International Association of Fire Chiefs

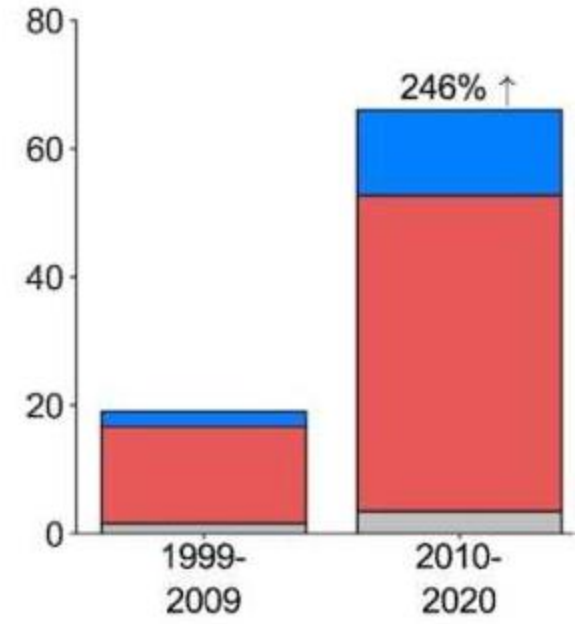
Aligning Mitigations and Insurability;

The Path Ahead for Optimized Risk Reduction in WUI Communities

#WUI2024

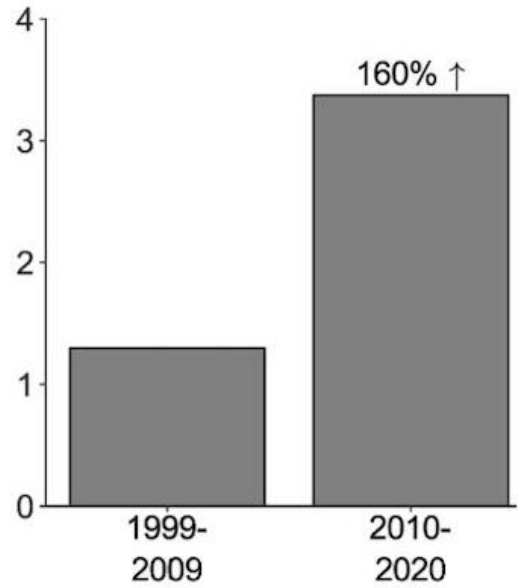
We are Responding to Unprecedented Environmental and Property Losses

Structures Destroyed x 1000



Red = Human Caused
Blue = Lightening Caused
Grey = Undetermined

Structures Destroyed Per 1000 Hectares Burned



Source: https://phys.org/news/2023-02-western-wildfires-destroyed-homes-decade.html

Why Now?

- Significant Increase in Fuel Loading
- More Development in Fire Dependent Landscapes
- Increasing Vapor Pressure Deficit

A)

B)

Photographs of Yosemite Valley in California from 1892 (**A**) and 2011 (**B**) show denser forest and shrub growth. Source for A: https://www.usgs.gov/news/yosemite-science , Photo B by Gabrielle Boisrame

Source: https://fireecology.springeropen.com/articles/10.1186/s42408-022-00129-4/figures/9

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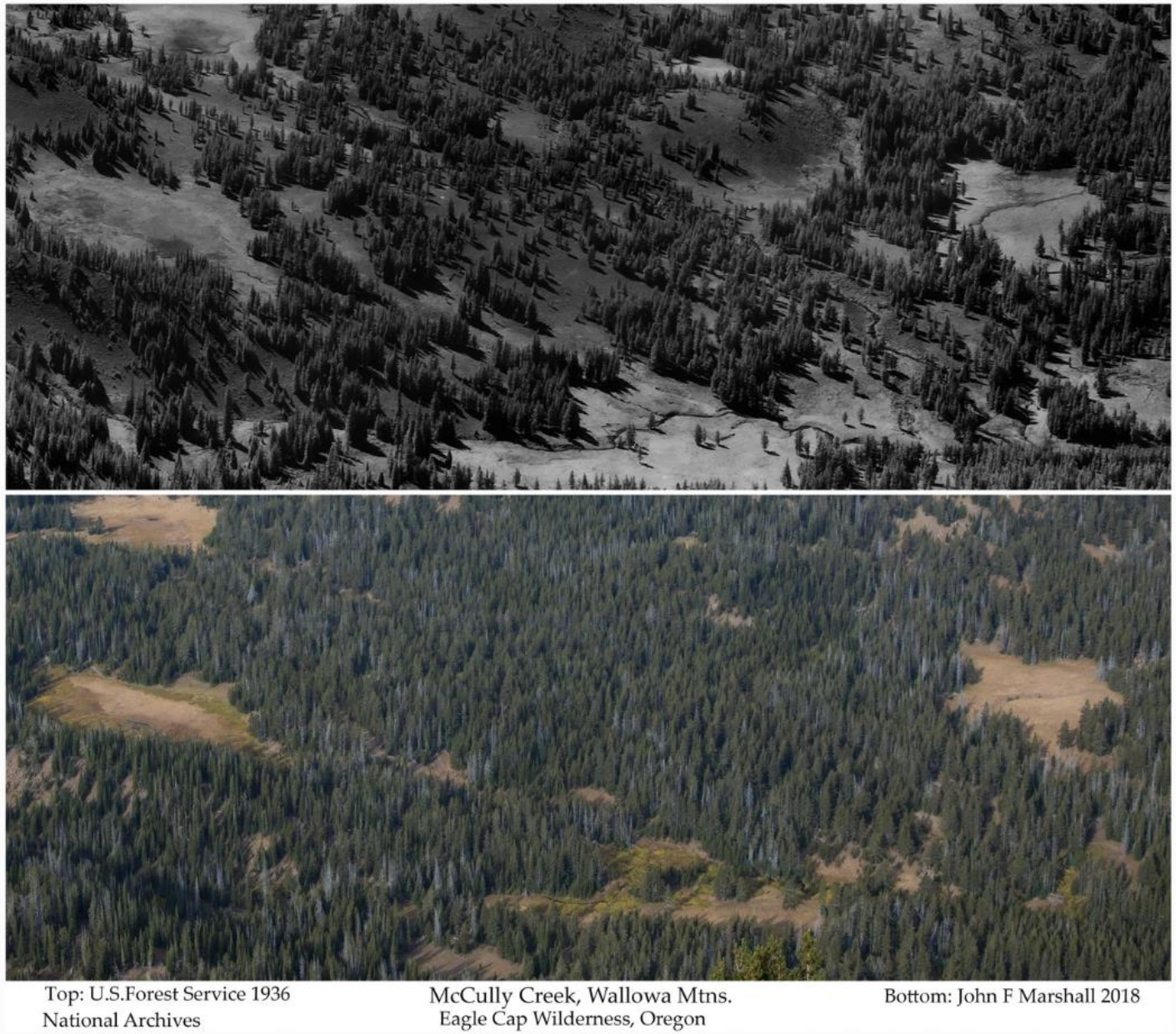


Wallowa Mountains in Oregon. Photos from 1936 (top) and 2018 (bottom). Adapted from Hessburg et al. (2019). Original sources: U.S. Forest Service National Archive (1936) and John F Marshall (2018)

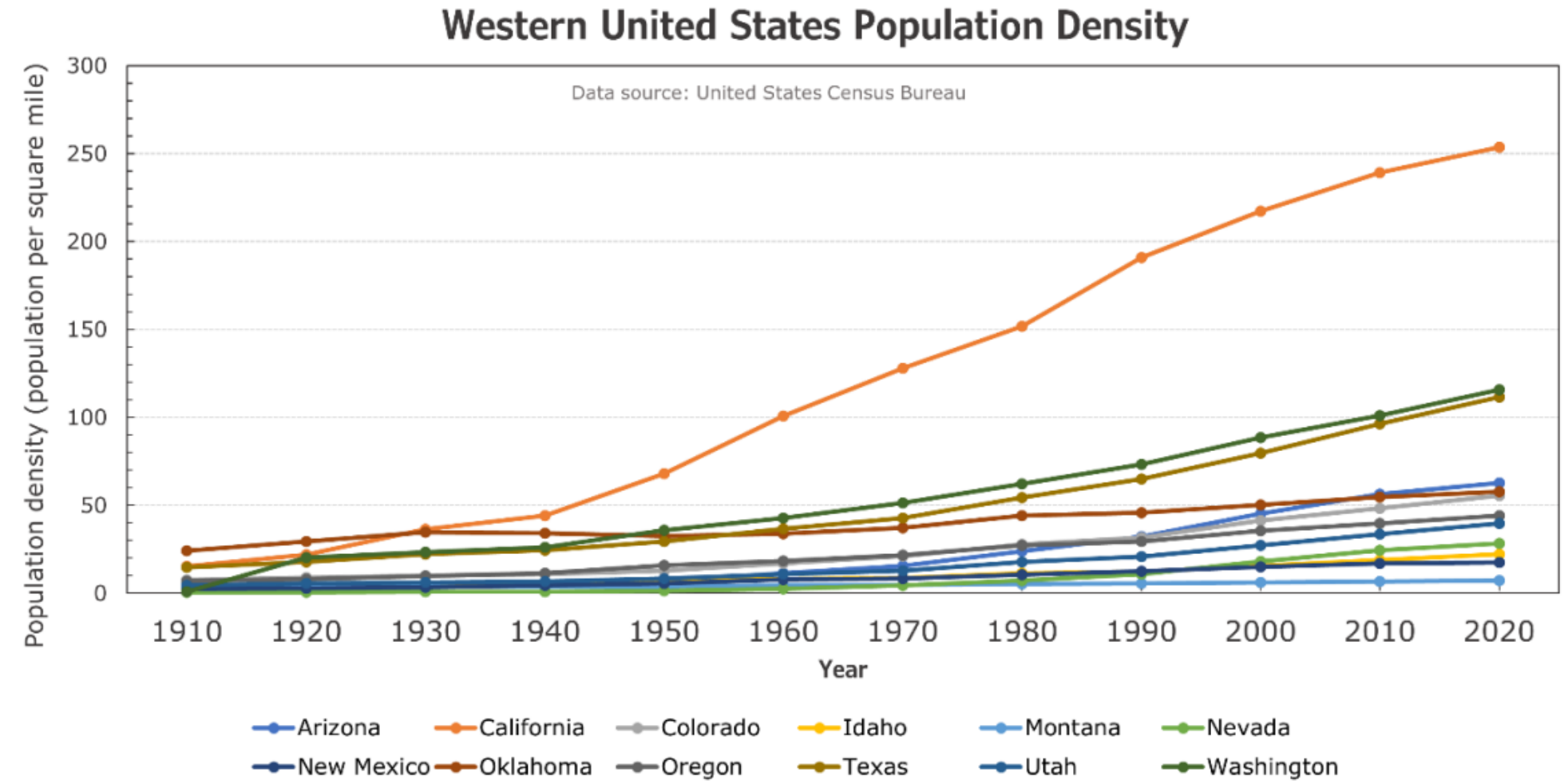


Figure 1: Time history of population density across thirteen western US states. Data source: US Census Bureau

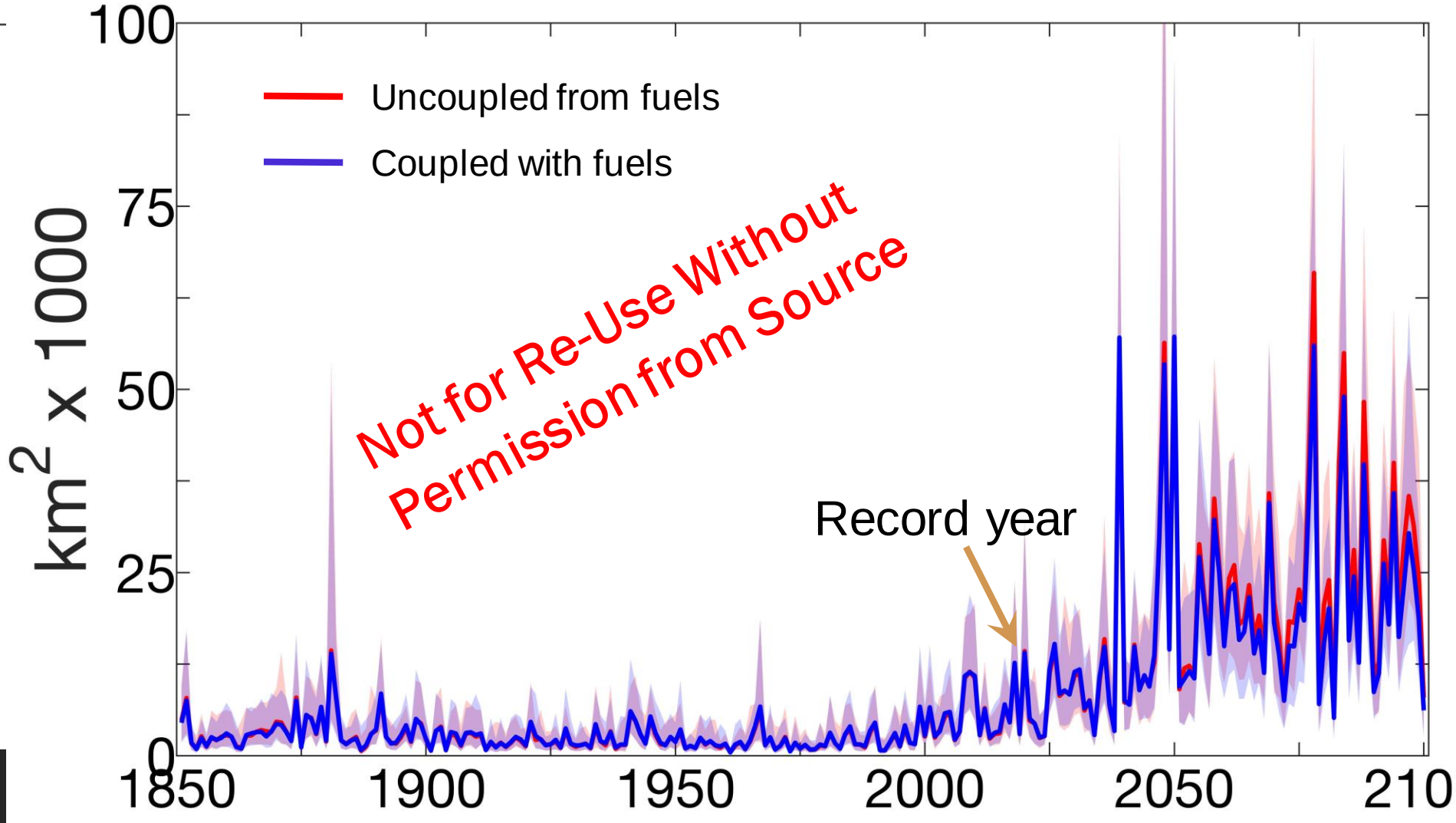
Secondary source: https://ibhs.org/wp-content/uploads/Suburban_Wildfire_Conflagration_WhitePaper.pdf

The vapor-pressure deficit in August in California, as calculated by Park Williams

Source: https://www.theatlantic.com/science/archive/2020/09/most-important-number-for-the-wests-wildfires-california/616359/

The Future is Frightening

Forest area burned (Middle of the road emissions scenario)



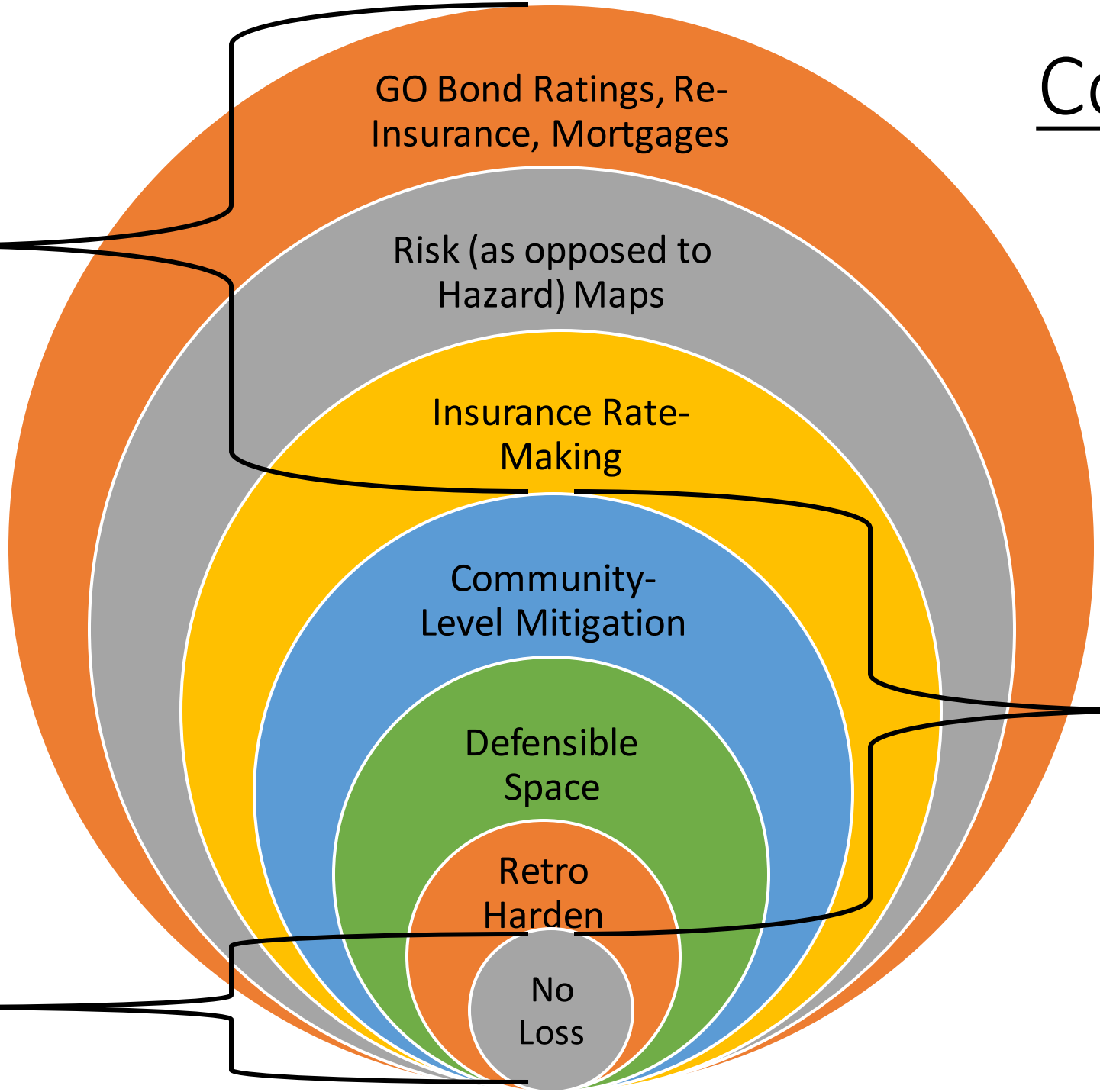
Source: Williams, Hansen, et al. In Prep.

Disconnect in Understanding Wildfire Risk

- The “Smiths” and a “Tale of Two Inspections”
- Why legacy data and systems won’t work
- We Cannot Suppress, Regulate, or Price Our Way Out of the WUI Conundrum

Coordinated Policy:

The WUI issue viewed as a Nested Policy Construct



Risk Policy Focus

Mitigation Policy Focus

Policy Outcome Focus

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The Necessity of Strategic Alignment on Mitigations that Matter (MTM)

- Unless “we” provide a clear and consistent mitigation alignment strategy, implemented and maintained at scale, we will face more frequent and severe life and property loss to wildfire, including cascading financial consequences from insurance, to reinsurance, possibly extending to the mortgage and municipal bond markets.

An Informal "WUI We" Working Together on a Path Forward:

- Systematic alignment of multiple stakeholders
- Taking coordinated and effective action to disrupt fire pathways in the WUI
- Facilitating visibility of effective resilience actions by WUI communities

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

CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
CAL FIRE
SINCE 1885

GORDON AND BETTY MOORE FOUNDATION

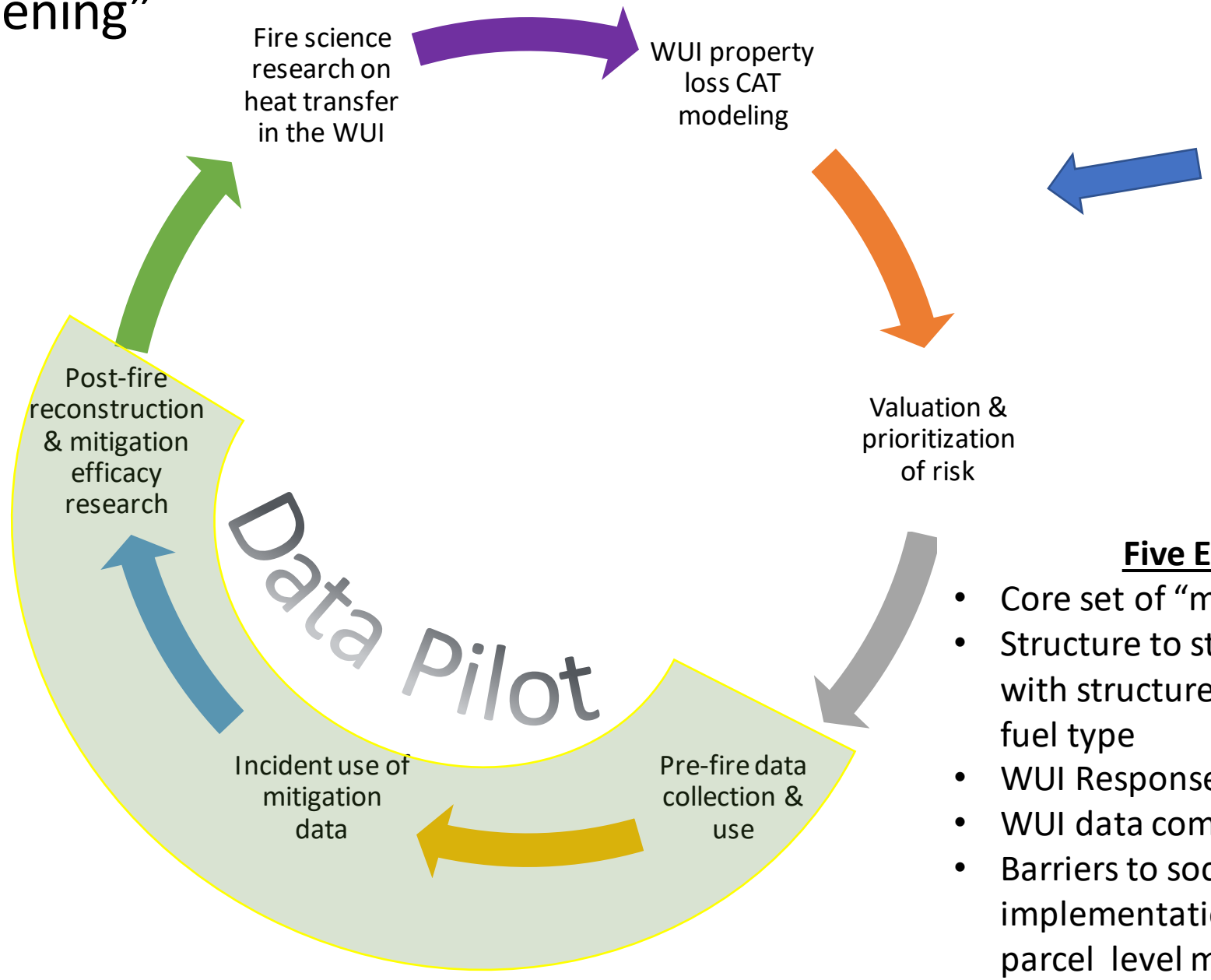
Colorado State University

WESTERN FIRE CHIEFS ASSOCIATION

CALIFORNIA FIRE CHIEFS ASSOC.
CFCA

Milliman

Ideal State for Sustained WUI Mitigation from "The Convening"



Five Enabling Tasks:

- Core set of "mitigations-that-matter"
- Structure to structure spread modeling with structures as a new and distinct fuel type
- WUI Response rating
- WUI data commons
- Barriers to social support for implementation and maintenance of parcel level mitigations

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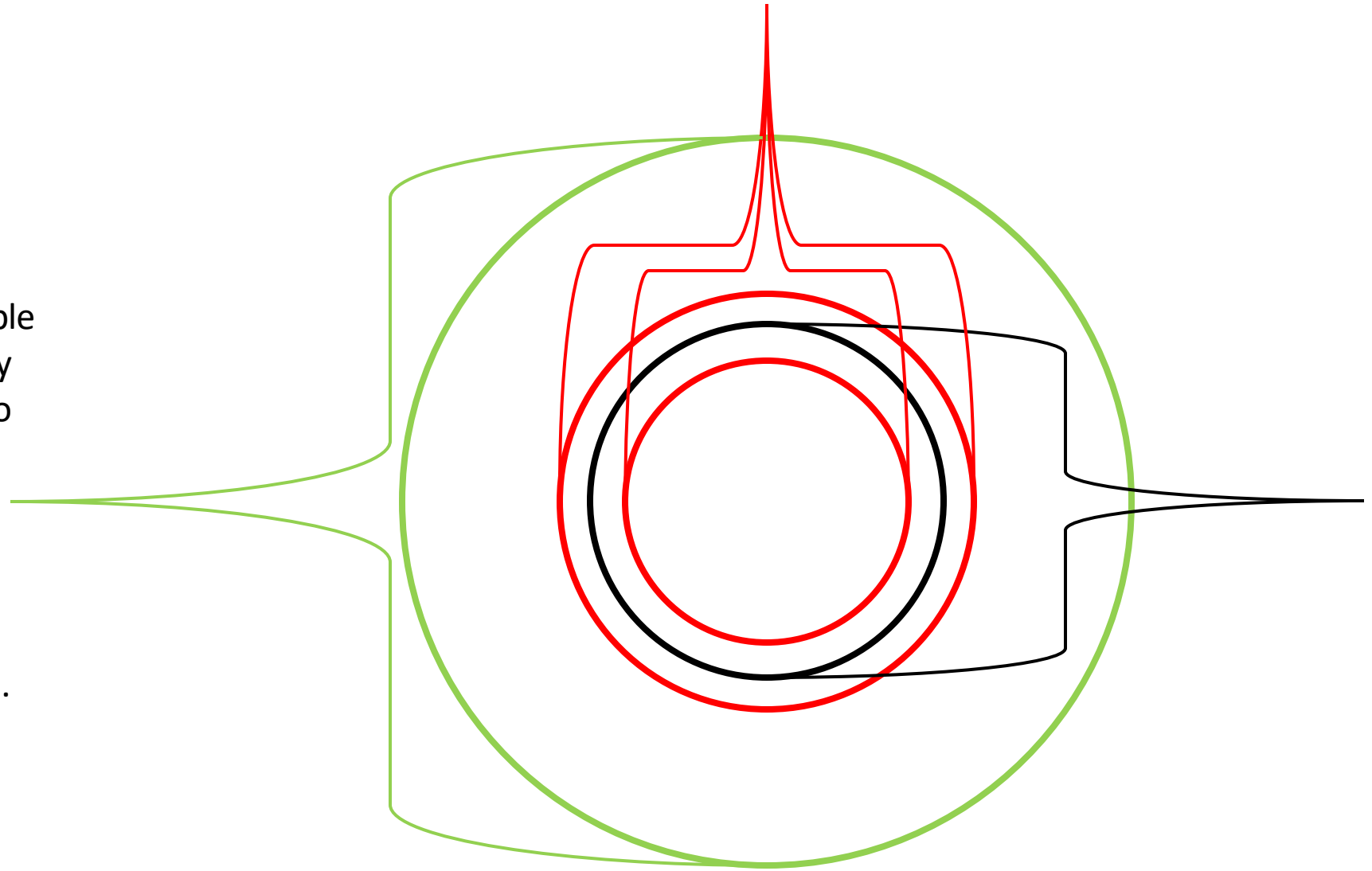
"Interface" = band within 100' of WUI Community boundary to 2nd layer of structures with SSD < 70'

"Most Probable Fire Pathway SOI" = 1/2 to 1/4 mile of interface in vegetation landscapes capable of carrying fire.



"WUI Community" = ≥ 100 structures where 50% or more have SSD < 70'

WUI Fire Pathway Taxonomy

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Disrupted through "edge" mitigation and WUI Response Capability in all three pathways

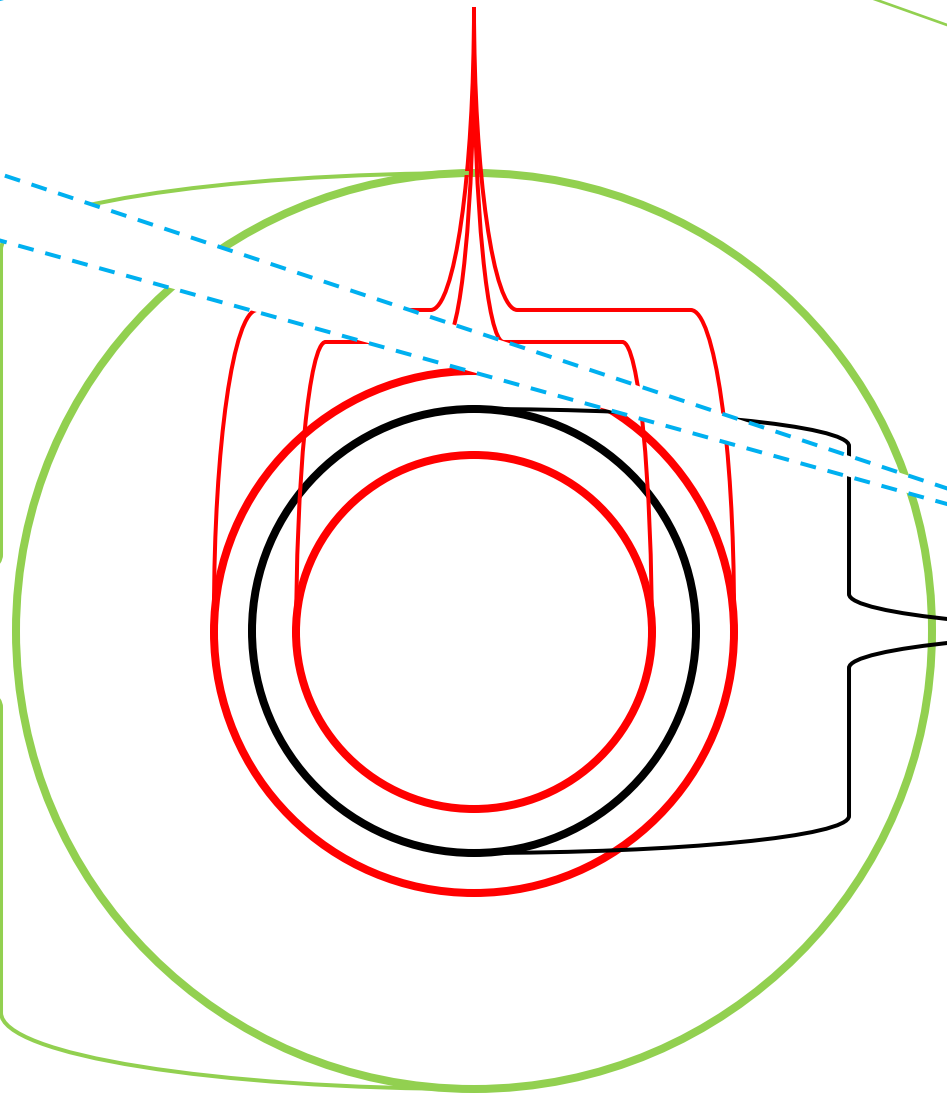
Vegetation to Structure

Modeled through Graph Theory populated by a MTM WUI Data Commons

Vegetation to Vegetation

Structure to Structure

Modeled through minimum-relative time pathways



WUI Fire Pathway Disruption

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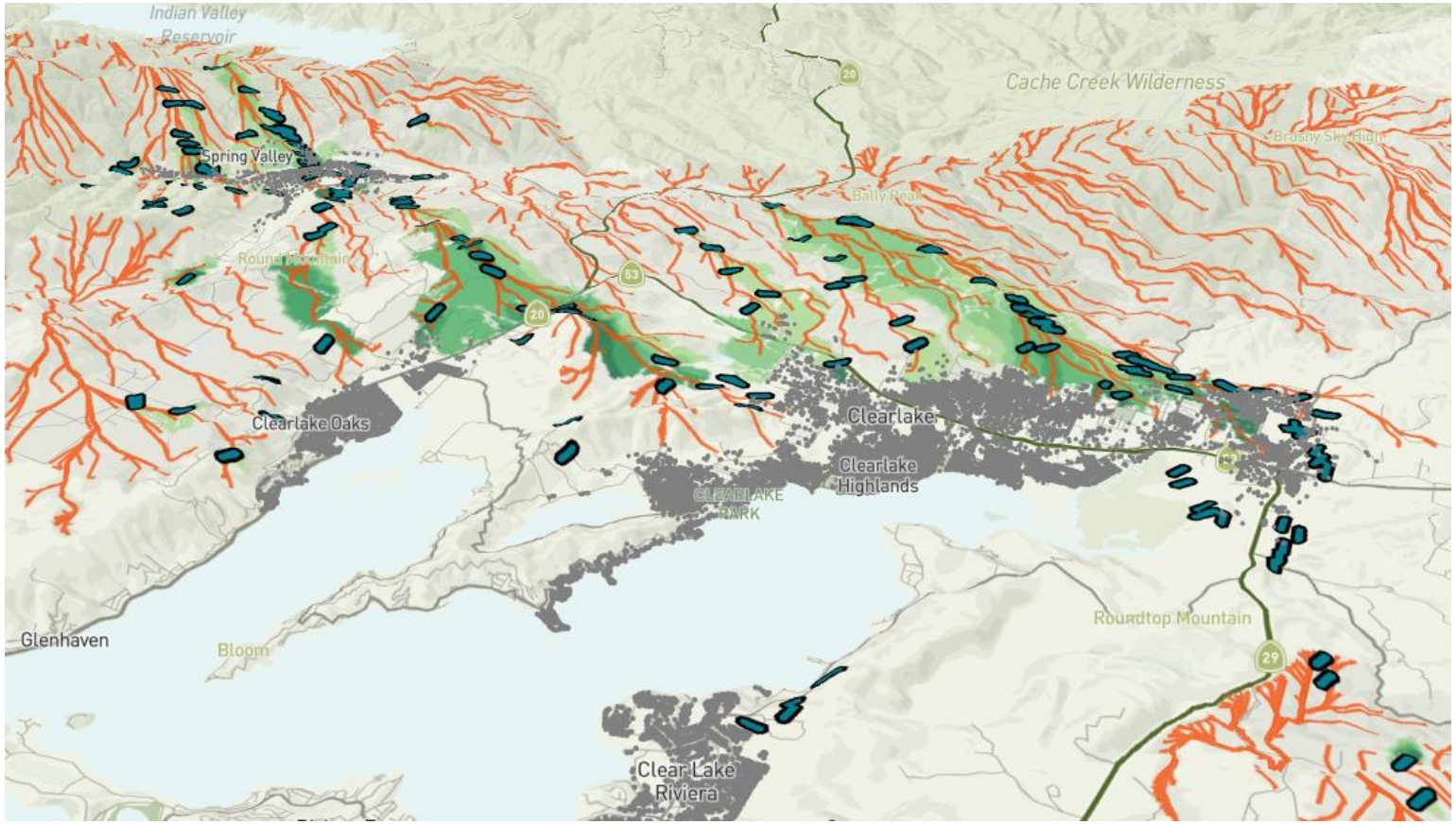
Vegetation to Vegetation: Speed Based Fire Pathways



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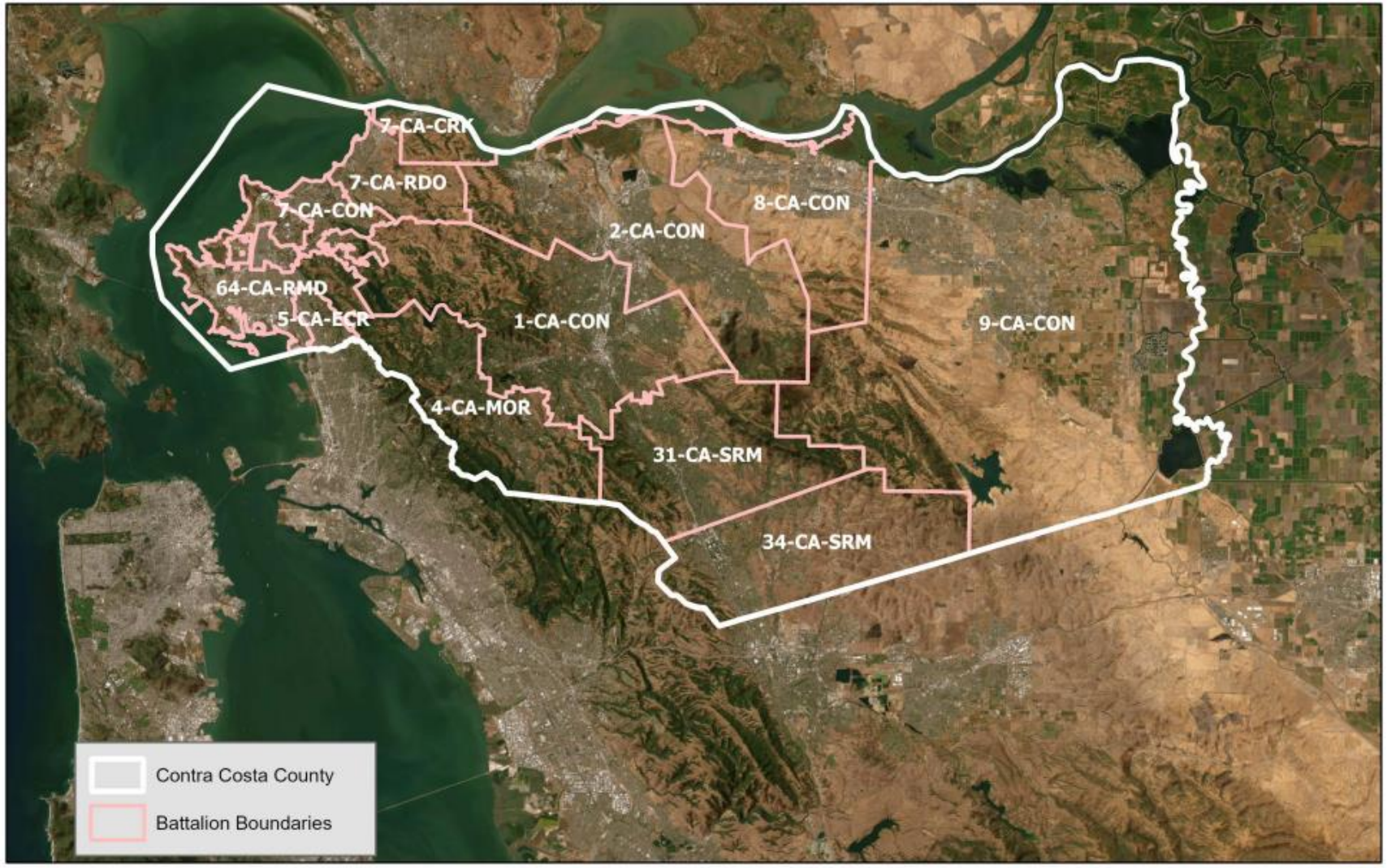
Vegetation to Structure: Simplified WUI Response Rating

Resource Categories & Type	Capability			Capacity		
	Vegetation to Vegetation	Vegetation to Structure	Structure to Structure	Vegetation to Vegetation	Vegetation to Structure	Structure to Structure
Type 1 Fire Engine	.5	1	1.5	2	4	6
Hand Crews	1.5	.7	0	6	2	0
Bulldozer	3	2	0	1	0	0
Agency Aid Agreement Type Factor	Recognizes the (in)efficiencies of coordination among resource types when single, several, or numerous agencies are responding together.					

WUI Response Rating

Battalion Boundaries
Contra Costa County

Map 1

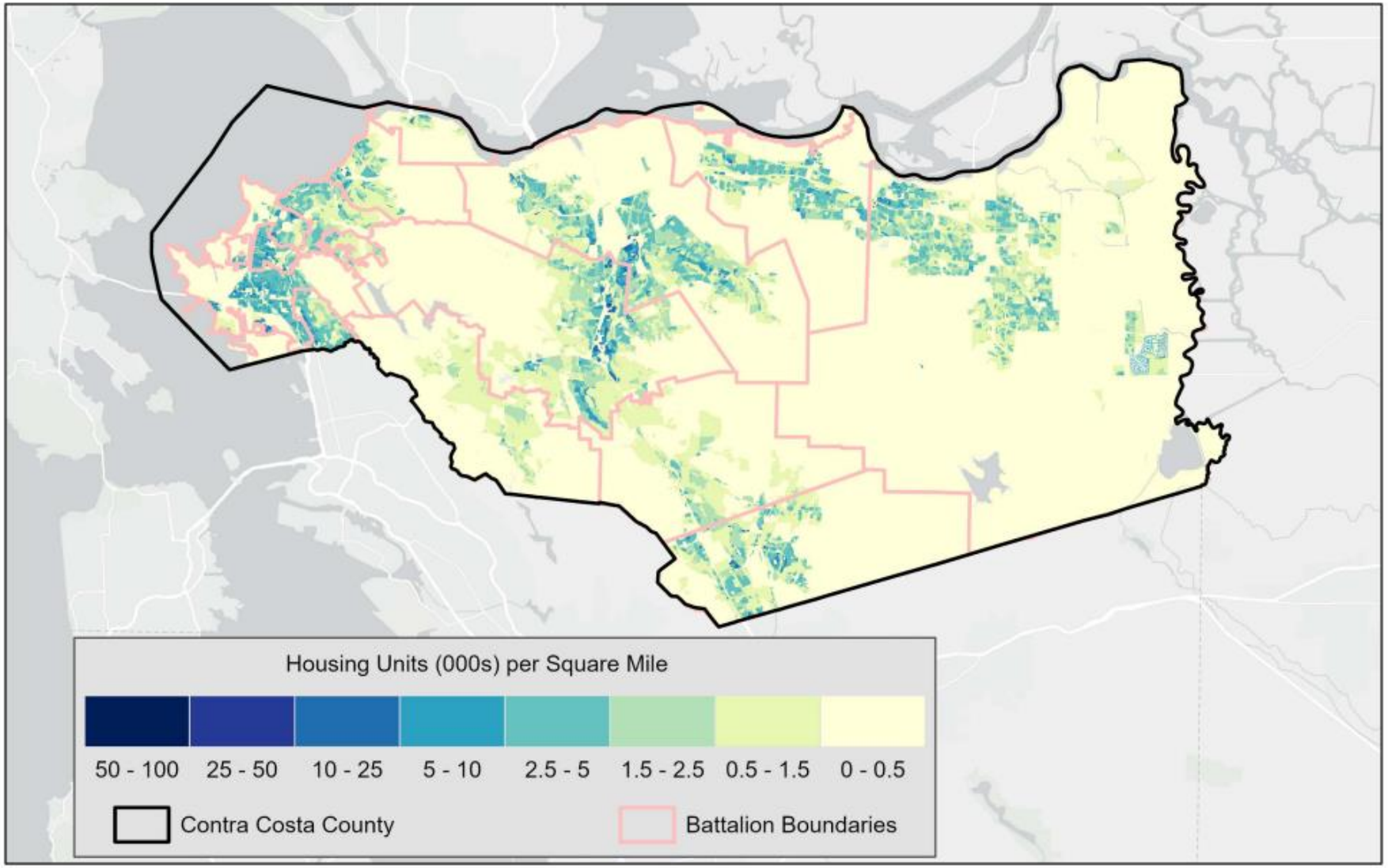


1. Battalion boundaries based on data collected from agency contacts and other publicly available sources.

Population Density

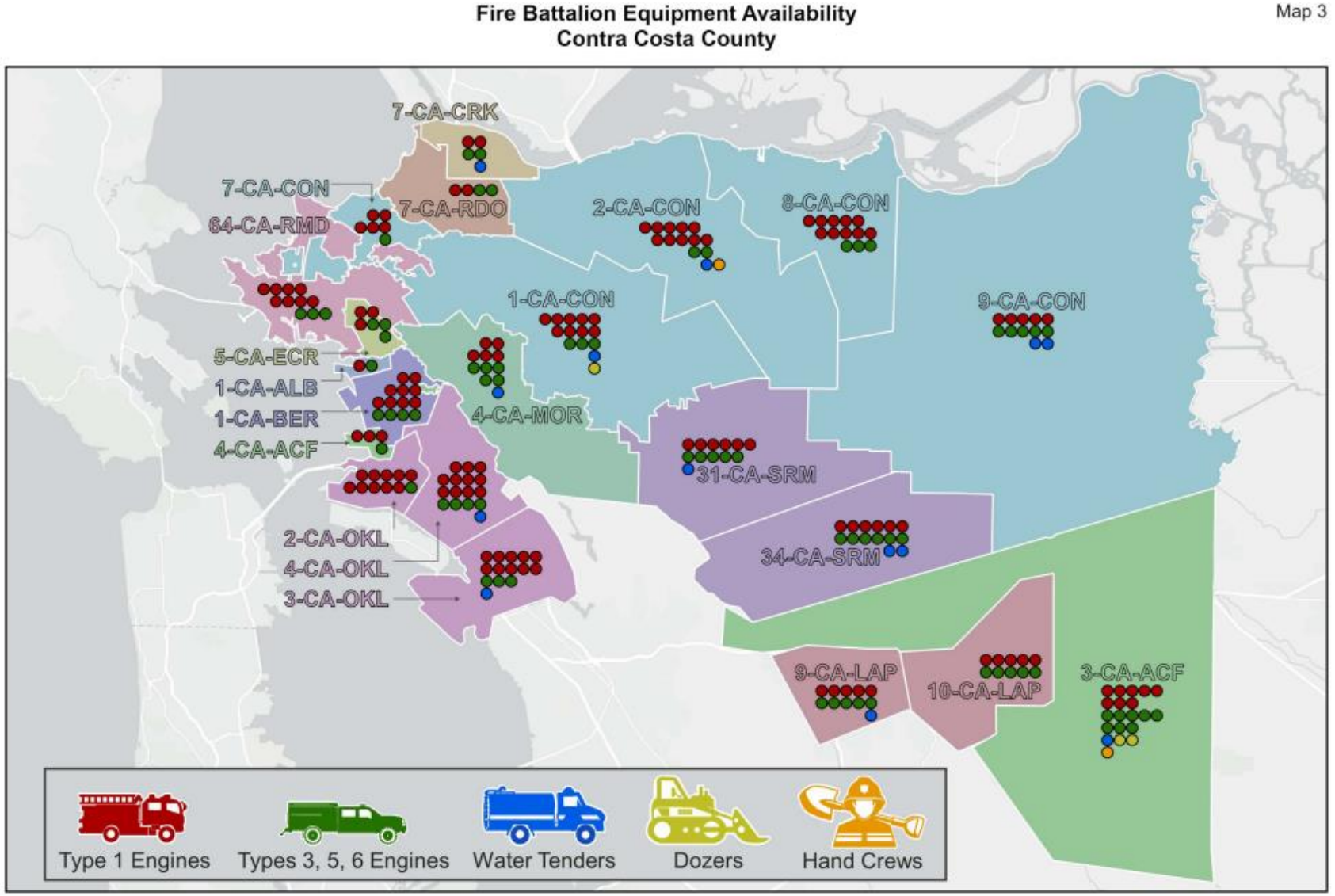
Housing Unit Density by Census Block
Contra Costa County

Map 2



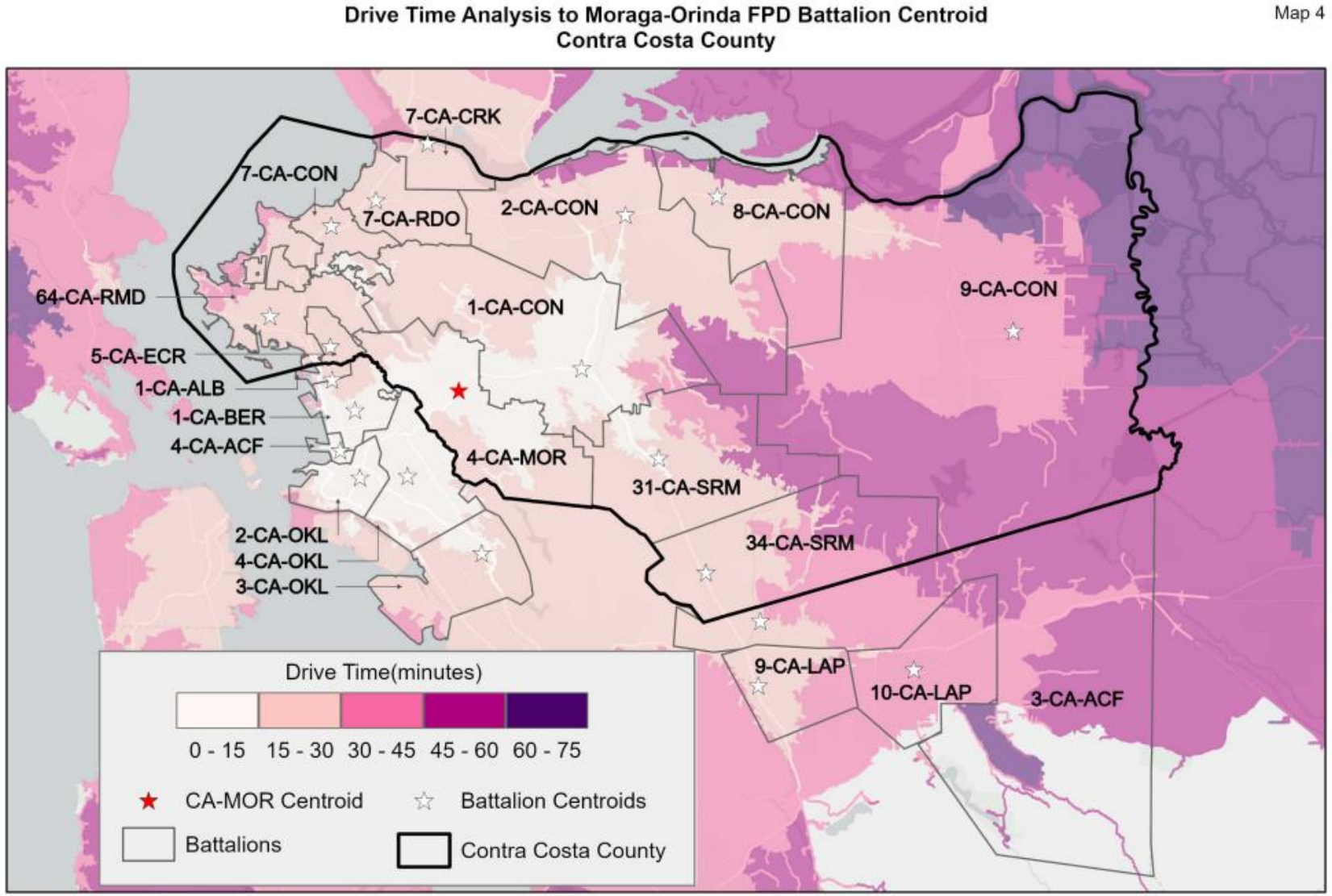
1. Housing unit density calculated with housing unit data from 2020 Decennial Census.

Resource Density



1. Colored circles on the map represent the total number of specific equipment as shown in the legend. Orange circles denote that hand crews are available for a given battalion, but do not show the total crew size. Battalions 3-CA-ACF and 2-CA-CON were both reported to have a total of 12 hand crew members available.
2. Fire engine totals represent staffed engines. Dozer and water tender totals represent total available equipment.

Travel Time



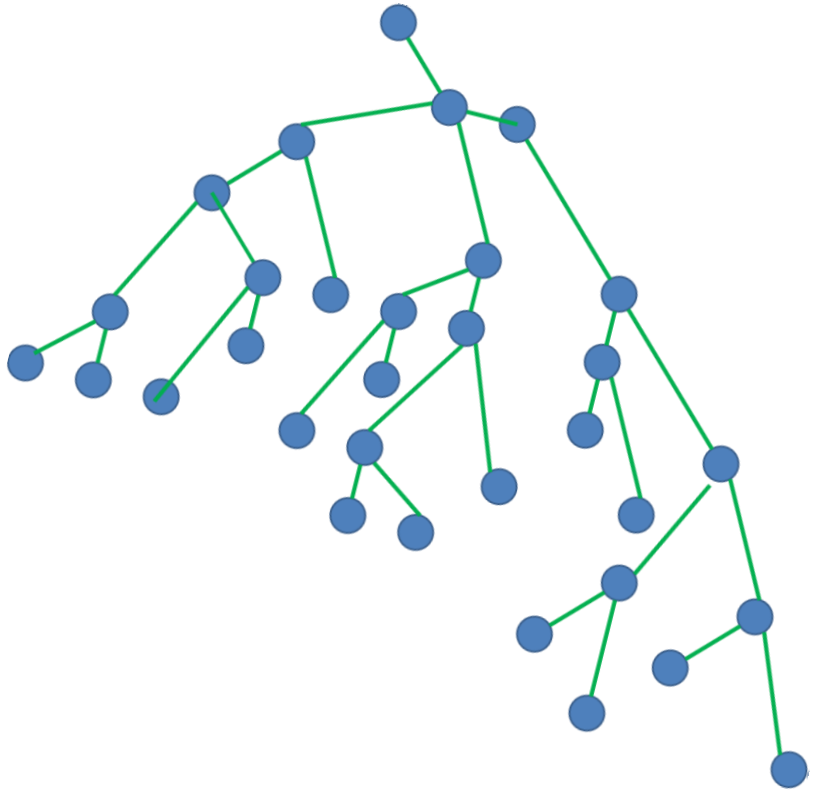
1. Drive time polygons are rendered using ESRI ArcGIS Online Create Drive-Time Areas.
2. The Create Drive-Time Areas considers typical traffic conditions and assumes land areas are reachable by car from the CA-MOR battalion centroid.

Comprehensive View of Risk

1. How fire will come to the community
2. Where it will enter
3. How resilient are those entry points
4. How many firefighters are available
5. What are those firefighters equipped for
6. How long will it take them to get there
7. Under what command relationships will they work

= An understanding of risk, mitigations and residual risk of conflagration level loss

Structure-to-Structure: Most Probable Spread Modeling



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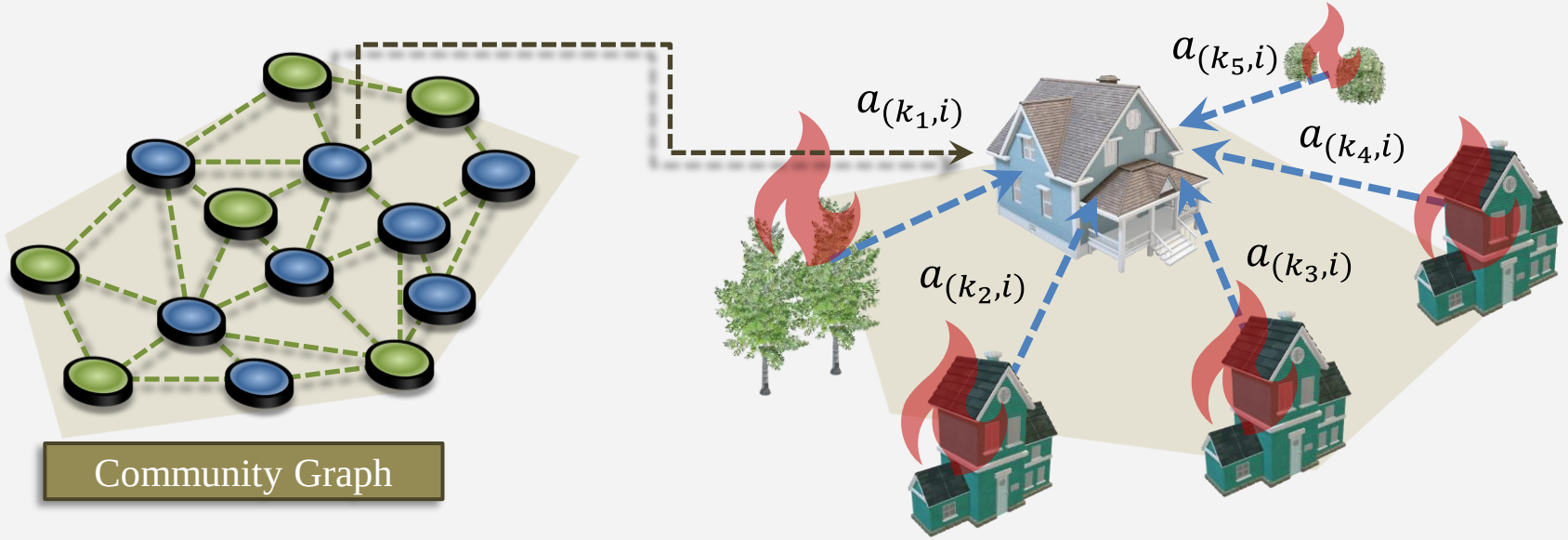
Vulnerability – Relative Vulnerability

- The Vulnerability values calculated for individual structures are **relative** to each other.
- Structures with higher Relative Vulnerability are expected to have lower chances of Survival than structures with lower Vulnerability.

Relative Vulnerability calculated for building nodes from Community Graph



- Vulnerability of a building node evaluated as the cumulative impact of all its neighbors assuming they have been ignited

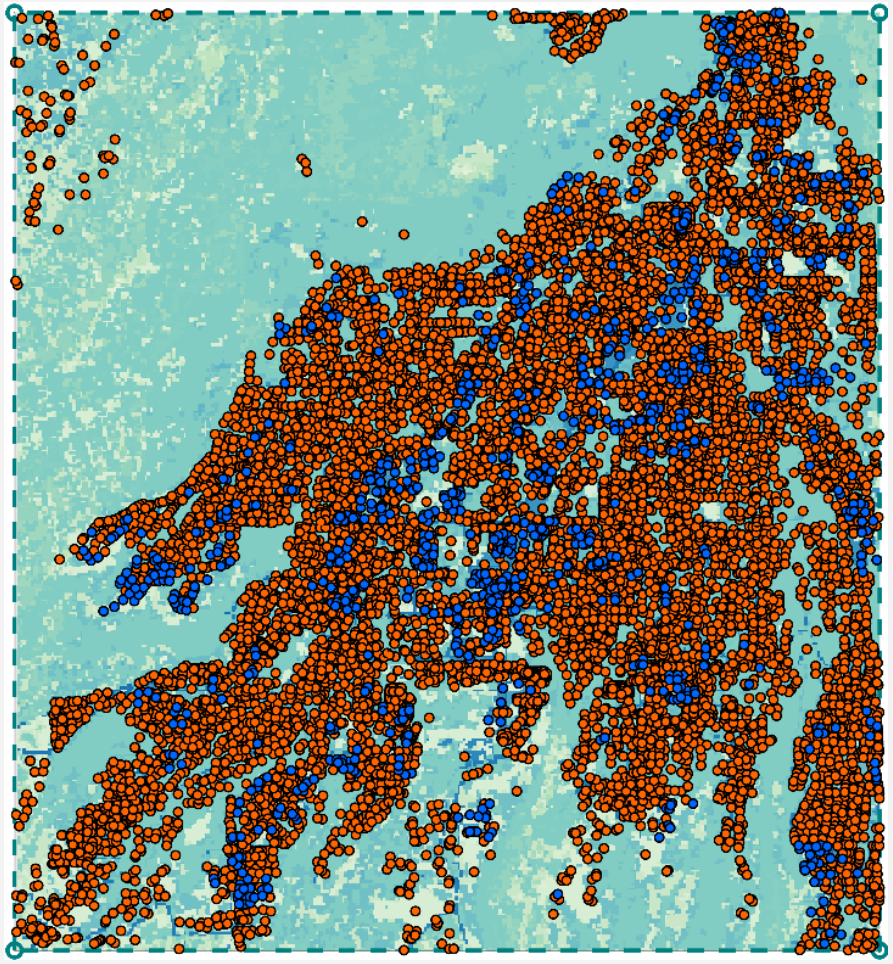
$$V^{(i)} = \frac{\sum_{k \in g(i)} a_{(k,i)}}{n^{g}_{(i)}}$$

$\sum_{k \in g(i)} a_{(k,i)}$ → Probability of Ignition of node *i* when node *k* is ignited

$n^{g}_{(i)}$ → No. of closest neighbors to node *i*

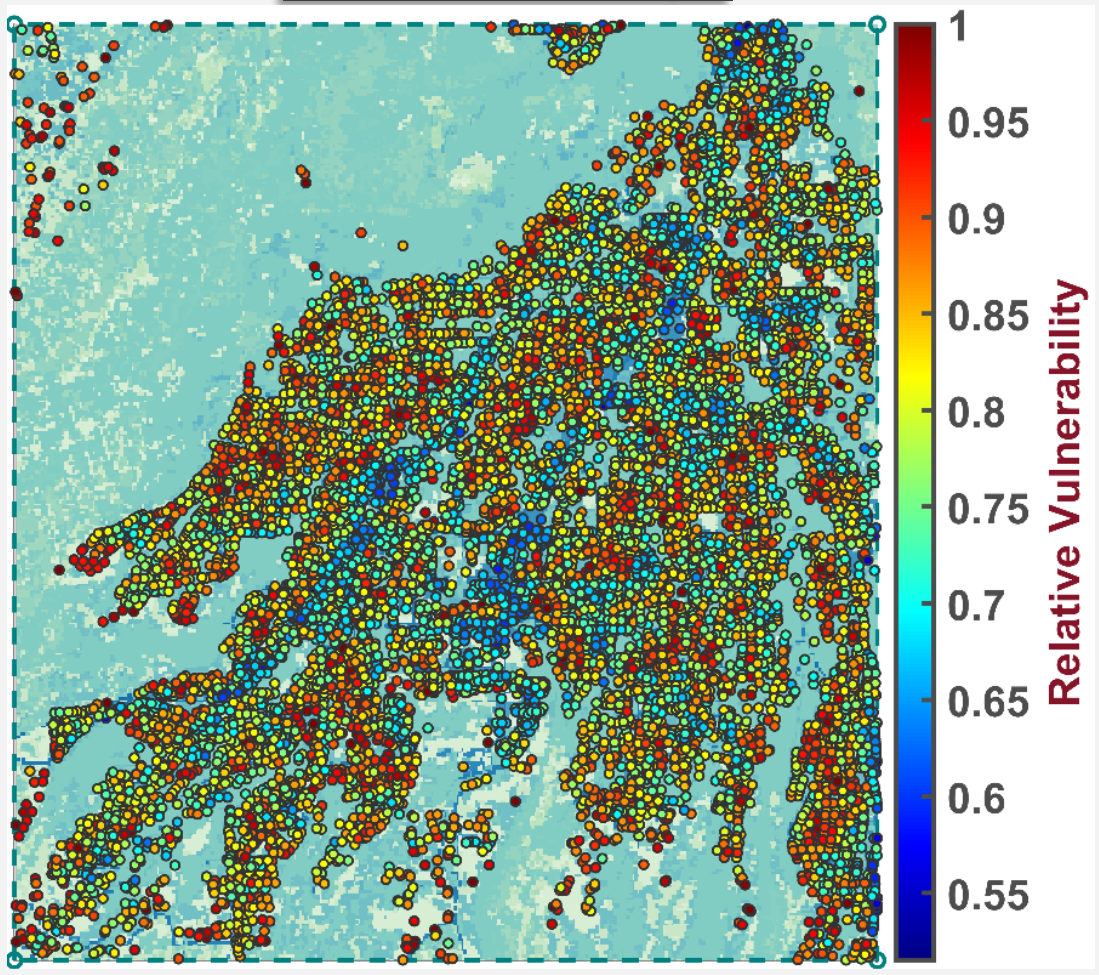
Damage Assessment – 2018 Camp Fire

Observed Damage



Survived Destroyed

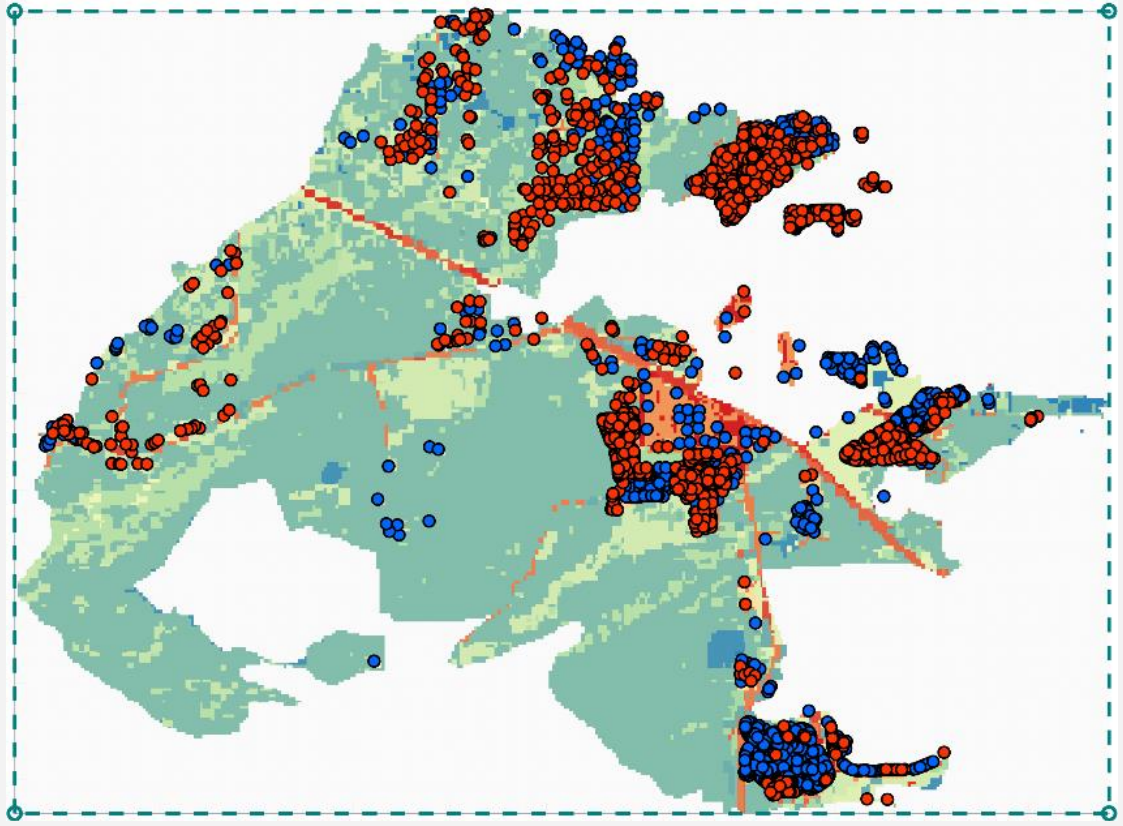
Relative Vulnerability



Chulahwat and Mahmoud et al. (2022) ***Sci. Rep.***

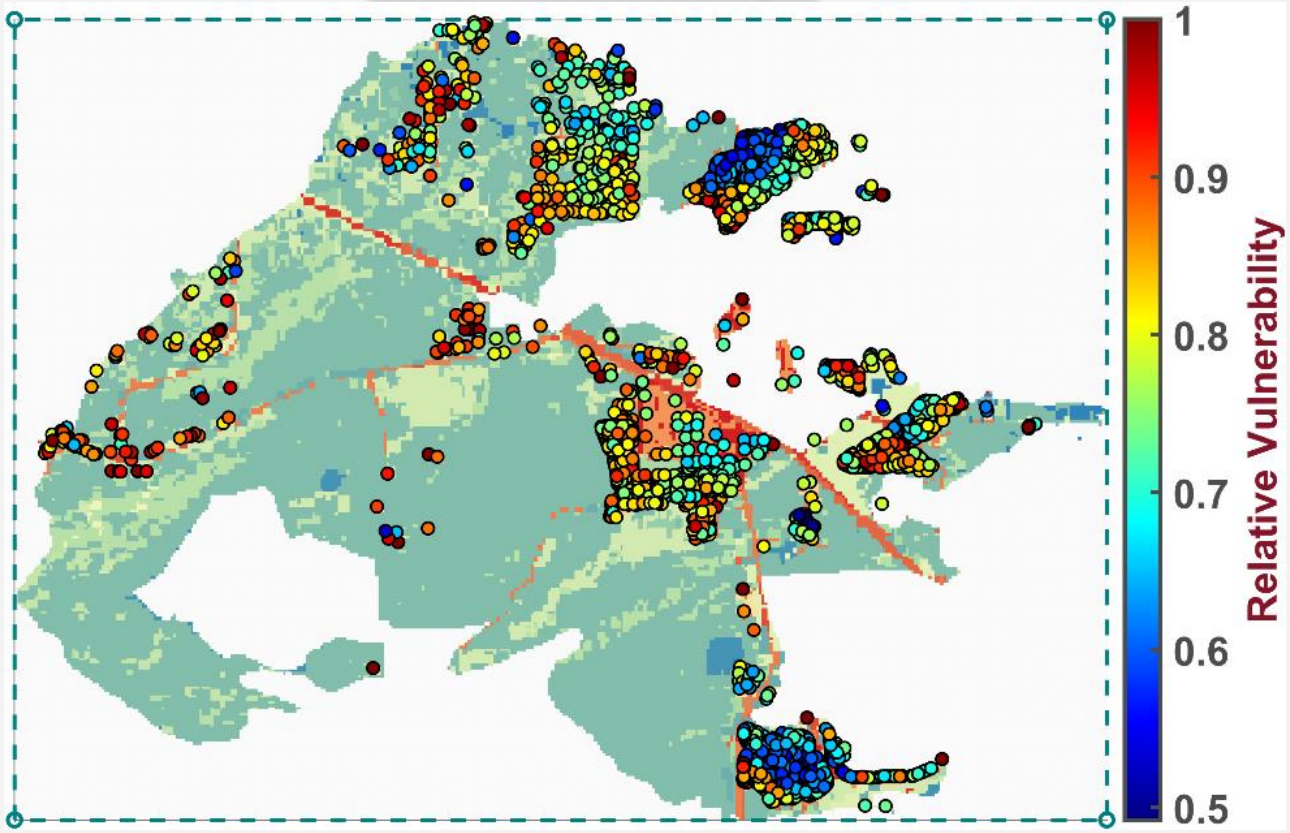
Damage Assessment – 2022 Marshall Fire

Observed Damage



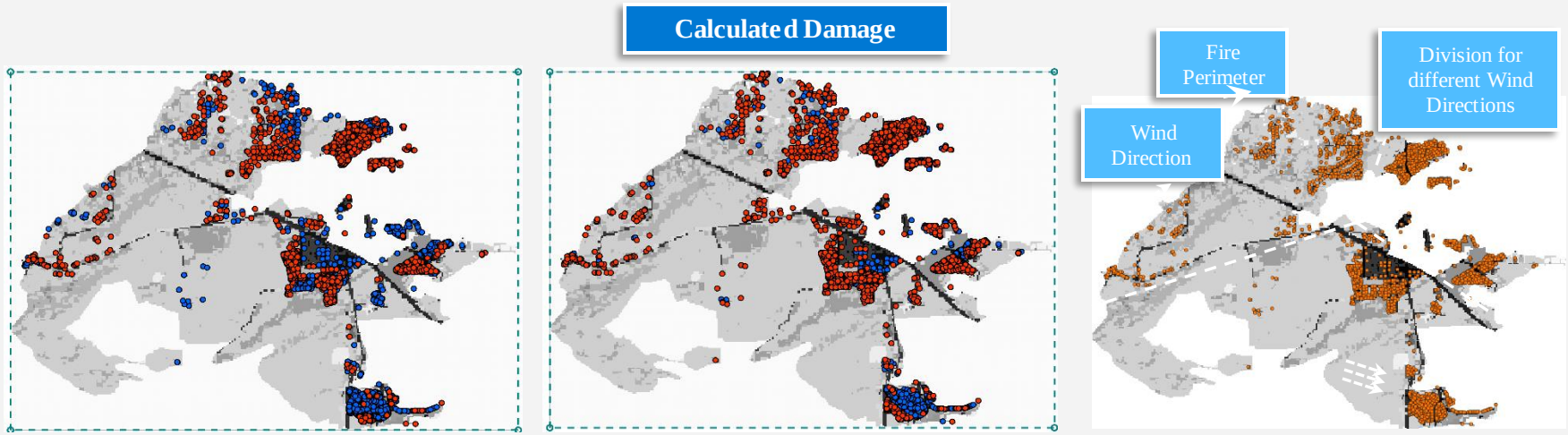
Survived Destroyed

Relative Vulnerability

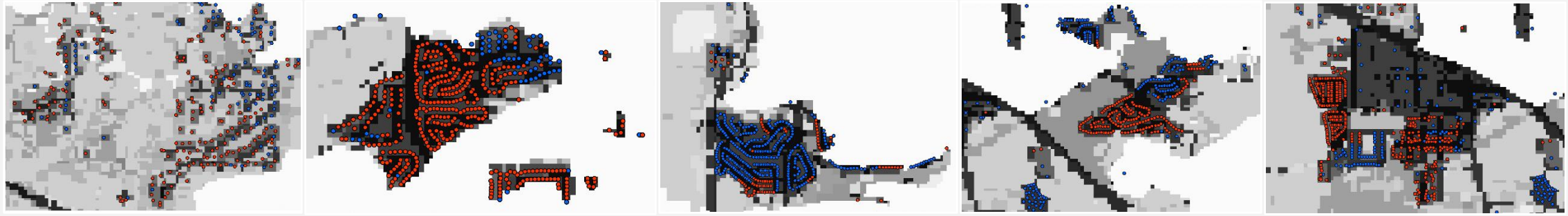


Chulahwat and Mahmoud (2023) ***Natural Hazard Review***

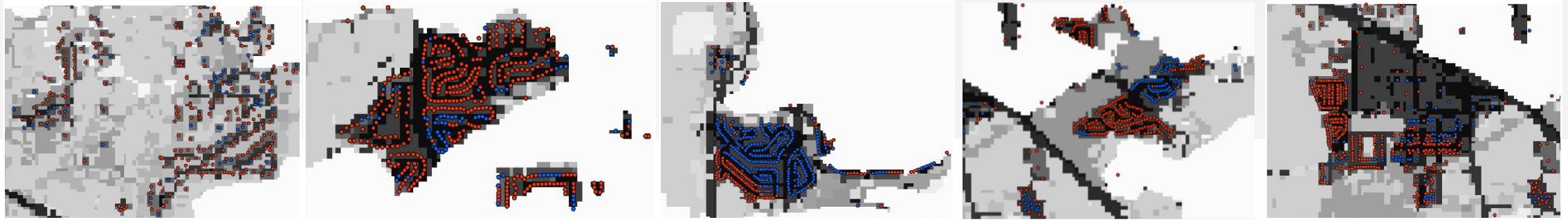
Marshall Fire (2022)



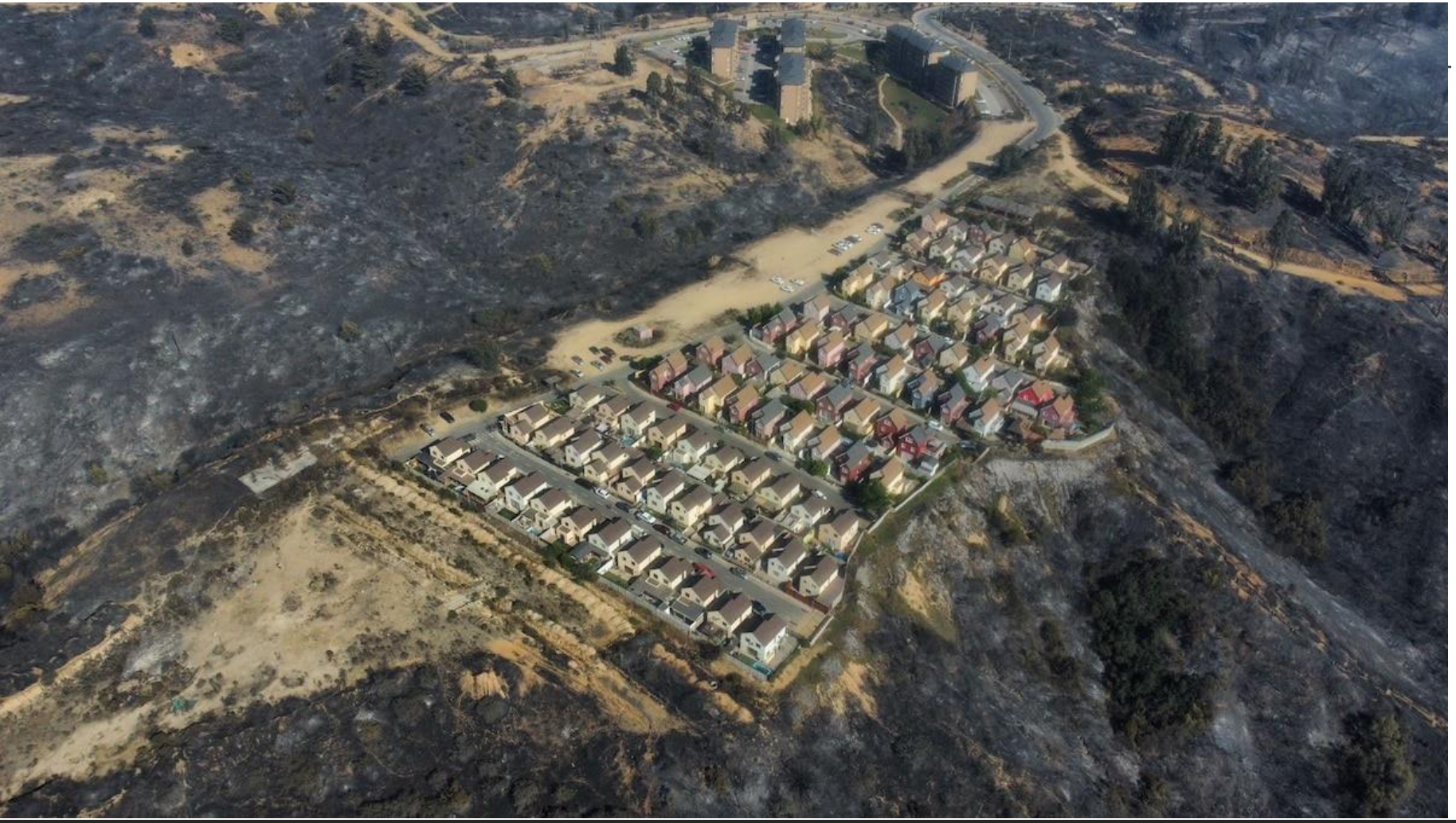
Observed Damage



Calculated Damage



"We could no longer be spectators."



- Community Member
Botania, Chile

Source: Wall Street Journal

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In Closing….

- We’re at the end of the beginning; time to stop admiring the problem and start solving it.
- Environmental and economic calamities have arrived without our permission; move with appropriate urgency.
- We are not hapless victims, communities can survive.
- Read Fire Weather: A True Story from a Hotter World