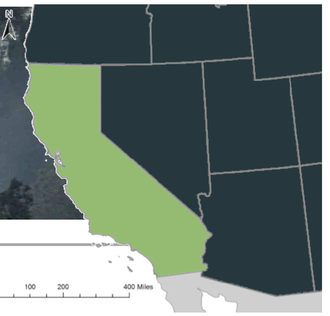
BURN SCARS: Examining the Vulnerability & Adaptive Capacity of California's Communities in Response to Wildfire



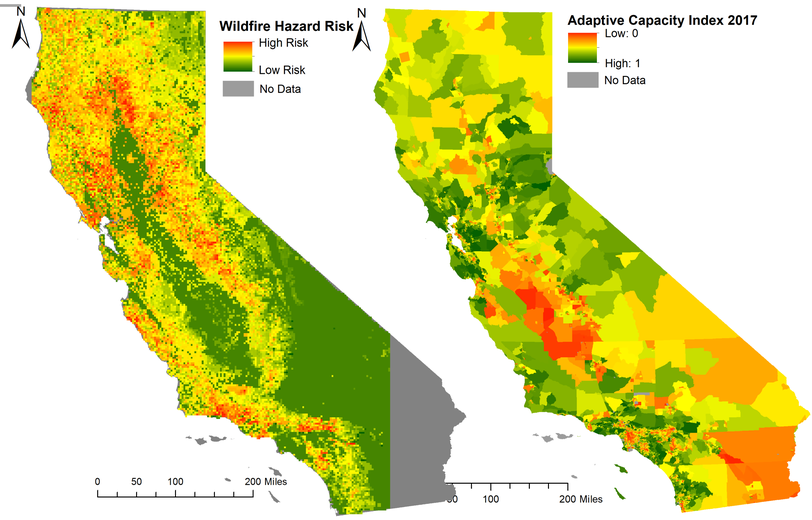
BACKGROUND

In the past two years, several areas of California have been ravaged by some of the worst wildfires on record. The Camp Fire (2018) in Butte County, California burned over 150,000 acres, damaged almost 20,000 structures and killed at least 85 people. The effects of and recovery from wildfire, as with most natural disasters, however, disproportionally impact low-income communities and communities of color. Technology and increasingly accurate wildfire probability models make our ability to predict and contain wildfires better, but the conversation of environmental justice is often left out. Recently, research into socioeconomic indicators is beginning to help identify "socio-ecologically" vulnerable areas that are or will potentially be underserved in the event of an emergency. This project researches how socioeconomic indicators change after a wildfire and the adaptive capacities of communities in California. Adaptive capacity can be defined as "the ability of a census tract to absorb and adjust to disturbances, like wildfire, while minimizing damage to life, property, and services".

Fire damage in the 2018 Camp Fire, Paradise, CA. *Photo: Butte County GIS*

METHODS

SQL was used to query and sort relevant demographic information within the definition of adaptive capability by year. Climate data was processed in Excel, then these station data points were interpolated in ArcMap. The ecological factor maps (2017 project, not shown) were rasterized and reclassified on a scale of one to five according to different schemes for each layer. A weighted overlay was used to produce the wildfire hazard risk map. ArcPy was used to calculate fields for demographics, housing and transit, language and education, and socioeconomic status, as well as the overall change in adaptive capacity from 2010 to 2017. This map was analyzed using a local Moran's I to determine clustering and outliers, and overlaid with a map of severe wildfires from 2010-2017. A model for ecological vulnerability was parameterized so that new data could be used each year.



Wildfire Vulnerability and Adaptive Capacity

The map on the left shows the overlay of several factors that contribute to wildfire. A map of 2017 adaptive capacity by census tract can be seen on the right. The vulnerability map shows that the areas at the greatest risk for 2017 fires, and the map on the right shows communities that may be disproportionately impacted by wildfires.

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Projection: 1984 California Teale-Albers Equal Area Conic

RESULTS AND DISCUSSION

Although the wildfire vulnerability map does closely line up with published risk maps and recent fire point locations, there are many other variables that are left out of this analysis, including the short term factors that control fires severity and risk (e.g. high winds, lightning strikes). Adaptive capacity clustering can only be looked at qualitatively, as a clustering analysis *between* the variables of high change in adaptive capacity and high wildfire severity was not performed. Sources of error in this analysis come from the tenuous assumption that all variables involved in both vulnerability analyses are independent of each other, interpolation of climate data, and error in the data itself (e.g. Census margins of error and satellite resolution). The weighting schemes (see Table 1) were based on research, but understanding how the analysis results change under different weighting schemes is important for a more robust analysis. Fire hazard risk is already well-understood, and hopefully future research undertakes a more in-depth analysis of adaptive capacity components and changes in a community. Understanding the implications of environmental justice is important to ensure more equitable recovery from wildfire and other inevitable natural disasters in the future.

Adaptive Capacity			
Category	**Weight**	**Sub-Category**	**Weight**
Demographics	25%	Age	33%
		Disabled	33%
		Single-Parent Households	33%
Housing and Transit	25%	Crowding	33%
		Mobile Homes	33%
		No Vehicle Access	33%
Language and Education	25%	Household	50%
		No High School Diploma	50%
Socioeconomic Status	25%	Income	33%
		Unemployment	33%
		Below Poverty Level	33%

Table 1: Adaptive Capacity weighting factors chosen to represent equal shares

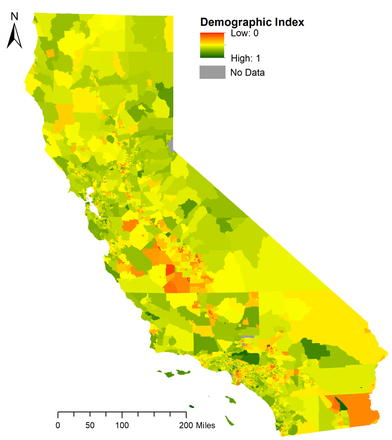
SOURCES

Anderson, Hal E. "Aids to Determining Fuel Models for Estimating Fire Behavior." Apr. 1982, www.fs.fed.us/rm/pubs_int/int_gtr122.pdf.

Davies et al. "The unequal vulnerability of communities of color to wildfire." *PLOS ONE*, 2 Nov. 2018.

Preisler, et al. "Probability based models for estimation of wildfire risk." *International Journal of Wildland Fire*. 2004, 133-142.

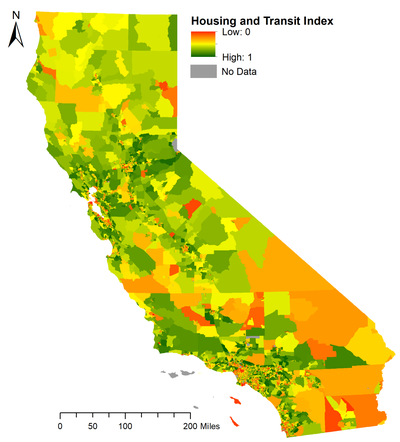
ADAPTIVE CAPACITY MAPS



Demographics

The demographic index includes percent of the population under 17 or over 65, disability status, and the percent of single parent households.

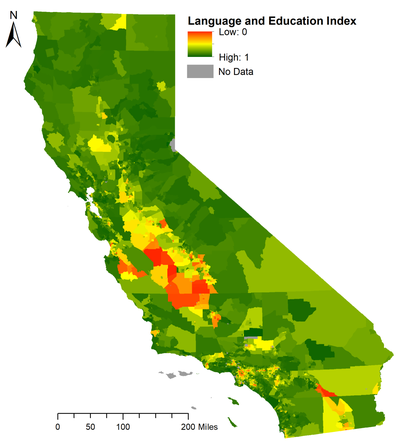
Data: US Census Bureau



Housing & Transit

The housing and transit index is comprised of household vehicle access, percent multi-unit or mobile homes, and population living in group quarters.

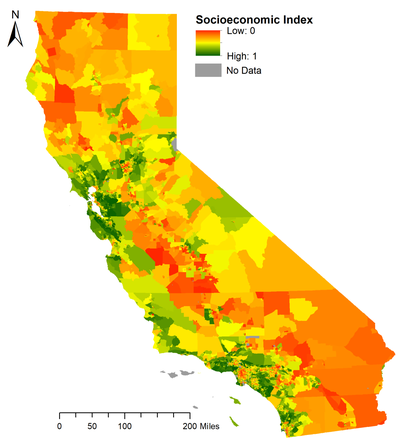
Data: US Census Bureau



Language & Education

The language and education index includes households with no English speakers and people over the age of 25 with no high school diploma.

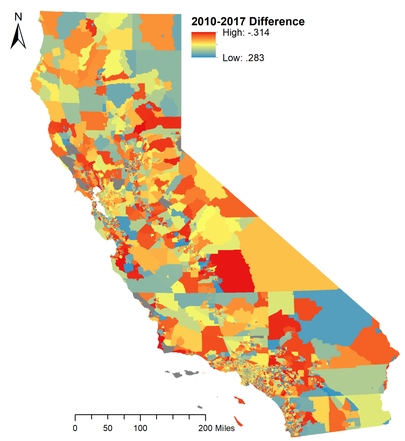
Data: US Census Bureau



Socioeconomic Status

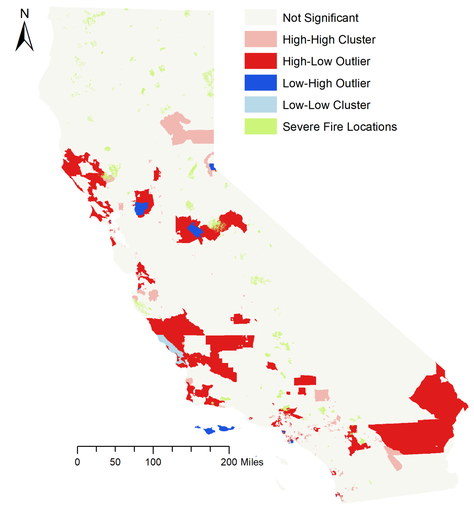
The socioeconomic index incorporates median household income, unemployment rate, and percentage of families living below the poverty level.

Data: US Census Bureau



Adaptive Capacity: 2010-2017

This map shows the change in the overall Adaptive Capacity Index between 2010 and 2017. The maps to the right show the factors for adaptive capacity for 2017 only.



Clustering and Major Fire Points

This map shows clustering of changes in adaptive capacity in relation to locations of severe wildfires from 2010 to 2017. *Note:* a Global Moran's I would be useful for a quantitative analysis here.