Land use planning and fire

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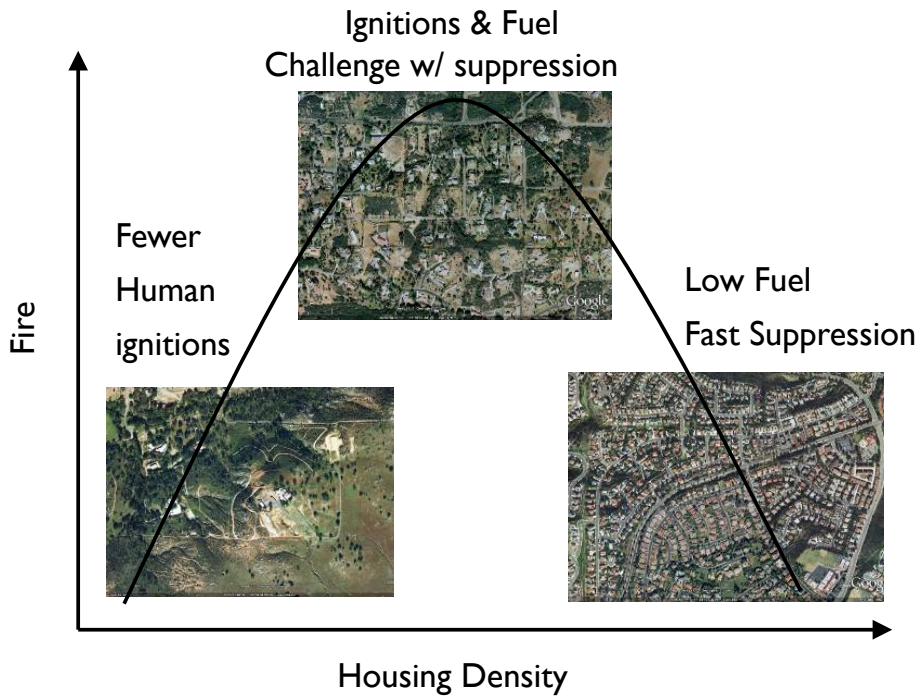
Presentation outline

- Basic theory on land use planning and fire risk
- WUI – definitions, growth, and California
- Can we reduce fire risk through planning?
- The new normal (Tubbs fire example)
- What happens after the fire?

Land use planning and fire



Syphard AD, Bar Massada A, Butsic V, Keeley JE (2013) Land Use Planning and Wildfire: Development Policies Influence Future Probability of Housing Loss. PLoS ONE 8(8):

What is the WUI

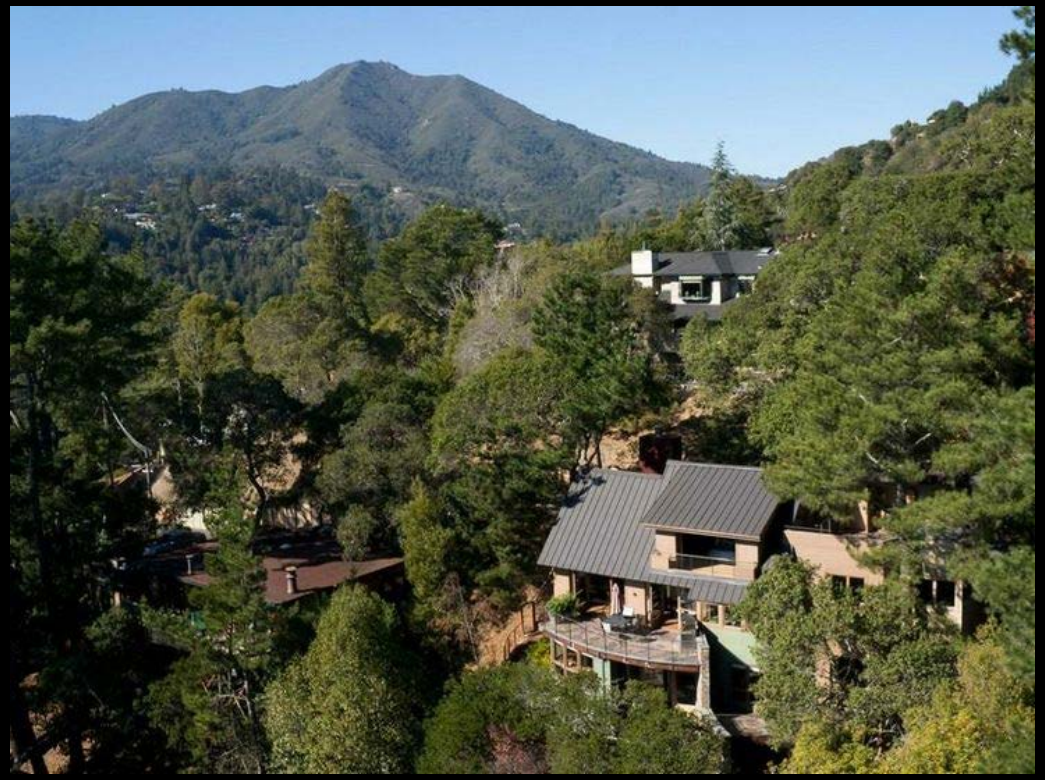
"The Wildland Urban Interface is the area where houses meet or intermingle with undeveloped wildland."

Federal Register, 2001

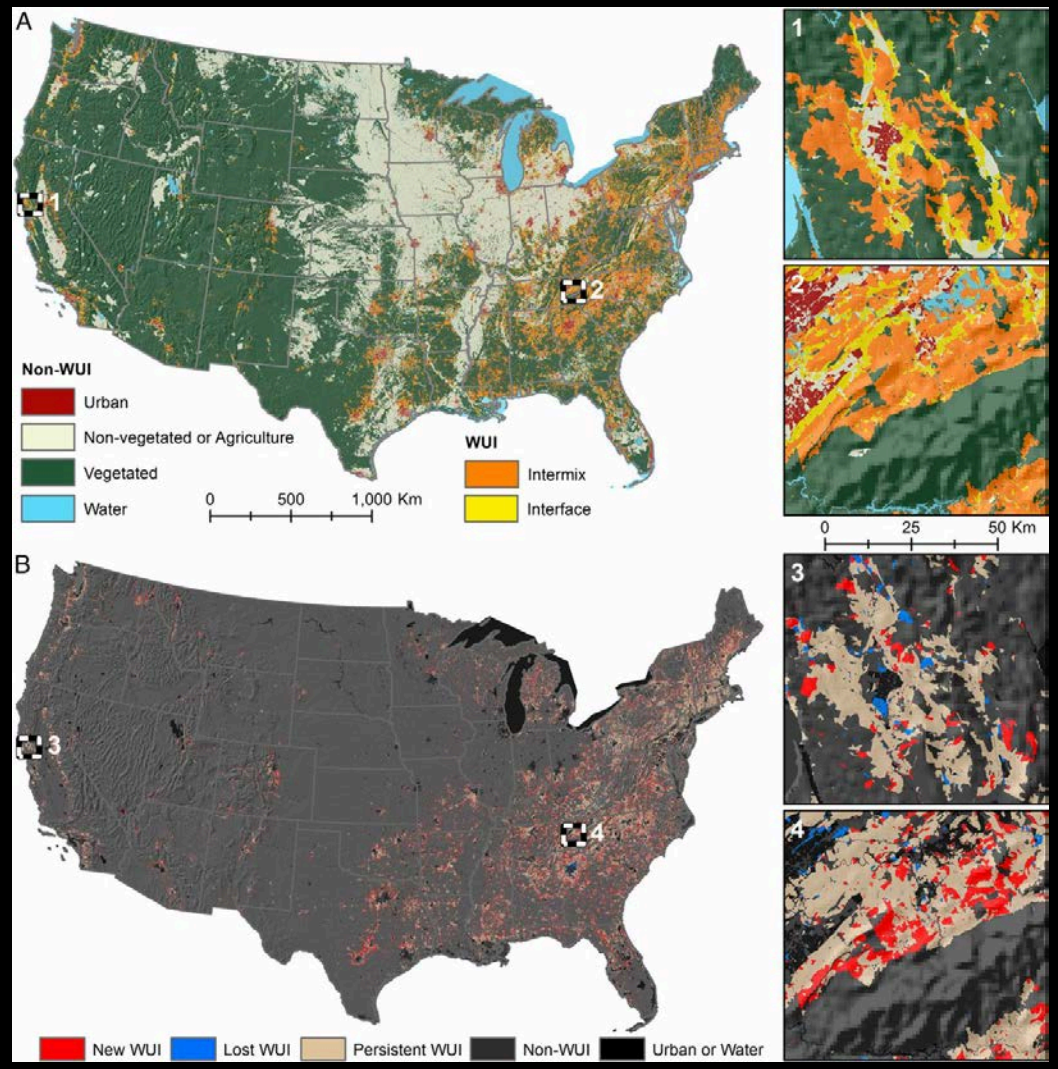
A formal definition of the WUI

WUI is composed of both interface and intermix communities. In both interface and intermix communities, housing must meet or exceed a minimum density of one structure per 40 acres (16 ha). Intermix communities are places where housing and vegetation intermingle. In intermix, wildland vegetation is continuous, more than 50 percent vegetation, in areas with more than 1 house per 16 ha. Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 mi of an area (made up of one or more contiguous Census blocks) over 1,325 acres (500 ha) that is more than 75 percent vegetated. The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI

Intermix vs interface

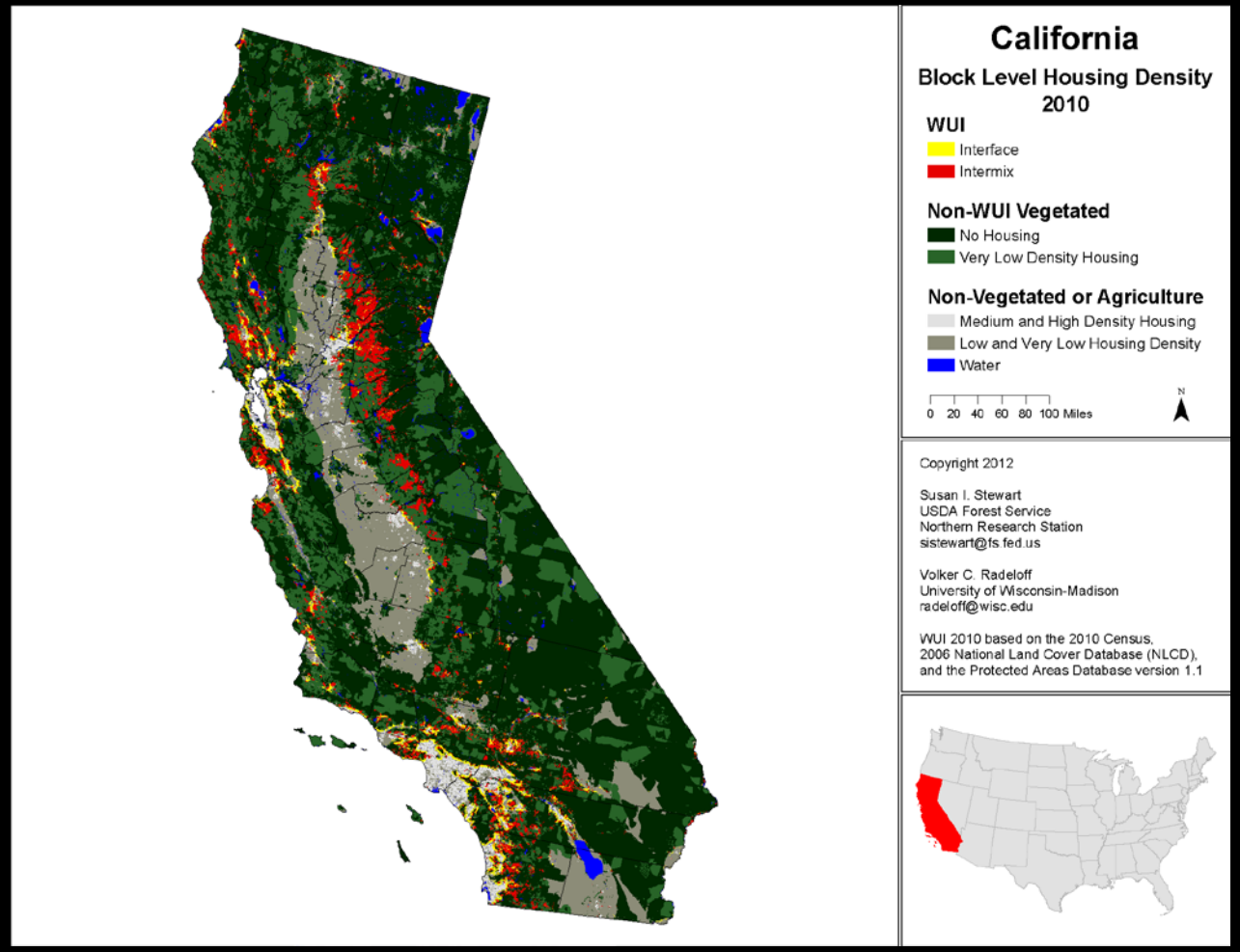


The WUI in the US

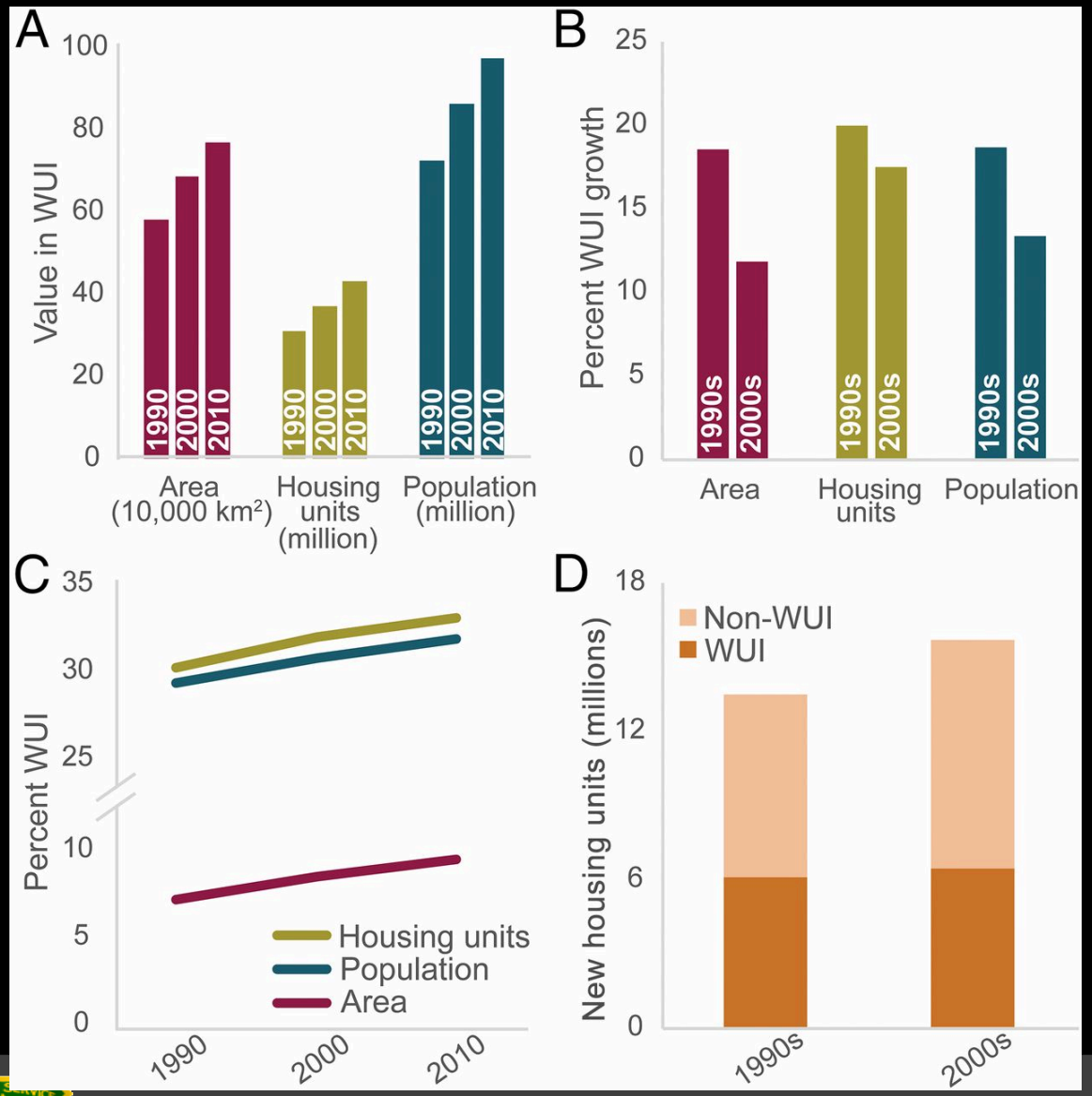


The WUI in the United States was widespread in 2010 (A), as were changes in WUI area (B), for example, in and around Santa Rosa, California (1, 3), and Gatlinburg, Tennessee (2, 4), areas where wildfires destroyed many homes in 2017 and 2016,

The WUI in California

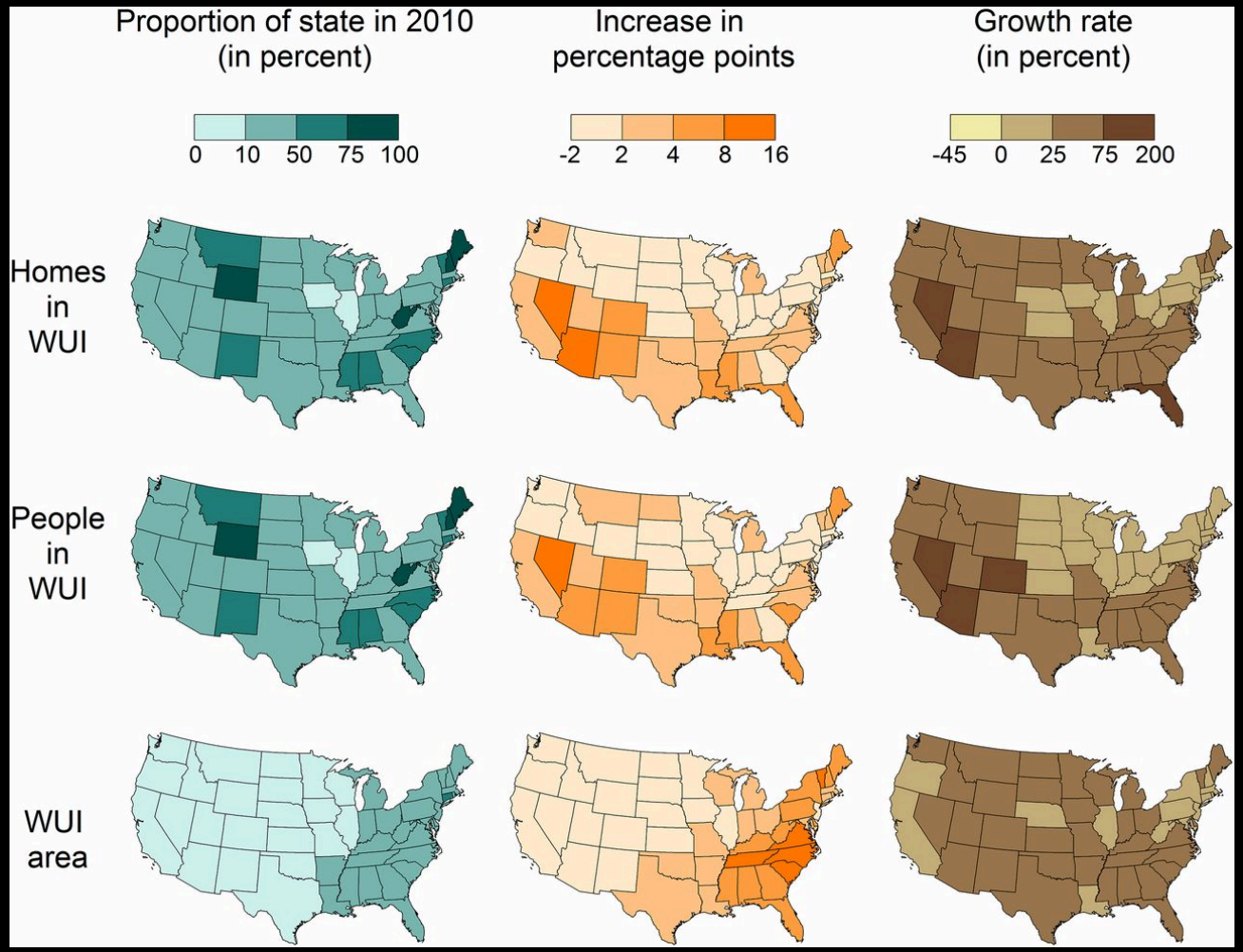


The WUI is growing



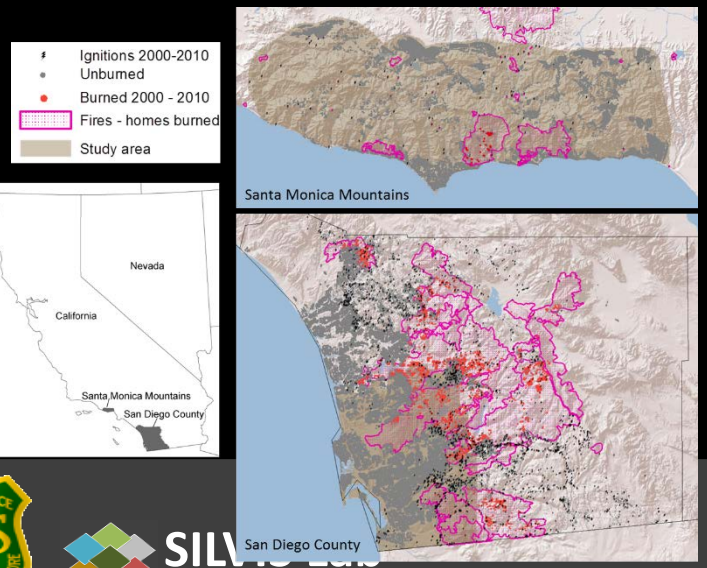
WUI growth was rapid in terms of the absolute numbers of the area, houses, and people in the WUI in 1990, 2000, and 2010 (*A*); WUI growth rates during the 1990s and the 2000s (*B*); the proportion of all houses and people, as well as the land area in the WUI in 1990, 2000, and 2010 (*C*); and the absolute number of all new housing units within and outside the WUI during the 1990s and 2000s (*D*).

Growth in California is relatively slow



WUI growth differed greatly among states, especially in the Southwest versus the Southeast, in terms of houses in the WUI, people in the WUI, and WUI area, calculated as the percentage of the state total in 2010, change in the WUI percentage from 1990 to 2010, and the growth rate (in percent) of the WUI from 1990 to 2010. Only the District of Columbia had negative absolute growth in the WUI (homes, people, and area).

The fire problem in San Diego County



Very fast moving fires – over 5000 acres an hour

Over 3500 homes and 30 lives lost in 2003 and 2007 events

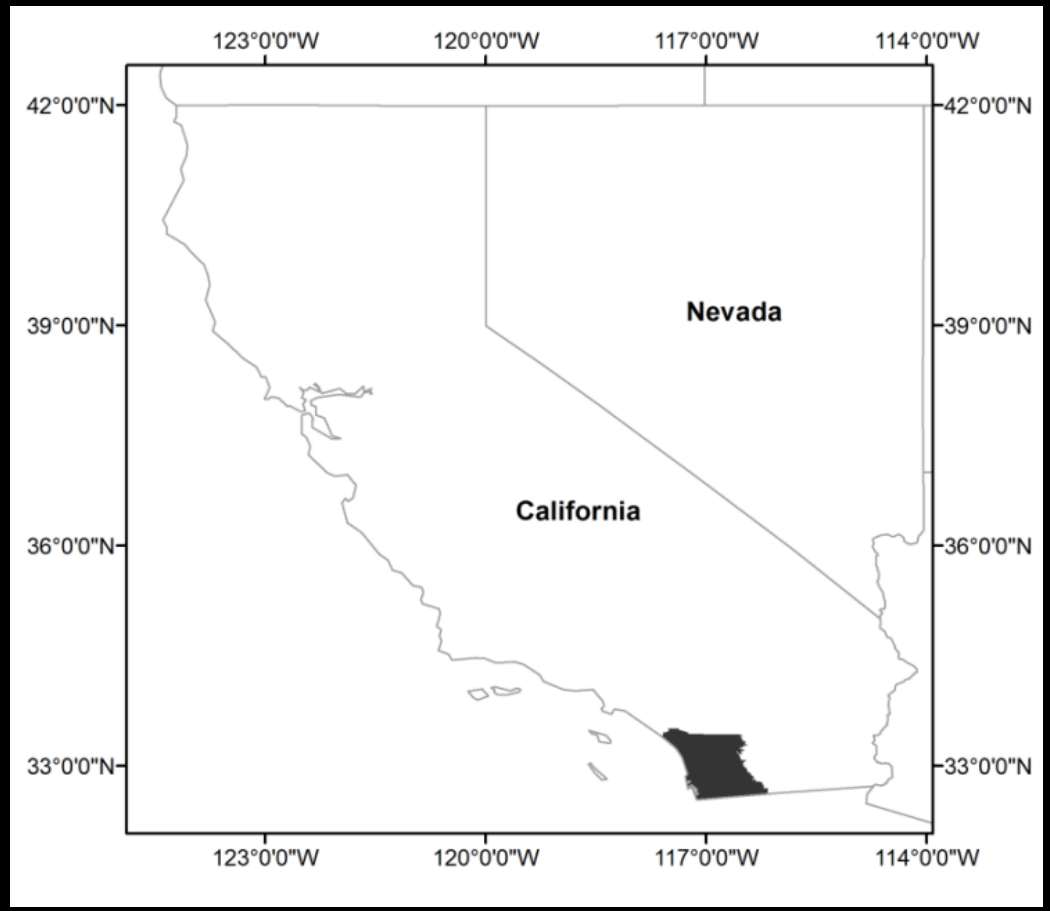
Vegetation can burn 3 years after last fires.

Research questions

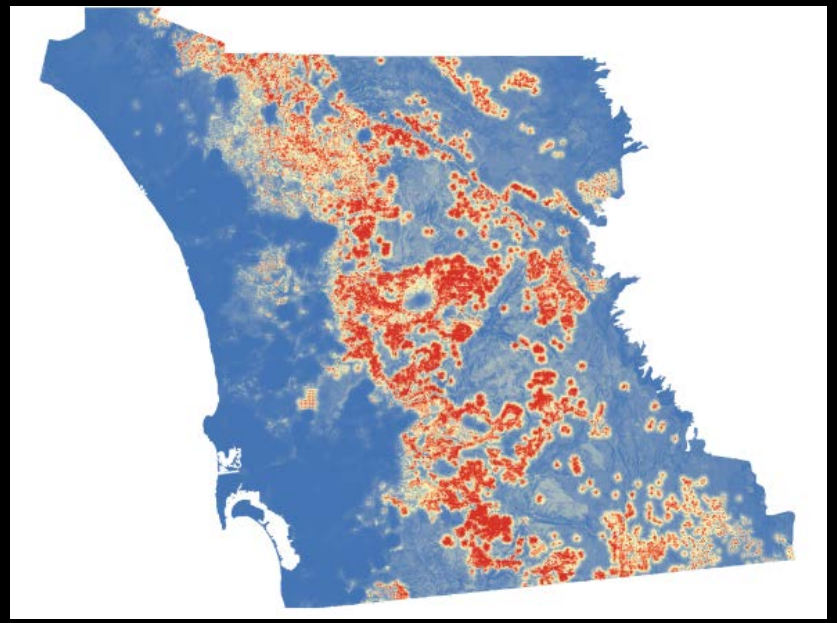
- Is land acquisition capable of reducing fire risk at the landscape scale?
- Is there an best way to select parcels for conservation to reduce fire risk?
- Do different development strategies (infill, expansion, leapfrog) lead to different levels of fire risk?

An empirical example in San Diego CA.

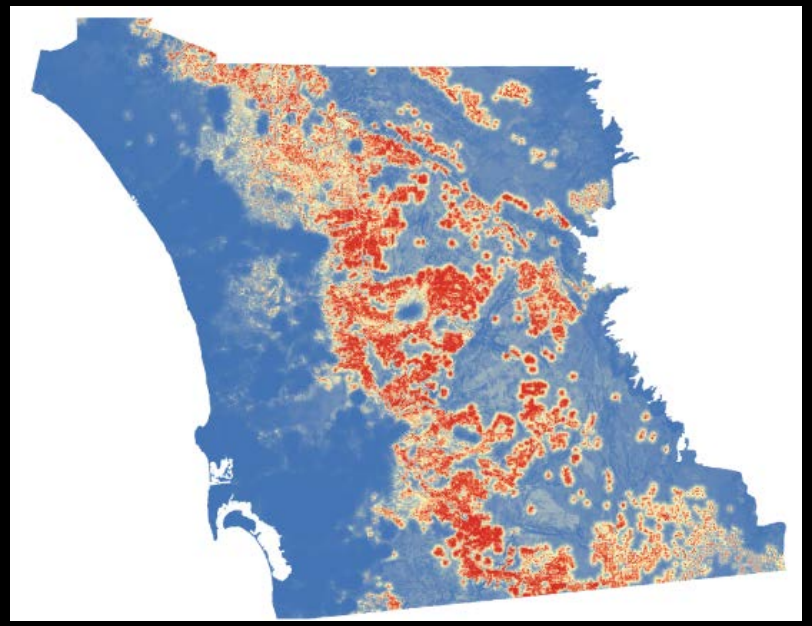
- County has about $20 million a year to spend on land acquisition each year.
- Over the next 20 years about 30,000 new housing units will be needed in San Diego County to meet expected population growth.



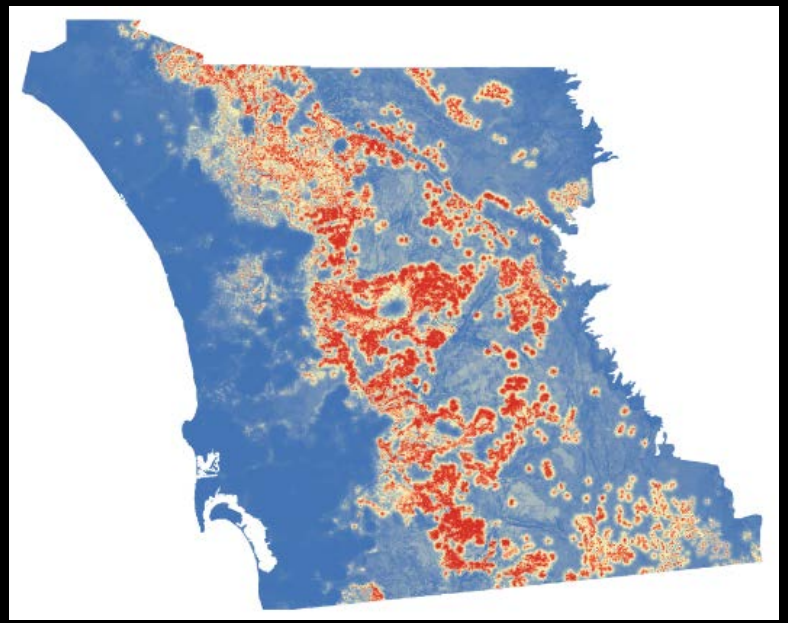
Fire risk at the end of the simulation



No protection

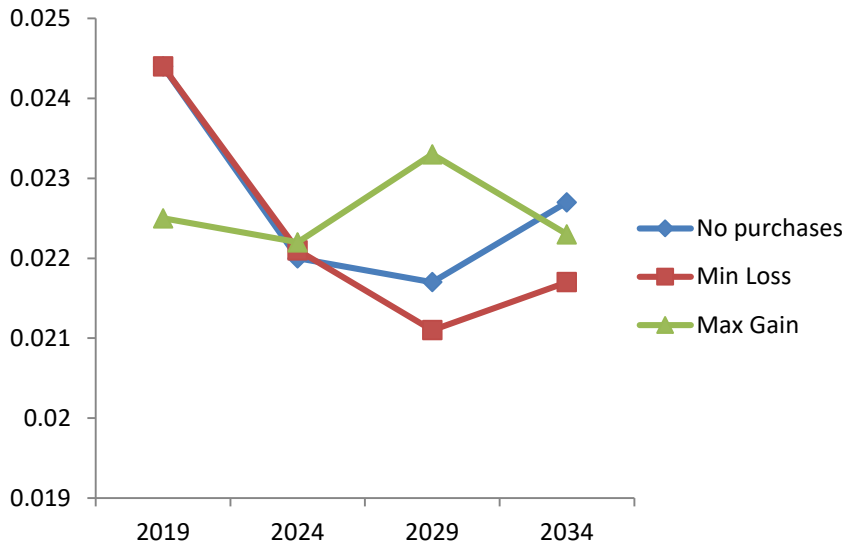


Minimize Loss

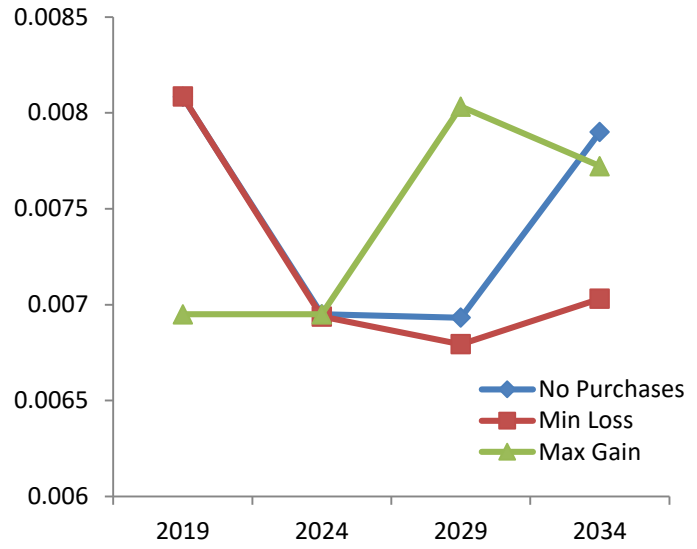


Maximize Gain

Fire risk at the end of the simulation

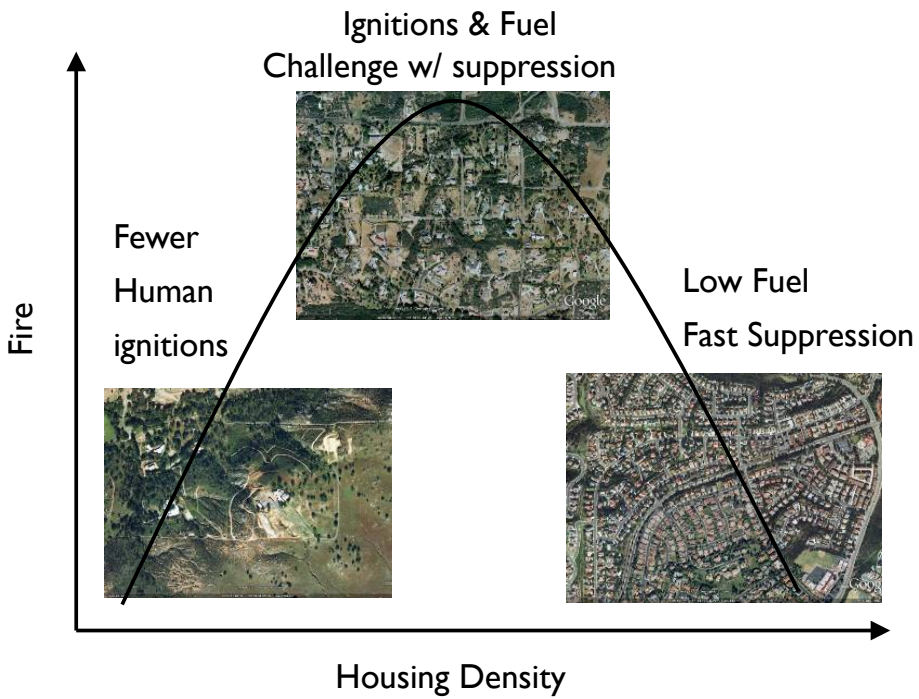


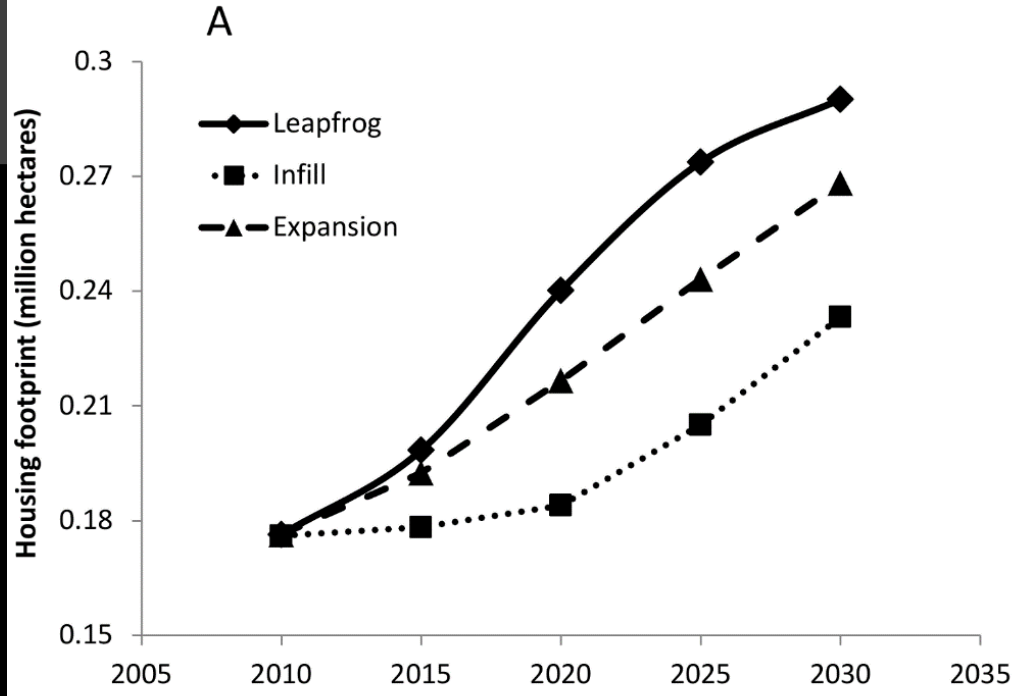
Mean fire risk to structures

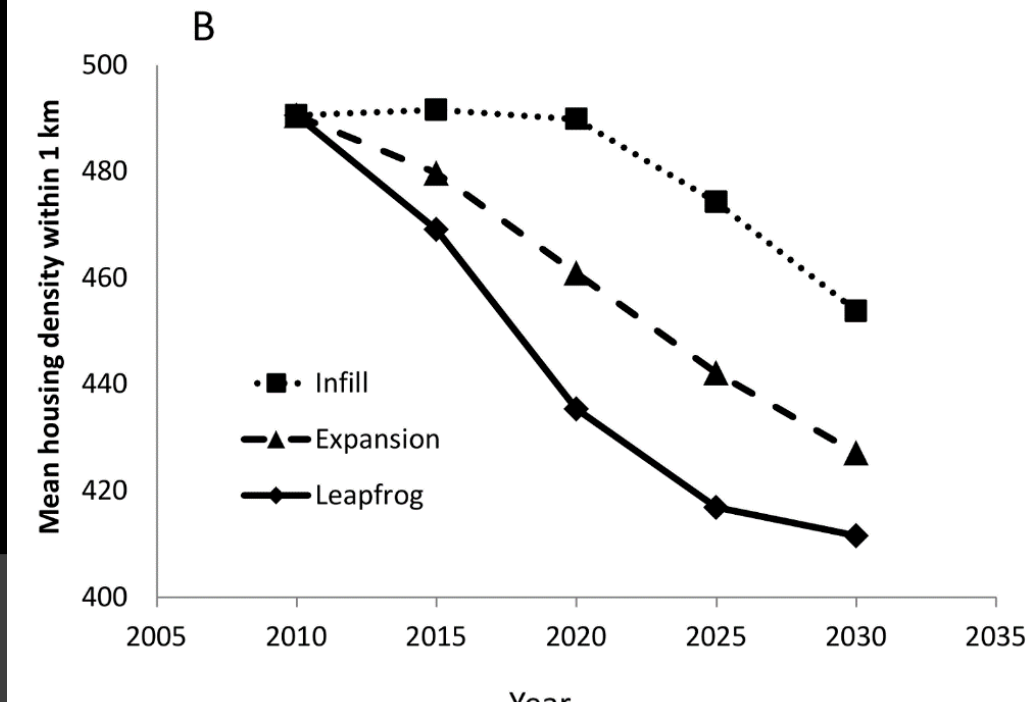


Proportion structures at risk when threshold is at 0.5

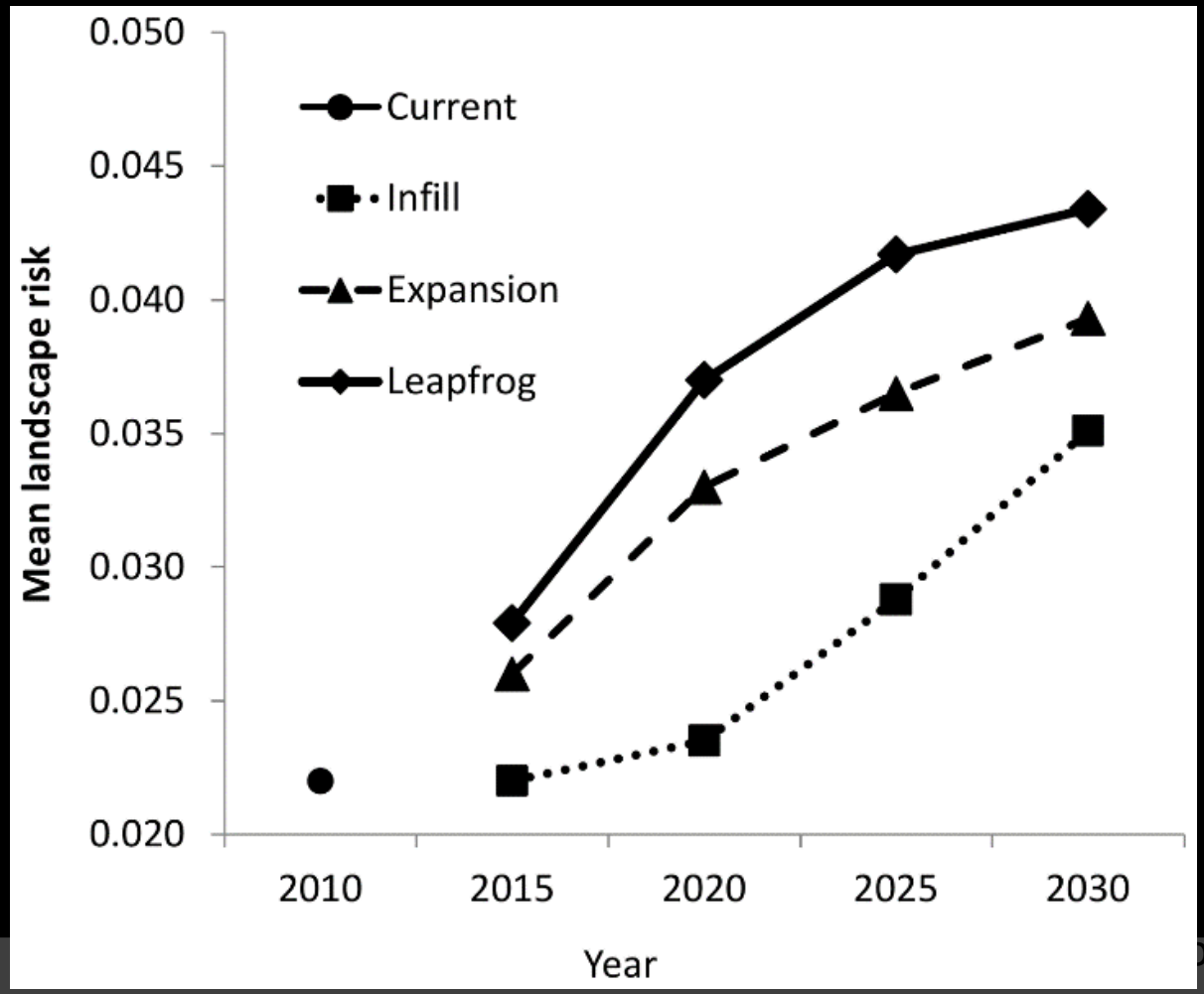
Land Use at end of simulation







Fire risk at the end of the simulation



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Conclusions

- Purchasing land can influence landscape scale housing density and the total amount of undeveloped habitat on the land.
- Land conservation can also impact fire risk
- Land use planning can reduce fire risk.

The 2017 Tubbs vs. "average" fire:
before, during, and after

On some streets in Coffey Park, homes on one side were incinerated while those on the other side appeared untouched. Derek Watkins/The New York Times

Before the Fire

C. Hanly Fire

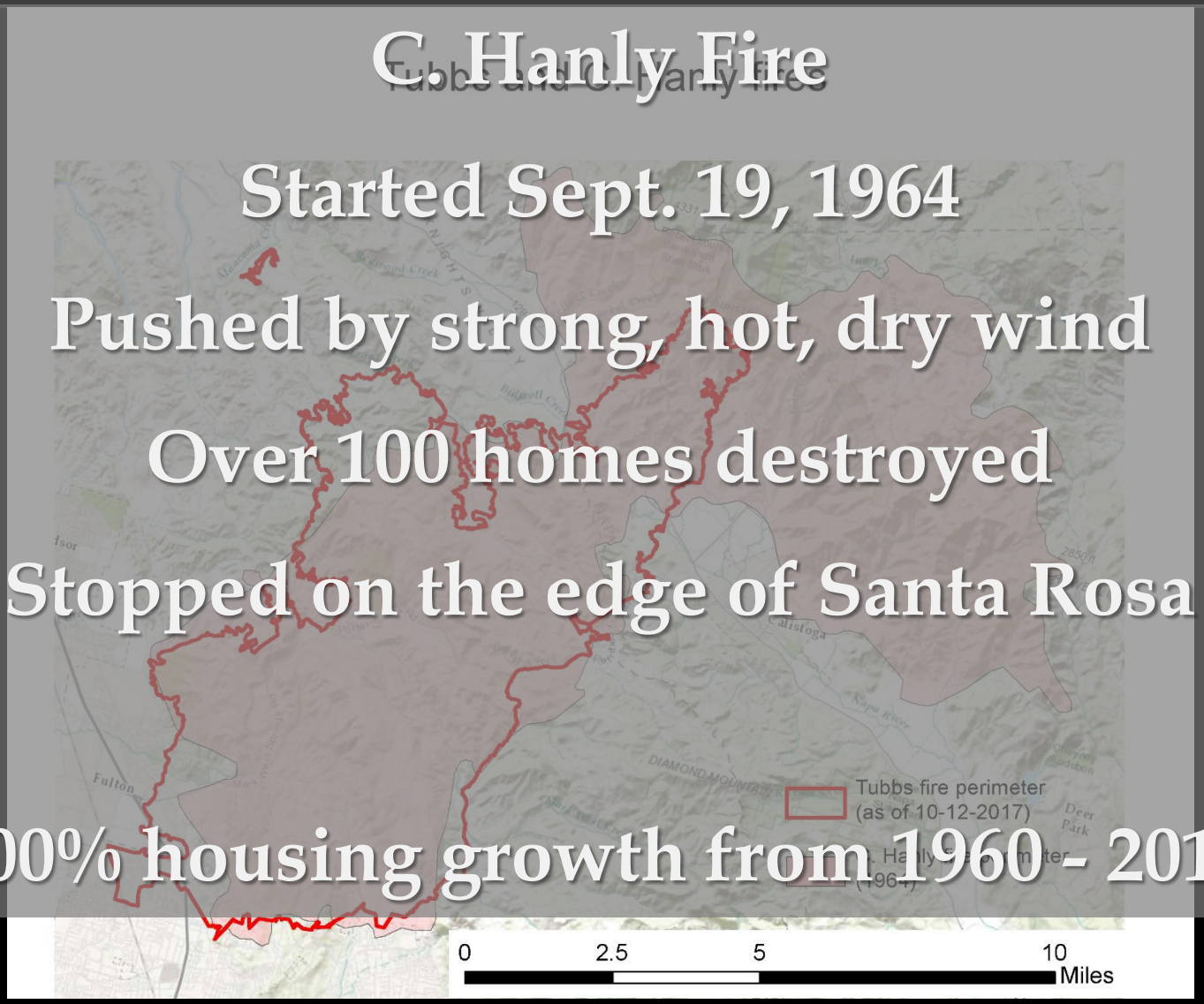
Started Sept. 19, 1964

Pushed by strong, hot, dry wind

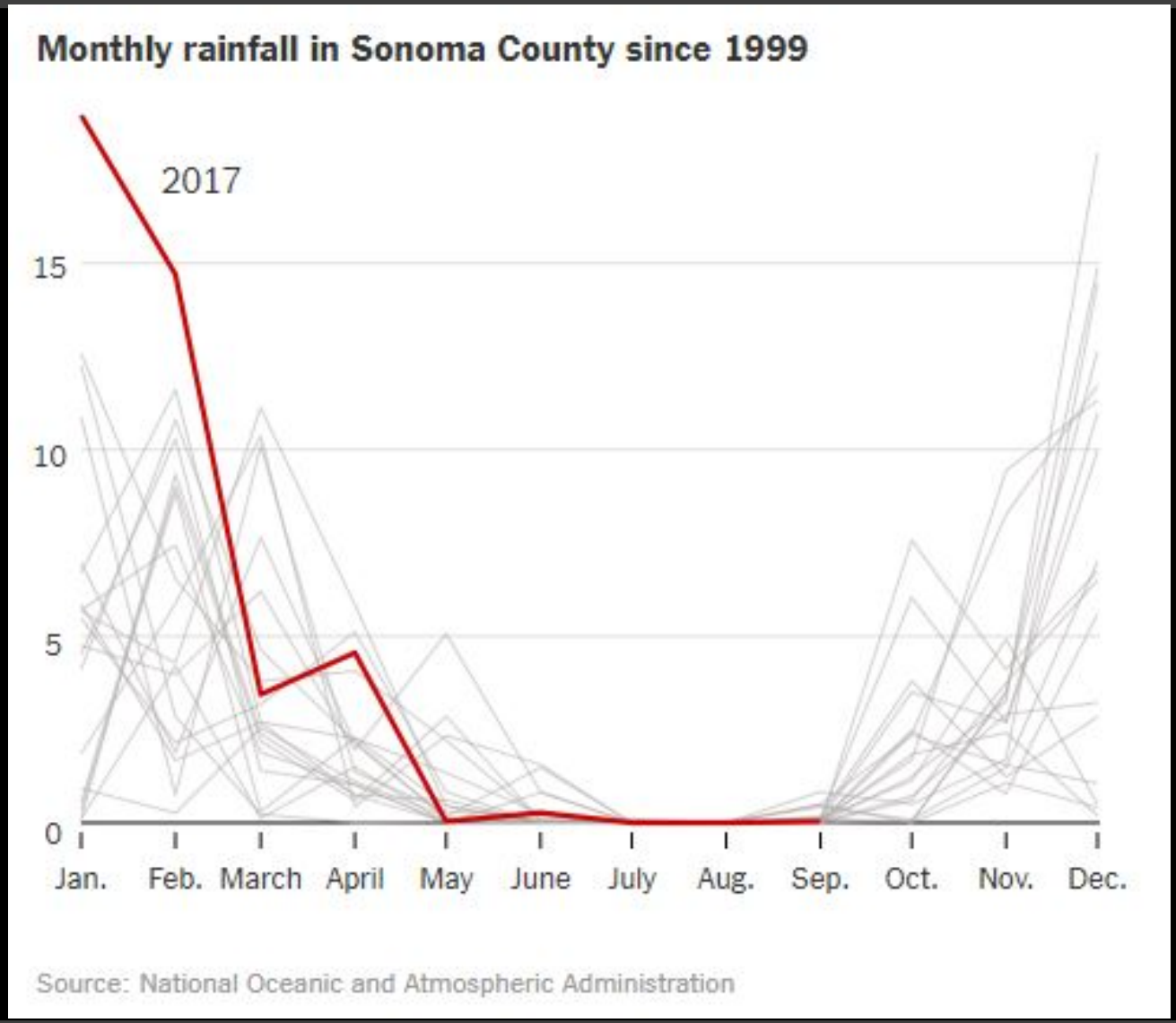
Over 100 homes destroyed

Stopped on the edge of Santa Rosa

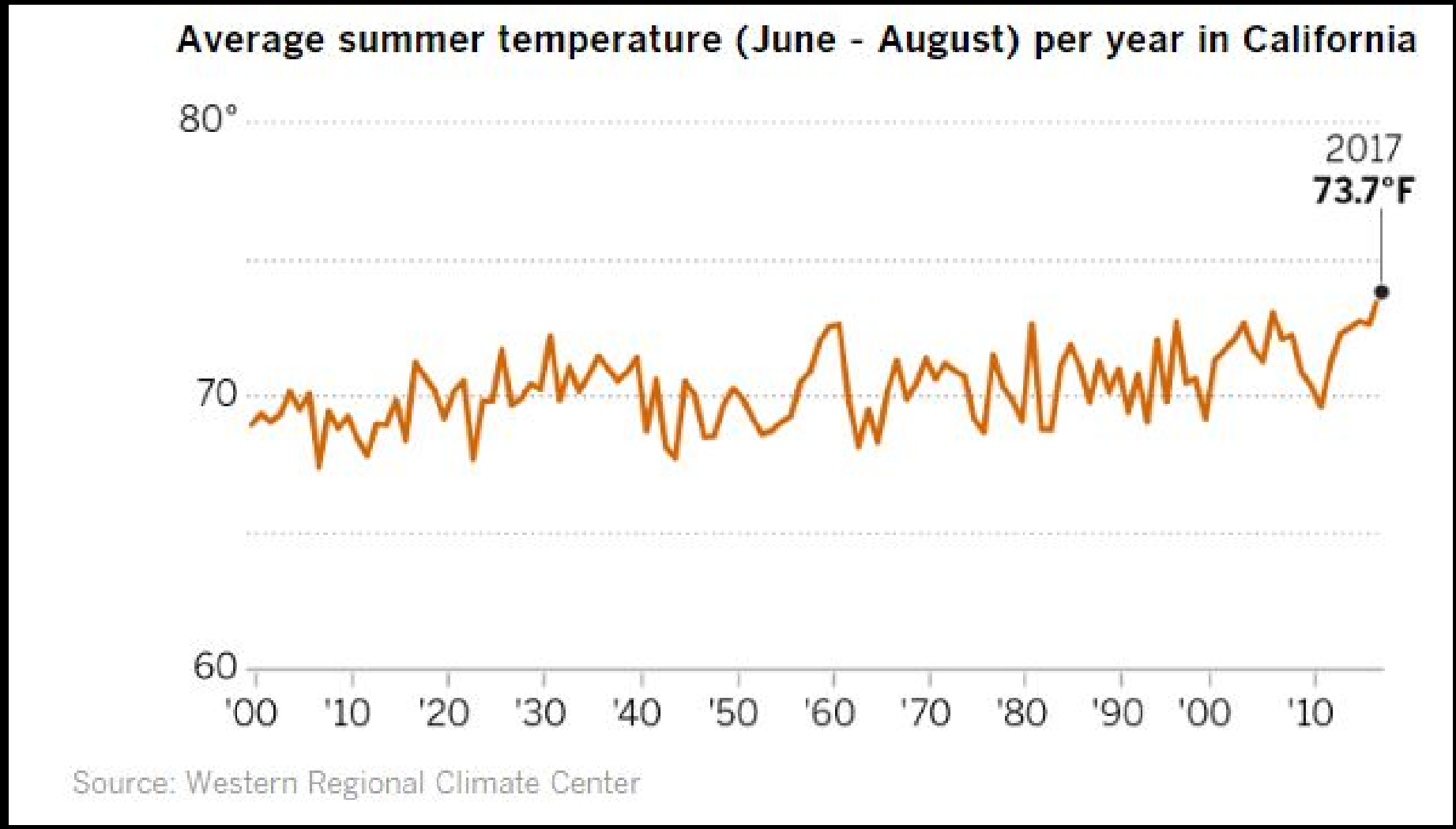
700% housing growth from 1960 - 2010



Before the Fire



Before the Fire



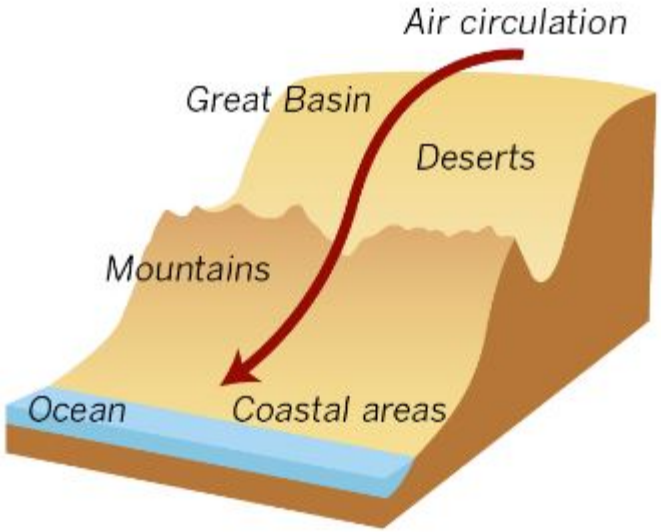
Before the Fire

How these winds work

Winds originate inland in areas of high pressure.

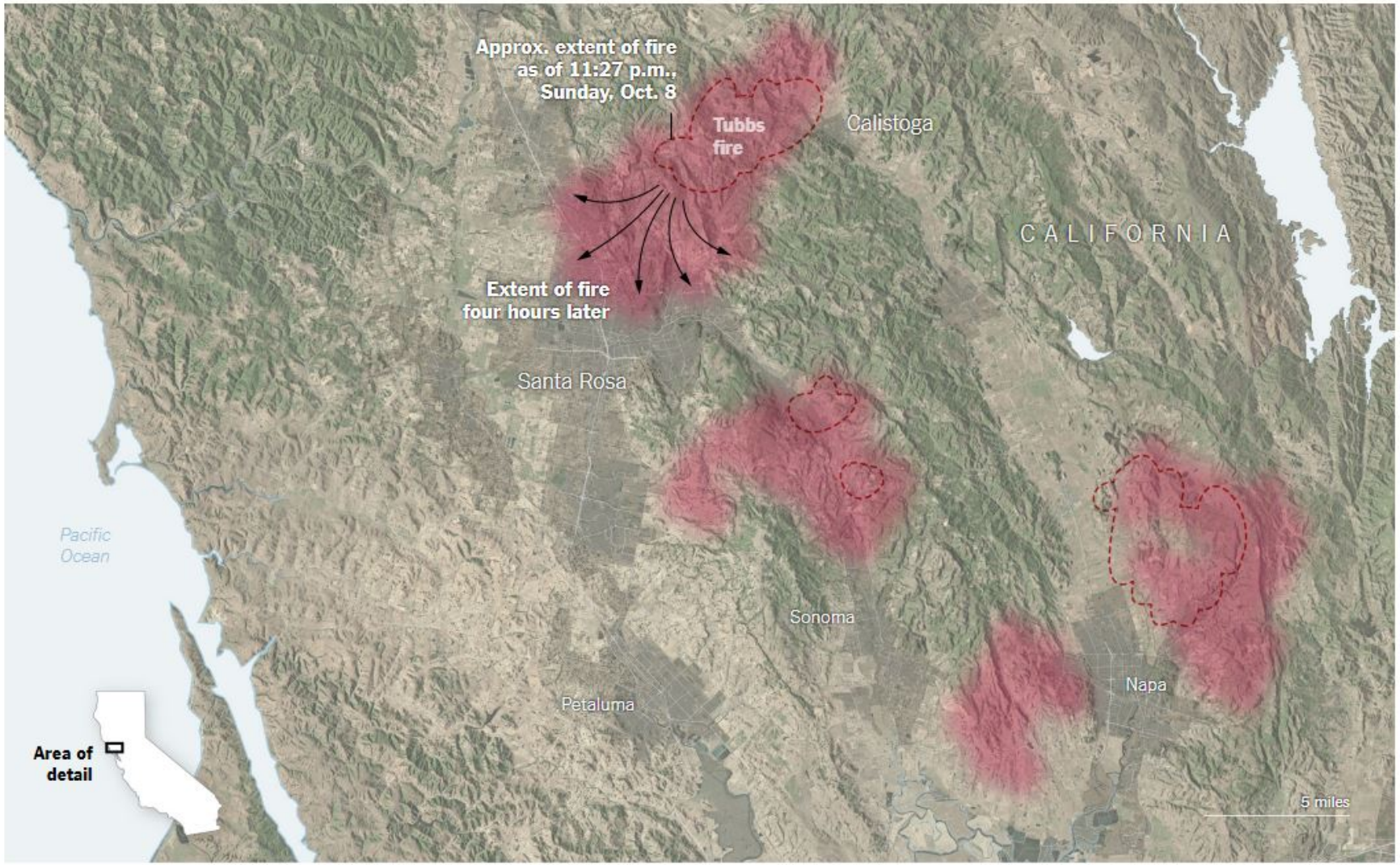
The winds travel down to lower-pressure, coastal areas, picking up speed and becoming hotter.

Winds may speed up more as they squeeze through canyons and narrow mountain spaces.



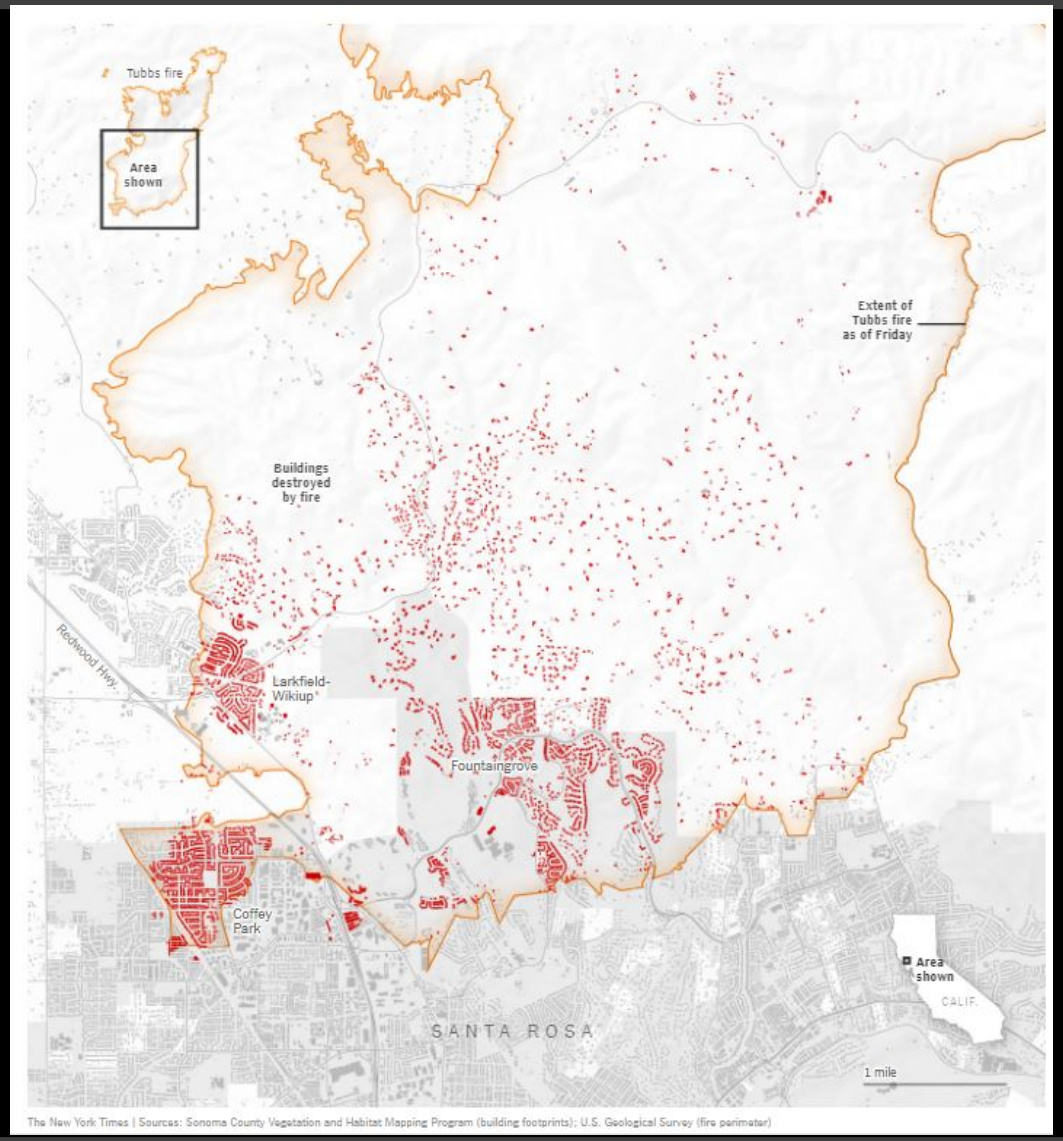
Source: Times reporting, Mapzen, OpenStreetmap.

Before the Fire



Source: NASA MODIS

During the Fire



During the Fire

- **In the US, only a few fires account for the majority of destruction:**
  - Between 2000 and 2013, 4% of destructive fires accounted for 70% of all destroyed buildings
  - Destruction in these fires averaged 39% and ranged between 11% and 73%
- **Tubbs was a highly destructive fire**
  - Second most destructive in CA history
  - 5,000 buildings were destroyed (*data from NYT, 10-13*)
  - 69% of all threatened buildings were destroyed

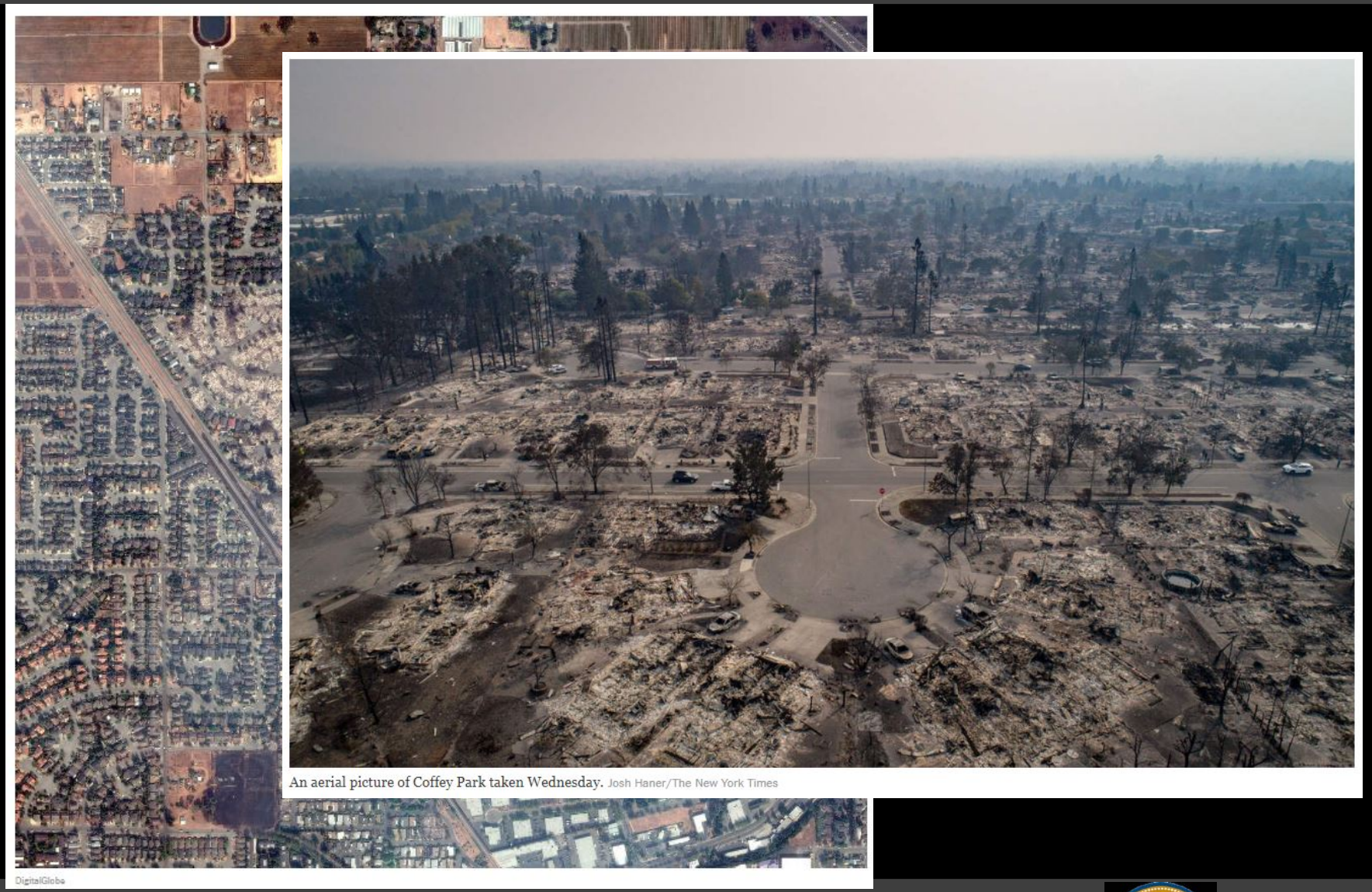
During the Fire

- **In the US:**
  - 69% buildings destroyed by wildfire in WUI
  - 2% destroyed buildings in non-WUI, urban
  - 29% buildings in non-WUI, non-urban

During the Fire

- **In the US:**
  - 69% buildings destroyed by wildfire in WUI
  - 2% destroyed buildings in non-WUI, urban
  - 29% buildings in non-WUI, non-urban
- **In Tubbs:**
  - 73% buildings destroyed by wildfire in WUI
  - 25% destroyed buildings in non-WUI, urban
  - 2% buildings in non-WUI, non-urban

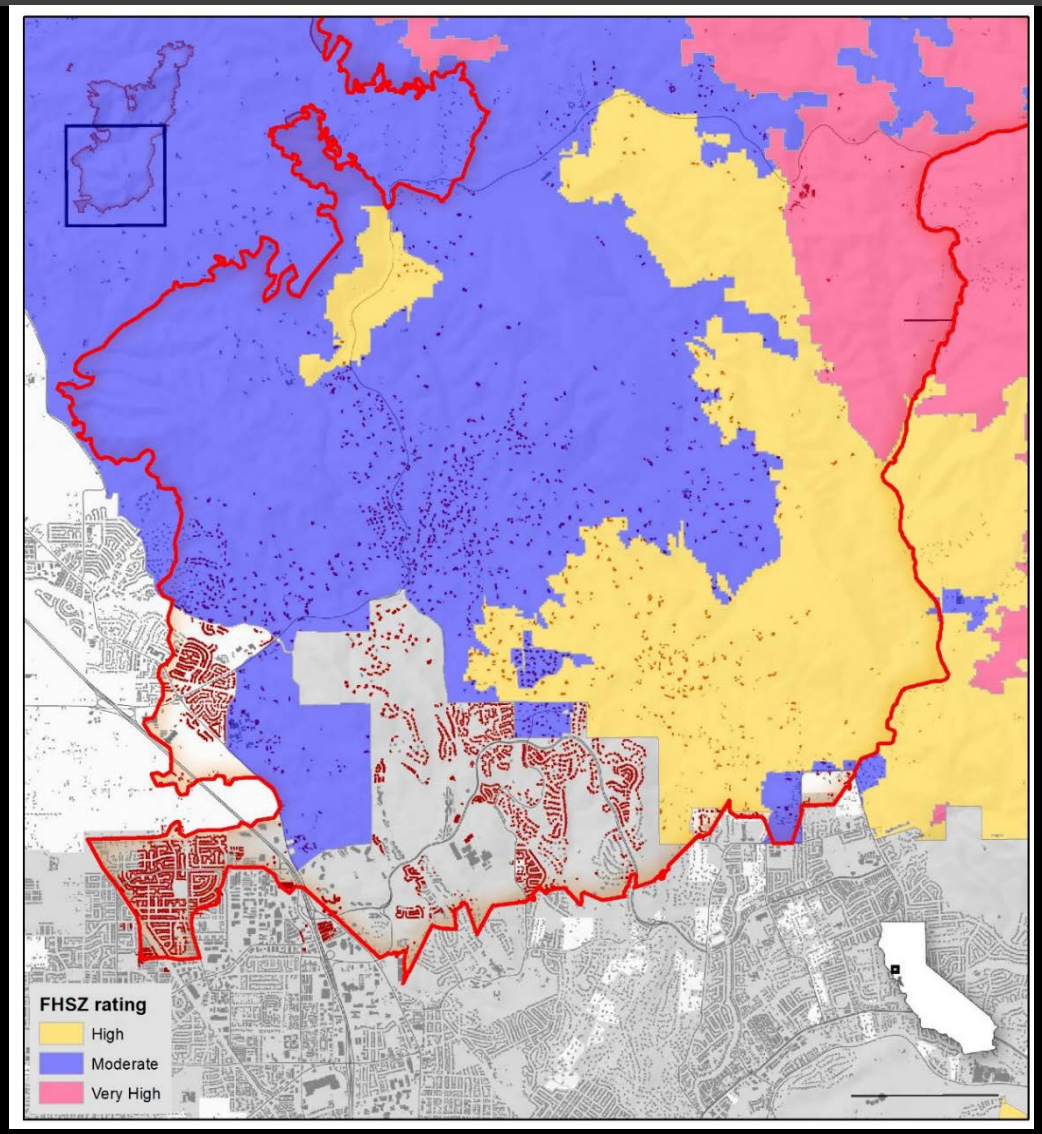
During the Fire



An aerial picture of Coffey Park taken Wednesday. Josh Haner/The New York Times

DigitalGlobe

During the Fire



During the Fire

	very high	high	moderate	No rating	TOTAL
total	159	637	1968	4353	7117
destroyed	53	351	1173	3300	4877
% destroyed (destruction rate)	33	55	60	76	69
% total buildings	2	9	28	61	100
% total destroyed	1	7	24	68	100

Highest destruction rate occurred in unrated FHSZ

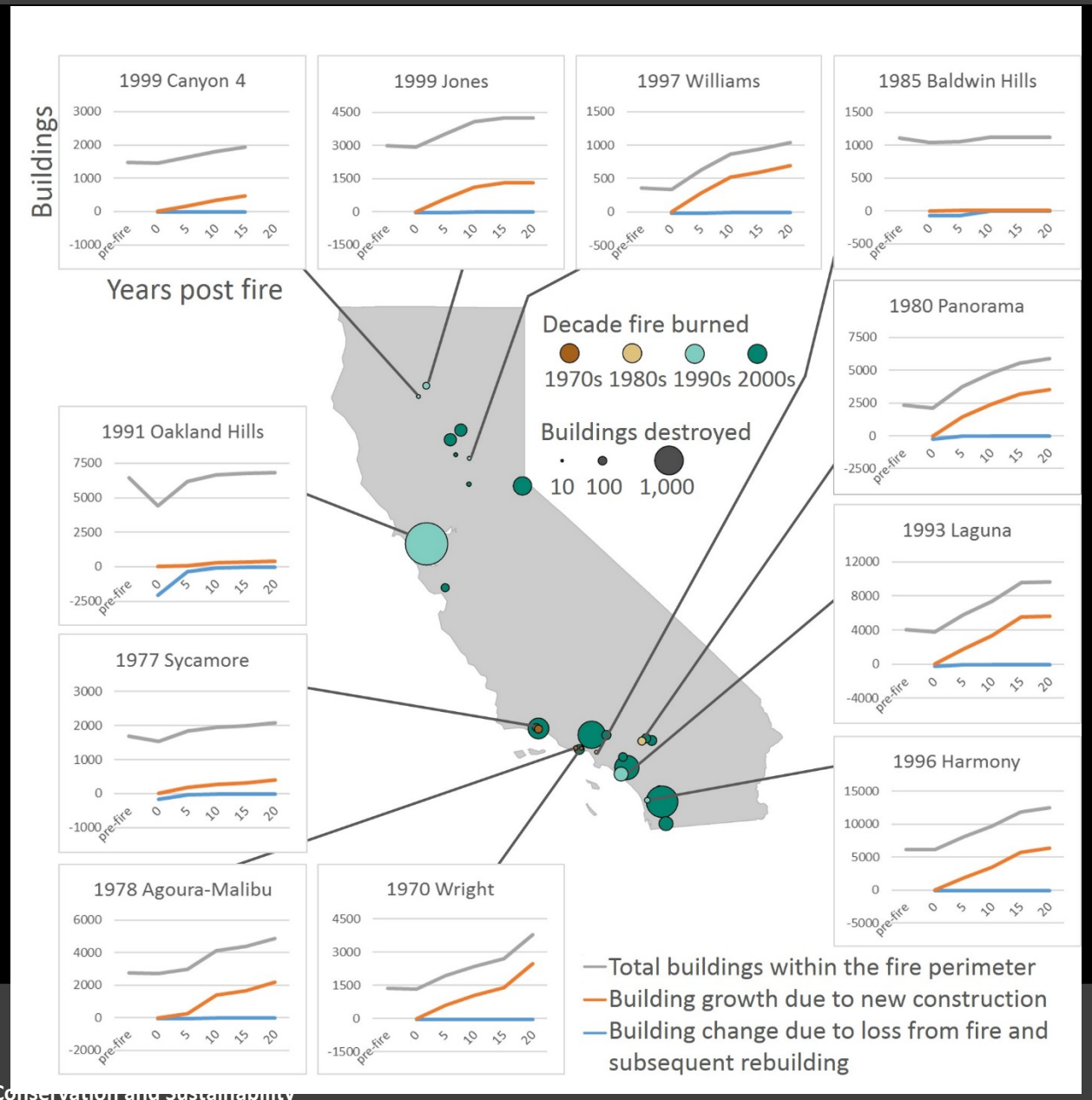
Lowest destruction rate occurred in highest FHSZ

After Fire

- Not all buildings are rebuilt
- In the U.S., 23% are rebuilt within 5 years
- In CA, 35% are rebuilt within 5 years
- In CA, 72% are rebuilt within 20 years (ranging from 13% to 100%)

After Fire

- Of all rebuilt buildings, 67% are rebuilt in 5 years & 94% in 10
- With new construction, most fires contain more buildings 5 years after fire than before


1999 Canyon 4
1999 Jones
1997 Williams
1985 Baldwin Hills
Buildings
Years post fire
Decade fire burned
1970s 1980s 1990s 2000s
Buildings destroyed
10 100 1,000
1980 Panorama
1991 Oakland Hills
1993 Laguna
1977 Sycamore
1996 Harmony
1978 Agoura-Malibu
1970 Wright
Total buildings within the fire perimeter
Building growth due to new construction
Building change due to loss from fire and subsequent rebuilding

Summary Statistics

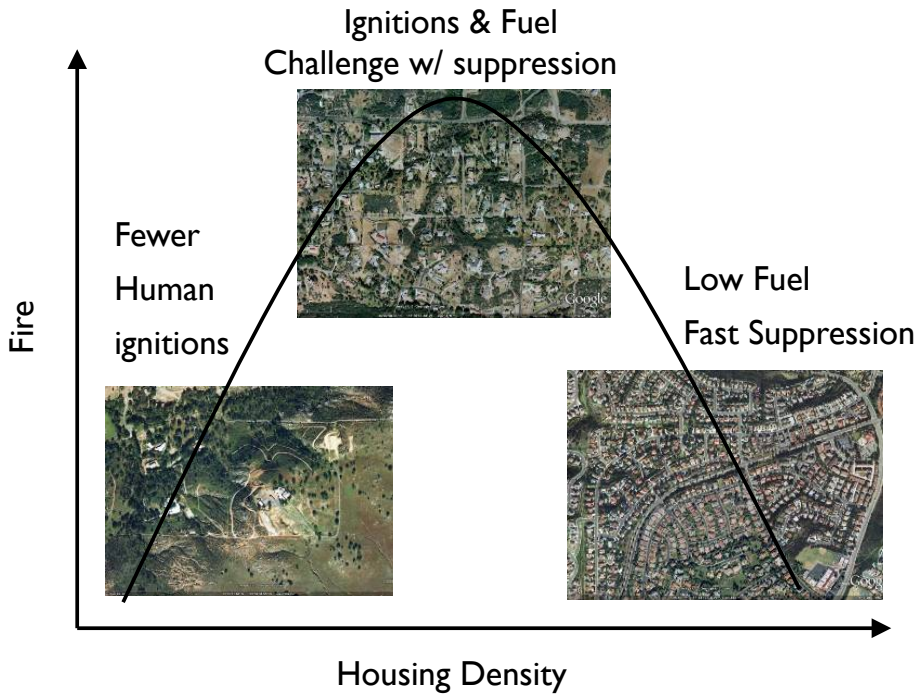
		six years post-fire (29 fires; 1970-2009)	25 years post-fire (11 fires; 1970-1999)
	Total survived	50,516	27,818
All Buildings	Total destroyed	8,274	3,005
	Total rebuilt	4,086	2,813
	Proportion rebuilt (%)	49	94
	Total new buildings	7,617	23,396
	Growth from new (%) [1]	15	84
Range of values by fire	Proportion rebuilt (%)	0 - 99	13 – 100
	Growth from new (%) [1]	0 - 85	1 - 205

	Are rebuilt homes in areas of lower or higher fire risk than homes not rebuilt?		Are new homes in areas of lower or fire risk than homes before the fire?		Are rebuilds that take greater than five years in areas of lower or higher fire risk than quick rebuilds?		Do new buildings built longer after fire have lower or higher fire risk?	
	# fires	Mean difference	# fires	Mean difference	# fires	Mean difference	# fires	Mean difference
Higher fire risk	7	0.266	5	0.176	2	16.854	5	10.510
Lower fire risk	2	-0.044	7	-0.040	2	-84.135	0	-----
No Effect	19	-----	6	-----	5	-----	4	-----

Overall

Points to discuss

- Planning does seem to make a difference
- Density is typically best?
- Land acquisition can increase density
- Almost everyone will rebuild, and we will see new housing within fire parameters.
- These houses will be located in areas just as risky as previous houses



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