



ALERT wildfire

# FUEGO



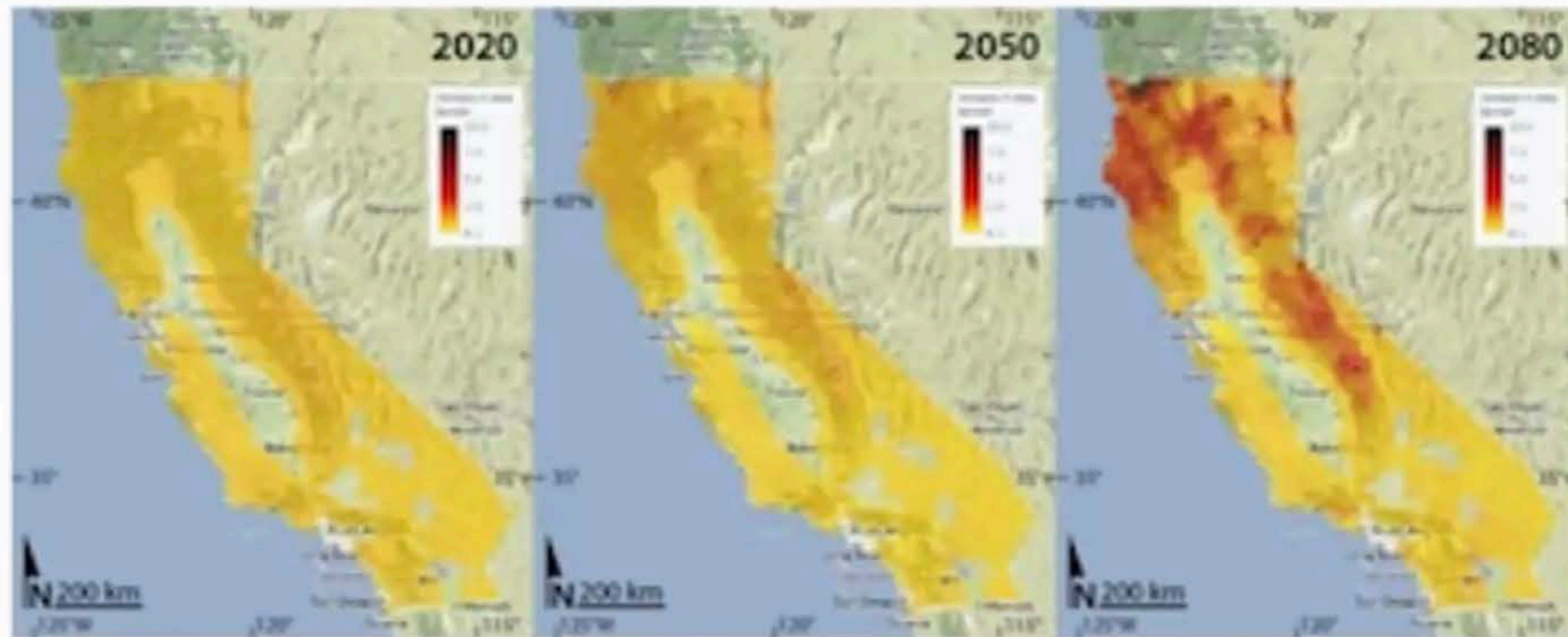
Early Detection of Fires:  
Applied Machine Learning and other  
Technology for the Well-Being of  
Claremont Canyon



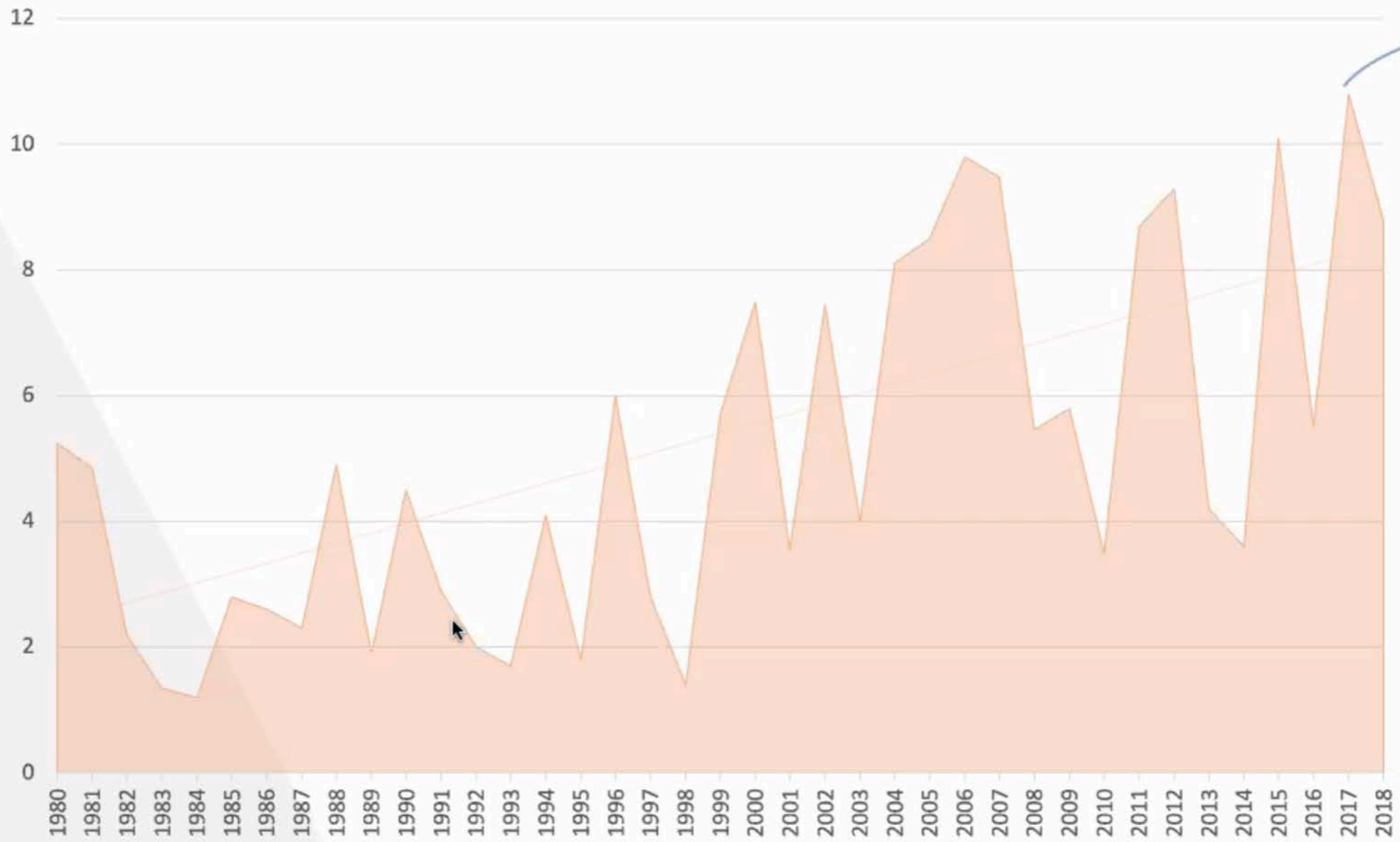
UC San Diego



Things will get a lot worse in Northern California  
(my slide from 2013) CalAdopt –  
Welcome to the *Pyrocene*!



There is probably a place in one level of hell for people who say “I told you so” so I won’t say it...

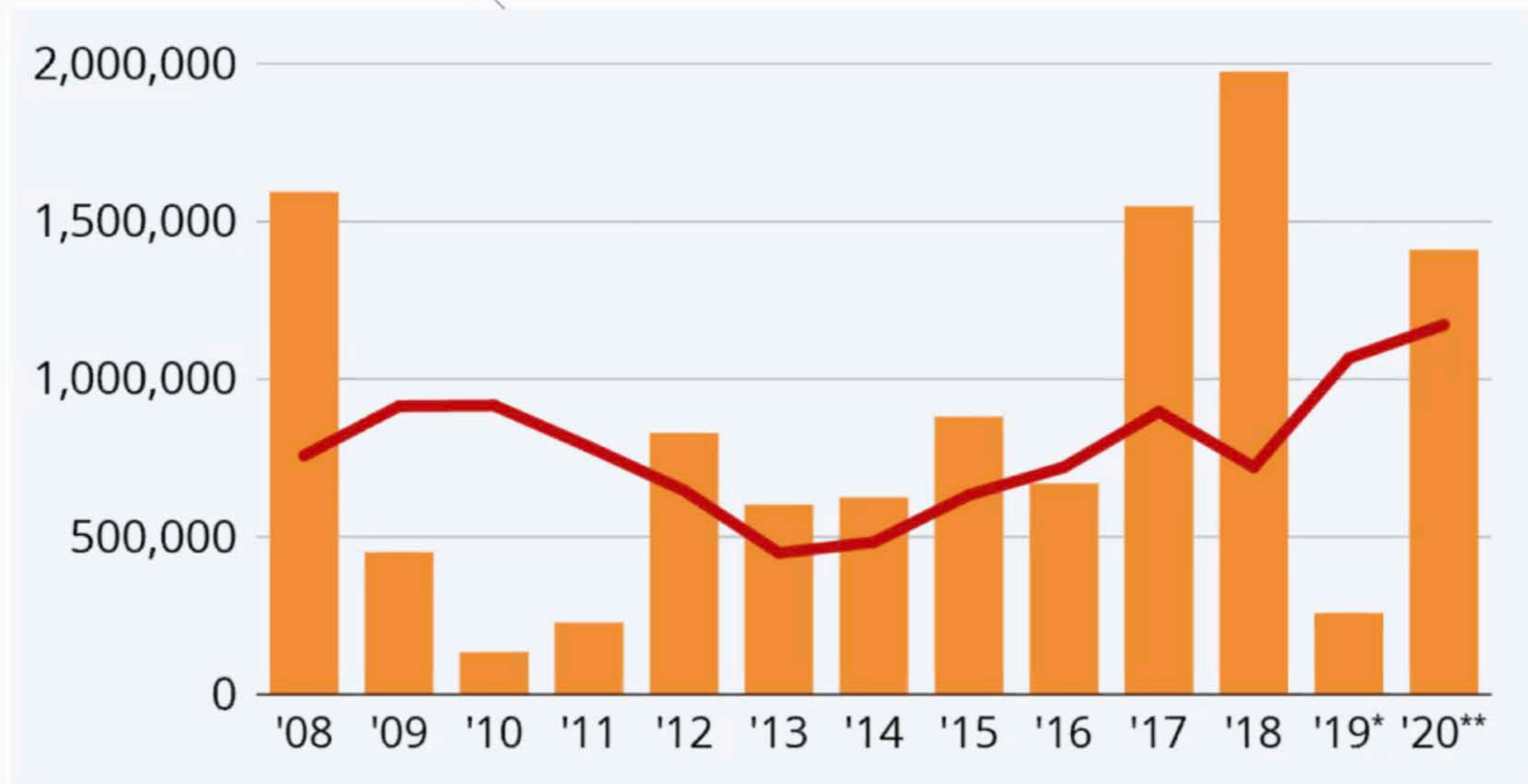


Annual Number of Million Acres destroyed by Fire -- US (1980-2018)



## California Acreage

(and ~10% of California's CO2 Contribution is from Wildfires too)



## Collaboration (Growing – it takes a village):

- Tim Ball, Fireball Reno
- FUEGO Australia, Fireball International – many good programmers there.
- UCB Space Sciences Lab – Ed Wishnow and Kodi Rider
- Neal Driscoll, UCSD

**E&E**NEWS

CLIMATE

# The World's Winds Are Speeding Up

The trend contradicts concerns of a “global stilling,” with implications for wind energy

# It's not just California...

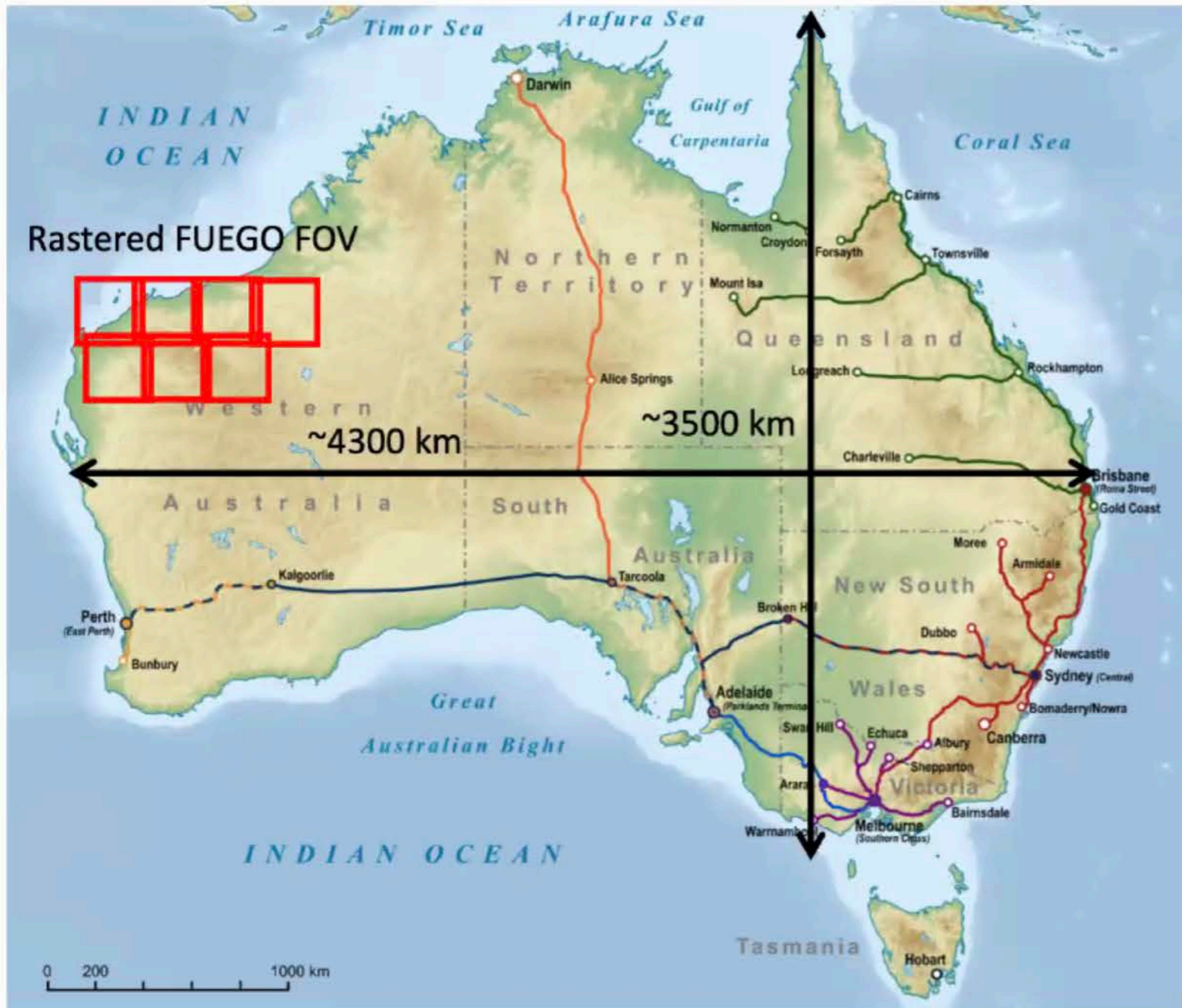
## Fierce Fires in Bolivia



### East Troublesome Fire Spreads to the Rockies

The blaze grew 140,000 acres in 24 hours to become the second largest fire in Colorado history.

# Steering Mirror Considerations



- Australia total land area = 7,682,300 km<sup>2</sup>
- Assuming 330x330 km FOV and 10% overlap between scans:
  - **~85 steering mirror positions** would be required to cover the country.
  - Consider 4s to slew/settle scan mirror, 1s integration; **revisit time = 7 minutes**
    - (readout happens on following slew)
  - Required Steering mirror **range of motion: 6.8 x 5.6 deg.**
  - **~1.5 arcmin measurement resolution** for optical encoder is reasonable assumption. Corresponds to 15 km on the ground.
  - Total mechanism cycles will be a driving requirement on the steering mirror design=
    - **17.5K cycles per day**
    - **532K cycles per month**
    - **6.4M cycles per year**

(for reference, the ICON FUV turret was qualified to ~175K cycles on the ground)



# *'The Seven Deadly Sins of Climate Change for Fires* (discussion of Sin on Sunday! Humans have caused Climate Change!)



- 1). Drier Fuels.
- 2) Stronger Winds
- 3) Longer fire seasons
- 4) Lower nighttime humidity
- 5) More extreme spotting
- 6) Firenadoes (a consequence of some of the earlier sins)
- 7) More dead trees (not direct...)

The Seven Deadly Sins and the Four Last Things

Attributed to Hieronymus Bosch, 1500

## Ways we are helping now:

- Growing capability to detect fires (smoke) from cameras on towers, etc.
- Using GOES Satellite Data
- Designing our own satellite
- Building an airborne mapping system

# Origins: Widely Applied Particle Astrophysics – the Berkeley Supernova Searches

Key Concepts: Wide FOV Automated Search

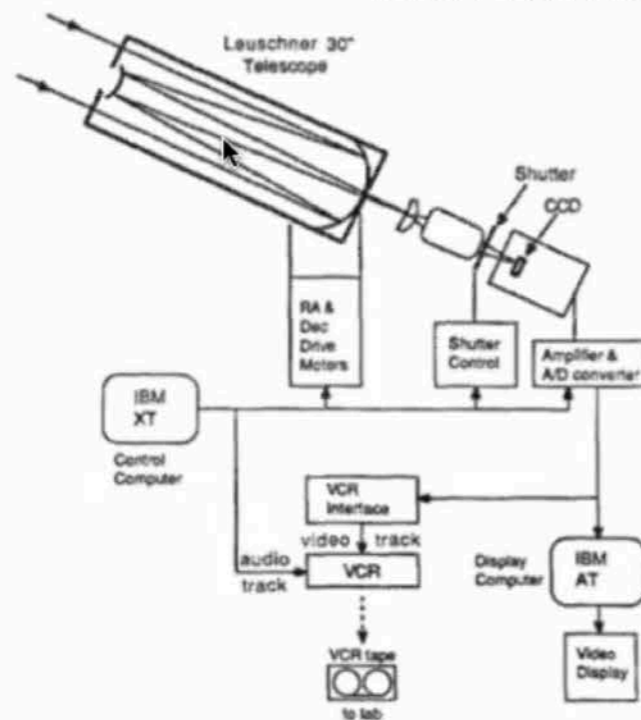


FIG. 1. Design of the Berkeley system—overview. The Berkeley system shown uses a computer-controlled, fast-slewing telescope and charge coupled device (CCD) camera to collect images of galaxies; these images are compared in the lab to stored reference images by a dedicated minicomputer.

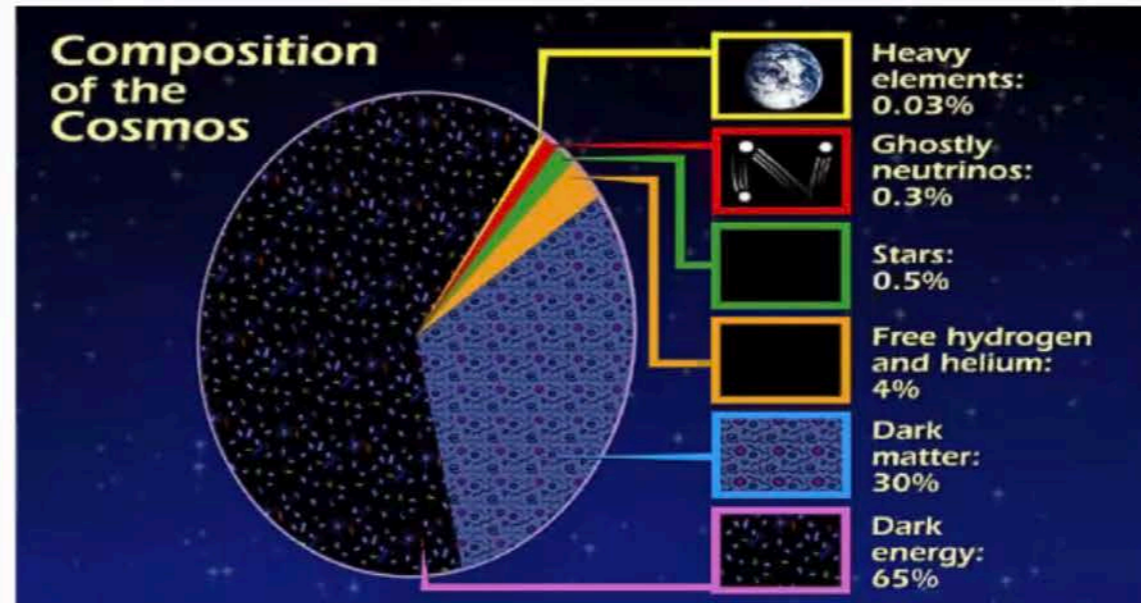
- 1) Coupling large format imagers with real-time analysis & embedded capabilities to find weak sources.
- 2) Use as many small-signal finding tools as possible, including:
  - a) Co-adding
  - b) Optimal subtractions
  - c) Crowded background tolerance

- False Alarms would have had great financial impact on our partner observatories.
- Over 100 Super Novae found ZERO false alarms

Led to Nobel Prize (Saul) , Breakthrough Prize, Gruber Prize for whole team (Seminal Role of Gerson Goldhaber!)



The Nobel Prize medal for Physics, Chemistry, Physiology (or Medicine) and Literature Nobel Prizes C...



Improved Fire Detection and Tracking from Space and the ground and the air - would be an even better prize





Early Detection – From Geosynchronous Orbit to 50 feet on “Lookout” towers.

Data Acquisition, Analysis with Machine Learning, Simulation.

Actionable Intelligence by keeping fire fighters aware of the contextual picture

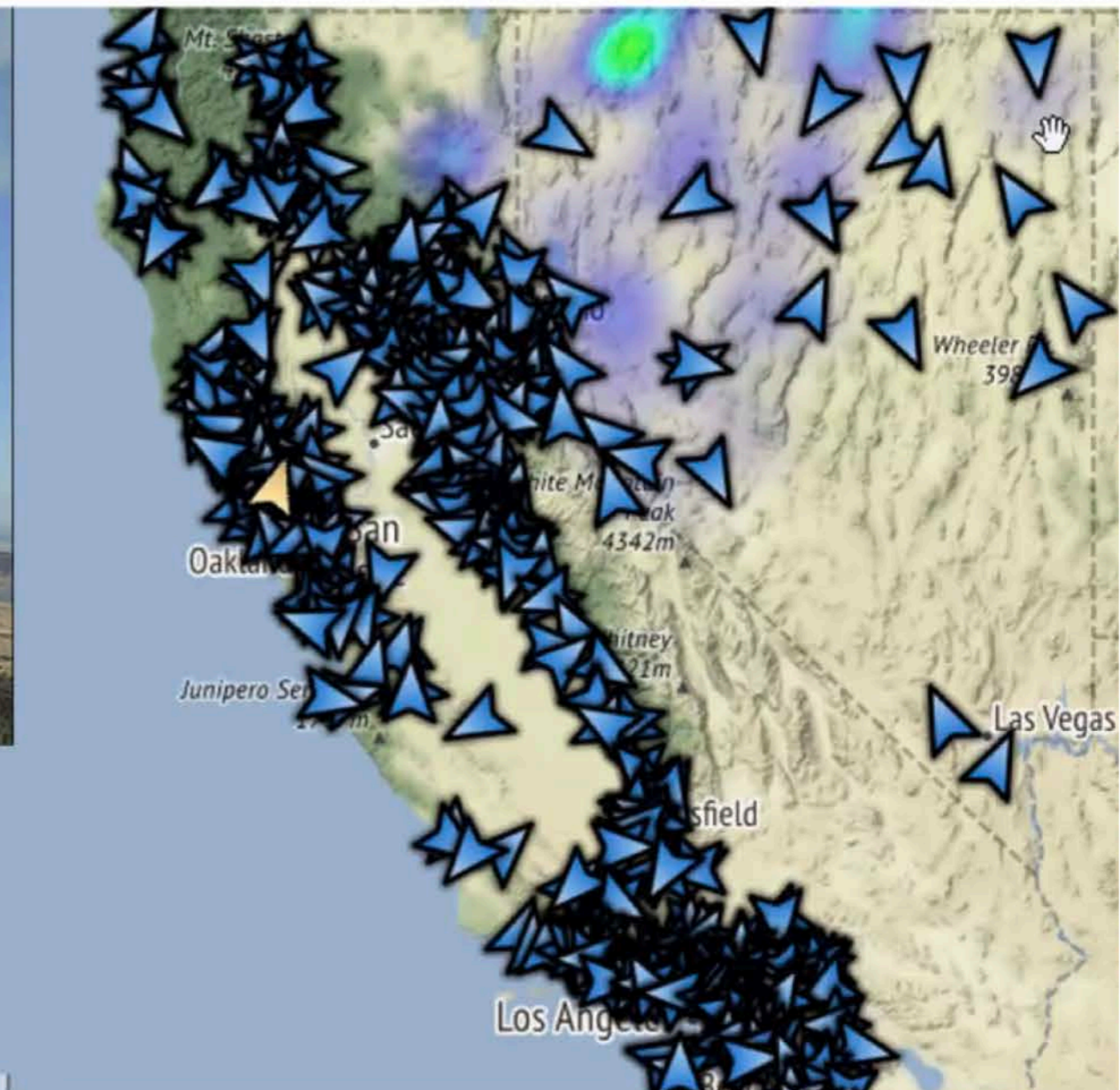
# On the Ground: Alertwildfire Camera Network

Current ~885 cameras => 1100 in California

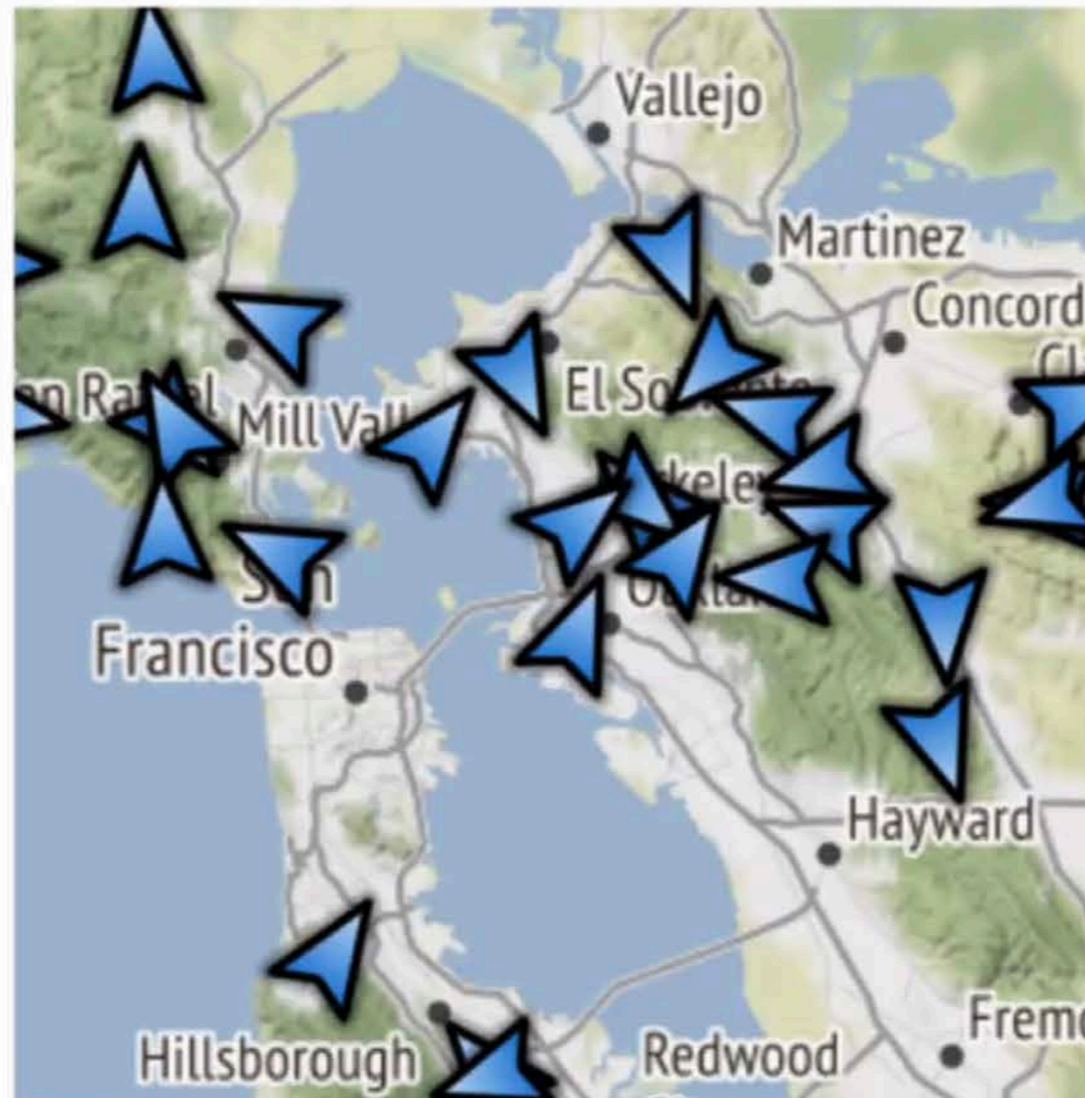


51 © Nevada Seismo Lab 2020/06/16 17:58:13.13

Funders include  
PG&E, SCE, SDG&E,  
Cal Fire, USFS, BLM  
Some of the images  
are spectacular



# Bay Area Cameras





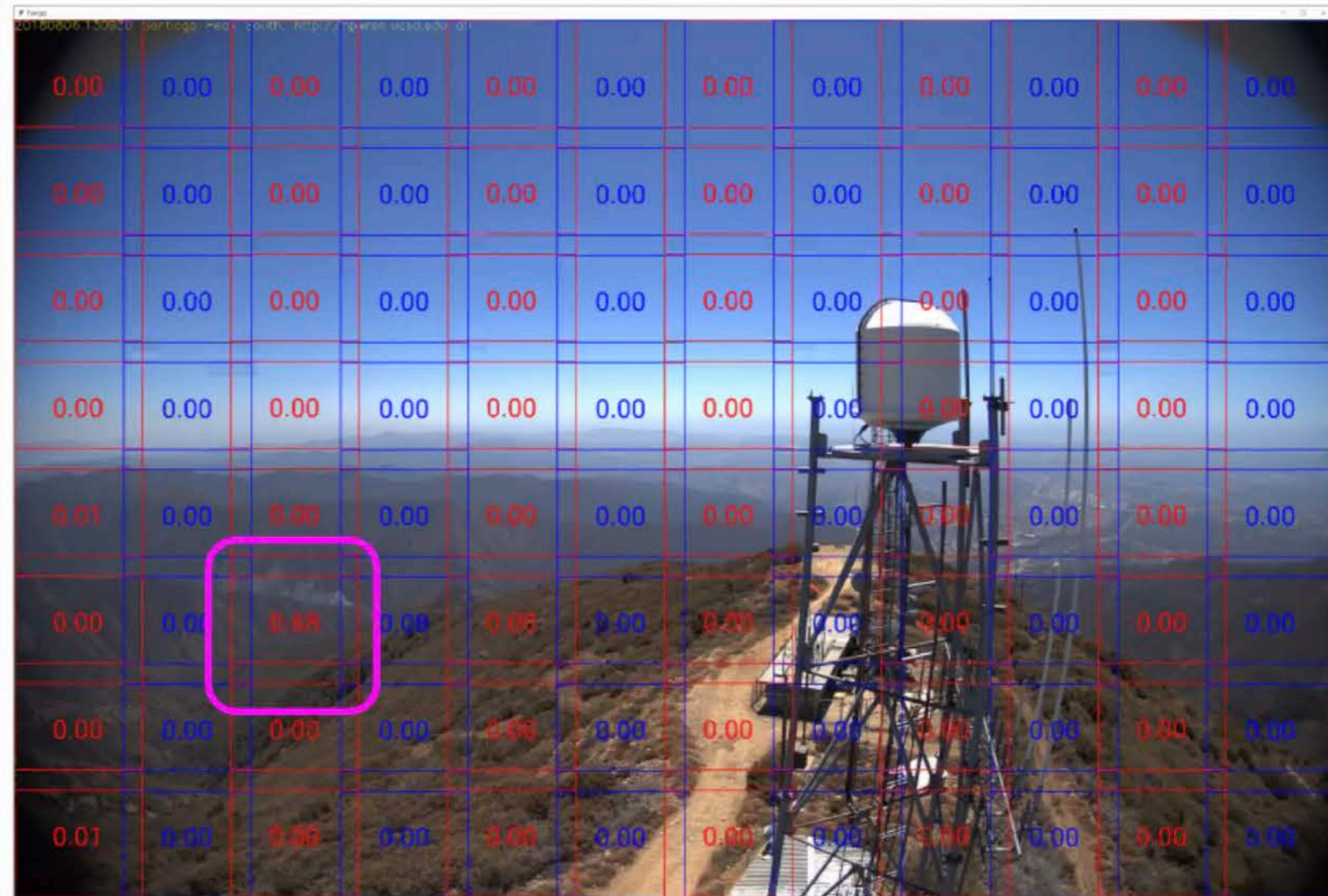
# Alert Wildfire Camera with the potential to see Smoke in the Canyon, Atop:

- Wells Fargo Bld. Berkeley
- Vollmer peak
- Vollmer tower top
- Clorox
- Nichol Knob

# Example of detection: 2018 Holy fire (August 6<sup>th</sup>)

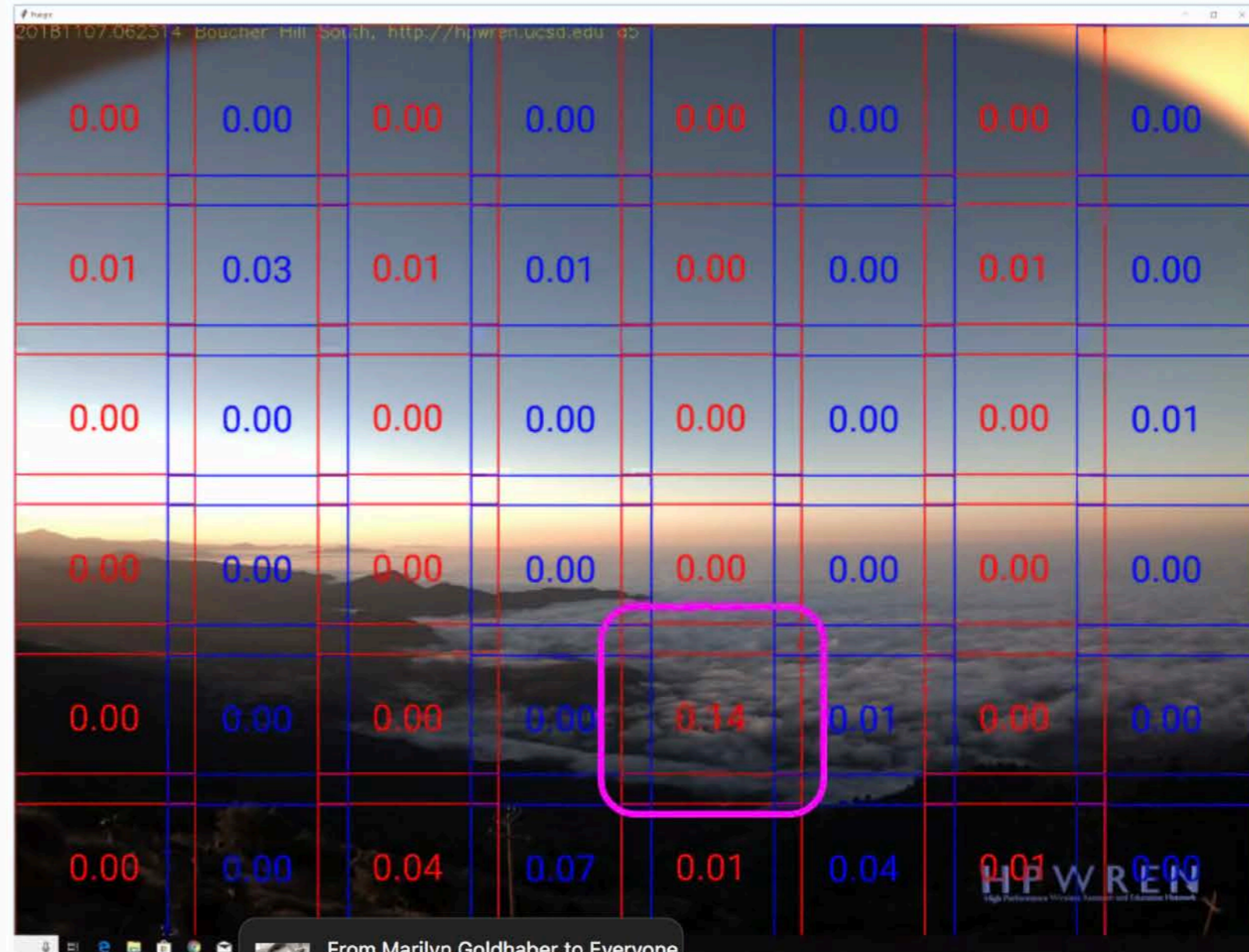
HPWREN Santiago Peak South Camera archive has per-minute images

1. 13:05 First image with visible smoke
2. 13:09 First image where our system can detect smoke
3. 13:17 First 9-1-1 call
4. 13:20 Fire start time as recorded in CalFire database (unclear what this means)



# Sample test set true negative result

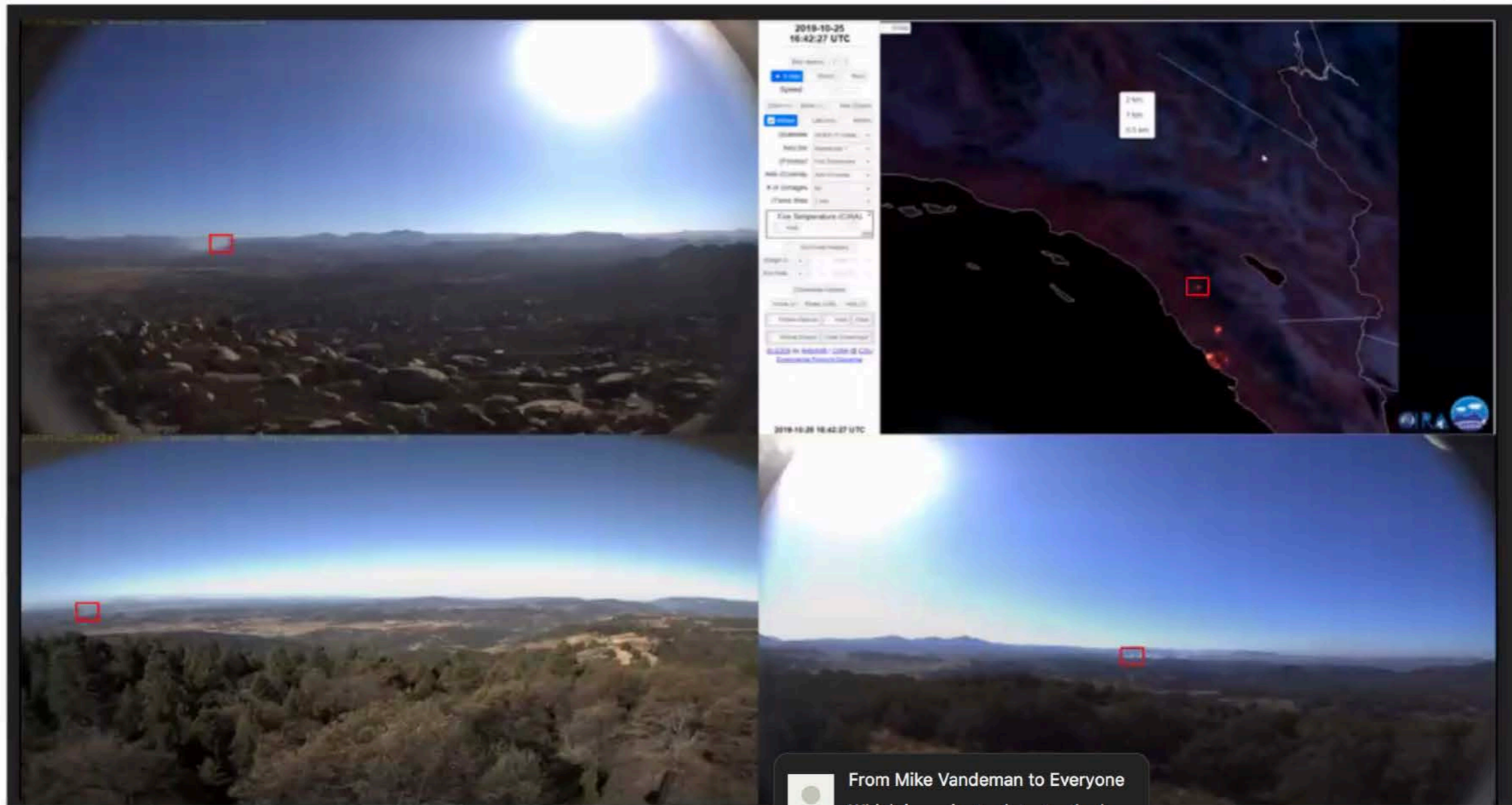
- Highest score: 0.14
- Fog correctly ignored



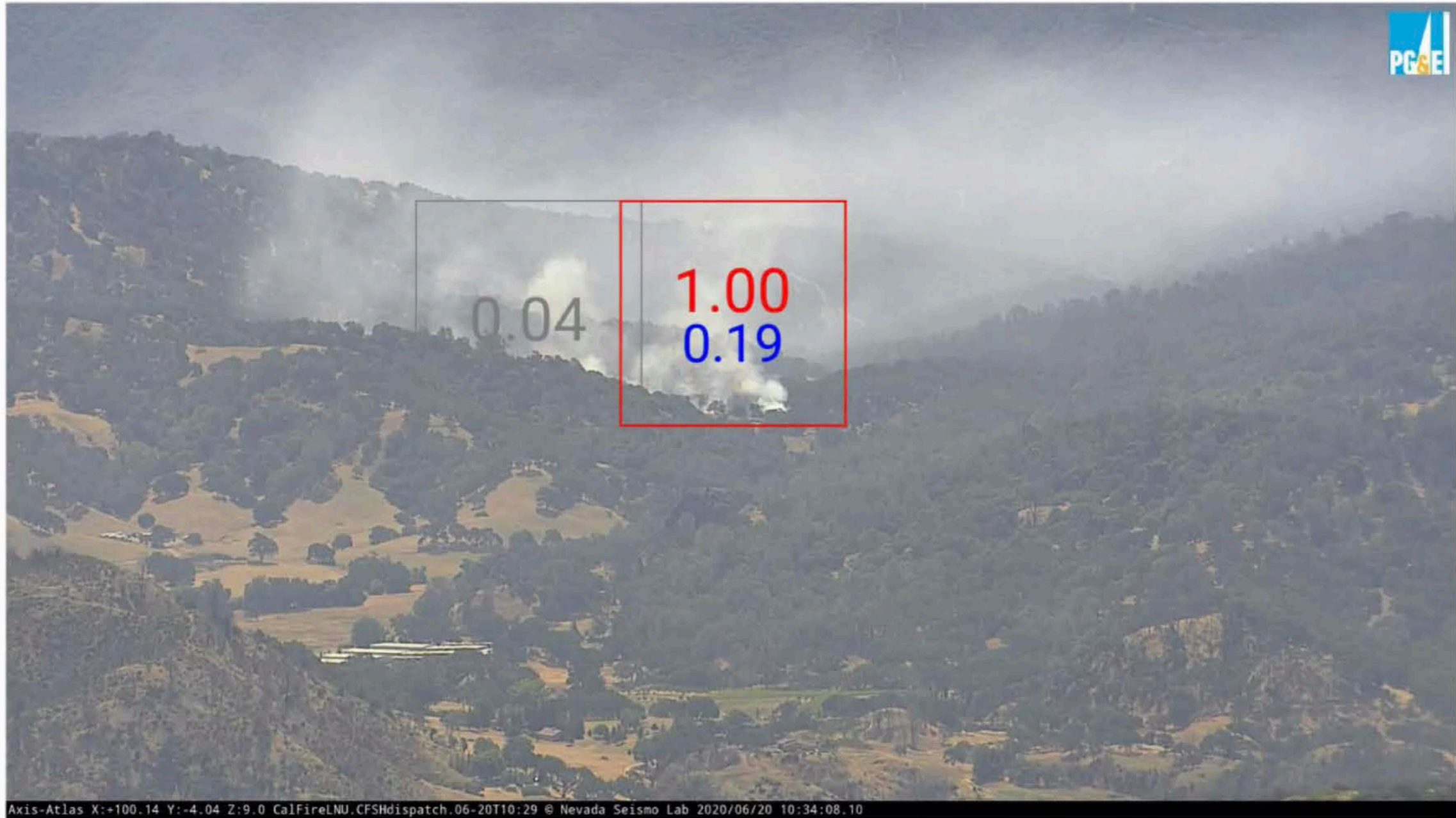
From Marilyn Goldhaber to Everyone

# Three Camera Triangulation and GOES-17 Establish Location

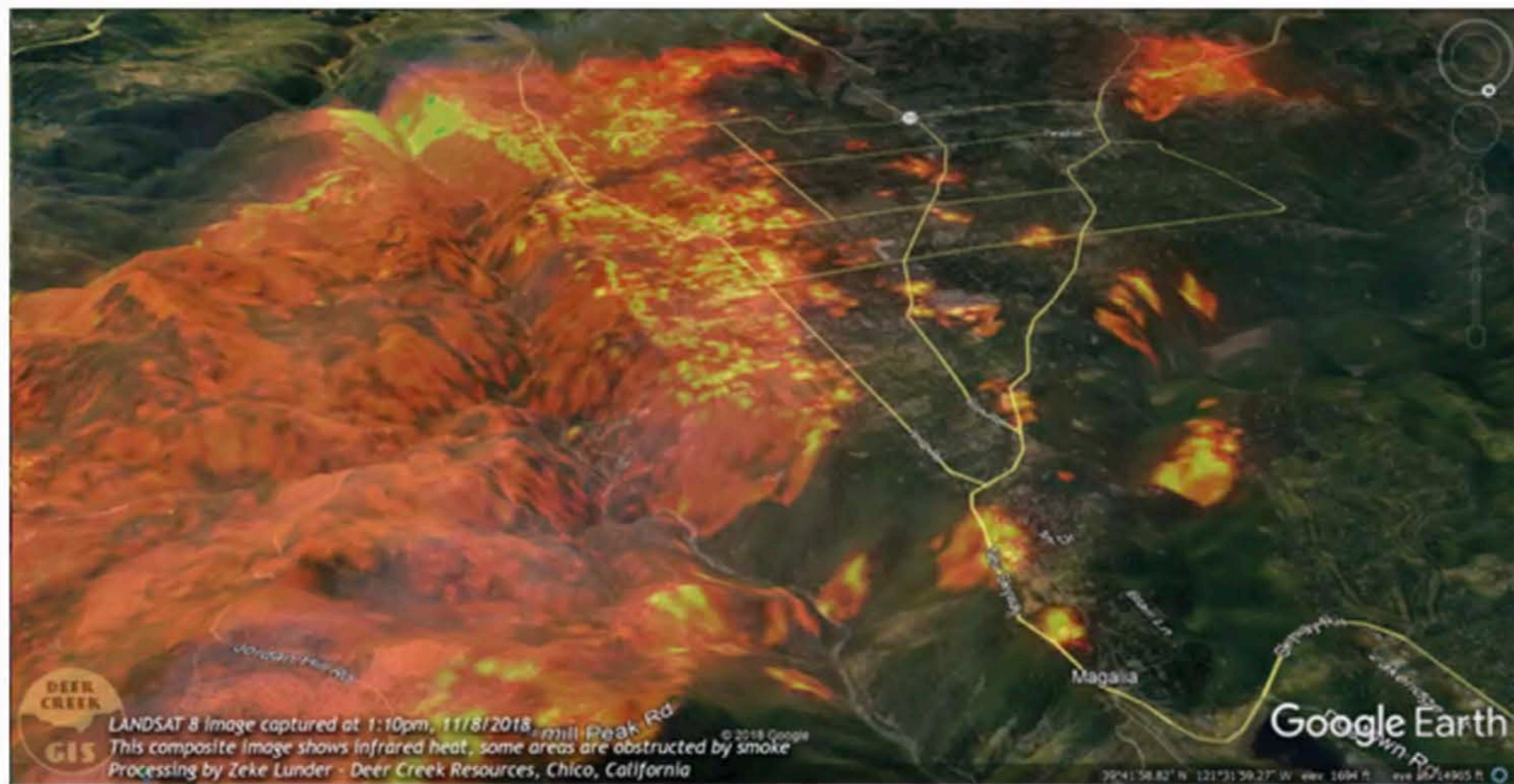
20191025CA-MVU-Sawday0930



Saturday, June 20, 2020 10:34 AM  
Detection in Napa County



## Initiative 2: Improved Mapping Urgently Needed – Example, Camp Fire (see Frontline Show on Fire in Paradise)



## Initiative 3: FUEGO (2026 Launch?) It's Tiny and Inexpensive



# FUEGO Paper

*Remote Sens.* **2013**, *5*, 5173-5192; doi:10.3390/rs5105173

OPEN ACCESS

*Remote Sensing*

ISSN 2072-4292

www.mdpi.com/journal/remotesensing

*Article*

## **FUEGO — Fire Urgency Estimator in Geosynchronous Orbit — A Proposed Early-Warning Fire Detection System**

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E-Mail: RDTripp@lbl.gov

<sup>3</sup> College of Natural Resources, UC Berkeley, Berkeley, CA 94720, USA;  
E-Mails: marek@berkeley.edu (M.K.J.); maggi@berkeley.edu (M.K.); sstephens@berkeley.edu (S.S.)

<sup>4</sup> Cooperative Institute for Meteorological Satellite Studies, UW-Madison, Madison, 1225 W. Dayton St., Madison, WI 53706, USA; E-Mail: chris.schmidt@ssec.wisc.edu



# FUEGO Patent (UC Assignment)

(12) **United States Patent**  
**Pennypacker et al.**

(10) **Patent No.:** **US 9,792,500 B2**  
(45) **Date of Patent:** **Oct. 17, 2017**

(54) **FIRE URGENCY ESTIMATOR IN  
GEOSYNCHRONOUS ORBIT (FUEGO)**

(58) **Field of Classification Search**  
CPC ..... G06K 9/0063; G06K 9/40; G06K 9/6202;  
G06K 9/6255; G06K 9/6262; G06T 7/97;  
(Continued)

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UNIVERSITY OF CALIFORNIA,**  
Oakland, CA (US)

(56) **References Cited**

(72) Inventors: **Carlton R. Pennypacker,** El Cerrito,  
CA (US); **Robert D. Tripp,** Berkeley,  
CA (US); **Scott L. Stephens,** Walnut  
Creek, CA (US); **Nina M. Kelly,**  
Berkeley, CA (US); **Marek K.**  
**Jakubowski,** Berkeley, CA (US); **Mike**  
**Lampton,** Berkeley, CA (US)

**U.S. PATENT DOCUMENTS**

5,832,187 A \* 11/1998 Pedersen ..... G06Q 10/06  
340/577  
7,898,458 B2 \* 3/2011 Shibayama ..... G01S 13/90  
342/179

(Continued)

(73) Assignee: **THE REGENTS OF THE  
UNIVERSITY OF CALIFORNIA,**  
Oakland, CA (US)

**FOREIGN PATENT DOCUMENTS**

JP 2005-078566 \* 3/2005 ..... G08B 25/00  
JP 2005-078566 A 3/2005

(Continued)

(\* ) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 126 days.

**OTHER PUBLICATIONS**

(21) Appl. No.: **14/927,137**

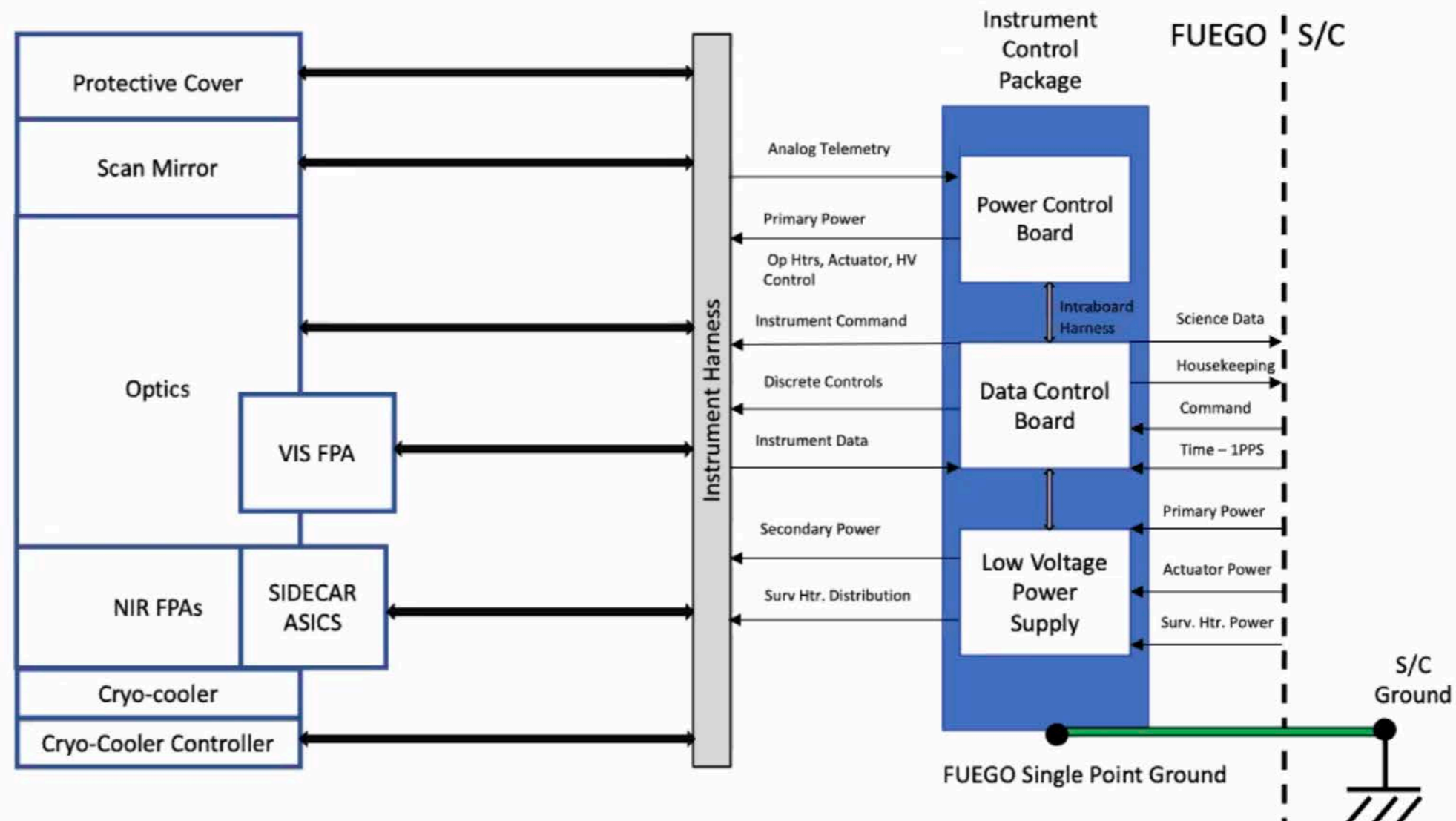
Korean Intellectual Property Office (KIPO), International Search  
Report and Written Opinion, Sep. 3, 2014, PCT/US2014/036209,

# FUEGO Payload Block Diagram

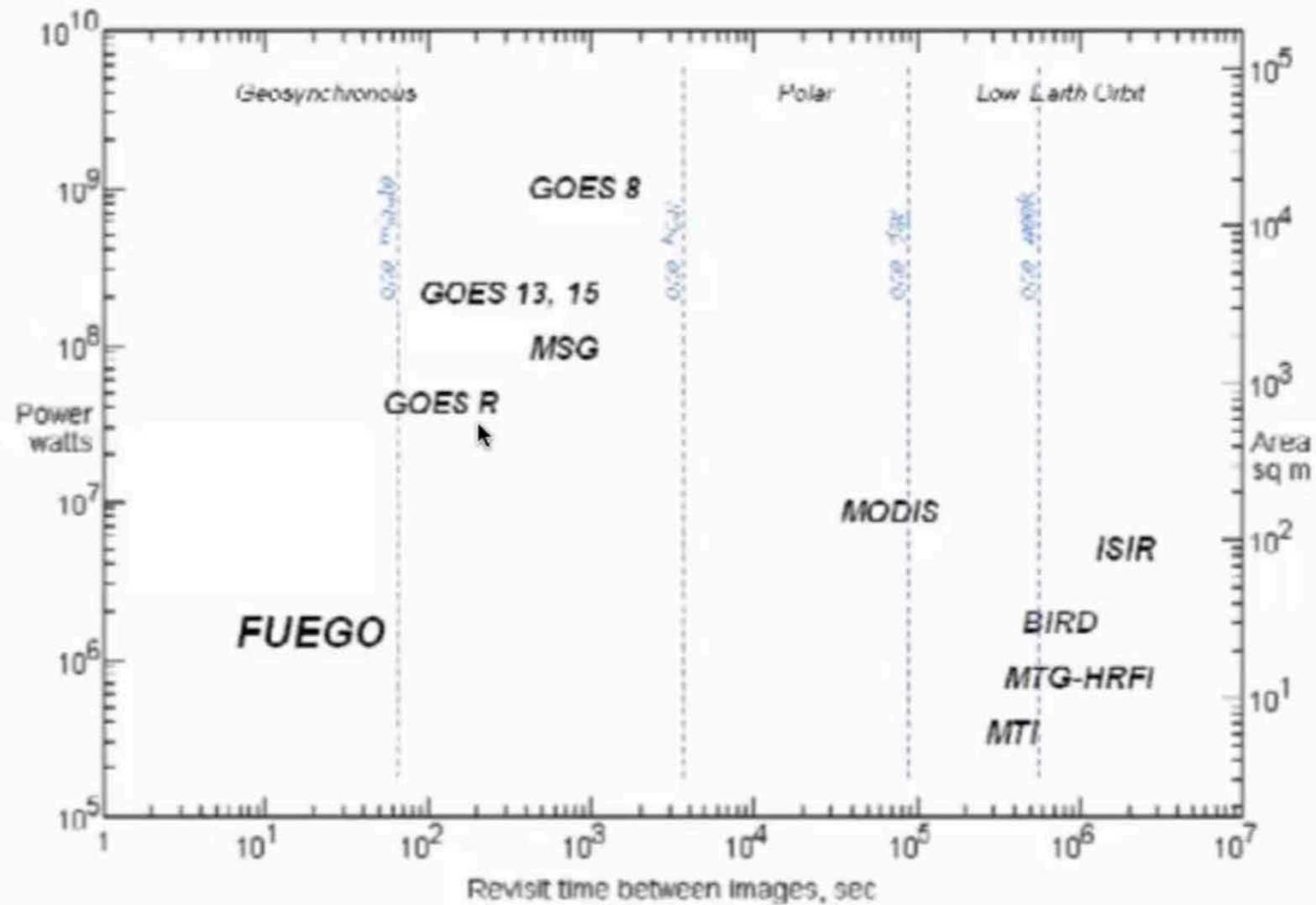
- Single Payload Electronics (ICP) simplifies interface to the S/C; Requires only power and data services from S/C.
- Implemented on a number of UCB/SSL missions; simple “plug and play” interface to the spacecraft:
  - Experience with a variety of data interfaces (RS-422, UARTs, Hi/Lo Speed Serial, 1553) for numerous missions (ICON, MAVEN, STEREO, PSP, THEMIS, RBSP, etc.).



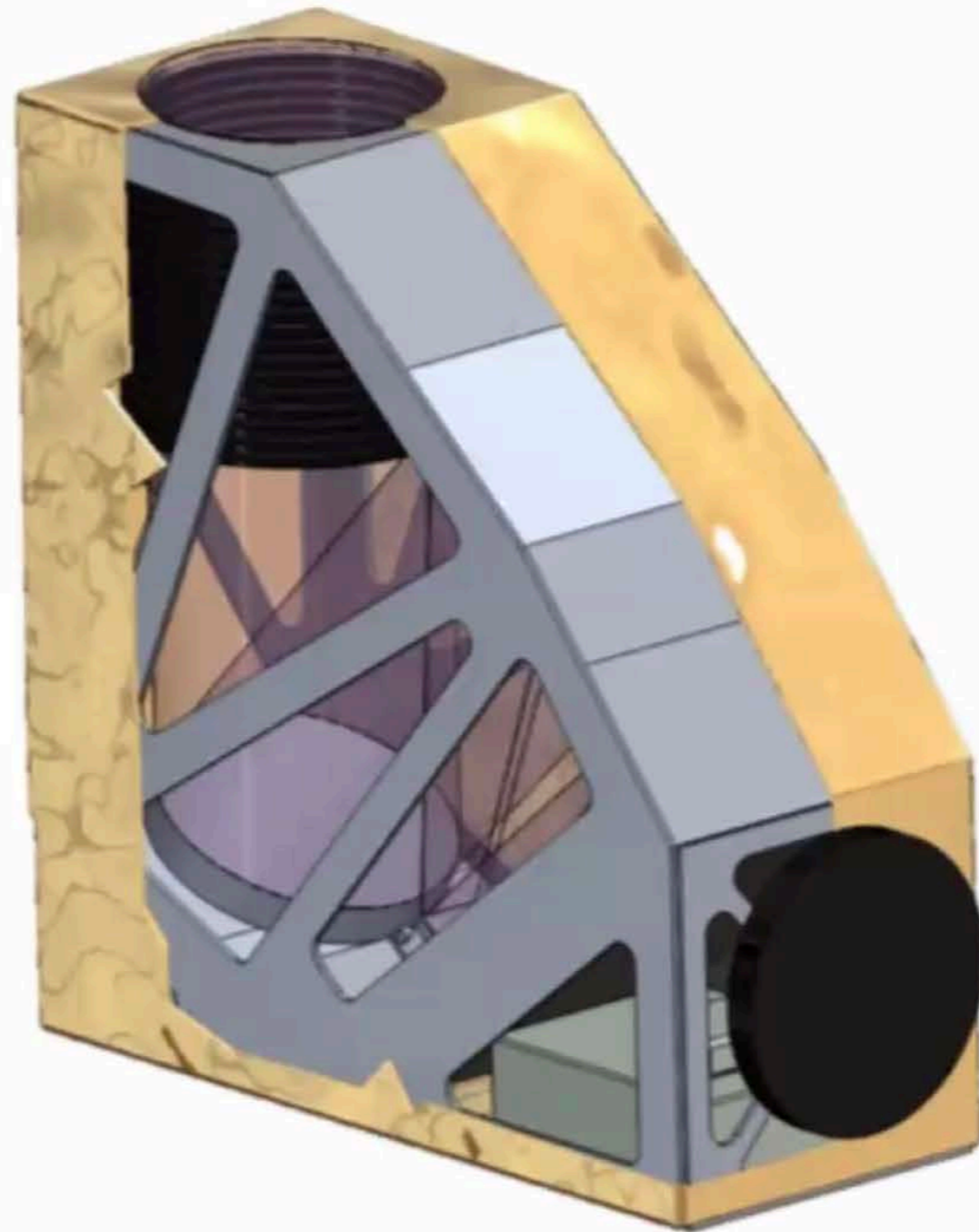
Strong, recent heritage from the ICON Instrument Control Package (ICP)



# Where Does FUEGO FIT IN?



## Hosted Payload concept



# Funding News:!!



- CalFire Funds helping with Camera and Satellite data acquisition
- Moore Foundation just awarded us funds for satellite design and airborne camera system

# So What if you find a fire earlier?

- Example: Based solely on insured losses, finding a fire within 10 minutes would save \$8B AUD in a decade. (no assumptions of climate change – modest change makes it \$14B AUD)
- With Airborne Supertanker during red flag warning, we could get to fires within about 15 minutes, and we could do a better job in California, and probably probably increase savings by 2 or 3.



A close-up photograph of the side of a red fire truck. The words "OAKLAND FIRE DEPARTMENT" are embossed in gold lettering on the truck's body. A silver door handle and a portion of a black control panel are visible in the lower-left and bottom-center areas. Overlaid on the image is white text.

**Deputy Chief Nick Luby**  
**Oakland Fire**  
**Operations Bureau**

**Wildfire Evacuation and More**  
**November 2020**

# Today's Discussion

- The New Norm Extreme and 2020 Fire Season
- Alameda County Evacuation Task Force
- Evacuation Planning In Oakland
- Fire Safe Streets
- What Else Does OFD Have Up Their Sleeves
- Q & A





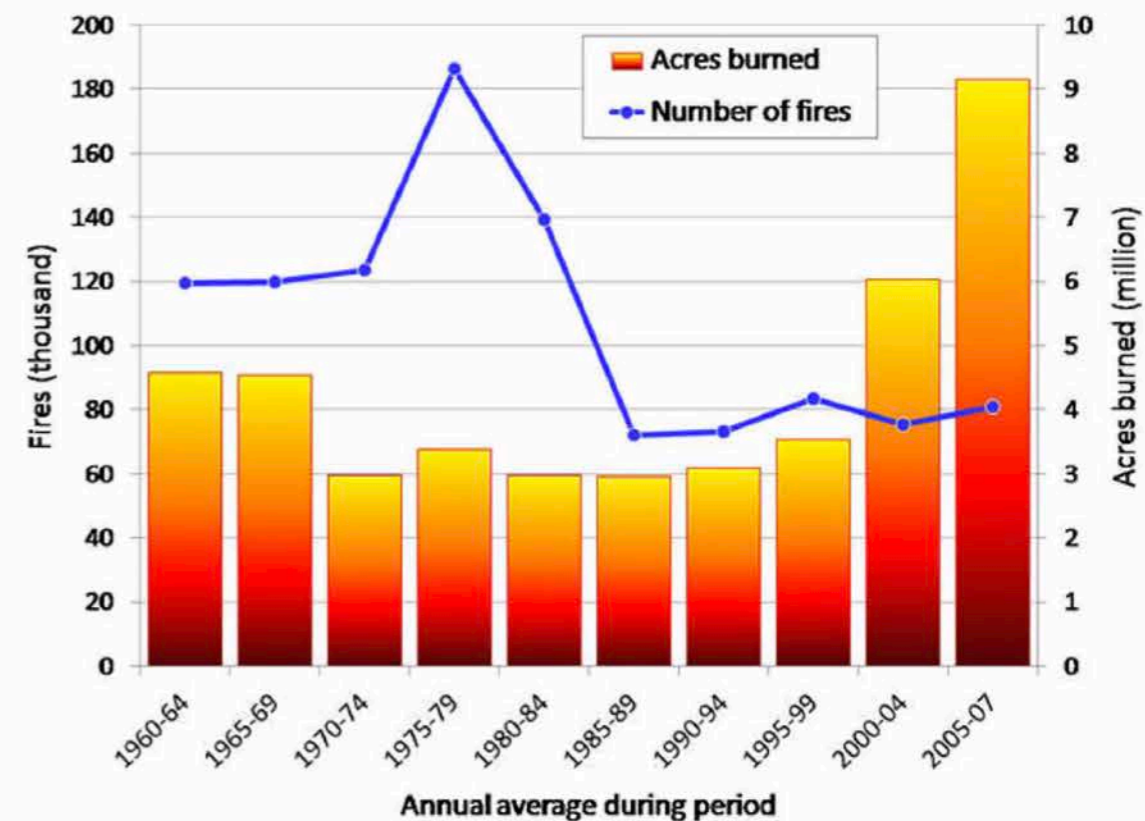
# Who Am I

- Deputy Chief of Operations  
(if it is red and has wheels, it is my responsibility)
  - Field Operations, Technical Operations, & Support Operations ( 537 FTE's)
- 21 years with OFD
- CalFire
- Proud Oakland Resident
- Strike Team Leader and Federal IMT Experience
- Passionate About Wildfire Surge Capacity, Community Resiliency, and Preventing/Preparing For Our Next Large Wildfire (but always hoping for the best)

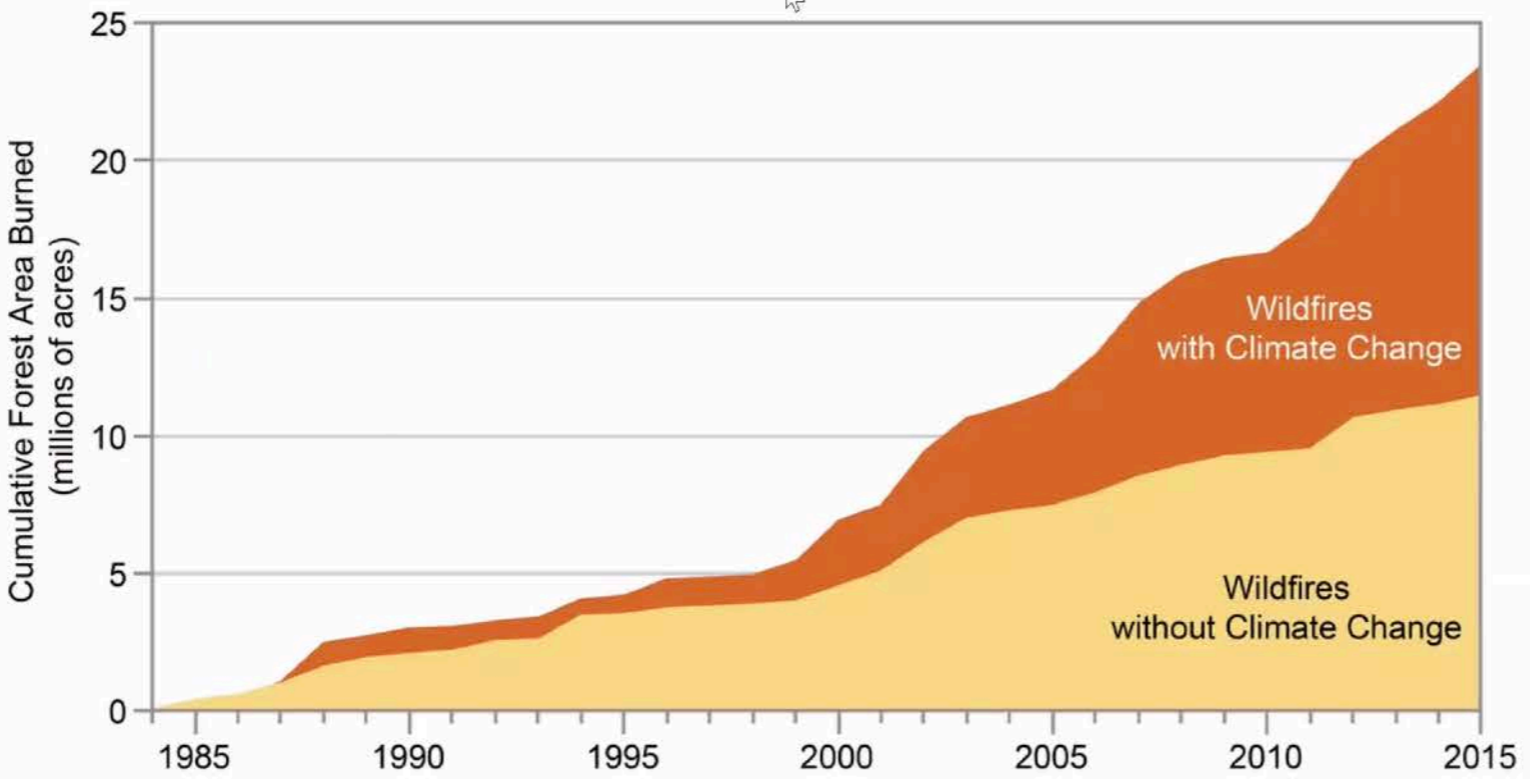


# The New Extreme

- It Is Here To Stay For A While – Data And Science Doesn't Lie
- Fire Season Will Be Longer-Rainy Season Will Be Shorter
- Does Fire Season Still Exist Or Is It Year Round Now
- Droughts Will Not Be Uncommon
- Temperatures Will Be Hotter
- Fires Will Burn Intense And Uncontrolled
- Climate Impact And Wildfires Are a Reality



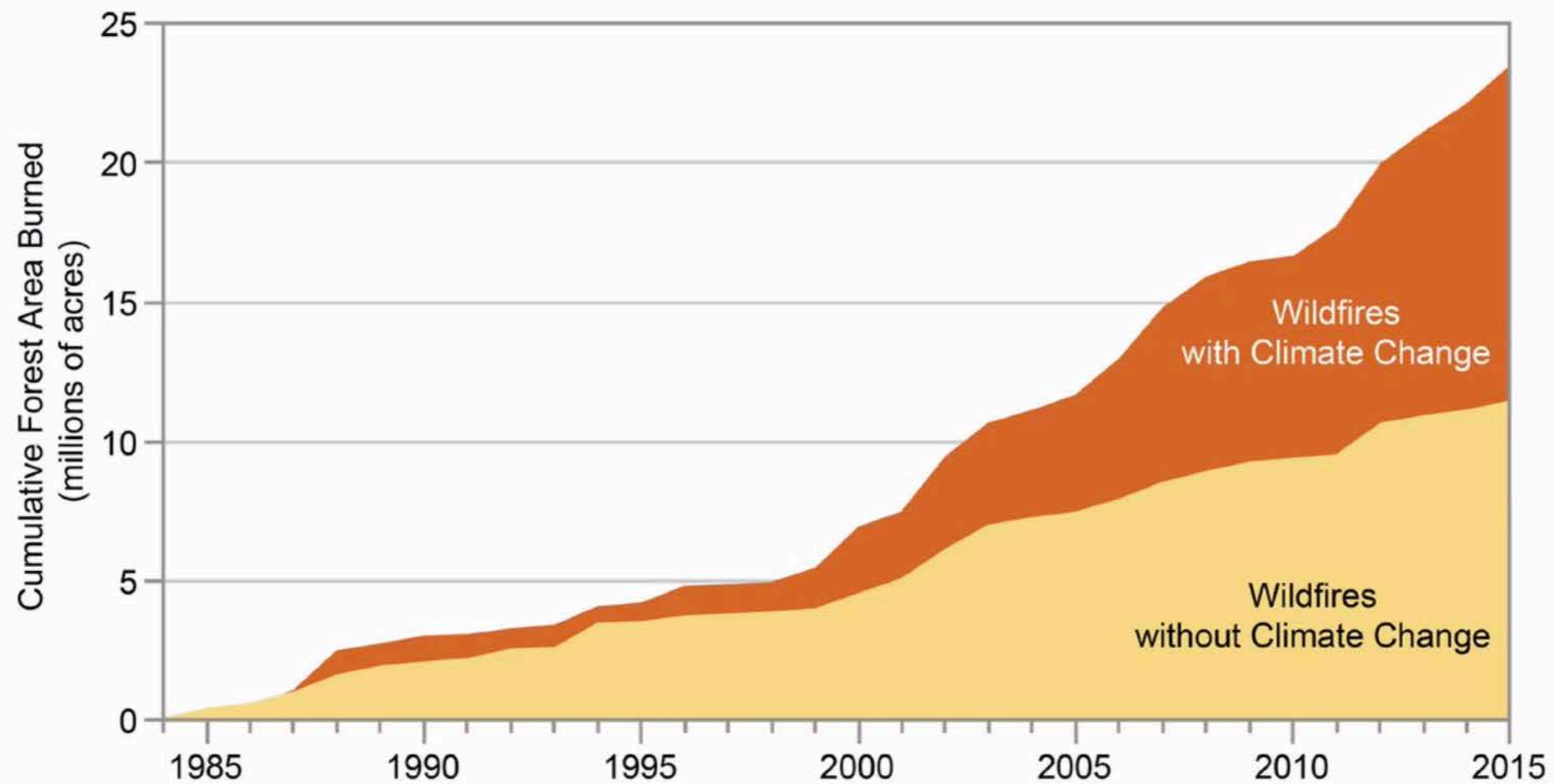
### Figure 25.4: Climate Change Has Increased Wildfire



**Figure 25.4:** The cumulative forest area burned by wildfires has greatly increased between 1984 and 2015, with analyses estimating that the area burned by wildfire across the western United States over that period was twice what would have burned had climate change not occurred. Source: adapted from Abatzoglou and Williams 2016.<sup>7</sup>



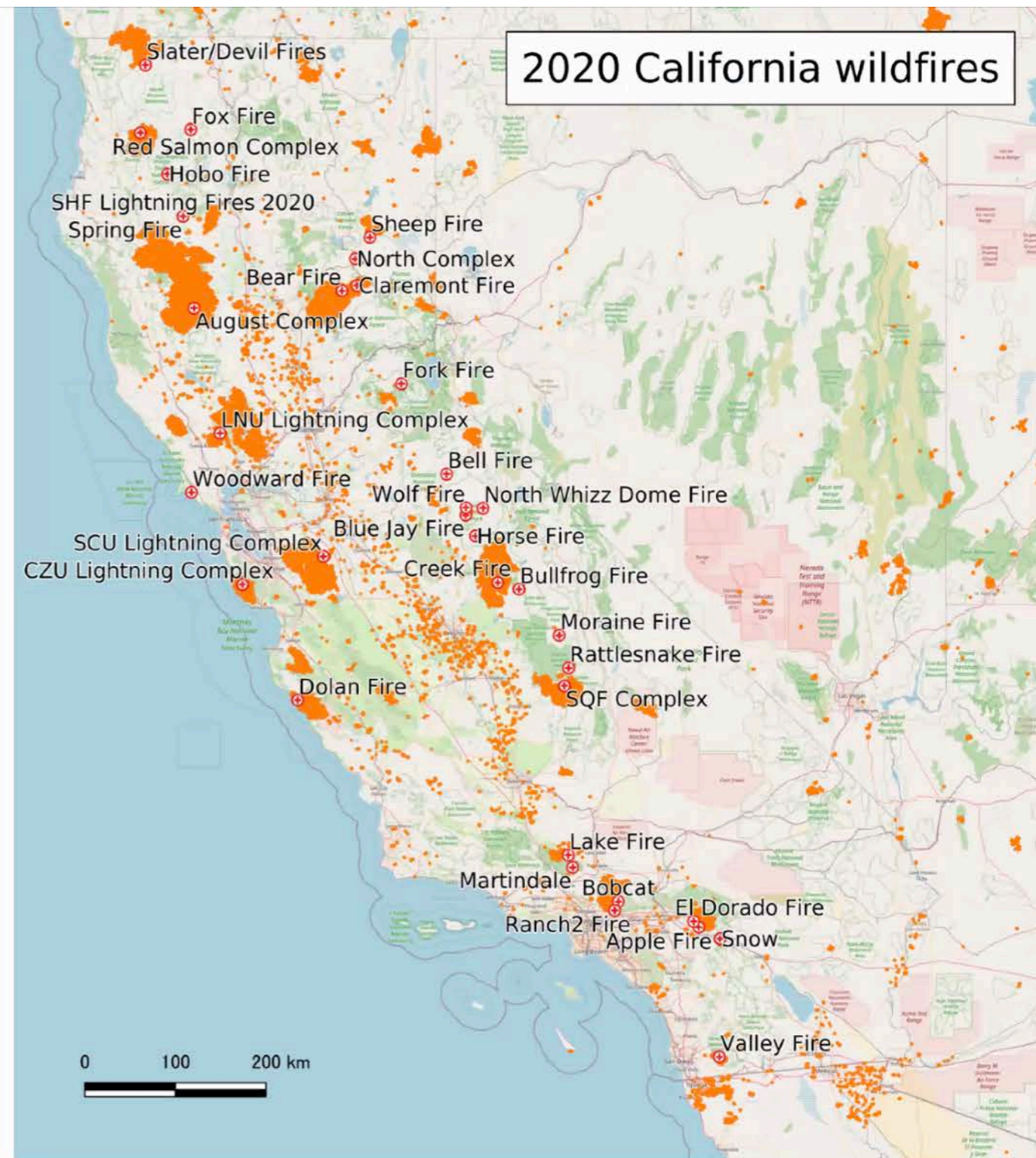
Figure 25.4: Climate Change Has Increased Wildfire



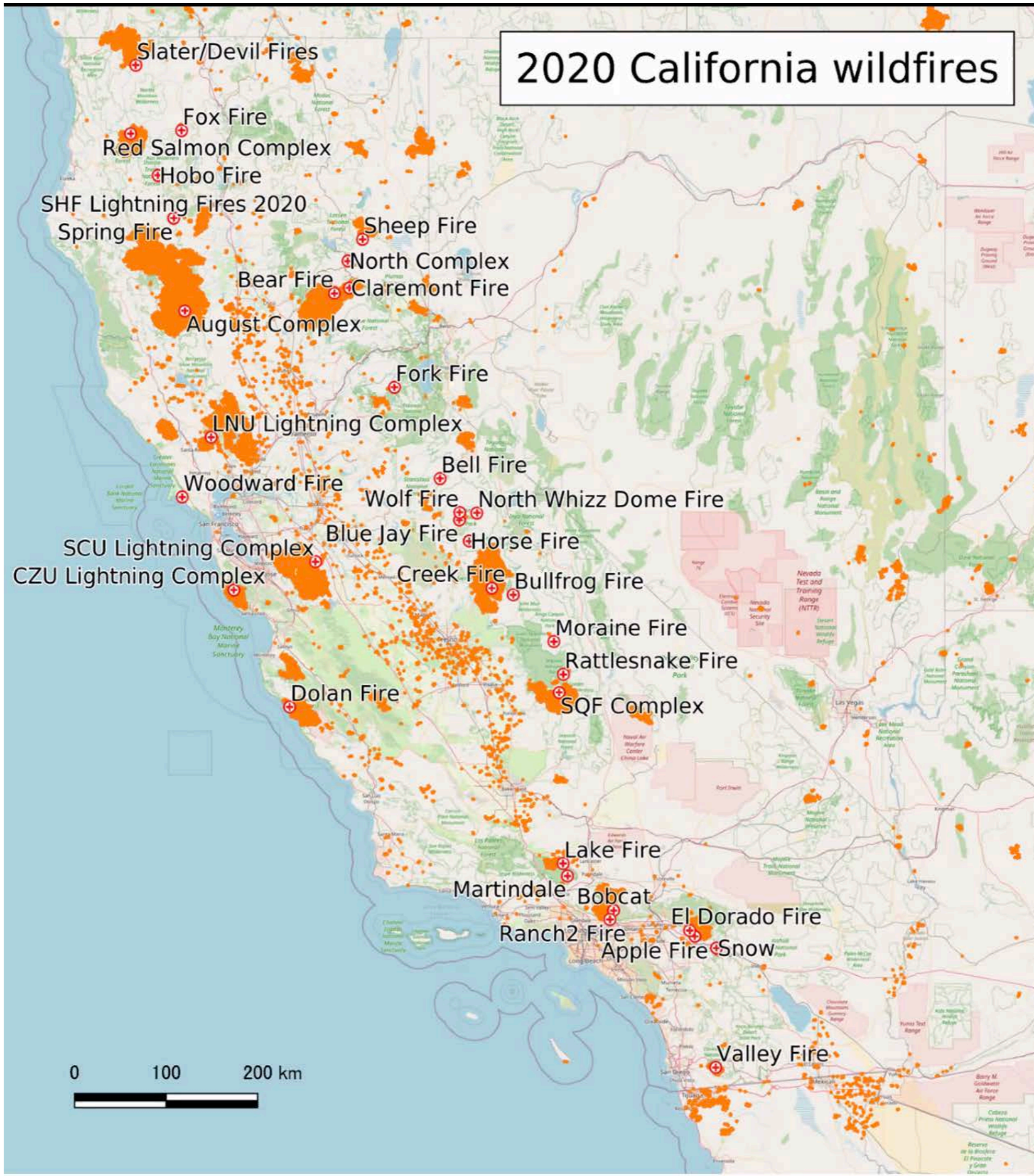
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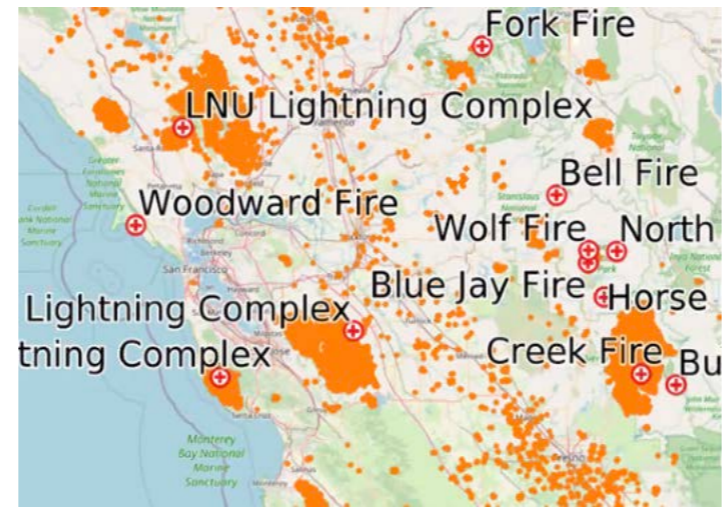
# 2020 Fire Season

- 4.2 Million Acres
- Roughly 4% of CA Burned
- 9177 Fires YTD (SRA and FRA)
- Over 30 Fatalities
- Over 8000 Structures Burned
- PG&E PSPS- The New Standard
- RED FLAG after RED FLAG  
(red flag fatigue)



# 2020 California wildfires

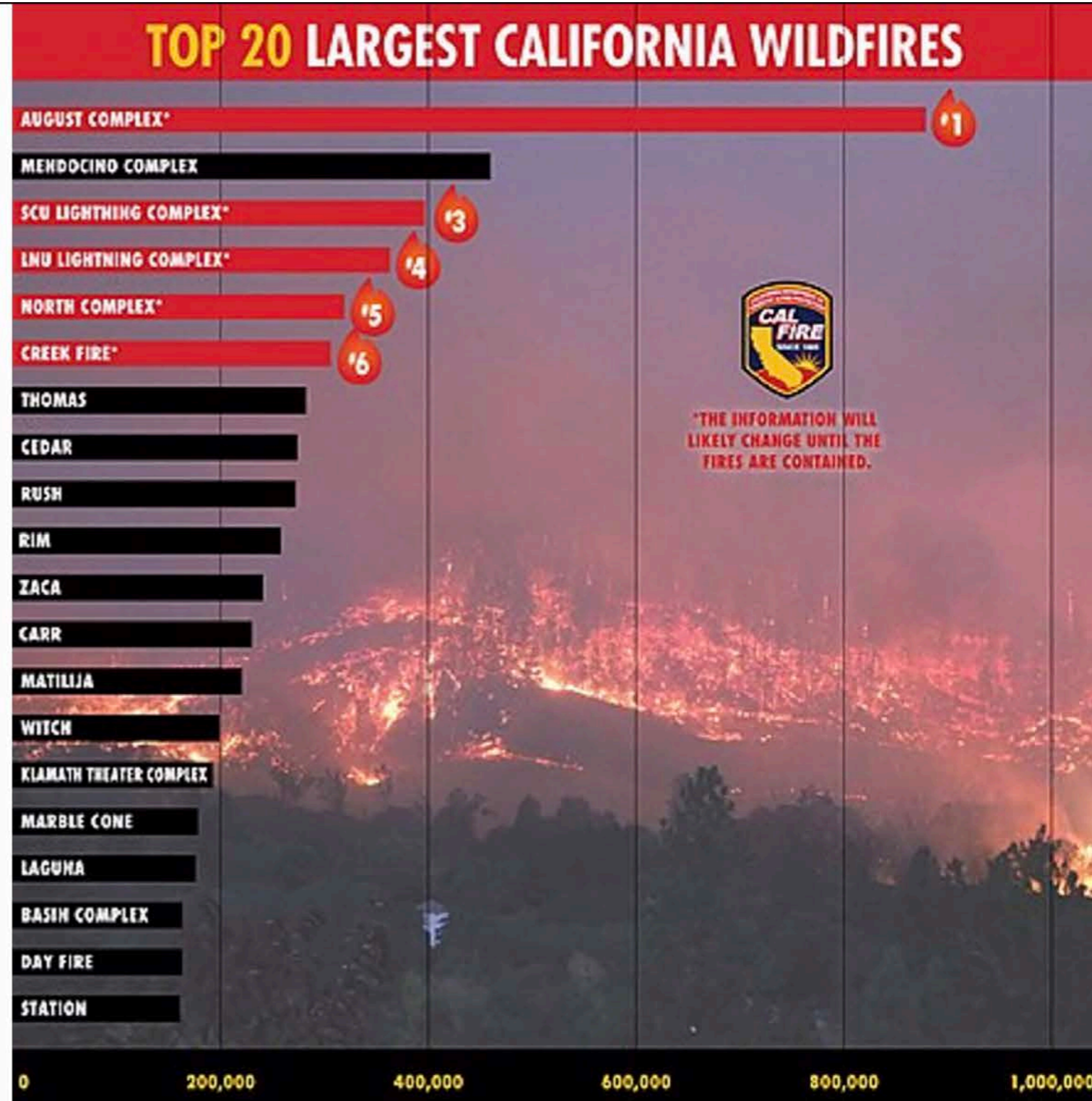




- 51 Spare The Air Days (so far)
- Five Largest Fires Of All Time In 2020



City Hall September 9<sup>th</sup>, 2020 0930





- August 16<sup>th</sup> Lightning Siege (LNU,SCU, and CZU-2500 ground strikes)



# Crown Fire –October 27<sup>th</sup>, 2020

**“DODGED A BULLET”**







# Our Infrastructure Will Be One Of Our Biggest Issues







# Alameda County Evacuation Task Force (XALETF)

- Interagency – Fire, Police, OES (EM's), GIS
  - 2017 42 fatalities – WUI majorly impacted (North Bay Fires and Thomas Fire)
- XALETF Established Spring of 2018
  - Carr Fire (8 fatalities-3FF) & Camp Fire (85 fatalities)
- 2019 – Progress was slow and boundary coordination challenging
  - We were not alone and multi jurisdictional coordination was needed – Zonehaven appears!
  - Late 2019 achieved countywide support, identified 5 years of funding, and ALCO OES identified as lead for contracting
- 2020 – COVID And Success
  - Early 2020 sole source approval, COVID delay addressed, contract executed September 2020, implementation in progress!!







ZONEHAVEN.COM

# EVACUATION MANAGEMENT

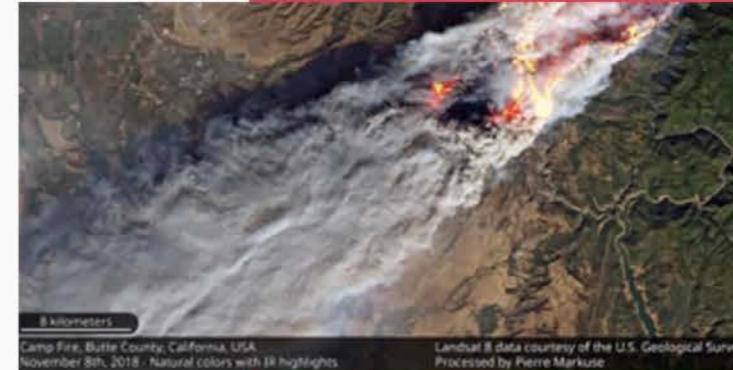
# Types of Evacuations and Terminology

- Planned And No Notice (Go Now)
- Terminology –CA OES adopted May 2020
  - **Evacuation Order:** Immediate threat to life. This is a lawful order to leave now. The area is lawfully closed to public access.
  - **Evacuation Warning:** Potential threat to life and/or property. Those who require additional time to evacuate, and those with pets and livestock should leave now.
  - **Shelter in Place:** Go indoors. Shut and lock doors and windows. Prepare to self-sustain until further notice and/or contacted by emergency personnel for



## THE WILDFIRE PROBLEM

- Firefighting **not** effective in the initial attack
- Multi-agency coordination and command is **required**
- Wildfires are Mass **Rescue/Casualty** Incidents
- Evacuation Orders Required Earlier over **Larger** Areas
- Traffic Congestion Coordination Now **Necessary**
- Vulnerable Populations are **Most** at Risk



## EVACUATIONS 101



*Most evacuations are ad-hoc, decided and created at each incident, usually using printed maps*

# EVACUATIONS 101



Radio/Phone

Live Meetings

Messaging

Webmaster

News Release



WIRELESS  
EMERGENCY  
ALERTS



*Communicating an evacuation plan to agencies and the public is time consuming and prone to error*

ZONEHAVEN SOLUTION

## 1 CLICK PLATFORM



### Multi-Agency Coordination

All agencies can use to coordinate evacuations with all stakeholders



### Real-time Map based Information

Real-Time platform allowing everyone to see evacuation information



### Integration with existing channels

Tool that integrates with pre-existing and new communication channels



### Hyper-local knowledge

Local knowledge allows for mutual aid to more quickly execute evacuations



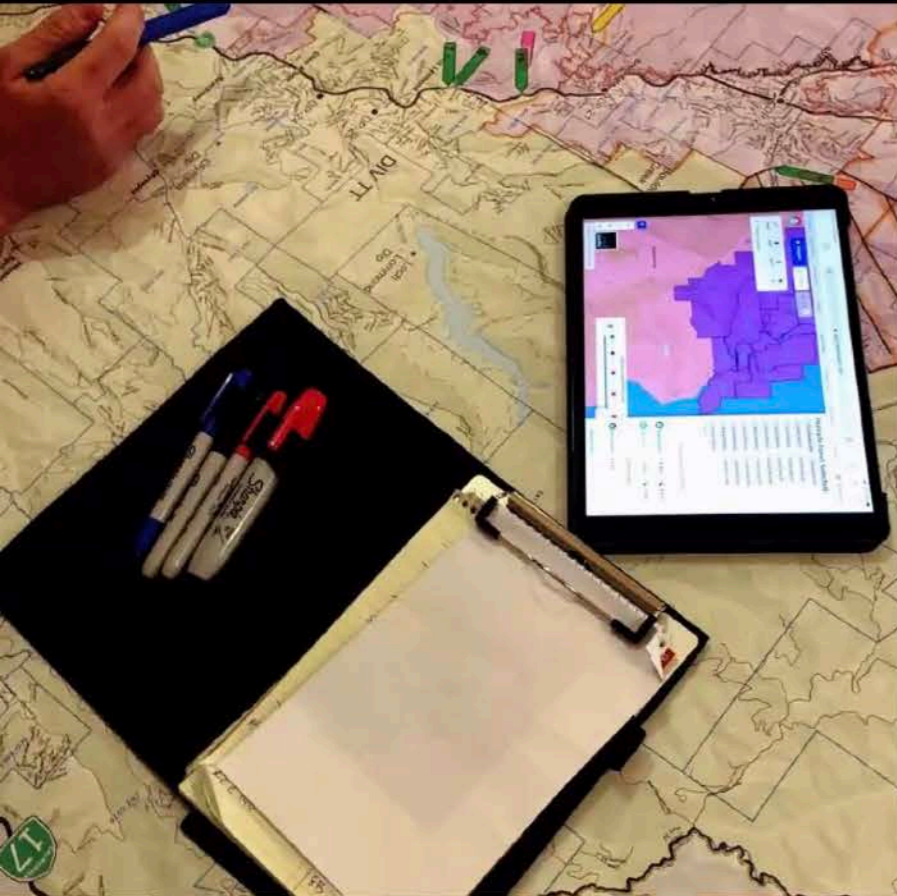
### Reduce Complication and Time

Reduce complication, reduce time, & get information to the public faster




### Accessible to Communities

Available to the public to allow real-time communication



# EVACUATION ON FAST MOVING FIRE

**CAL FIRE NEWS RELEASE**  
California Department of Forestry and Fire Protection



**CONTACT:** Incident Information Line: (831) 335-6717      **RELEASE DATE:** August 18, 2020 2:00 p.m.

**CZU AUGUST LIGHTNING COMPLEX  
EVACUATION WARNING ISSUED IN SAN MATEO COUNTY**

**WHAT:** **EVACUATION WARNINGS**


**WHEN:** EFFECTIVE IMMEDIATELY

**WHERE:** An **EVACUATION WARNING** has been placed for the community of Loma Mar and Dearborn Park in Southern San Mateo County. (Zonehaven Evacuation Zone SMC-E018)

**NOTES:** Due to fire activity in the area south of Loma Mar residents are requested to prepare to evacuate. Please be prepared to leave your property if the fire continues to progress. Recommended actions include packing your vehicle with personal belongings, securing your buildings, packing medications and ensuring your vehicle has fuel.

View the most current evacuation information at:  
[www.smcocalifornia.com/zonehaven](http://www.smcocalifornia.com/zonehaven)

Residents who would like to receive email updates can follow the link below to opt-in:  
<https://bit.ly/2G04b7m1g>



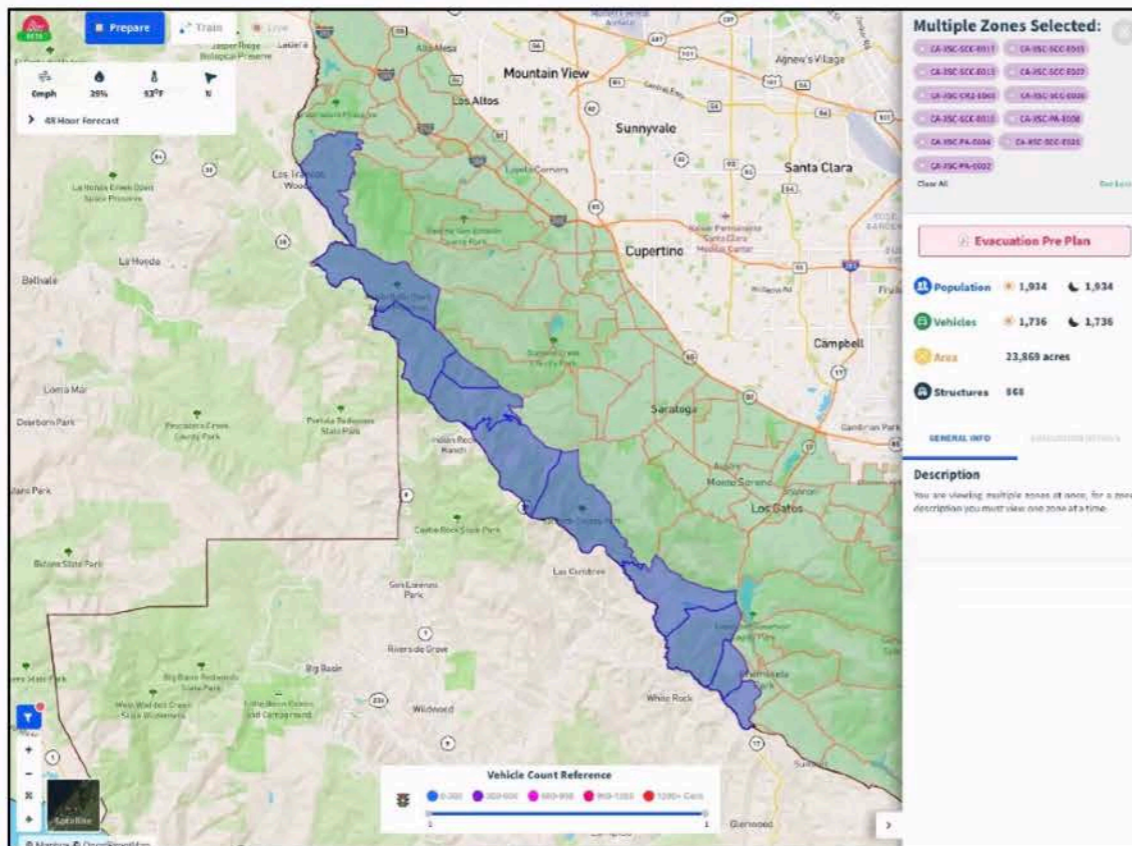
1 Zone - August 18



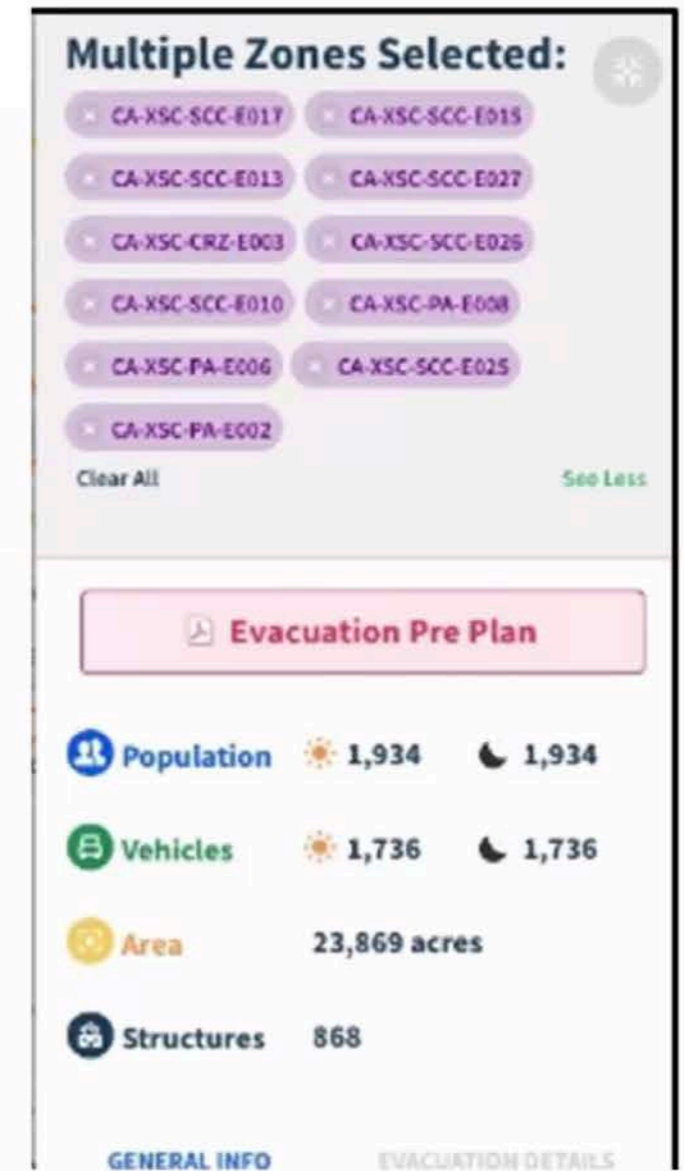
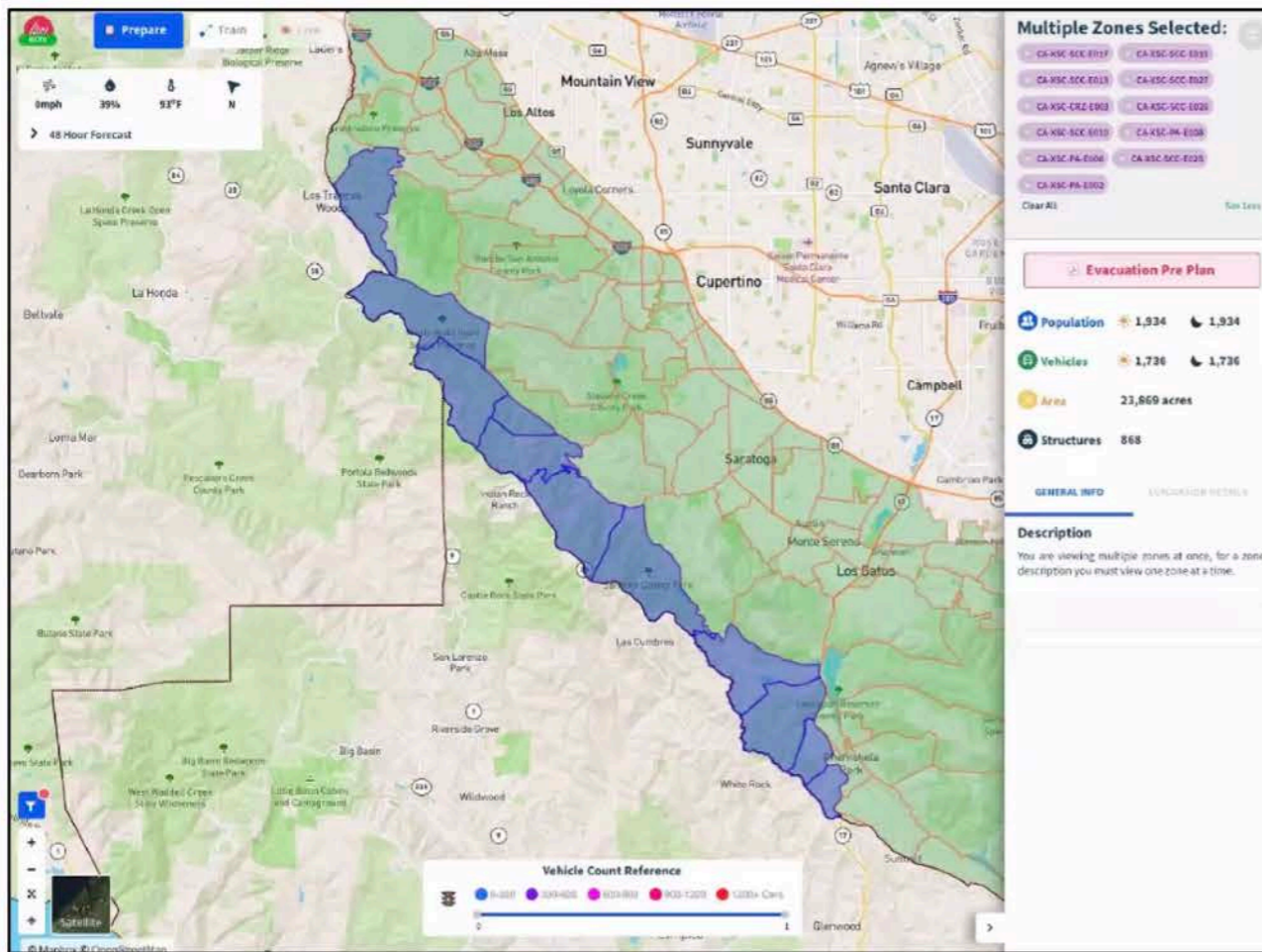
134 Zones - August 23

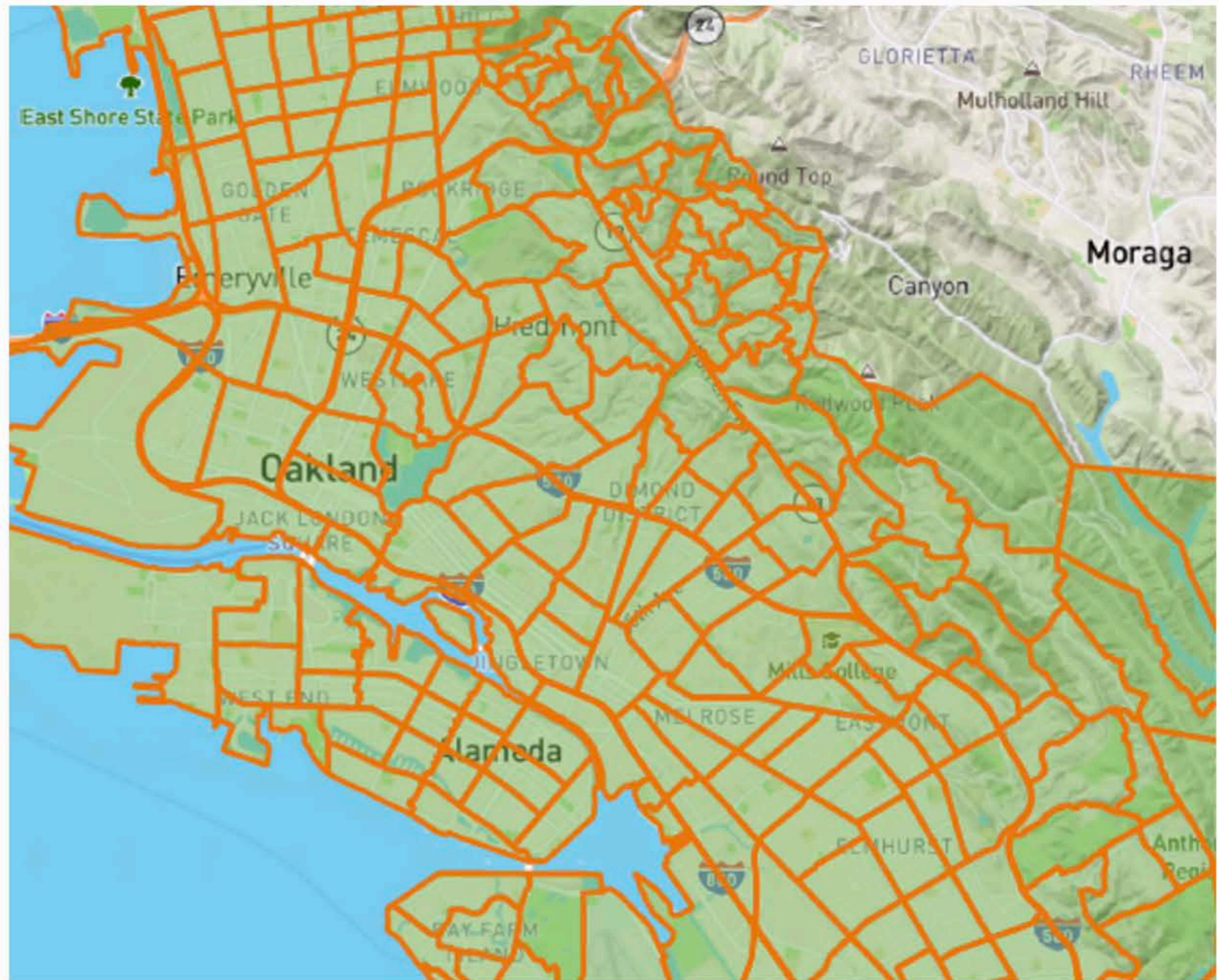
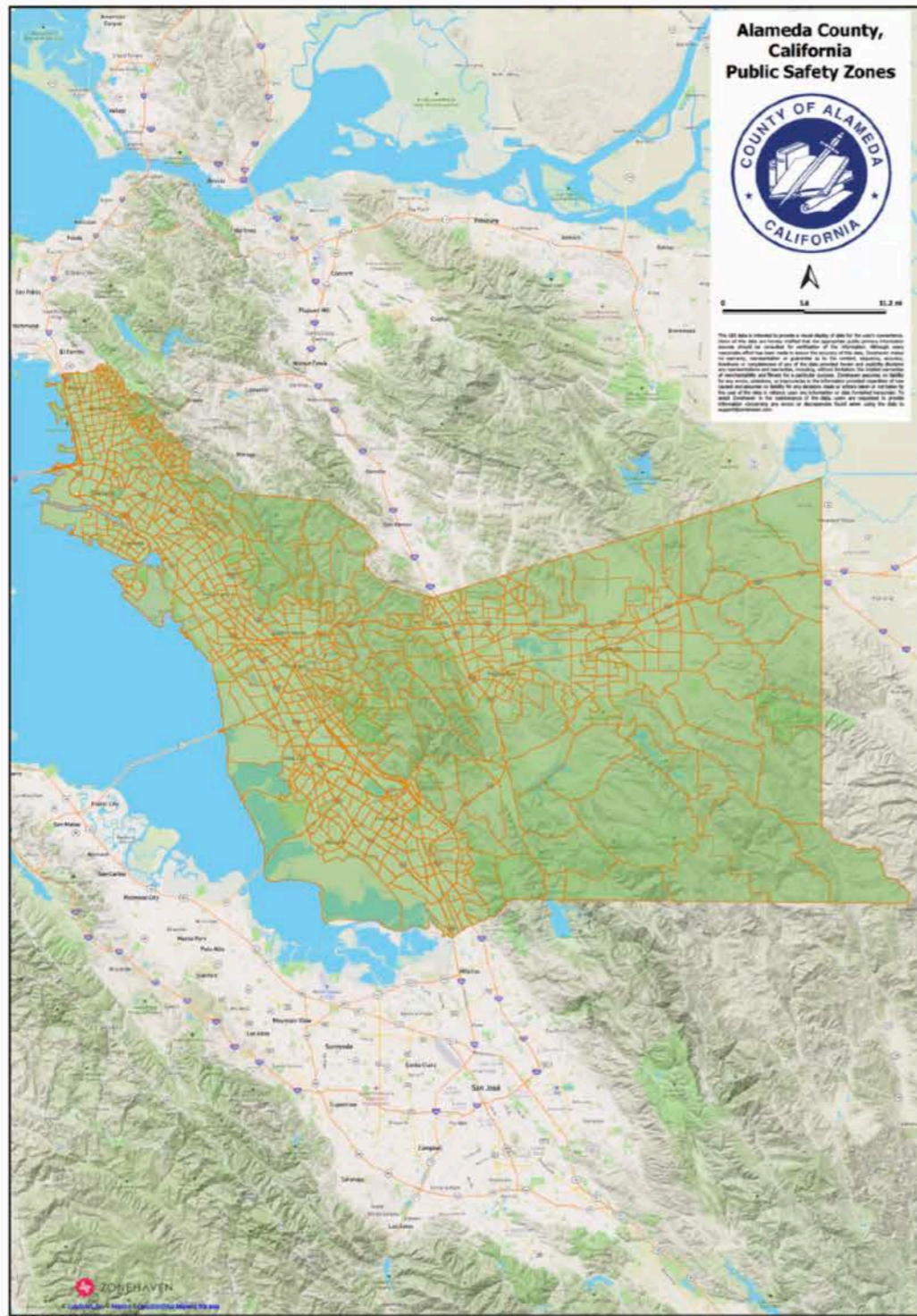


# AUTHORITATIVE SOURCE



# AUTHORITATIVE SOURCE





# EVACUATION NOTIFICATION- IF IN DOUBT? **GO!**

- DOOR to DOOR
- NEIGHBOR ALERTING NEIGHBOR
- ACALERT (WEA)
- NIXLE
- NEXT DOOR
- TWITTER
- CITIZEN
- SIREN SYSTEM (fast wail)
- ZONEHAVEN (COMING SOON)



# EVACUATION ROUTES

- Know Two Or More Ways Out
- Your Normal Way May Not Be Your Best Way
- Identify Temporary Refuge Areas (is your home prepared “hardened” to save your life?)
- “Will You Tell Us Travel Route And Where To Go?”
- Go Early!!!!!!!
- Access And Functional Need (AFN) Residents (and others) Must Monitor Red Flag Events And Seriously Consider Relocating Prior To A Fire.



## COMMUNITY NEXT STEPS FOR ZONEHAVEN

- Sign up for AC Alert – [ACALERT.ORG](http://ACALERT.ORG)
- Watch for **Know Your Zone** campaign in 2021
- **Be Ready:** Create and maintain defensible space and harden your home against flying embers.
- **Get Set:** Prepare your family and home ahead of time for the possibility of having to evacuate and the possibility of losing your home.
- **GO!:** When wildfire strikes, go early for your safety.



# READY-SET-GO

“In California, wildfires aren't a question of if, but only a question of when. If you choose to live near a natural area of the state, you are at risk for wildfires and it's your responsibility to prepare yourself, your family, and your home. And that preparation starts with three simple steps: **READY, SET, GO!**”

[Readyforwildfire.org](https://www.readyforwildfire.org)

# FIRE SAFE STREETS

- Program Started In 2017
- Partnership Between ODOT and OFD—How Are Streets Chosen?
- 23 Streets Completed
- Streets Analyzed By OFD and ODOT:
  - Less than 20' – usually no parking both sides
  - 20' to 26' – usually no parking on side
  - Greater 26'- usually no restrictions required
- Community Agreement And Collaboration Helps The Process



[Firesafestreets@oaklandca.gov](mailto:Firesafestreets@oaklandca.gov)



# What else have we been doing or have up our sleeves?

- New Type 3 And Two Water Tenders Coming
- Fire Trail Maintenance
- Grizzly Peak
  - Turnouts and no parking signage
  - Internal wildfire coordination group established (citywide)
  - External multi agency law coordination group established
- UC San Diego WIFRE Project – <https://wifire.ucsd.edu/>
- UC San Diego ALERT Wildfire Project - <http://www.alertwildfire.org/index.html>
- UC Berkeley/UC Davis – “Building Community Resilience to changing California hazards Through Digital Twins and Social Gaming” Project”.



# WHAT ARE WE DOING CONT.

- Enhanced Participation In Mutual Aid System And Operations Training
- CA OES PREPO
- Remote Automated Weather Stations



# Take Away

- Sign Up For ACALERT ([ACALERT.ORG](http://ACALERT.ORG))
- Visit [READY-SET-GO-](http://READY-SET-GO-) Prepare For Evacuation Now
- Get Excited About ZONEHAVEN
- Never Wait To Be Told To GO
- Don't Forget The Hayward Fault
- RED FLAG Warnings - NWS Does It For A Reason
- OFD Is Here To Help And Is Committed To Ensuring Your Safety, But We Cannot Do It Alone
- Cross Your Fingers And Hope For A Wet Winter





**LET IT RAIN!**