

# Assessing Wildfire Risk in Los Angeles County: A Multi-Criteria Spatial Analysis

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GIS 5571  
Fall 2024





# Los Angeles County, CA

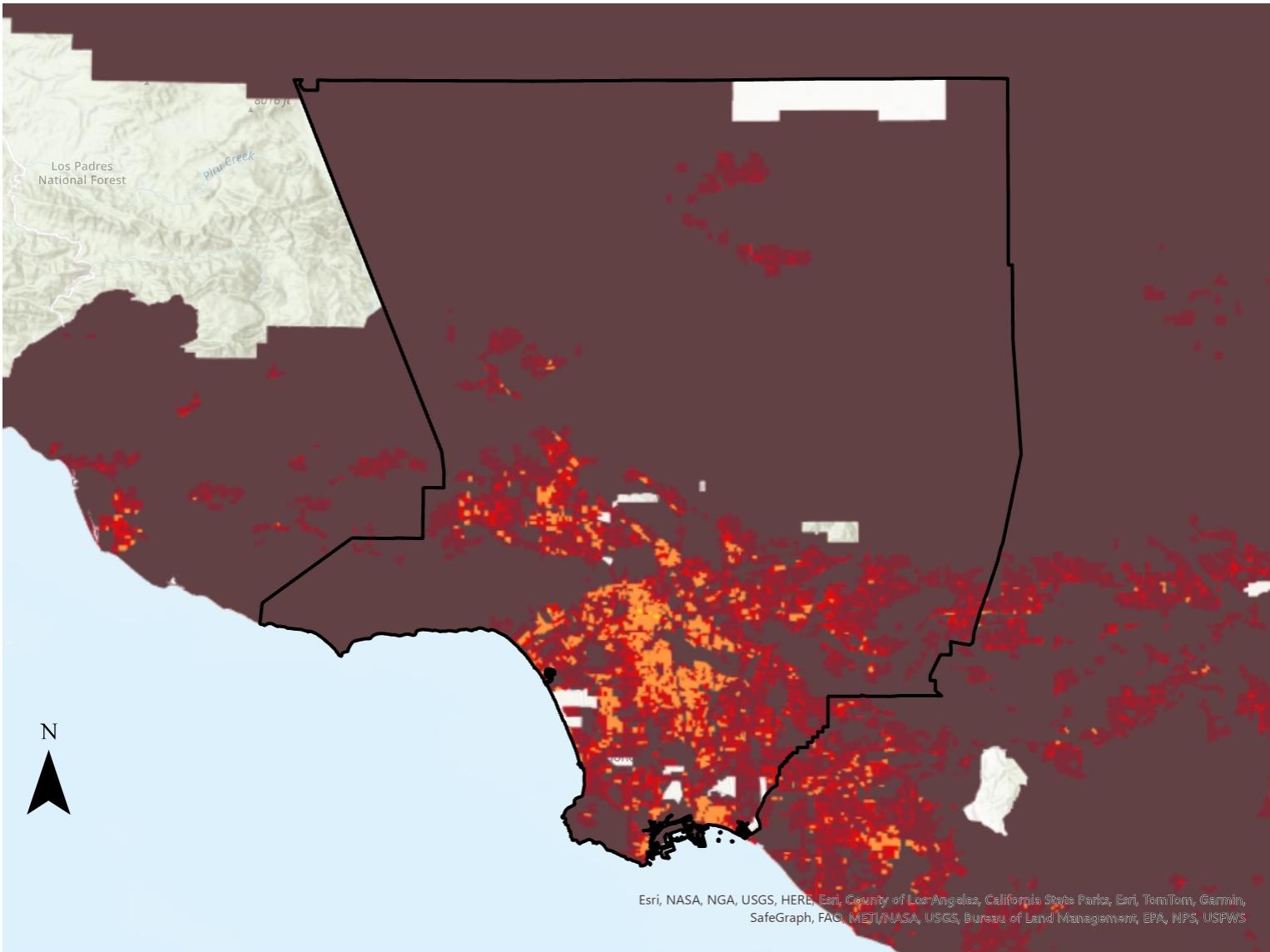
4,751 square miles



# Los Angeles County, CA

Population:  
10,014,009  
(2020)

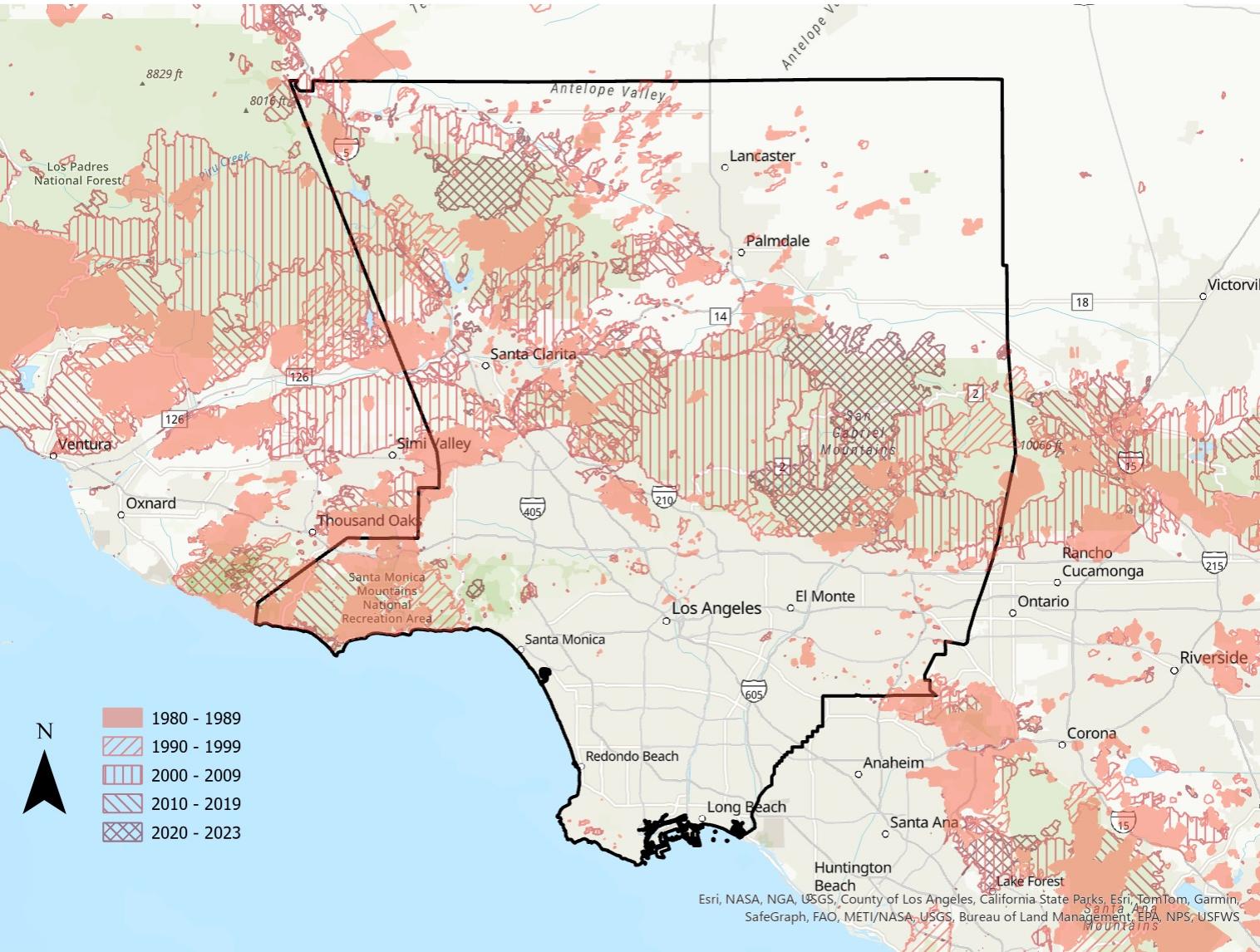
10<sup>th</sup> largest  
“State”



# Wildfires 1980 - 2023

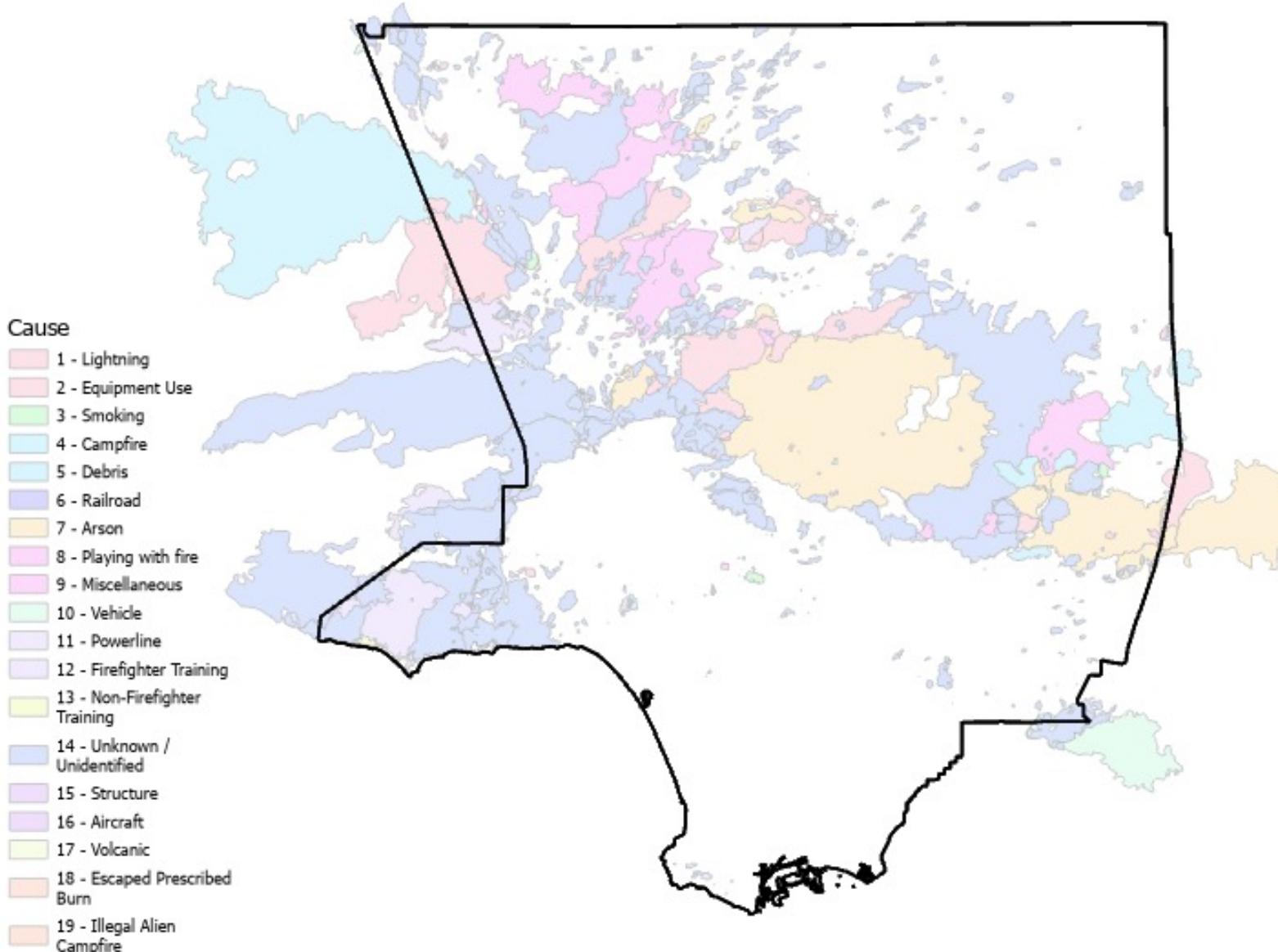
1,120 incidents

1,696,321.32  
acres



~75% of acres  
burned in last 20  
years

# Known causes (1980 – 2023)

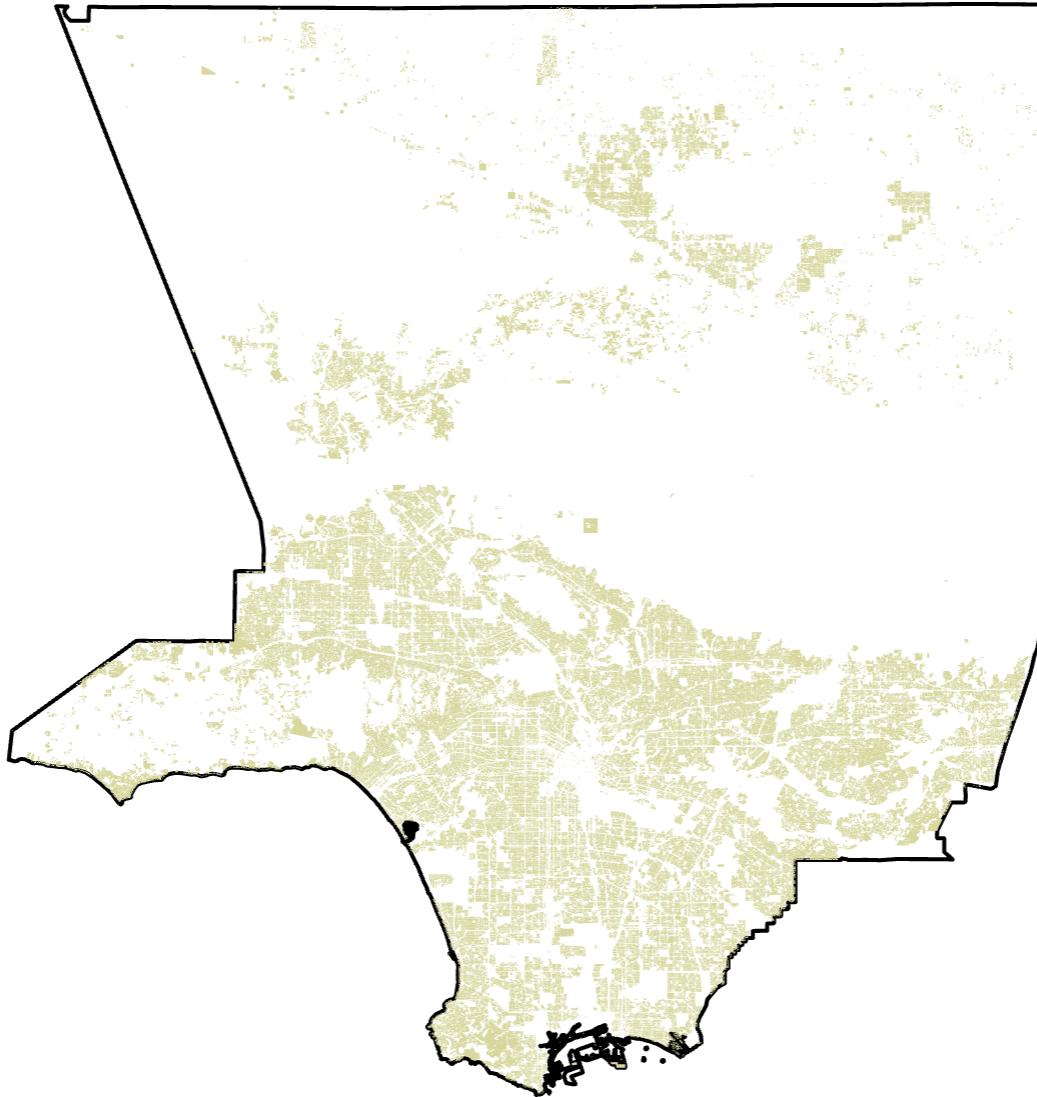


Cause	count	percent	Acres (Sum)
Unknown / Unidentified	724	65%	741,695
Equipment Use	98	9%	164,359
Miscellaneous	96	9%	94,841
Arson	40	4%	287,514
Vehicle	38	3%	32,040
Powerline	27	2%	110,239
Lightning	24	2%	4,837
Campfire	23	2%	13,481
Playing with fire	16	1%	39,617
Smoking	13	1%	2,312
Debris	7	1%	180,246
Aircraft	6	1%	8,983
Structure	4	0%	362
Non-Firefighter Training	2	0%	948

*Can we identify develop a  
model of residential wildfire  
risk in Los Angeles County at  
the parcel level?*

# Residential land uses (all classes) 2019

1.9+ million  
parcels



**Study  
Area**

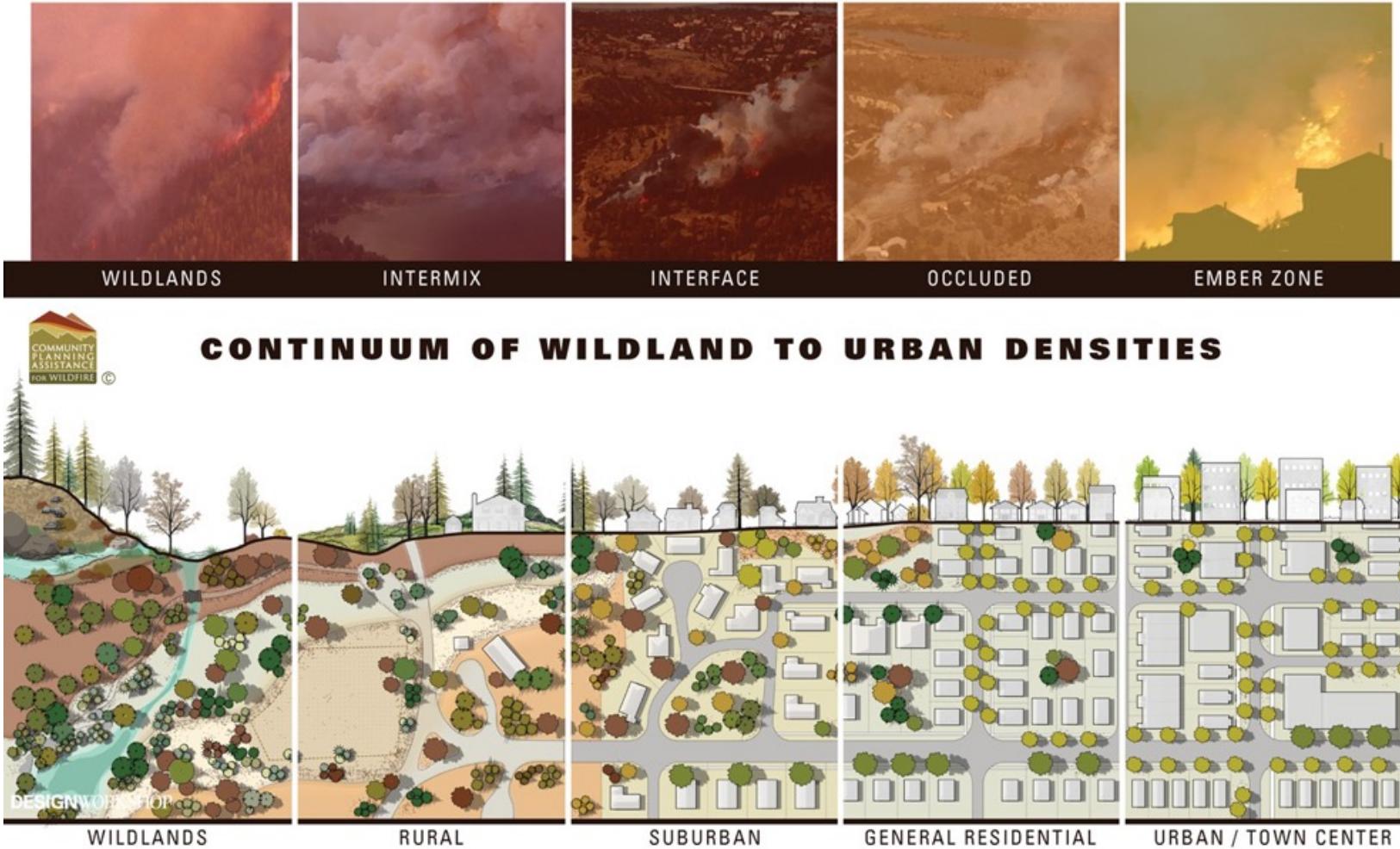
# Wildland Urban Interface

## Study Area

The WUI is the zone of transition between unoccupied land and human development. It is the line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.

[Source: FEMA](#)

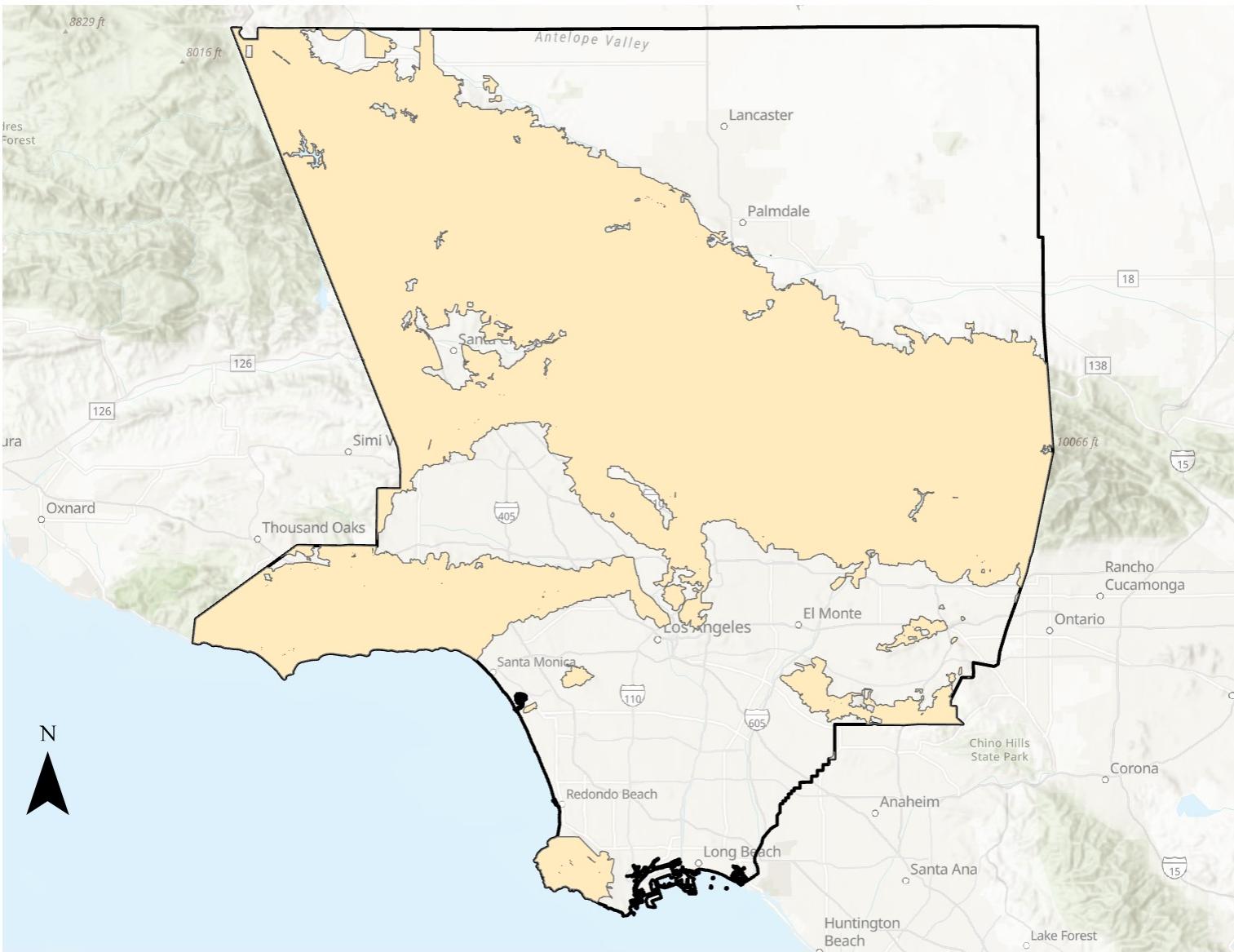
# Wildland Urban Interface



Study  
Area



# Wildland Urban Interface

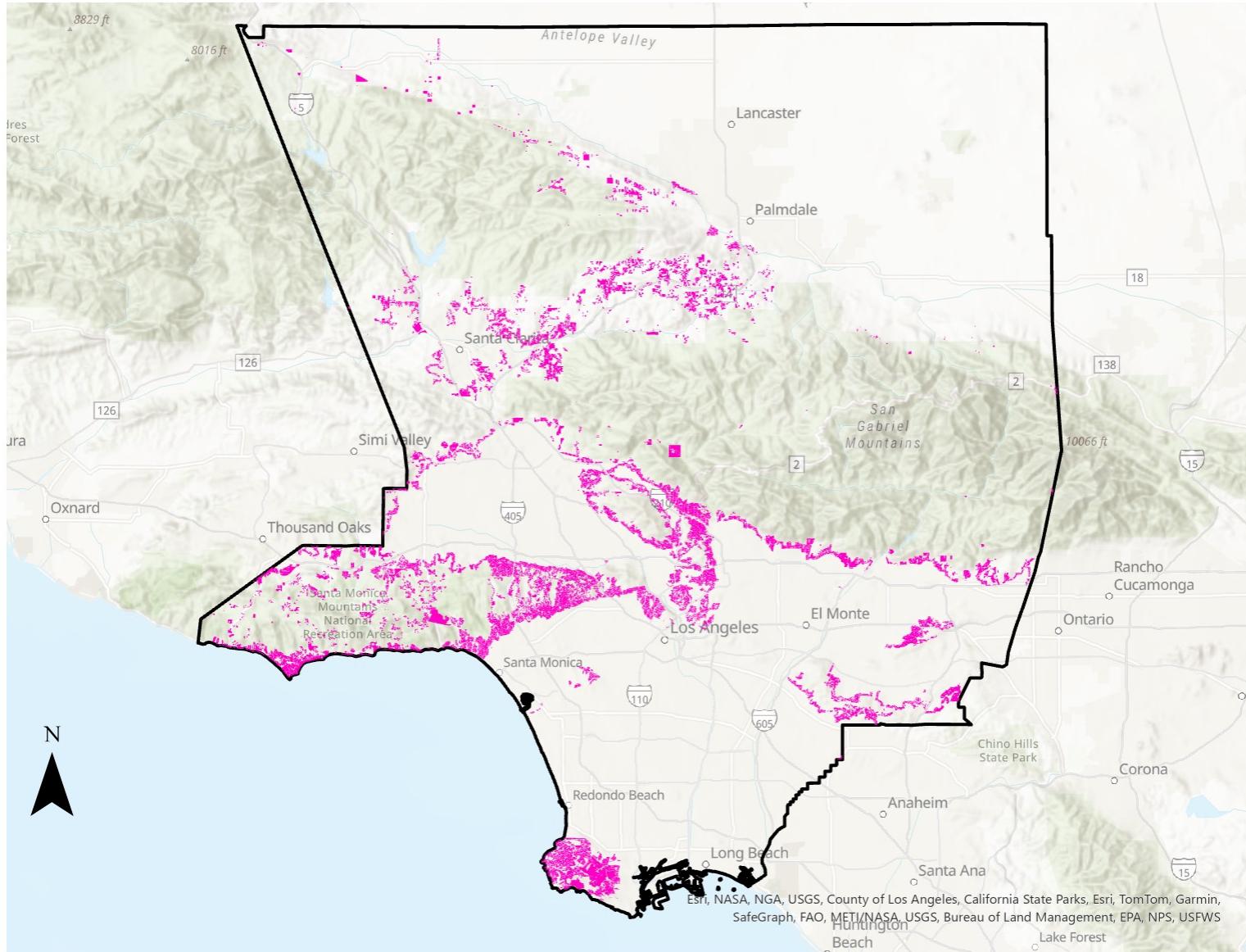


# Study Area

# Study Area

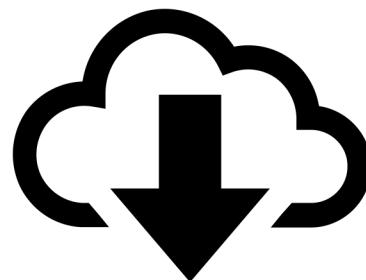
- Residential land use
- Wildlife Urban Interface
- LA County

**264,661 parcels**  
**250,812 acres**  
(~8%)



# Data Sources

- Los Angeles County
- City of Los Angeles
- California Department of Forestry and Fire Protection
- Southern California Association of Governments
- Federal Emergency Management Agency



# Multi-criteria decision analysis (MCDA)

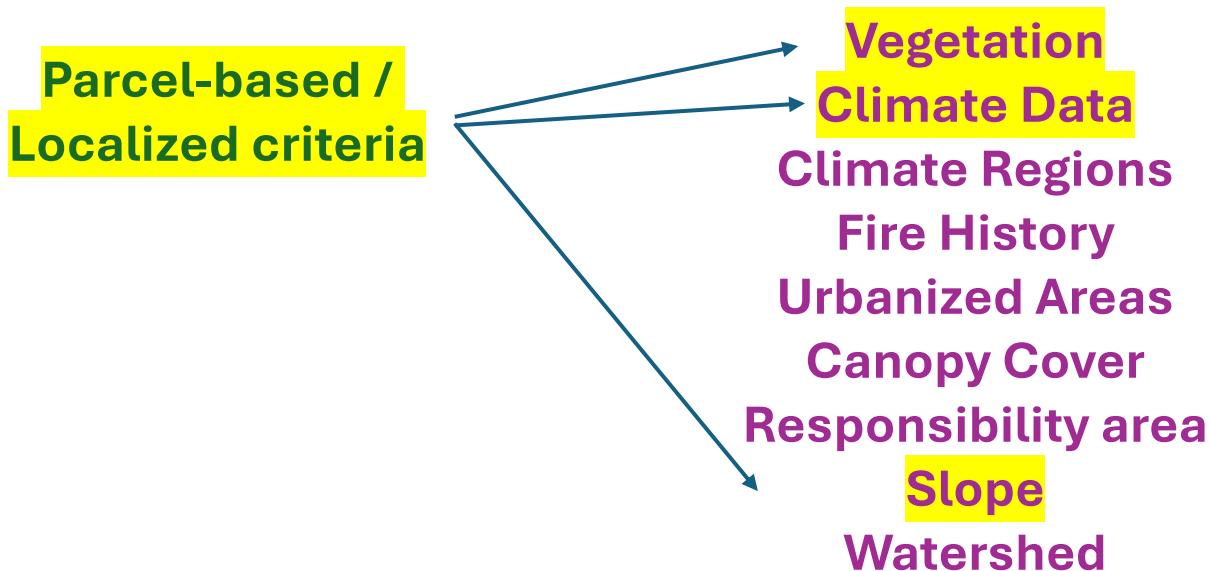
## Model?

- Vegetation
- Climate Data
- Climate Regions
- Fire History
- Urbanized Areas
- Canopy Cover
- Responsibility area
- Slope
- Watershed

Source: Cal Fire

# Multi-criteria decision analysis (MCDA)

Model?



Source: Cal Fire

# Multi-criteria decision analysis (MCDA)



High-Risk \*NATIVE\* Vegetation:  
Los Angeles County

**Shrubs**  
Chamise-Redshank Chaparral  
Mixed Chaparral



**Grassland**  
Annual Grassland  
Perennial Grassland



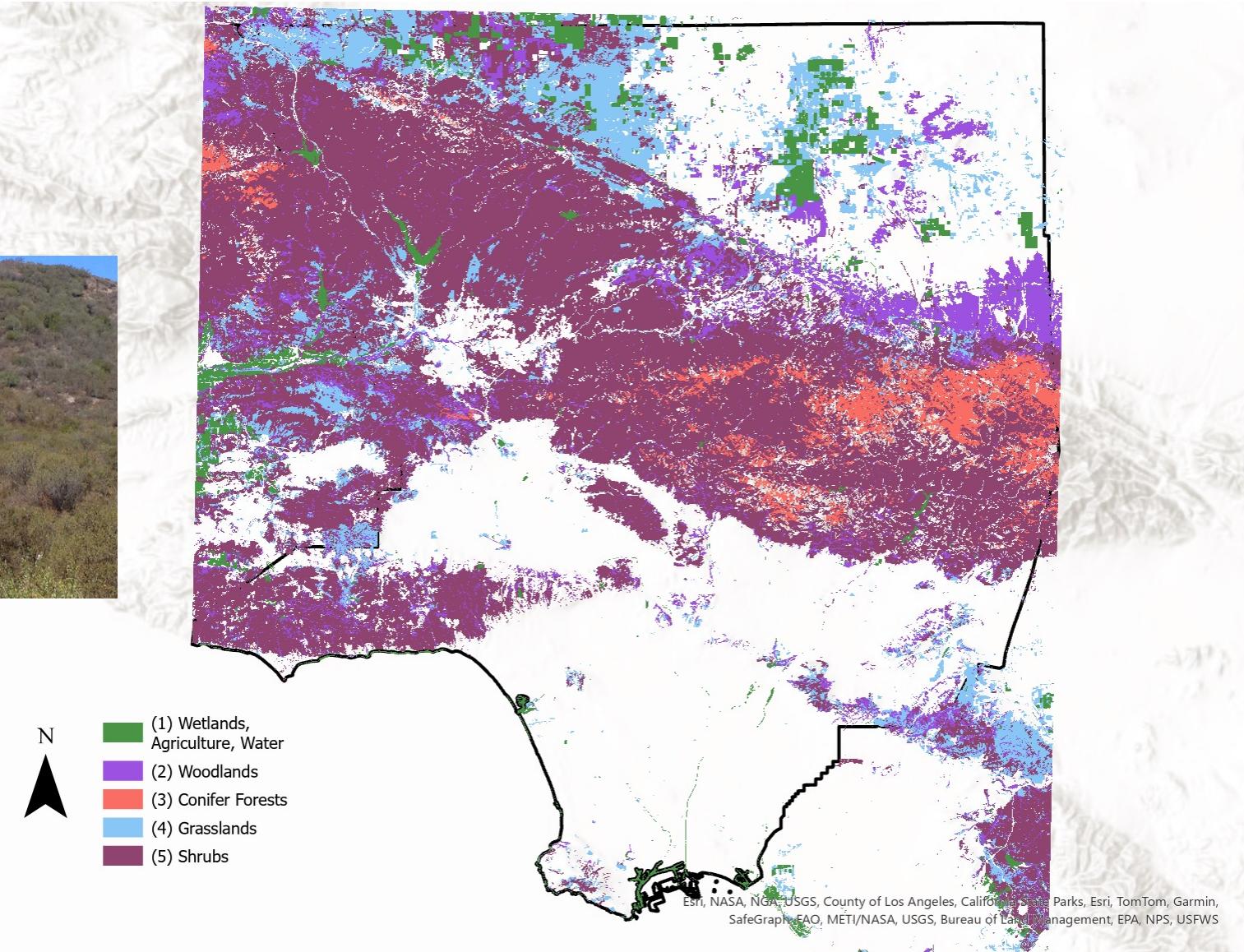
**Conifer Forests**  
Ponderosa Pine  
Douglas Fir



**Woodlands**  
Pinyon-Juniper  
Blue Oak-Foothill Pine

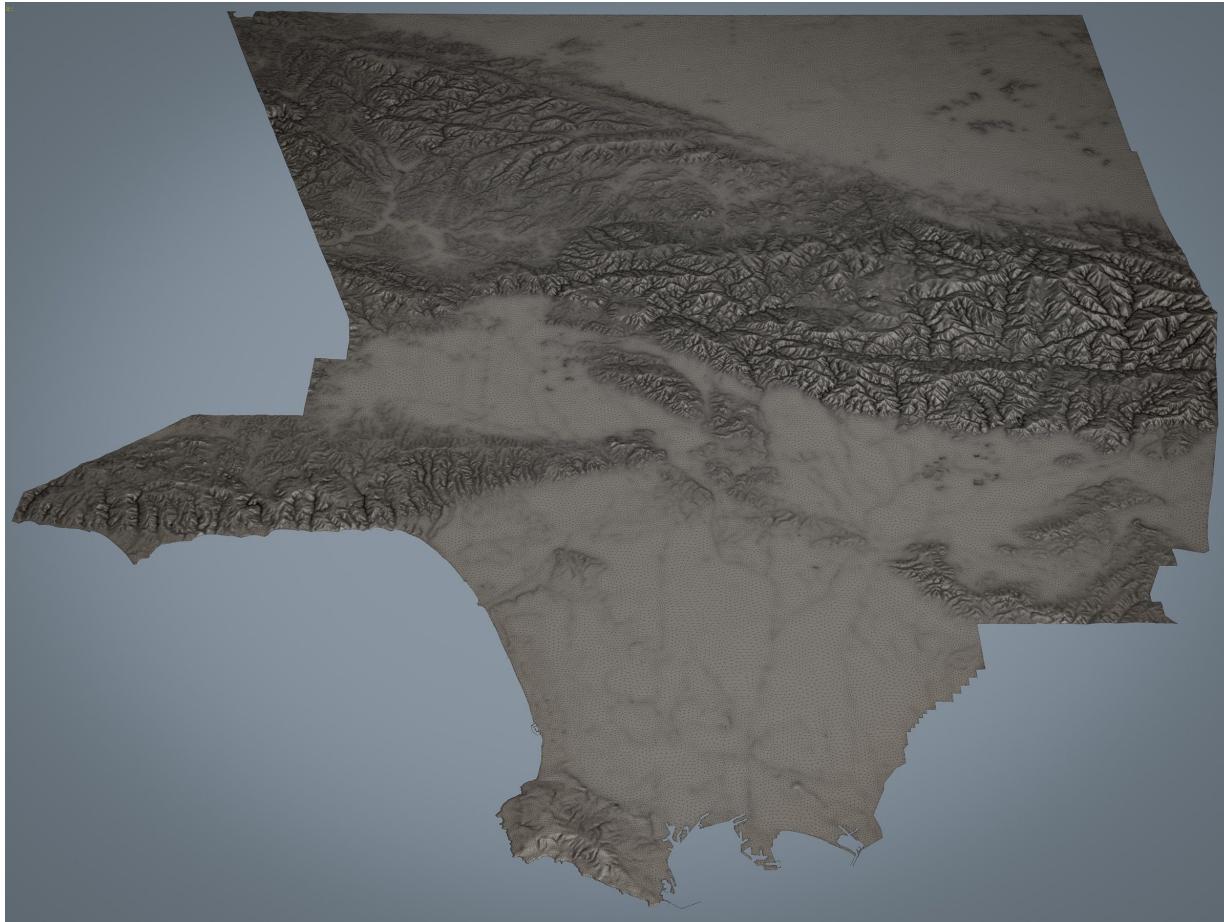
Source:  
[California Forest Action Plan](#)  
[US Forest Service](#)

# Multi-criteria decision analysis (MCDA)



Vegetation	Risk Score
Shrubs	5
Grasslands	4
Conifer Forests	3
Woodlands	2
Wetlands, Agriculture, Water	1

# Multi-criteria decision analysis (MCDA)



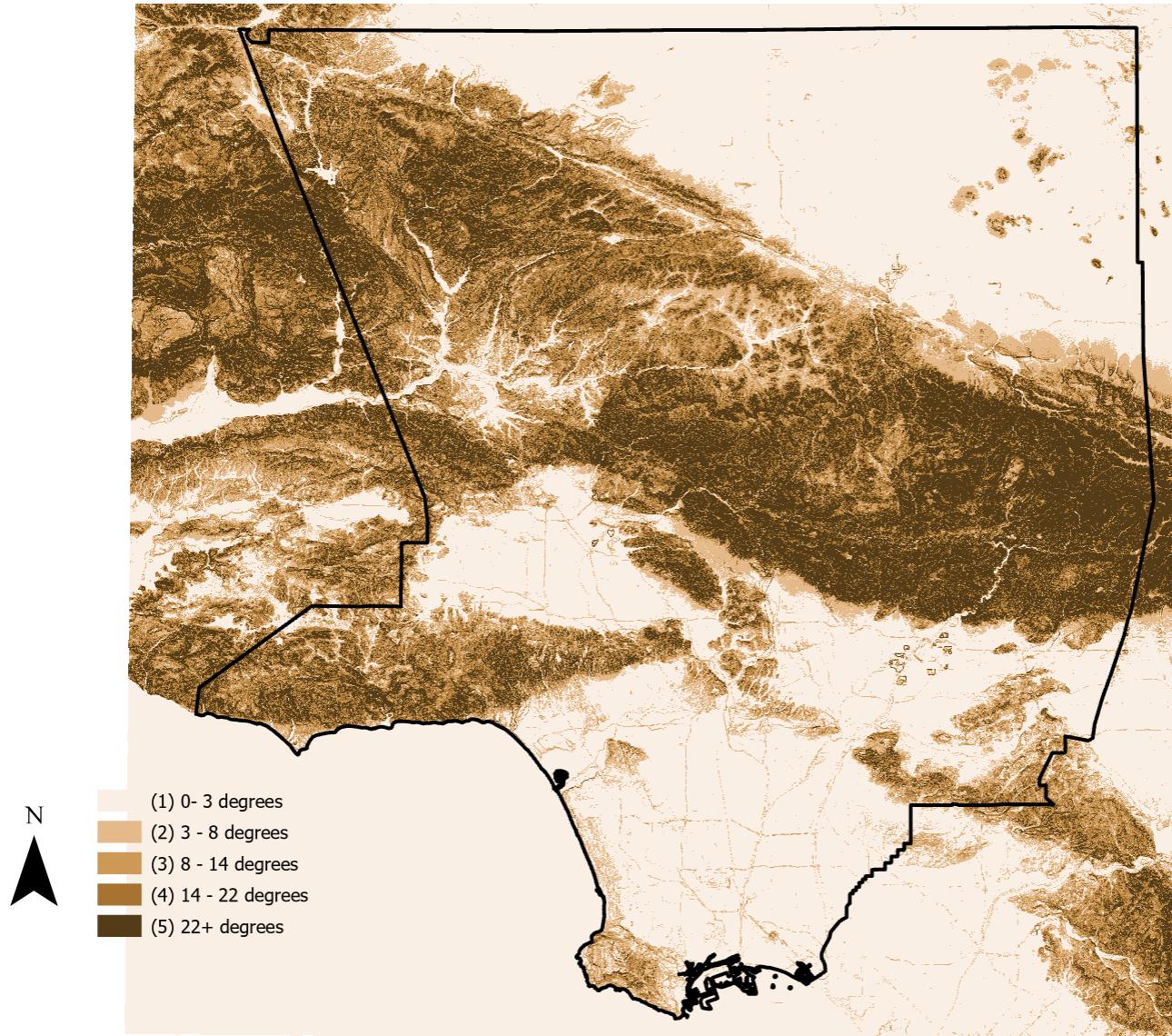
**Sea-level to 10,000+ feet**

## **Slope:**

As terrain steepens from flat to very steep, wildfires increasingly spread faster and become progressively harder, and eventually nearly impossible, to control.

[Source: US Forest Service Fire Science](#)

# Multi-criteria decision analysis (MCDA)



# Multi-criteria decision analysis (MCDA)

Slope Range	Description	Risk Score
0% - 5% (0 - 3 degrees)	Flat terrain or very mild slopes. Fires spread slowly, easy to control.	1
6% - 15% (3 - 8 degrees)	Slightly inclined terrain. Fire still spreads moderately, manageable with resources.	2
16% - 25% (9 - 14 degrees)	Noticeable slope. Fire spreads more quickly uphill, more difficult to suppress.	3
26% - 40% (15 - 22 degrees)	Steep terrain, high risk. Fire spreads much faster, extreme challenge for firefighting.	4
>40% (>22 degrees)	Very steep slopes. Fires move rapidly, highly dangerous, suppression nearly impossible.	5

# Multi-criteria decision analysis (MCDA)

## Weather

### ► Red Flag Warnings

- **Relative Humidity:** Often at or **below 15%**
- **Winds:** Sustained wind speeds of around 15 mph or higher and/or gusts over 25 mph (especially during **Santa Ana wind events**)
- **Temperature:** Usually above normal (often 75°F/24°C or higher), contributing to rapid drying of fuels

Source: National Weather Service

**Red Flag Warning  
Particularly Dangerous  
Situation (PDS)**

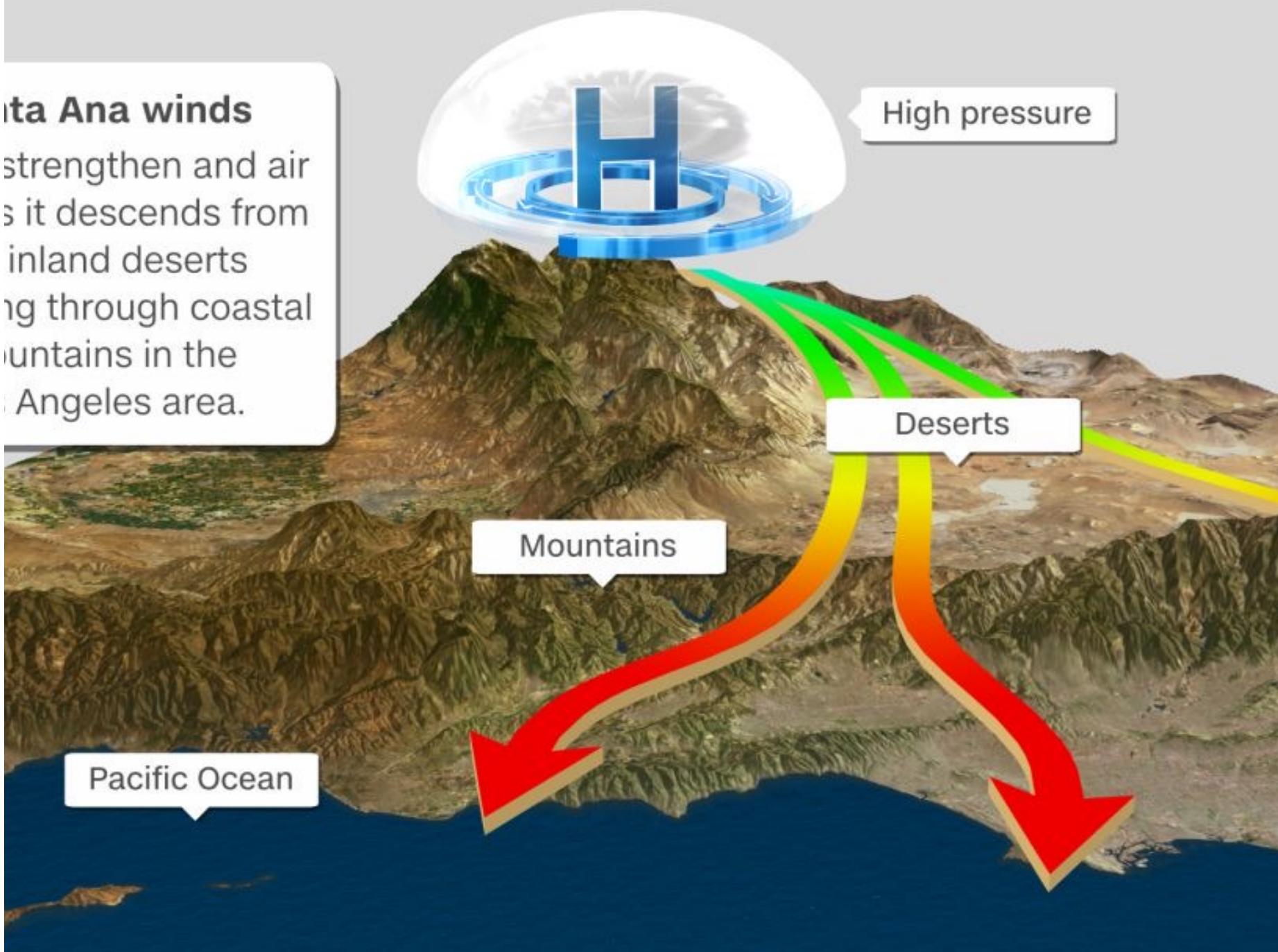


The NWS issues a PDS Red Flag Warning to alert emergency officials and the public to an ongoing or imminent fire weather pattern that is especially dangerous. What does this mean?

High risk of...	Criteria
❖ Extreme fire behavior and rapid growth	❖ Extremely low humidity
❖ Downed trees	❖ Strong winds
❖ Power outages and Public Safety Power Shutoffs (PSPS)	❖ Very dry vegetation
	❖ Typically issued once every few years

## Santa Ana winds

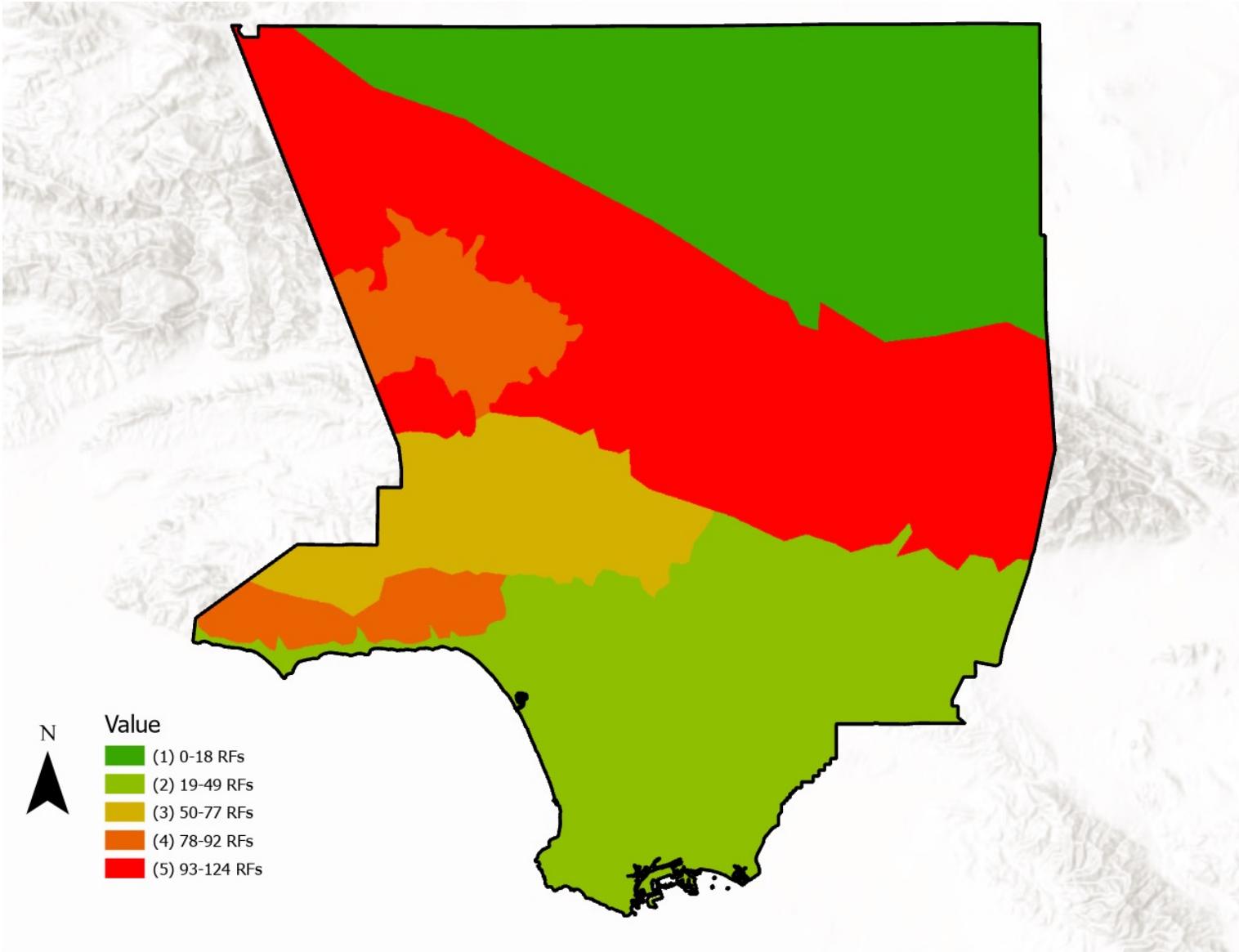
strengthen and air as it descends from inland deserts through coastal mountains in the Angeles area.



# Multi-criteria decision analysis (MCDA)

Number of Red Flag “Events” per county region  
(2004-2019)

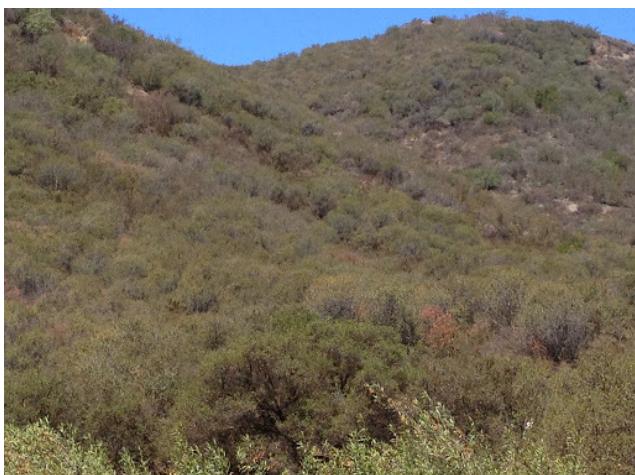
415,000+ acres burned



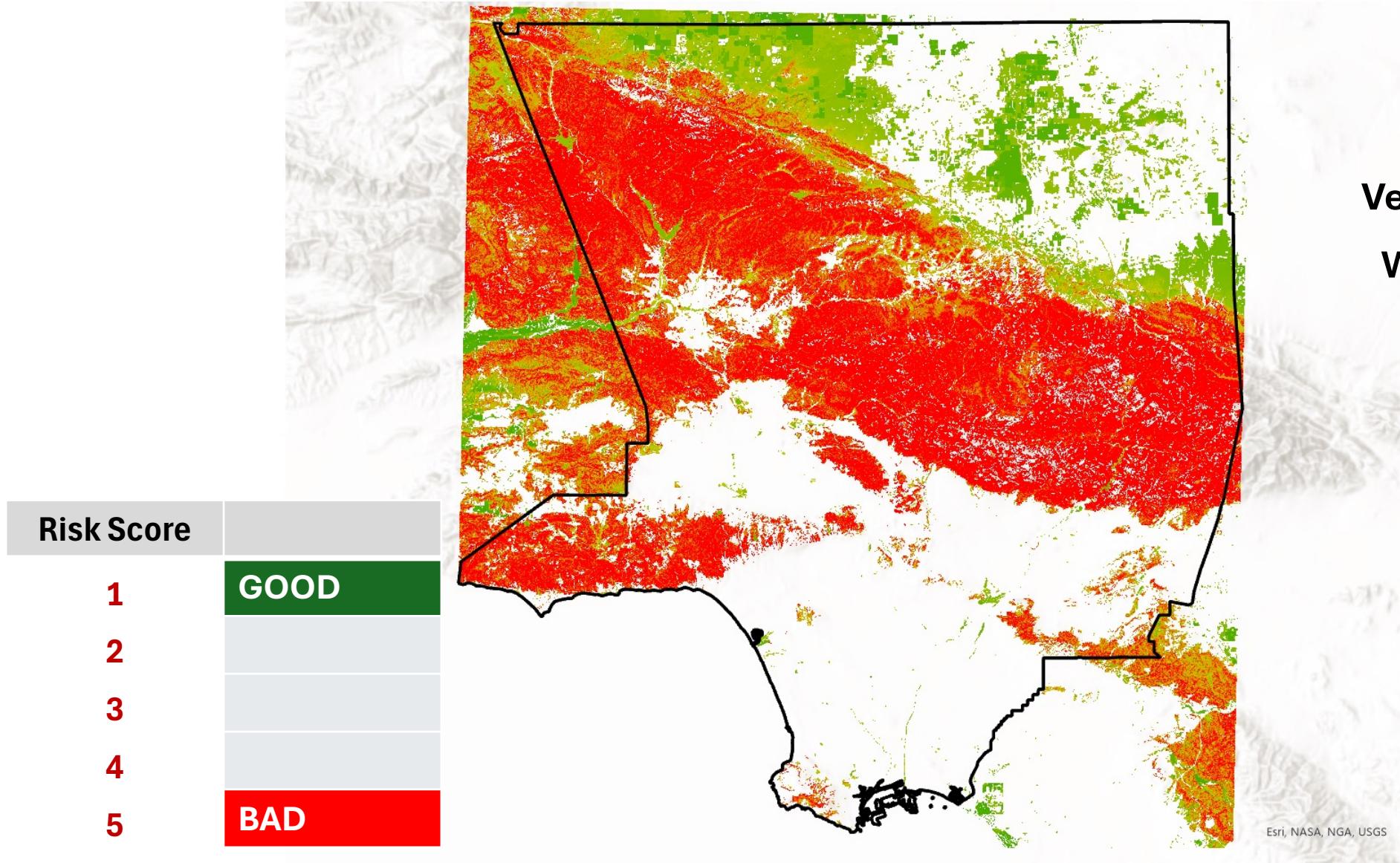
#	Risk Score
0-18	1
19-49	2
50-77	3
78-92	4
93-124	5

# Multi-criteria decision analysis (MCDA)

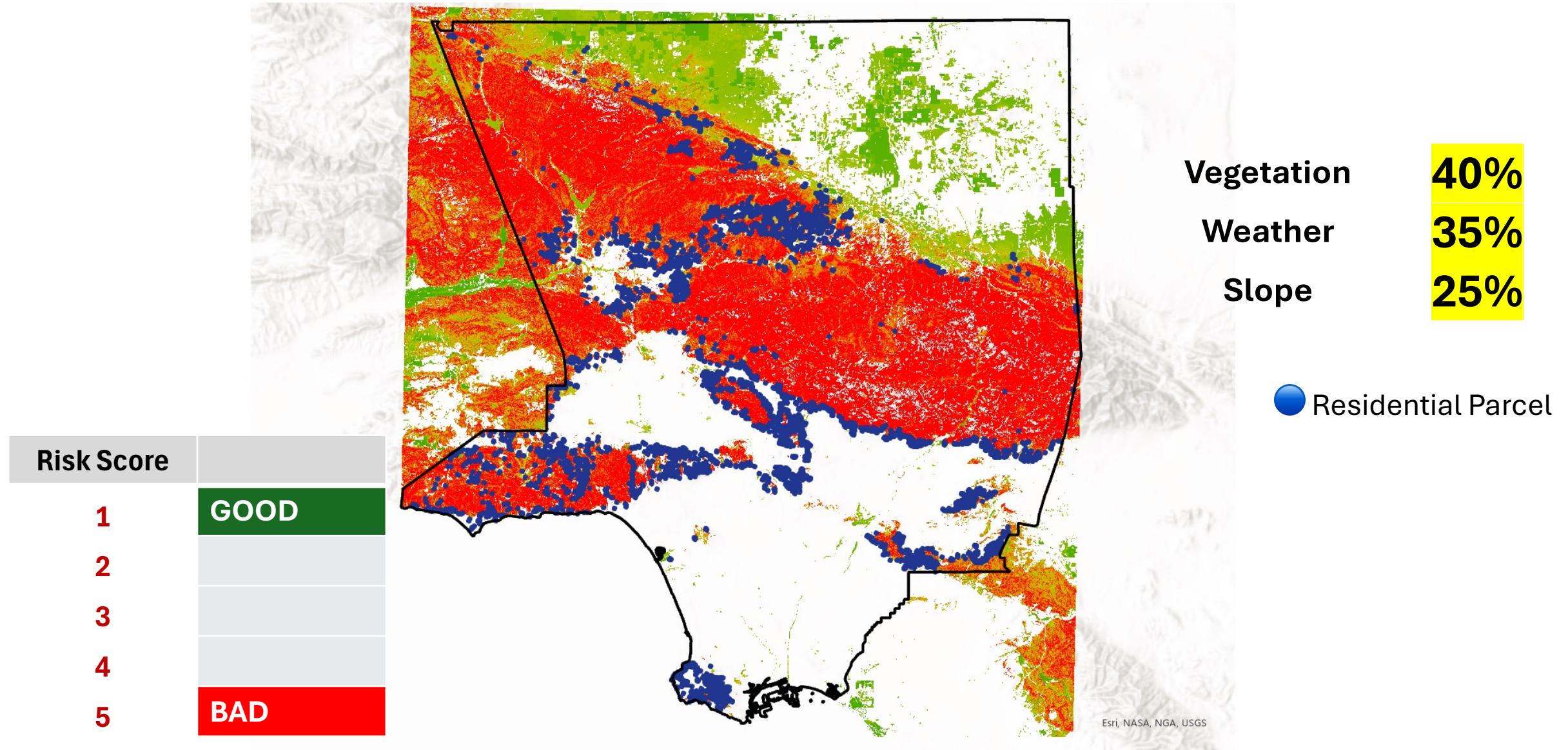
	Weight	
<b>Vegetation</b>	<b>40%</b>	Dense vegetation provides more fuel for fires, increasing their severity and spread.
<b>Weather</b>	<b>35%</b>	Wind, humidity, and temperature directly influence fire behavior and spread.
<b>Slope</b>	<b>25%</b>	Steeper slopes can spread fires more rapidly.



# Multi-criteria decision analysis (MCDA)

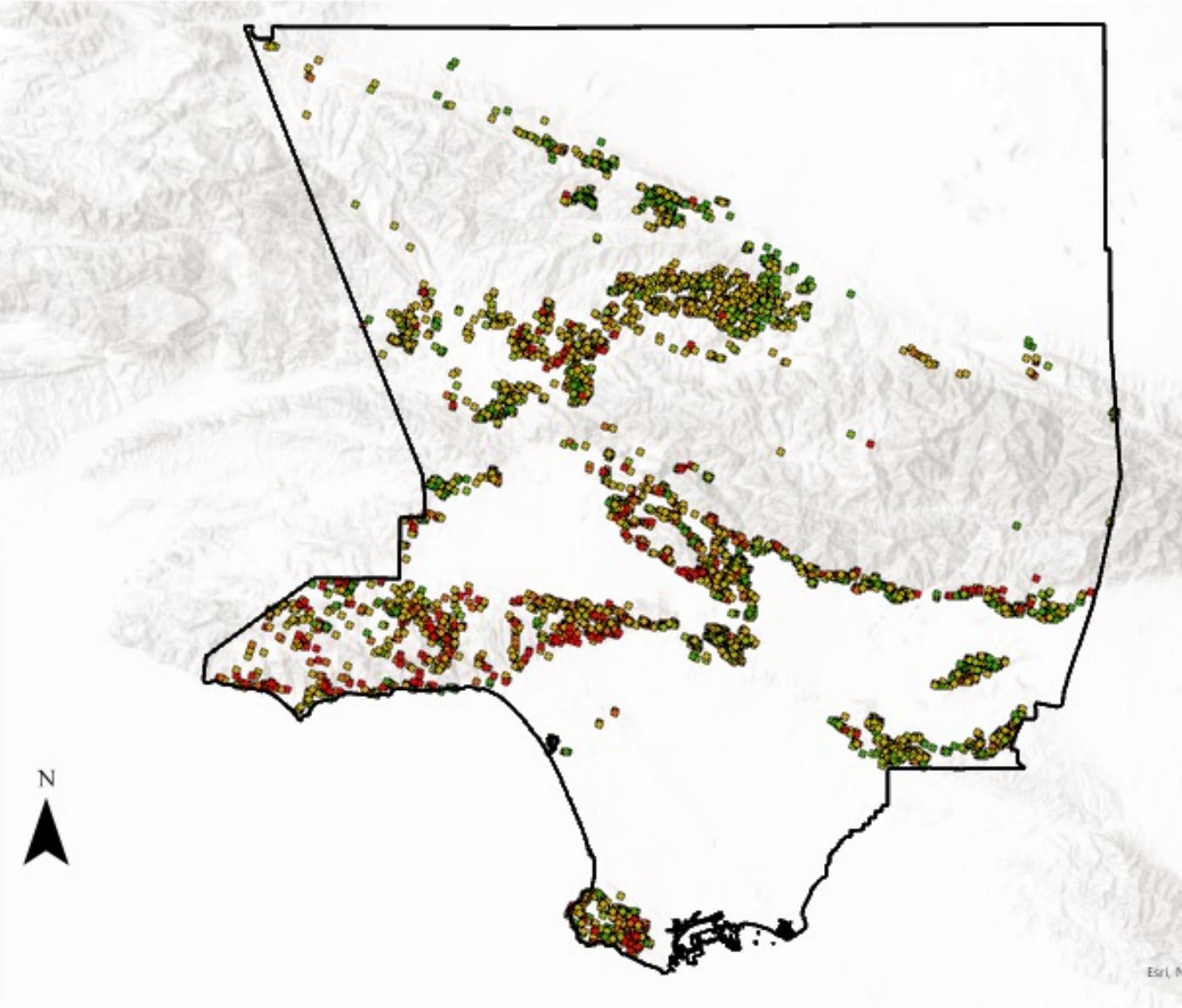


# Multi-criteria decision analysis (MCDA)



# Risk Map

Assign risk score  
to points

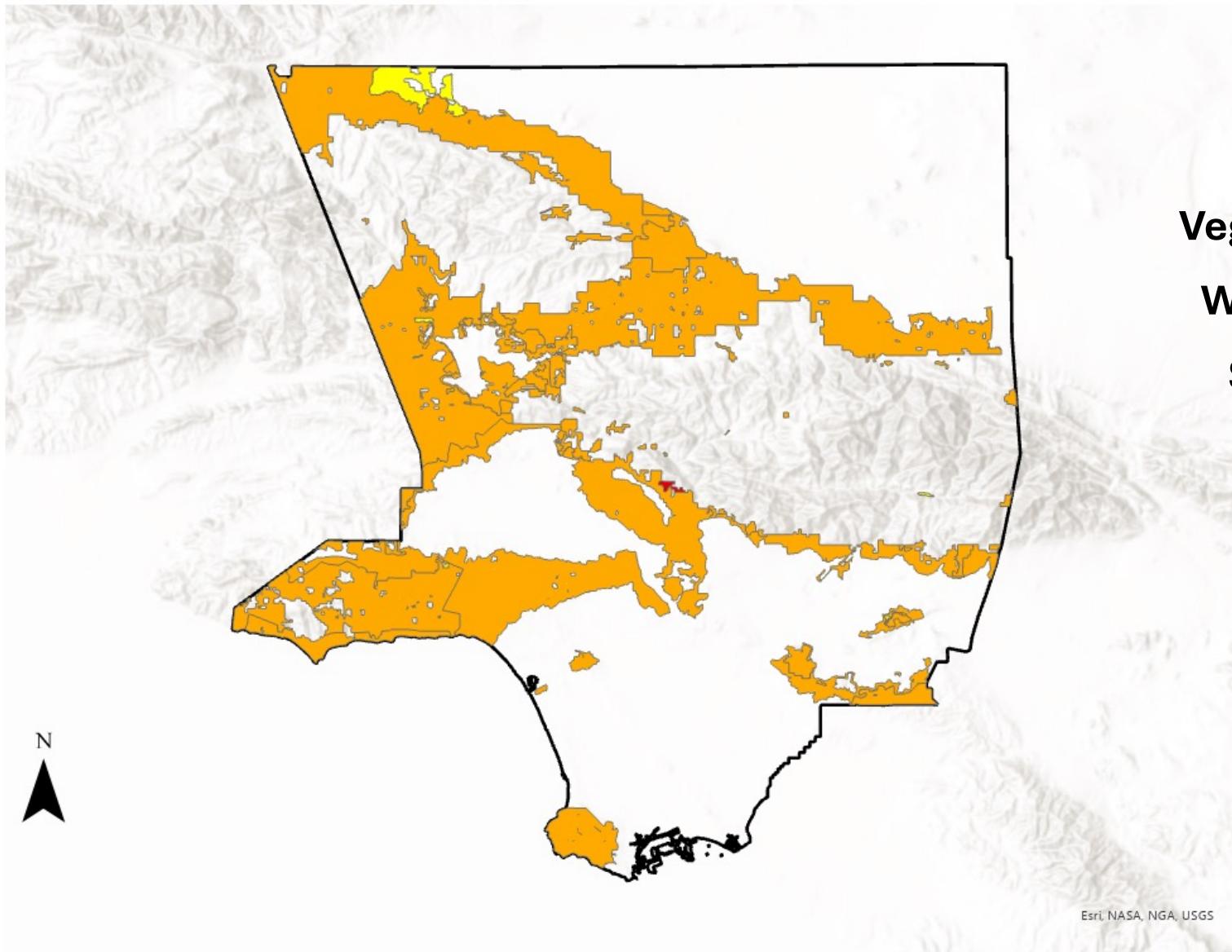


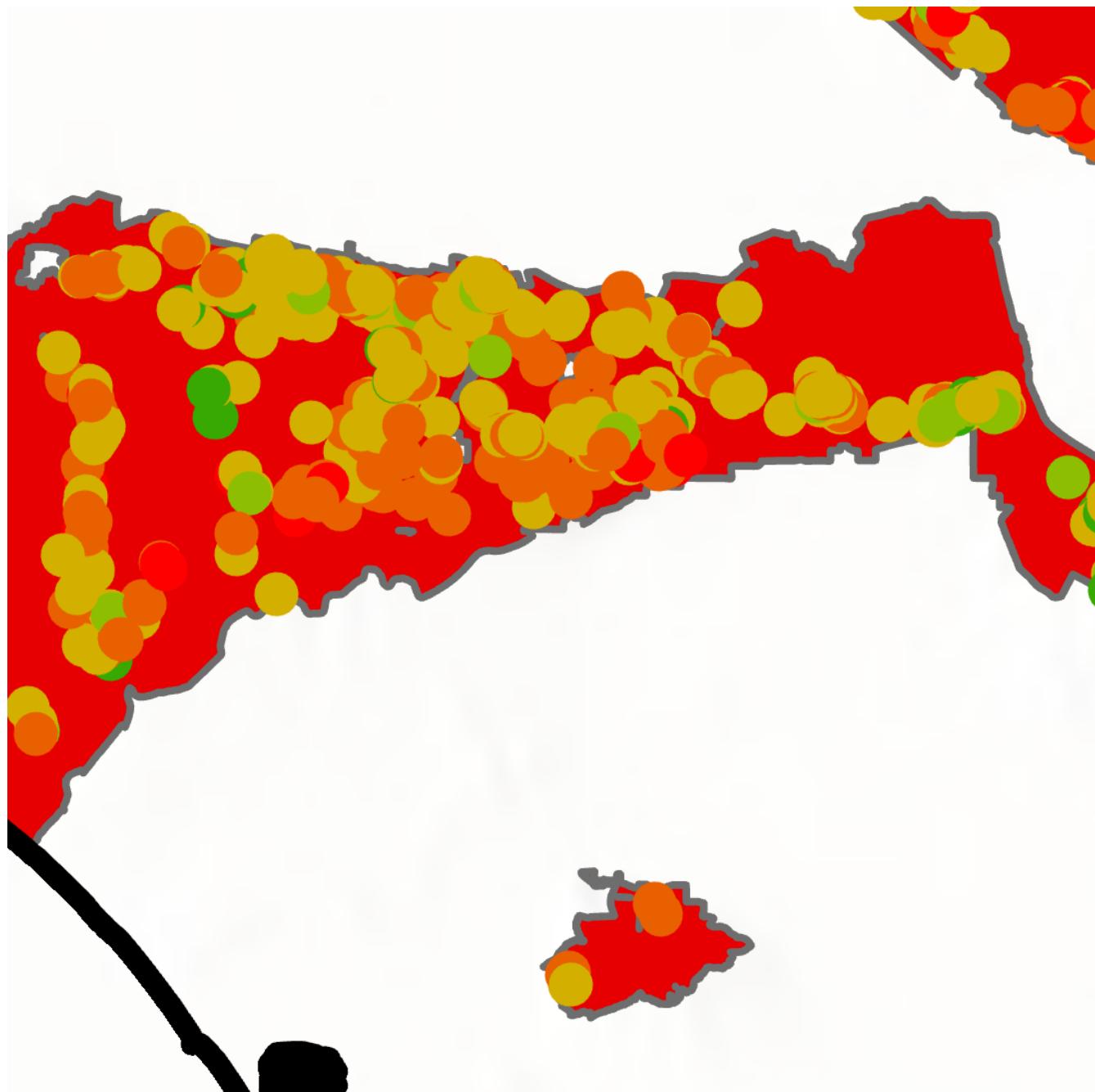
Vegetation	40%
Weather	35%
Slope	25%



# Risk Map

Assign risk score  
to points

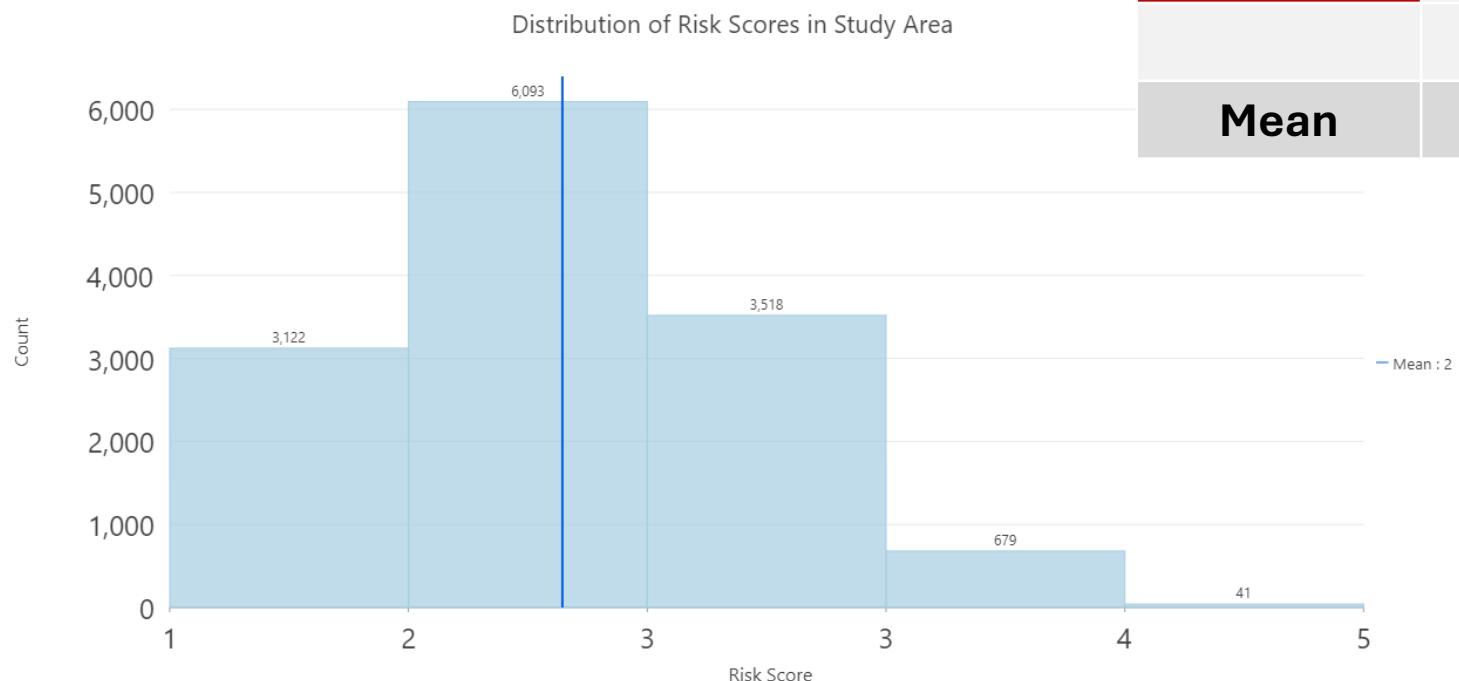




# Risk Map

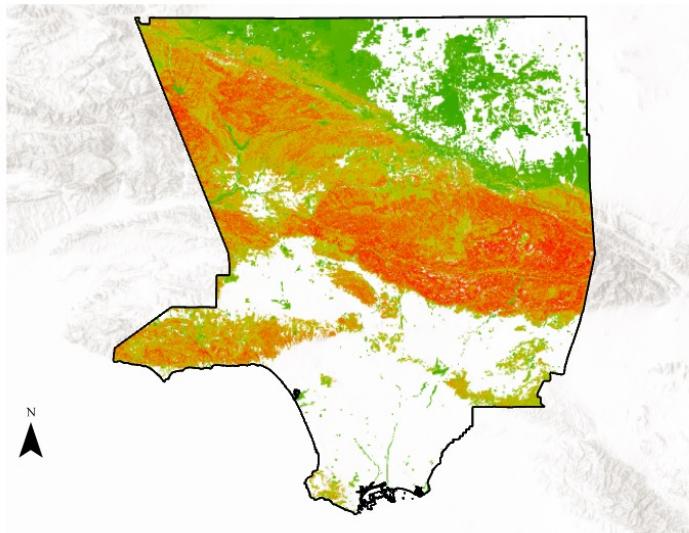
	<b>Land Area (Acres)</b>	<b>Parcels</b>
Sum	<b>24,500 ac</b>	<b>13,707</b>
% of Study Area	<b>9.8%</b>	<b>5.2%</b>
% of County	<b>0.94%</b>	<b>0.001%</b>

<b>Risk Scores</b>	<b>Land Area (Acres)</b>	<b>Parcels</b>
<b>1</b>	3,122	22.8%
<b>2</b>	6,093	44.55%
<b>3</b>	3,518	25.57%
<b>4</b>	679	5.0%
<b>5</b>	41	0.03%
<b>Mean</b>	<b>2.3</b>	



# Sensitivity Analysis

	Project	Scenario 1	Scenario 2	Scenario 3
Vegetation	40%	50%	30%	33.33%
Weather	35%	30%	40%	33.33%
Slope	25%	20%	30%	33.34%

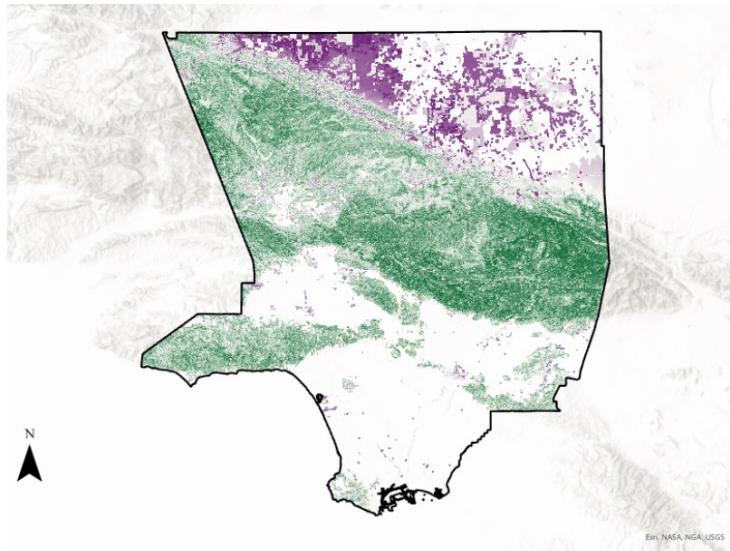


Project	MEAN RISK VALUE (normalized)
Project	2.3

# Sensitivity Analysis

	Project	Scenario 1	Scenario 2	Scenario 3
<b>Vegetation</b>	40%	50%	30%	33.33%
<b>Weather</b>	35%	30%	40%	33.33%
<b>Slope</b>	25%	20%	30%	33.34%

Vegetation emphasis



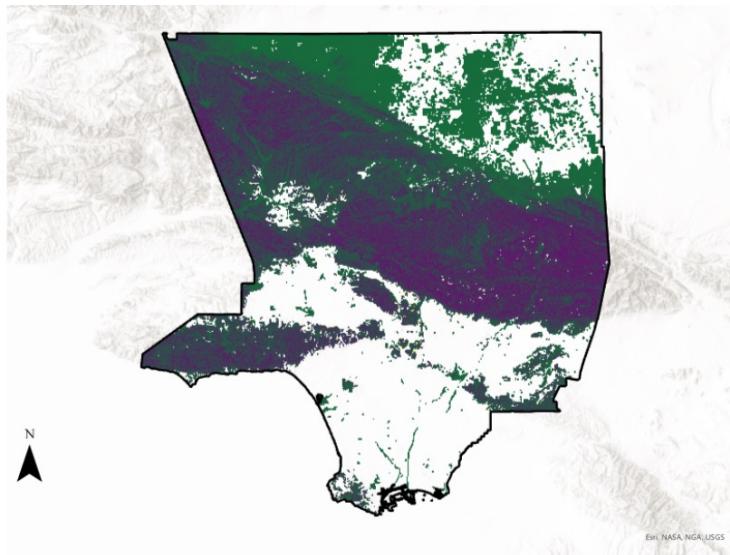
Project	MEAN RISK VALUE (normalized)
Scenario 1	2.3

Scenario 1	+0.14
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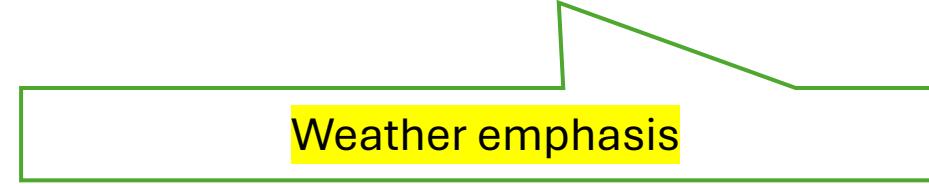
High Desert Increase in Vegetation related risk

# Sensitivity Analysis

	Project	Scenario 1	Scenario 2	Scenario 3
Vegetation	40%	50%	30%	33.33%
Weather	35%	30%	40%	33.33%
Slope	25%	20%	30%	33.34%



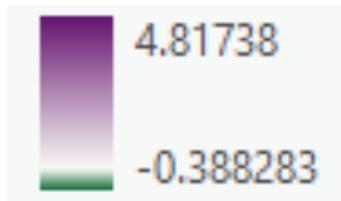
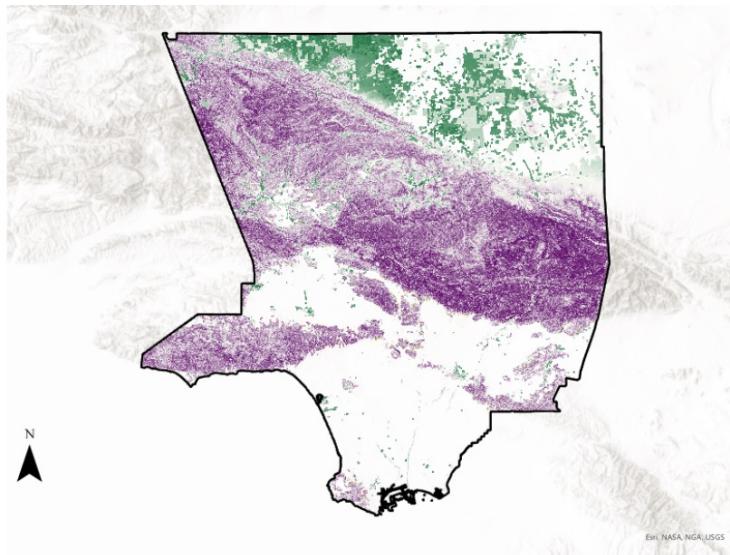
Mountains and canyons increase in Red Flag  
Warning impacts (Santa Ana winds)



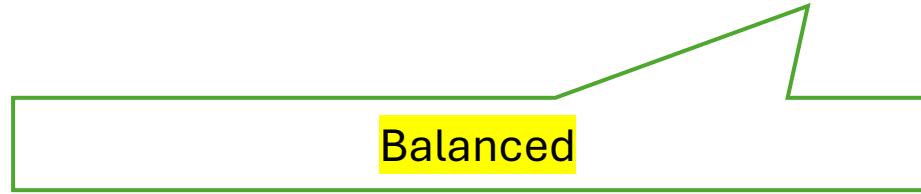
	MEAN RISK VALUE (normalized)
Project	2.3
Scenario 1	+0.14
Scenario 2	+0.45

# Sensitivity Analysis

	Project	Scenario 1	Scenario 2	Scenario 3
Vegetation	40%	50%	30%	33.33%
Weather	35%	30%	40%	33.33%
Slope	25%	20%	30%	33.34%



Slope emphasis ?



	Project	MEAN RISK VALUE (normalized)
Project		2.3
Scenario 1		+0.14
Scenario 2		+0.45
Scenario 3		+0.94

# Validation

## **Fire Cause**

Influence of past fire incidents on future risk

## **Containment Years Ago**

More recent containment leads to higher future risk due to lingering effects.

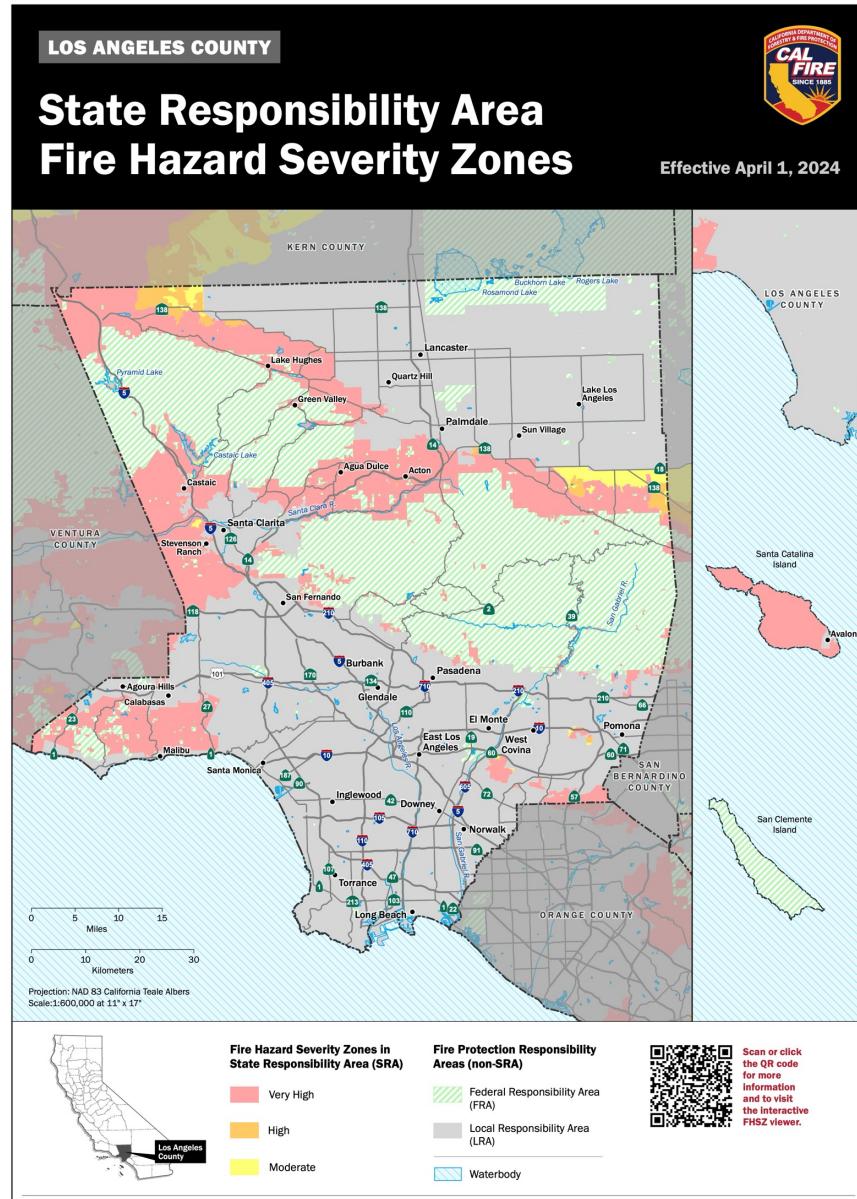
## **Recent Fire Proximity Distance**

Closer proximity to fire-prone areas increases risk.

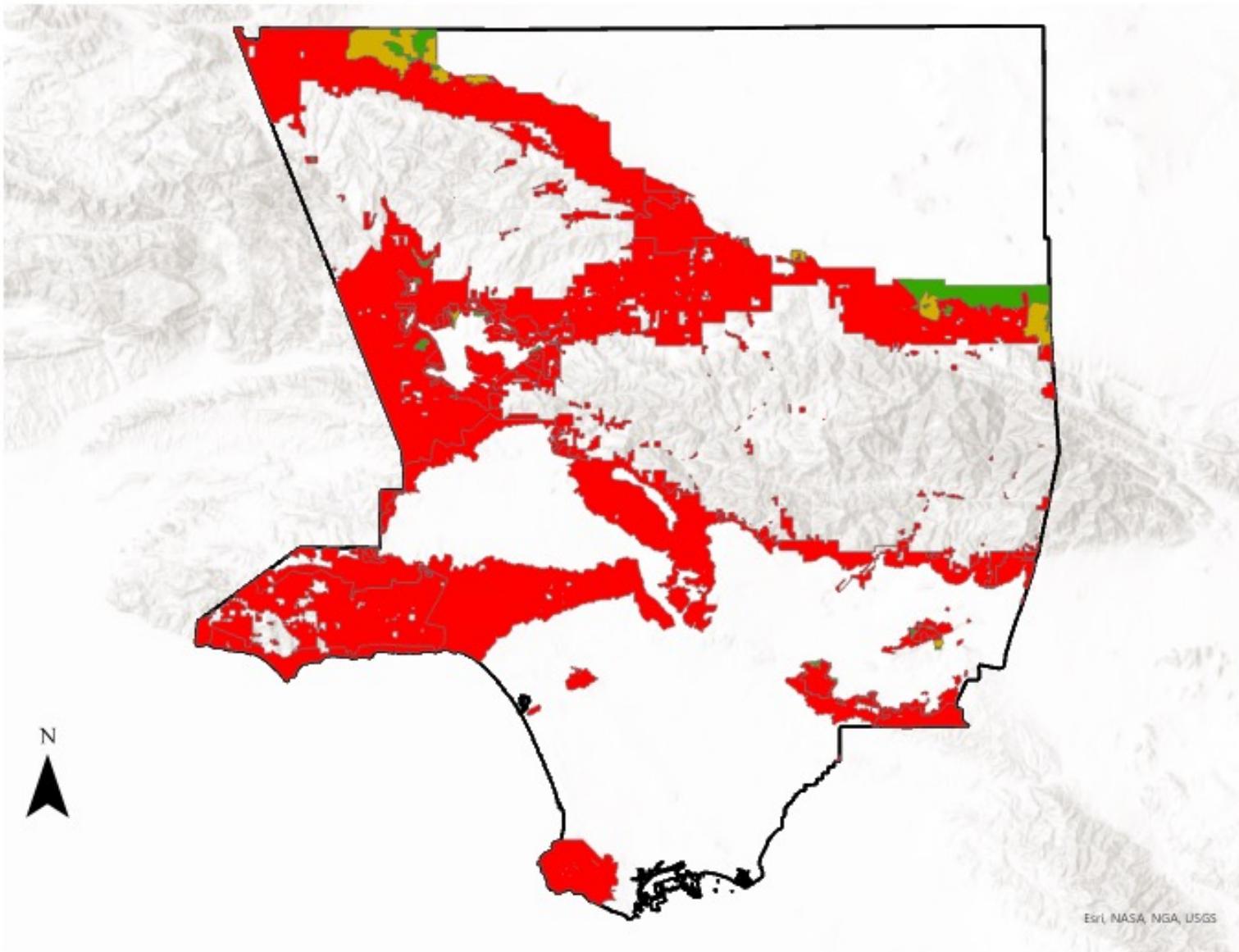
## **Drought Risk**

Drought conditions increase fire risk due to dry vegetation and high temperatures.

# Validation

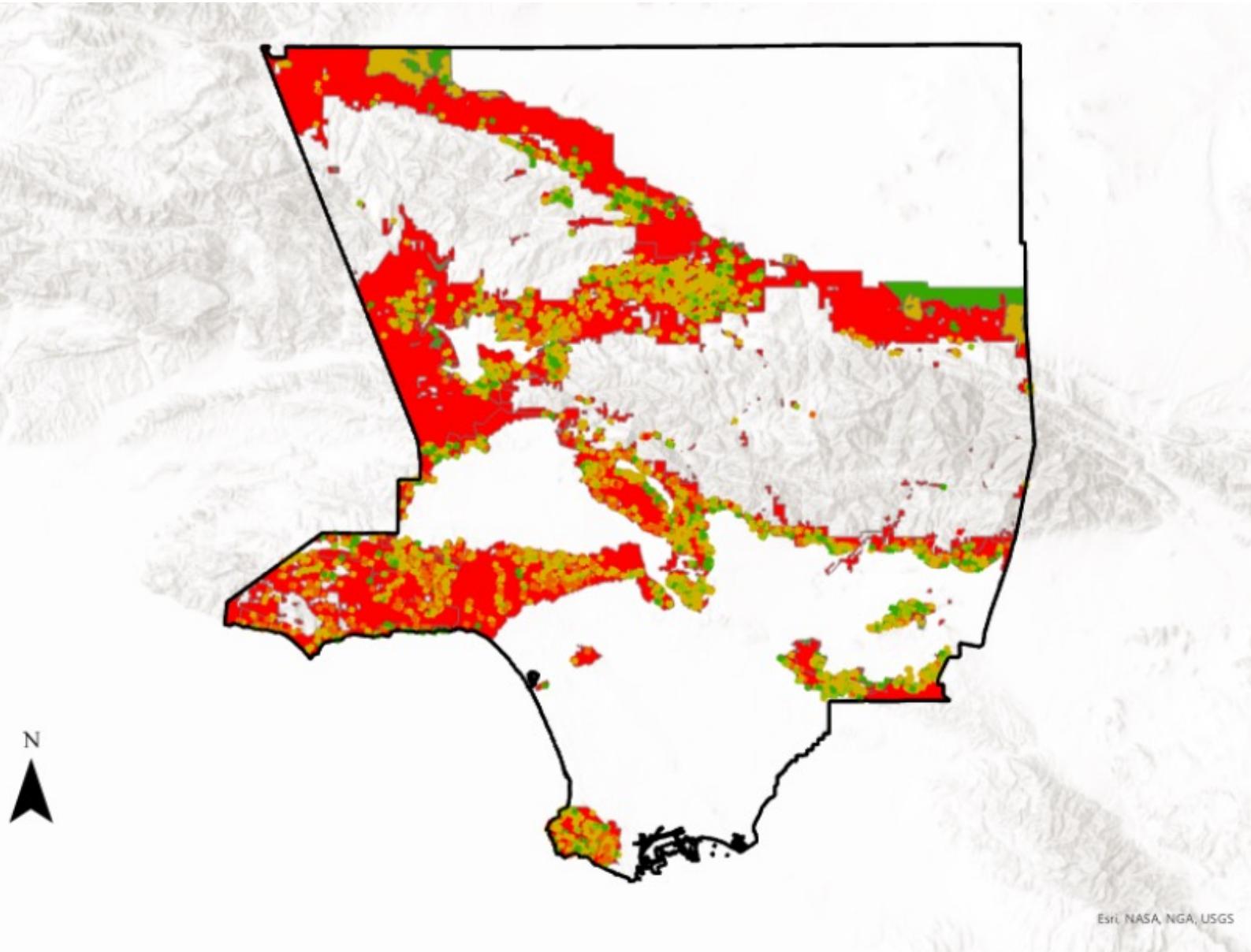


# Validation

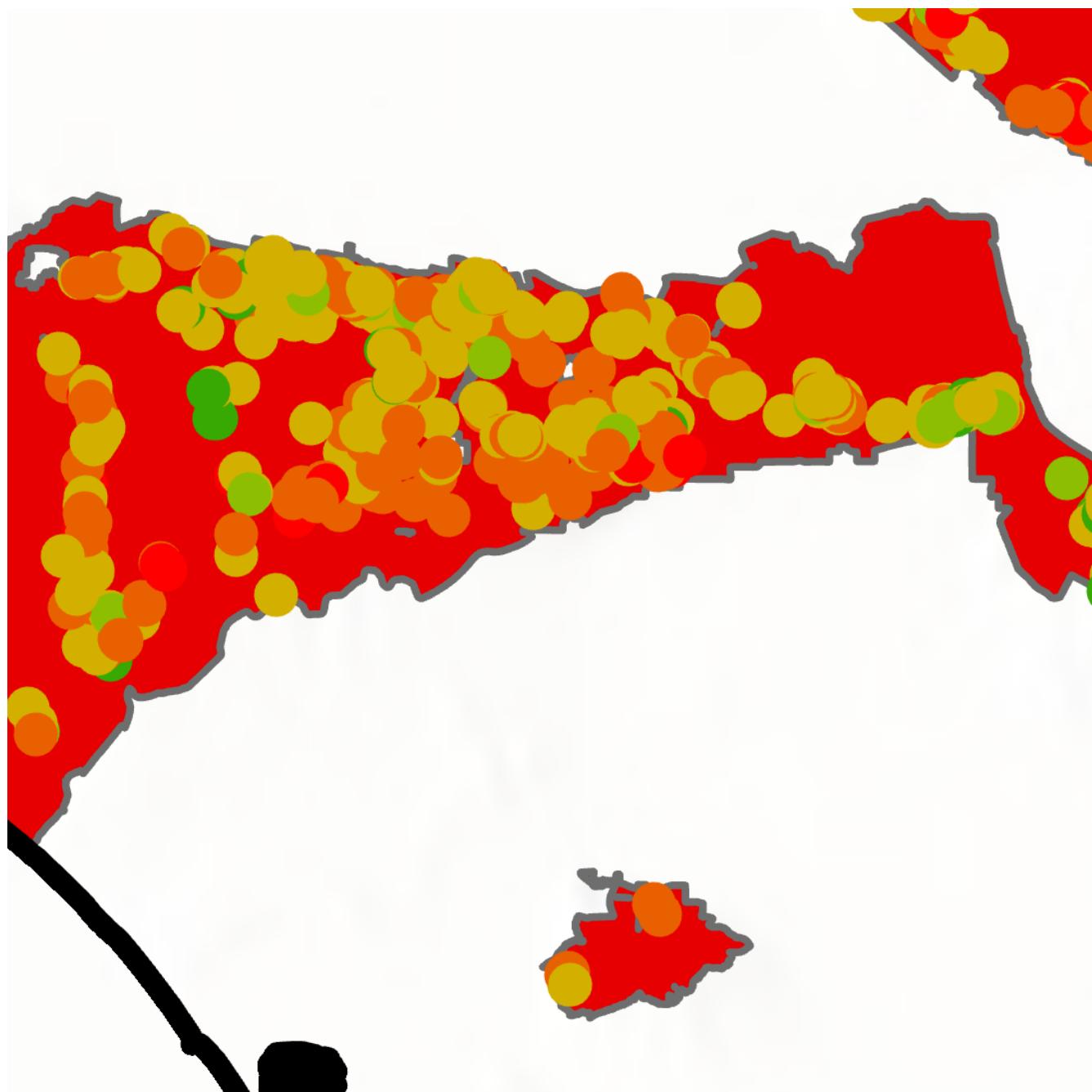


**Moderate**  
**High**  
**Very High**

# Validation



**Moderate**  
**High**  
**Very High**

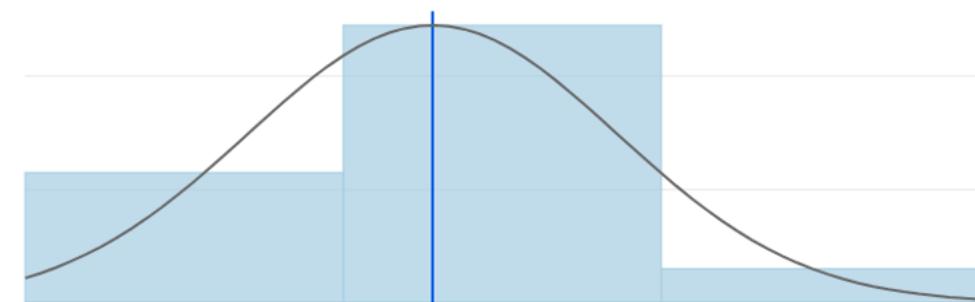
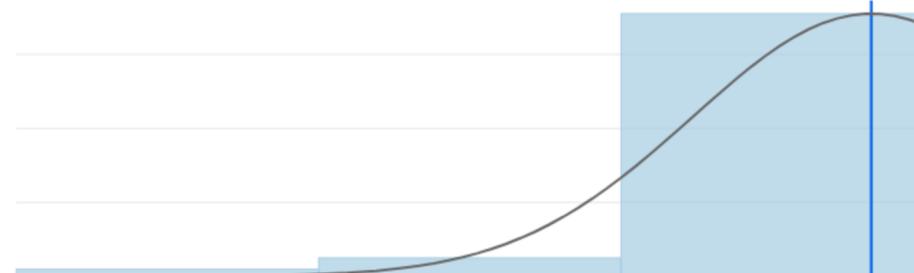


# Validation

1-3

Normalized  
from 1-5 to 1-3

Fire Hazard Zone	# Study Area Parcels	Mean Risk Score
(1) Moderate	12	1.07
(2) High	30	1.11
(3) Very High	13,459	1.38
2.8	Mean	1.3 (2.3 on 1-5 scale)
3	Median	1.35
0.394	Standard Deviation	0.258



## Study Area

- Residential land use
- Wildlife Urban Interface
- LA County

264,661 parcels  
250,812 acres (~8% of the County)

Vegetation	Risk Score
Shrubs	5
Grasslands	4
Conifer Forests	3
Woodlands	2
Wetlands, Agriculture, Water	1

MCDA weights:

0.4

# ► ('04-'19)	Risk Score
0-18	1
19-49	2
50-77	3
78-92	4
93-124	5

0.35

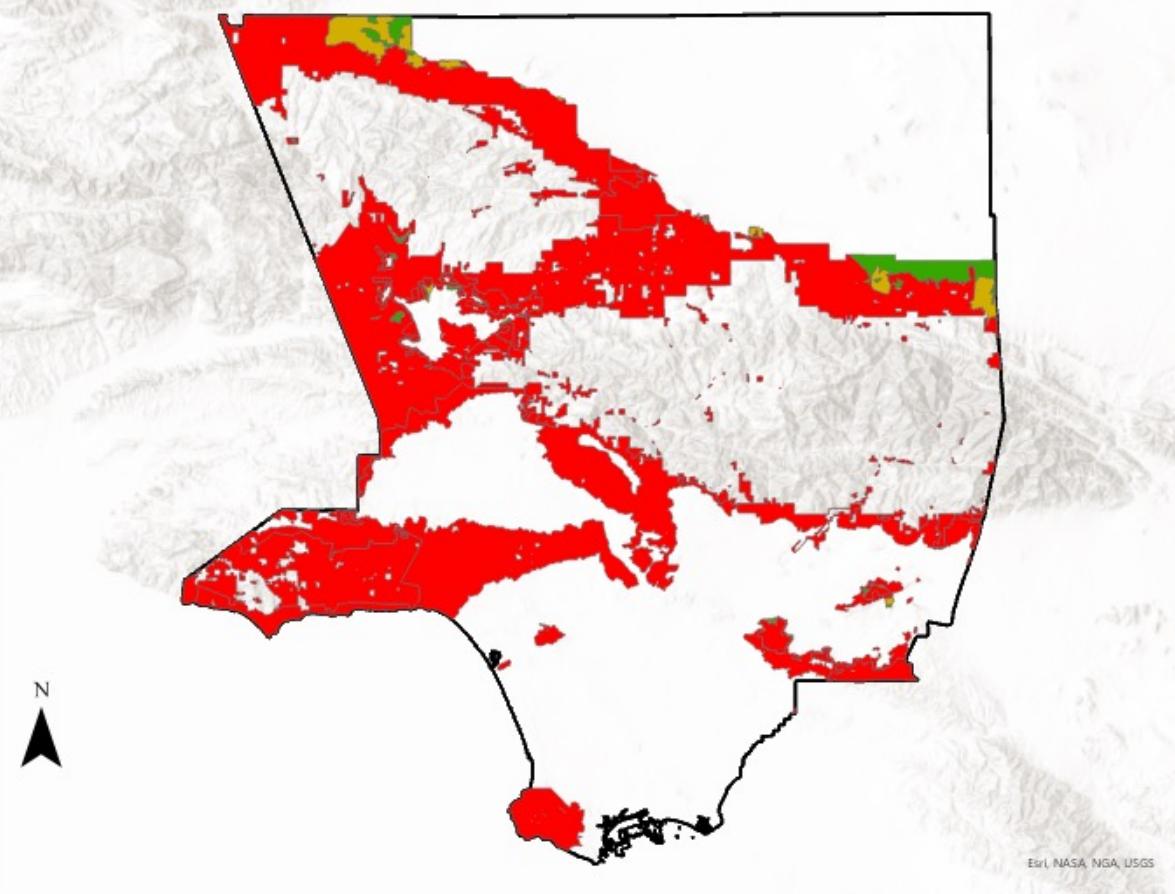
Slope Range	Risk Score
22 degrees	5
15 - 22 degrees	4
9 - 14 degrees	3
3 - 8 degrees	2
0 - 3 degrees	1

0.25

Sensitivity Analysis	Project	Scenario 1	Scenario 2	Scenario 3
Vegetation	40%	50%	30%	33.33%
Weather	35%	30%	40%	33.33%
Slope	25%	20%	30%	33.34%
Mean Risk (1-5)	2.3	+0.14	+0.45	+0.94

## Verification: Risk Scores within Fire Zones

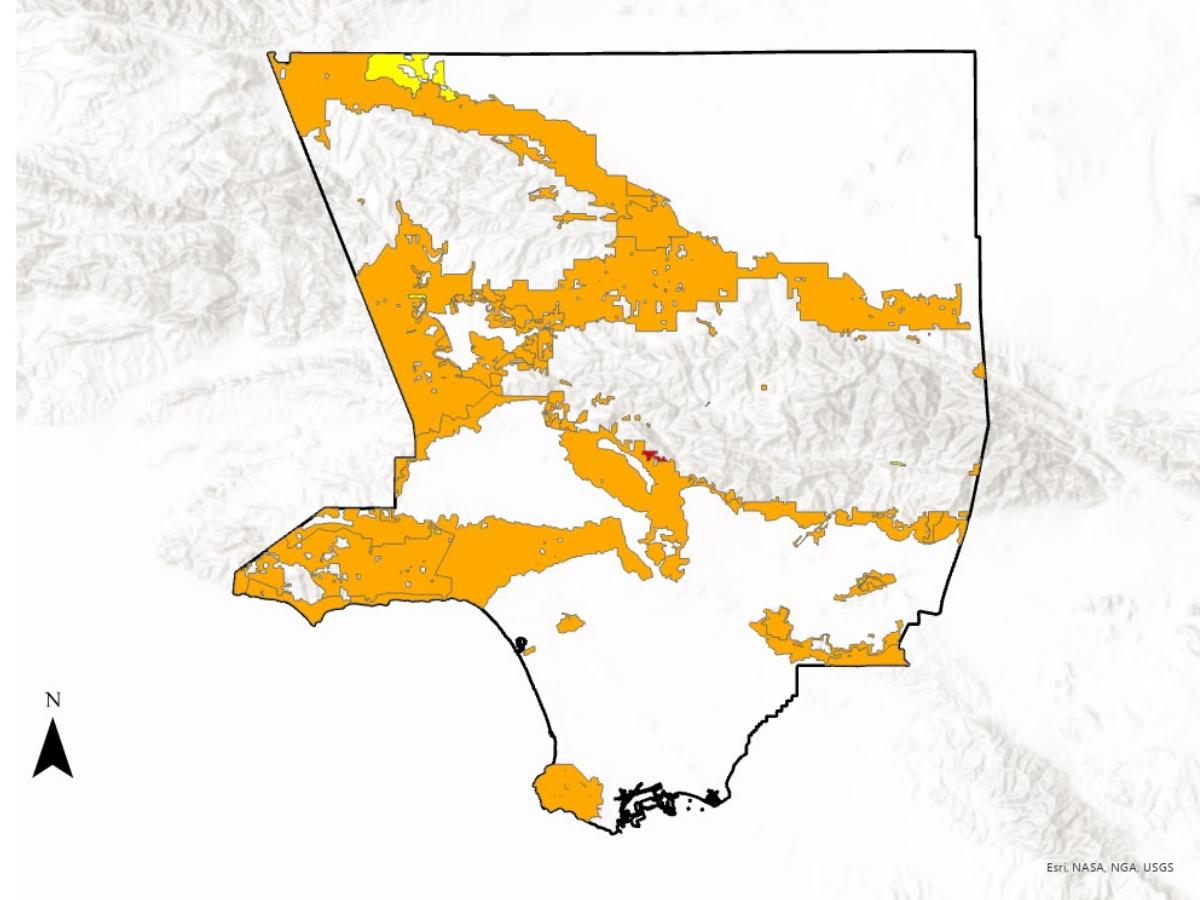
Fire Hazard Zone	Verification << >>	Mean Risk Score (Project)
(1) Moderate	12	1.07
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(3) Very High	13,459	1.38
2.8	Mean	1.3 (2.3 on 1-5 scale)
3	Median	1.35
0.394	Standard Deviation	0.258



### Fire Hazard Zone

(1-3 scale)

Moderate	2.8
High	3
Very High	0.394



### Mean Risk Score (Project)

Correlation = **0.107**  
P-value = **1.597**  
**Weak**

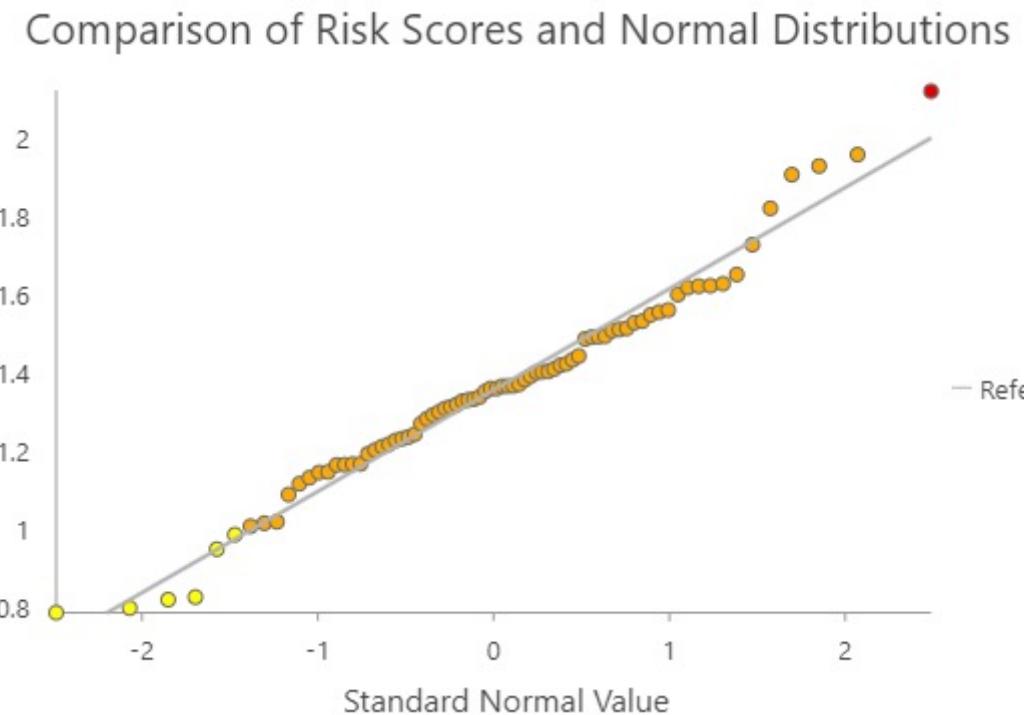
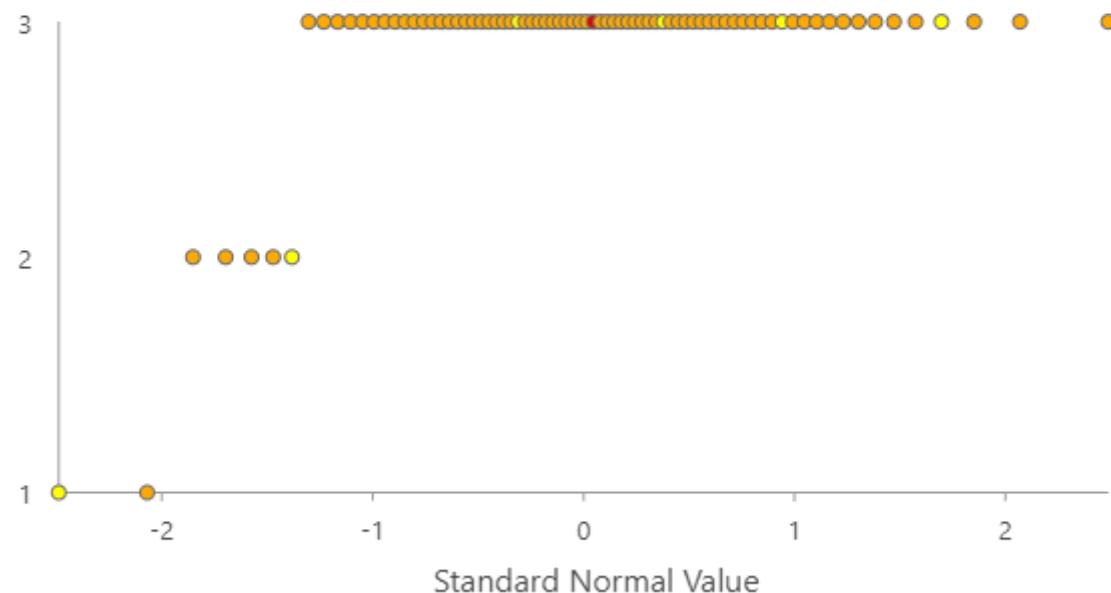
Mean

Median

SD

Comparison of Fire Hazard Zones and Normal Distributions

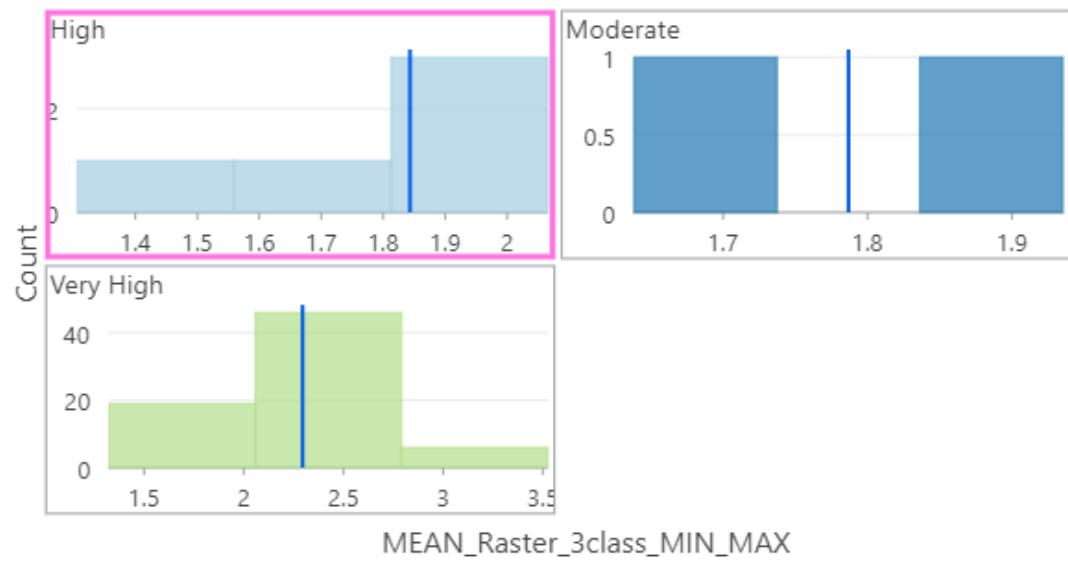
Fire Hazard Zones



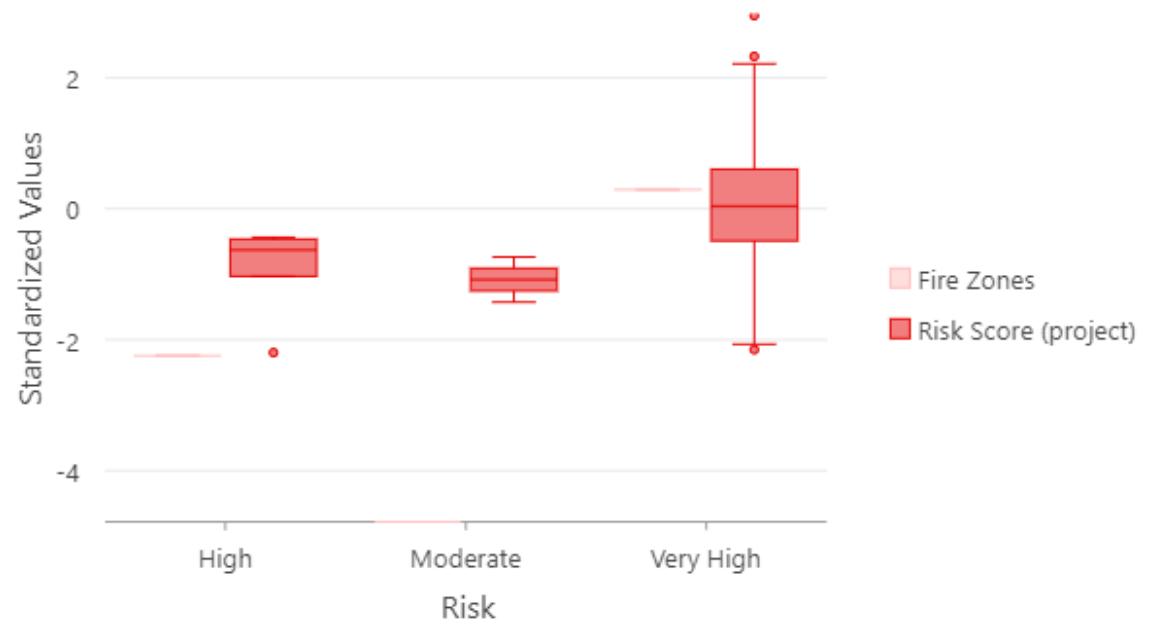
Distribution of MEAN\_Raster\_3class\_MIN\_MAX by FHSZ\_Descr



Distribution of MEAN\_Raster\_3class\_MIN\_MAX by FHSZ\_Descr



Distribution of Fire Zones & Risk Scores



# Conclusion

*Can we identify develop a model  
of residential wildfire risk in Los  
Angeles County at the parcel  
level?*

# Conclusion

## Findings:

- Most parcels moderate to high risk.
- Steep slopes & vegetation type are significant contributors.
- Validation shows general alignment with historical fire hazard zones, but predictive accuracy is low.

## Conclusions:

- Targeted mitigation is critical in high-risk areas
- Climate Change
- Increase In-fill development density!!!!

# Shortcomings & Challenges



- Defining & justifying variables
- Narrow focus study area
- Better weather modeling data
- Scoring 1-5 or 1-3 !!!
- Historic data helpful?
- Drought projections?
- QC?
- Too much data!!??
- Deeper analysis & conclusions
- DFD to come