Multiple Hazards and Social Vulnerability Analysis

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Overview

In this analysis, we consider five hazard types facing California communities: wildfires, earthquakes, floods, drought, and extreme heat. To identify communities that might benefit most from support to implement hazard mitigation projects, we 1) attempt to objectively estimate community exposures to each of these hazards across the state, and 2) link these estimates to a commonly used measure of social vulnerability, the Social Vulnerability Index (SVI) published by the Centers for Disease Control and Prevention (CDC).

This analysis is done at the census tract level.[1] All census tracts with available data are ranked from lowest to highest in terms of their overall hazard exposure and social vulnerability, and then assigned a percentile rank relative to all other census tracts in the state. This ranking ranges from zero to one, where a higher rank indicates greater estimated hazard exposure or social vulnerability. For example, if a census tract has an overall hazard percentile rank of 0.75, 75% of census tracts in the state should have lower hazard exposure than that tract and 25% should have higher exposure.

Our approach to estimating hazard exposures attempts to characterize the relative likelihood of an event occurring in a particular census tract using available data. We do not attempt to estimate the population, economic, or business damages that would result from a disaster event.

Eligibility

The key measures used to determine eligibility in this analysis are the five hazard percentile rankings, the overall hazard exposure percentile ranking, and the SVI. Methods for calculating the five hazard percentile rankings are described below. The overall hazard exposure percentile ranking is calculated by adding the four highest hazard percentile rankings for each census tract and then ranking census tracts by this sum.

In this analysis, eligible census tracts are those that:

- Rank above the 70th percentile in terms of SVI.

AND

- Rank above the 90th percentile in any of the five hazard categories OR rank above the 70th percentile in overall hazard exposure.

[1] We define census tract boundaries using 2018 TIGER/Line shapefiles published by the Census Bureau. These are based on 2010 Census geographies.

Hazard Exposure Data

Wildfire

Wildfire hazard exposure is summarized as the mean current and future burn probability in each census tract. Current burn probabilities are based on the Pyrologix annual burn probability dataset. Future burn probability is calculated by averaging decadal burn probability estimates for 2020-2070 under four climate models and two climate scenarios: RCP4.5 and RCP8.5. These layers across decades and models are averaged and the final estimate takes the maximum probability across the two climate scenarios.

To rank census tracts by their overall wildfire hazard, we first ranked them by current and future burn probabilities individually and then ranked them by the sum of those individual rankings.

Sources:

- Wildfire Simulation Derived Products. "Annual decadal wildfire probability, RCP 4.5 and 8.5." Downloaded from https://cal-adapt.org/data/download/.
- Pyrologix California Statewide Fire Data. 2021. "Annual burn probability." Downloaded from https://storymaps.arcgis.com/stories/32de73f1cfb040c79f80c189ccefe061.

Flood

Flood hazard exposure is measured as the percentage of properties predicted to flood under 2020 and 2050 100-year flood scenarios. Estimates are based on the Flood Factor 1.3 model from the First Street Foundation. This data is reported at the ZIP code level, so the census-tract values used in the current analysis are based on summarizing those detailed values.

To rank census tracts by their overall flood hazard, we first ranked them by current and future flood exposures and then ranked them by the sum of those individual rankings.

Source:

- First Street Foundation. 2021. First Street Aggregated Flood Risk Summary Statistics Version 1.3. Downloaded from https://www.arcgis.com/home/item.html?id=4df5faffaa0744349ac575940d542879.

Earthquake

To estimate earthquake hazard exposure, we use the annualized frequency of Minor-Damage Earthquake Shaking included in FEMA's National Risk Index. This estimate is based on a set of raster files provided to FEMA by USGS and is derived from models used to create the 2018 USGS National Seismic Hazard Maps. Raster files were first converted to polygons and then intersected with census tract shapefiles to calculate the average probability for each census tract.

Source:

- Zuzak, C., E. Goodenough, C. Stanton, M. Mowrer, N. Ranalli, D. Kealey, and J. Rozelle. 2021. National Risk Index. "Annualized earthquake probability." Federal Emergency Management Agency, Washington, DC. Downloaded from https://hazards.fema.gov/nri/data-resources.

Drought

To estimate drought exposure, we use the annualized frequency of Extreme or Exceptional drought included in FEMA's National Risk Index. This estimate is based on data from the US Drought Monitor for 2000-2017.

Source:

- Zuzak, C., E. Goodenough, C. Stanton, M. Mowrer, N. Ranalli, D. Kealey, and J. Rozelle. 2021. National Risk Index. "Annualized drought probability." Federal Emergency Management Agency, Washington, DC. Downloaded from https://hazards.fema.gov/nri/data-resources.

Extreme Heat

Exposure to extreme heat is estimated as the current and future likelihood of abnormal heat events. Current exposure is based on the annualized frequency of heat waves included in FEMA's National Risk Index, which is derived from National Weather Service heat wave alerts for 2005-2017. Future exposure is based on the estimated average number of extreme heat days for 2035-2099 averaged across multiple climate models and under two future emissions scenarios: RCP 4.5 and 8.5.

To rank census tracts by their overall extreme heat exposure, we first ranked them by current and future probabilities of extreme heat events and then ranked them by the sum of those individual rankings.

Sources:

- Zuzak, C., E. Goodenough, C. Stanton, M. Mowrer, N. Ranalli, D. Kealey, and J. Rozelle. 2021. National Risk Index. "Annualized heat wave probability." Federal Emergency Management Agency, Washington, DC. Downloaded from https://hazards.fema.gov/nri/data-resources.
- LOCA Derived Data Products. "30-year annual average number of extreme heat days per year from 32 model maximum, RCP 4.5 and 8.5, 2035-2099." Downloaded from https://cal-adapt.org/data/download/.

Social Vulnerability

To measure social vulnerability, we use the CDC's Social Vulnerability Index, which combines 15 measures across four themes—socioeconomic status, household composition and disability, minority status and language, and housing type and transportation. Higher values indicate greater vulnerability.

Note: two versions of the SVI are available from the CDC website, one ranking census tracts within a given geography, and one ranking tracts for the United States as a whole. In this analysis we use the former, meaning census tract percentile rankings compare all census tracts in California. This differs from the publicly-facing map published by the CDC, which compares all census tracts in the United States.

Source:

- Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry/Geospatial Research, Analysis, and Services Program. CDC/ATSDR Social Vulnerability Index 2018 Database. California. Downloaded from https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html.