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An Investigation of the Populations Impacted by California Wildfire Evacuation Orders

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Abstract

The frequency, size, and intensity of wildfires in California have increased substantially in recent years, leading to widespread mandatory evacuations affecting millions of residents. However, because evacuation orders are implemented by local agencies, there is limited quantitative evidence on the scope of evacuations statewide. In order to improve the understanding of wildfire evacuations, we assembled information on historical evacuation orders for two distinct wildfire-prone regions — Fresno and Sonoma county — in California. This data was used to understand how the frequency and extent of evacuations have changed over time. We then combined this information with census data to characterize which populations have been most affected by evacuation orders. Ultimately, our work aims to quantify this important element of wildfire impacts in key regions around California. Collectively, it provides a starting point for a public database of evacuation orders that could be used by researchers and policymakers to better understand dynamics and improve decision-making around wildfire evacuations.

An Investigation of the Populations Affected by California Wildfire Evacuation Orders

Jena Alsup, Prathmesh Sonawane, Sam Heft-Neal

INTRO

Wildfires have increased in severity in recent years, with six of the top 20 largest California wildfires occurring in 2020 according to Cal Fire. While much research has investigated the changing dynamics and impacts of wildfires, there is a dearth of quantitative research on the people likely most impacted by these fires: the populations evacuated. This is largely because no centralized database of evacuation orders exists at the national, state, or local levels. Instead, orders are disseminated in disparate fashions at the local level. In order to gain a better understanding of the populations impacted by evacuation orders, we assembled our own database on the timing and location of wildfire evacuation orders and linked it to demographic data from the census. We focused on two distinct wildfire-prone regions in California, Fresno and Sonoma counties.

DATA / METHODS

We utilized the Cal Fire Incidents database (https://www.fire.ca.gov/incidents/) of California wildfires dating back to 2012 to identify fires in Fresno and Sonoma counties. For each fire, we parsed government agency websites, emergency alerts, and online news articles to determine whether there were any evacuation orders associated with that fire and if so, when and where the evacuation orders occurred. After assembling a database of evacuation orders for each county, we used evacuation order maps and location descriptions to identify the locations of each order. Through overlaying the evacuation location for each order onto a map of census tracts, we were able to pair orders with tracts.

We accessed the American Community Survey (ACS), a demographics survey program conducted by the United States Census Bureau, using the TidyCensus R package and linked evacuation orders to education level, income level, race/ethnicity, english proficiency, and age.

BACKGROUND FOR FRESNO AND SONOMA COUNTY

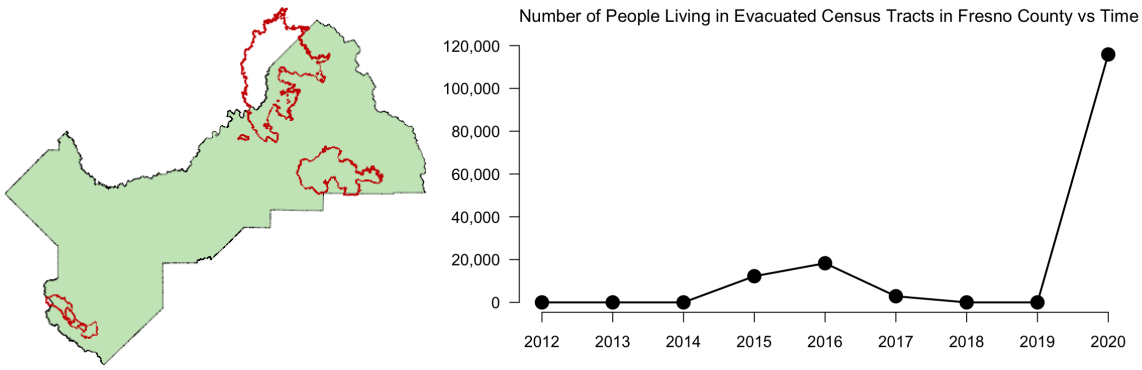
Fresno

Fresno County is located in central California, approximately halfway between San Francisco and Los Angeles with a 2020 population of 1,008,654 people. Fresno County consists mostly of California's Central Valley, and thus it's terrain is relatively flat. However, the eastern side of Fresno County is home to the foothills of the Sierra Nevada Mountains and its more rugged

terrain. Similarly, the western border of Fresno County also has some hills with higher elevation. Populations are denser in the middle of the county where the Central Valley is, and sparser in the mountainous regions.

Fresno County had 57 wildfires from 2012-2020, 7 of which required evacuation orders. Of the wildfires that had evacuations, all of them took place in the mountainous regions of Fresno, three being on the east side, and four being on the west side. The average length of an evacuation order was 4 days and the total number of evacuation orders since 2012 is 43.

The number of people living in census tracts with evacuation orders increased dramatically in 2020 due largely to the Creek Fire, which is the fifth largest wildfire in documented California history as of November 2021.

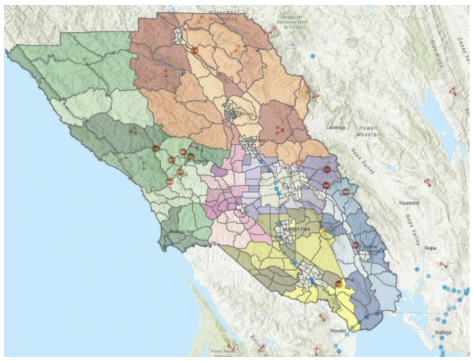


Sonoma

Sonoma County is located in Northern California just north of San Francisco's Bay Area and has a 2020 population of 488,000. Sonoma County consists of large mountain ranges to the east and west of the Sonoma Valley which is found in the heart of the county. Sonoma Valley, accompanied by the county's most populated city, Santa Rosa, have far lower elevations than their bordering mountain ranges. Populations are denser within the Sonoma Valley and diminish moving outwards towards the county's mountain ranges.

A majority of Sonoma County's wildfires occur at its eastern mountainous border, frequently overlapping with Napa County. The LNU Lightning Complex fire, the sixth largest fire documented in California, coupled with the Kincade Fire resulted in a large spike in the number of evacuations seen in recent years.



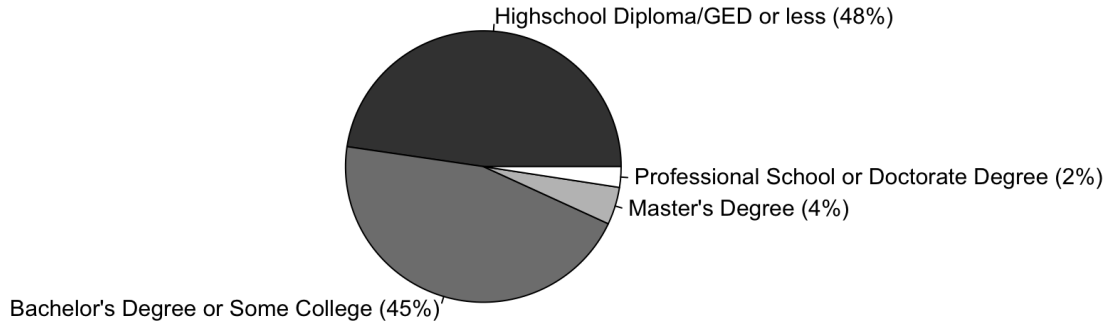


RESULTS

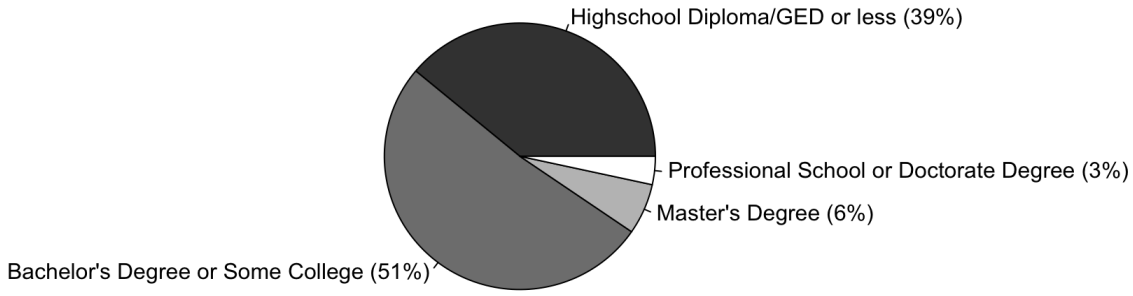
Education

In Fresno County, 48% of the overall population did not attend college while 6% attended graduate school. Among the populations living in evacuated census tracts, 39% of individuals did not go to college and 9% attended graduate school. The evacuated population is thus higher educated, on average, than the total population.

Fresno County Total Population:

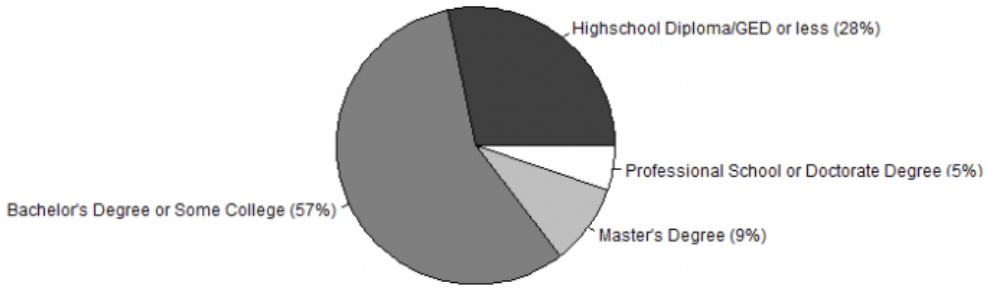


Fresno County Evacuated Population:

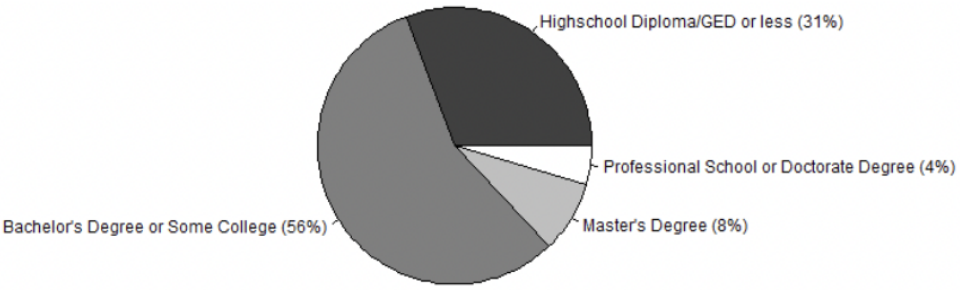


Sonoma County's distribution of education levels were similar between the total and evacuated population. However, populations with some college experience were slightly overrepresented in the evacuated regions of the county by three percent. Thus, while education levels were similar across Sonoma County, evacuation orders were more likely to affect more educated populations.

Sonoma County Total Population:



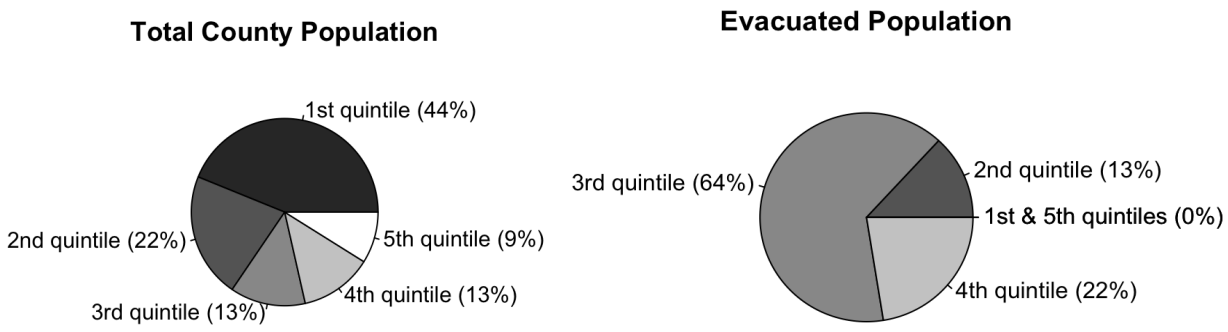
Sonoma County Evacuated Population:



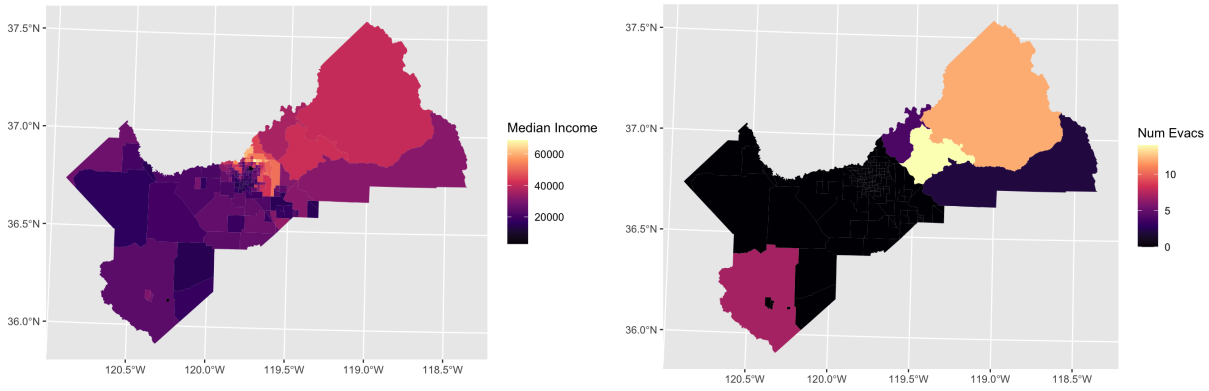
Income

To study income in both Fresno and Sonoma County, we collected median household income data at the census tract level. We then divided income into quintiles according to the state-level income distribution, with the 1st and 5th quintile representing the lowest and highest income groups, respectively.

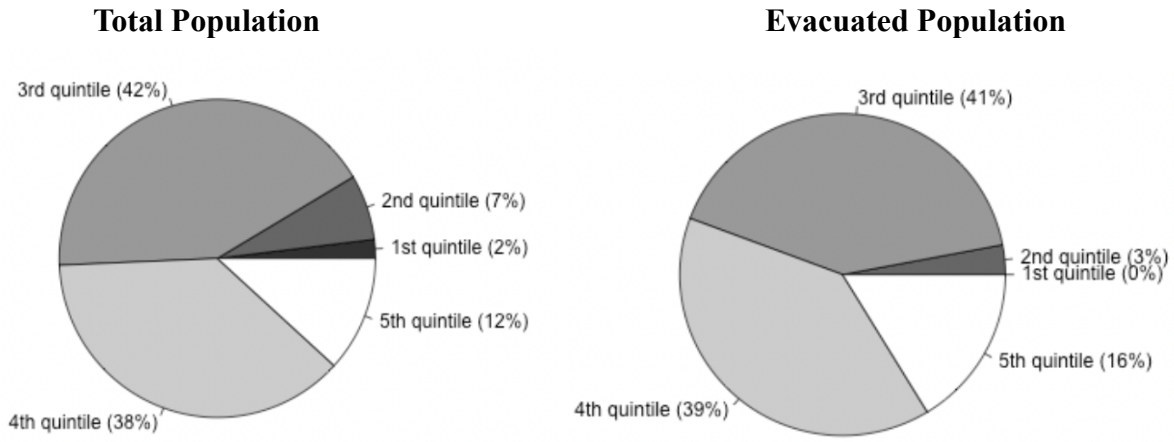
In Fresno County, the 3rd and 4th quintiles are overrepresented in the evacuated population, suggesting that middle-income individuals are most affected by evacuation orders. Individuals living in the highest- and lowest-income brackets are significantly less affected by evacuation orders.



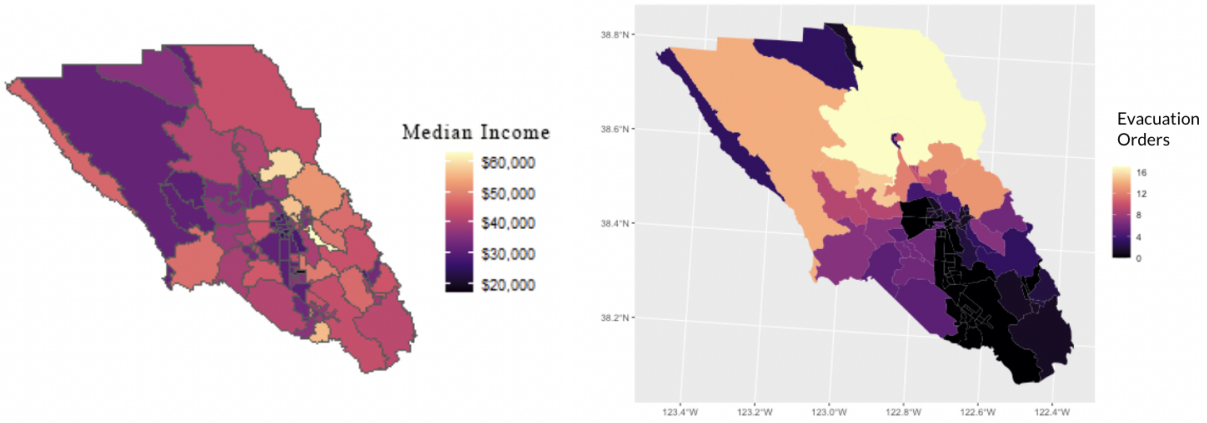
Note: 1st quintile = lowest income. 5th quintile = highest income.



In Sonoma County, the income quintiles are similarly distributed between the total county and evacuated population, with those in the 3rd and 4th quintile making up 80 percent of each.



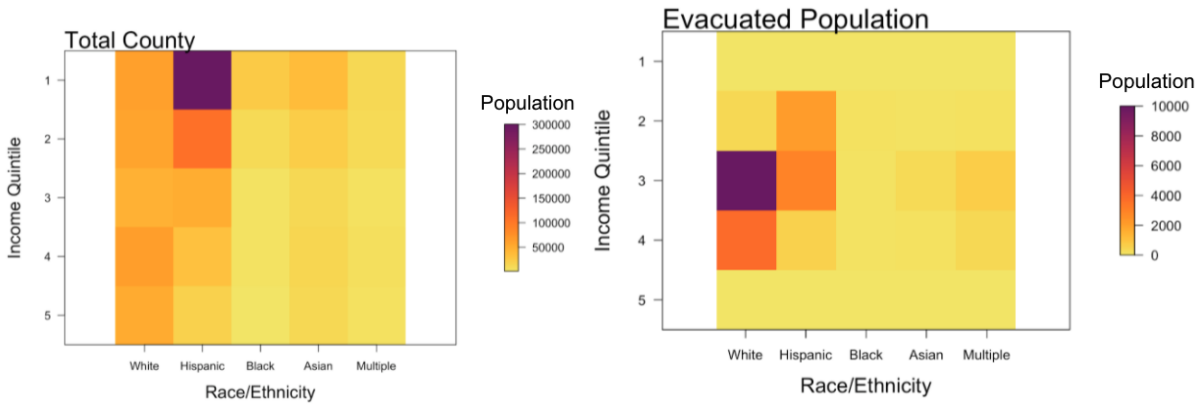
Note: 1st quintile = lowest income. 5th quintile = highest income.



Race / Ethnicity

To study race and ethnicity we split populations into Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and non-Hispanic two or more races. We chose to group all Hispanic individuals together as the majority of the Hispanic population in Fresno and Sonoma county do not fall under Black, Asian, or Other racial categories. Recognizing that racial/ethnic categorization in the census data does not take into account other factors like income levels or citizenship status, we created a matrix of the intersection between race/ethnicity and income.

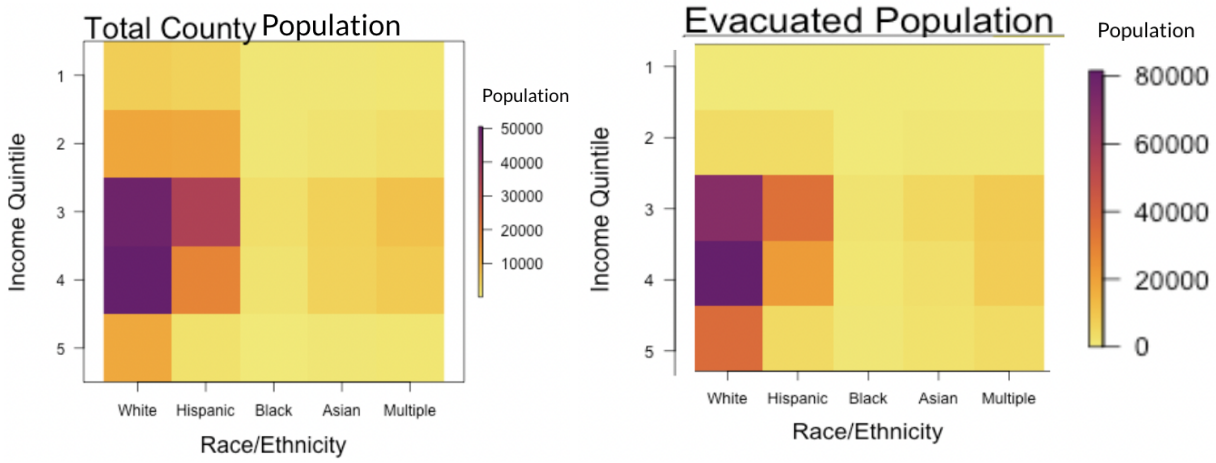
In Fresno county, approximately half of the county is Hispanic at 52%, with non-Hispanic White making up 29%, non-Hispanic Asian at 10%, non-Hispanic Black at 4%, and Multiracial at 4%. We found that middle-income White and Hispanic individuals were most affected by evacuation orders.



Note: 1st quintile = lowest income. 5th quintile = highest income.

In Sonoma County, 60% of the population is non-Hispanic White, with the Hispanic population making up the second largest at 27%. The multiracial population is the next largest at 7%, with

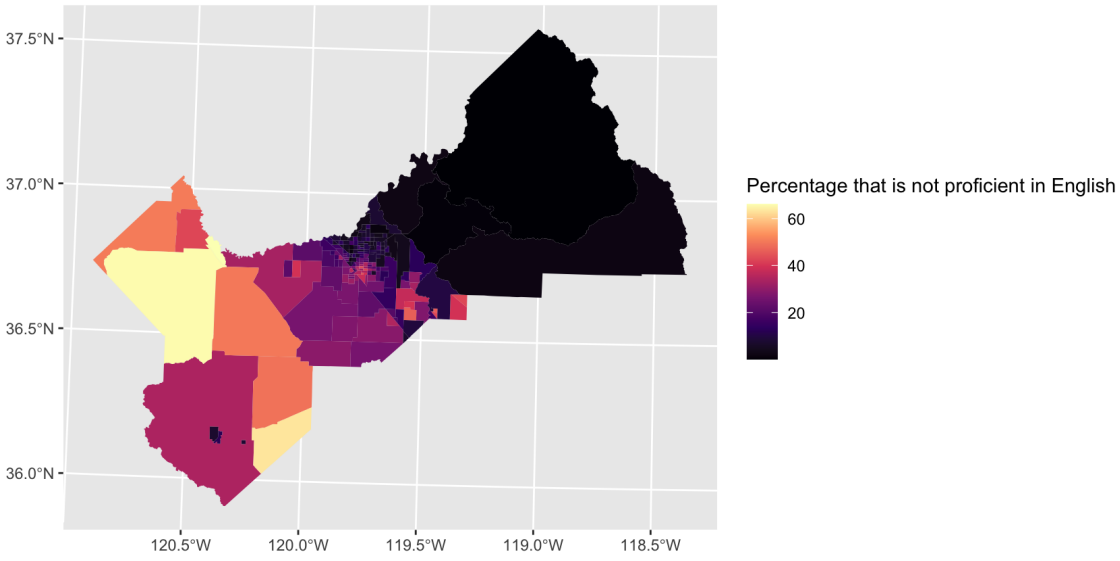
non-Hispanic Asian and non-Hispanic Black populations making up 4% and 2% of the entire county population, respectively. Our research shows that White and Hispanic individuals, specifically those of middle- and higher- income, make up most of both the total and the evacuated population.



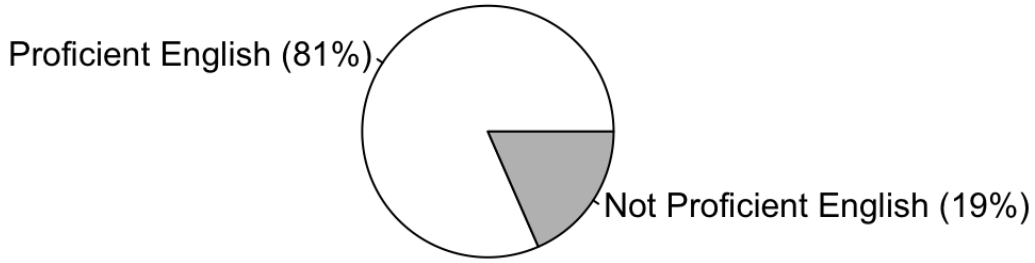
Note: 1st quintile = lowest income. 5th quintile = highest income.

English Proficiency

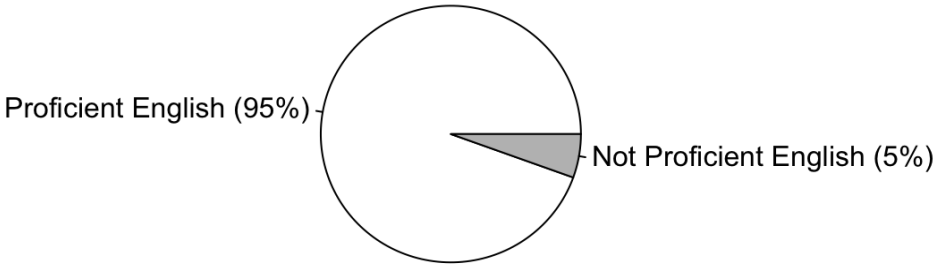
In Fresno County, Spanish is the second most common language after English with 77% of the population that isn't proficient in English being only proficient in Spanish. Since 2012, more than 7,000 people living in Fresno census tracts with evacuation orders are not proficient in English with the vast majority speaking Spanish, demonstrating that there is a need for dissemination of evacuation information in both English and Spanish.



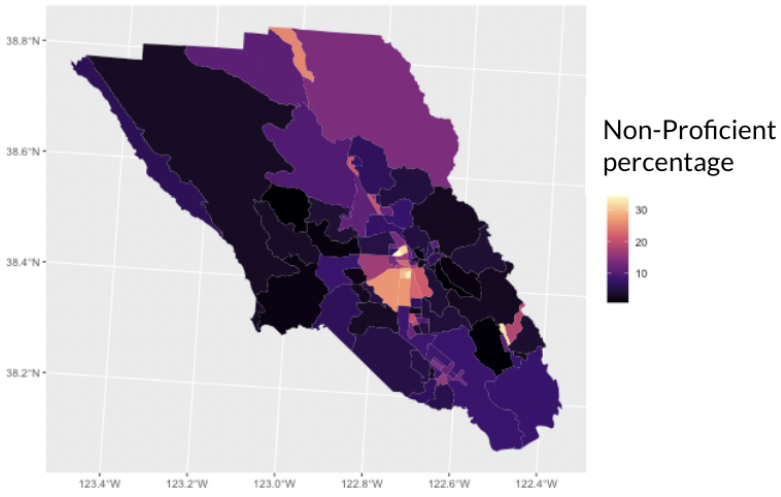
Fresno County Total Population:



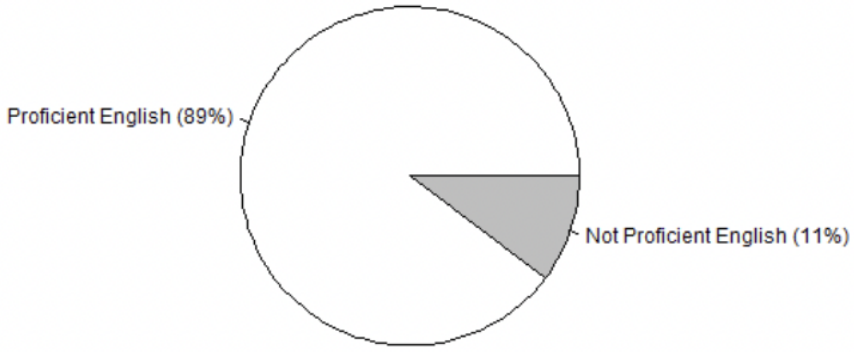
Fresno County Evacuated Population:



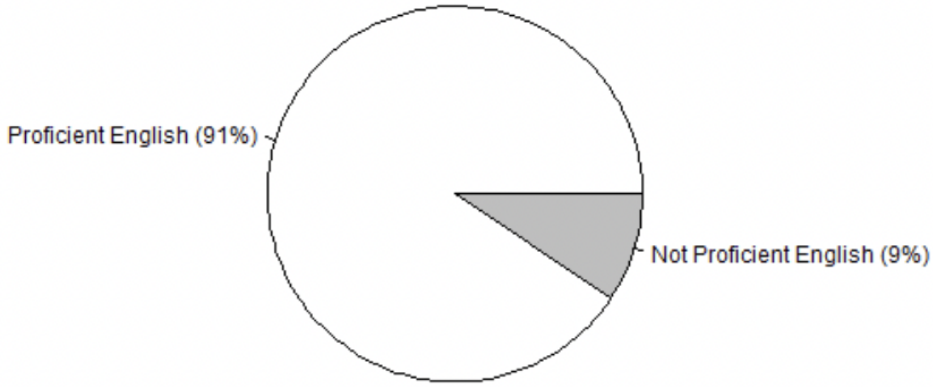
In Sonoma County, since 2012, 120,000 people residing in evacuated census tracts are not proficient in English, but almost all speak Spanish. Approximately 82.6% of the population that was not proficient in English was only proficient in Spanish, further suggesting that Spanish evacuation orders are needed to effectively reach this population.



Sonoma County Total Population:

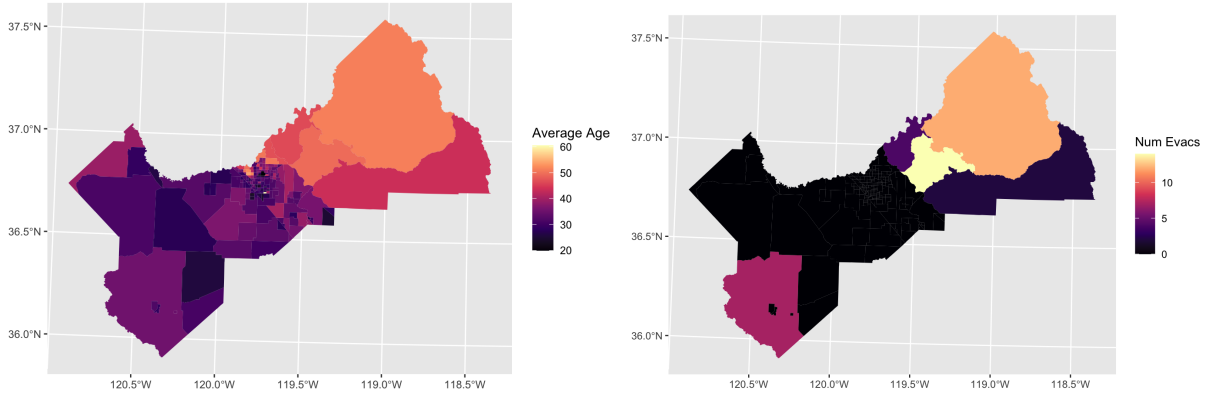


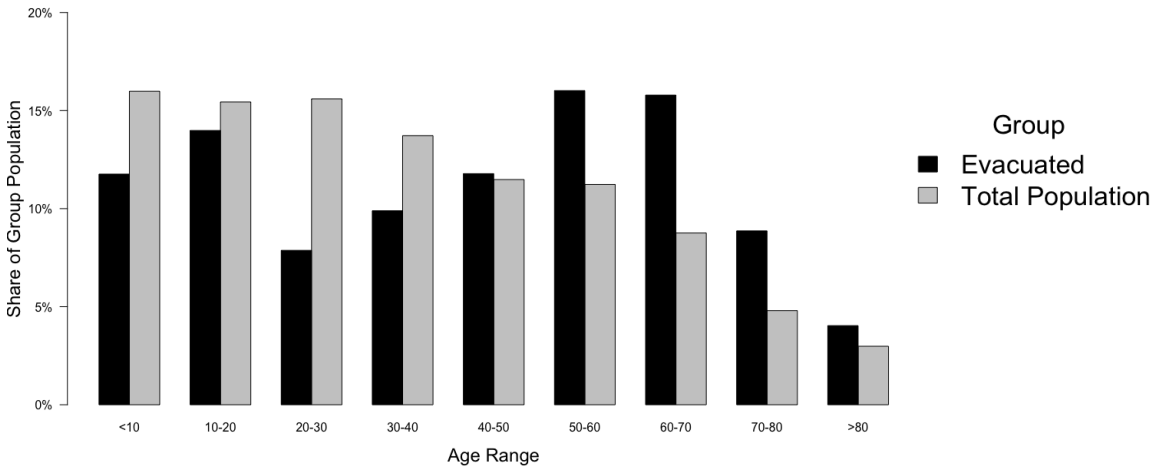
Sonoma County Evacuated Population:



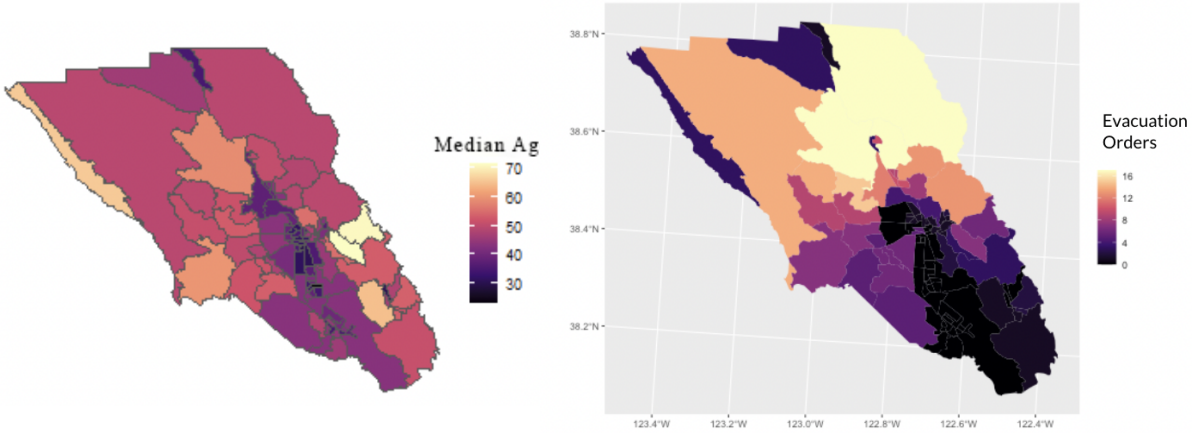
Age

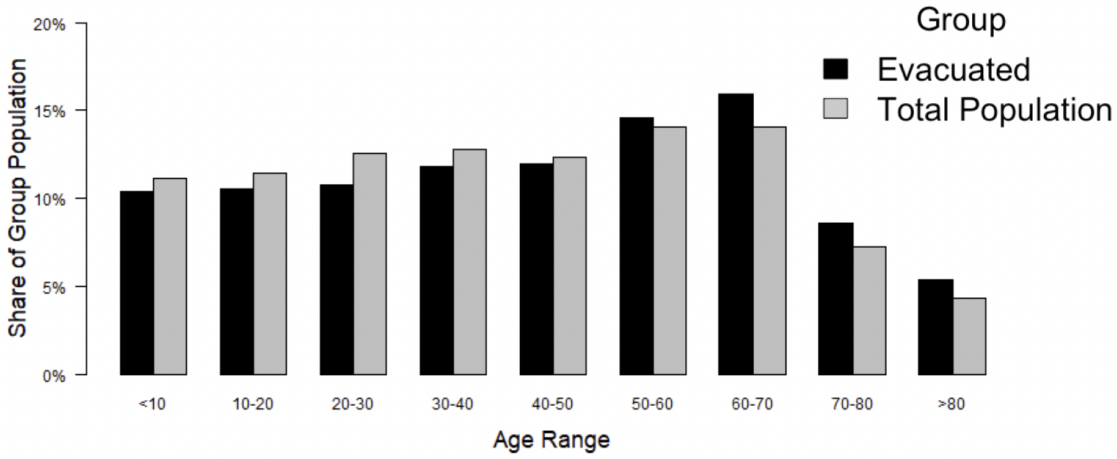
In Fresno County, individuals over the age of 60 make up roughly 16% of the county population, but nearly 29% of the evacuated population, demonstrating that elderly populations are overrepresented in evacuated groups.





In Sonoma County, populations over the age of 50 made up 39.7% of the county population but nearly 44.5% of the evacuated population, further suggesting that older populations are overrepresented in evacuated wildfire regions.





CONCLUSION

Policy Implications

Given that a large number of evacuees in both Fresno and Sonoma county are only proficient in Spanish, we recommend beginning the dissemination of evacuation information in Spanish as well. In addition, since eldery populations are frequent in the evacuated groups, we recommend providing extra resources to senior individuals.

Next Steps

Moving forward, we hope to expand our research to quantify the impact of evacuation orders in the rest of the California counties. We also hope to analyze other variables, such as disability status, to better quantify individual vulnerability to evacuation orders. Moreover, we aim to better understand the underlying mechanisms, such as fire risk patterns and geographical influences, driving our results.

Link to slideshow presentation with all figures:
https://docs.google.com/presentation/d/1W33vCAduVEWKemOzQdkuz991mIYpMnBUUKHSw1lO2po/edit?usp=sharing