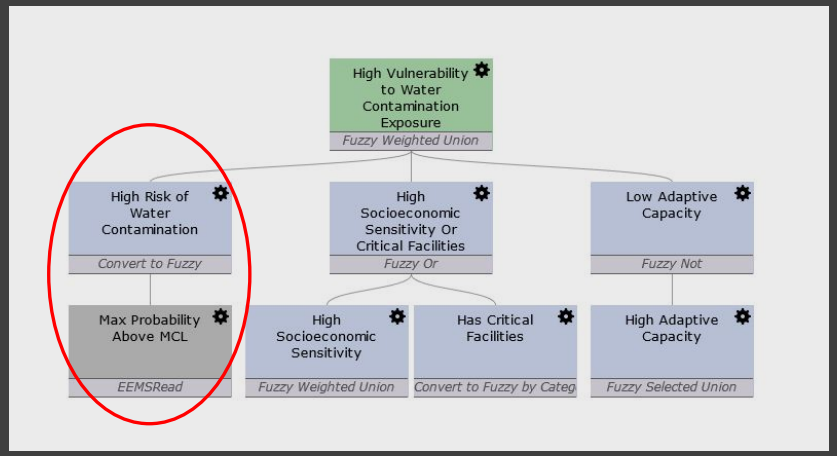


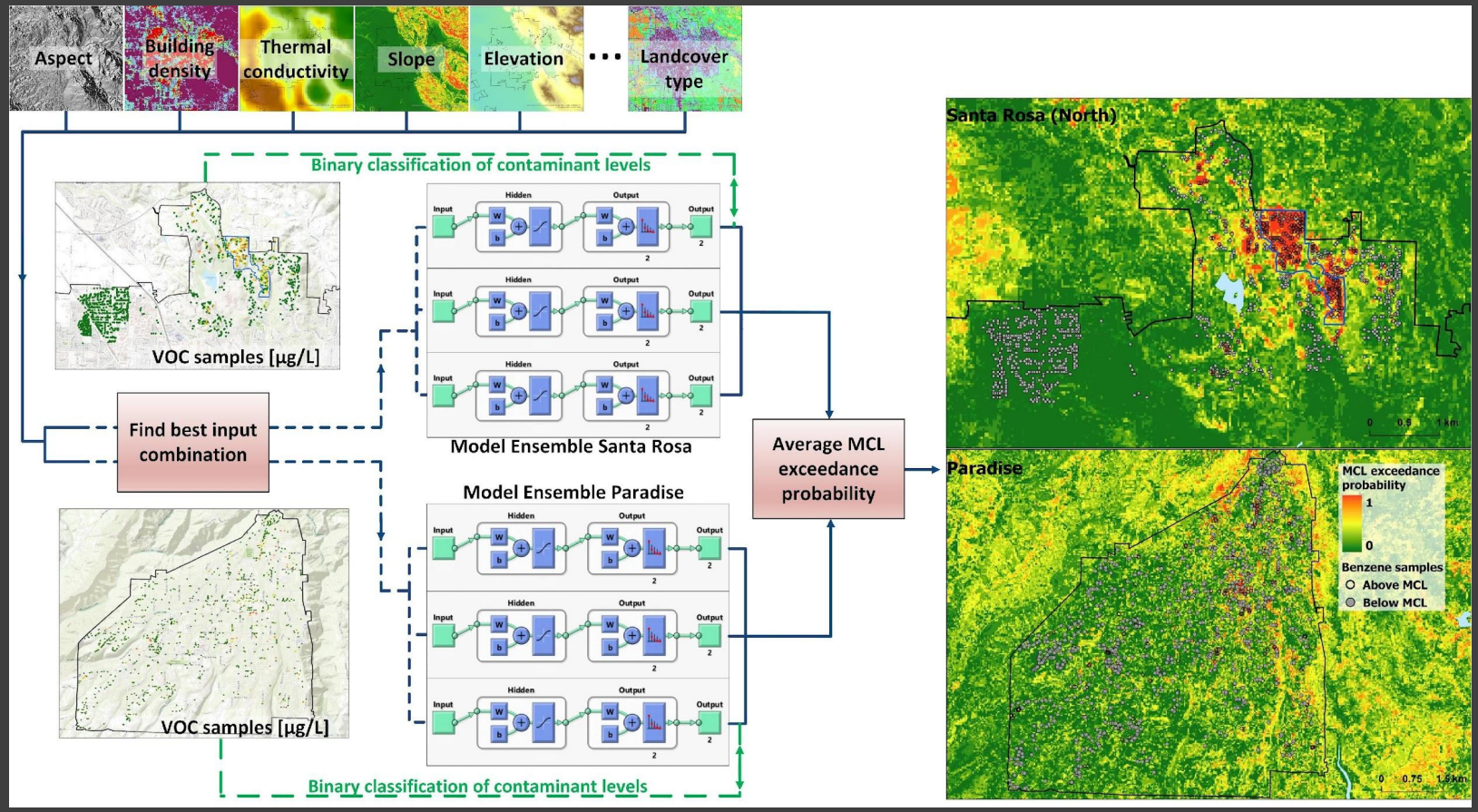
What areas might be most vulnerable to water contamination?



Modeling the risk of water contamination exposure

- Not all processes causing WDS contamination are known and/or understood.
- Instead, postfire-data available from Santa Rosa and Paradise used to train data-driven neural network model.
- Accurately predicts 85% of the known contamination points.





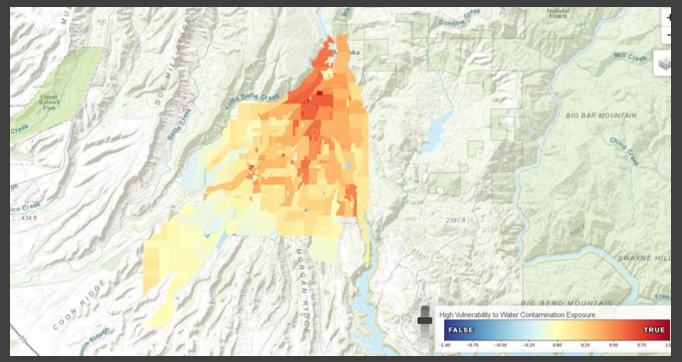
Schmidt et al., 2022, Schmidt et al., 2023

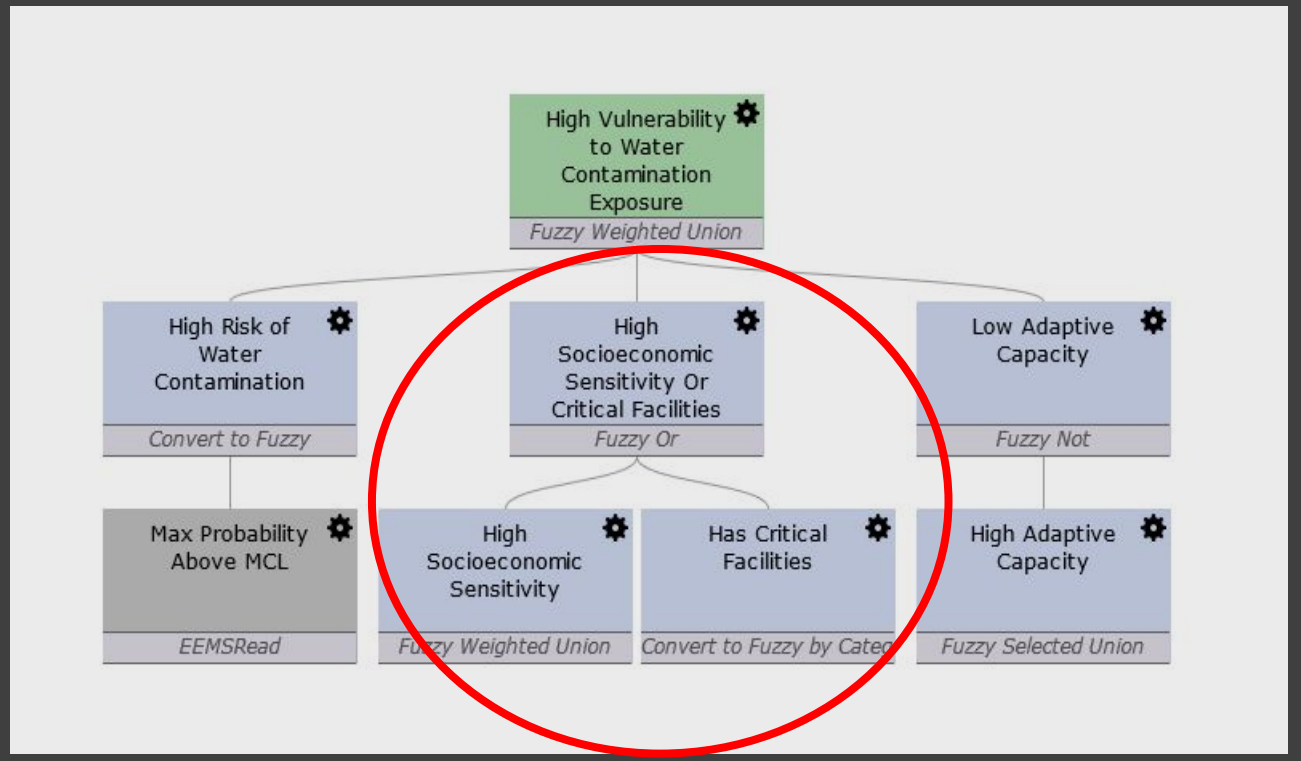
SENSITIVITY

Who and what may be more sensitive to water contamination?

Data Collection and Analysis

- Pre-Fire population characteristics and community data
- 2010 and 2015 Census Data
- County and City Data (property type, property value, critical facilities)
- Calculated % of individuals/households or count critical infrastructure within each **Census block** with each variable.





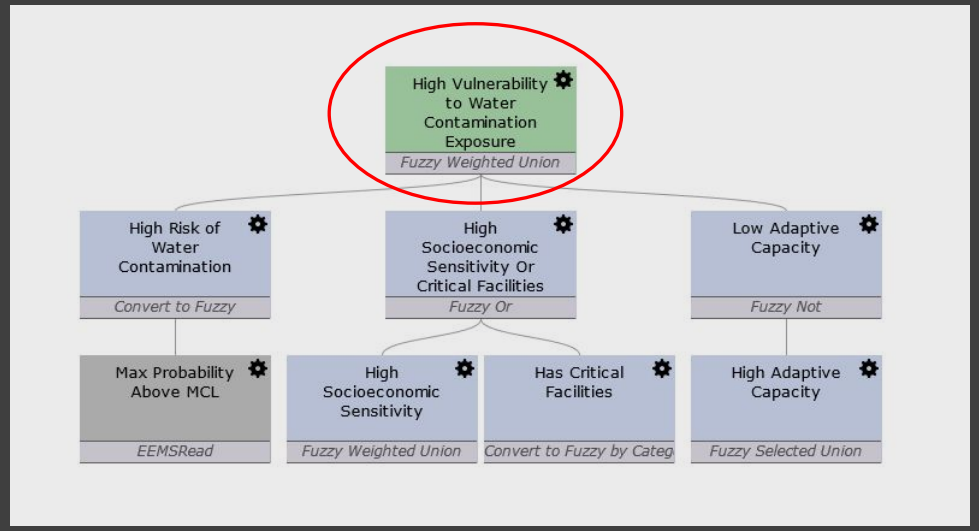
Wildfire Vulnerability Explorer

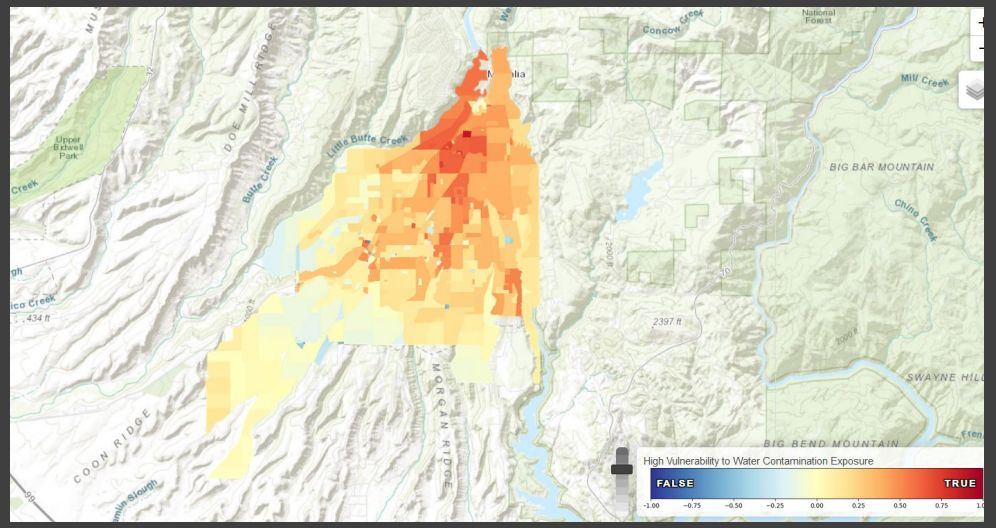
Predictive map of *Vulnerability of Water Contamination* for both pre-fire planning and post-fire assessment

Uses **past** fire events from Santa Rosa and Paradise, CA and Oregon to build a predictive model that maps **future** vulnerabilities

Components

1) Hierarchical interactive diagram of factors contributing to water contamination vulnerability
2) Dynamic map that visualizes areas of water exposure, population sensitivity, & overall vulnerability. Exposure, Sensitivity, and Adaptive Capacity is based on Fuzzy Logic.





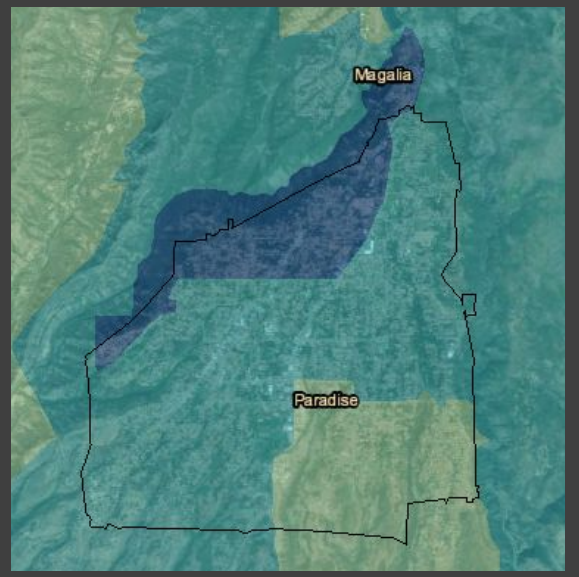
Schmidt et al., 2022, Schmidt et al., in review

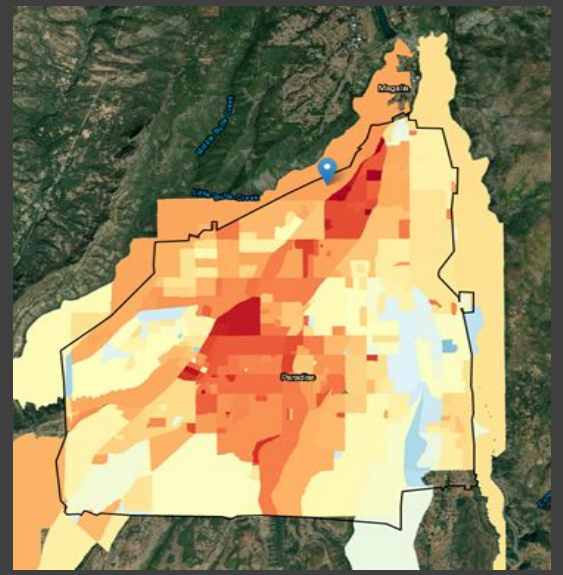
Stakeholder Validation & Beyond the Map

Fire and Water (n=20)
- City Managers
- Fire Response & Prevention
- Public Works
- Private Consultants

Health and Human Services (n=13)
- School District
- Disaster Navigators
- Houseless providers
- Other nonprofits

Wildfire Explorer: Application
- "More accurate and easier to use than the CDC"
- Grant applications, target specific areas
- Concerns regarding access to the tool





Understanding Adaptive Capacity in WUI Communities

What Adaptive Capacity factors are important to Paradise and Santa Rosa?

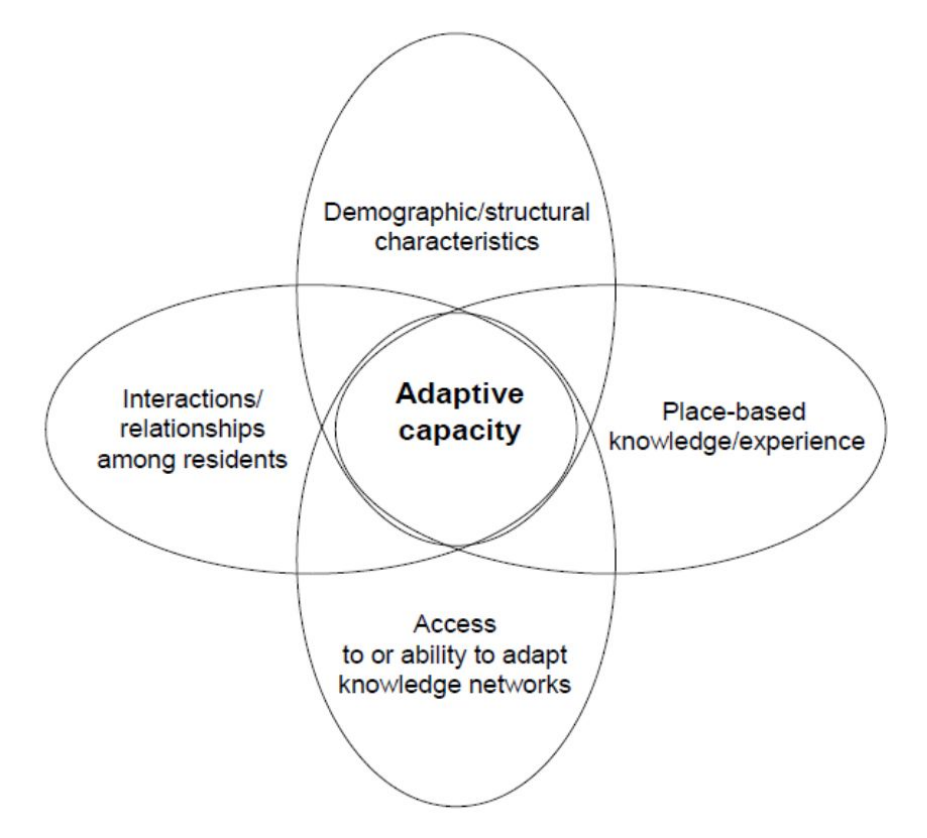


Fig. 1. – Adaptive capacity framework for wildfire, identifying four elements that interact to create adaptive capacity (initial model) (Paveglio et al. 2009).

Demographic/structural characteristics

[*We are] trying to have affordable housing but if you keep adding on and adding on* [fire sprinklers] *then the affordable housing goes away…this makes it increasingly difficult to live here. (Paradise Fire & Water)*

Place-based knowledge/experience

We're sharing really detailed data about people's water with the public, which takes a lot of communication…part of that was helping people navigate this sudden influx of scientific data (Paradise Fire & Water)

Access to or ability to adapt scientific knowledge networks

In Glass fire, we had zero issues, we could quickly start our communication protocol, and everything got done…. Protocols were not widely communicated before; it took time for members to understand value in process. (Santa Rosa Fire & Water).

Interactions/relationships among residents

I think there's a spirit about what people are excited about Paradise, which represents nature, apple tree history, the ethic of living with the land, knowing how to rebuild, knowing how to be frugal. So that the old America sort of ethos. (Paradise Health and Human Services).

Key Similarities and Differences between Santa Rosa and Paradise related to Adaptive Capacity

Similarities

Paradise & Santa Rosa

- Collective action / Community Organizations
- Diverse communication networks
- Local experience with / history of wildfire

During Glass fire, regulators are more educated – They knew what we had done previously and followed our flushing protocol. Drinking water could get clearances faster (Santa Rosa Fire & Water).

I don't see that [clean water definition] having changed at all and I don't know how that would change. That would take unfortunately, other events like this which I hope will never happen. (Paradise Fire & Water).

Notable Outliers

- Multiple Layers of Trauma contributing to Socio-economic Sensitivity
- Displacement
- Frustration with Agency Response
- Hazard Theater

It's partially optics so the public knows we are doing something (Paradise Fire & Water)

Differences

Paradise

- Local Independence

[Some residents have their] *own systems of commerce. They don't trust systems and have their own networks. The fire destroyed those networks and it has been hard to re-establish (Paradise Health and Human Services).*

Santa Rosa

- Long-term community involvement by organizations

Building the trust so that when we do have more of these emergencies, we have trusted people who can go out to our community and let them know that the water might not be okay (Santa Rosa Health & Human Services).

Notable Outliers

- Root cause of displacement & layered trauma
- Views on Backflow Prevention Devices

The backflow devices might be the highest risk – there are plastic components that melted in a lot of cases and part of them are metal so they conduct heat. These are probably the weakest link (Santa Rosa Fire & Water)

Thank You!

REFERENCES

Paveglio, T. B., Jakes, P. J., Carroll, M. S., & Williams, D. R. (2009). Understanding social complexity within the wildland–urban interface: a new species of human habitation?. *Environmental management*, *43*, 1085-1095.

Schmidt, A., Ellsworth, L. M., Tilt, J. H., & Gough, M. (2023). Application of deep convolutional networks for improved risk assessments of post-wildfire drinking water contamination. *Machine Learning with Applications*, 100454.

Schmidt, A., Ellsworth, L. M., Tilt, J. H., & Gough, M. (2022). Predicting conditional maximum contaminant level exceedance probabilities for drinking water after wildfires with Bayesian regularized network ensembles. *Machine Learning with Applications*, *7*, 100227.

Project Website: https://blogs.oregonstate.edu/wildfireresilience/

Contacts:

- Jenna Tilt: tiltj@oregonstate.edu
- Eliza Amstutz: amstutze@oregonstate.edu
- Andres Schmidt: andres.schmidt@oregonstate.edu