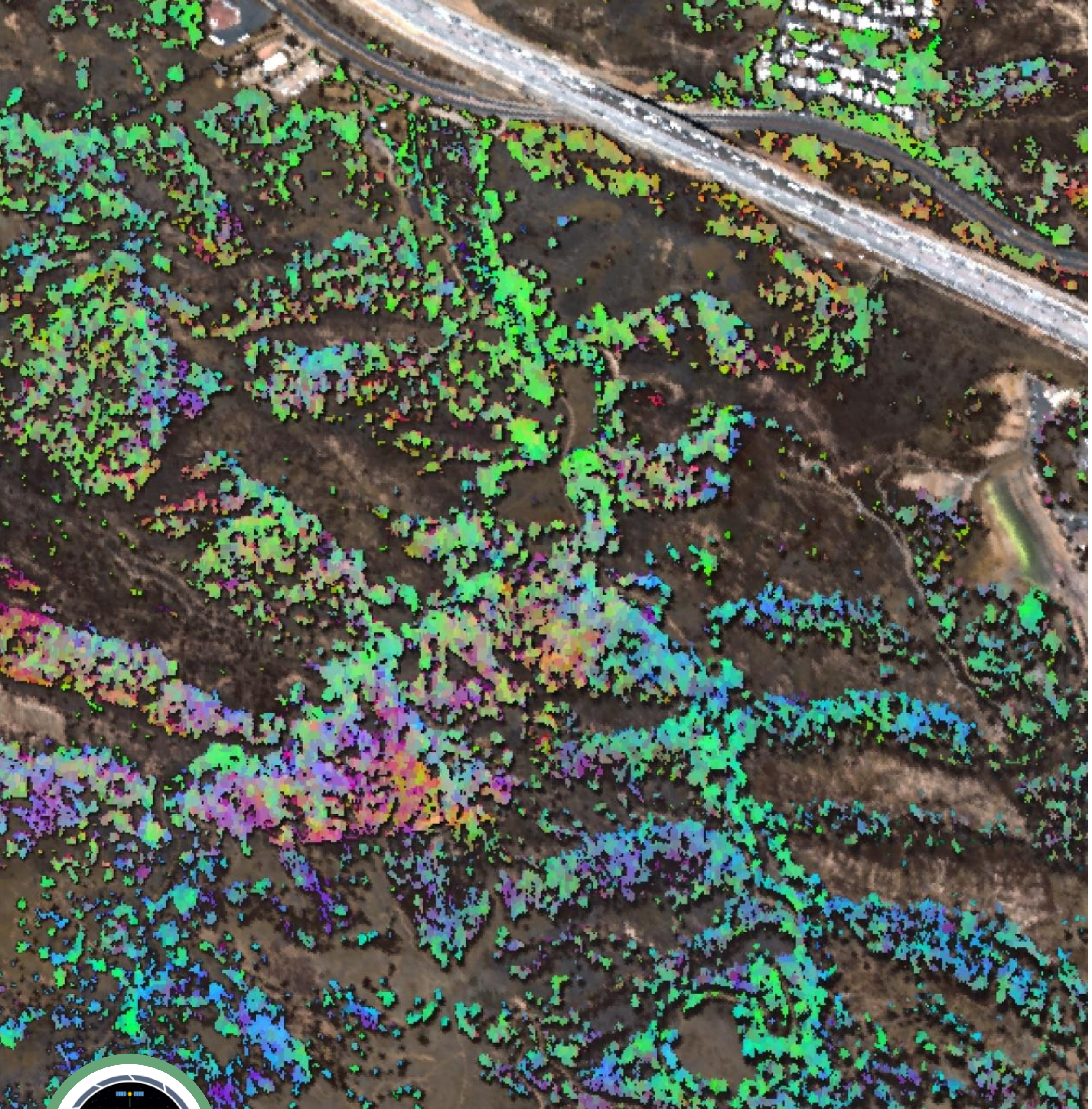


National Aeronautics and Space Administration

SANTA CLARITA VALLEY ECOLOGICAL CONSERVATION

Identifying Oak Woodland Infested with the Goldspotted Oak Borer in the Santa Clarita Valley Using Earth Observations

Madison Elowitt
Justine Pendergraft
Simon Ng
Nathalie Lai

California – JPL | Fall 2024

Outline

Background

- Team & Partner Introduction
- Concerns

Objectives

- Study Area
- End Products
- Earth Observations

End Products

- Methods
- Results

Outcomes

- Uncertainty & Limitations
- Conclusions & Acknowledgements

Meet the Team

Madison Elowitt,
Project Lead

Justine Pendergraft

Simon Ng

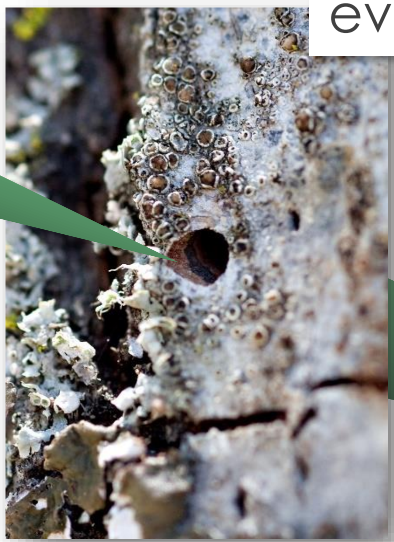
Nathalie Lai

Background – Goldspotted Oak Borer

The invasive Goldspotted Oak Borer (GSOB) presents a major threat to Southern California's native oak woodlands.

Agrilus auroguttatus

GSOB larvae feed on water and nutrients in an oak's cambium.



Infestations can lead to visible damage within 2 – 3 years and eventual widespread mortality.

Coast live oak, *Quercus agrifolia*

Image Credit (L–R): Mike Lewis, Center for Invasive Species Research, Mark Gunn

Community Concerns – GSOB in SoCal

As a keystone species in SoCal, oak trees provide:

- Macro-ecosystem Structure
- Shade and Habitat
- Food
- Cultural Connection

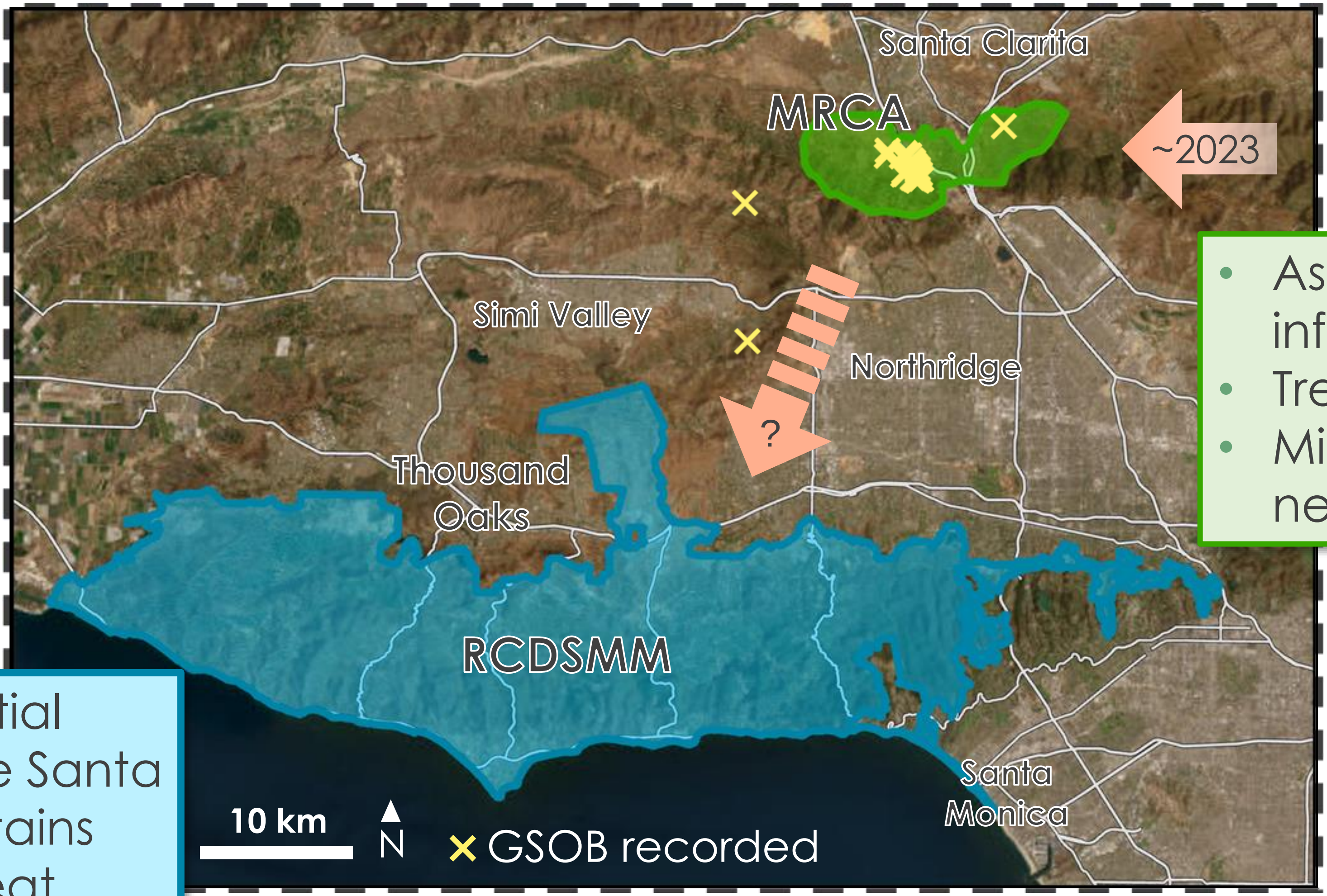
Basemap credits: Earthstar Geographics

Image Credit: Mike Lewis

Partner Concerns

Resource Conservation District of Santa Monica Mountains (RCDSMM)

- Prevent potential spread into the Santa Monica Mountains
- Detect and treat migration early



Basemap Credit: Earthstar Geographics

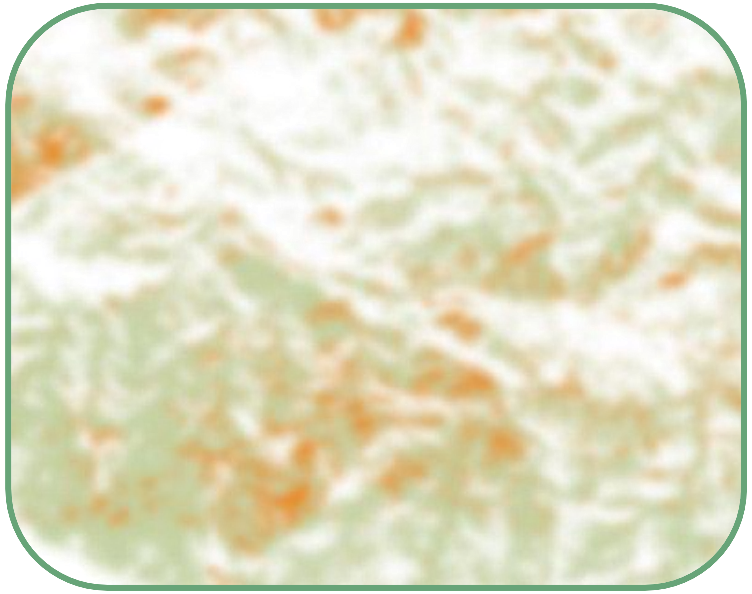
Mountains Recreation & Conservation Authority (MRCA)

- Assess the extent of infestation
- Treat impacted trees
- Mitigate spread within nearby parklands

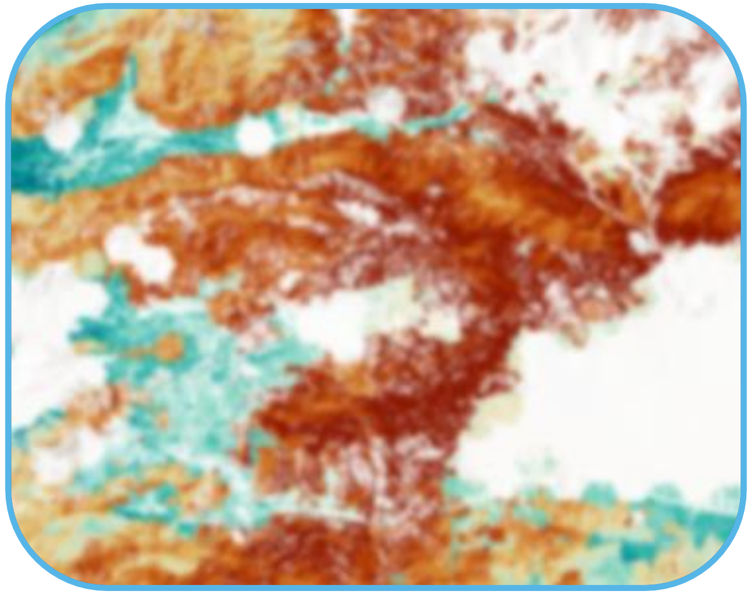
Project Objectives

Identify infested trees and mitigate GSOB spread throughout Santa Clarita Valley

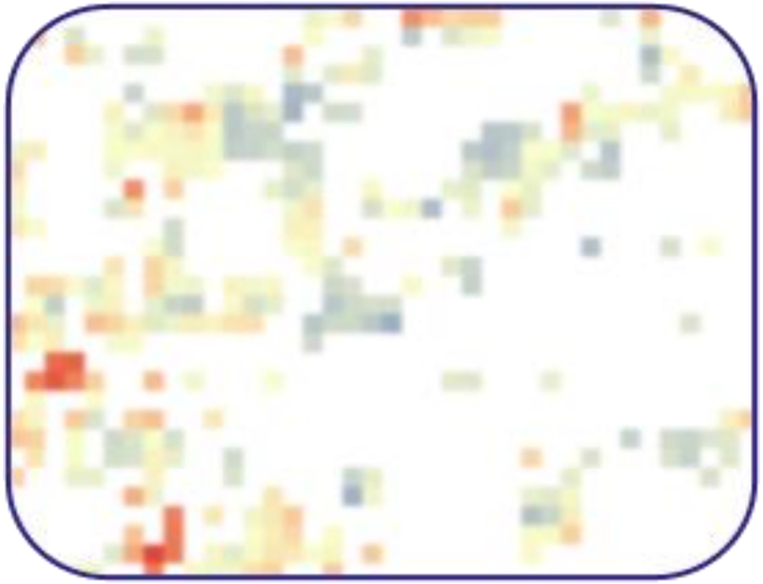
Anticipate and prevent future migration to the Santa Monica Mountains



Infested Oak Tree Classification Map

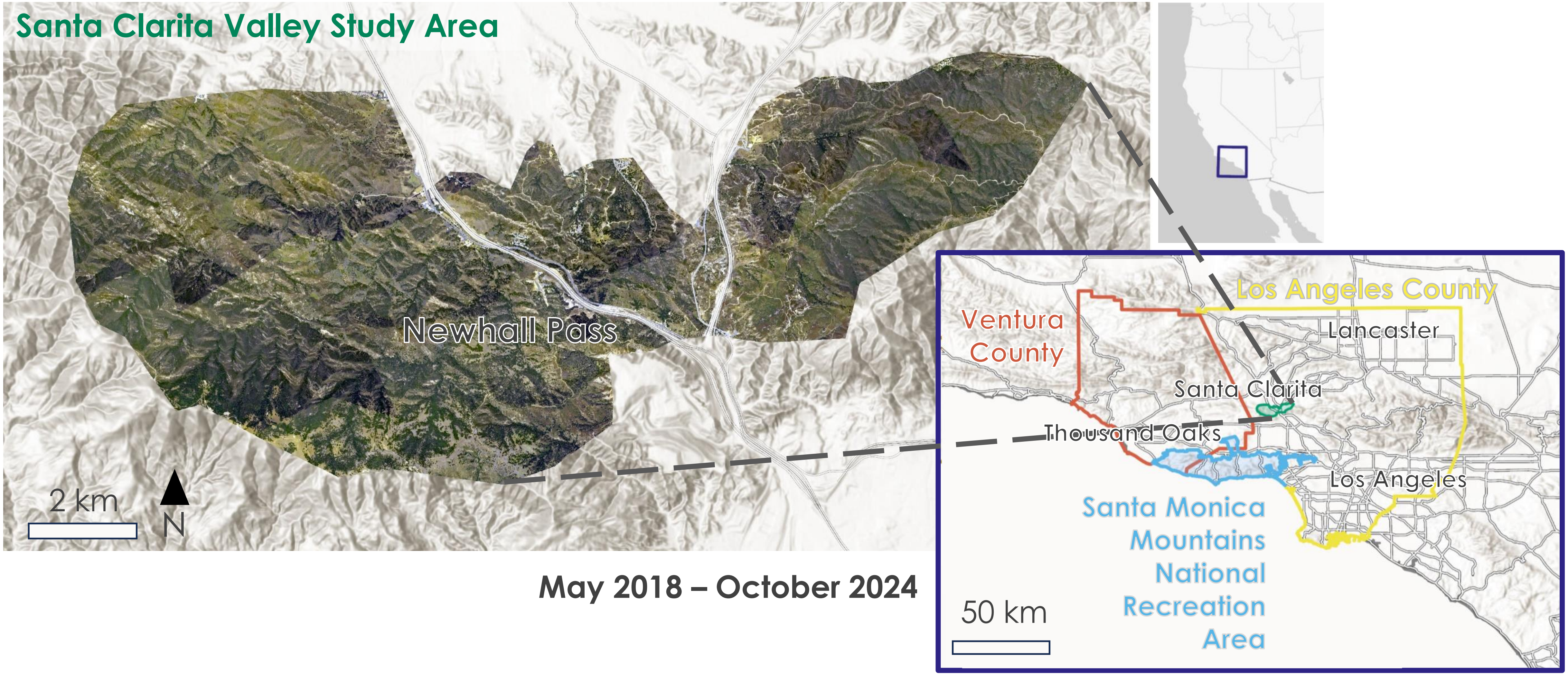


Risk Assessment Map



Landcover Change Map

Study Area and Period

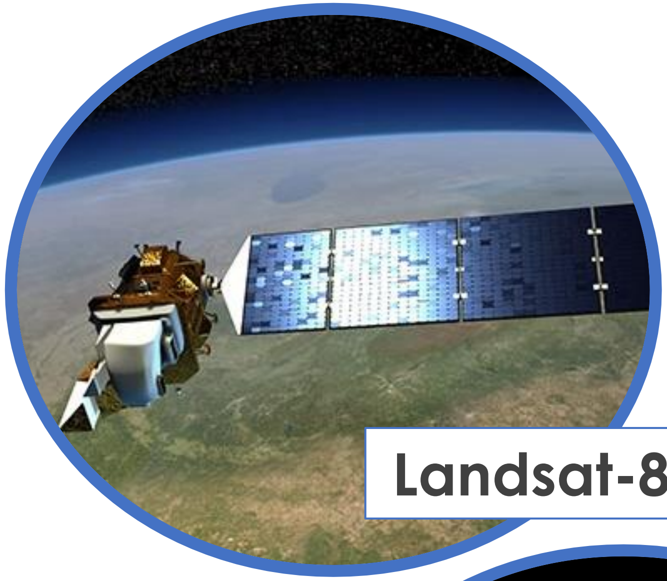


May 2018 – October 2024

Basemap Credits: AVIRIS-3, Esri, CGIAR, USGS, NASA, NGA, FEMA, TomTom, Garmin, FAO, NOAA, EPA, USFWS

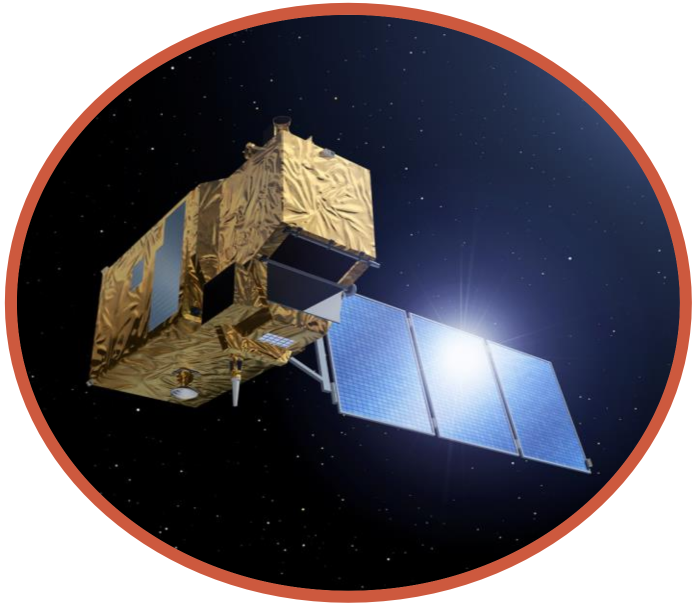
Earth Observations – Sensors

AVIRIS-3



Landsat-8 OLI TIRS

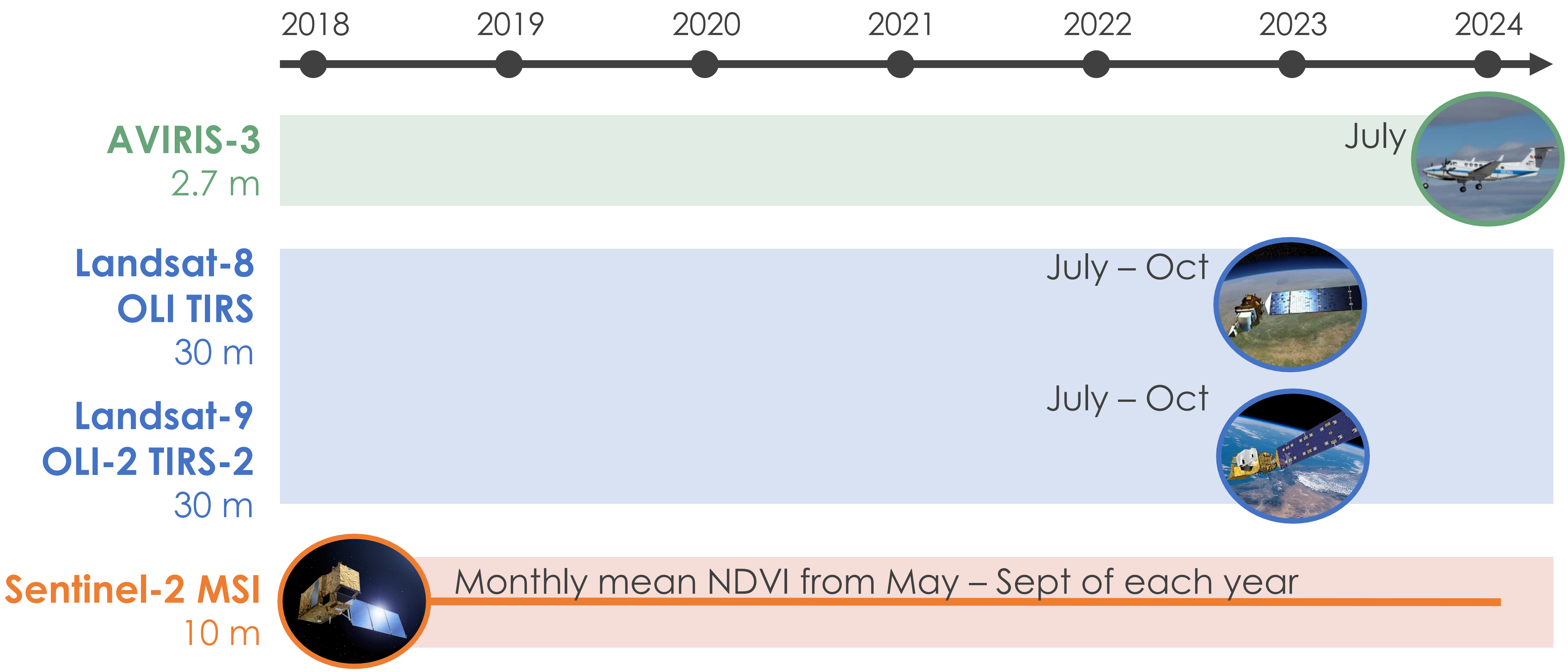
Landsat-9 OLI-2 TIRS-2



Sentinel-2 MSI

Image Credit (L–R): NASA;
Copernicus, ESA

Earth Observations – Time Period



Methods – Classification Overview

Methods – Ground Truth Data Processing

Raw Tree Points

- Healthy Crown
- Healthy Crown with Beetle Holes
- Minor Dieback
- Minor Dieback with Beetle Holes
- Moderate Dieback
- Moderate Dieback with Beetle Holes
- Severe Dieback
- Severe Dieback with Beetle Holes

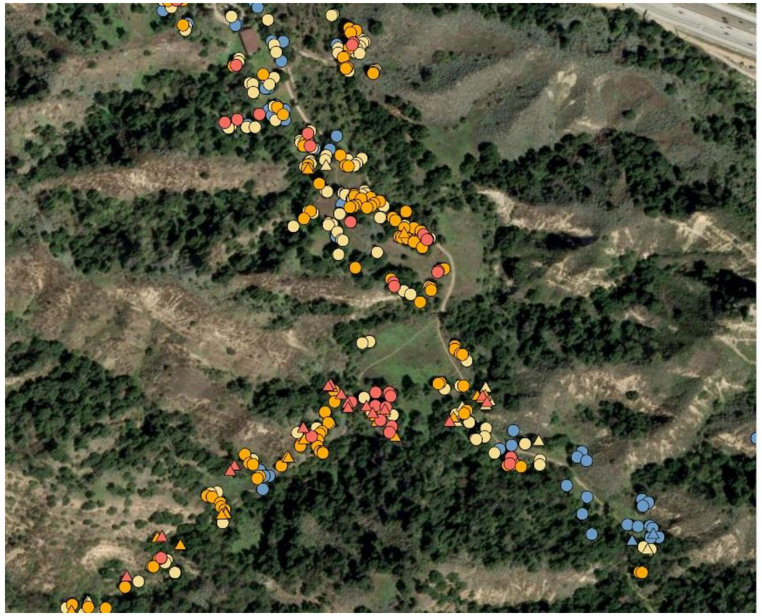
N

5 km

Basemap Credits: AVIRIS-3

Methods – Ground Truth Data Processing

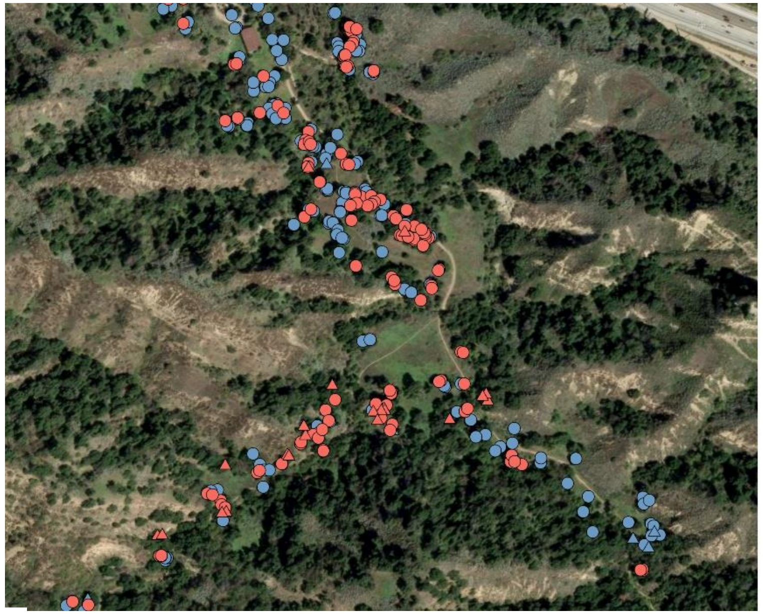
Raw



- Healthy Crown
- Healthy Crown with Beetle Holes
- Minor Dieback
- Minor Dieback with Beetle Holes
- Moderate Dieback
- Moderate Dieback with Beetle Holes
- Severe Dieback
- Severe Dieback with Beetle Holes

Data Wrangling

Analysis-Ready



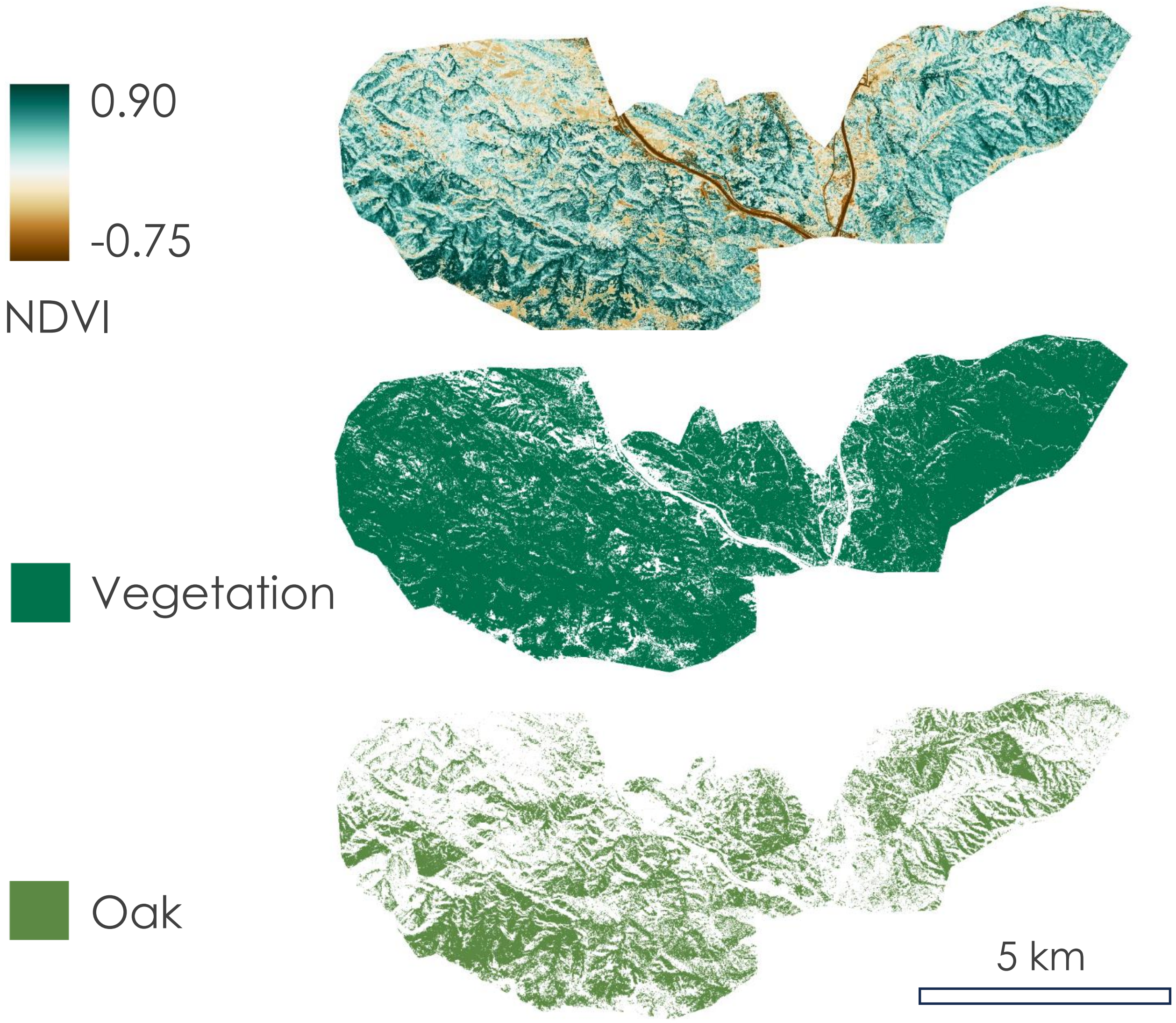
- Healthy/Minor Dieback
- Healthy/Minor Dieback with Beetle Holes
- Moderate/Severe Dieback
- Moderate/Severe Dieback with Beetle Holes

0.5 km

N

Basemap Credits: MAXAR

Results – Oak Tree Classification

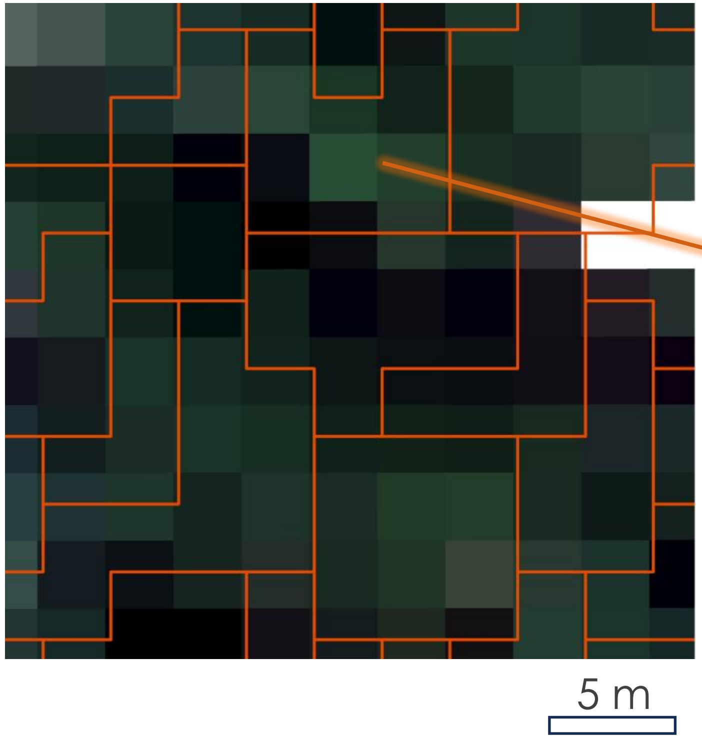


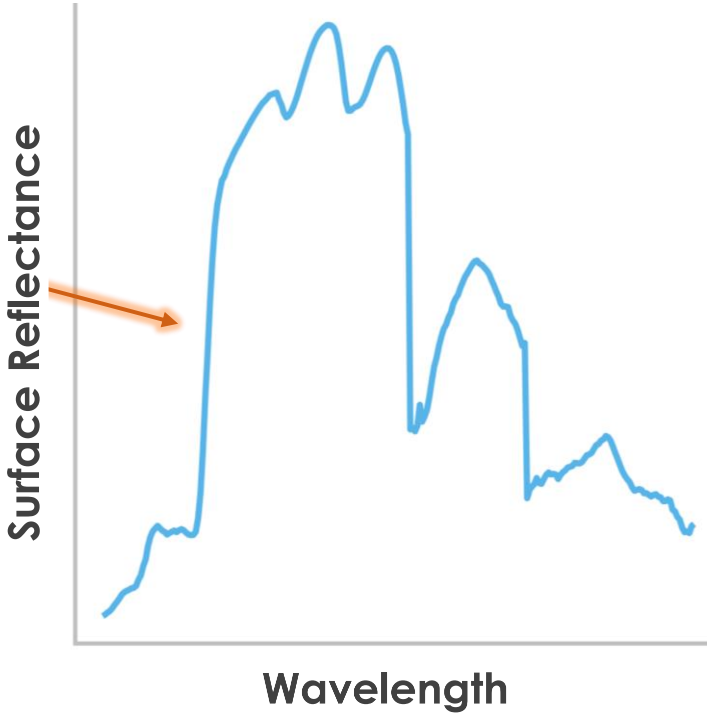
UAV Credits: CSUN CGST September 2024

Results – Oak Tree Classification Accuracy

Classifier	Accuracy	Kappa	AUC	Cross Validation Accuracy
K-Nearest Neighbor (1 Neighbor)	96.3%	0.92	0.95	96%
K-Nearest Neighbor (5 Neighbors)	97.2%	0.92	0.97	96%
Random Forest	100%	0.92	0.97	100%
Support Vector Machine	100%	1	1	100%

Methods – Infested Oak Tree Classification





Train model using spectral profiles of known infested and healthy oak pixels

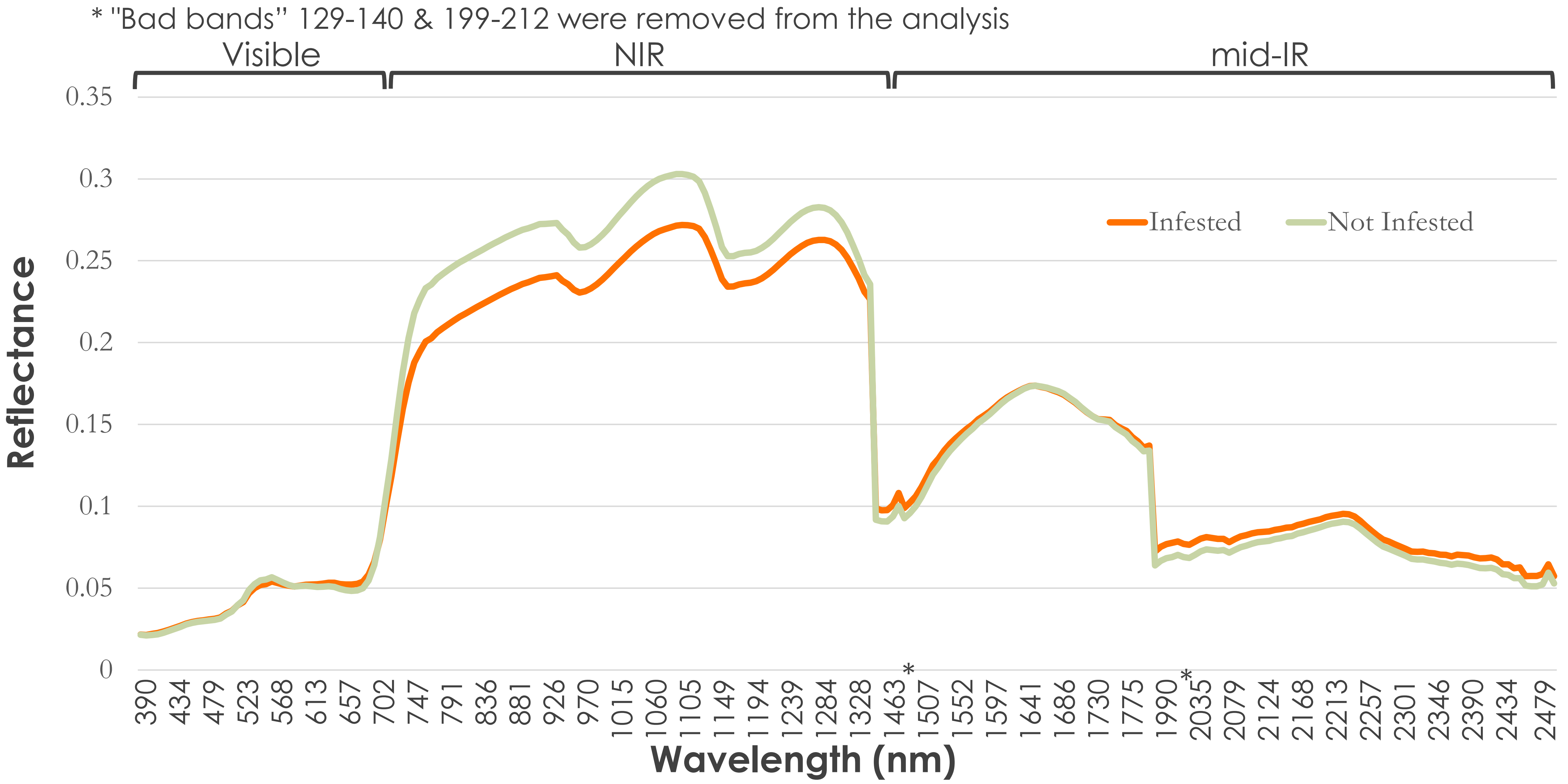
Classify canopies based on their spectral profiles

Segment oak layer into canopies

Calculate average spectral profile for each canopy

Results – Infested Oak Tree Classification

Results – Infested Oak Tree Classification



Results – Infested Oak Tree Classification

		Testing	
		Infested	Not Infested
Training	Infested	73	26
	Not Infested	16	65

Overall Accuracy: 76.67%

Methods – Risk Assessment

Natural Population Spread

Known GSOB Infestation

Environmental Stressors

Past Wildfires

Heat (High Temperatures)

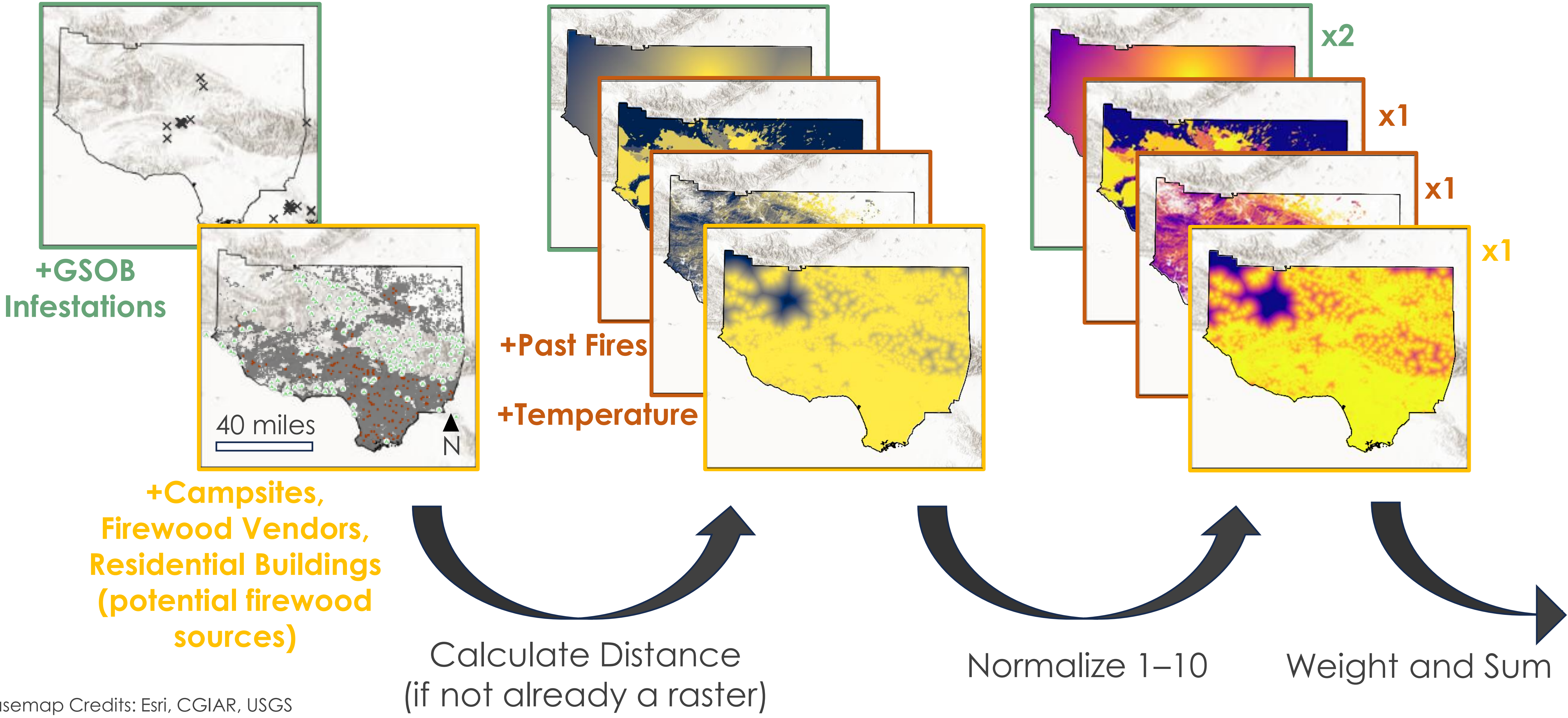
Potential Human Movement of Infested Wood

Campsites

Firewood Vendors

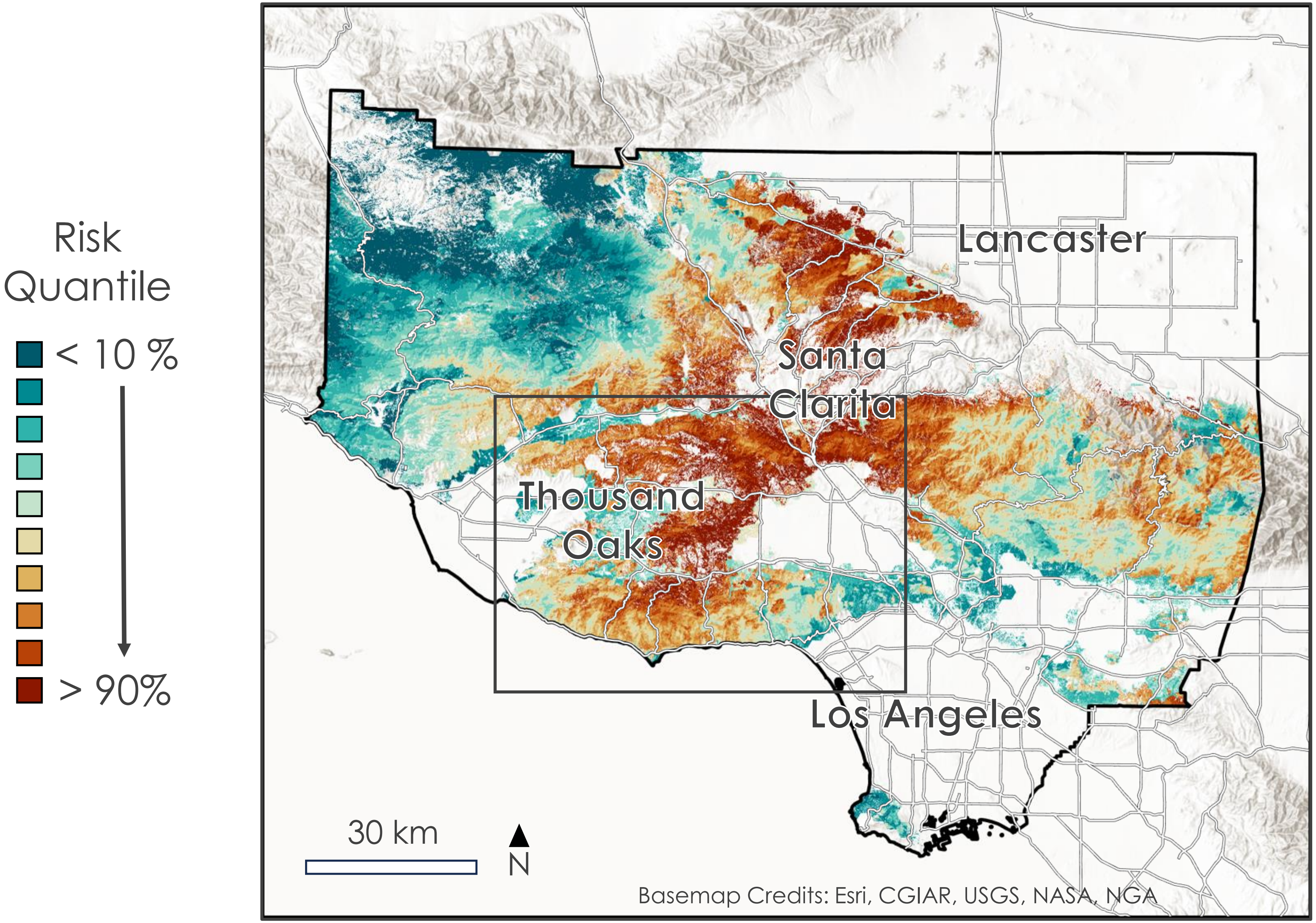
Residential Buildings

Methods – Risk Assessment Inputs



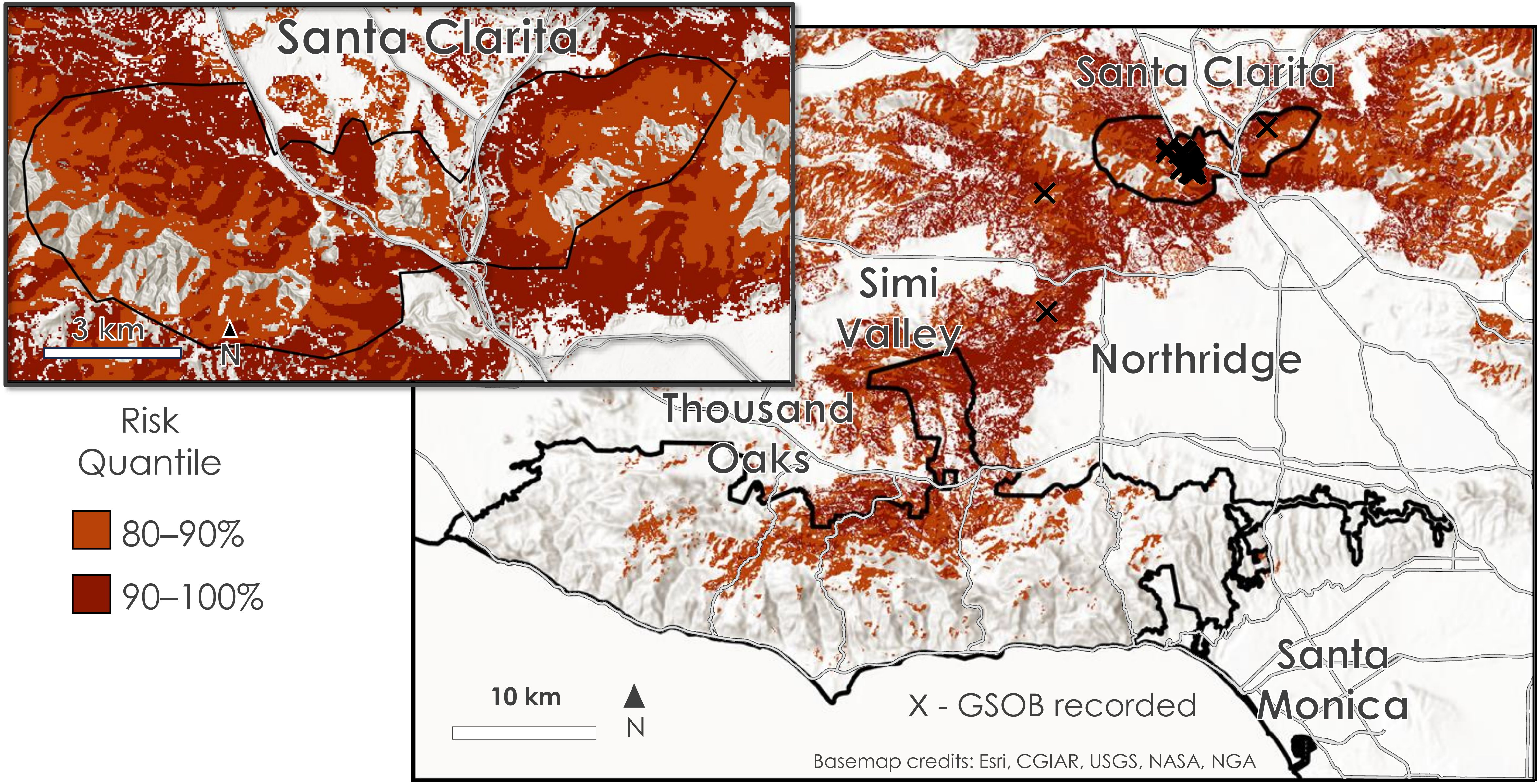
Basemap Credits: Esri, CGIAR, USGS

Results – Risk Assessment

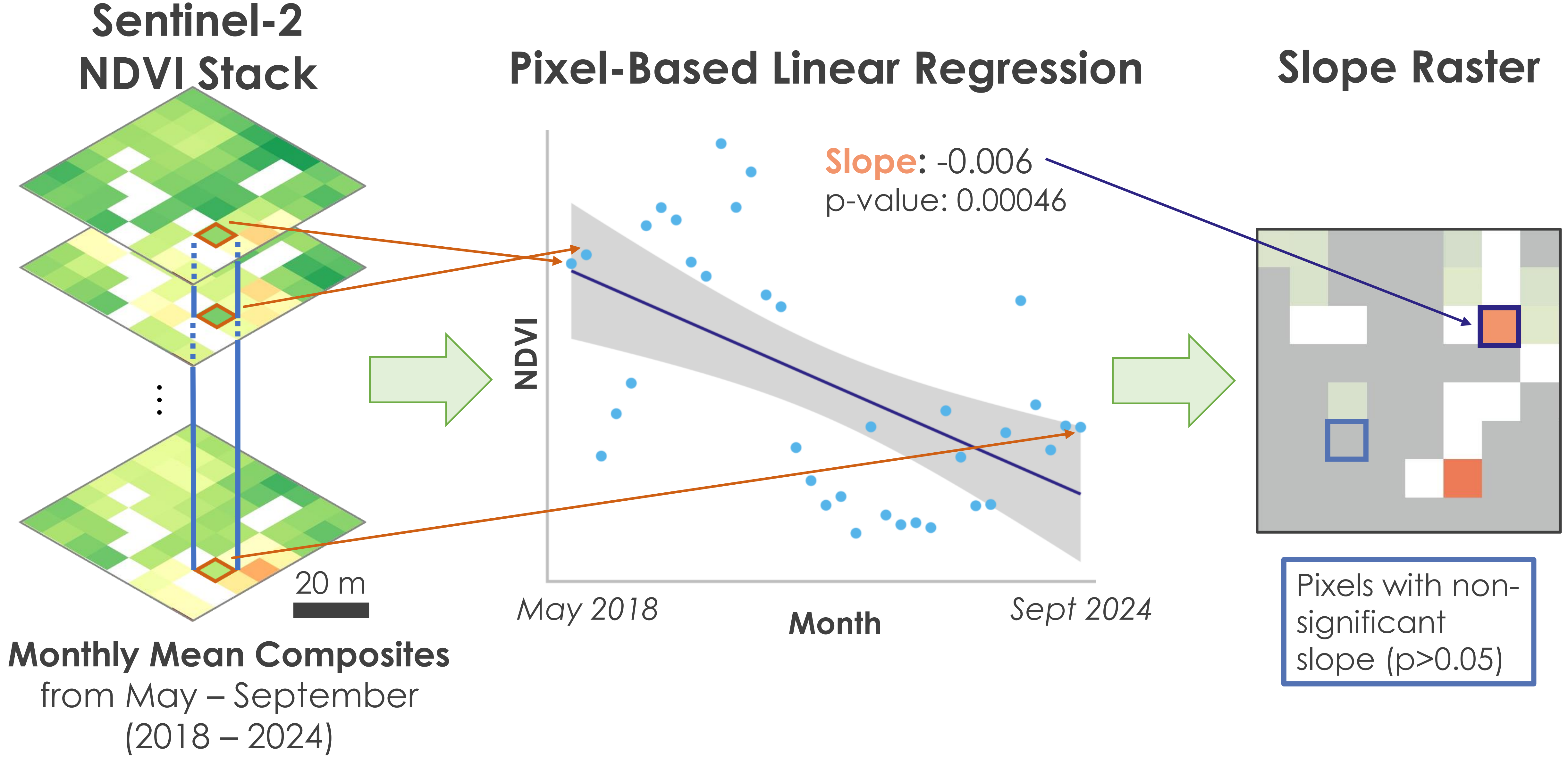


Criteria	Weight
Infestation	x 2
Past Fires	x 1
2023 Temperature	x 1
Firewood Sources	x 1

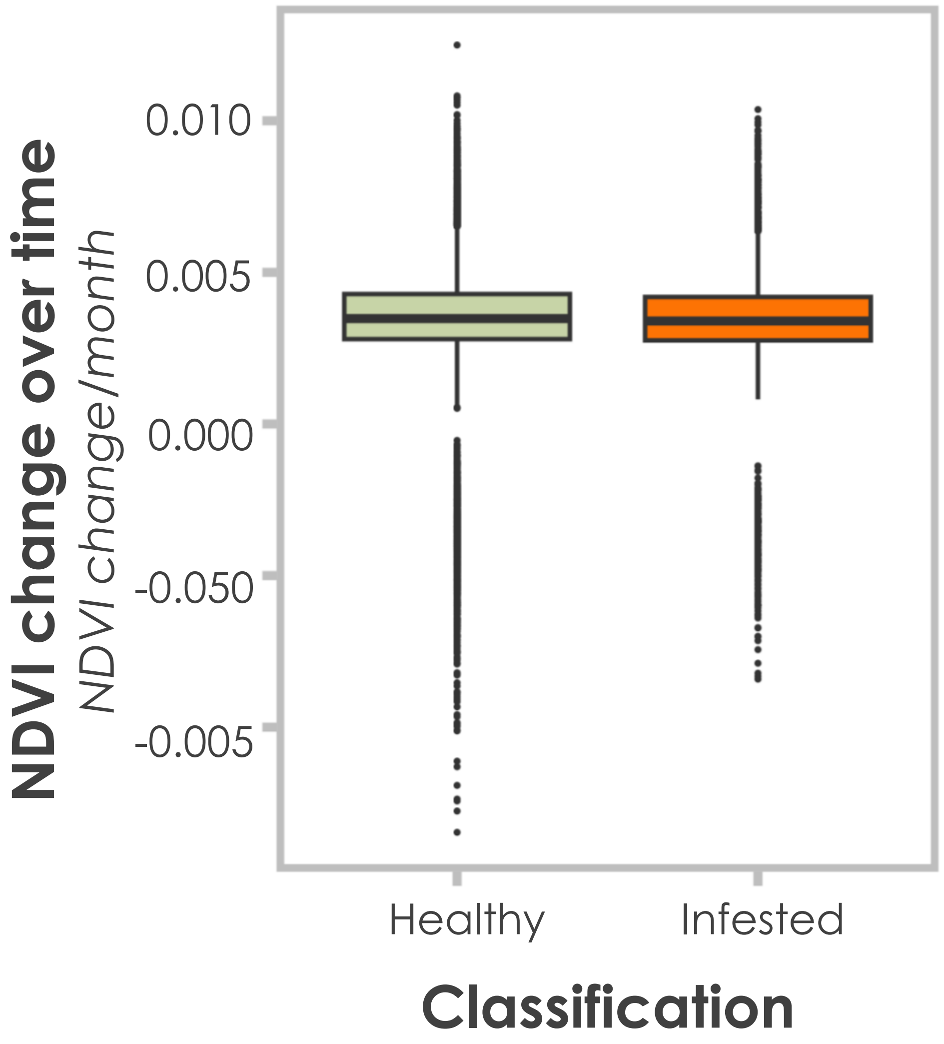
Results – Risk Assessment



Methods – Landcover Change



Results – Landcover Change



10-m Sentinel-2 MSI-based NDVI does not provide enough sensitivity to track oak woodland decline as a result of GSOB infestations.

Classification	Mean Slope	% Significant Pixels
Healthy	0.003352	17.3%
Infested	0.003355	19.7%

Difference in mean slopes: not statistically significant (p=0.93)

Sources of Error and Uncertainty

Infested Oak Tree Classification

- Ground survey constraints
- No recent LiDAR data

Risk Assessment

- No geographic variability in infested tree points
- Weightings of inputs are not empirically determined

Landcover Change

- Coarse spatial resolution
- Multispectral imagery

Image Credit: Anita Gould

Conclusions

Our Work

Demonstrate feasibility of utilizing NASA Earth observations to:

- detect infested oaks
- assess areas at risk

Illustrate limitations of landcover change analyses

+

Partner Capabilities

Visualize full extent of GSOB infestation in Santa Clarita Valley

Treat infested trees

Target GSOB mitigation and prevention efforts in vulnerable areas, especially in RCDSMM

=

Public Outreach

Inform firewood users of presence and threat of GSOB

Empower them to safely purchase and burn local firewood

Acknowledgments

Partners (End Users)

- Matthew Ribarich (Mountains Recreation and Conservation Authority)
- Rosi Dagit (Resource District of the Santa Monica Mountains)

Advisors

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- Dr. Latha Baskaran (NASA Jet Propulsion Laboratory, California Institute of Technology)
- Dr. Zoe Pierrat (NASA Jet Propulsion Laboratory, California Institute of Technology)
- Benjamin Holt (NASA Jet Propulsion Laboratory, California Institute of Technology)

Center Lead & Fellow

- Michael Pazmino (California – JPL)
- Marisa Smedsrud (Maryland – Goddard)

We also extend our gratitude to collaborators Julie Clark (University of California, Agriculture and Natural Resources), Kim Corella (CalFire), Danielle Bram and Hilary Johnson (California State University, Northridge), Dr. Alana Rader (Lewis & Clark College), and Beth Kyre (USDA, U.S. Forest Service, Southern California Shared Service Area).

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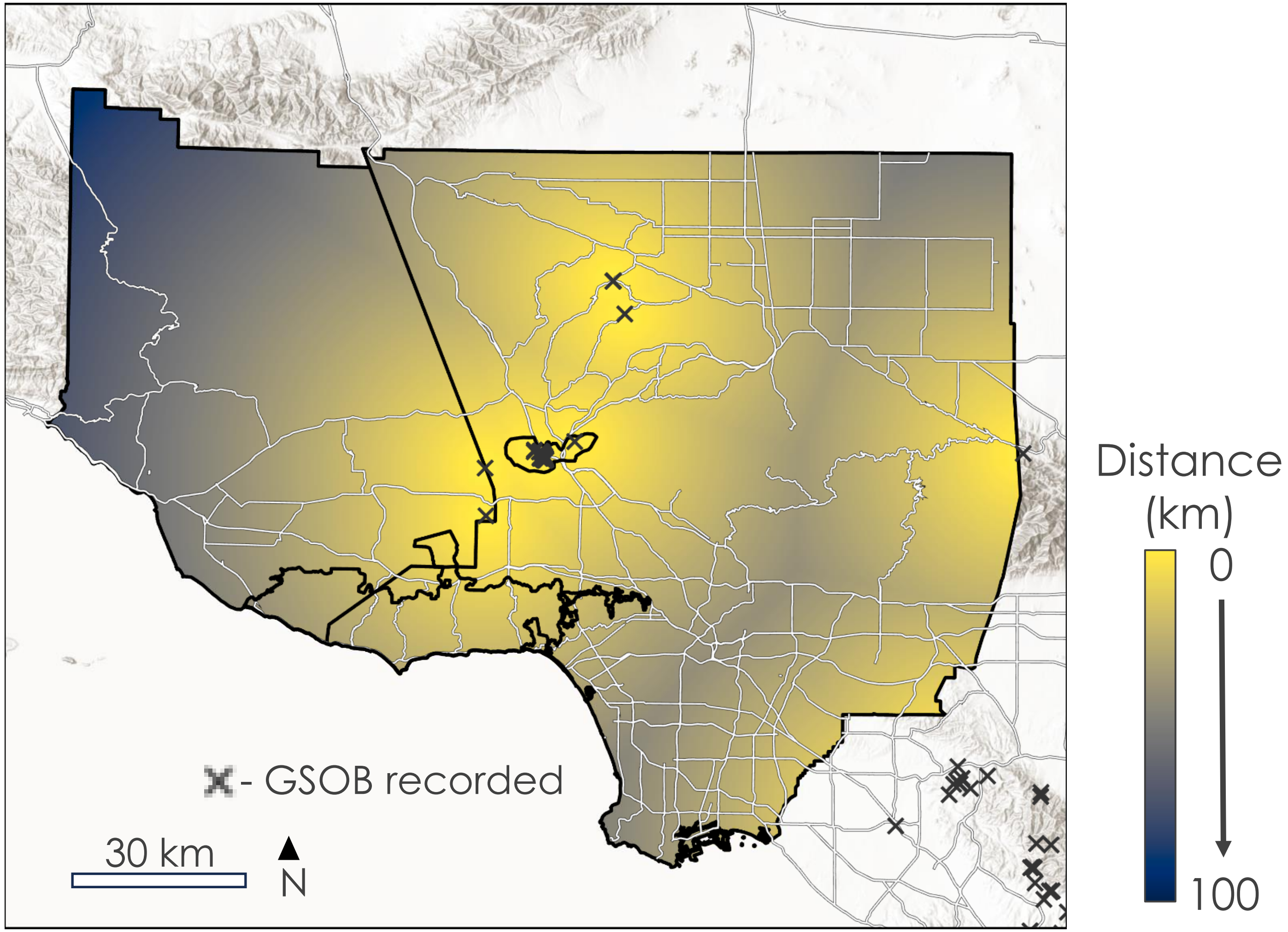
Appendix

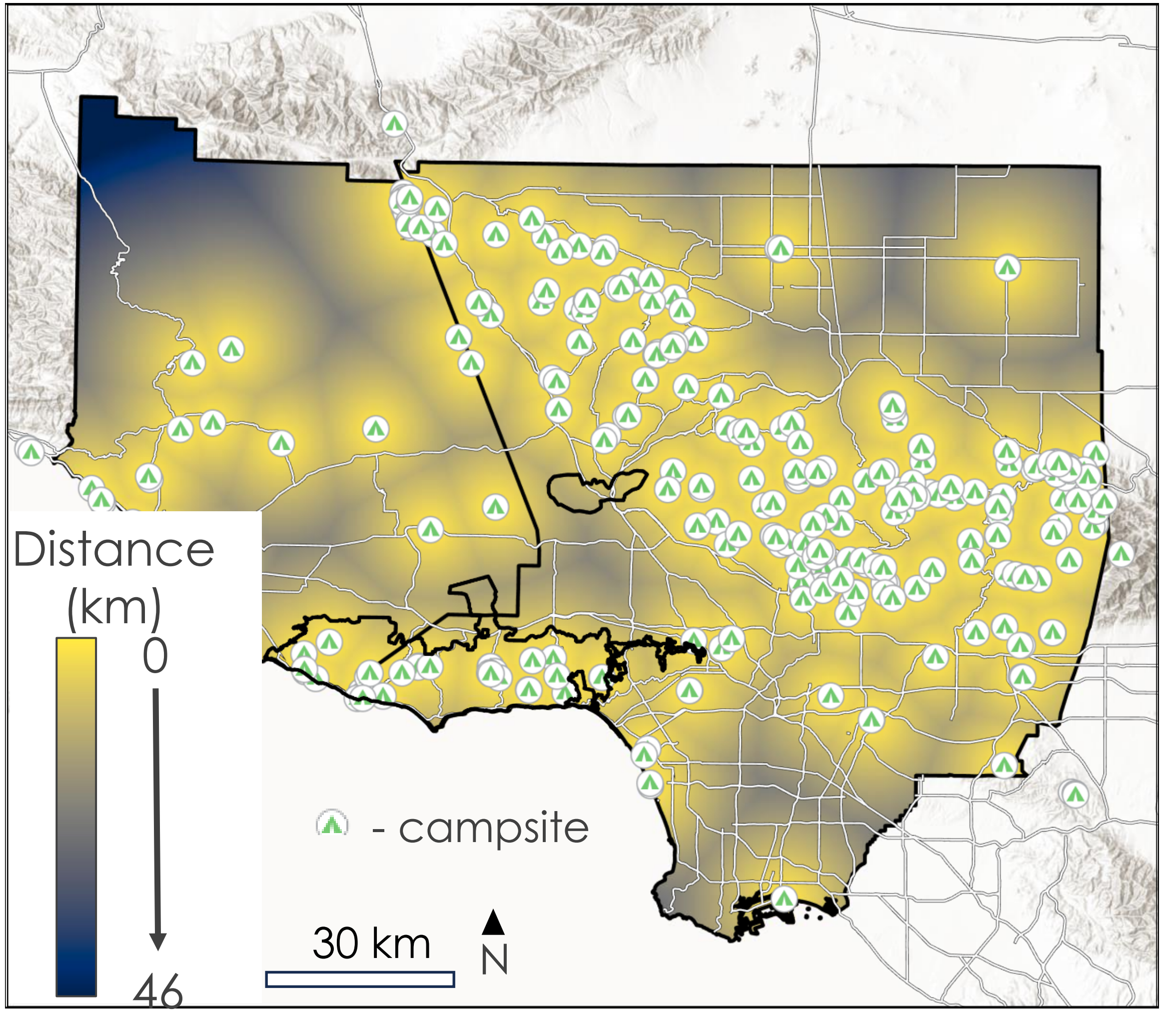
Risk Assessment Components: Infestations



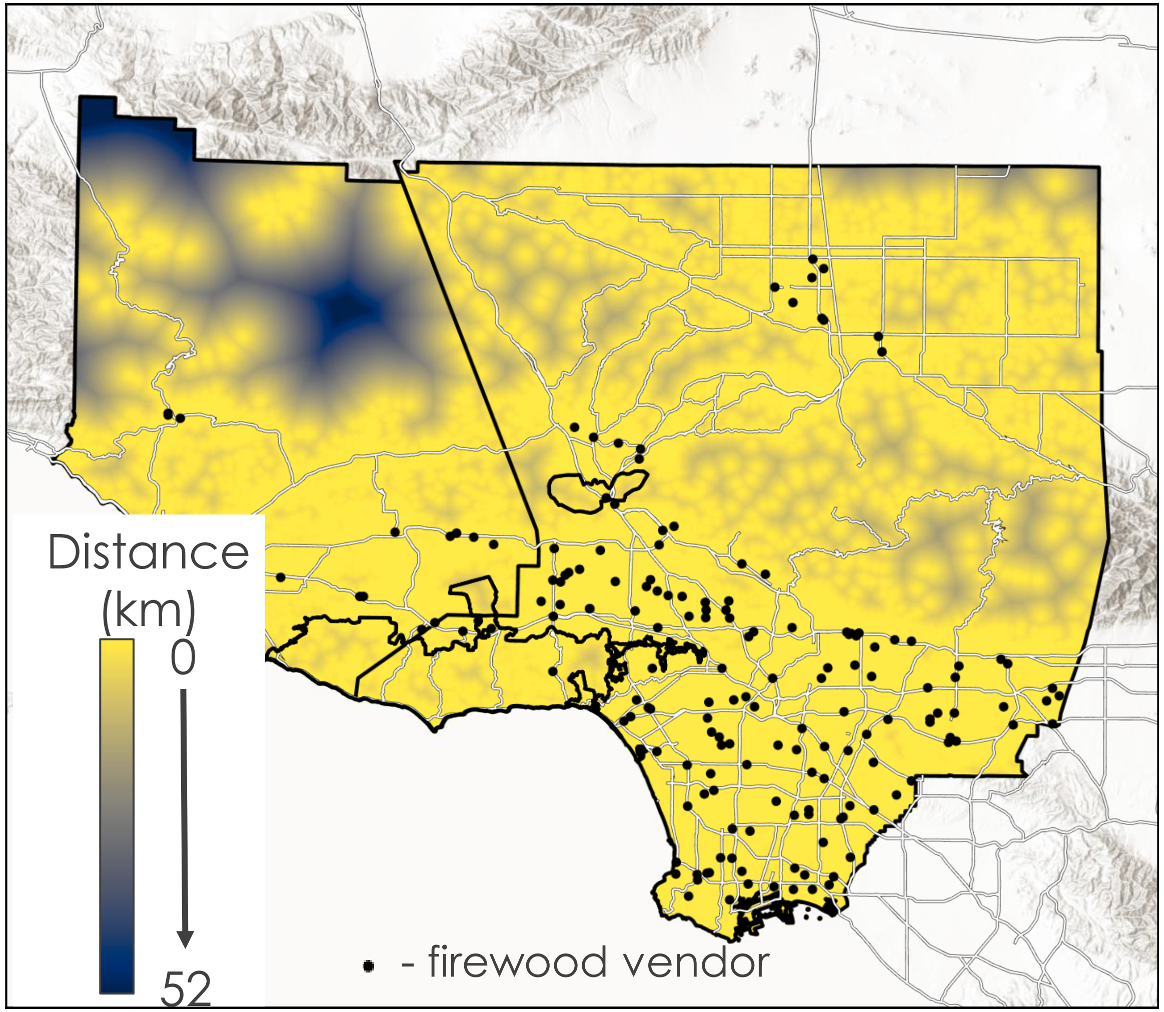
Distance to GSOB Infestations

Basemap Credits: Esri, CGIAR, USGS, NASA, NGA

Risk Assessment Components: Firewood



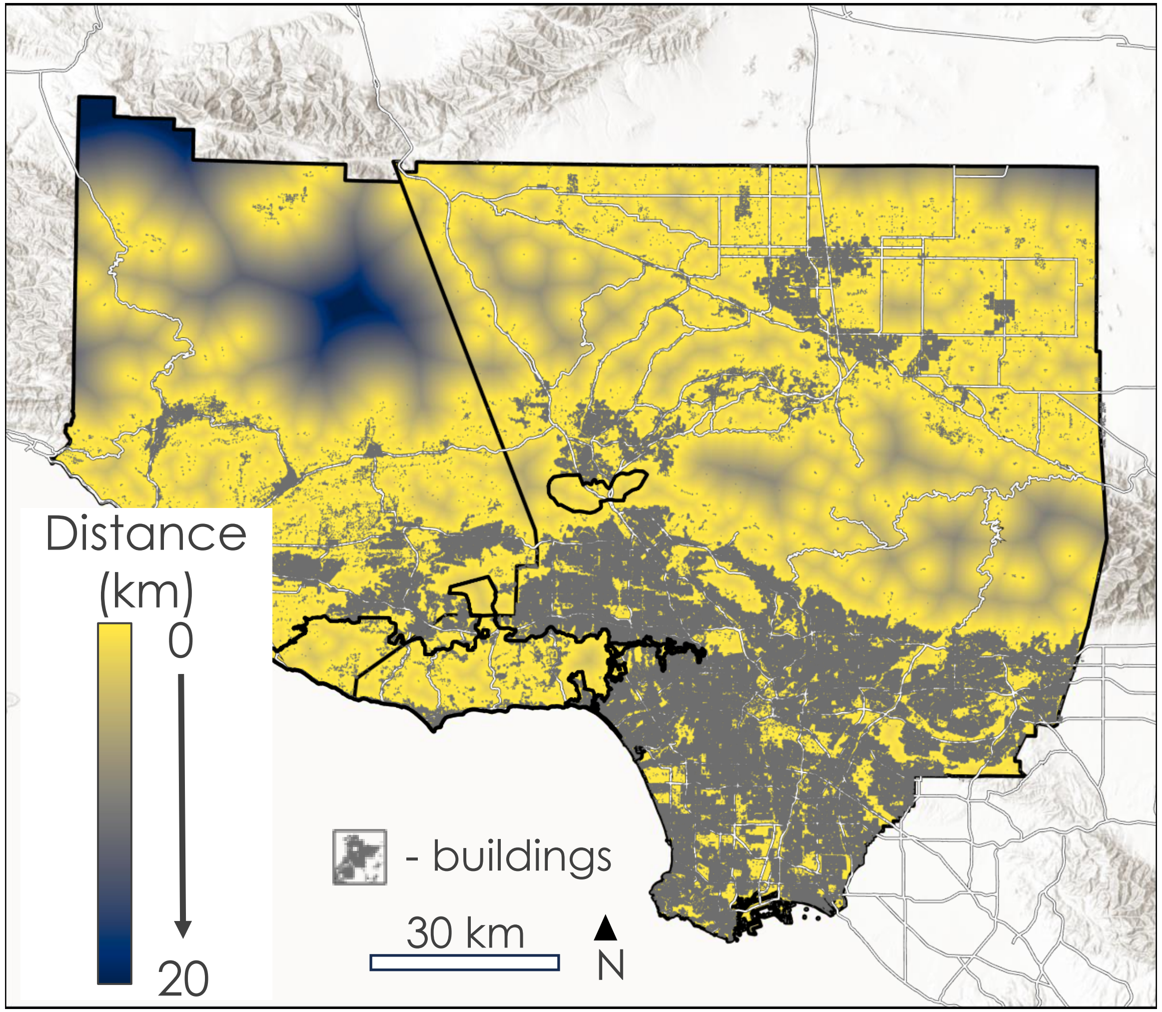
Distance to Campsites



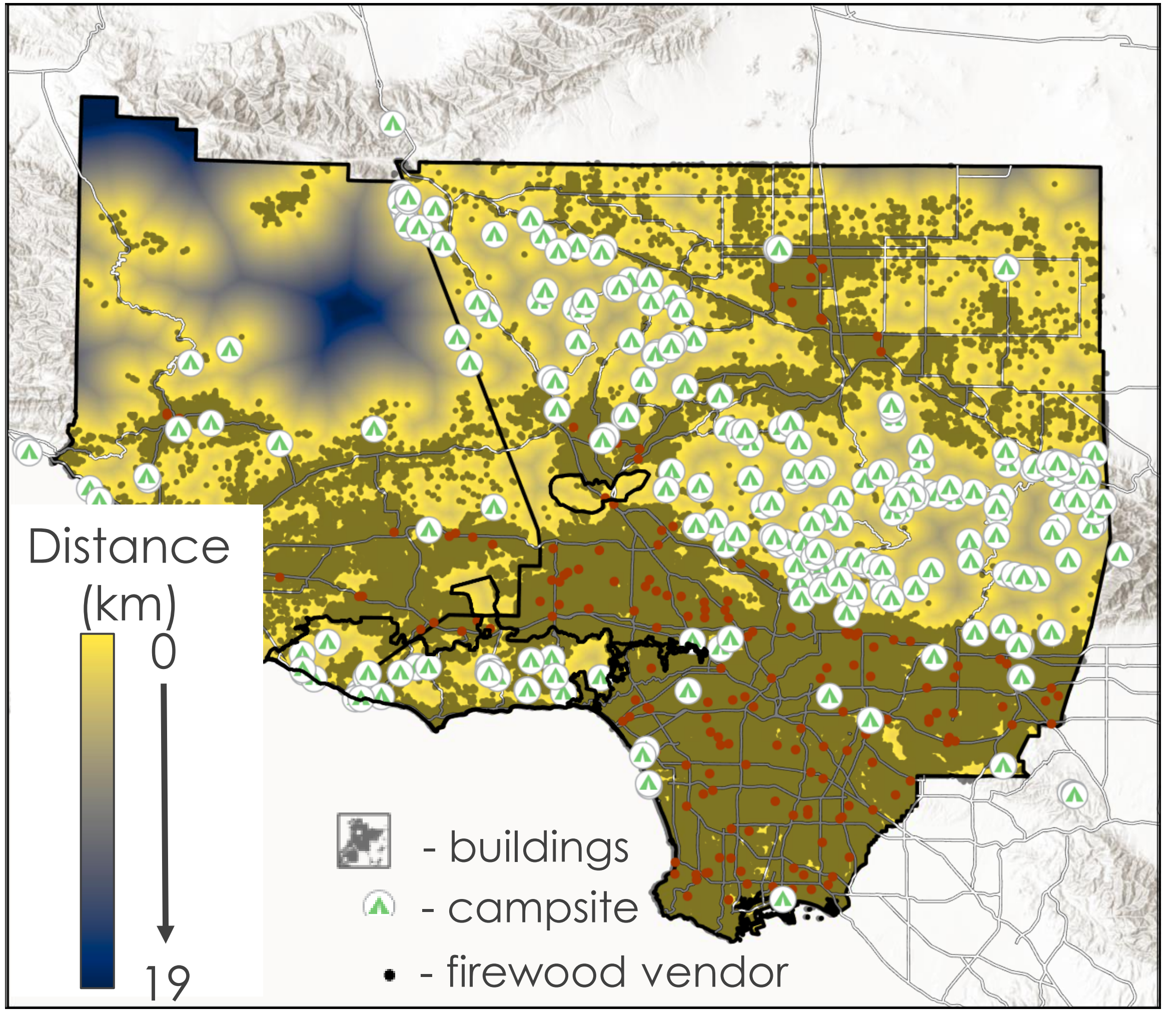
Distance to Firewood Vendors

Basemap Credits: Esri, CGIAR, USGS, NASA, NGA

Risk Assessment Components: Firewood



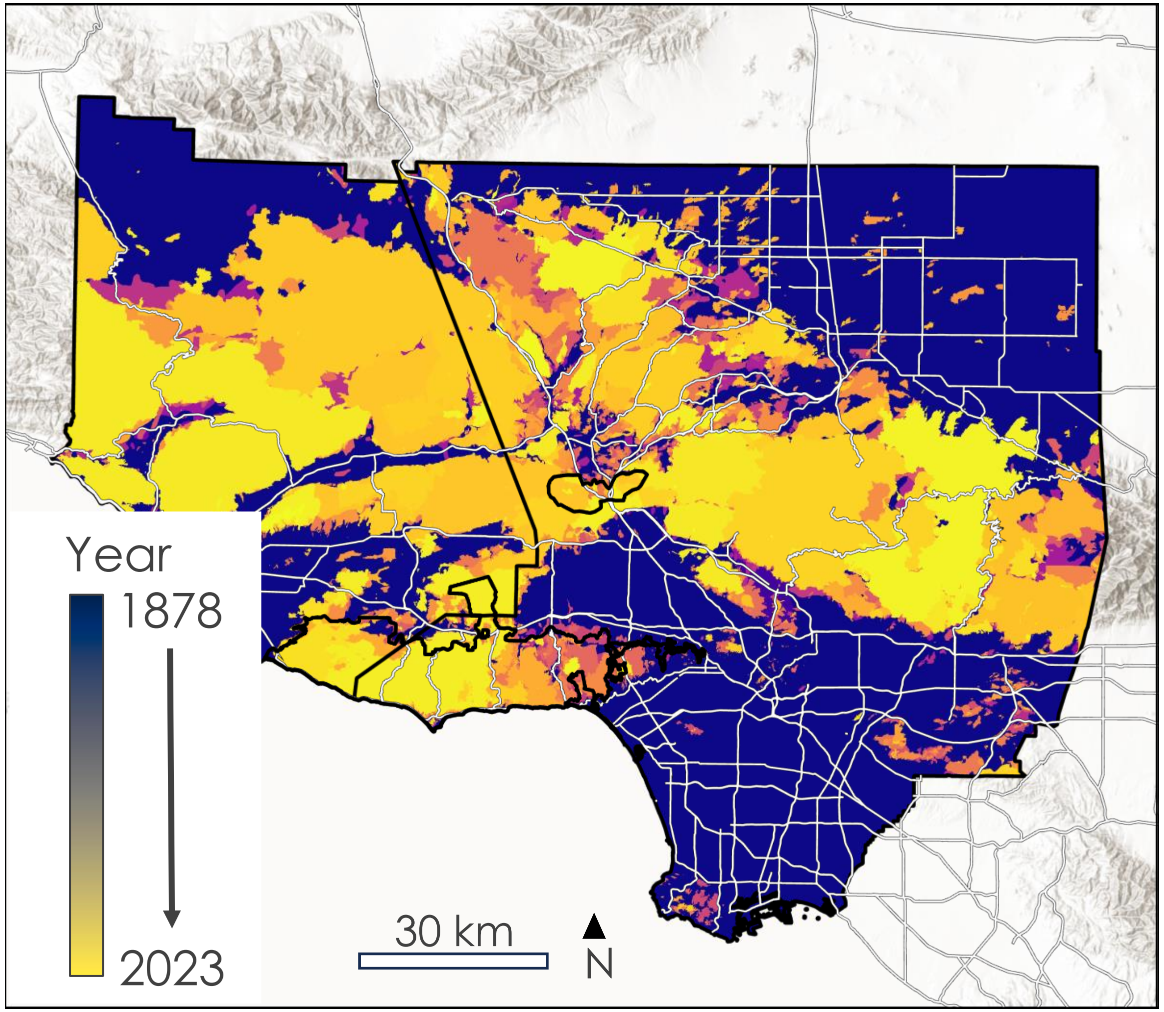
Distance to Residential Buildings



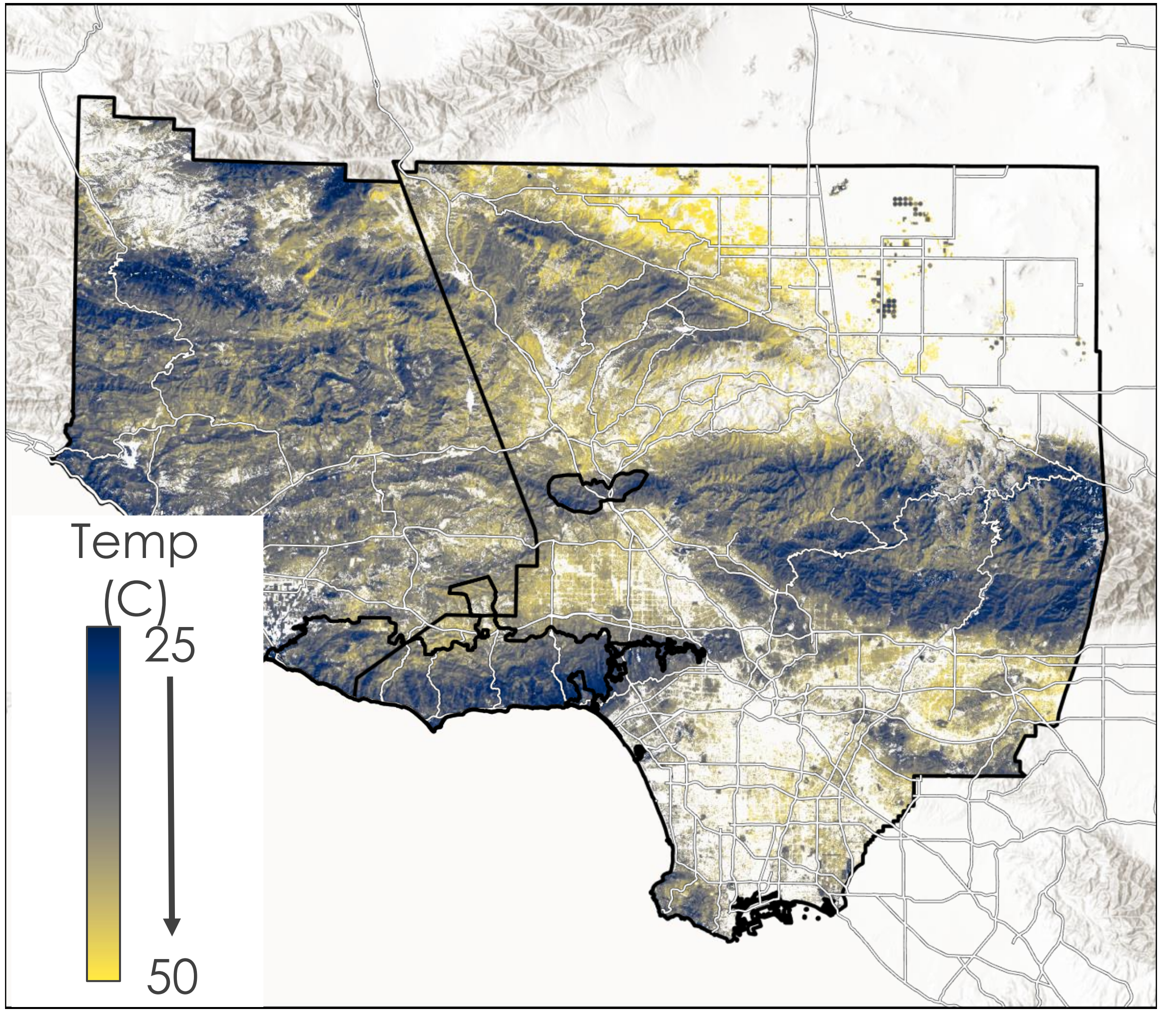
Distance to Residential Buildings, Campsites, and Firewood Vendors Combined

Basemap Credits: Esri, CGIAR, USGS, NASA, NGA

Risk Assessment Components: Environmental



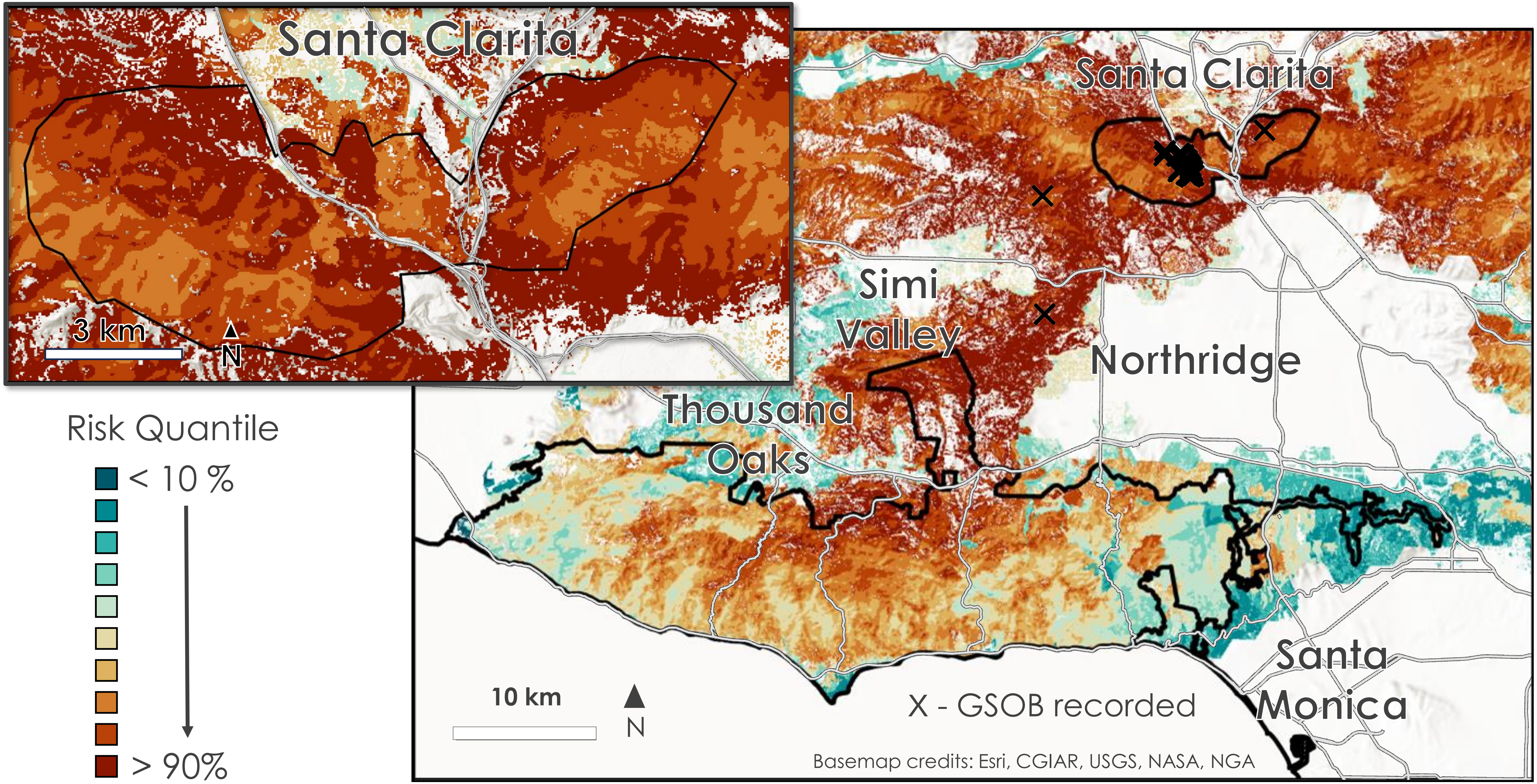
Past Fires



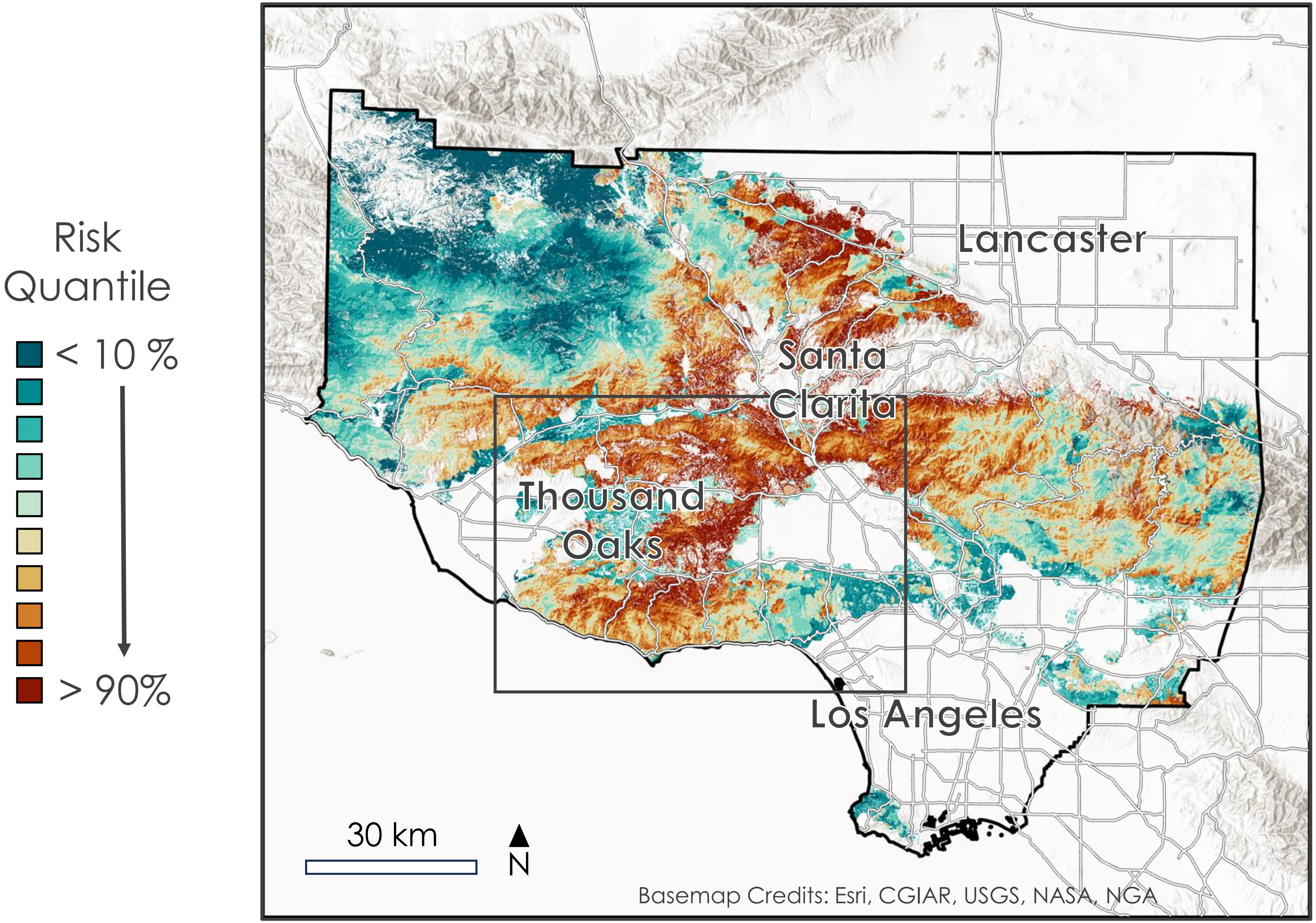
Land Temperature 2023

Basemap Credits: Esri, CGIAR, USGS, NASA, NGA

Results – Risk Assessment, Infestation x2



Results – Risk Assessment, Equal weights



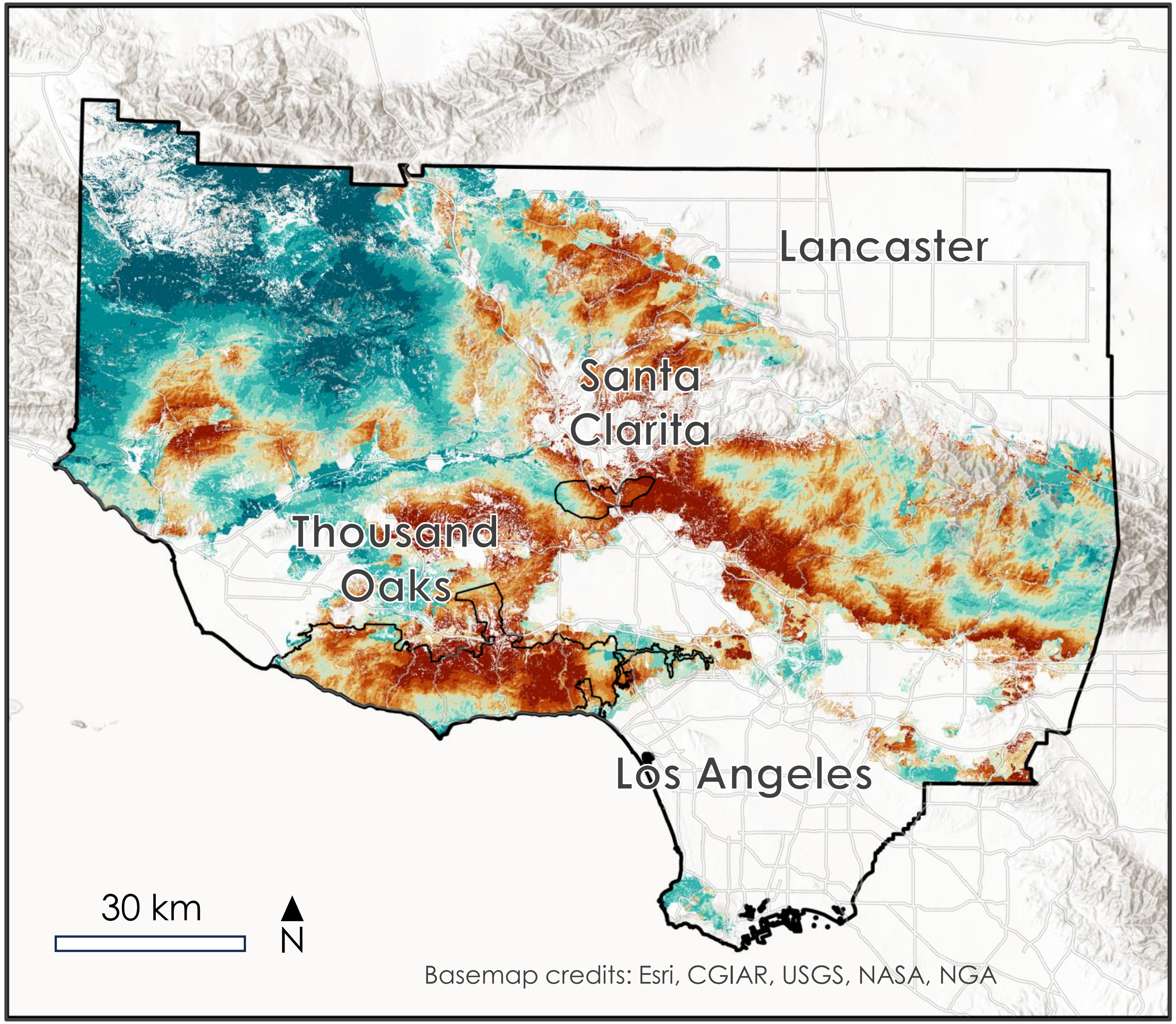
Criteria	Weight
Infestation	x 1
Past Fires	x 1
2023 Temperature	x 1
Firewood Sources	x 1

Results – Risk Assessment, Firewood sources included individually

Risk Quantile

< 10 %

> 90%



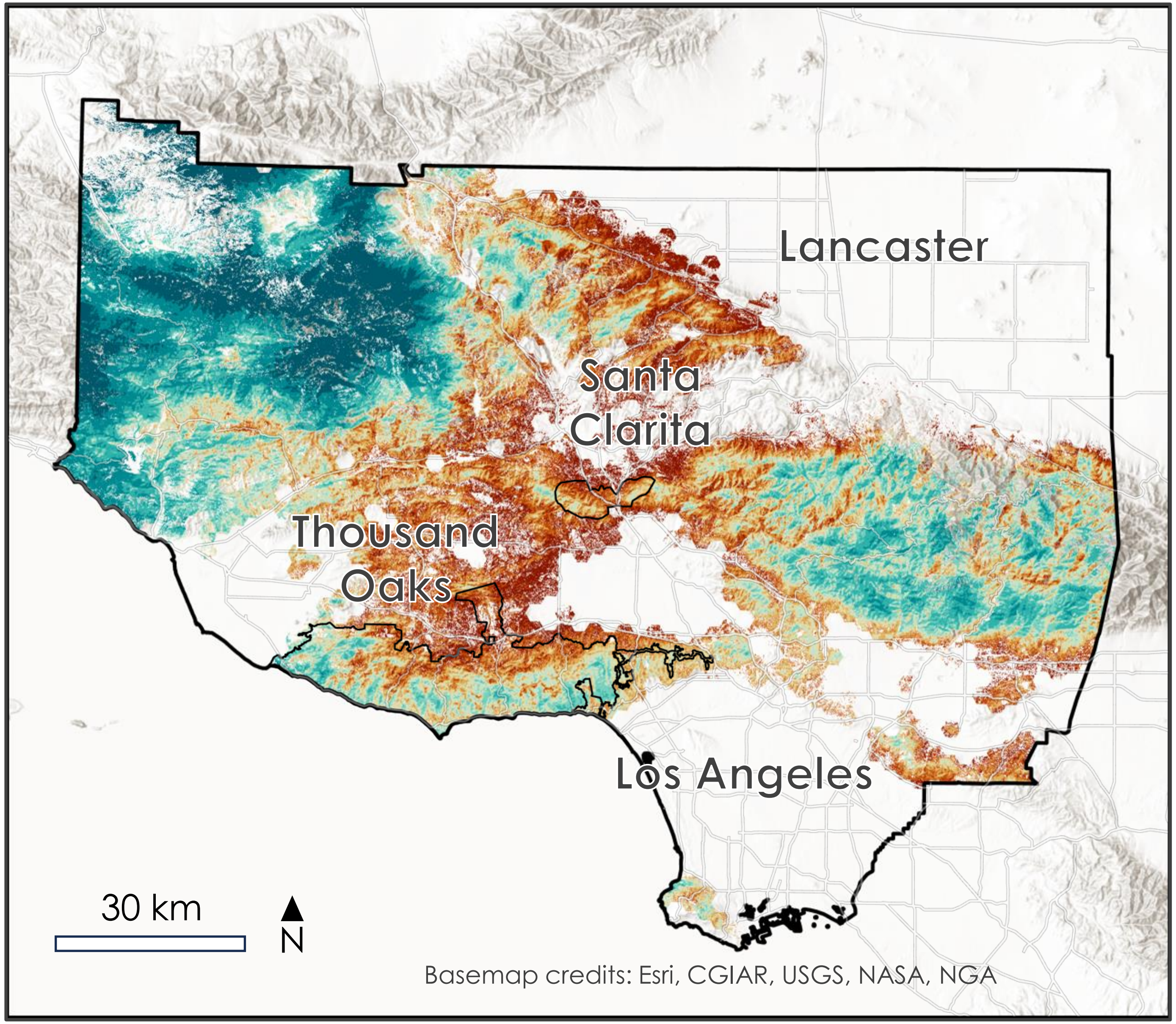
Criteria	Weight
Infestation	x 1
Past fires	x 1
2023 Temperature	x 1
Campsites	**x 1**
Firewood vendors	**x 1**
Residential Buildings	**x 1**

Results – Risk Assessment, Fire excluded

Risk Quantile

< 10 %

> 90%



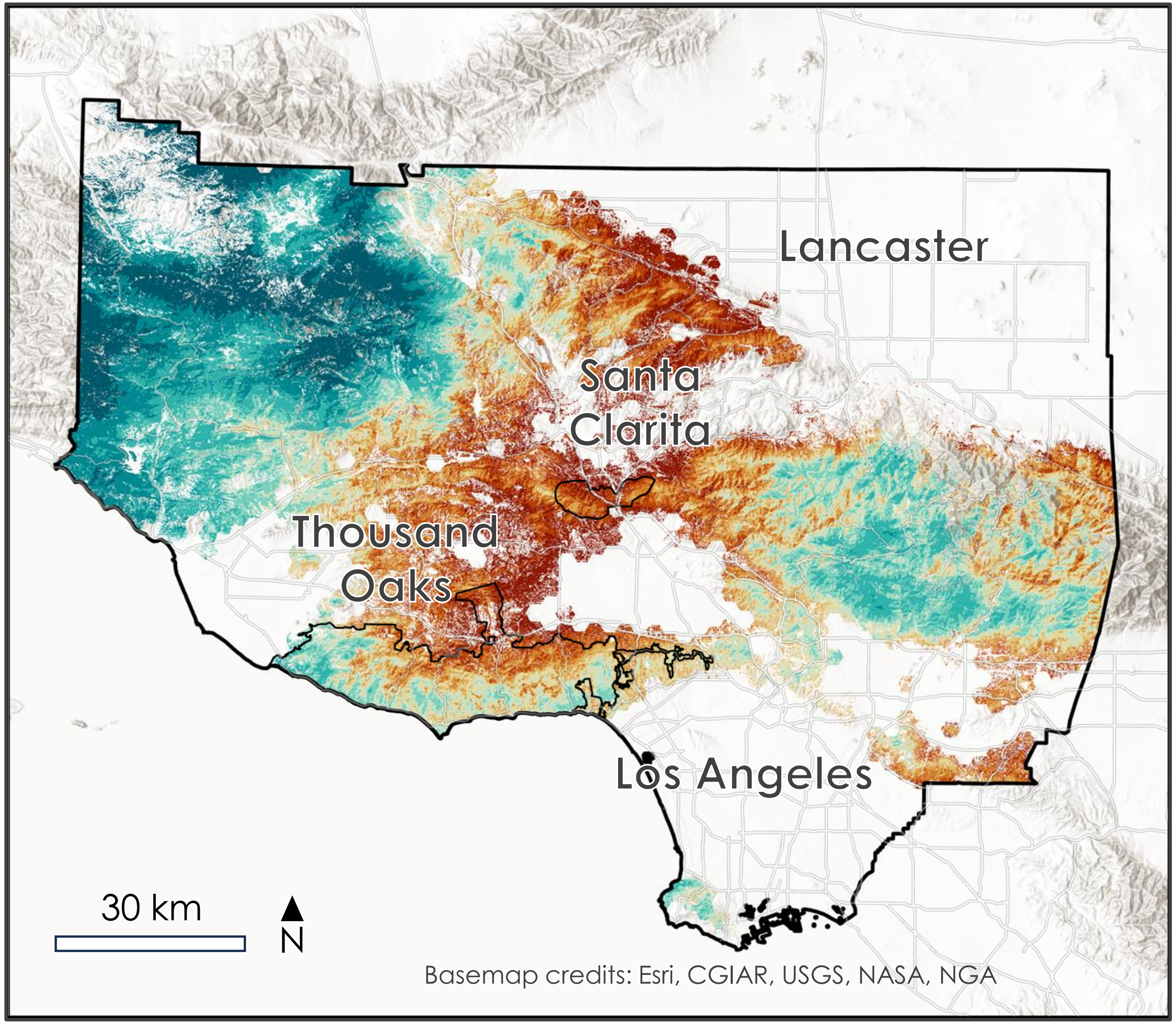
Criteria	Weight
Infestation	x 1
Past Fires	**x 0**
2023 Temperature	x 1
Firewood Sources	x 1

Results – Risk Assessment, Fire excluded v2

Risk Quantile

< 10 %

> 90%



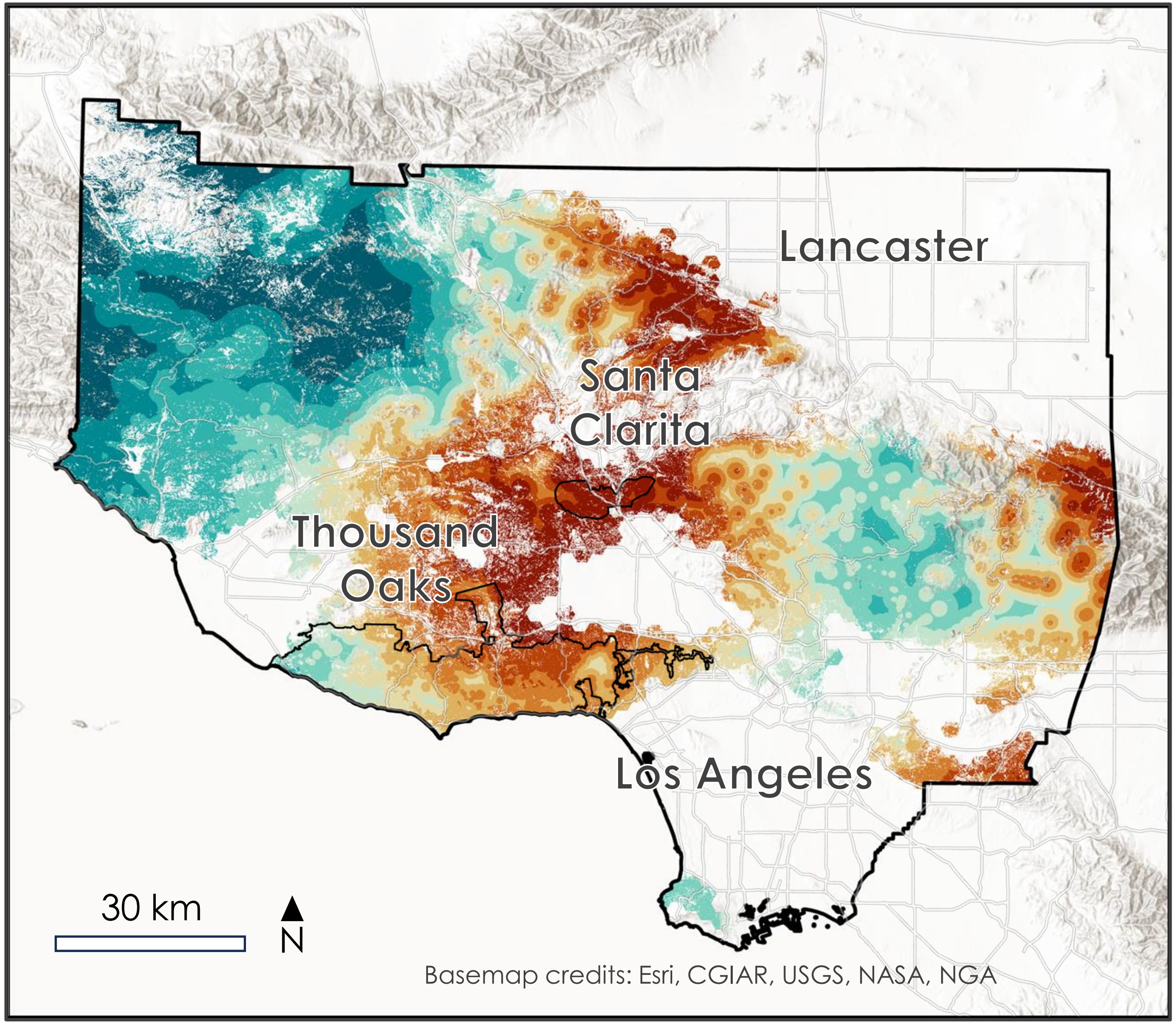
Criteria	Weight
Infestation	x 2
Past Fires	**x 0**
2023 Temperature	x 1
Firewood Sources	x 1

Results – Risk Assessment, Fire & Temp excluded

Risk Quantile

< 10 %

> 90%



Criteria	Weight
Infestation	x 2
Past Fires	**x 0**
2023 Temperature	**x 0**
Firewood Sources	x 1

Results – Landcover Change