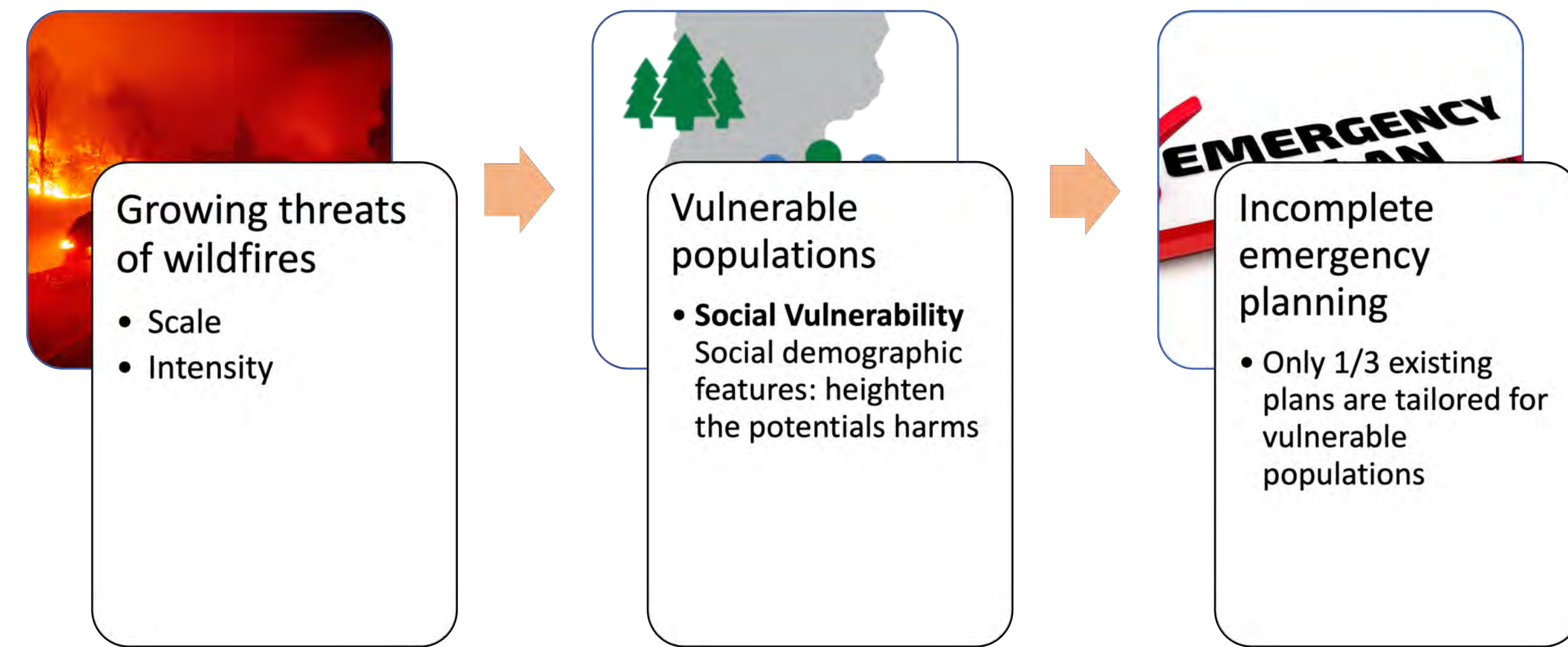


# Social Vulnerabilities and Wildfire Evacuations: A Case Study of the 2019 Kincadee Fire

## Background



- Enhancing current emergency planning It is crucial to understand the impacts of social vulnerabilities on evacuation decisions including the initial decision of whether to evacuate and subsequent decisions for evacuees such as departure time and destinations.

## Research gap and limitations

- Inadequate research on evacuee's subsequent decisions
- Neglect of key social vulnerabilities
- Inadequate research on spatial variation
- Inadequate research comparing impacts on different decisions.

## Research Questions

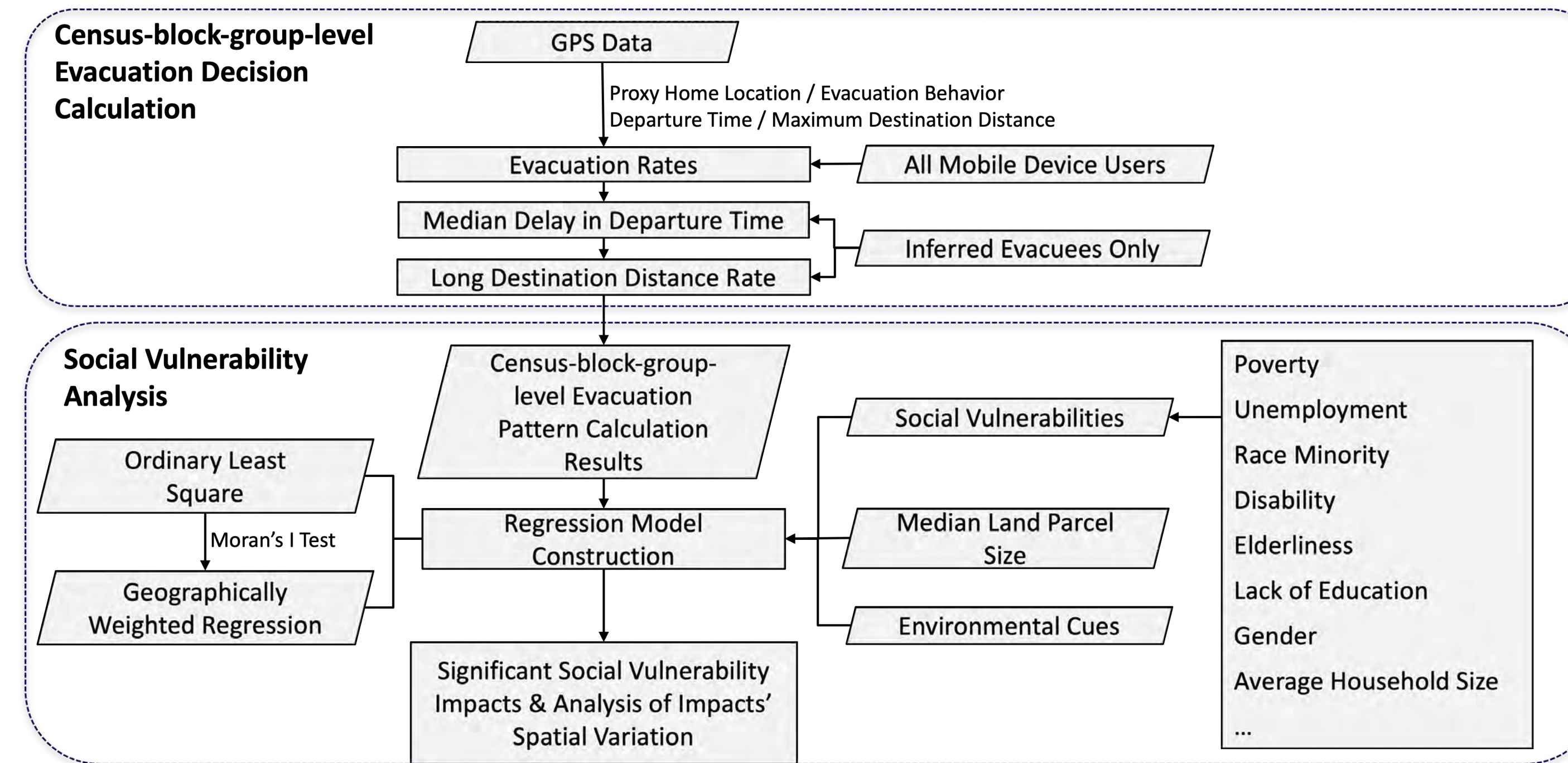
The study is at an aggregate level because individual sociodemographic details are unknown due to the anonymity of the GPS data.

- Are social vulnerabilities associated with aggregate-level wildfire evacuation decisions?
- If yes, to what extent are social vulnerabilities associated with these decisions?
- Do social vulnerabilities' impacts on aggregate-level evacuation decisions show spatial heterogeneity and how do the coefficient estimates change across different spatial areas?

## Methodology

The study is conducted at the census block group level.

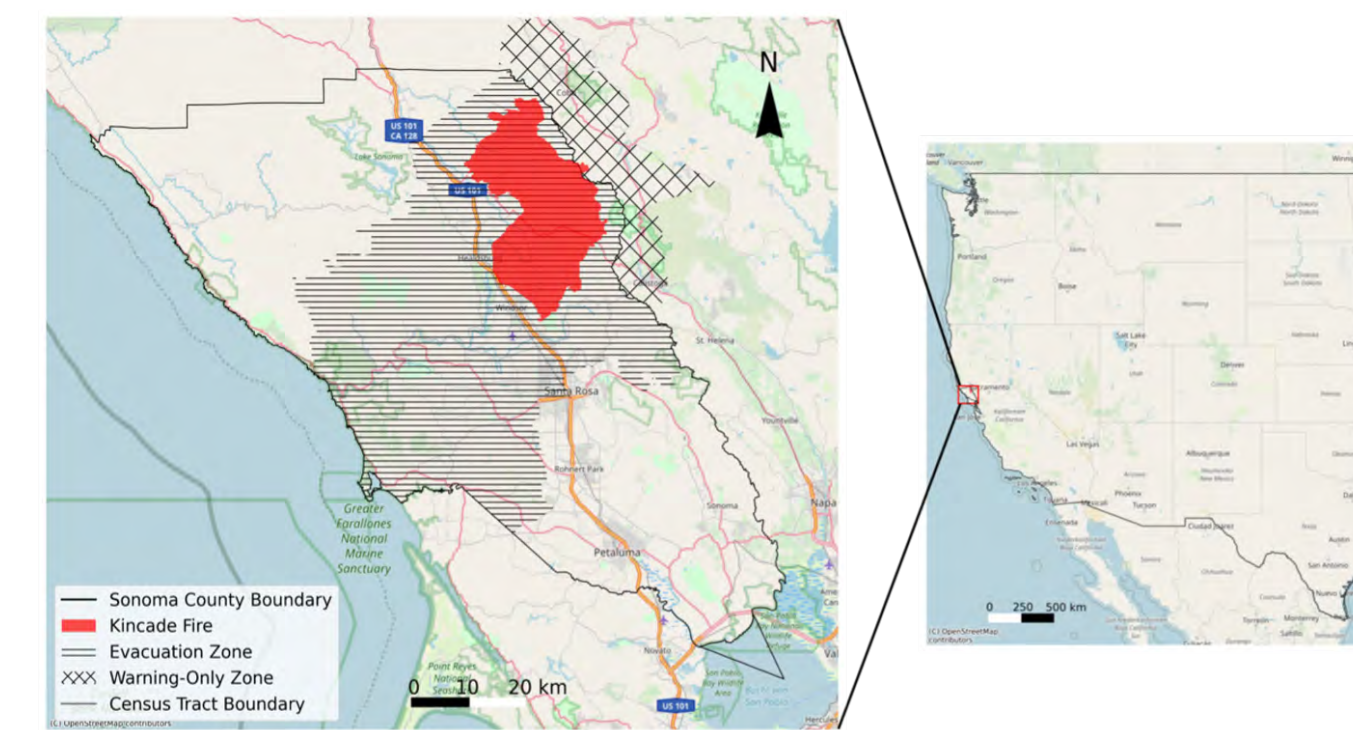
- Evacuation rate** The percentage of the population within a block group evacuated.
- Delay in departure time** The time gap between departure time and official evacuation orders/warnings (0 if departure preceded orders/warnings).
- Median delay in departure time** The median delay times for evacuees from a block group.
- Long destination distance rate** The proportion of evacuees whose maximum evacuation distance exceeds 50 miles.



## Case study

### Study Area

The 2019 Kincadee Fire in Sonoma County, California, is selected as the case study.



Only census block groups intersecting with the evacuation zone are selected for analysis. Some census block groups are merged with adjacent ones to ensure sufficient data.

## Results

### Ordinary Least Square Models



## Significance of Spatial Variations

	OLS		GWR	
	Moran's I	p value	Moran's I	p value
Evacuation Rate	0.177	0.001	0.048	0.124
Median Delay in Departure Time	0.043	0.130	/	/
Long Destination Distance Rate	-0.059	0.142	/	/

According to the results of Moran's I test, spatial variations are significant only in the impact of social vulnerabilities on evacuation rates.

## Geographically Weighted Regression Model Results

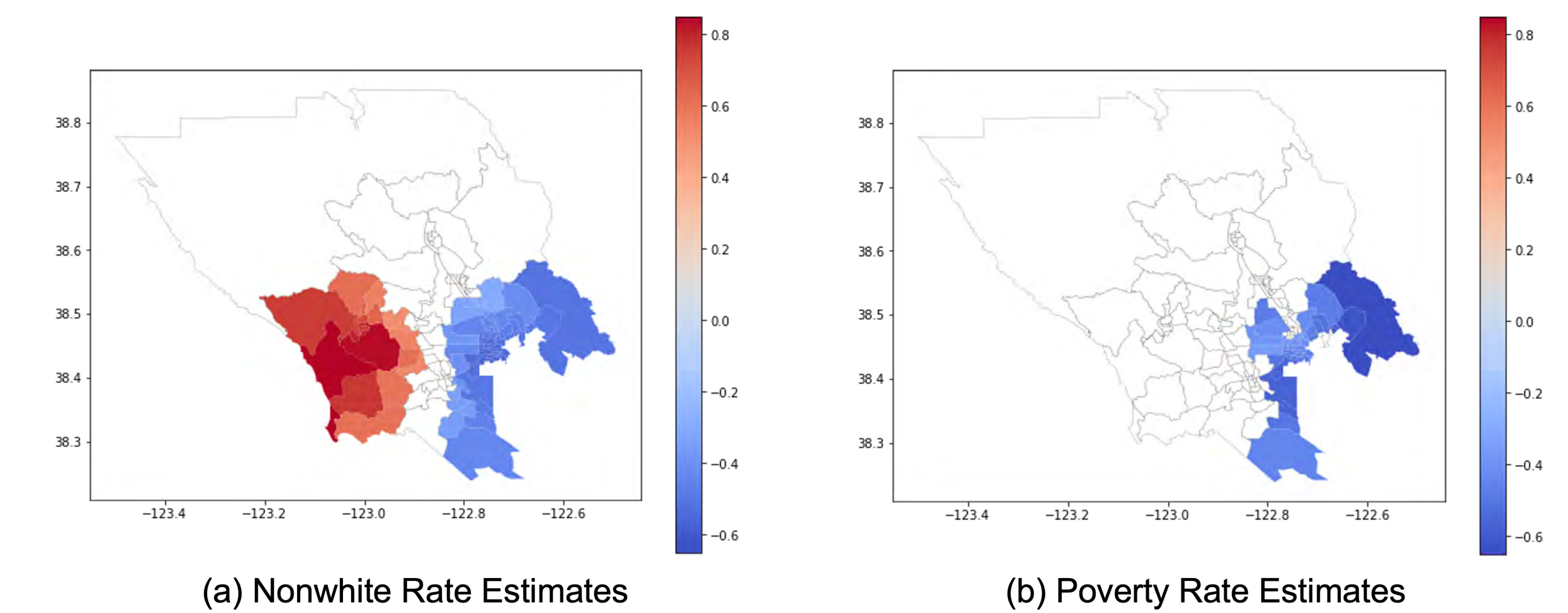


Figure 1. Coefficient Estimates of Nonwhite and Poverty Rates across Different Census Block Groups in the GWR Model for the Evacuation Rate. Only Coefficients Statistically Significant with a P-value  $\leq 0.05$  Are Included.

## Major takeaways

- Spatial Variation in Evacuation Impact** Social vulnerabilities affect evacuation rates differently across regions. Some vulnerabilities significantly affect specific block groups, and their effects can vary or even reverse in other areas. → Strategies should be universally applicable to targeted vulnerable groups, yet flexible enough to address local needs.
- Unemployment's impacts** Previous studies often overlook unemployment, yet it significantly influences multiple evacuation decisions → Prioritizing emergency assistance, such as providing timely updates on fire-related situations and essential evacuation resources, for these affected populations is crucial.
- Impact of social vulnerabilities on different decisions** The study highlights the differences and similarities in significant vulnerabilities affecting different evacuation decisions. These insights underscore the need for tailored approaches for aiding various vulnerable groups in different decision-making scenarios. Prioritizing vulnerabilities that influence multiple decisions is also crucial.