# Wildfire Evacuation Roundtable

January 31, 2024

# Agenda

- Opening Remarks — Deanne Criswell, FEMA Administrator
- State of the Problem — Dr. Lori Moore-Merrell, U.S. Fire Administrator
- Roundtable Introductions
- Setting the Stage: Camp Fire Evacuation
- Local and State Perspectives on Wildfire Evacuation
- Resources for Wildfire Evacuation Readiness
- Social Science Expert Perspective – Human Behavior
- Data and Technology for Wildfire Readiness and Evacuation
- Roundtable Discussion
- Courses of Action – Next Steps Moving Forward
- Closing Remarks – Dr. Moore-Merrell, USFA

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# Wildfire Commission on Evacuation

“While the Commission was not specifically tasked with formulating recommendations related to evacuation, members felt evacuation to be an essential part of the Commission’s charge related to the protection of human life.

Recent fires that quickly moved into and through communities, such as the 2023 fires in Hawai’i, the 2021 Marshall Fire in Colorado, and the 2018 Camp Fire in California have highlighted the critical importance of evacuation, evacuation planning, and evacuation communication.

During catastrophic fire events, evacuation can be essential in conditions that enable rapid fire spread and limit fire response”.”

# DHS Secretary's 2024 Priorities

- **Priority 11 – Ready the nation to respond to and recover from disasters and combat the climate crisis**
  - **Remove barriers** to disaster resilience and recovery programs to **achieve equitable outcomes** for those we serve
  - **Improve disaster response capabilities** to prepare for emerging and catastrophic threats
  - **Enhance information sharing** with vulnerable communities to **minimize risk and improve disaster readiness**

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# FEMA 2024 Annual Planning Guidance

- **Goal 2 – Lead Whole of Community in Climate Resilience**
  - Support SLTT partners' efforts to conduct immediate **lifesaving and safety planning and response, informed by risk and behavior research**. *(Objective 2.3 Risk-Informed Decision Making)*

- **Goal 3 – Promote and Sustain a Ready FEMA and Prepared Nation**
  - Foster a Ready Nation by helping the emergency management community **incorporate emerging and catastrophic threats** into planning, training, partnerships, and consequence management. *(Objective 3.1 Emergency Management Workforce; Objective 3.3 Delivery of Federal Assistance)*

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# USFA

Wildland urban interface (WUI) fire disasters and community risk reduction efforts can be very complex, crossing multiple geographic jurisdictions.

This unique fire problem has become a high-risk public safety concern for life safety, public and responder health, private property and businesses, the economy, and ecology.

Likewise, potential solutions also require an all-hands approach. The need for the engagement of multiple agencies is real.

Dr. Lori Moore-Merrell, U.S. Fire Administrator


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# Facilitated Discussion – Connecting Resources & Tools

- Integrating and connecting resources & tools for improved wildfire evacuation before and during an incident

- Discussion Topics
  - Achieving Agile Decision Making
  - Affecting Human Behavior
  - Executing evacuation at the local level

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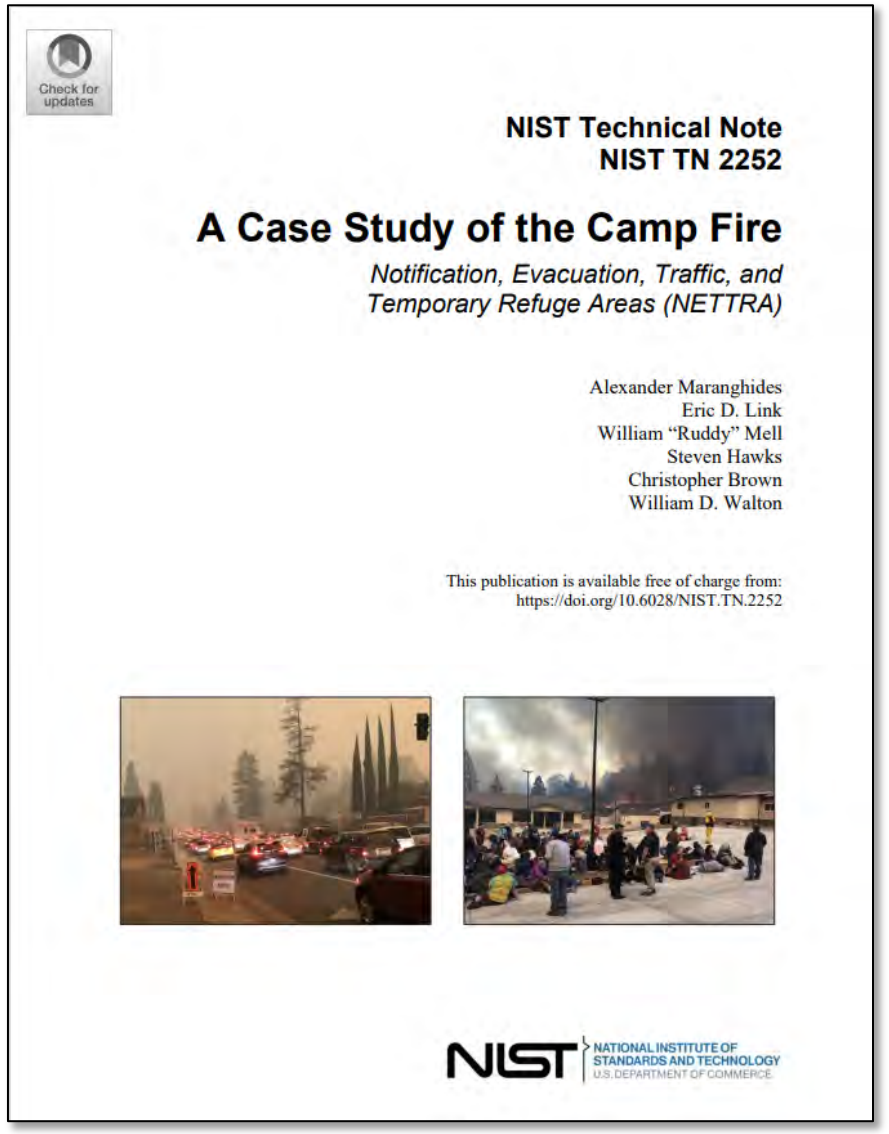
# NIST Case Study - 2018 Camp Fire

- Evacuation lessons learned from NIST's investigation of the California Camp Fire
  - o Notification
  - o Evacuation
  - o Traffic
  - o Temporary refuge areas
  - o Rescues
  - o Fatalities

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# WUI Fire Evacuation and Sheltering Considerations

## *Assessment, Planning and Execution*

## *ESCAPE*

Photo courtesy of Paradise Police Department


Photo courtesy of CAL FIRE

***2024 Wildfire Evacuation Roundtable***

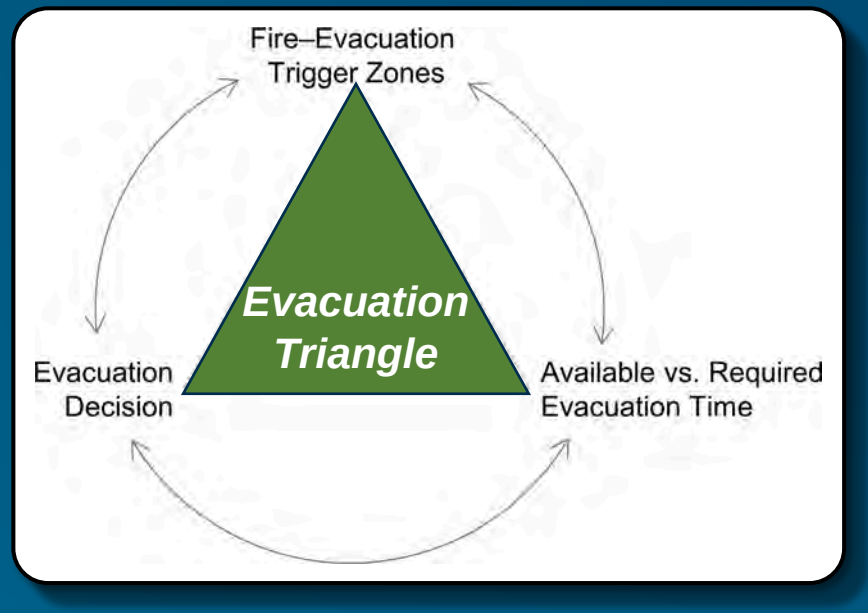
January 31, 2024

**Alexander Maranghides**
**Eric Link**
National Institute of Standards and Technology

https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/escape

# Wildfire and WUI Evacuations Different from Other Disasters

- Wildfire and WUI intersection
- Energy Release and Self Propagation of WUI Disasters
- Can be a no-notification event
- Existing vs New Community



# WUI Evacuations - Many Scenarios

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| Attribute | Options | Inputs | Impact |
|---|---|---|---|
| Community impacted | Interface vs intermix | Type of community | Fuel loading in and around community and impacts on fire progression |
| Size of communities and egress arteries | Small vs intermediate vs large | Size and community and ratio of road capacity (OHUs/lane) | Time to evacuation and evacuation options, available first responders |
| Location of community | Near larger town/metro area vs remote, or in between | Placement of community | Access to first responders |
| Prepared (plan and notification systems and messaging in place) | Yes / No | What systems are in place including for critical care facilities | How notification and evacuation takes place and impacts on life safety |
| Public engaged in evac process (drill) and aware of fire hazard | Yes / No | What public engagement systems have been implemented | How notification and evacuation takes place and impacts on life safety |
| Time of day and day of week | Night or day and workday vs weekend | Time and Day | Where residents will be and how rapidly they will respond |
| Egress pathway | Clear vs not clear from fire danger | Fuels around roadways and egress arteries | Ability to safely move through and out of town |
| Time to evaluate | sufficient vs insufficient (fire will impact evacuation) | Ignition location, ITA, ES | Life safety |
| Message of required action received by majority of public | Reached the public vs not (including Infrastructure hardening) | Infrastructure in place and ability to withstand exposures and power outages | Life safety |

# WUI Evacuations – An Example

| Attribute | Options | Inputs | Impact |
|---|---|---|---|
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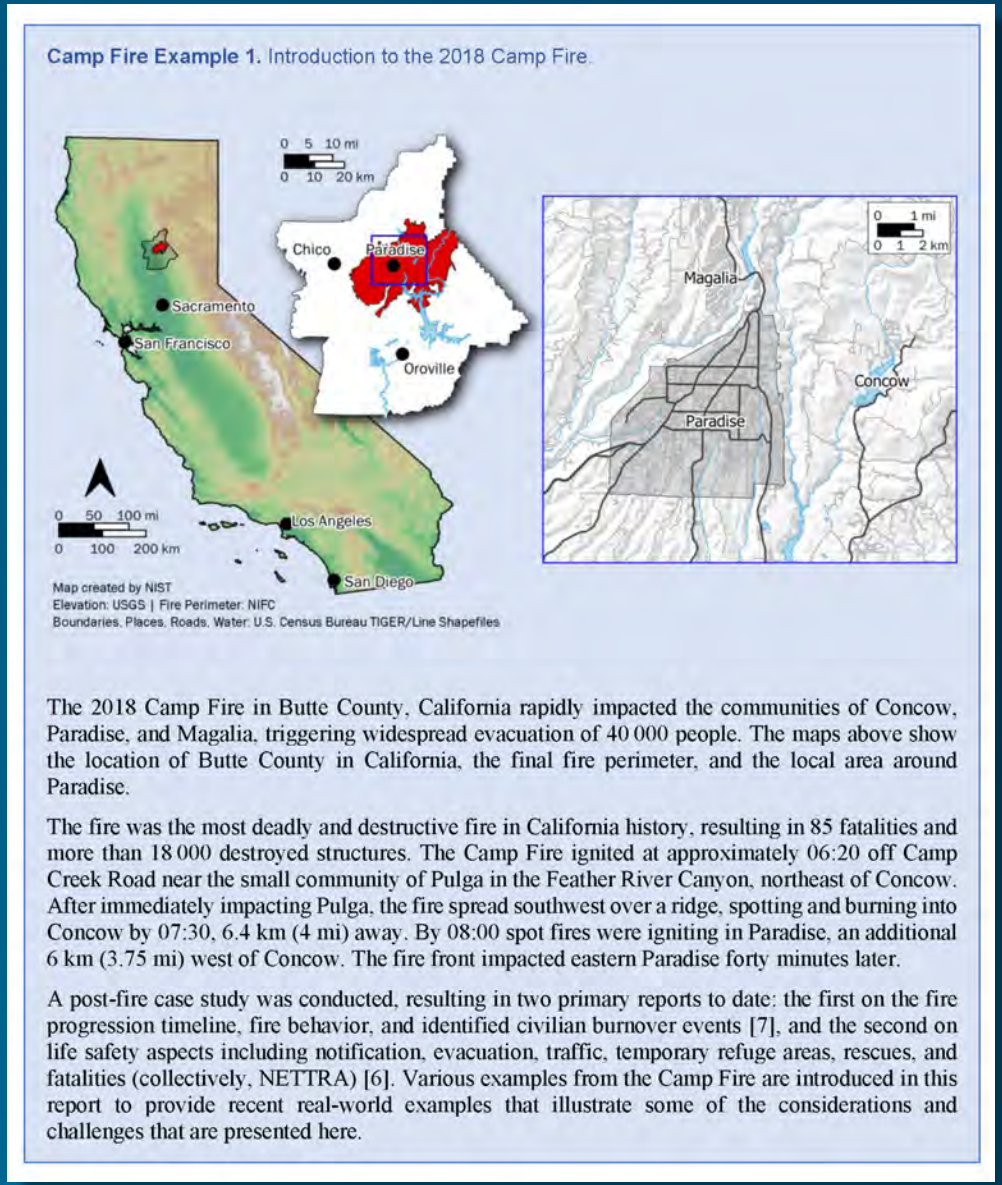
| Message of required action received by majority of public | Reached the public vs **not** (including Infrastructure hardening) | Infrastructure in place and ability to withstand exposures and power outages | Life safety |

# Why was ESCAPE developed?

- To facilitate the use of lessons learned from the Camp Fire Case Study.
- ESCAPE is a methodology for small to intermediate size intermix communities to assist with the development and implementation of Notification and Evacuation Plans
- 24 examples from the Camp Fire case study



**Camp Fire Example 1.** Introduction to the 2018 Camp Fire.



The 2018 Camp Fire in Butte County, California rapidly impacted the communities of Concow, Paradise, and Magalia, triggering widespread evacuation of 40 000 people. The maps above show the location of Butte County in California, the final fire perimeter, and the local area around Paradise.

The fire was the most deadly and destructive fire in California history, resulting in 85 fatalities and more than 18 000 destroyed structures. The Camp Fire ignited at approximately 06:20 off Camp Creek Road near the small community of Pulga in the Feather River Canyon, northeast of Concow. After immediately impacting Pulga, the fire spread southwest over a ridge, spotting and burning into Concow by 07:30, 6.4 km (4 mi) away. By 08:00 spot fires were igniting in Paradise, an additional 6 km (3.75 mi) west of Concow. The fire front impacted eastern Paradise forty minutes later.

A post-fire case study was conducted, resulting in two primary reports to date: the first on the fire progression timeline, fire behavior, and identified civilian burnover events [7], and the second on life safety aspects including notification, evacuation, traffic, temporary refuge areas, rescues, and fatalities (collectively, NETTRA) [6]. Various examples from the Camp Fire are introduced in this report to provide recent real-world examples that illustrate some of the considerations and challenges that are presented here.

# What is the Problem?

- Addressing the life safety risk when there is insufficient time to evacuate out of the community
- Burnovers and need for Temporary Refuge Areas (TRAs)
- Existing built environment is not designed to act as fire shelters

**Camp Fire Example 3.** Inadequacy of existing infrastructure buildings as fire shelters.

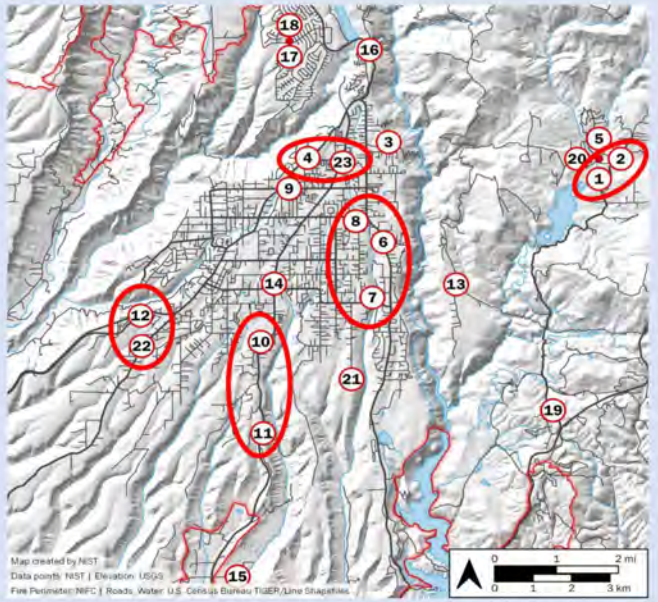
a) Ponderosa Elementary School

b) Feather River Hospital

c) Feather River Hospital

The damage to Ponderosa Elementary School (a) and Feather River Hospital (b and c) illustrate just two examples of existing infrastructure that were not adequate for use as WUI fire shelters during the Camp Fire. Despite having more robust construction than typical residential structures, they are not currently designed to withstand WUI fire exposures. Both the school and hospital buildings ignited and were actively defended by firefighters, largely saving the structures. The damage to the buildings was extensive, even with significant efforts by firefighters, and one defended hospital building was destroyed. School children, hospital patients, and other susceptible populations cannot shelter in place in existing infrastructure that is not designed specifically to withstand WUI fire and ember exposures.

**Camp Fire Example 9.** Burnover events that impacted evacuating civilians and responding emergency personnel.




Entrapment/burnover events are defined as life-threatening situations where planned escape routes or safety zones are inadequate or compromised and individuals are overtaken or trapped by fire, often resulting in equipment damage and personal injury or death. The post-fire case study identified 23 such events that occurred in the first 26 hours of the Camp Fire [6, 7, 78], 17 of which involved an estimated combined total of up to 500 civilians. A total of seven civilians were killed in three of the 23 events. The locations of the 23 burnover incidents are shown in the map above, occurring throughout the fire area.

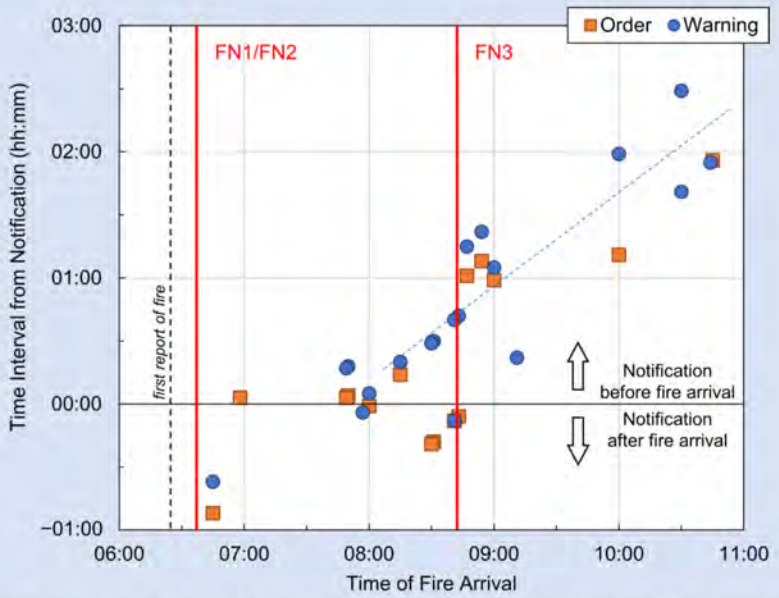
Out of the 23 identified burnovers, 11 impacted primary egress arteries during the peak of the evacuation, roughly between 08:00 and 12:00. These events are indicated by the circled burnover ID points in the map above. Fire overtook evacuees who were stuck in gridlocked traffic in five instances, and intense fire impeded or trapped moving traffic in six instances. The closure of Concow Road, the sole egress route in Concow, significantly affected the evacuation of that community. In Paradise, some egress arteries were closed for several hours, impacting both civilian egress and first responder access and operations. At 09:45, two hours after the first spot fire ignited in Paradise and a little over three hours after the fire was reported, two of the four southbound egress arteries were closed due to fire. By 11:45, during the peak of the Paradise evacuation, three of the four were closed due to fire, significantly impacting evacuation.

The concurrence of evacuation and fire impact on the community significantly affected the life safety of evacuating civilians. The formation and use of TRAs significantly enhanced the life safety of entrapped individuals.

# What is the Problem?

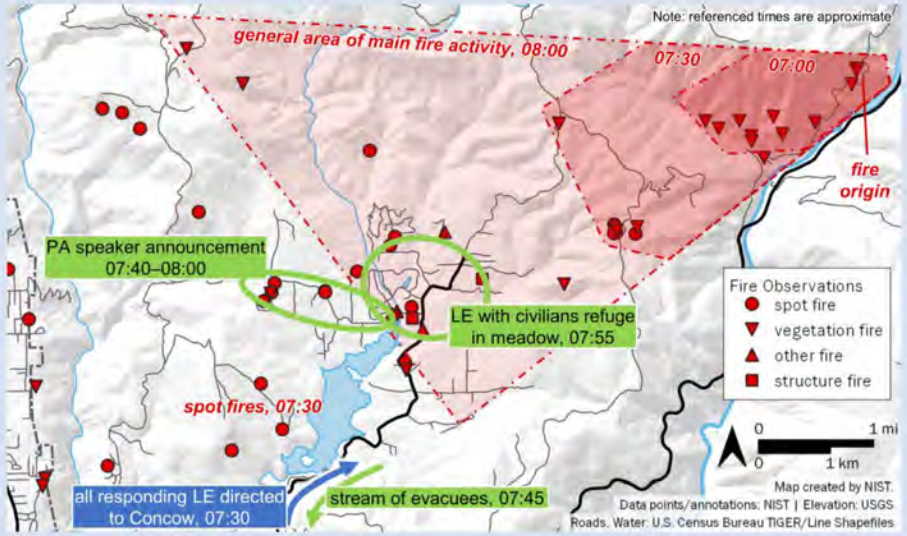
## Time and distance to safety

**Camp Fire Example 11.** Time of fire arrival and first official evacuation notification, by evacuation zone.




The plot above, adapted from Ref. [6], illustrates the time gap between time of fire arrival and the time of official notification for each evacuation zone for the Camp Fire as it spread through Concow and Paradise. Early in the incident, before 08:45, evacuation notifications were sent after or concurrent with the arrival of the fire in each evacuation zone (FN1 and FN2). This is represented in the plot by data points below the *x*-axis. At 07:45, 80 minutes after the first report of the fire, evacuation notifications were being sent at the same time as fire arrived within the notified evacuation zones. The positive gap illustrated on the right side of the graph, after 08:45, shows how notifications were issued ahead of the fire as the incident continued to evolve, giving the civilians in these zones more time to evacuate before the arrival of fire (FN3).

**Camp Fire Example 12.** Simultaneous arrival of fire and evacuation notification, leading to entrapment during evacuation in Concow.




The map above shows the area of Concow, a rural community located between the origin of the fire in Pulga and the town of Paradise. Red data points indicate individual fire observations before 08:00. The red shaded areas roughly indicate the area of main fire activity in 30-minute intervals after ignition. Note the significant number of spot fires ahead of the main fire activity.

The IC requested evacuation of Concow at 07:37, seven minutes after the first 911 calls were received reporting spot fires in the area. All responding law enforcement officers (LE) were directed to Concow to begin evacuations. Due to the location and the scattered spot fires ahead of the main fire front, the 911 calls were the first indication to the IC that the fire was within Concow. Firefighters on the ridge between Concow and Pulga observed the fire front spreading west at 07:30, indicated by the intermediate shaded polygon.

One of the first firefighters to access the Concow area conducted drive-by notifications of residents using the vehicle siren and public address speaker between 07:40 and 08:00. At the same time, law enforcement was directing civilians to seek shelter in the designated Wild Fire Safety Zone at the Camelot Meadow. Multiple spot fires grew rapidly and within minutes created impassable conditions, entrapping evacuating civilians and first responders at several locations and resulting in multiple burnover events and the formation of multiple TRAs (see Camp Fire Examples 15 and 19).

# Existing Practices and Current Research

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## Leaving

- Emphasis on early out – **Ready Set Go**

## Staying

- Some jurisdictions recommend Stay and Defend

There is no standardized way to determine what is defensible – including by whom and with what equipment and under what conditions

- Some jurisdictions recommend Shelter in Place or offer Shelter in Community (wildfire safety zones)

There are no standards for fire shelters or wildfire safety zones

# Civilian Stay and Defend

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Critical difference in fuel density from large rural parcels to suburban settings

**Table 1.** Differences between private civilians and firefighters.

| Preparedness/Response Attribute | Typical Civilian | Firefighter |
|---|---|---|
| Training and maintenance of proficiency of WUI/wildland firefighting strategies and tactics | Limited | Mandatory training; experience gained through practice and annual recertification |
| Physical fitness | Variable | Required, tested |
| Equipment | Limited | Available, maintained, tested, and specialized |
| Standalone water supply (independent of community infrastructure) | Variable | Available on apparatus and locally accessible sources |
| PPE and safety training, including wildland fire shelter use | Likely inadequate | Standard and required |
| Situational awareness | Limited to media, internet, and radio scanners, and may be dependent on electrical power supply | Fully integrated in ICS with an incident action plan (IAP) |
| Lookouts, Communication, Escape Routes, and Safety Zones (LCES) | Unlikely | Yes |
| Operational support | No | Yes |

**Camp Fire Example 2.** Defensible space and exposures from neighboring parcels.


Exposures from neighboring parcels must be accounted for when assessing the defensibility of a property. The fully involved parcel (including structure, vehicle, and vegetation) seen above illustrates the very high fire exposures that can be generated during WUI fires. Fully involved fuels with flame lengths greater than 6 m (20 ft), as in the image above, would be difficult to contain even with several firefighting apparatus and cannot be contained by defensive actions by residents.

In this scenario, the structure separation distance (SSD) was 13 m (43 ft) from the burning home shown in the image to the neighboring structure. The structure to property line distance (SPLD) was 8 m (26 ft). Defensible space may be difficult to implement in moderate and high-density communities where significant fire exposures can originate from neighboring parcels and structures are spaced even closer than in this example.

Exposure sources from adjacent parcels are beyond the control of residents and typically beyond their ability to suppress them

# Consequences, and the Missing Link

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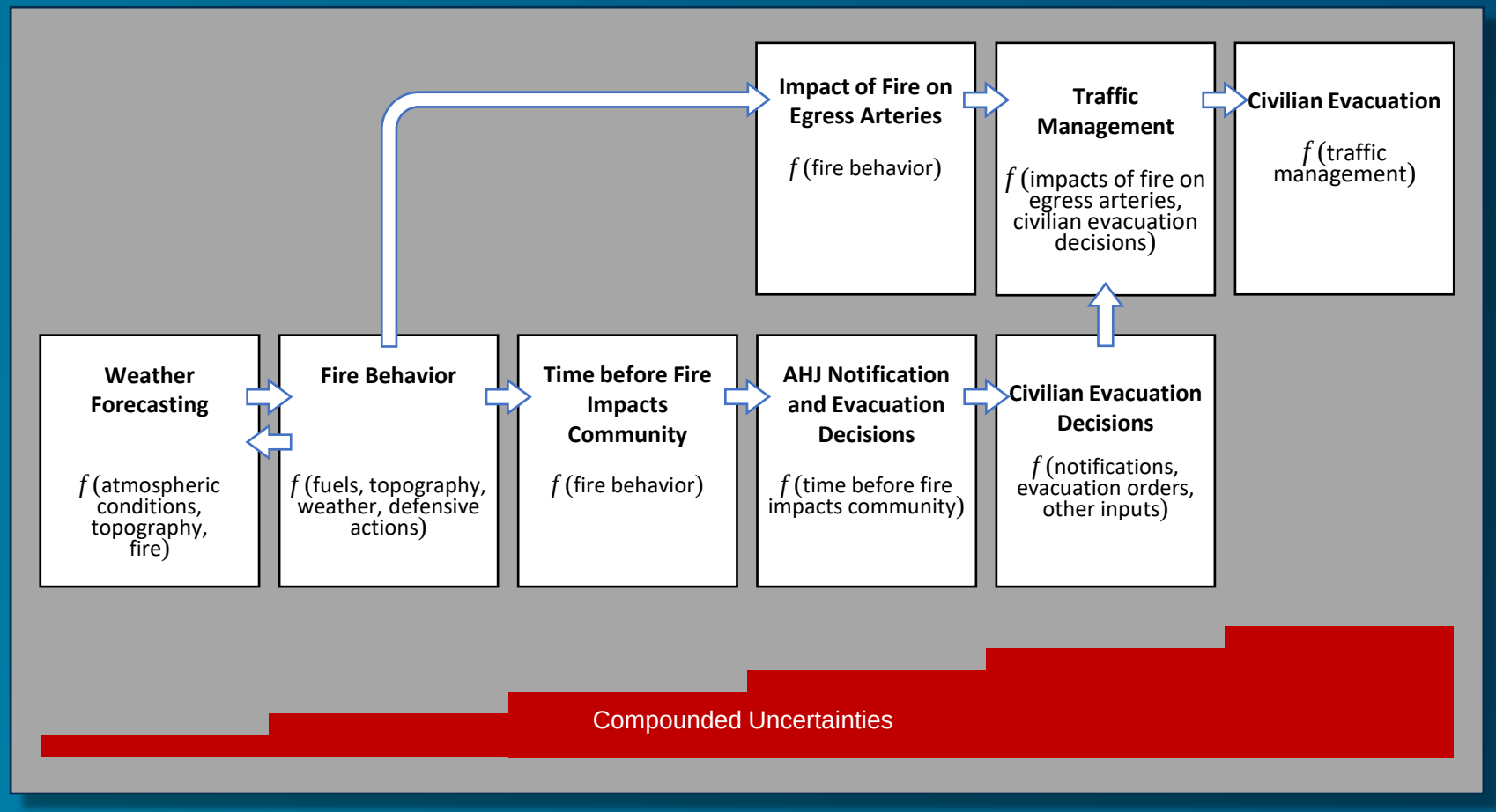
- Civilians perish in their homes
  (US, Portugal, Australia)

- Civilians perish in their vehicles as they try to evacuate
  (US, Portugal)

The missing link: addressing evacuation scenarios where there is insufficient time to evacuate from the community by *managing life safety risks*

# Why is it so hard to reliably predict evacuations?

Modules associated with evacuation predictions are linked or coupled.




Uncertainties are compounded and propagate from left to right and illustrated in red (not to scale).

**Figure 3**

# Characterizing Evacuation "Failures"

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- Type 1: Undesirable Evacuation Consequences – *no impacts to life safety*

- Type 2: Evacuation Failures – *impacts to life safety*

# What causes civilians to experience high exposures?

1. An *inability to evacuate* owing to reduced mobility (e.g., physical or medical factors) or no access to a vehicle or other transportation.
2. High exposures at one's residence experienced after a *decision to stay* (whether to shelter in place or stay and defend).
3. High exposures experienced during egress;
   a) during a late or delayed evacuation after an initial decision to stay or after accomplishing specific tasks like getting kids from school.
   b) being overrun by fire due to rapid fire spread or due to traffic or other evacuation delay.

Scenarios related to staying

Scenarios related to transit

# Addressing Type 2 Evacuation Events

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1. **Hardening Care Facilities and Buildings Requiring Evacuation Considerations including Residences**

*Goal: Enhance life safety*

Hardening of the structure/facility to extend the time available for evacuation . The NIST HMM is a comprehensive approach to address structure/ parcel/ community hardening for both fire and ember exposures.


Photo courtesy of TD-112, 15:10.


NIST Structure Separation Experiments

⚠ Hardening the facility against fire does not imply that the facility will necessarily be suitable as a fire shelter. Ventilation, power, and other tenability and access requirements are necessary to create a fire shelter


* Building is designed not to ignite based on expected exposures. This may not always be achievable for very high exposures. Fire shelters must “stand alone” and be able to withstand the incoming exposures

# Addressing Type 2 Evacuation Events

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**2. High exposures (e.g., burnover conditions) at residence**

*Goal: Enhance life safety*

- Injuries or fatality from decision to stay (shelter in place or stay and defend)

→ Education and "Ready Set Go"

- Education and information campaigns highlighting the dangers of wildfires, together with the challenges of reaching residents during these events, can be used to inform the public.

# Addressing Type 2 Evacuation Events

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**3. High exposures (BO conditions) during egress that result in injuries or fatality.**

*Goal: Reduce the potential for high fire exposures along the key egress routes and arteries.*

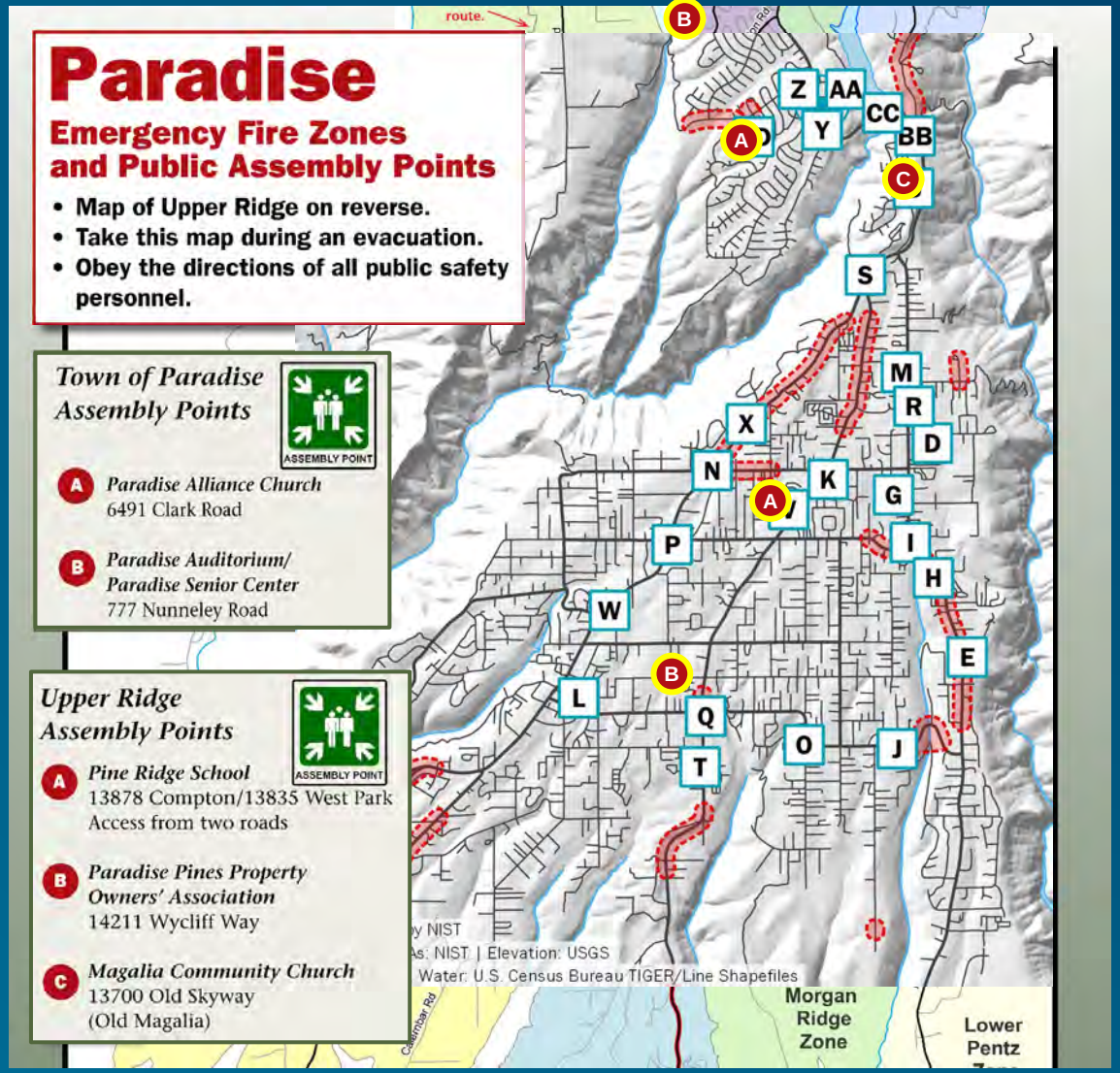
- This maintains tenability of the egress routes and allows evacuees to remain in their vehicles and allows them to egress to safety.
- For this approach to be effective it will require fuel thinning and vegetation removal along these corridors and continued maintenance of these fuel treatments over time.

# Addressing Type 2 Evacuation Events



- Another approach to mitigating the risk of high exposures to evacuees is to assemble residents at a wildfire safety zone – a *Temporary Fire Refuge Area (TFRA)*

A distributed network of wildfire safety zones can reduce travel time for residents seeking shelter when there is no safe evacuation route.




Paradise Evacuation Plan Document, combined/annotated by NIST
TRA map overlay by NIST

# Getting to the Wildfire Safety Zone

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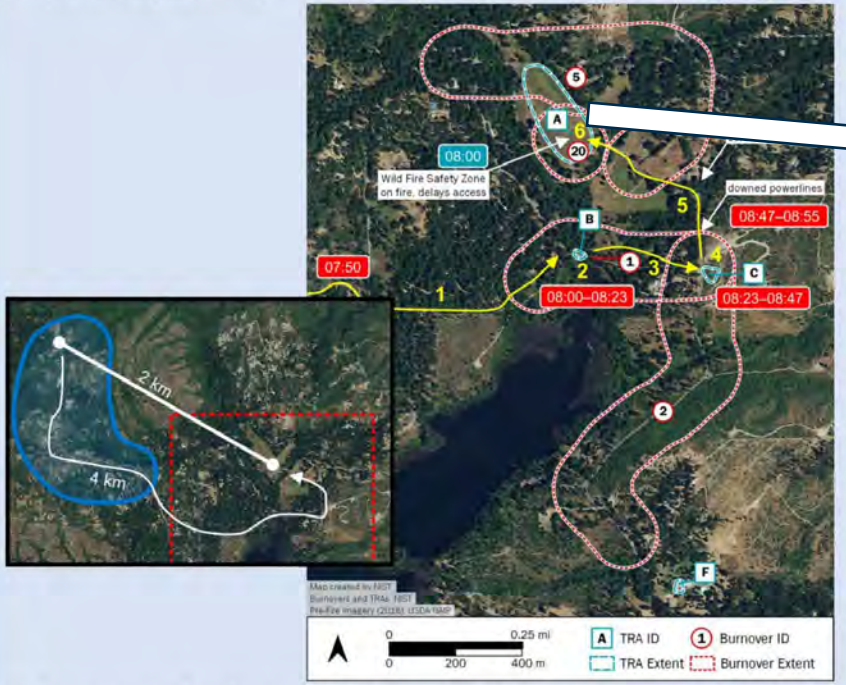
**Camp Fire Example 15.** Entrapment en route to the safety zone at Camelot Meadow in Concow.




Civilians evacuating from the area circled in blue, west of the egress artery, were up to 2 km (1.2 mi) straight line distance and 4 km (2.5 mi) driving distance away from the pre-designated Wild Fire Safety Zone at Camelot Meadow (*TRA-A*, indicated with a blue square and outline). These civilians were caught in two burnovers (*BO #1* and *#2*, indicated with red circles and outlines) and took shelter in two TRAs (*B* and *C*) on their way to the meadow.

Two firefighters in a pickup truck were scouting out the fire and evacuating civilians in the west portion of Concow. Returning toward the exit (**1**, in yellow text), they were blocked by fire and debris on Hoffman Road with 10 to 15 civilian vehicles following them (*BO #1*) (**2**). The firefighters deployed fire shelters to shield civilians as they moved them to a TRA in the creek (*TRA-B*) while several vehicles were igniting. A dozer was able to access the TRA and clear the obstructed roadway (**3**). However, the group was unable to reach the Camelot Meadow, and instead had to take refuge in a second TRA (*C*) at the intersection of Hoffman Road and Concow Road (*BO #2*) (**4**). After 24 minutes, fire activity subsided enough that they could convoy (**5**) to the safety zone at the meadow to join the group already taking refuge there (**6**).

The two burnovers that occurred before residents could reach the designated safety zone highlights the need for a distributed wildfire safety zone system that would reduce the travel distance between areas of relative safety.

**Camp Fire Example 19.** Natural areas used as wildfire safety zones.


a) Camelot Meadow


b) Crain Memorial Park

The photos above show two examples of natural area safety zones on Concow; a) Camelot Meadow and b) Crain Memorial Park. Both locations were indicated in the existing pre-fire evacuation plans for the Concow area and had signage indicating their intended use as public assembly points during fire incidents.

The Camelot Meadow was minimally maintained as a 3.2 ha (8 ac) natural grass meadow; during the Camp Fire, the safety zone was temporarily unusable while the fire burned through it. Afterwards, an estimated 70 to 85 civilians took refuge in the burned meadow in addition to several first responders. The photo above shows the condition of the meadow one year after the fire.

Crain Memorial Park was another natural safety zone in Concow, characterized by a maintained field. It's use during the Camp Fire was undetermined.

# Mitigating Civilian Fire Exposures

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Not enough time to fully evacuate before the fire impacts community

*Shelter in Place/ Stay and Defend*

Very High Hazard Potential

Make Structure* into a Fire Shelter

Science and Tech Gap ~$$$

*Evacuate to nearby Fire Shelter*

Science and Tech Gap ~$$$

Evacuate residents along treated routes to safety outside of fire

Science and Tech Gap ~$ to $$

Evacuate residents to nearby Distributed Safety Zone System (DSZS) within the community

Science and Tech Gap ~$ to $$

* (care facility/hospital/home)

# Mitigating Civilian Fire Exposures During Evacuation

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Early Out
*Ready Set Go*

Part of comprehensive evacuation plan

*Challenges:*
- Public education
- Clear messaging and notification for early out vs shelter in community

***Enough time to fully evacuate***
before the fire impacts community

Reduce risk by mitigating the potential hazard presented by fire to the evacuating public

Fuel management within the community and along egress arteries

*Challenges:*
- Access
- Environmental considerations
- Maintenance

Create Distributed Safety Zone System (DSZS) within the community

Provide areas of reduced fire exposure

*Challenges:*
- Access
- Design Guidance: density/size
- Environmental considerations
- Maintenance
- Public education

***Not enough time to fully evacuate***
before the fire impacts community

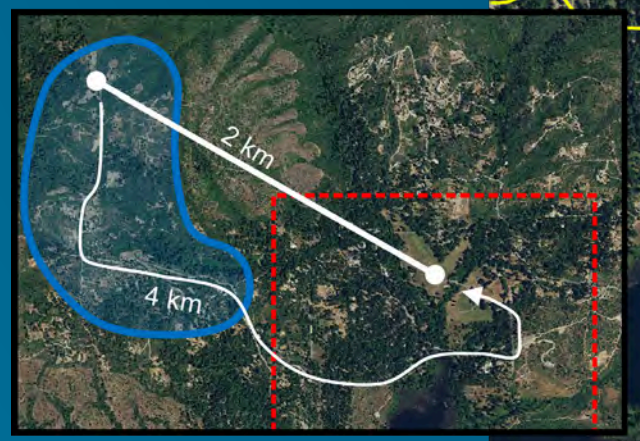
# Distributed Safety Zone System

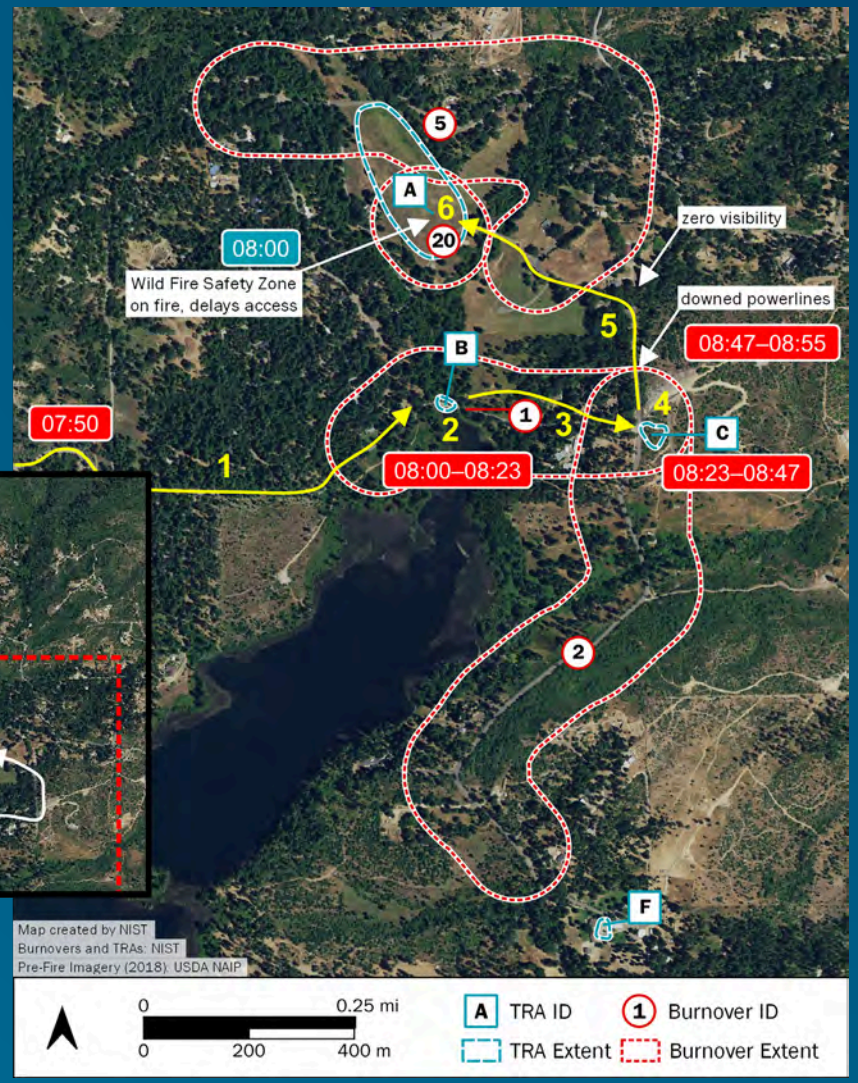
*Wildfire Safety Zone "next to" residence*

*Least travel*

*Wildfire Safety Zone on "other side" of the community*

*Most travel*




Exposure Potential, Travel Distance, Traffic and Evacuation Timing will all impact safely reaching safety zone

# Community Evacuation Time

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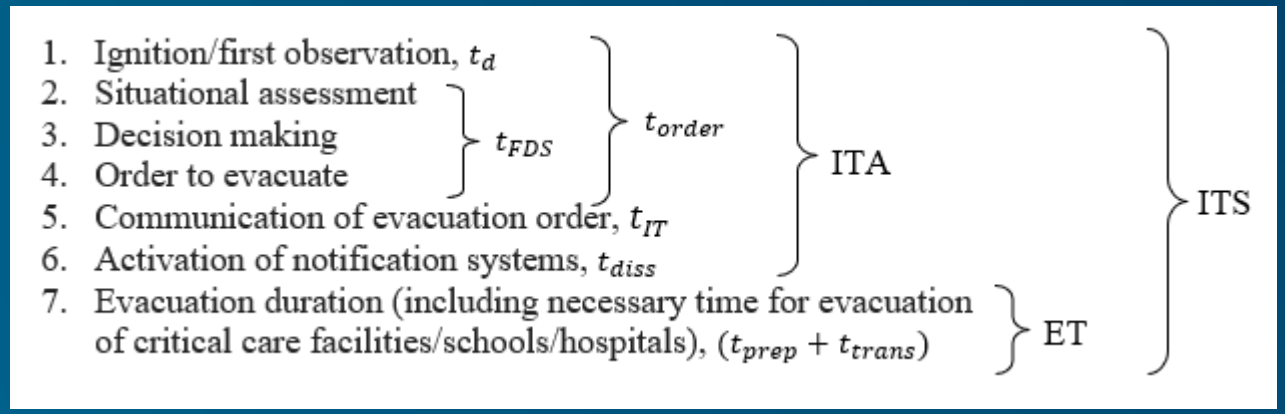
- There is a minimum amount of time needed to execute an evacuation.
- Traditional RSET includes time for detection, alarm, pre-movement, and evacuation.




In the WUI, the WUI RSET (WRSET) includes time required to:

- assess the ignition/fire situation
- communicate this information to the incident commander and emergency operations center
- decide on the required evacuations
- begin the notification and evacuation processes
- conduct the evacuation.

Ignition to Safety | Ignition to Activation | Evacuation Time

$$ITS = WRSET = ITA+ET$$

# Summary

- The ESCAPE methodology specifically addresses critical temporal/spatial thresholds between fire spread and evacuation for *existing* communities.

- Specifically designed to help *small and medium size intermix WUI communities* develop evacuations plans.

- *Signage and fact sheet* – first steps of a broader national campaign.

# TFRA Fact Sheet and Signage

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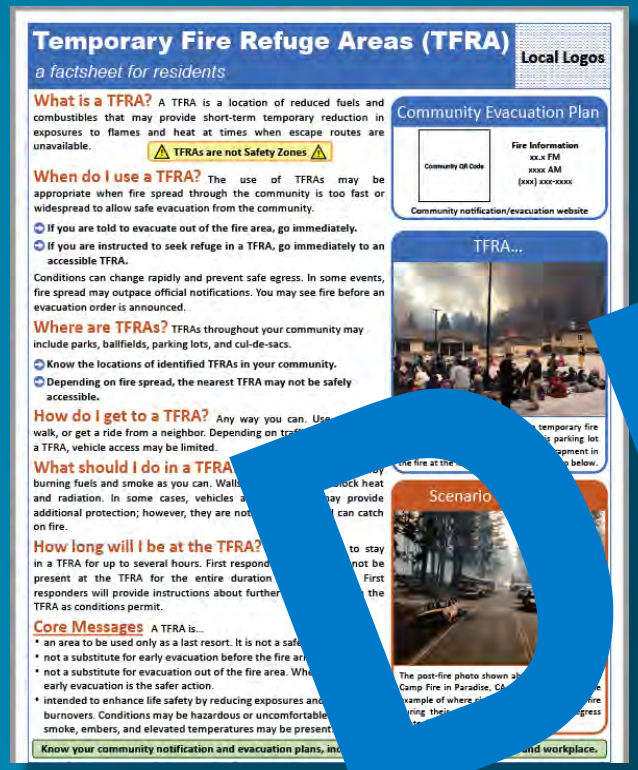
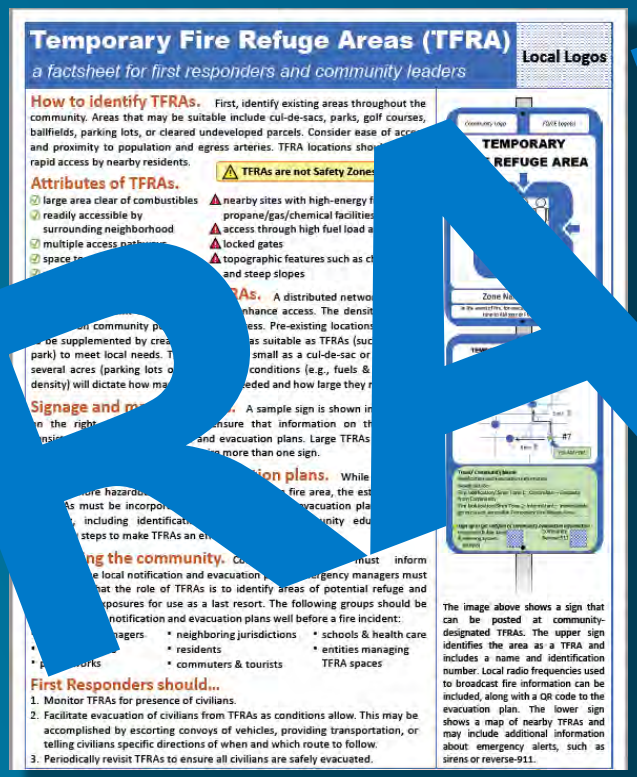
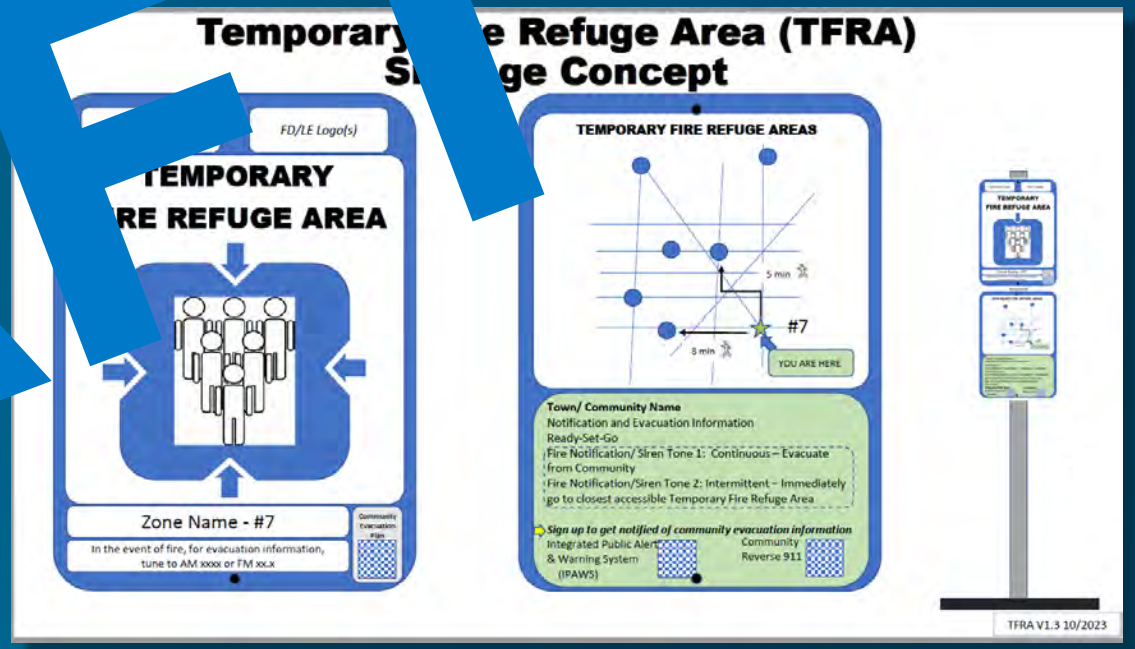
Collaborative effort NIST / USFA / FEMA/ CALFIRE and others


Temporary Fire Refuge Areas (TFRA)
a factsheet for residents
Local Logos
What is a TFRA? A TFRA is a location of reduced fuels and combustibles that may provide short-term temporary reduction in exposures to flames and heat at times when escape routes are unavailable.
TFRAs are not Safety Zones
When do I use a TFRA? The use of TFRAs may be appropriate when fire spread through the community is too fast or widespread to allow safe evacuation from the community.
If you are told to evacuate out of the fire area, go immediately.
If you are instructed to seek refuge in a TFRA, go immediately to an accessible TFRA.
Conditions can change rapidly and prevent safe egress. In some events, fire spread may outpace official notifications. You may see fire before an evacuation order is announced.
Where are TFRAs? TFRAs throughout your community may include parks, ballfields, parking lots, and cul-de-sacs.
Know the locations of identified TFRAs in your community.
Depending on fire spread, the nearest TFRA may not be safely accessible.
How do I get to a TFRA? Any way you can. Use
walk, or get a ride from a neighbor. Depending on tra
a TFRA, vehicle access may be limited.
What should I do in a TFRA
burning fuels and smoke as you can. Wall
and radiation. In some cases, vehicles
additional protection; however, they are not
on fire.
How long will I be at the TFRA?
in a TFRA for up to several hours. First respond
present at the TFRA for the entire duration
responders will provide instructions about further
TFRA as conditions permit.
Core Messages A TFRA is...
• an area to be used only as a last resort. It is not a saf
• not a substitute for early evacuation before the fire ar
• not a substitute for evacuation out of the fire area. Wh
early evacuation is the safer action.
• intended to enhance life safety by reducing exposures and
burnovers. Conditions may be hazardous or uncomfortable
smoke, embers, and elevated temperatures may be present
Know your community notification and evacuation plans, inc
and workplace.
Community Evacuation Plan
Community QR Code
Fire Information
xx.x FM
xxxx AM
(xxx) xxx-xxxx
Community notification/evacuation website
TFRA...
Scenario
The post-fire photo shown a
Camp Fire in Paradise, CA
example of where


Temporary Fire Refuge Areas (TFRA)
a factsheet for first responders and community leaders
Local Logos
How to identify TFRAs. First, identify existing areas throughout the community. Areas that may be suitable include cul-de-sacs, parks, golf courses, ballfields, parking lots, or cleared undeveloped parcels. Consider ease of acc
and proximity to population and egress arteries. TFRA locations sho
rapid access by nearby residents.
TFRAs are not Safety Zones
Attributes of TFRAs.
large area clear of combustibles
readily accessible by surrounding neighborhood
multiple access pathways
space to
nearby sites with high-energy f
propane/gas/chemical facilities
access through high fuel load a
locked gates
topographic features such as c
and steep slopes
RAs. A distributed netwo
nhance access. The densit
ess. Pre-existing location
as suitable as TFRAs (suc
small as a cul-de-sac or
conditions (e.g., fuels &
eeded and how large they
Signage and m
A sample sign is shown i
ensure that information on th
and evacuation plans. Large TFRAs
more than one sign.
ion plans. While
fire area, the est
vacuation pla
unity edu
ng the community. co
must inform
local notification and evacuation p
ergency managers must
hat the role of TFRAs is to identify areas of potential refuge and
posures for use as a last resort. The following groups should be
notification and evacuation plans well before a fire incident:
nagers
works
• neighboring jurisdictions
• residents
• commuters & tourists
• schools & health care
• entities managing TFRA spaces
First Responders should...
1. Monitor TFRAs for presence of civilians.
2. Facilitate evacuation of civilians from TFRAs as conditions allow. This may be accomplished by escorting convoys of vehicles, providing transportation, or telling civilians specific directions of when and which route to follow.
3. Periodically revisit TFRAs to ensure all civilians are safely evacuated.
TEMPORARY
REFUGE AREA
Zone Na
#7
The image above shows a sign that can be posted at community-designated TFRAs. The upper sign identifies the area as a TFRA and includes a name and identification number. Local radio frequencies used to broadcast fire information can be included, along with a QR code to the evacuation plan. The lower sign shows a map of nearby TFRAs and may include additional information about emergency alerts, such as sirens or reverse-911.


Temporary e Refuge Area (TFRA)
S ge Concept
FD/LE Logo(s)
TEMPORARY
RE REFUGE AREA
Zone Name - #7
In the event of fire, for evacuation information, tune to AM xxxx or FM xx.x
Community Evacuation Plan
TEMPORARY FIRE REFUGE AREAS
5 min
8 min
#7
YOU ARE HERE
Town/ Community Name
Notification and Evacuation Information
Ready-Set-Go
Fire Notification/ Siren Tone 1: Continuous – Evacuate from Community
Fire Notification/Siren Tone 2: Intermittent – Immediately go to closest accessible Temporary Fire Refuge Area
Sign up to get notified of community evacuation information
Integrated Public Alert & Warning System (IPAWS)
Community Reverse 911
TFRA V1.3 10/2023

# Thank You

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Contact Information: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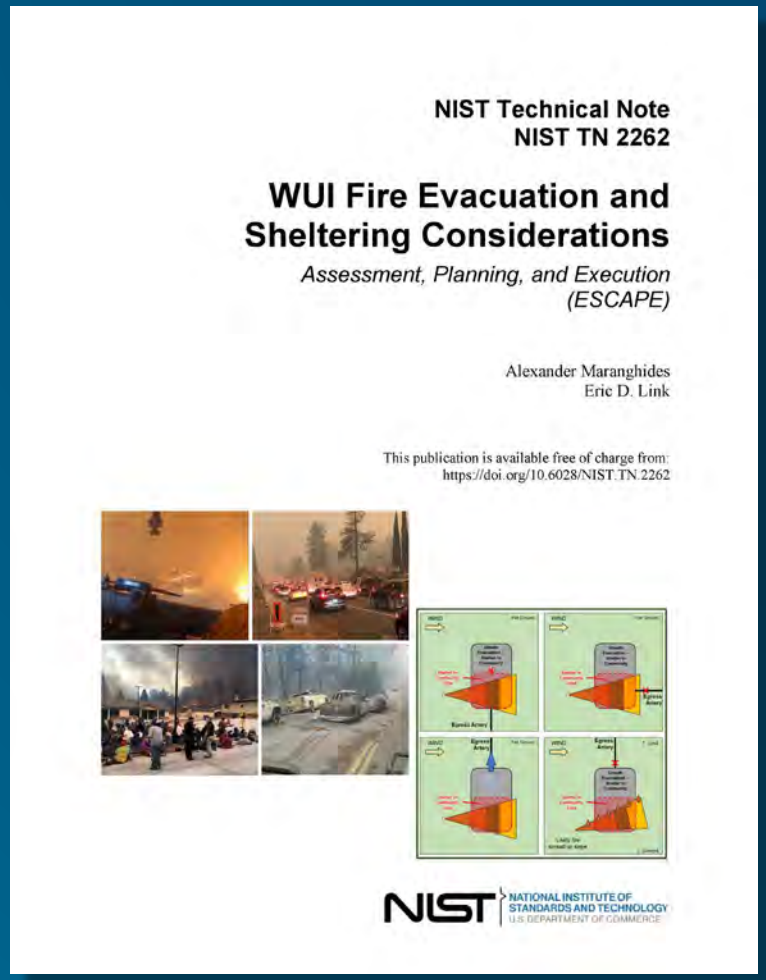
202-567-1634

Eric Link
eric.link@nist.gov


https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305/escape

# Local and State Perspectives on Wildfire Evacuation

## Decision Making on Wildfire Evacuation

- Fire Service Leaders
- Law Enforcement Leaders
- Tribal Nations
- State Emergency Management

**Ready Set Go for Law Enforcement training video**
https://www.youtube.com/watch?v=NEdjXNHqisg

**Town of Vail Wildfire Evacuation video**
https://www.youtube.com/watch?v=yWMUs52jfzY

FEMA | U.S. Fire Administration

# USFA Wildfire Evacuation Roundtable

**BRIAN FENNESSY**
Fire Chief, Orange County Fire Authority (CA)

- 2/3 of California’s 39M+ population reside in SoCal
- Wildfire evacuations common occurrence in Southern California
- Law Enforcement (LE) responsible for evacuation in California
- Fire Service generally provides LE evacuation parameters
- History of poorly coordinated mass notifications & evacuations
- Very good off-the-shelf vendor provided evacuation software solutions available now
- Joint Fire/LE exercises commonplace
- Mass notification commonplace

- Prepare, Stay, Defend or Leave Early – Australia
  - 2009 “Black Saturday” Bushfires – 173 fatalities
- Ready, Set, Go (RSG) – 2010 California
  - RSG generally emphasize the need for leaving early
    - Knowing when to leave
    - Where to go
    - How to get there to prevent getting caught in smoke, fire and road congestion
- However, two different types of “Go” are being experienced…
  - The Leave Early “Go” for which there is considerable detail
  - No Notice Immediate “Go” for which there is no detail = Gap

- No Notice Immediate “Go” Environmental Common Threads
  - Wind-driven
  - Low relative humidity
  - Low light/dark conditions when citizens are asleep
  - Fire direction/path is predictable
- Common Outcomes
  - High human life loss & structure loss
  - WUI incident transitions to Urban Conflagration
  - Seconds or minutes to make decision
    - Attempt escape or shelter in place

# Courageous Conversations Needed…

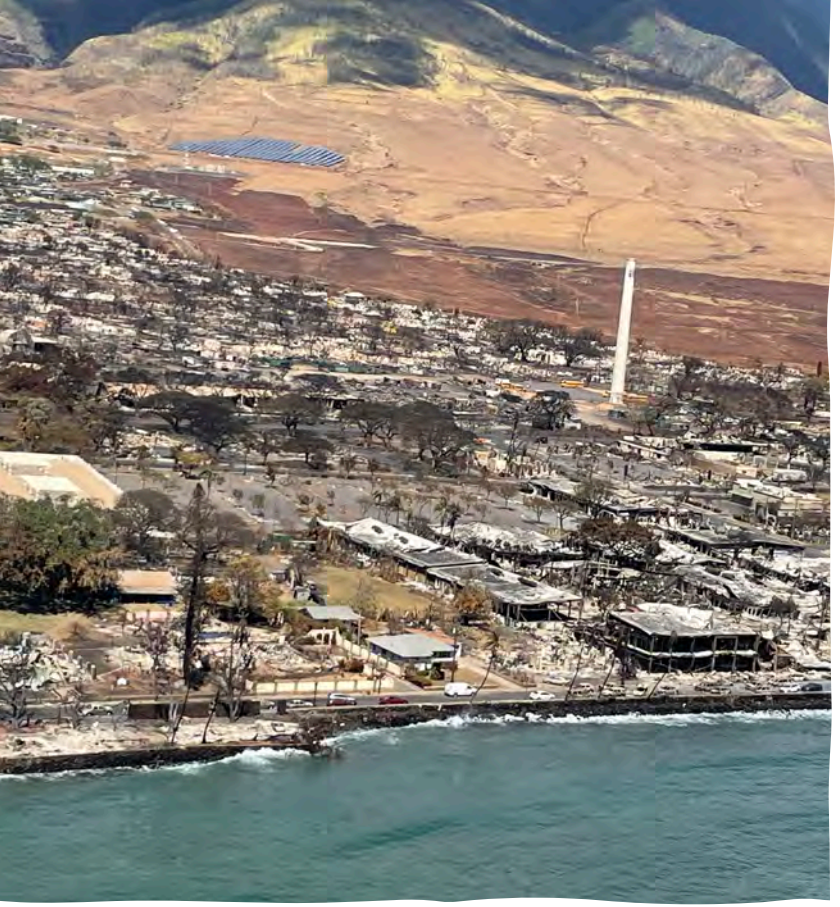
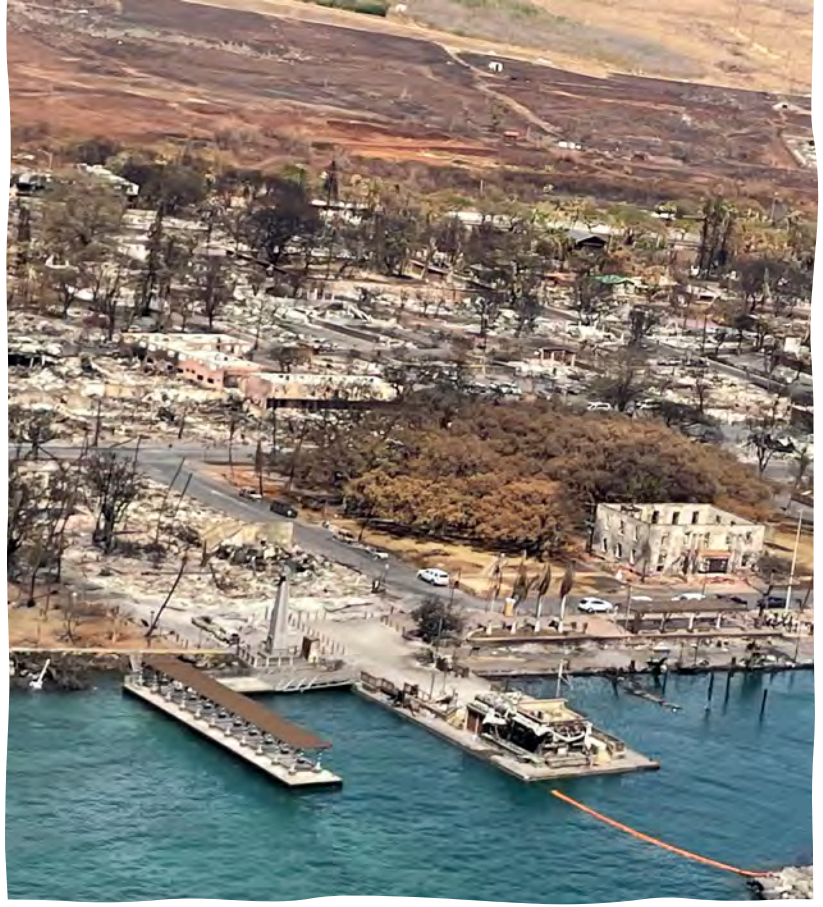
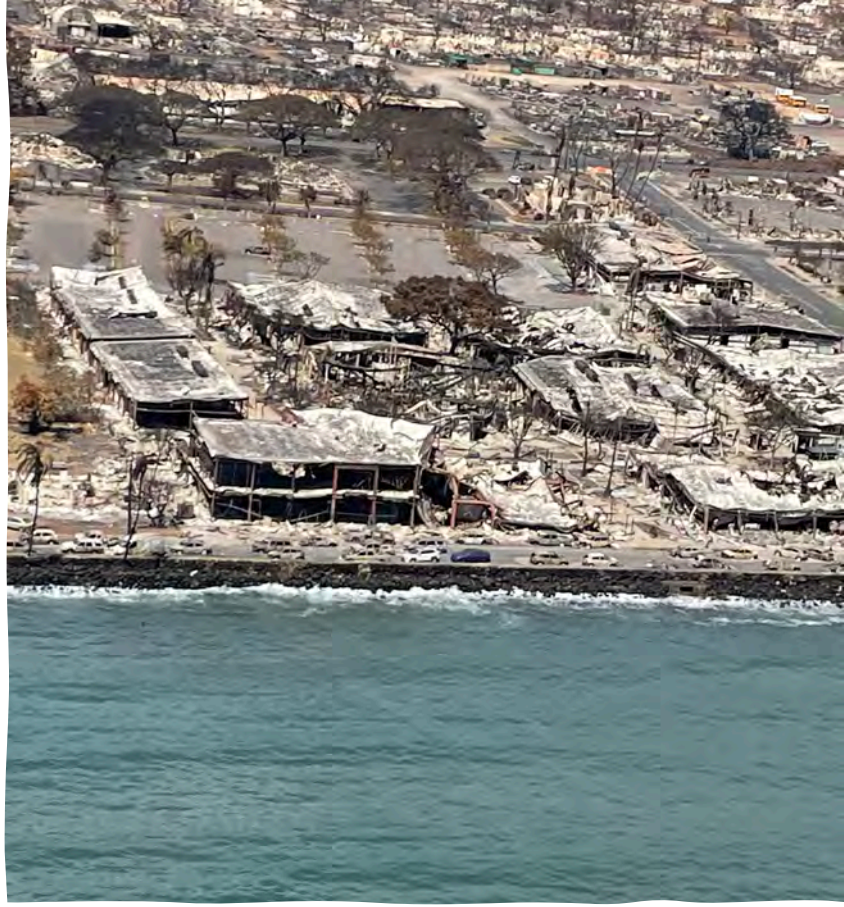
- Citizen survival strategy/training we provide our own firefighters
  - Escape Routes
  - Temporary Refuge Areas (TRA)
  - Safety Zones
  - Shelter-in-Place
- Provide citizens with basic wildfire behavior education
  - Topographic Features
    - Home
    - Neighborhood
    - Community
- Survival Pre-Planning – Escape Routes, TRAs & Safety Zones
  - Signage
  - Road Reflectors

# Use of Existing Capabilities & Future Technologies

- Make available to public real-time/near real-time situational awareness apps and tools
  - Example – Watch Duty app
    - Advance techniques of acquired data and distribution
  - Social Media Analytics in Disaster Response
    - Platforms that facilitate citizen provided real-time sharing of situation
- Make available to public real-time aircraft/satellite video/maps
  - FIRIS (California)
  - Low orbit satellite data (soon)
    - Fire perimeters
    - Predictive models/projections


AEVEX FIRIS ORCO INTEL 12
33°07'41.52" N 117°20'26.97" W
SPD 156 KTS HDG 104 °T
ALT 8708 FT
01/20/21
14:54:44
N
41°T
N E
33°08'44.41" N 117°19'23.02" W
SPD 0 MPH HDG --- °T
ELV 90 FT SLT 2.0 NM
LRF TARGET
33°08'46.12" N
117°19'24.54" W
ELV 90 FT
SLT 3.8 NM
LRF ARMED
LP C ARMED
HDEO
DDE
FOC MAN
EXP AUT
W N
410 FT
-44°
296°
GEOPOINT
INS NAV 0.26°
TRK IR CEN
SLAVE ACTIVE


AEVEX FIRIS ORCO INTEL 12
40°03'35.80" N 120°44'56.73" W
SPD 234 KTS HDG 309 °T
ALT 26816 FT
301°T
W N
40°08'25.12" N 120°55'31.02" W
SPD 0 MPH HDG --- °T
ELV 4668 FT SLT 10 NM
08/04/21
18:58:44
LRF TARGET
--°--'--.--" -
---°--'--.--" -
ELV --- FT
SLT --- NM
N
LRF L ARMED
LP C ARMED
HDIR
M WH
FOC GEO
EXP MAN
W N 1.0 NM
-17°
347°
GEOPOINT-IA
INS NAV 0.18°
TRK CEN
SLAVE ACTIVE

# Lahaina Wildfire
# Maui, HI

# Local and State Perspectives on Wildfire Evacuation

Decision Making on Wildfire Evacuation

- Fire Service Leaders
- Law Enforcement Leaders
- Tribal Nations
- State Emergency Management

**LAW ENFORCEMENT**

**Ready Set Go for Law Enforcement training video**
**https://www.youtube.com/watch?v=NEdjXNHqisg**

**Town of Vail Wildfire Evacuation video**
**https://www.youtube.com/watch?v=yWMUs52jfzY**

FEMA | U.S. Fire Administration

# Local and State Perspectives on Wildfire Evacuation

## Facilitated Discussion

- Have all **states** transitioned from the USFS “One, Two, Three” to “Ready, Set, Go!”?
- What is the **greatest problem** in how we handle wildfire evacuations today?
- What are the **key resources** for decision maker-level education today on wildfire evacuation?
- Where are the **priority gaps**?

FEMA | U.S. Fire Administration

# Wildfire Evacuation Thresholds

## One, Two, Three *(Legacy)*

- **Level 1** – Evacuation or Protection Alert
  - A wildfire threat is in your area. It would be wise to consider planning and/or packing, in the event an evacuation becomes necessary.
- **Level 2** – Evacuation Warning or Notice
  - High probability of a need to evacuate. You should prepare now by packing necessary items and preparing your family, pets, and vehicle for potential departure.
- **Level 3** – Evacuation Request or Order
  - Occupants of the affected area(s) are asked to leave within a specified time period, by pre-designated route(s). Perimeter roadblocks are typically established.

## Ready, Set, Go! *(Current)*

- **Ready** - Create and maintain defensible space and harden your home against flying embers.
- **Set** - Prepare your family and home ahead of time for the possibility of having to evacuate.
- **Go** - When wildfire strikes, go early for your safety. Take the evacuation steps necessary to give your family and home the best chance of surviving a wildfire.

# FEMA Documents

## Facilitated Discussion

- As we look to a review & update to the National Response Framework, how should guidance on mass evacuation be expanded and/or more information provided specific to wildfire evacuation planning and execution?

- For the NIMS doctrine, how should guidance for FSLTT coordination around evacuation be incorporated? OR would a supporting NIMS Guide focused on evacuation planning and execution be better suited?

- Are we currently measuring SLTT evacuation capabilities through the Unified Reporting Tool? And - subsequently reporting on change/improvements in evacuation capabilities via the National Preparedness Report

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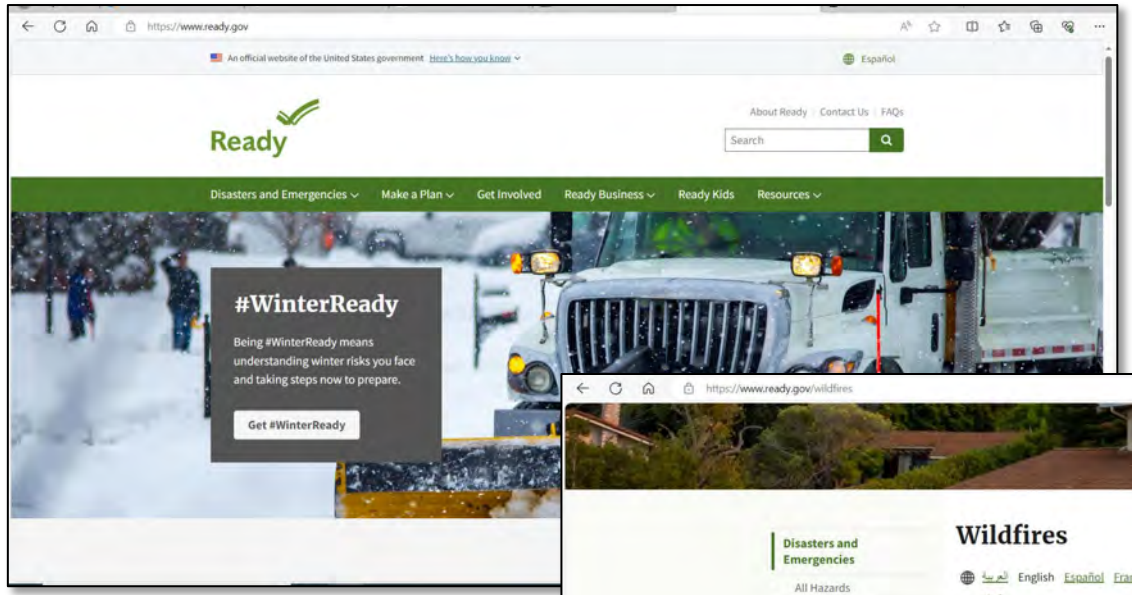
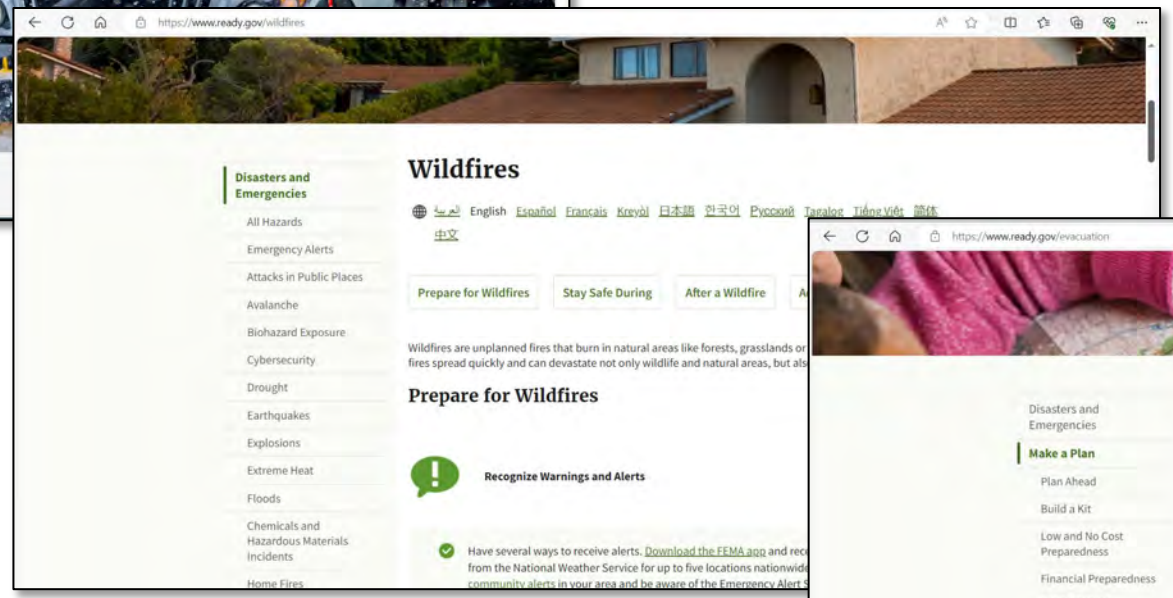
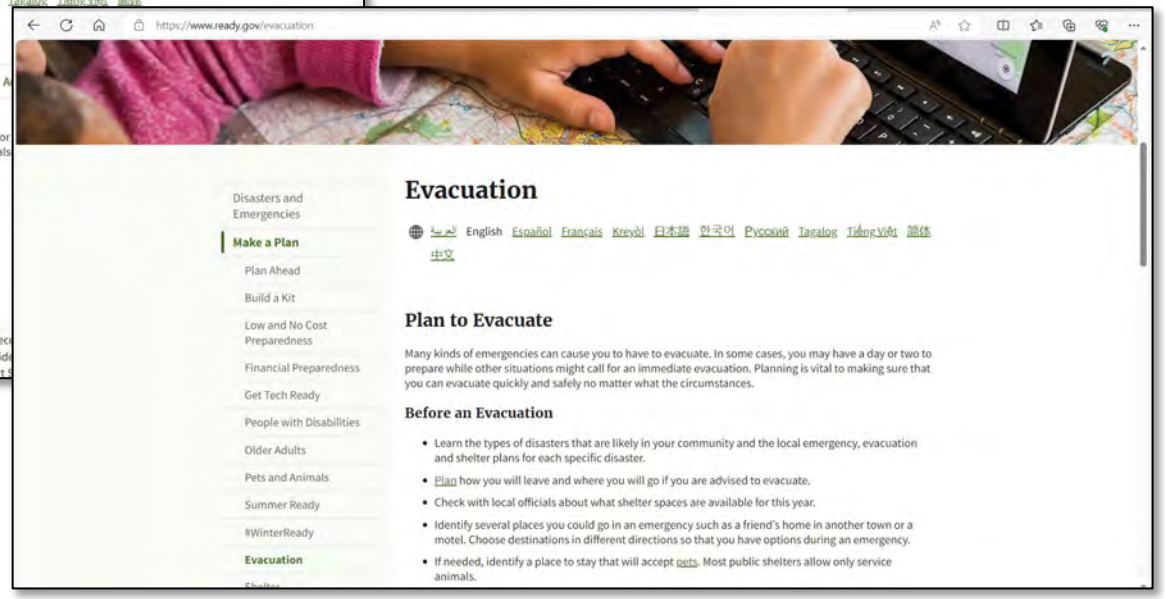
# FEMA Resources for Wildfire Evacuation



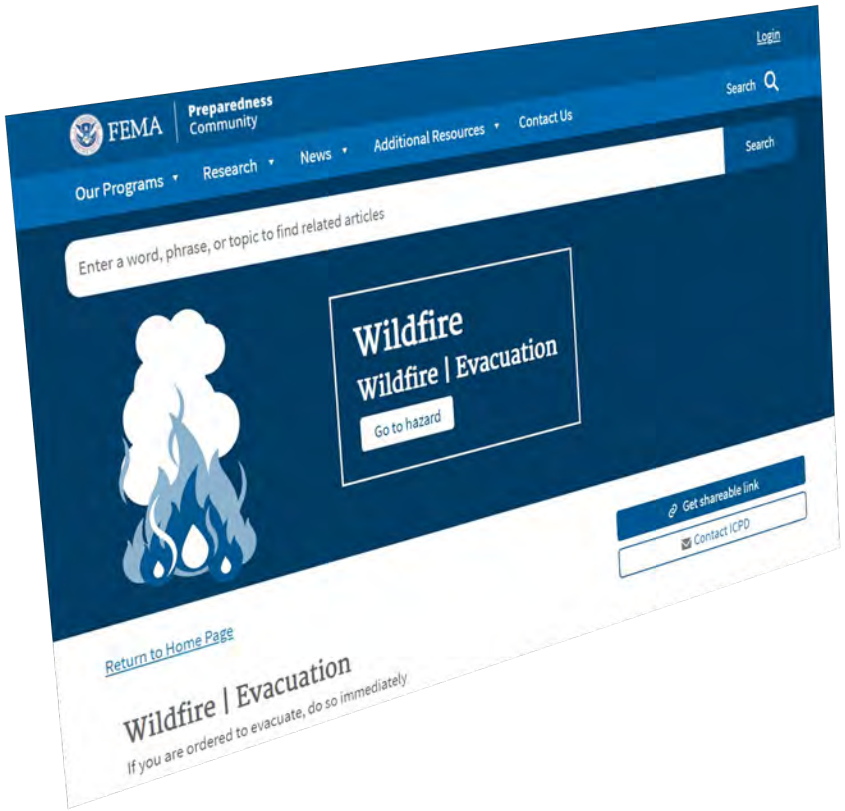




Ready

FEMA | U.S. Fire Administration

[Evacuation | Ready.gov]

# FEMA Resources for Wildfire Evacuation- Message




[Wildfire | Evacuation (fema.gov)]

- If you are ordered to evacuate, do so immediately.

- While your family's safety is most important, if there is time before you leave, there are things you can do to help firefighters:
  - close up the house and leave lights on for visibility,
  - move flammable materials to the center of the home,
  - away from windows; leave hoses connected to a water source so they are available for the fire department.

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# USFA Resources

- National Fire Academy Training
- Resources for Engaging with Residents
- Research and Technology
- NERIS and WUI Awareness Toolkit

FEMA U.S. Fire Administration

# National Fire Academy Training

## Introduction to WUI Evacuation Planning and Procedures F0597

**This 2-day National Fire Academy course is intended to help wildland fire partners develop educational programs and processes for creating, implementing and maintaining evacuation plans.**

- **Discuss the characteristics of the WUI**, its problems, and how to reduce risk, including key elements of legal and social issues pertaining to evacuations.
- **Describe the different elements included in evacuation planning**, explain how to use maps to aid in evacuation planning, and apply notification methods for a specific community.
- **Identify procedures and apply key concepts to implement and maintain the evacuation plan**.

# Resources for Engaging with Residents

- Handouts and Social Media Cards






FEMA | U.S. Fire Administration

# Resources for Engaging with Residents

## Talking Points to assist first responders with community engagement before, during and after a wildfire evacuation.

### Plan

- Encourage residents to sign up for local emergency alerts and warnings on their home phones, cellphones and other devices. They can get alerts when a wildfire is reported in their chosen ZIP code or within 30 miles.
- Inform residents about the community's emergency notification and evacuation plans. Help them plan primary and alternate routes out of their neighborhood and community.
- Encourage them to make sure their designated contact knows their plan and how they will communicate that they are safe. Sometimes using text messages or notifying contacts through social media channels may be a better alt than relying on cellphone calls.
- Encourage residents to know their workplace, school and commuter evacuation plans.
- Tell people to leave early, especially if they have small children, pets, physical challenges or other concerns that need additional assistance time.

### Creating community safe zones

First responders should work with residents to develop best practices for wildfire evacuations. This includes creating community safe zones within communities and along evacuation routes that can be used as a "last resort safety zone."

Important considerations for these zones are:

1. Safety zone design, specifically what fuel setbacks are needed and what (person and/or vehicle) capacity is required.
2. Safety zone density: how many zones are needed and where they should be

### Take action

Wildfire evacuation planning considerations should encourage neighbors within the wildland urban interface to work together to reduce their shared ignition risk by making improvements to structures and the landscapes surrounding them.

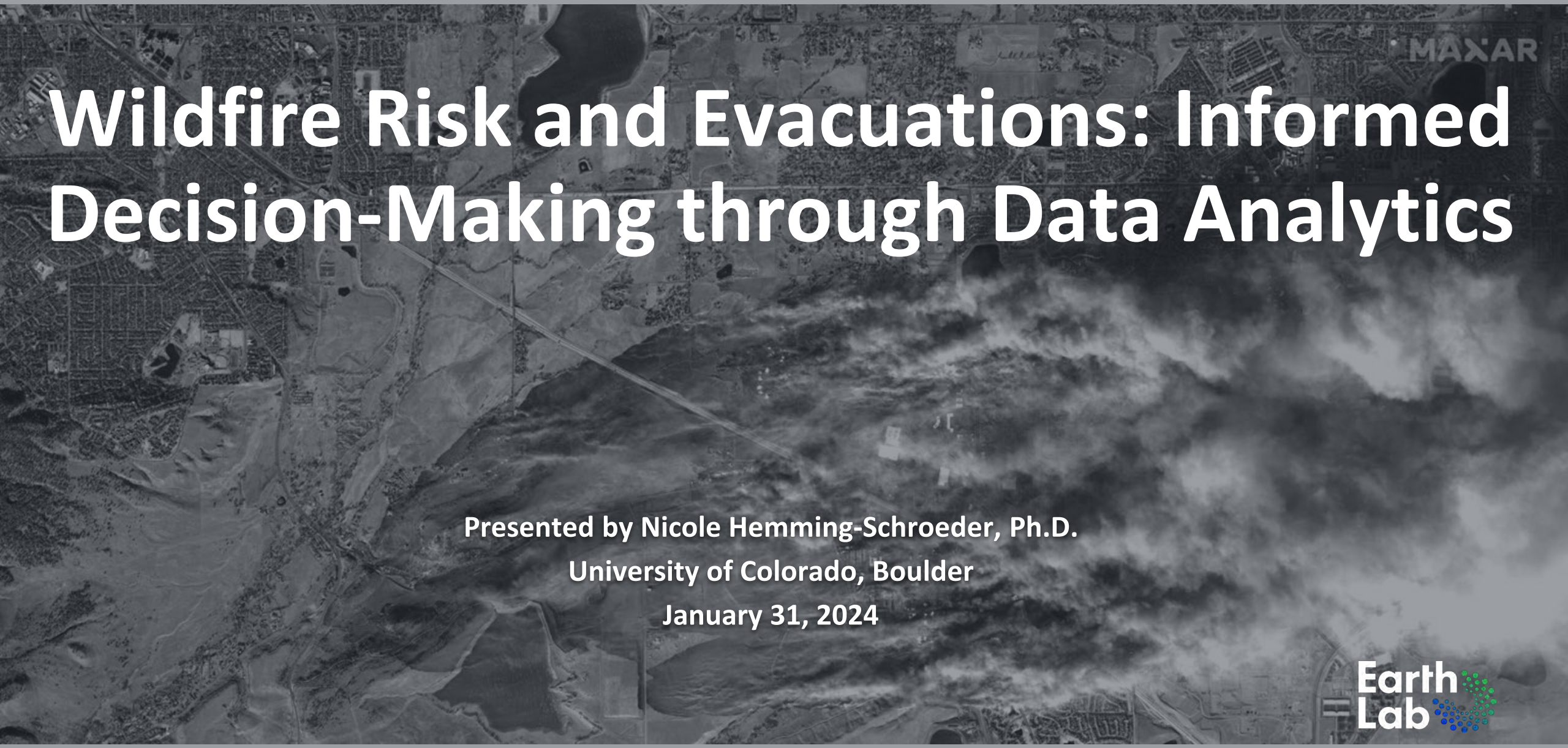
### Prepare

- Teach residents about the importance of backing vehicles into the garage or parking in an open space facing the direction of escape and to always keep the gas tank in vehicles at least half full.
- Teach them to prepack kits with essentials, like medicine, family records, important phone numbers, cash (ATMs may not work), credit cards, a change of clothing and enough food and water for each household member for up to 72 hours for everyone in your household, including pets.

FEMA | U.S. Fire Administration

# Expert Perspective - Social Science and Human Behavior

- Is what we have by way of resources for engaging residents working?
- Do we have the RIGHT messaging?




# Wildfire Risk and Evacuations: Informed Decision-Making through Data Analytics

Presented by Nicole Hemming-Schroeder, Ph.D.
University of Colorado, Boulder
January 31, 2024

Earth Lab

# Climate Innovation Collaboratory

A collaboration between University of Colorado Boulder and Deloitte

1. Predicting wildfire risk
2. Applying social sensing to disaster response
3. Modeling fire speed and evacuation

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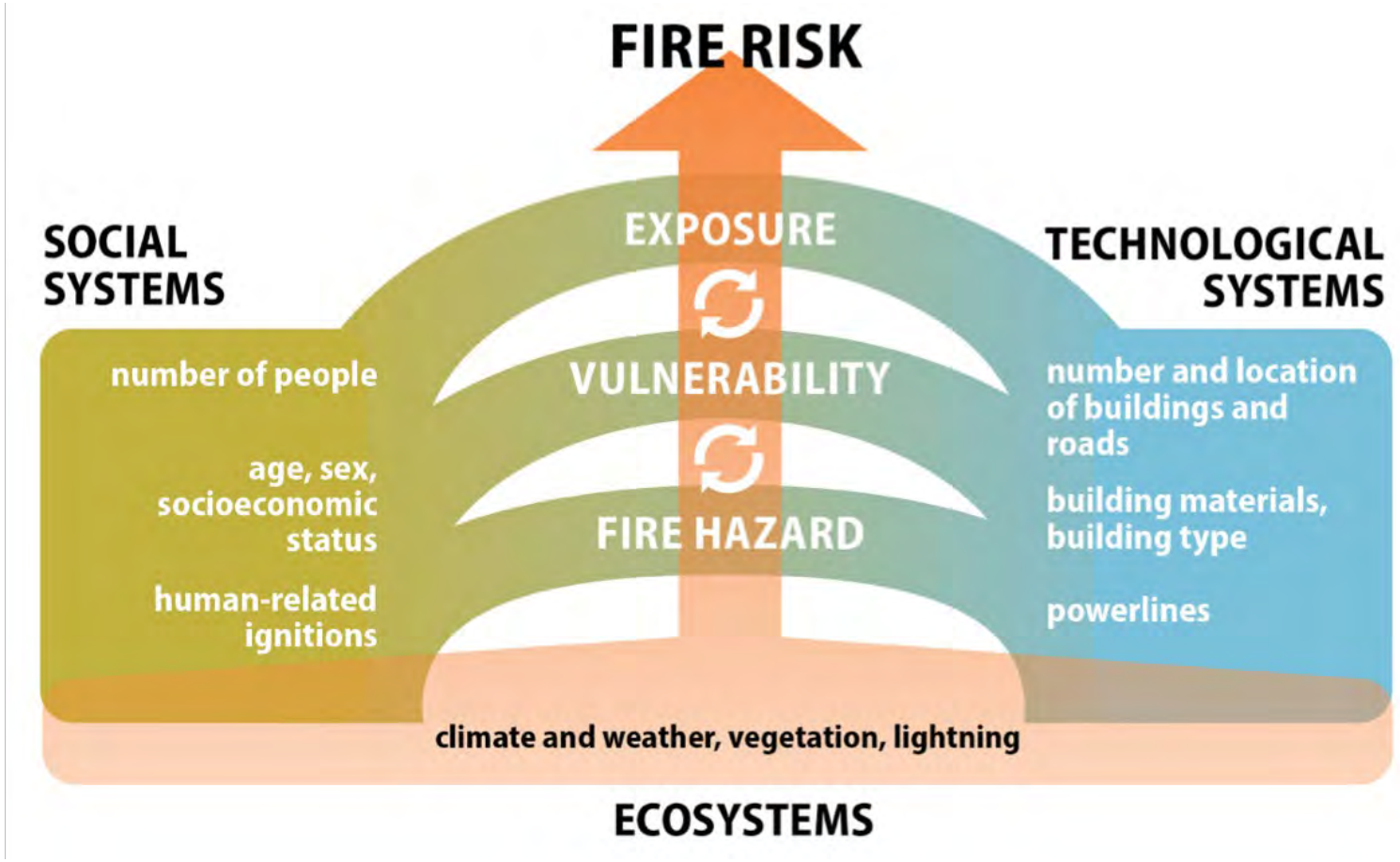
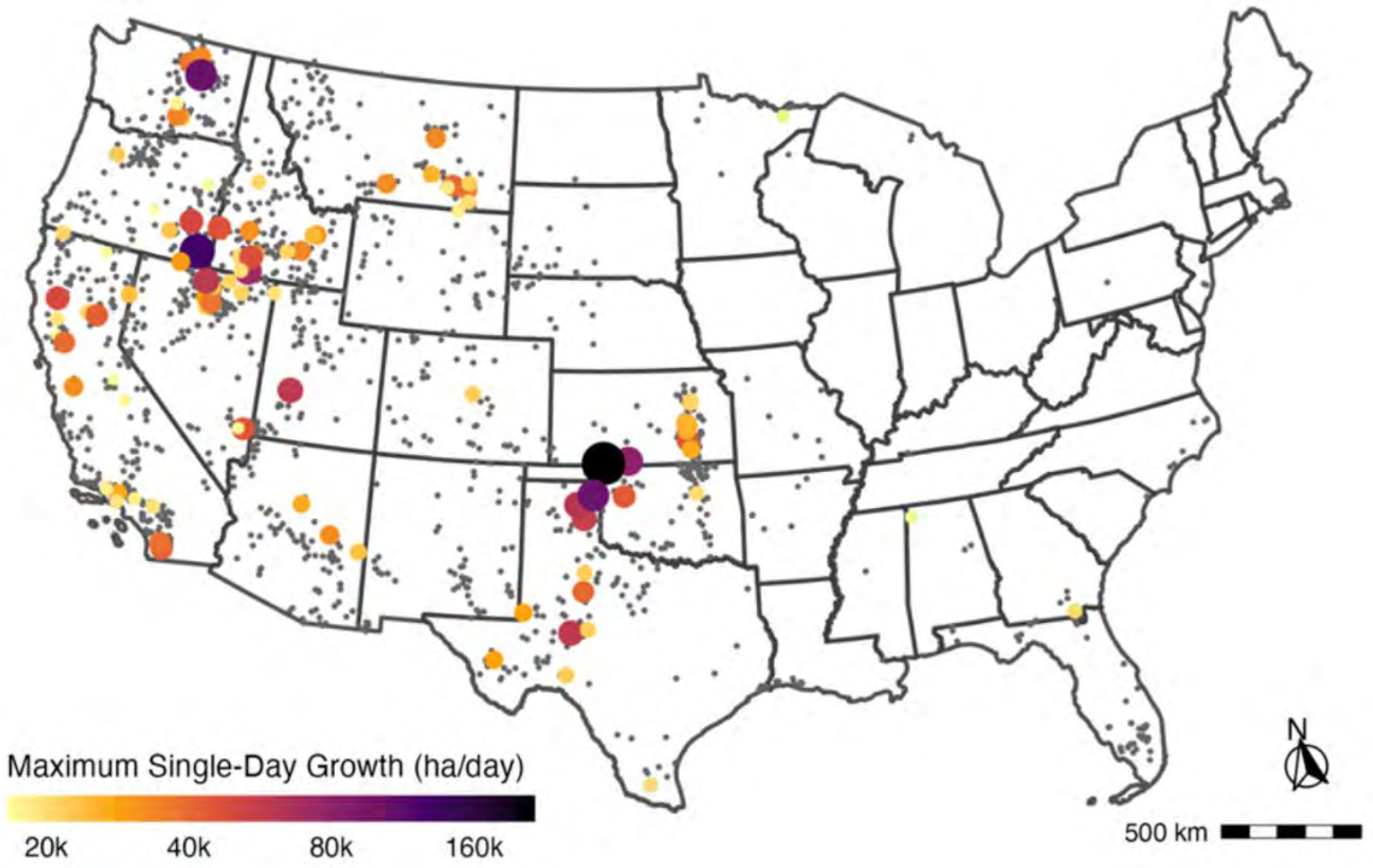
1. **Predicting wildfire risk**
2. Applying social sensing to disaster response
3. Modeling fire speed and evacuation

# Fire risk is a combination of fire hazard, vulnerability, and exposure



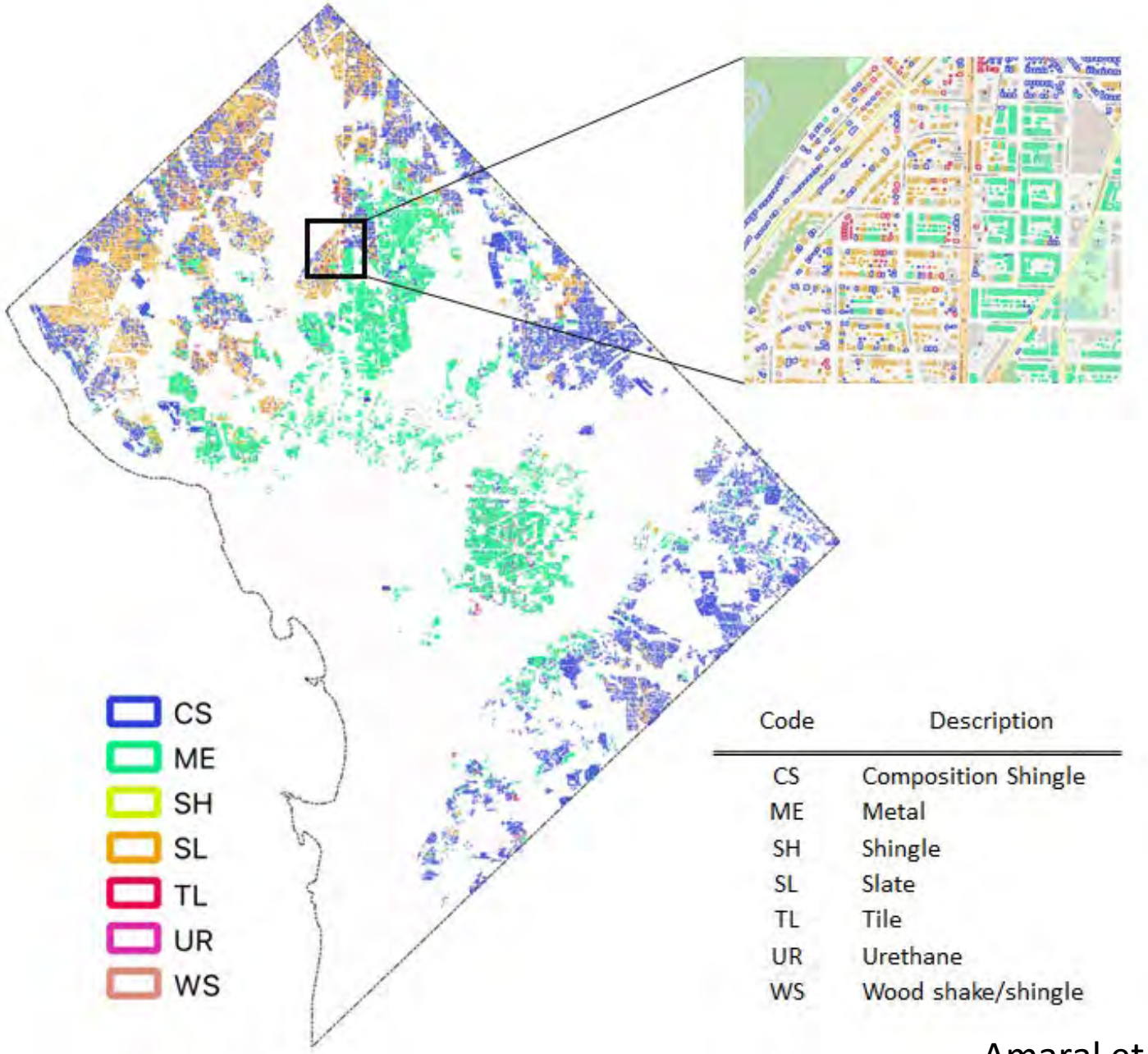

Iglesias et al., 2022, *Environmental Research Letters*

# The fastest 100 fires in the U.S. between 2001 and 2020 are scaled by size and color




Balch et al., in review at *Science*

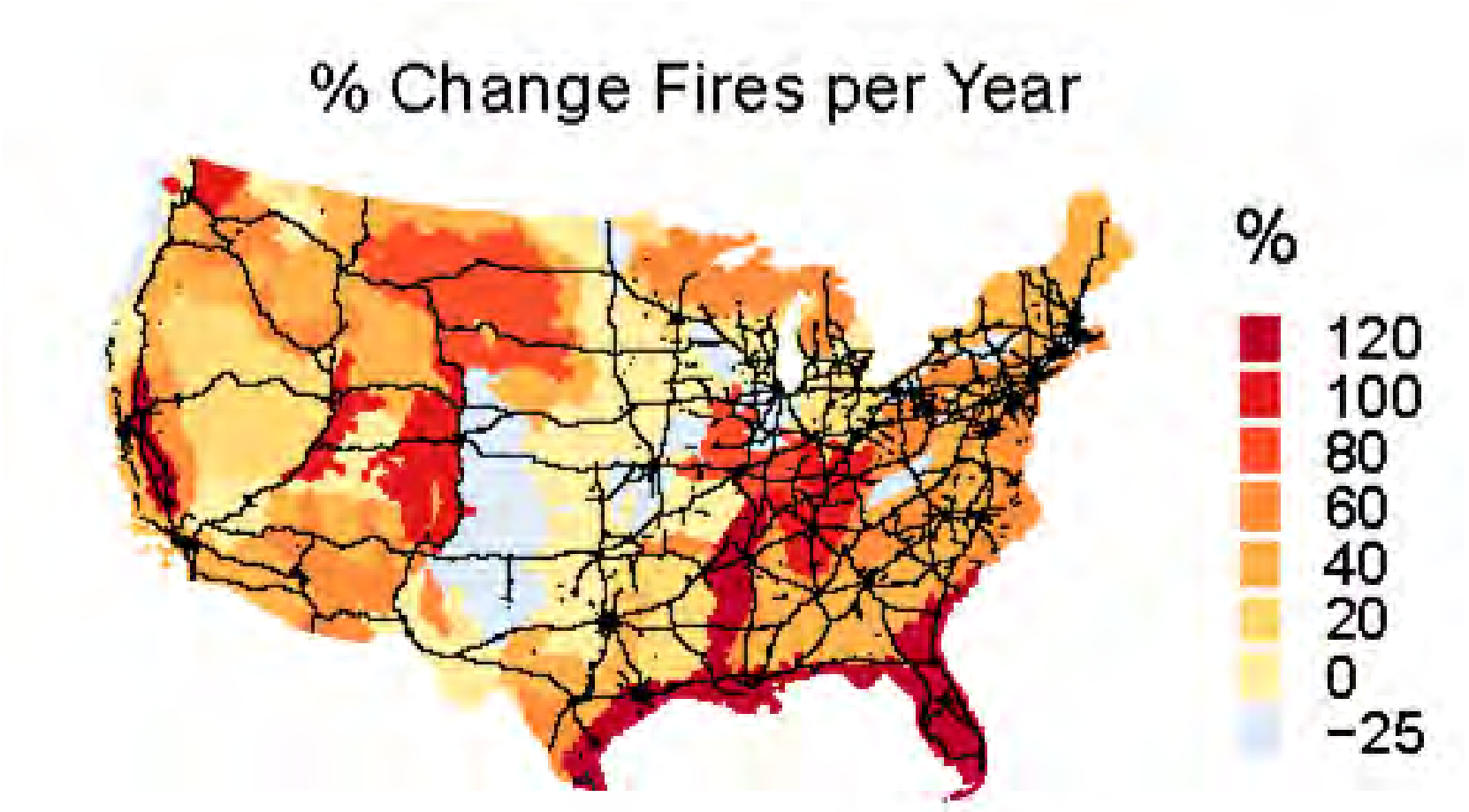
# We can estimate urban fuels from space




| Code | Description |
|---|---|
| CS | Composition Shingle |
| ME | Metal |
| SH | Shingle |
| SL | Slate |
| TL | Tile |
| UR | Urethane |
| WS | Wood shake/shingle |

Amaral et al. in prep.

# We predict a 50% increase in fire and burned area by 2060




Stephens et al. (2023), in review *Earth's Future* & preprint

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1. Predicting wildfire risk
2. **Applying social sensing to disaster response**
3. Modeling fire speed and evacuation

# We can use a classifier on Twitter data to identify local accounts during disasters

Inputs:

1. Profile picture
2. User information
    a. e.g. number of tweets
3. Tweet content

Output 1:

1. Individual
2. Organization
3. Feed-based

Output 2:

1. Personalized
2. Emergency management
3. Public sector
4. Media
5. Redistribution

Diaz et al., 2020, *Proceedings of the 17th ISCRAM Conference*

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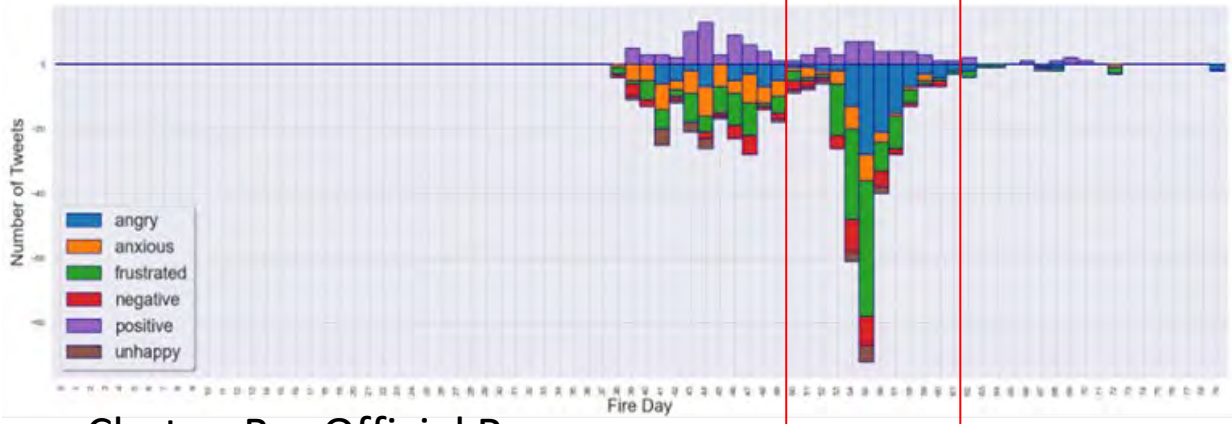
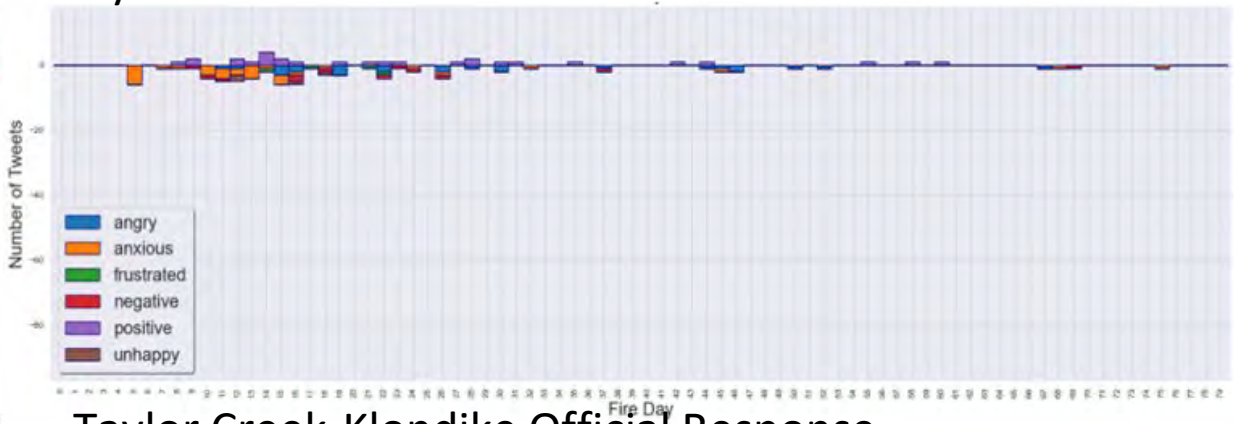
Diaz et al., 2020, *Proceedings of the 17th ISCRAM Conference*

# A case study of two similar fires in the same region showed that negative public response can increase in the absence of personalized official communications

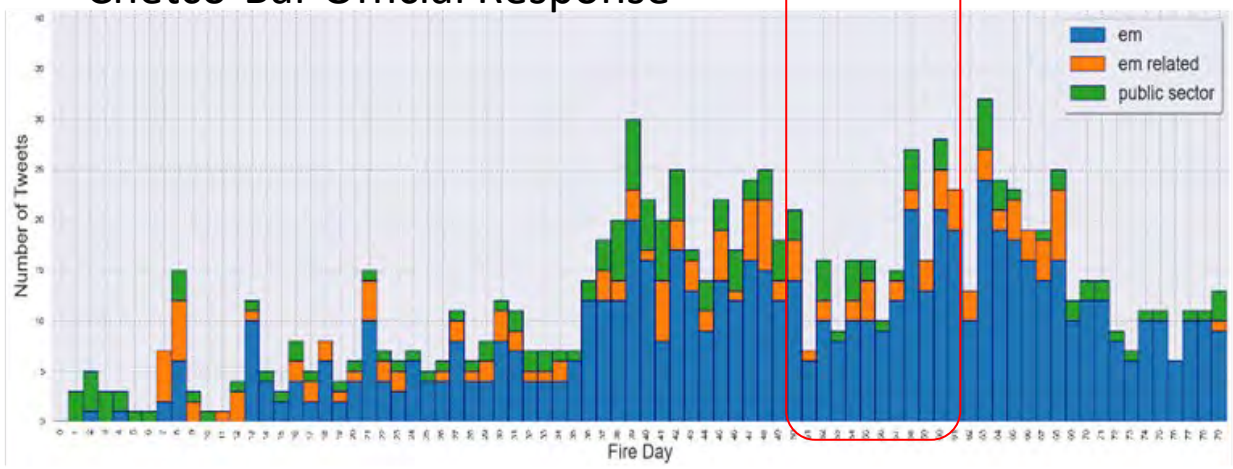
Chetco-Bar Sentiment



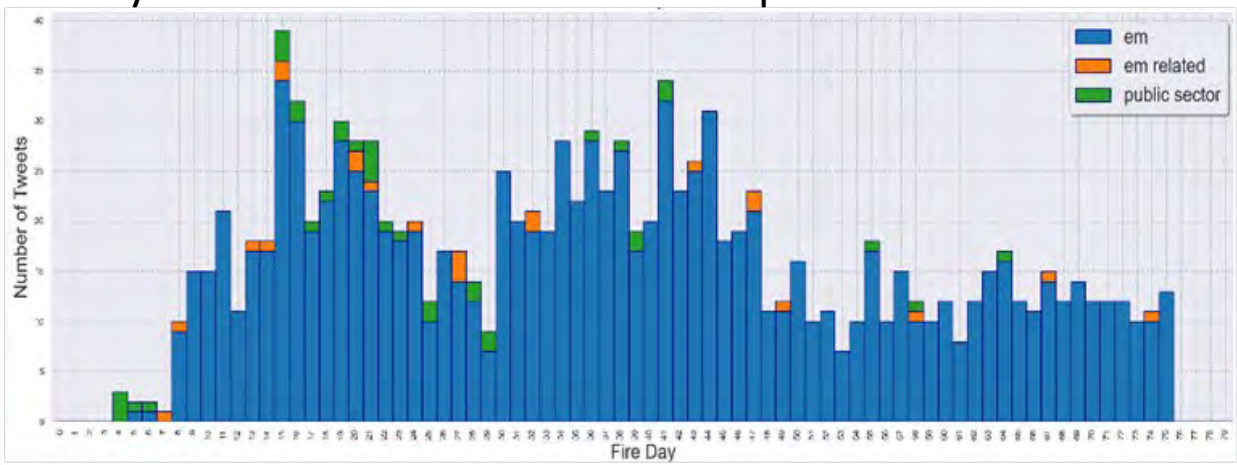

Taylor Creek-Klondike Sentiment




Chetco-Bar Official Response




Taylor Creek-Klondike Official Response



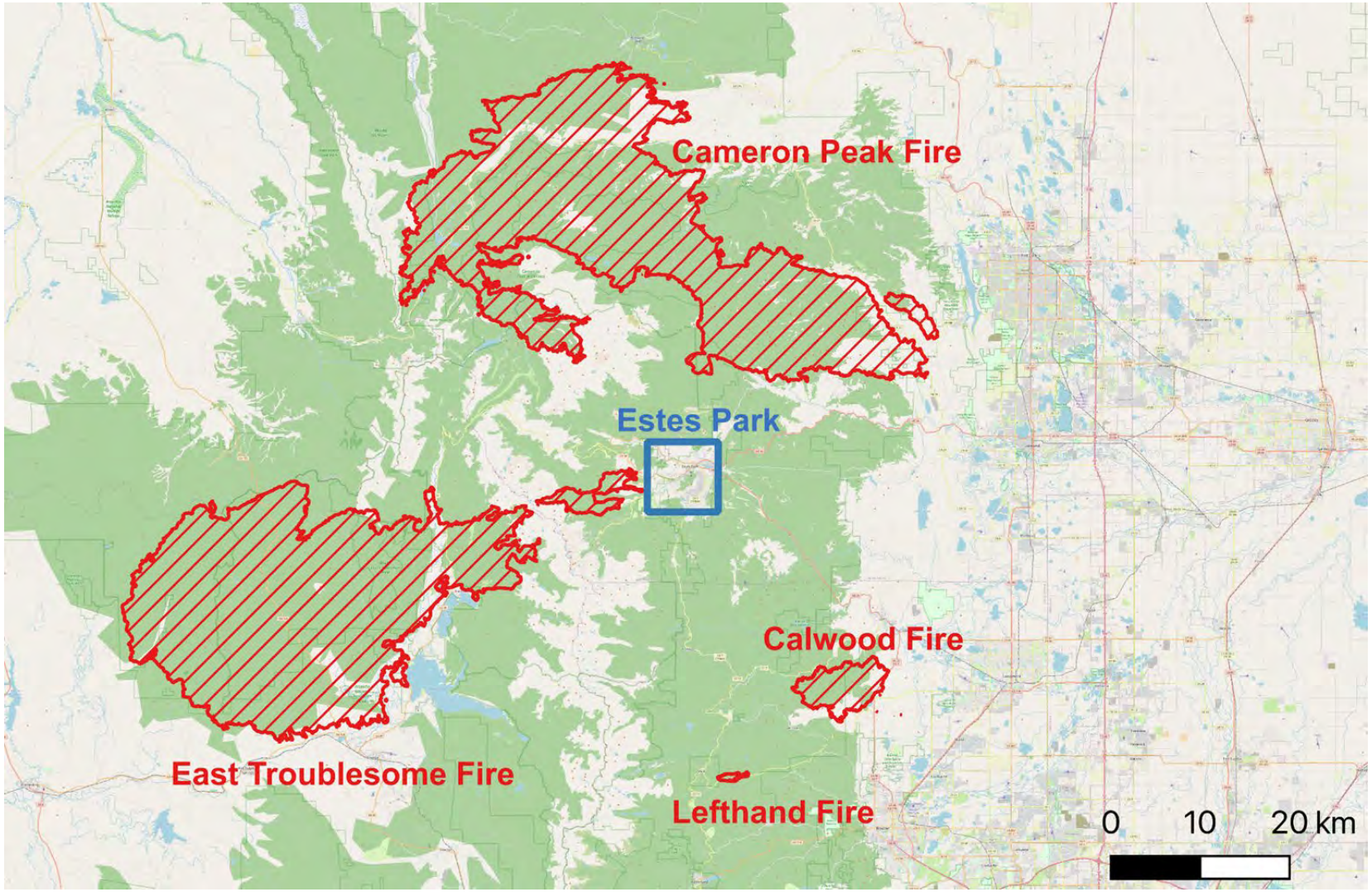

St. Denis et al., in prep

# Climate Innovation Collaboratory

A collaboration between University of Colorado Boulder and Deloitte

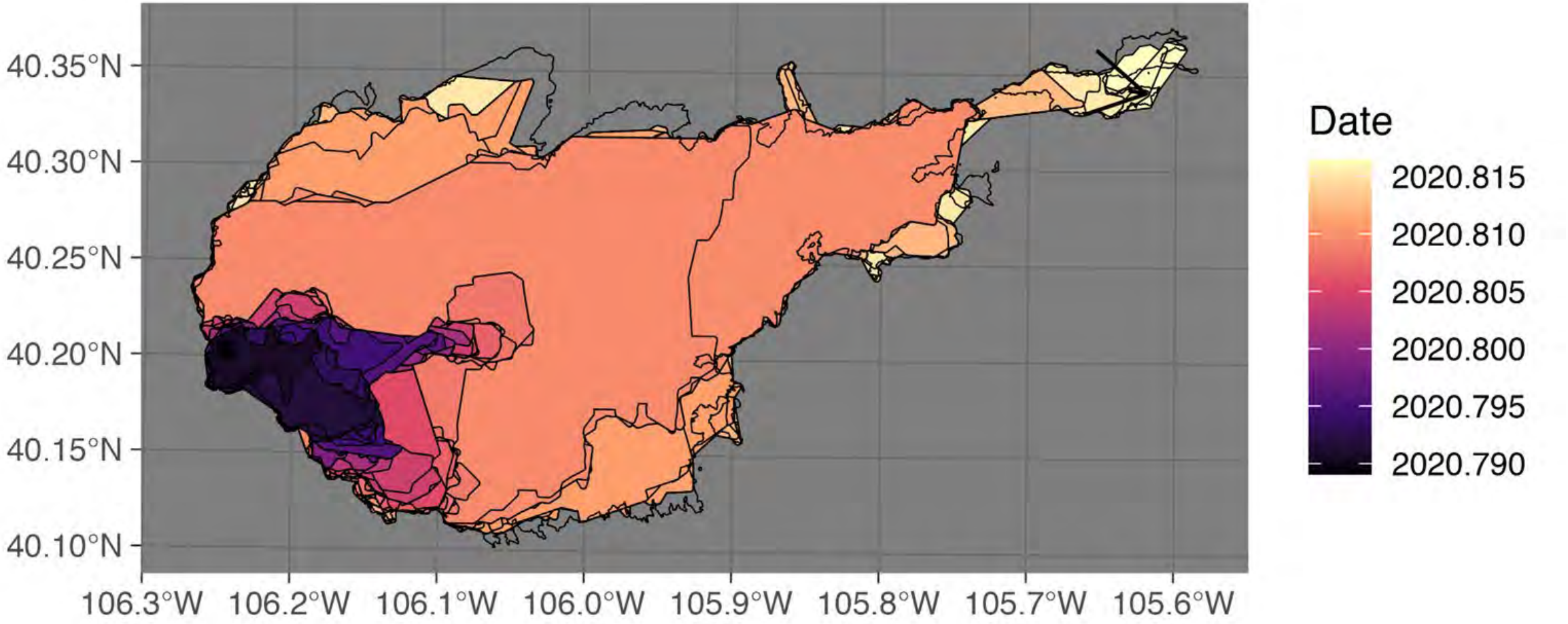
1. Predicting wildfire risk
2. Applying social sensing to disaster response
3. **Modeling fire speed and evacuation**

# Two large fires threatened Estes Park in 2020



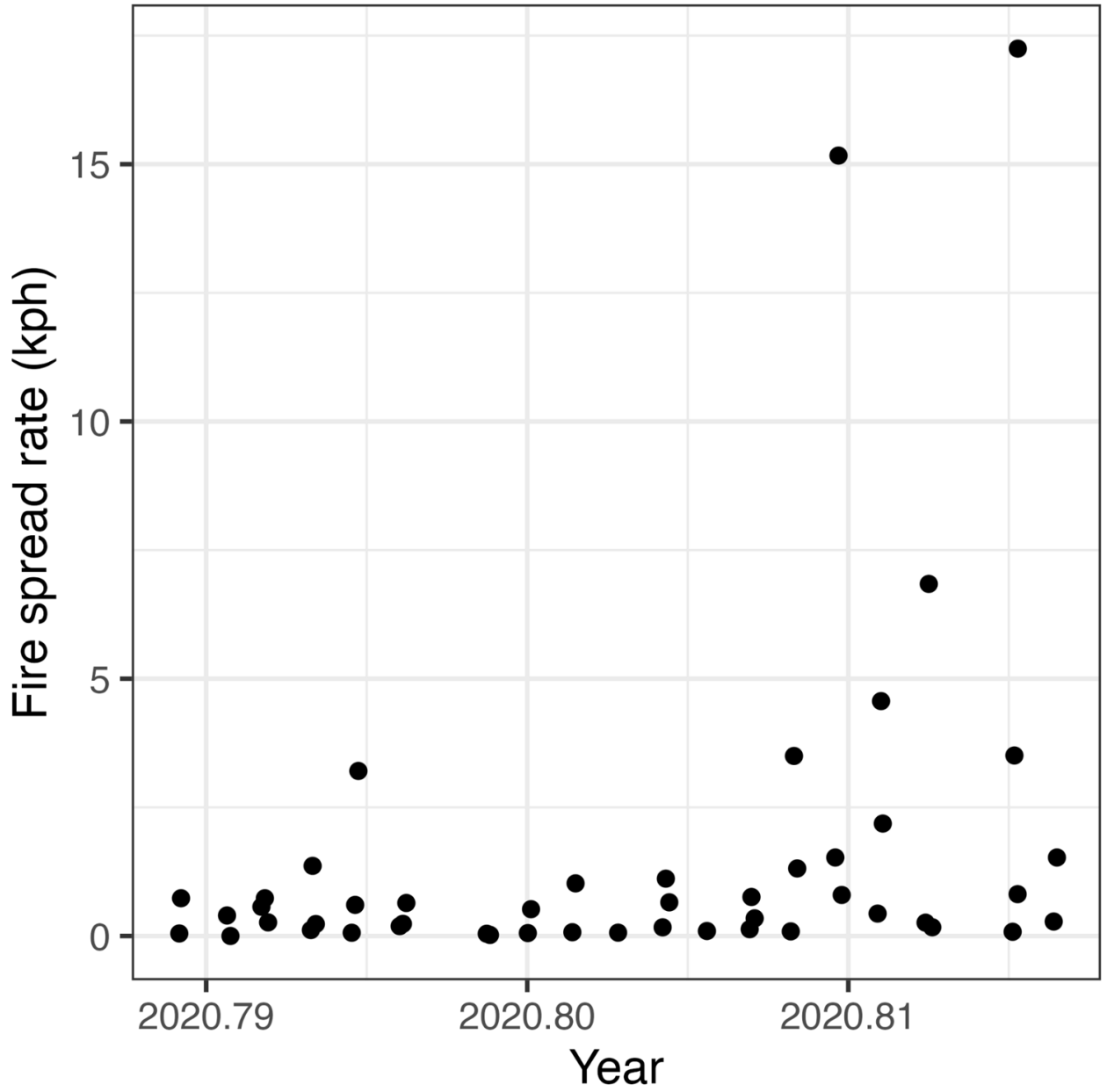

Background map from Open Street Map and fire perimeters from USFS final fire perimeters

# We can estimate speed and direction of wildfires using VIIRS active fire pixels (2020 East Troublesome Fire)




Hemming-Schroeder et al., in prep

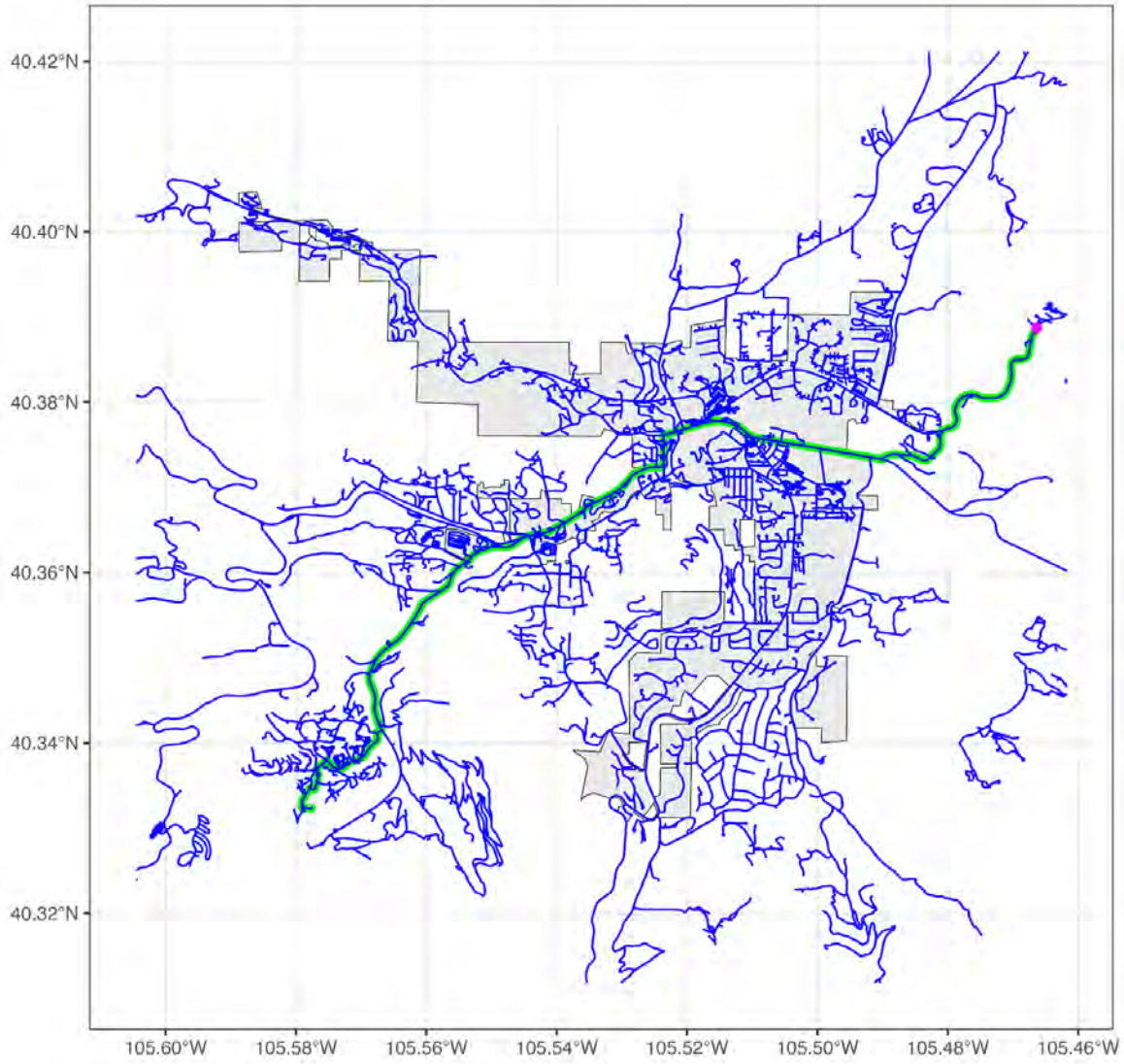
The East Troublesome Fire spread approached Estes Park with a maximum speed above 15 km per hour




Hemming-Schroeder et al., in prep

# We are working on an evacuation model for a case study of Estes Park

- Use r5r for network and routing
- Add code to simulate traffic for multiple scenarios
- Begin with simple scenario: everyone starts from home and leaves by one exit (US-34)




Example route (green) to exit (magenta)

# Key takeaways and questions

- Burn area and fire incidence is projected to increase in the future

**Presenter: Nicole Hemming-Schroeder**
**(nicole.hemming-schroeder@colorado.edu)**

Earth Lab

# Key takeaways and questions

- Burn area and fire incidence is projected to increase in the future
- Filtering for local, personalized accounts and official responses can help improve the efficacy of official communication during wildfires

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Earth Lab

# Key takeaways and questions

- Burn area and fire incidence is projected to increase in the future
- Filtering for local, personalized accounts and official responses can help improve the efficacy of official communication during wildfires
- Accurate assessments of fire speed and evacuation rates are needed to address **entrapment risk**, particularly for **fast fires**
  - What best-available evacuation models are being used by FEMA?
  - What tools are being used by FEMA to identify high risk areas?

**Presenter: Nicole Hemming-Schroeder**
**(nicole.hemming-schroeder@colorado.edu)**

Earth Lab

# Integrated Public Alert & Warning System (IPAWS)

- FEMA's national system for local alerting that provides authenticated emergency and life-saving information to the public through **mobile phones** using Wireless Emergency Alerts, to **radio and television** via the Emergency Alert System, and on the National Oceanic and Atmospheric Administration's **Weather Radio**.

IPAWS

***Celebrating 10 Years of Wireless Emergency Alerts***

FEMA | U.S. Fire Administration

# INTEGRATED PUBLIC ALERT & WARNING SYSTEM (IPAWS)

**INTEGRATED PUBLIC ALERT & WARNING SYSTEM (IPAWS)** is a tool that Federal, State, Local, Tribal, and Territorial (FSLTT) public safety agencies can use to notify the public of disasters and deliver emergency and public safety information.

- **NO SIGN-UP REQUIRED TO RECEIVE ALERTS:** There is no need to sign up or subscribe to receive alerts from IPAWS. There is no cost to receive alerts
- **MINIMAL COST TO ALERTING AUTHORITIES:** There is no cost to send or receive alerts through IPAWS. Alerting Authorities may incur costs to .purchase compatible alert origination software that meets IPAWS requirements.
- **LOCAL TARGETING:** With IPAWS, Alerting Authorities can target specific geographic areas to ensure only those in the affected area, including visitors, receive the alert. The content and timing of alerts is at the discretion of Alerting Authorities. FEMA does not review, edit, approve, or disapprove alerts sent by public safety agencies.
- **LANGUAGE & FUNCTIONAL ACCESSIBILITY:** WEA's recipients can currently choose to display alerts in English or Spanish and EAS messages can include multilingual audio. IPAWS also allows for the integration of images and has text-to-speech capability to accommodate those with functional needs.

HAAS ALERT

# IPAWS for Wildfire Evacuation

FEMA

U.S. Fire Administration

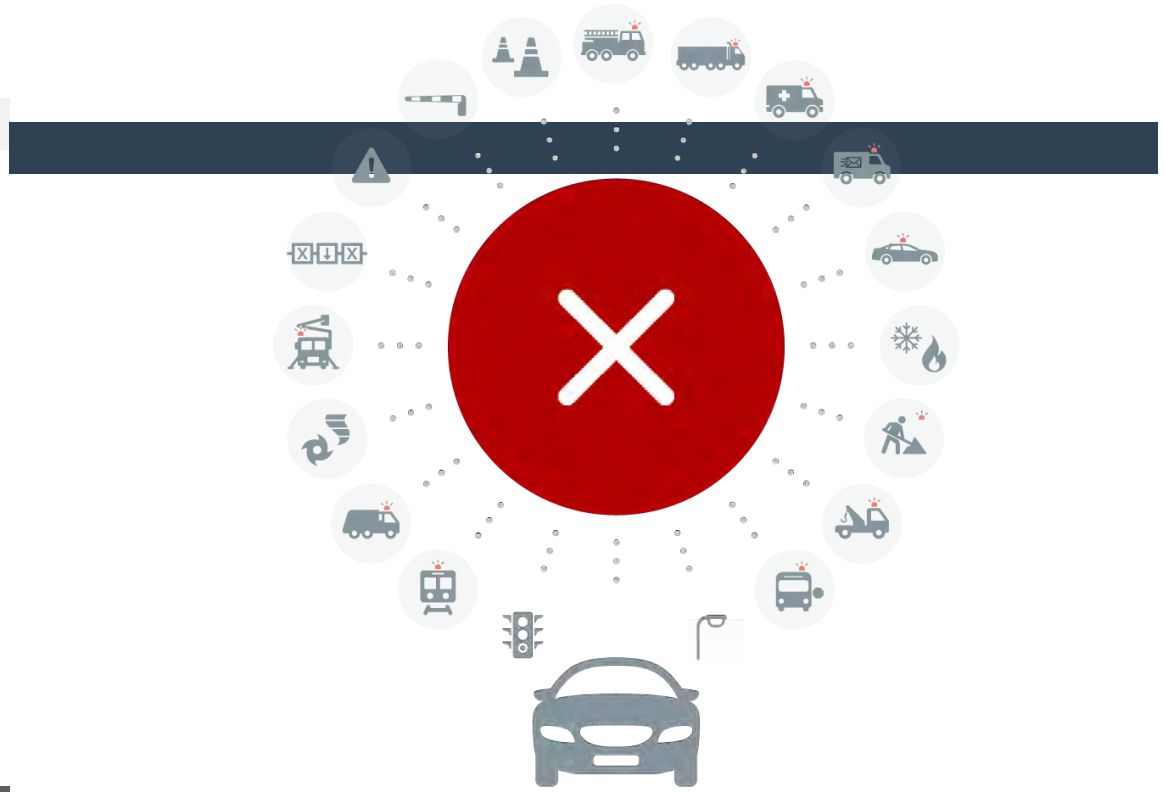
# Background

**42,000** American motorists killed, highest in a decade

Public safety and roadway fleets:
**Traffic accidents single largest cause of death and injury**

Prior to HAAS Alert
Firetrucks had no way to communicate except with lights and sirens – since the year 1906.


analog lights and sirens




4:46
53°out.
FM 104.3 HD
CAUTION
Emergency Vehicle Ahead
Dismiss
Not There
MODE
AUTO
FRONT
REAR
A/C
66°
66°
VOLUME
TUNE
BROWSE
ENTER
SCROLL
CHRYSLER
DODGE
Jeep
RAM

U.S. Department of Homeland Security | Science and Technology Directorate

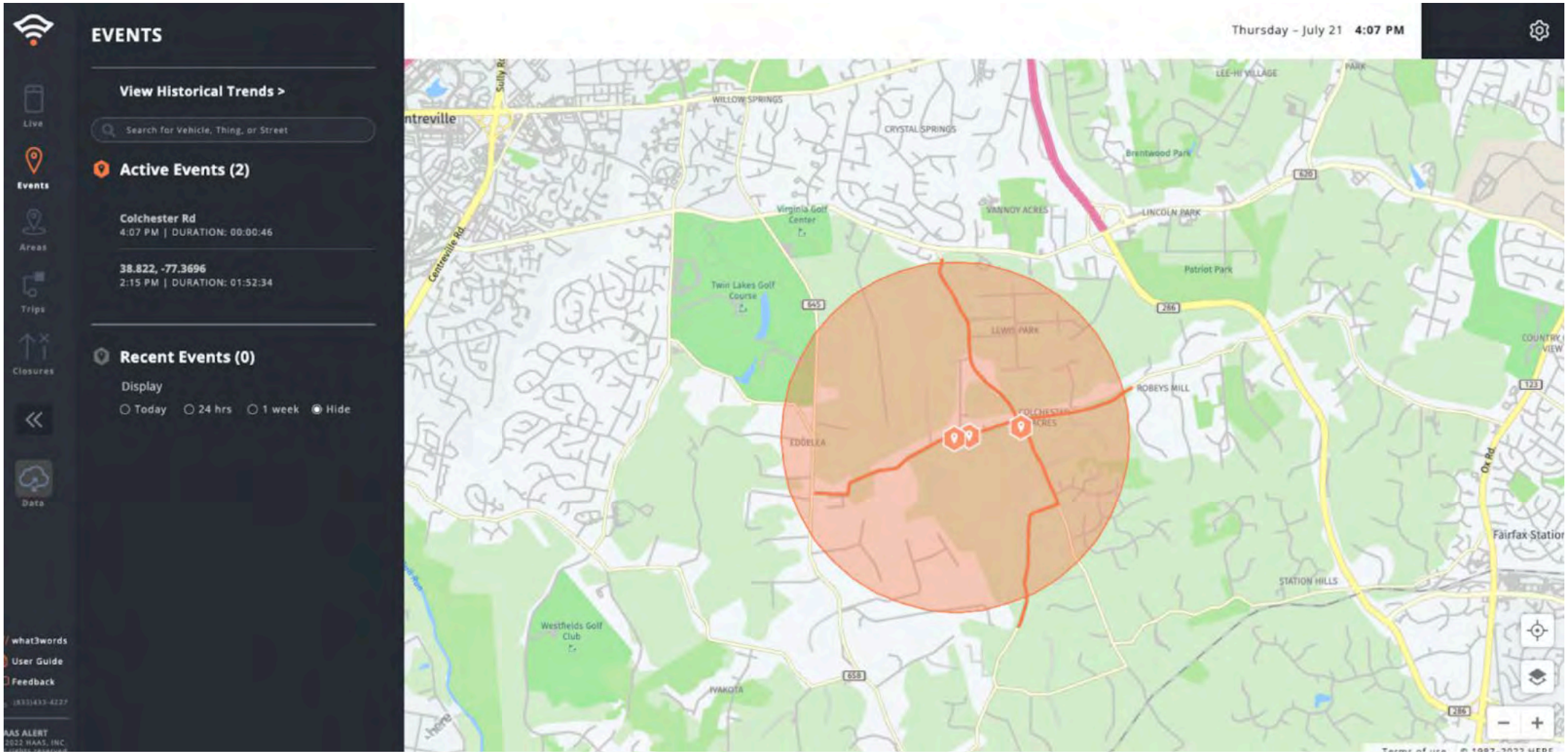
# A New Phase of Wildland Urban Interface (WUI) Emergency Alerting: What is the WUI Phase 2 Demonstration?

Science and Technology

FEMA

**Norman Speicher**
DHS & S&T Program Manager
March 28, 2023

# Wildfire Alert Zone on Geocoded Roads

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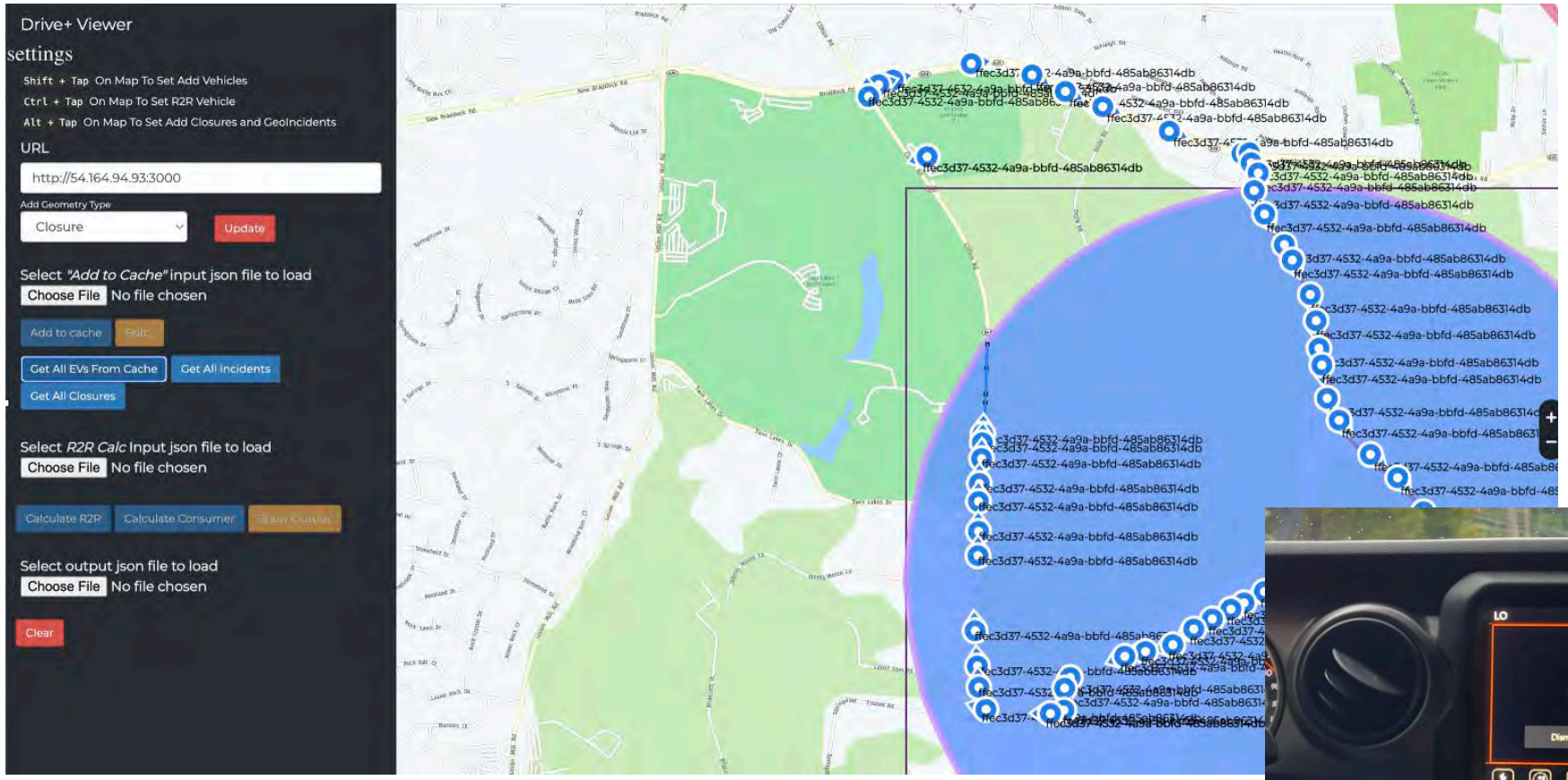
# Fiat/Chrysler Wildfire Driver Alerts

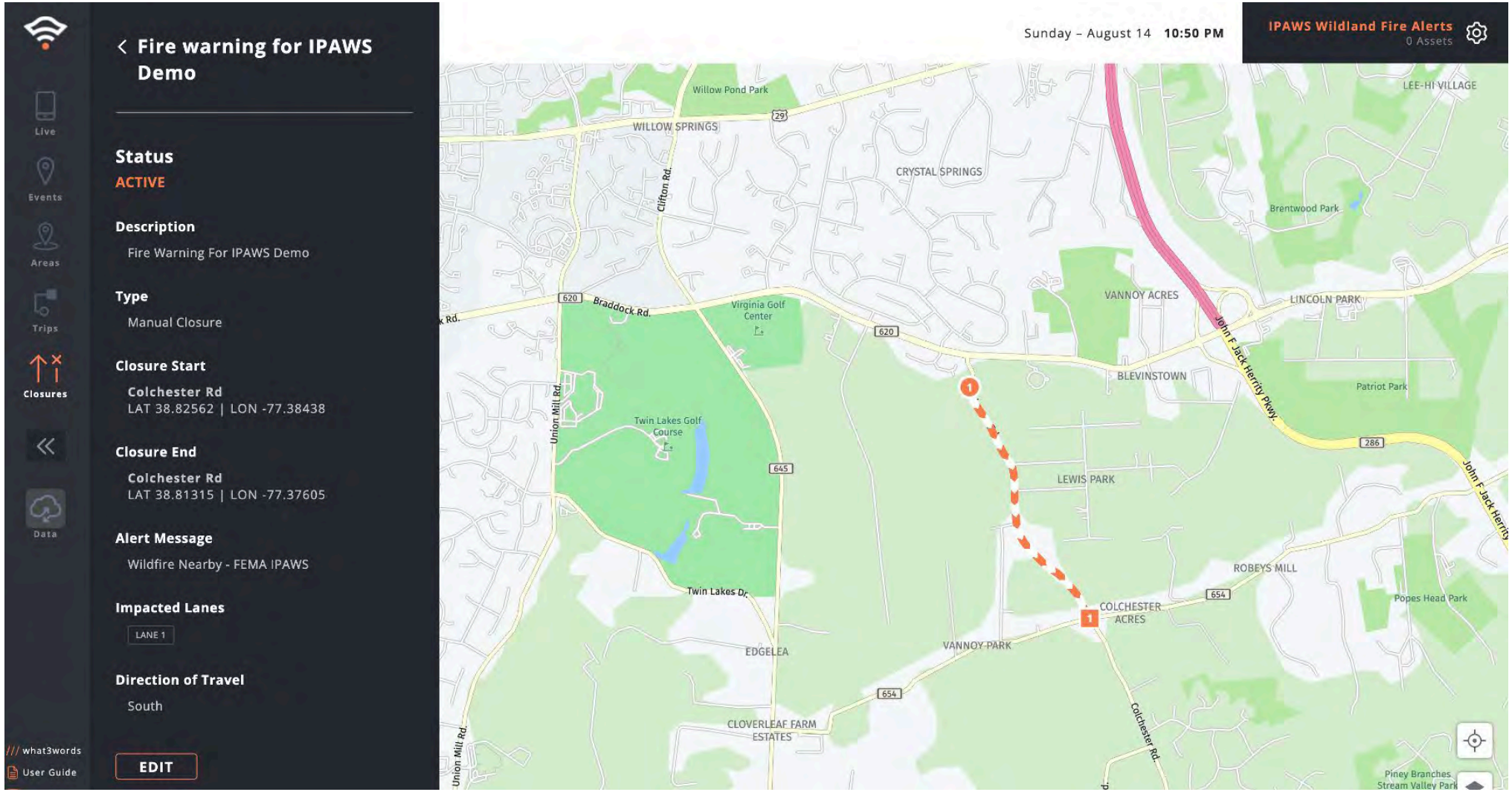




Science and Technology

FEMA

# Automated Wildfire Road Closure




Science and Technology

FEMA

# Wildfire Alerts




Science and Technology

FEMA

# Regulatory Backing and Federal Agencies

## Digital Alert Funding in Infrastructure Law

- $15M for Digital Alerting Funding
- Digital Alerting as fundable safety for roadway
- Congress to NHTSA in Omnibus Bill "Deploy Digital Alerting"

## Digital Alerting Contracts and Deployments

- 5 Digital Alert Contracts Currently – US DOT, DOD, & DHS
- NHTSA: "Digital Alert" funding completed
- Wildfire DHS/IPAWS Project Phase I and II
- Pre-installed by emergency vehicle manufacturers – no cost to agencies
- 3,600 active agencies and 7 billion alert messages

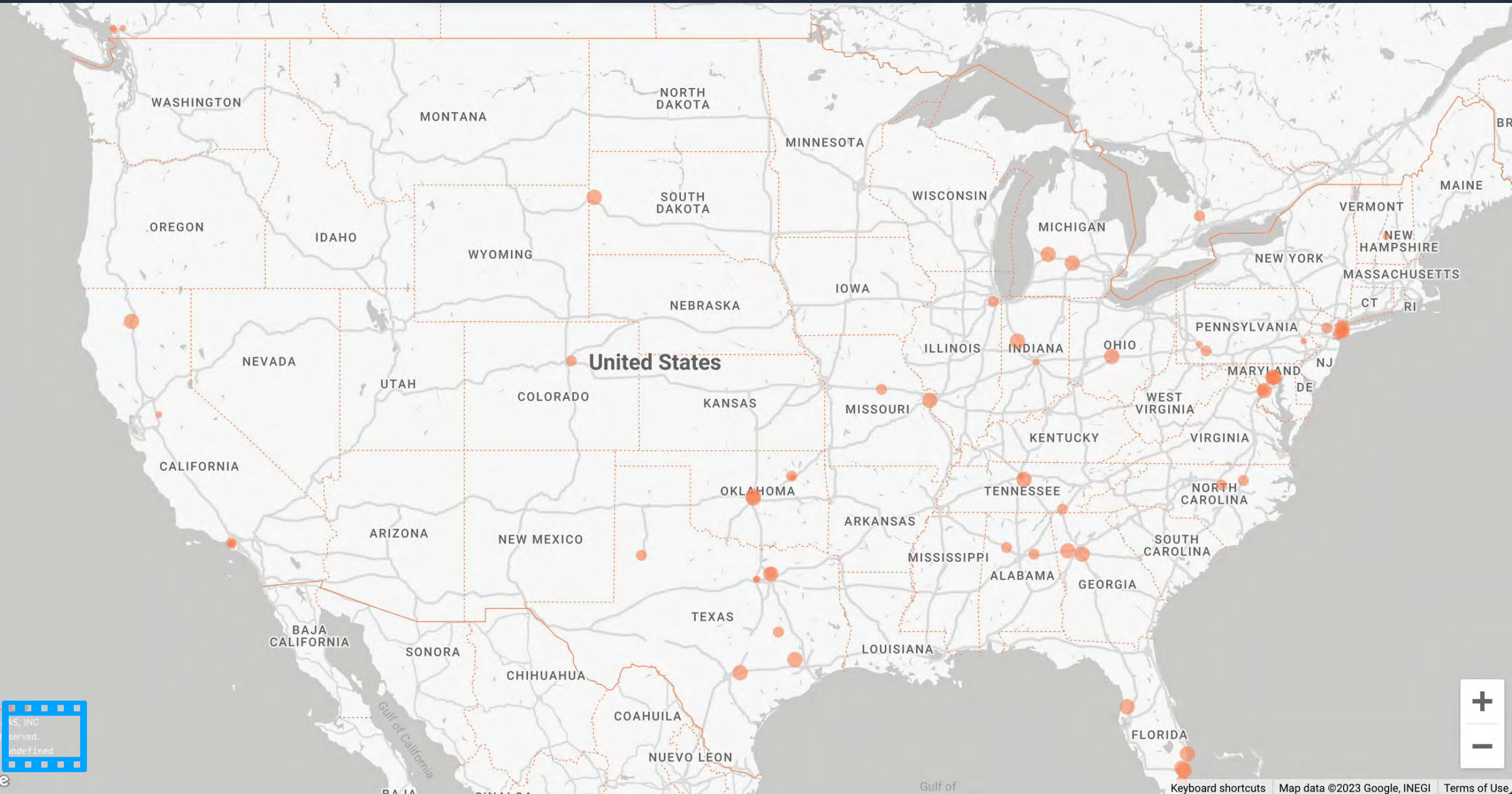
## What's Next

- Authority to Operate Designation for Federal
- Phase III for Wildfire IPAWS Integration






# 25,000,000 Messages Processed Every Hour



HAAS ALERT

## OUR MISSION

Building lifesaving mobility solutions to make roads safer and smarter

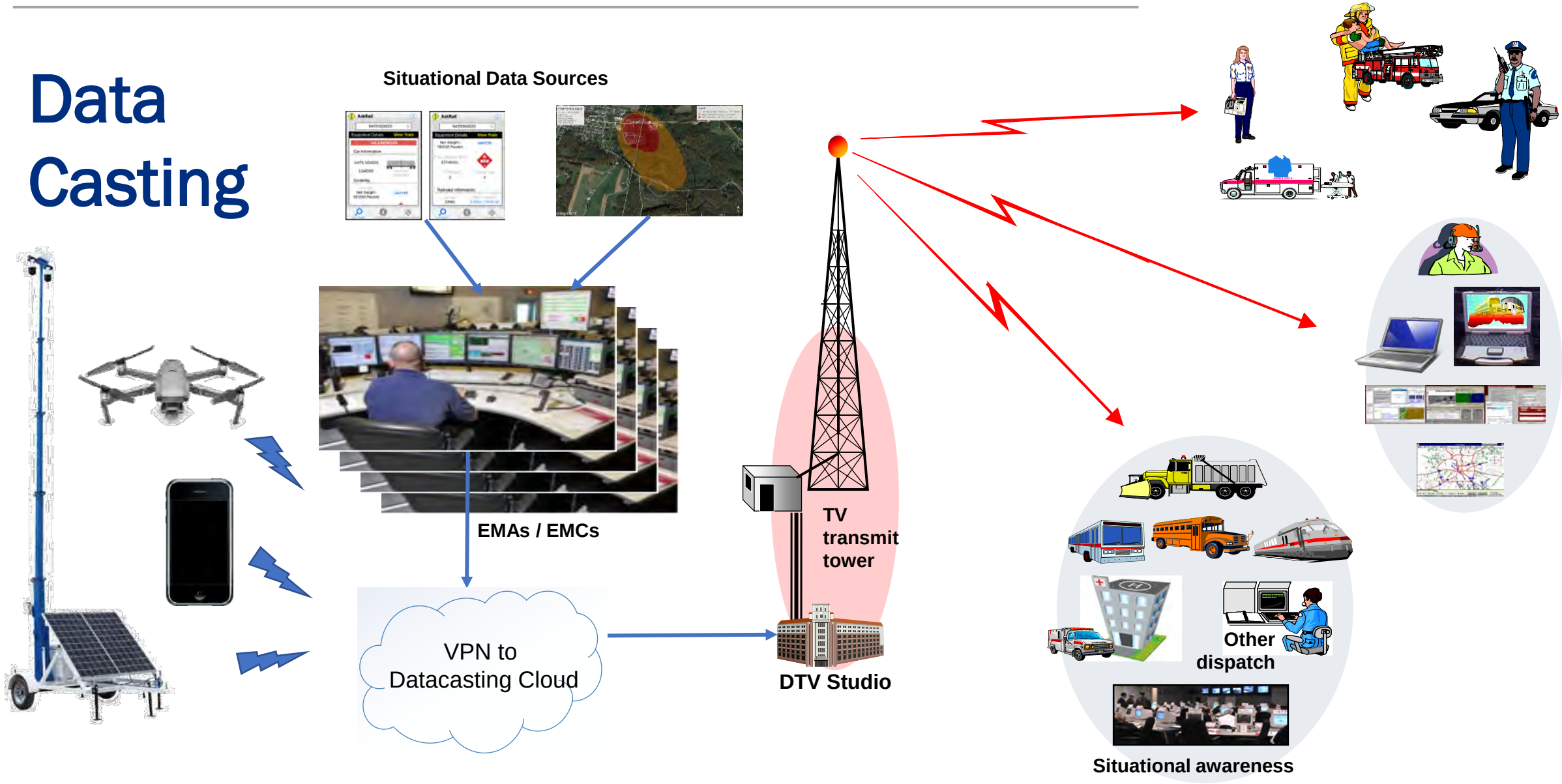
## OUR VISION

A connected, collision-free world where everyone gets home safely

**Where do we go from here?**

# Interoperable, Secure Content Distribution Over DTV

## Data Casting



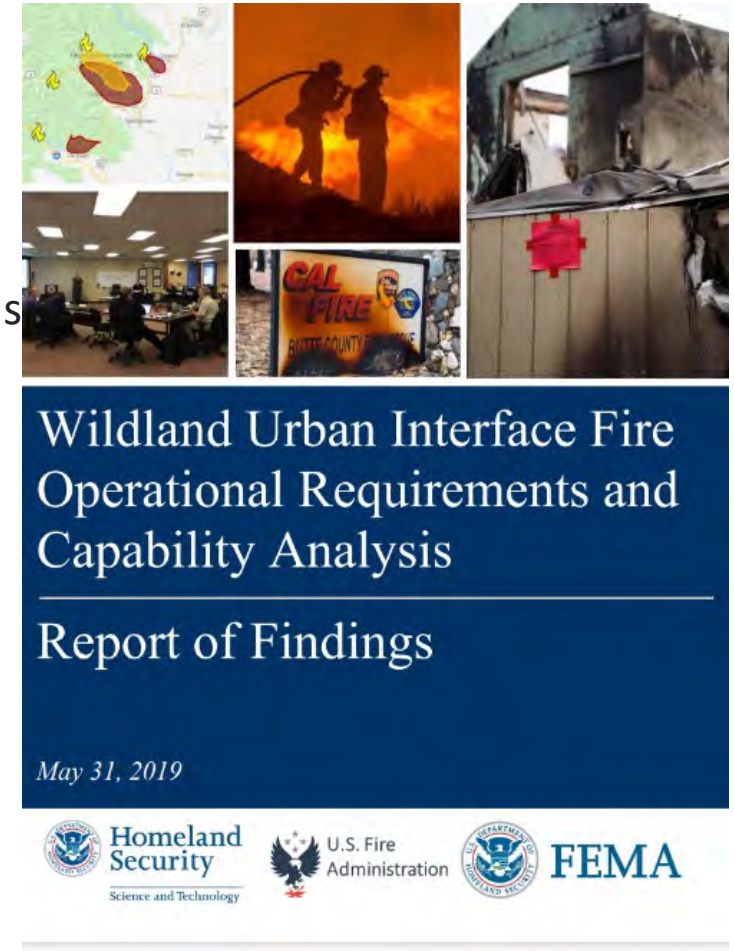
# Research and Technology

- Per the Commission report, “Communities should utilize wildfire detection systems, which can provide automated early warning detection.”

**Wildfire sensors**

A project to develop a suite of sensors, platforms and other early wildfire detection technologies to assist the Federal Emergency Management Agency and state and local emergency management partners in wildfire response.

**How this project helps the fire service:** Early, targeted warning of these fire events is critical for improved fire response and public and firefighter safety.




U.S. Fire Administration

# U.S. Fire Administration (USFA) Wildfire Evacuation Roundtable

## Notification & Communication: Wildfire Sensor Technology

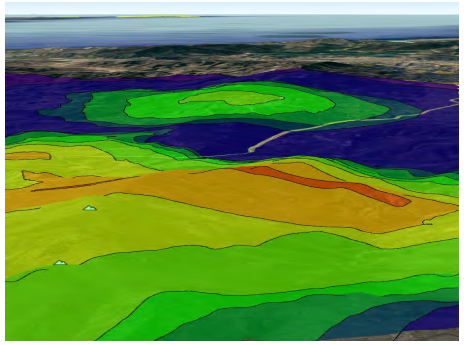
**Jeff Booth, Director**
**S&T Sensors & Platforms Technology Center**

January 31, 2024

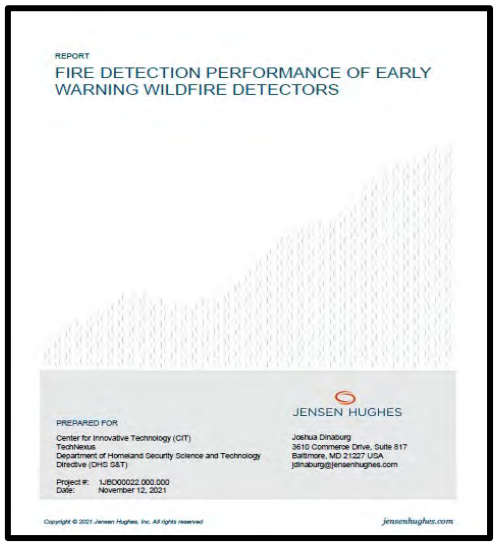
U.S. Fire Administration

# Wildfire Sensors – Science & Research

**Performed scientific literature review** of burn compositions  elements found in wildfire emissions including particulate matter microns ($PM_{1.0}$ $PM_{2.5}$, $PM_{4.0}$, & $PM_{10}$) and environmental air quality conditions and gases (e.g., temperature, humidity,  CO, NOx, SOx, & O3).



**Conducted modeling** of historic fires to define and understand the level of concentrations of smoke composition, particulate matter, and dispersion at a variety of distances and wind conditions.


REPORT

FIRE DETECTION PERFORMANCE OF EARLY WARNING WILDFIRE DETECTORS

JENSEN HUGHES

PREPARED FOR

Center for Innovative Technology (CIT)
TechNexus
Department of Homeland Security Science and Technology Directive (DHS S&T)

Project #: 1JB000022.000.000
Date: November 12, 2021

Joshua Dinaburg
3610 Commerce Drive, Suite 817
Baltimore, MD 21227 USA
jdinaburg@jensenhughes.com



jensenhughes.com

**Laboratory tested conditions** (ignition, smoldering, flaming, etc.) to evaluate concentration levels with sensors 1,000x more sensitive than COTS indoor alarms.

**Conducted interagency test and demonstration** at a ~1,000-acre prescribed burn over 2 days in Red Bluff, CA.  Sensors repeatedly demonstrated ability to detect smoke, at ignition and at a distance ~ 5 miles.

- Sensors could detect fires comparable to high end lab devices
- Ability to distinguish a new ignition vs. background fire smoke
- Cellular (LTE) data back-haul is most reliable with long-range radio (LoRa) in cellular denied areas
- Artificial Intelligence (AI) and Machine Learning (ML) algorithms being refined to address false positives
  - Multiple sensing algorithms to be developed for near vs. far detection (smoke particles clumped over longer distances as smaller particles travel further)
- ***On-going Alpha & Beta operational field testing***

U.S. Fire Administration

# Sensor Tech Specs…

N5 Sensors, Inc.
*Smart Sensors for a Safer World*

- Setup will consist of N5 sensor, solar panel, and universal mounting case with detachable features for variety of mounting conditions.
  - Current Device size: 9.5” x 4.5” x 2”
  - The device weighs about 3lbs and 9oz
  - Adding wind sensors in Beta

- N5 Sensors ChemNode platform utilizes a combination of particulate sensor, proprietary chip-scale gas sensors for capturing different signatures associated with wildfires.
- Data from each node is transmitted via LoRaWAN to a gateway with LTE or WiFi backhaul. Alerting algorithms in the cloud utilize data from multiple sensing modalities of detection (and, in the future, multiple nodes).

**Wildfire Detection System (AI / ML)**
Sensor utilizes for the edge - **multi-modal sensor fusion** where data from orthogonal sensors are fused to identify fire anomalies. This ML mode is called **Change Point Model (discrepancy).**

The cloud aggregates data from multiple nodes of the network to improve detection accuracy and reduce false positive alarms. For this Aggregation - a **Graph Neural Network** is used that takes 16 processed inputs from a subnet of ChemNodes in a network and predicts fire and its confidence level of the prediction. This also can integrate other data streams such as wind layers, lightning, etc.

U.S. Fire Administration

# Alpha Sensor Performance

**Results to date…**

- 185 fire alerts detected, which includes AI / ML training on prescribed / controlled burns.
- Detection of the following ignitions (unplanned)…this is not an exhaustive list of ignitions detected.
  i. Flare up from prescribed fire machine pile, start time unknown, with **detection 37 minutes** before 911 caller in Gilpin County, Colorado, west of Denver.
  ii. Detected a lightning strike on a tree in Baie Comeau, Canada at a distance of ~0.4 mile
  iii. Detected 3 small fires from munitions practice in Valcartier (2 ft x 2 ft patch burned, near sensor)
  iv. Detected an unauthorized campfire near a utility pole in Colorado (~0.5 mile from sensor)
  v. Detected a lightning strike which led to a small fire in Northern California. This was detected even though there were larger fires burning nearby.

**Gilpin County, Colorado**

The U.S. Forest Service and Gilpin County, Colorado, performed controlled burns in February 2023. S&T wildfire sensors remained after the fires were extinguished. Later that night, a flare-up occurred, resulting in a 911 dispatch call 37 minutes after the sensors had already detected and notified the local Gilpin County fire department.

Sensor Deployment Gilpin County CO.


Controlled Burn Flare Up & Sensor

11 HWY 119;FIRE MISC;PARTY WAS DRIVING BY
(Con't) 2 of 4
[02/02/22 20:06:28 SHARTVIGSON] SEEING A FIRE// RIGHT SIDE 119//SEES FLAMES// WEST SIDE OF HIGH WAY//CAN'T TELL WHAT IT IS BUT SEES
(Con't) 3 of 4
FLAMES//AT LEAST SEVERAL FEET WIDE//THERE WERE A FEW OF THEM [02/02/22 20:06:22 SHARTVIGSON] ;02/02/2022 20:04:32;D009;MISSOURI GULCH
(Con't) 4 of 4
RD;CREST VIEW

911 Dispatch

Santa Clara Fire Safe Council deployed N5 Sensors in the San Jose Watershed for protection in Santa Clara County. According to Seth Schalet, CEO, of the Santa Clara County FireSafe Council, ***"…the N5SHIELD system has been shown to provide accurate and reliable detection of fire ignitions, and the N5 team provides outstanding support and execution."***

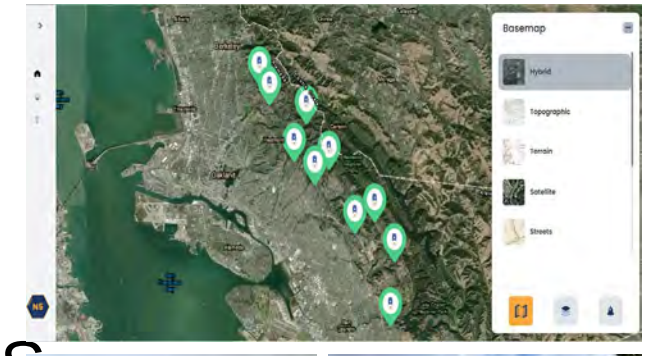
| | | | | |
|---|---|---|---|---|
| Canada - Baie Comeau | Lightening tree strike | ~0.4 mile | Unknown, reported 6/24 at 20:19 | 6/24/2023 16:20 and 20:24 |

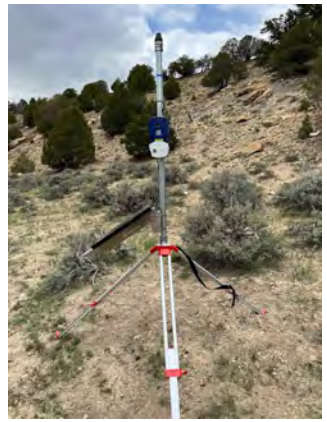
U.S. Fire Administration

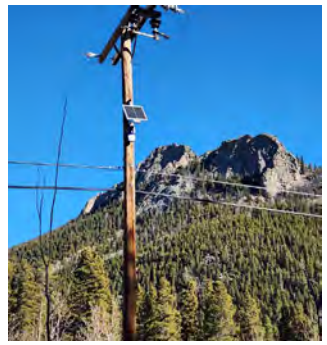
# Beta Sensor Deployment 2024…Next Steps

## Operational Test & Evaluation with Stakeholders ~ 200 Beta Sensors

- Densify network & test efficacy 1-5 miles apart
  - Add Wind Sensors for micro weather
  - Enhance ‘Warnings’ and ‘Alerts’ notifications
  - Deploy Mobile Sensors for Post Burn Monitoring
- Test integration with Mass Notification Systems & IPAWS
  - Sirens
  - Cell phones
  - In-Dash infotainment system





## Further Research Required…

- Data feeds for modeling and early AWN
- Alert messaging for fire perimeter movement
- Sensor miniaturization for home alerting capability

# Field Sensors

## Phase 2: Alpha Sensor Design, Test & Evaluation

- **2 Performers / 200 Sensors**
  - Final Reports in December (N5 Sensors & Breeze)
  - Promising early detections: lighting / controlled burn
  - IPAWS / Waze / Alert, Warning & Notification demo
  - Remaining challenge for Beta Phase:
    - Optimal sensor spacing / densification

| Organization | Approx location City or State) | # Sensors Deploye |
|---|---|---|
| CAL FIRE | Jackson Demonstration State Forest , California | 20 |
| PacifiCorp | Happy Camp and I5, California | 10 |
| Gilpin County / United Power | Colorado | 5 |
| Alert Wildfire / OHAZ | Oregon | 15 |
| Boulder County | Colorado | 5 |
| Quebec, DRDC | Quebec | 30 |
| Utah Forest Service | Moab, Utah | 10 |
| Orange Cnty Fire Authority (CFA) | Irvine, California | 5 |
| City of Oakland | Oakland, California | 25 |
| **Total** | | **125** |

**Gilpin County, Colorado**

The U.S. Forest Service and Gilpin County, Colorado, performed controlled burns in February 2023. S&T wildfire sensors remained after the fires were extinguished. Later that night, a flare-up occurred, resulting in a 911 dispatch call 37 minutes after the sensors had already detected and notified the local Gilpin County fire department.

Sensor Deployment Gilpin County CO.


Controlled Burn Flare Up & Sensor

911 Dispatch

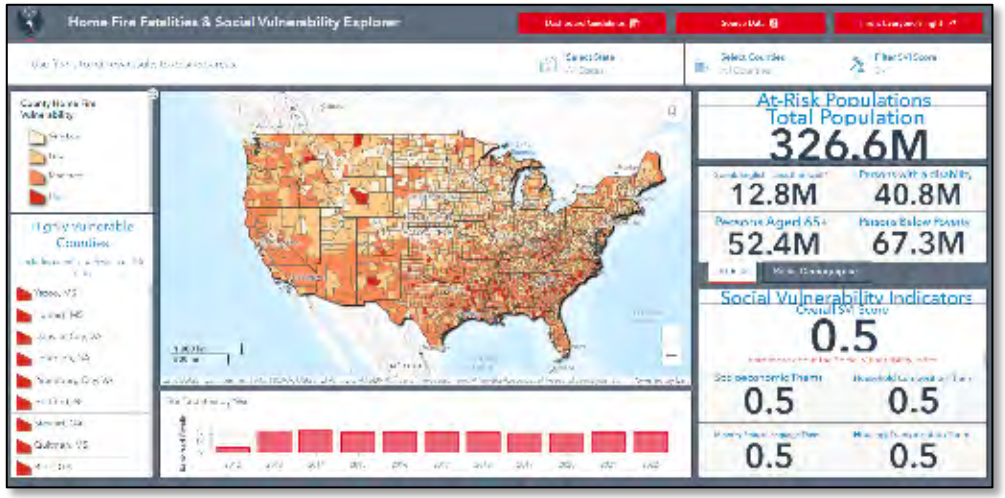
| | | | | |
|---|---|---|---|---|
| Canada - Baie Comeau | Lightening tree strike | ~0.4 mile | Unknown, reported 6/24 at 20:19 | 6/24/2023 16:20 and 20:24 |

Science and Technology


**The goal of NERIS is to empower the local fire and emergency services community** by equipping them with near real-time information and analytic tools that support data informed decision-making for enhanced preparedness and response to incidents involving all hazards.

FEMA U.S. Fire Administration

# Guiding Objectives




- Premier source for nationwide, all-hazards incident information.
- Replace the 20+ year legacy NFIRS.
- Improve quality, coverage, and timeliness of local, all-hazards incident data.

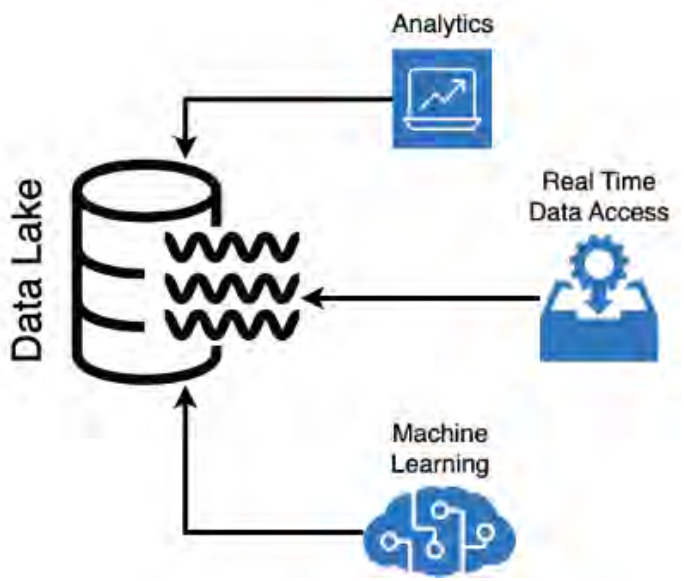
- Provide near real-time information and greater insights into exposures, vulnerabilities, and capability gaps.
- Capture data on community risk reduction programs at local level and visualizes trends.
- Integrate foundational data from best available sources.

# Foundational Information to Inform Wildfire Evacuation

- NOAA on Weather Data
- DOT on road and transportation data

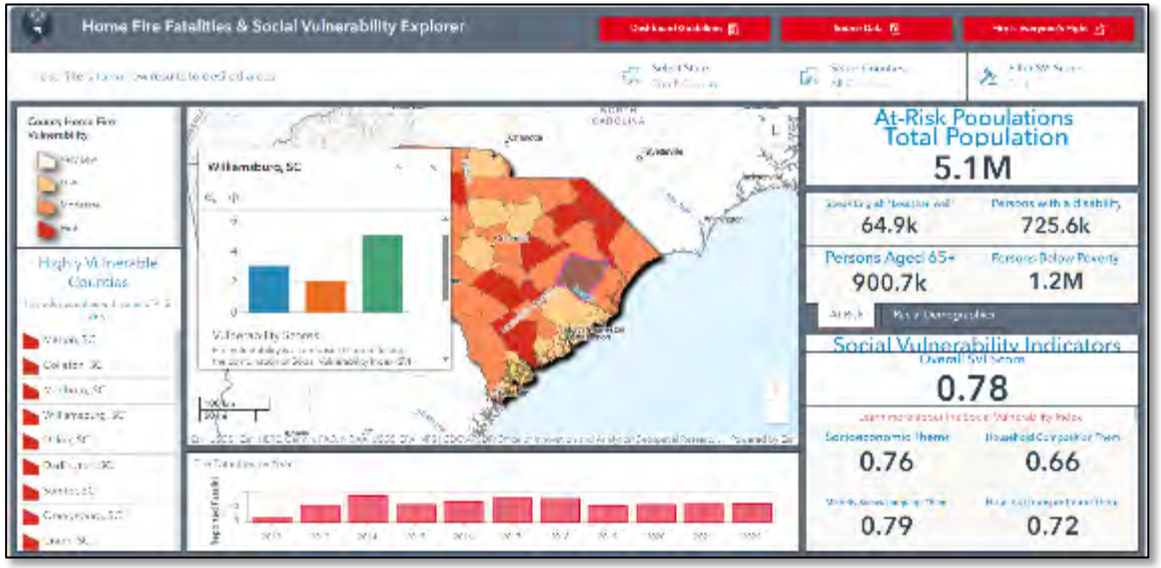
FEMA | U.S. Fire Administration

# Powering Innovative Analytics

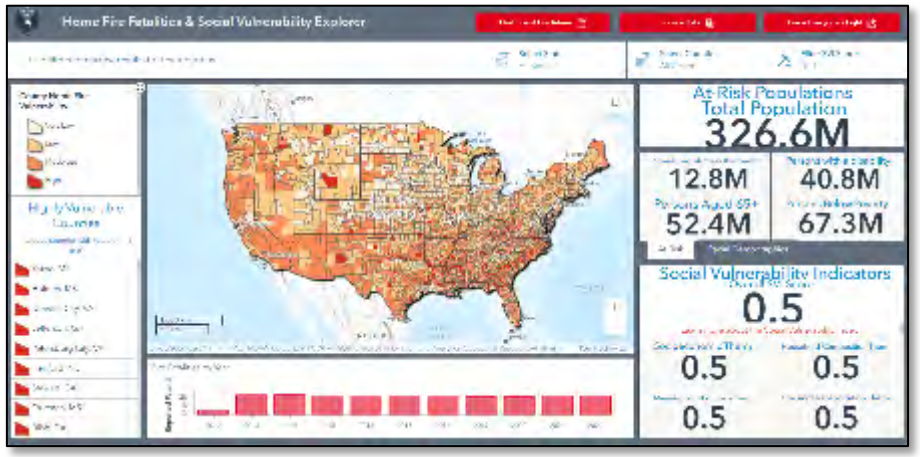


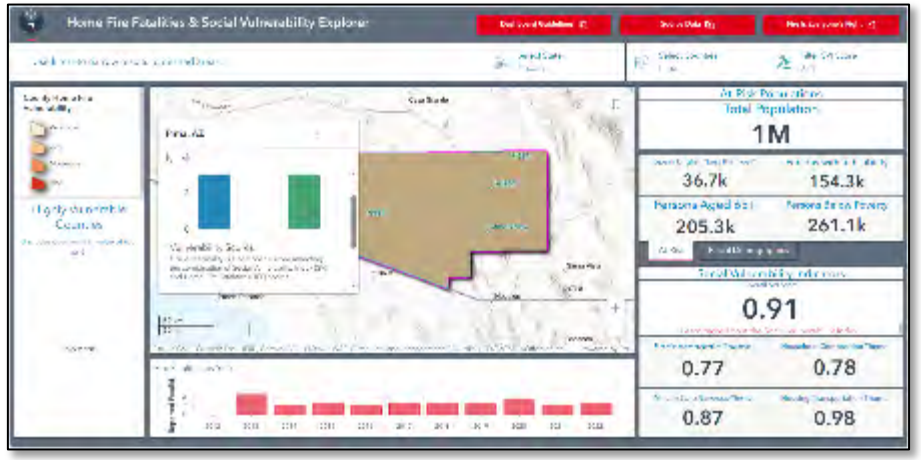

- Data management and integration environment for the Nation's fire-based incident data.
- Consume data from the best available, authoritative sources.
- Provide data out in multiple, interoperable formats.

- Provide basic, self-service analytic products for fire departments.
- Integrate and provide access to the latest models and analysis, includes:
  - Wildfire risk, WUI exposure, and data for wildfire evacuation planning.



# Eye into Future NERIS Analytics



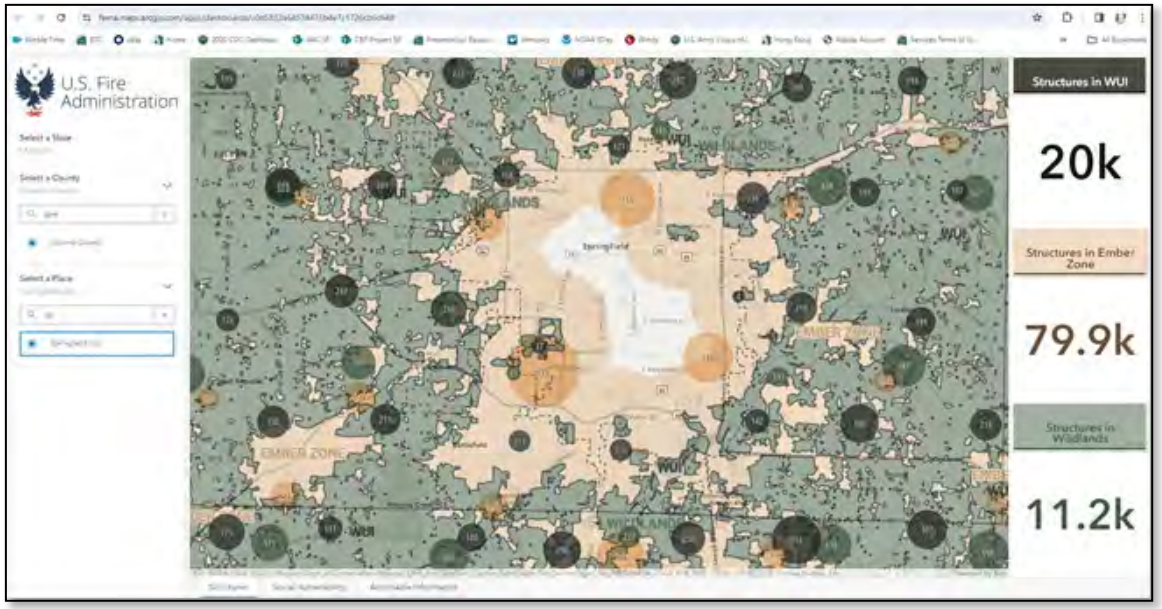




- **Current** - USFA working with Headwaters Economics to evaluate existing fire risk models.
  - Inclusive of wildfire, wildland urban interface (WUI), and structure fire spatial risk indices and models.
  - Focus on the degree to which the built environment is addressed by the various models.
- **Future** – Development of a National Fire Risk Index that leverages the best models across all fire environments.
- Development and integration of data-driven WUI community risk reduction tools, including wildfire evacuation readiness.

FEMA | U.S. Fire Administration

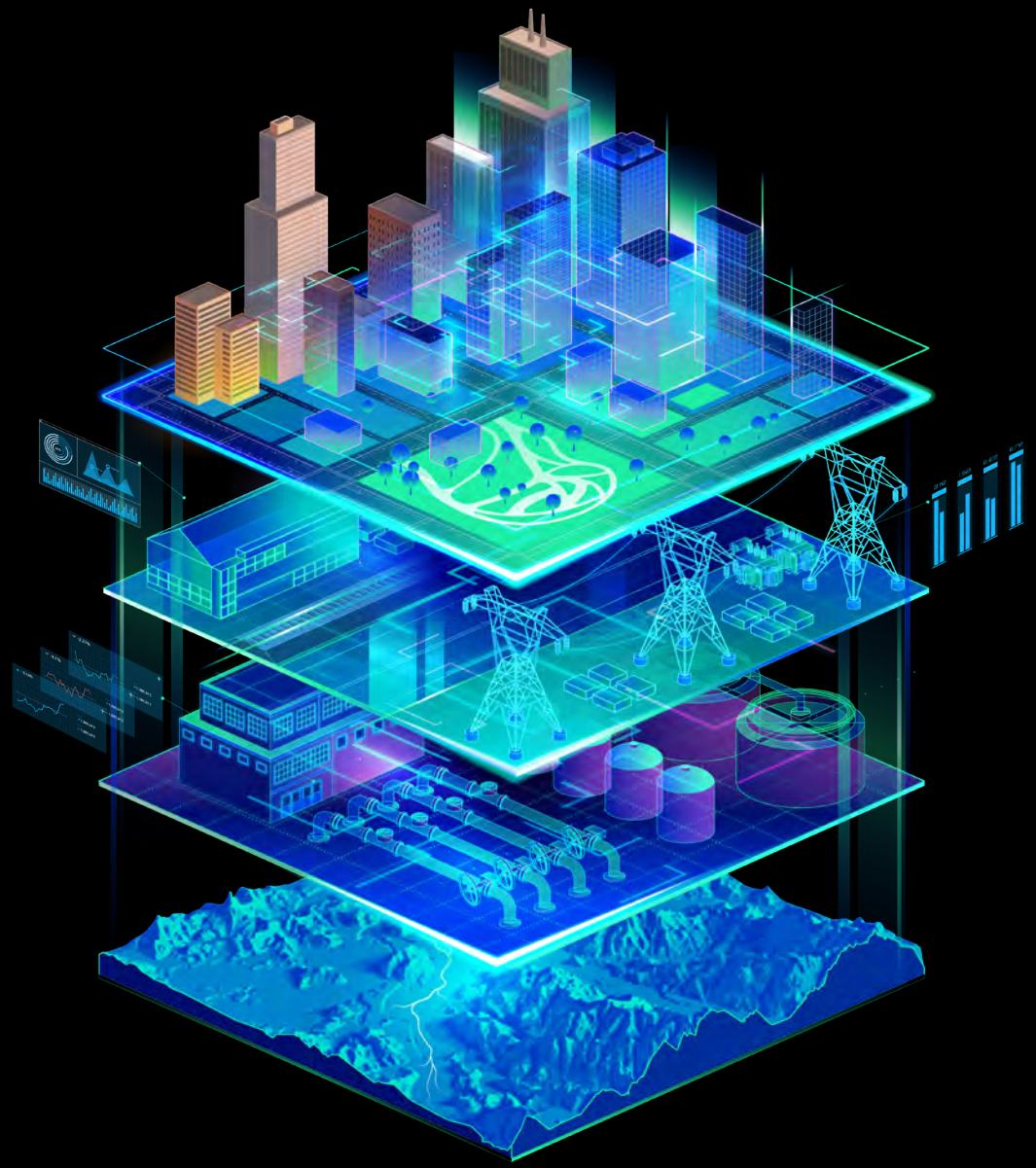
# WUI Exposure and Awareness

- Developing a GIS-based tool that will enable individuals and communities to have a better awareness of where they are relative to the Wildland Urban Interface (WUI).
- Understand the impact of structure density, location, proximity to the ember zone, and social vulnerability on potential fire spread.




FEMA

U.S. Fire Administration



# Wildfire Evacuation Roundtable

**Mike Cox**
**Director of Fire, Rescue & EMS**

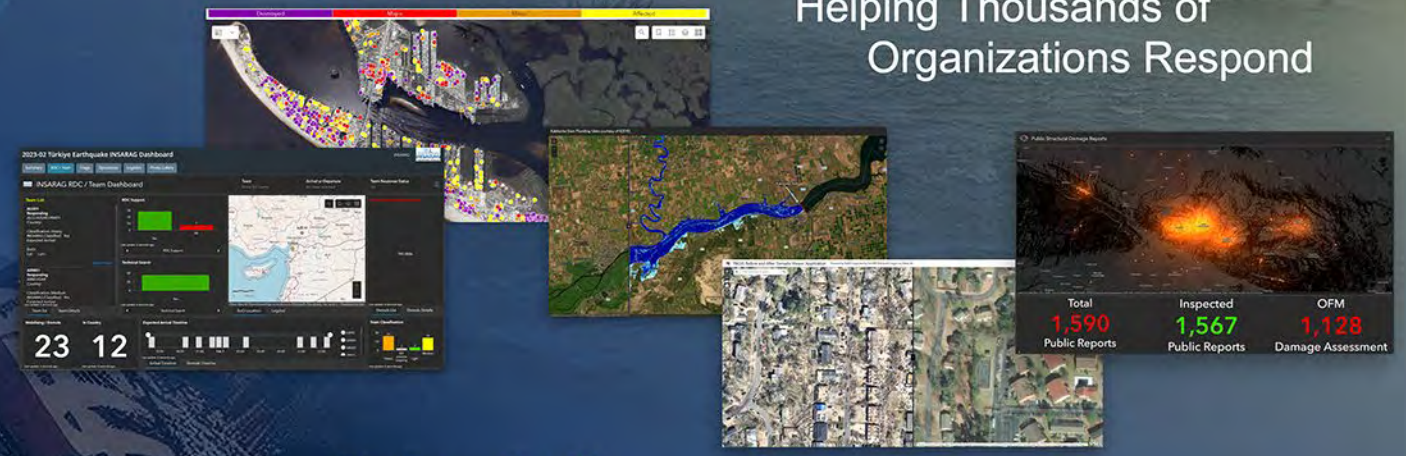
**Anthony Schultz**
**Director of Wildland Fire**

**THE SCIENCE OF WHERE**

# DISASTER RESPONSE

## Supporting Users Globally in Times of Crisis

### Helping Thousands of Organizations Respond




*Partnered with*

Users

HOT

Esri Partners

GISCorps

MapAction

American Red Cross

FEMA

*Mobilizing & Coordinating Resources Across Esri*

# Wildfire Evacuations Today

**No Standards**

No mandated Evac. Standards

Terminology Varies across the U.S.

No requirement for dynamic updates

Lack of holistic evac planning

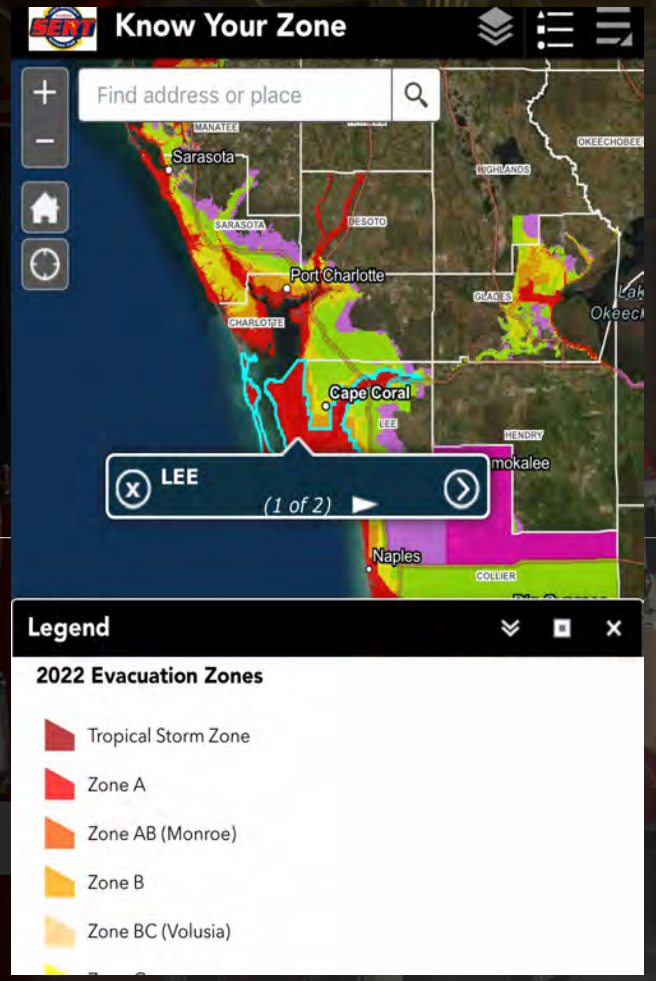
**Data Product Quality Varies**

Maps and messaging are static

No common template for planning

Limited use of real-time information

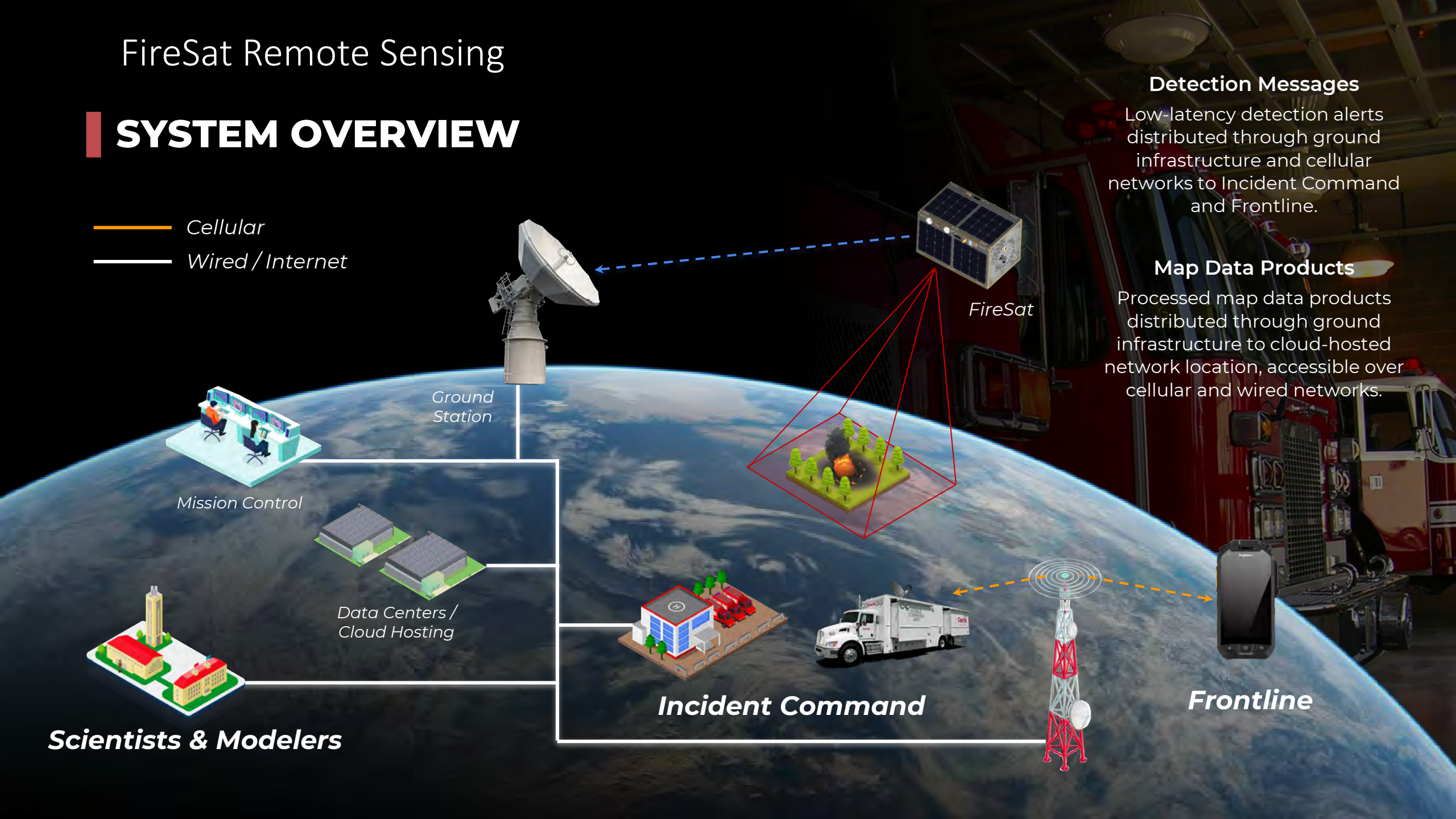
Public engagement is lacking


# We Need to Be Better...

# FireSat Remote Sensing

## SYSTEM OVERVIEW



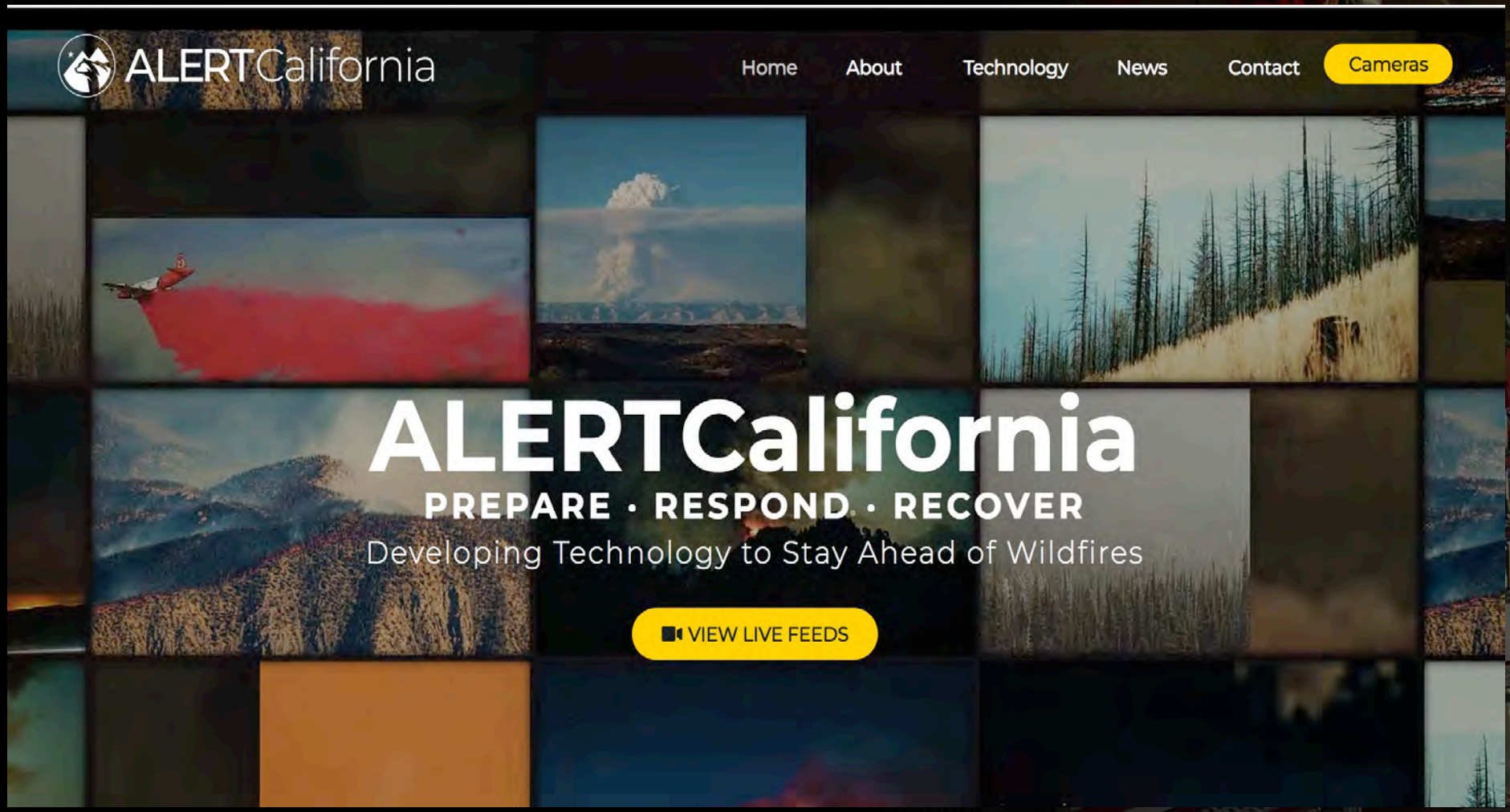

**Detection Messages**

Low-latency detection alerts distributed through ground infrastructure and cellular networks to Incident Command and Frontline.

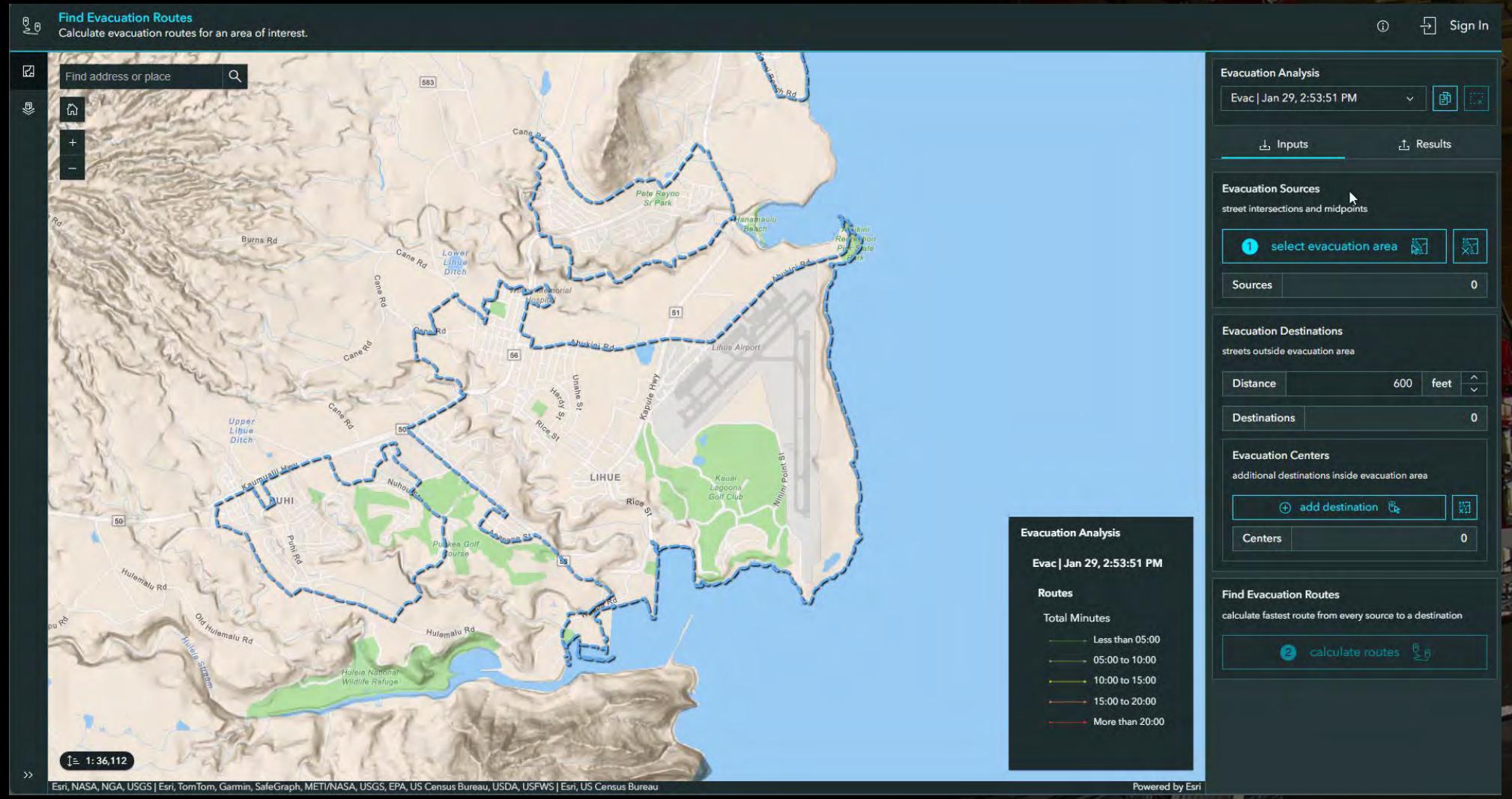
**Map Data Products**

Processed map data products distributed through ground infrastructure to cloud-hosted network location, accessible over cellular and wired networks.

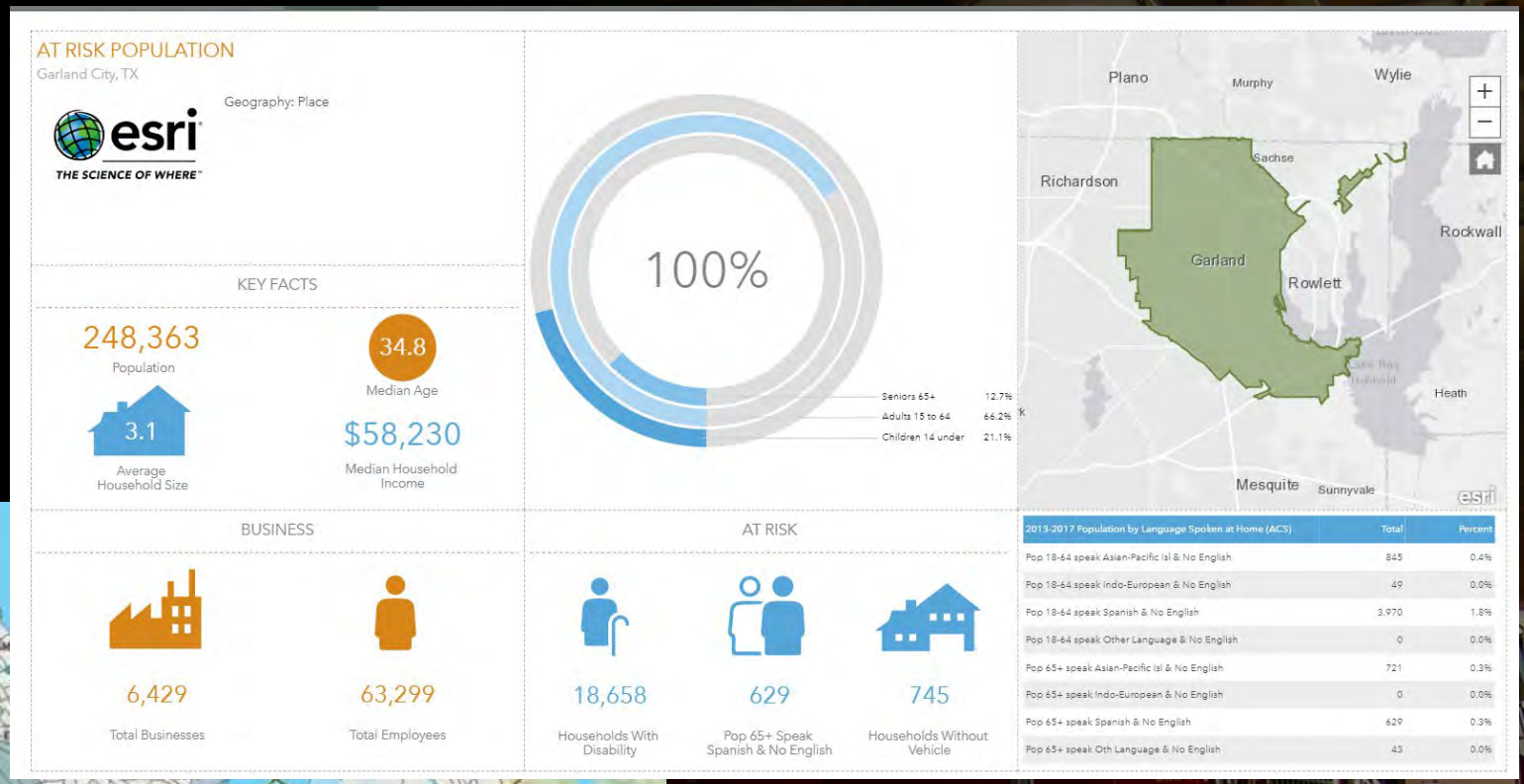
# Remote Sensing

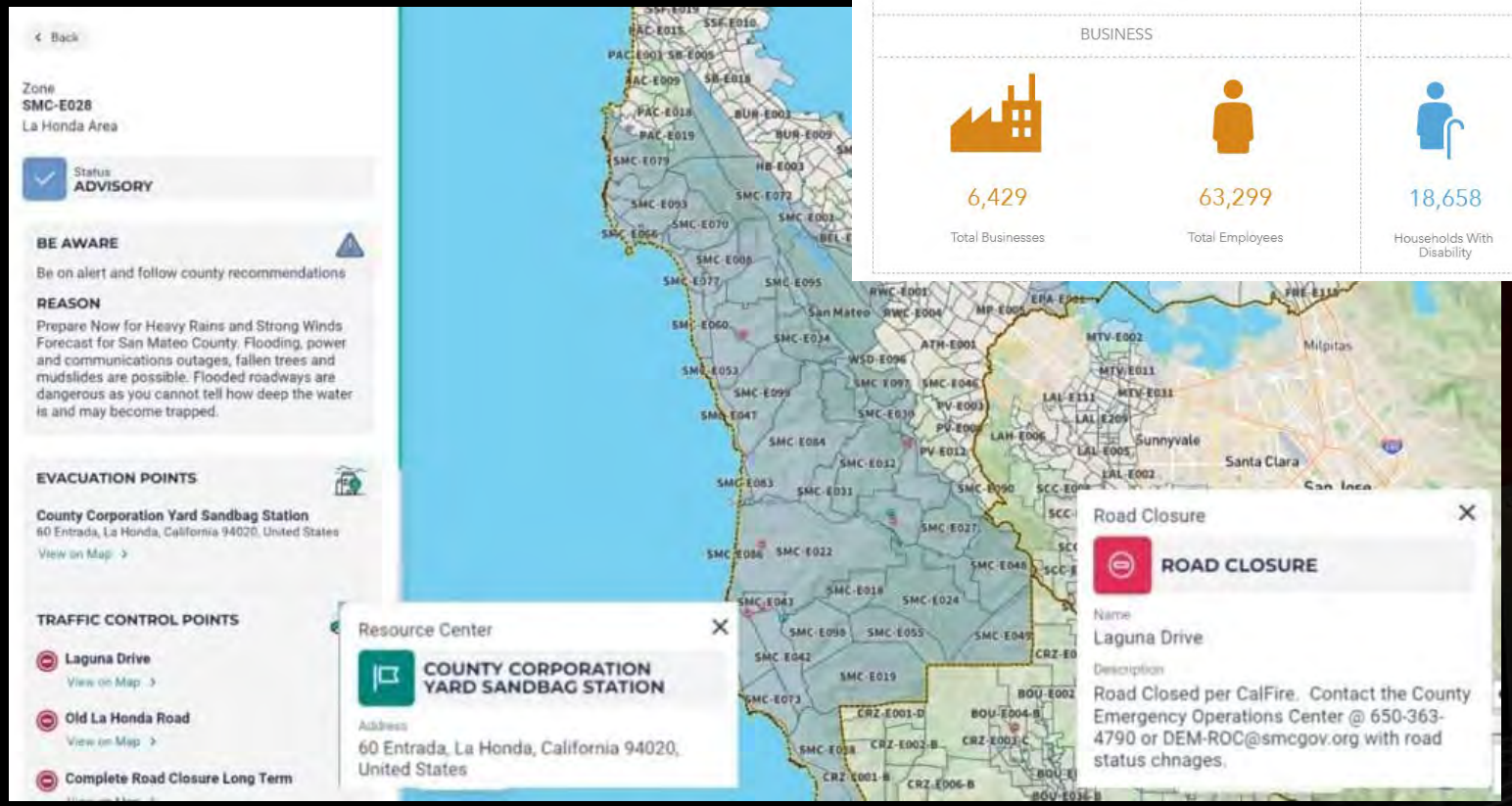


# Evacuation Analysis



# Evacuation Analysis




# Public Information & Notification

## Florida Hurricane Zones app

- Over 40M map request in two days

IAFC
International Association of Fire Chiefs


# Wildfire Evacuation Planning Toolkit

Jeff Dulin – Strategic Advisor

# Problem

- Wildfire threats to communities continue to grow.
- Communities are moving closer and into the WUI.
- As such, more people are needing to be evacuated in shorter periods of time, more frequently as the fires are growing larger and more common.
- Rural communities often lack access to innovative technologies.

SAFE, TIMELY AND EFFECTIVE EVACUATIONS ARE CRITICAL FOR PUBLIC SAFETY

Recent wildfires across North America and Australia have demonstrated that evacuation is a crucial component of wildfire management. Safe, timely, and effective evacuations are critical for public safety. Poorly executed evacuations can become the focal point for criticism of the emergency response effort and the fire agencies involved.

There are many reasons evacuations fail including: fast moving fires, limitations in our ability to predict fire spread, failure to coordinate with law enforcement, notification failures, lack of public preparedness, insufficient resources, failure to apply the proper strategy (rescue vs. suppression), inexperience, insufficient access, inadequate road capacity, and more.

While there is great opportunity to improve public notification and the way evacuations are planned and conducted, it is also important to change the narrative about evacuation. The public has developed unrealistic expectations about evacuations, so it is critically important to emphasize the personal responsibility inherent in evacuations. The preparation the individual takes prior to an incident and the situational awareness they maintain during the incident are just as important as a community evacuation plan. To achieve this end, the fire service must not only be a leader in planning for and implementing evacuations, but we must also work to provide our communities with the tools necessary to be prepared for an evacuation. We should also work towards an end state in which communities are fire adapted - designed, built and maintained in a manner that makes evacuation less necessary. See more at the Fire Adapted Communities website.

There are common factors that cause issues with evacuations. First, evacuation planning and implementation are complicated by the fact that the statutory responsibility for evacuation varies by jurisdiction. This responsibility could fall under the purview of law enforcement, the fire department, emergency management, or elected officials. In some areas, there is no legal basis to force a person to leave their home. The type of evacuation that may be instituted also varies by location. Regardless of the fire department's responsibility for evacuations, the fire department will most likely have some involvement in evacuations, even if it is limited to determining which areas to evacuate and when.

An additional complexity associated with evacuations is the wide variety of terminology that is used. As an example, the following terms potentially refer to the same type of evacuation, depending upon your location: pre-evacuation, evacuation warning, stage 1 evacuation, and ready. Your constituents should have a solid understanding of the terminology that is used in your jurisdiction or adjacent jurisdictions.

If an evacuation is not well executed, the fire department will likely be held accountable by the public. As the fire chief, evacuation planning should be viewed as a critical strategic initiative with the allocated resources necessary to develop a sound plan.

The intent of this section is to provide the fire chief and members of the fire department with tools to help them prepare for situations which may require an evacuation. Although this section has a wildland fire emphasis, evacuation planning has utility for other natural disasters that may require an evacuation including hurricanes and floods, as well as man-made disasters such as hazardous materials incidents.

# Introduction

The International Association of Fire Chiefs (**IAFC**) and its Wildland Fire Policy Committee have created this Wildfire Evacuation Planning Toolkit, aiding local jurisdictions in evacuation planning. The Wildfire Evacuation Planning Toolkit contains three distinct pieces:

1. **The Capabilities Assessment** serves as a checklist for agencies to assess their current capability and readiness for conducting evacuations.
2. **The Post Assessment Action Plan** contains a collection of materials to aid in jurisdictional evacuation planning efforts.
3. **The Evacuation Zone Pre-Planner** is a map-based platform for agencies to draw pre-planned evacuation areas.

This application is intended to be easy to use without any previous experience with geospatial technologies or platforms.

- Users can explore their community within a map-based environment to make informed decisions on evacuation zone sizes and locations.
- Within the application, users can create, save, edit, and export evacuation zones.
- To support interoperability, users can download their evacuation zones in KML/KMZ or shapefiles for use in external evacuation systems.

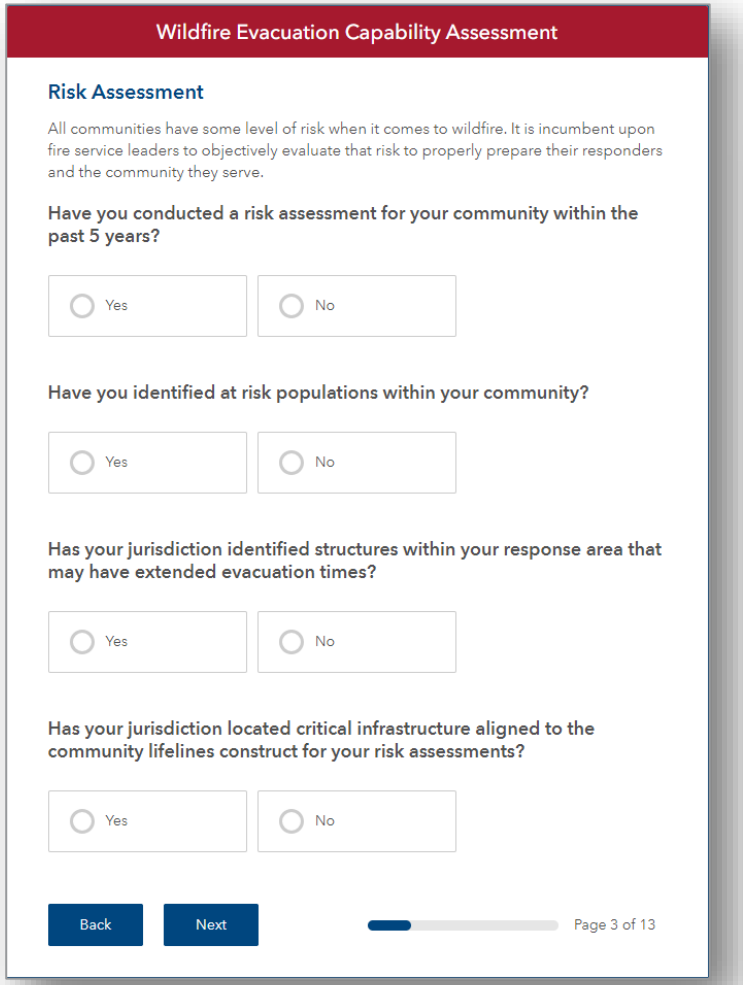

## Capabilities Assessment

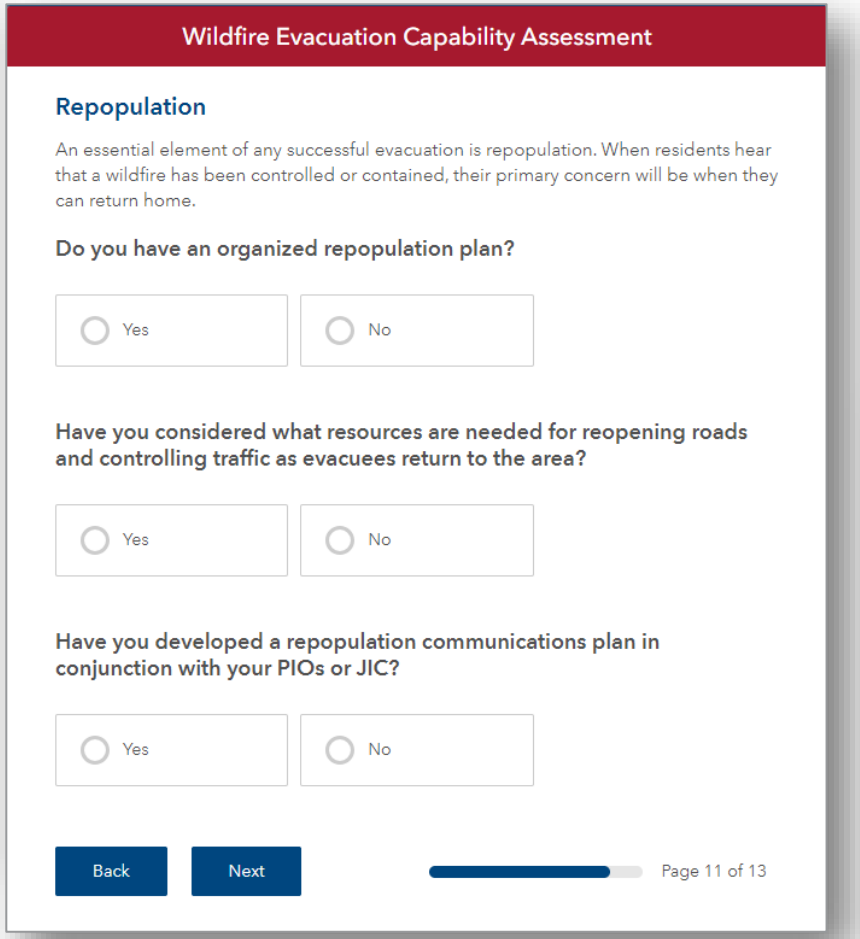

## Post Assessment Action Plan

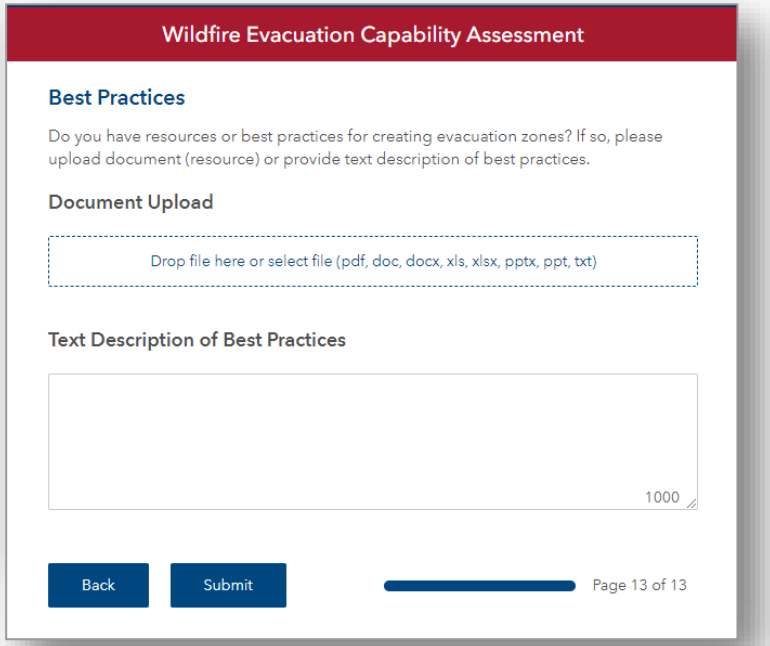

## Evacuation Zone Pre-Planner

*If you do not have access to the Pre-Planner, you can request access by completing this short form: **IAFC Application Access**.

# Capabilities Assessment

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## Capabilities Assessment


## Post Assessment Action Plan


## Evacuation Zone Pre-Planner

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To help fill gaps addressed in the Wildfire Evacuation Capability Assessment, relevant wildfire evacuation planning resources are provided.

# Wildfire Evacuation Planning Toolkit



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### Capabilities Assessment


### Post Assessment Action Plan


### Evacuation Zone Pre-Planner

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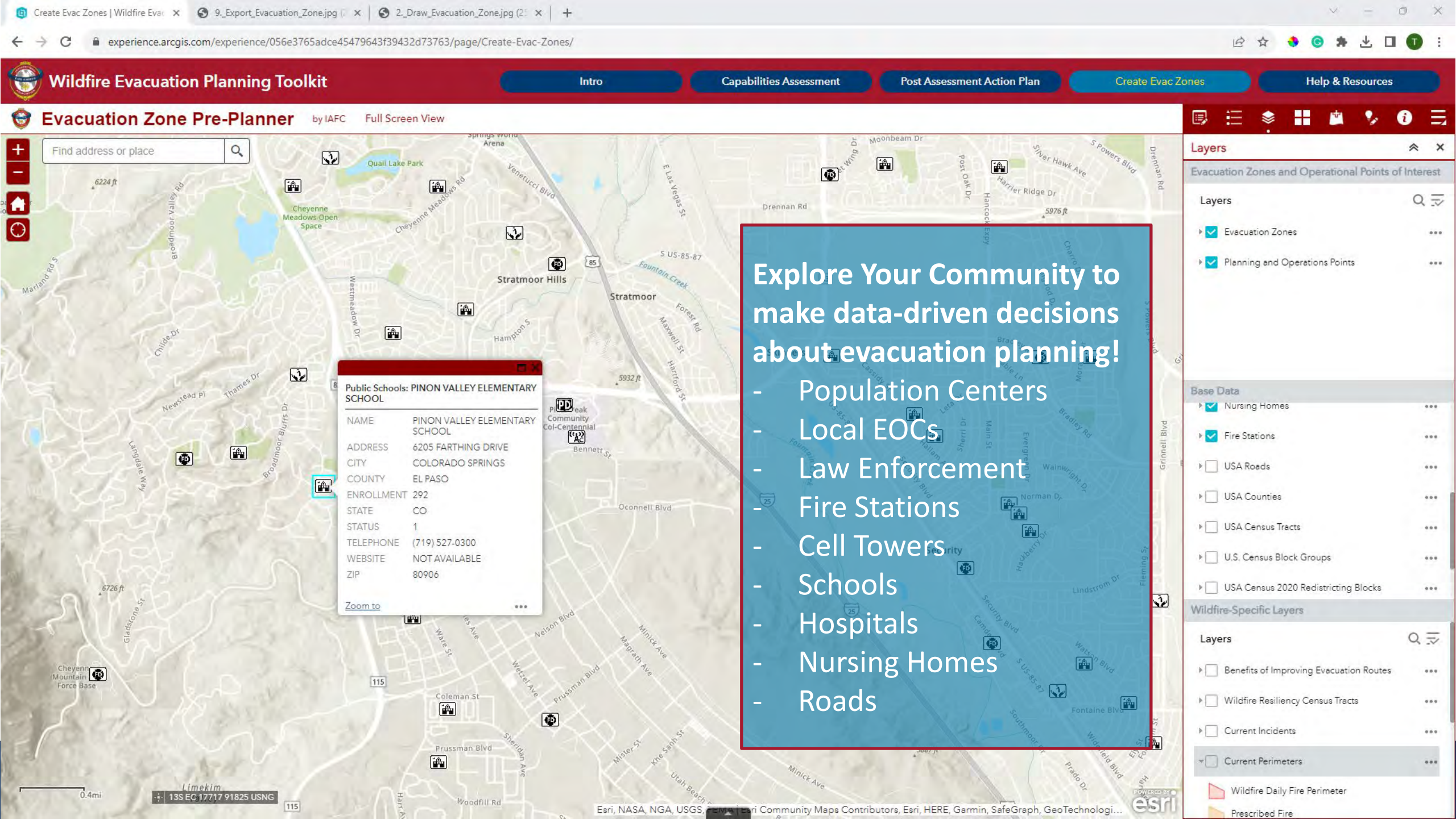
Create Evac Zones | Wildfire Evac
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Create Evac Zones
Help & Resources
Evacuation Zone Pre-Planner
by IAFC
Full Screen View
Find address or place
Public Schools: PINON VALLEY ELEMENTARY SCHOOL
NAME PINON VALLEY ELEMENTARY SCHOOL
ADDRESS 6205 FARTHING DRIVE
CITY COLORADO SPRINGS
COUNTY EL PASO
ENROLLMENT 292
STATE CO
STATUS 1
TELEPHONE (719) 527-0300
WEBSITE NOT AVAILABLE
ZIP 80906
Zoom to
Explore Your Community to make data-driven decisions about evacuation planning!
- Population Centers
- Local EOCs
- Law Enforcement
- Fire Stations
- Cell Towers
- Schools
- Hospitals
- Nursing Homes
- Roads
Layers
Evacuation Zones and Operational Points of Interest
Layers
Evacuation Zones
Planning and Operations Points
Base Data
Nursing Homes
Fire Stations
USA Roads
USA Counties
USA Census Tracts
U.S. Census Block Groups
USA Census 2020 Redistricting Blocks
Wildfire-Specific Layers
Layers
Benefits of Improving Evacuation Routes
Wildfire Resiliency Census Tracts
Current Incidents
Current Perimeters
Wildfire Daily Fire Perimeter
Prescribed Fire
Quail Lake Park
Cheyenne Meadows Open Space
Stratmoor Hills
Stratmoor
Drennan Rd
Moonbeam Dr
Harrier Ridge Dr
Silver Hawk Ave
S Powers Blvd
Venetucci Blvd
Cheyenne Meadows Rd
Broadmoor Valley Rd
Fountain Creek
Forest Rd
Maxwell St
Harford St
Hampton S
Westmeadow Dr
Childe Dr
Thames Dr
Newstead Pl
Broadmoor Bluffs Dr
Langdale Way
Gladstone St
Bennett St
Oconnell Blvd
Nelson Blvd
Prussman Blvd
Coleman St
Woodfill Rd
Minick Ave
Magrath Ave
Wetzel Ave
Ware St
Sheridan Ave
Mister St
Utah Beach
Security Blvd
Lindstrom Dr
Fontaine Blvd
Wainwright Dr
Norman Dr
Hackberry Dr
Bradley Rd
Grinnell Blvd
Fleming St
Watson Blvd
Prado Dr
Widefield Blvd
Cheyenne Mountain Force Base
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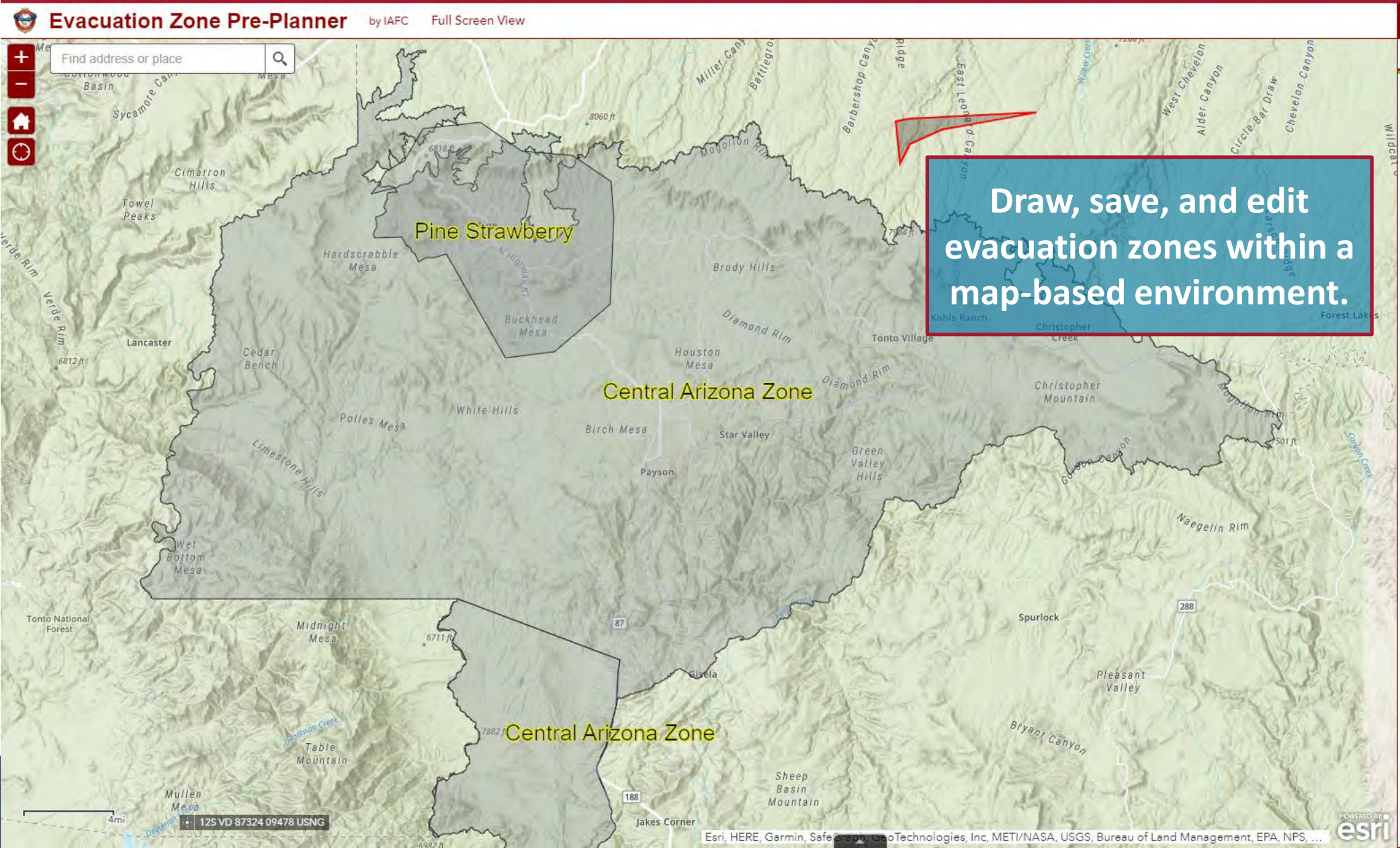
Esri, NASA, NGA, USGS, FEMA | Esri Community Maps Contributors, Esri, HERE, Garmin, SafeGraph, GeoTechnologi...
POWERED BY esri

# Evacuation Zone Pre-Planner

by IAFC Full Screen View




## Create Evac Zones and Add Points

Select the Evacuation Zone template below to start drawing an evacuation zone. Use the Census Tracts or Blocks layers to aid in drawing boundaries around areas that contain a 2020 population estimate. Provide descriptive but succinct detail in the Description section to help inform local citizens and other operational personnel.

Add a Planning or Operational Point of Interest to the map from the template below. This may be a road closure, staging point, safe refuge area, or other. Provide descriptive but succinct detail in the Description section to help inform local citizens and other operational personnel.

**Evacuation Zones**

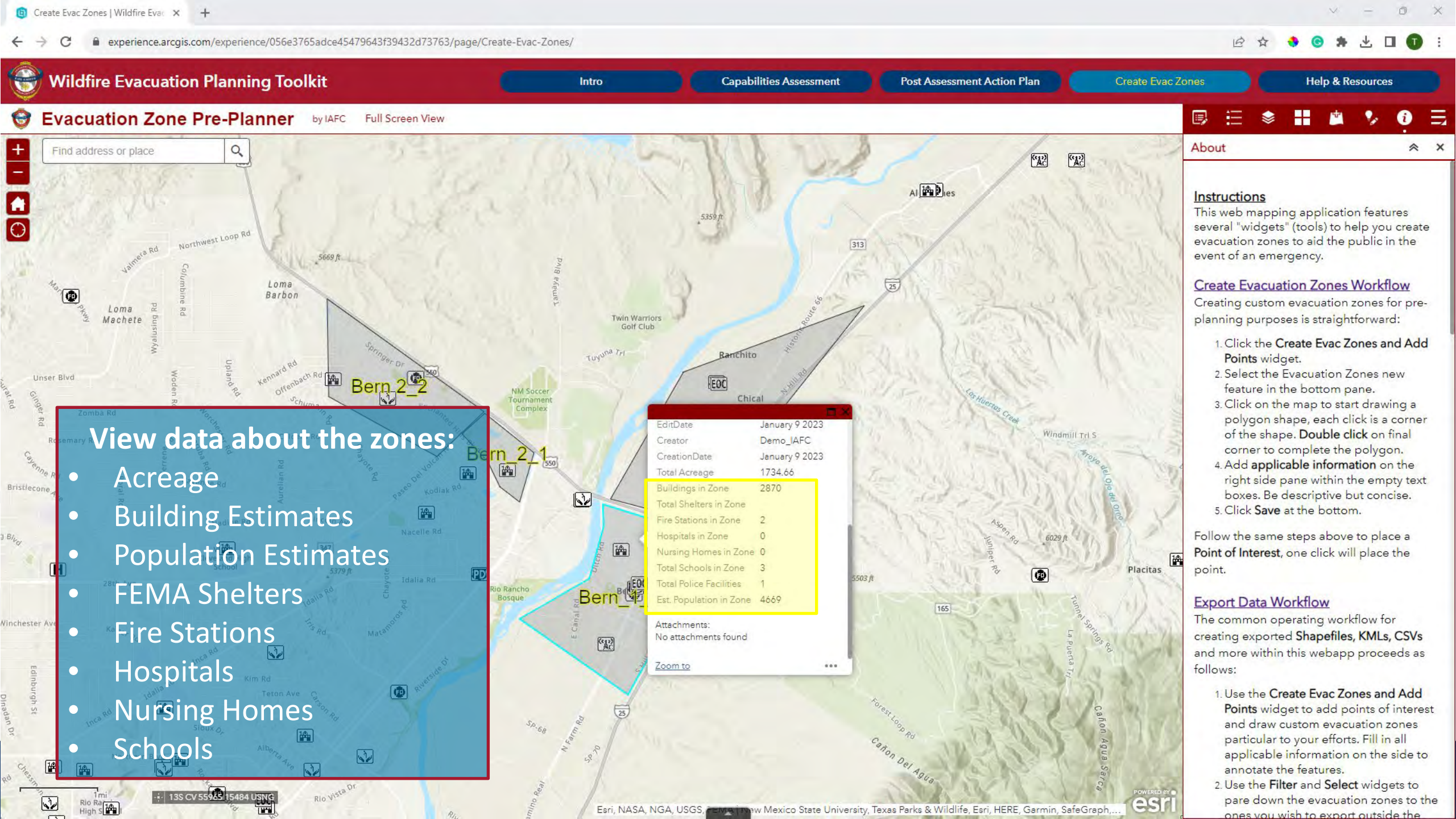
New Feature

**Planning and Operations Points**

Road Closure | Choke Point | Pinch Point

Staging | Temporary Evacuation Poin... | Temporary Refuge Area

Polygon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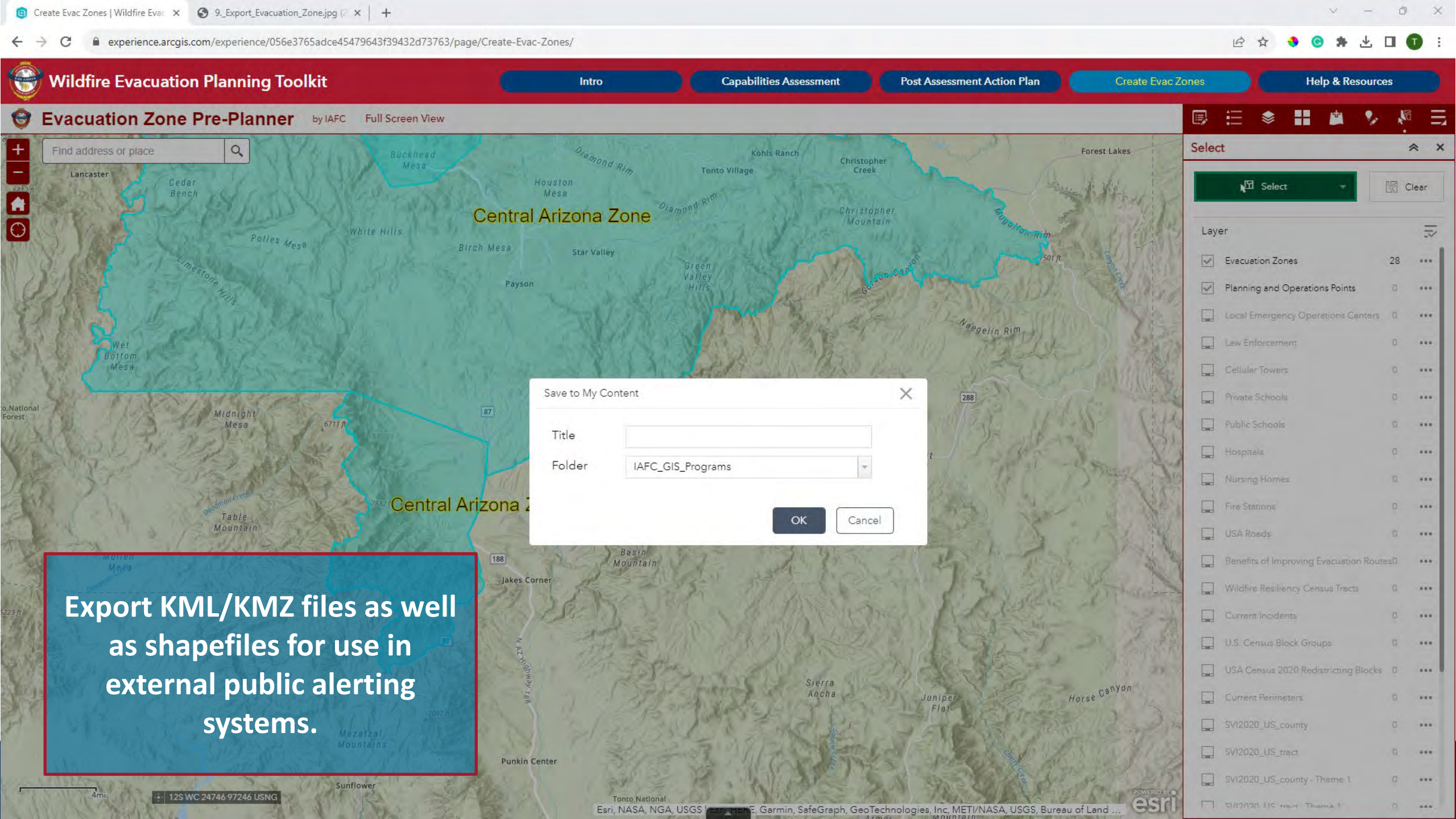
by IAFC
Full Screen View
Find address or place
About
Instructions
This web mapping application features several "widgets" (tools) to help you create evacuation zones to aid the public in the event of an emergency.
Create Evacuation Zones Workflow
Creating custom evacuation zones for pre-planning purposes is straightforward:
1. Click the Create Evac Zones and Add Points widget.
2. Select the Evacuation Zones new feature in the bottom pane.
3. Click on the map to start drawing a polygon shape, each click is a corner of the shape. Double click on final corner to complete the polygon.
4. Add applicable information on the right side pane within the empty text boxes. Be descriptive but concise.
5. Click Save at the bottom.
Follow the same steps above to place a Point of Interest, one click will place the point.
Export Data Workflow
The common operating workflow for creating exported Shapefiles, KMLs, CSVs and more within this webapp proceeds as follows:
1. Use the Create Evac Zones and Add Points widget to add points of interest and draw custom evacuation zones particular to your efforts. Fill in all applicable information on the side to annotate the features.
2. Use the Filter and Select widgets to pare down the evacuation zones to the
Bern_2_2
Bern_2_1
Bern_1
EditDate January 9 2023
Creator Demo_IAFC
CreationDate January 9 2023
Total Acreage 1734.66
Buildings in Zone 2870
Total Shelters in Zone
Fire Stations in Zone 2
Hospitals in Zone 0
Nursing Homes in Zone 0
Total Schools in Zone 3
Total Police Facilities 1
Est. Population in Zone 4669
Attachments:
No attachments found
Zoom to
View data about the zones:
Acreage
Building Estimates
Population Estimates
FEMA Shelters
Fire Stations
Hospitals
Nursing Homes
Schools
Esri, NASA, NGA, USGS, FEMA, New Mexico State University, Texas Parks & Wildlife, Esri, HERE, Garmin, SafeGraph,...
esri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9_Export_Evacuation_Zone.jpg
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Full Screen View
Find address or place
Central Arizona Zone
Save to My Content
Title
Folder
IAFC_GIS_Programs
OK
Cancel
Select
Clear
Layer
Evacuation Zones 28
Planning and Operations Points 0
Local Emergency Operations Centers 0
Law Enforcement 0
Cellular Towers 0
Private Schools 0
Public Schools 0
Hospitals 0
Nursing Homes 0
Fire Stations 0
USA Roads 0
Benefits of Improving Evacuation Routes 0
Wildfire Resiliency Census Tracts 0
Current Incidents 0
U.S. Census Block Groups 0
USA Census 2020 Redistricting Blocks 0
Current Perimeters 0
SVI2020_US_county 0
SVI2020_US_tract 0
SVI2020_US_county - Theme 1 0
Export KML/KMZ files as well as shapefiles for use in external public alerting systems.
Lancaster
Cedar Bench
Buckhead Mesa
Houston Mesa
Diamond Rim
Tonto Village
Kohls Ranch
Christopher Creek
Forest Lakes
Christopher Mountain
Mogollon Rim
Polles Mesa
White Hills
Birch Mesa
Star Valley
Green Valley Hills
Payson
Limestone Hills
Wet Bottom Mesa
Naegelin Rim
Midnight Mesa
Table Mountain
Basin Mountain
Jakes Corner
Sierra Ancha
Juniper Flat
Horse Canyon
Mazatzal Mountains
Punkin Center
Sunflower
Tonto National
12S WC 24746 97246 USNG
Esri, NASA, NGA, USGS, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land ...
esri

Wildfire Evacuation Planning Toc

experience.arcgis.com/experience/056e3765adce45479643f39432d73763/

# Wildfire Evacuation Planning Toolkit

Intro | Capabilities Assessment | Post Assessment Action Plan | Create Evac Zones | Help & Resources

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# Questions?

Jeff Dulin
Strategic Advisor IAFC
jdulin@iafc.org

# Facilitated Discussion: Solutions for Connecting Resources

- Integrating and connecting resources & tools for improved wildfire evacuation before and during an incident.
- Discussion Topics
  - Achieving Agile Decision Making
  - Affecting Human Behavior
  - Executing evacuation at the local level
- Local perspectives on solutions for improving wildfire evacuation readiness and execution.

FEMA | U.S. Fire Administration

# RoundTable Discussion

FEMA

U.S. Fire Administration