## Title

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**Authors**

English, Paul
Richardson, Max
Morello-Frosh, Rachel
et al.

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# Racial and Income Disparities in Relation to a Proposed Climate Change Vulnerability Screening Method for California

Paul English, California Department of Public Health, CA, USA
Max Richardson, California Department of Public Health, CA, USA
Rachel Morello-Frosh, University of California, CA, USA
Manuel Pastor, University of Southern California, CA, USA
James Sadd, Occidental College, CA, USA
Galatea King, CA Dept of Public Health, CA, USA
William Jesdale, University of California, CA, USA
Michael Jerrett, University of California, CA, USA

*Abstract: A key component for public health adaptation strategies for local communities and governments is the development of methods for climate change population vulnerability screening. There have been few attempts to combine multiple climate change threats in a measure which addresses a more holistic concept of population vulnerability that includes exposure, population sensitivity, and adaptive capacity. We propose a screening method to identify populations at high risk from climate change impacts using population vulnerability and the effects of cumulative stressors. We also investigate if racial/ethnic and income disparities interact with climate change vulnerability. We chose several metrics based on the literature and data availability at the sub-county (census tract) level for two California counties. They included measures of exposure related to climate change (sea-level rise, flood risk, and wildfire risk); measures of population sensitivity (elderly living alone and car ownership); and measures of adaptive capacity (tree canopy, impervious surfaces, air conditioner use, and public transit access). We add a previously developed index (Environmental Justice Screening Method) which reflects measures of cumulative impacts. Validation was conducted by using emergency room data from a recent extreme weather event. Analysis of the final scores showed the highest vulnerability in the urban areas, except also at the coast in Los Angeles County. African-Americans and Latinos were more likely to reside in the top two vulnerability areas in both counties compared to whites, and median household income was inversely linearly related to vulnerability risk score. We present a simple and transparent screening tool which could be developed in other regions and could be modified in order to best assess the risks that are of the greatest concern in communities.*

*Keywords: Vulnerability, Screening, Racial/Income Disparities*

## INTRODUCTION

With the failure of the U.S. to ratify the Kyoto protocols and the persistent recession of western economies diverting attention away from greenhouse gas reduction policies, the public health community has started to focus more on climate change adaptation, rather than mitigation. A key component for public health adaptation strategies for local communities and governments is a method to identify populations most vulnerable to climate change.

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For example, a core goal of the National Climate Assessment, a project of the U.S. Global Change Research Program, is the identification of information needs related to reducing climate impacts and vulnerability (National Climate Assessment 2011). And as part of California's recently initiated cap-and-trade program, decision-makers must determine whether there are ways to target program benefits in a manner that maximizes community-level health benefits from co-pollutant reductions, and minimizes the likelihood that market-based greenhouse gas emission reductions will produce or exacerbate disparities in public health. These benefits should be targeted to the most vulnerable, but there is no systematic method to identify these communities.

Population vulnerability to climate change is a broad concept which spans multiple disciplines, and encompasses natural, physical, biological, socio-economic, and institutional vulnerability (Aall and Norland 2005). The public health concept of climate change vulnerability falls more under the framework of "outcome vulnerability" rather than one of "contextual vulnerability", as described by O'Brian et al. (2007), and corresponds to the definition of vulnerability given by the Intergovernmental Panel on Climate Change (IPCC) (2007). Climate change outcome vulnerability entails an interaction of three factors: (1) exposure; (2) adaptive capacity; and (3) population sensitivity (Gallopin 2006).

From a public health perspective, exposures of interest include heat, and other weather events such as storms, and extreme precipitation (English et al. 2006 and Shonkoff et al. 2012). Adaptive capacity refers to the ability of the population to adapt to the exposure, take advantage of opportunities that enhance resilience or decrease the impact of exposures, and cope with the aftermath of the exposure (Gallopin 2006). From a health perspective, adaptive capacity could include access to air conditioning, measures to alter the built environment (such as increasing tree canopy), and the readiness of an area's emergency response or public health network. Finally, population sensitivity includes characteristics of a community such as co-morbidities and the percent of children which could either predispose or protect against the exposure. The concept of "resilience" is also important when discussing vulnerability. For the purposes of this exercise, however, resilience is thought to be part of adaptive capacity.

On a global level, Samson and colleagues have modeled population vulnerabilities based on population density and climate predictions, identifying Central America, central South America, the Arabian Peninsula, Southeast Asia, and much of Africa as areas which will suffer the greatest impacts (Samson et al. 2009). A census tract level heat vulnerability index for the U.S. was developed by Reid et al. (2009) using data on demographic characteristics, air conditioning, and diabetes prevalence. Cheng and Newbold (2010) applied principal component analysis to identify low-income immigrants and elderly living alone as the two main factors identifying vulnerable populations in Hamilton, Ontario. However, few attempts have been made to combine multiple climate change threats in a measure which addresses a more holistic concept of population vulnerability at the census tract level.

Cumulative impacts to additional stressors—such as social and health disparities, pollution exposure, and hazard proximity—will also increase population vulnerability (Sadd et al. 2011). We propose a screening method to identify populations at high risk from climate change impacts using this definition of vulnerability, plus a model adding cumulative impacts. We also investigate whether there is a relationship between climate change vulnerability, and racial/ethnic and income disparities. We piloted the screening method in two geographically, socially, and culturally distinct counties in California: Fresno County and Los Angeles County (Figure 1).

*Figure 1: The Two Study Areas for a Climate Change Population Vulnerability Screening Tool, Fresno County and Los Angeles County, CA*

## Methods

Fresno and Los Angeles counties represent two distinct Californian populations: an ethnically and economically diverse county with varied climate (Los Angeles); and a hot, inland, low-income, and primarily Hispanic county (Fresno). These two counties have been recognized as having significant environmental justice issues.

Indicators of vulnerability and environmental health related to climate change have been previously discussed (English et al. 2009 and Balbus and Malina 2009). We chose several metrics based on the literature and data availability at the sub-county (census tract) level. They included measures of exposure related to climate change (sea-level rise, flood risk, and wildfire risk); measures of population sensitivity (elderly living alone and car ownership); and measures of adaptive capacity (tree canopy, impervious surfaces, air conditioner (AC) use, and public transit access).

Data were compiled from various sources, and all data were publicly accessible online with the exception of data on AC prevalence and Fresno transit lines (Table 1). Data points were summarized at the census tract level, using tract boundaries from U.S. Census 2000 data. Each discrete indicator for each county was ranked into quintiles and scored 1 (low vulnerability) to 5 (high vulnerability). A final score was created by averaging across indicator rankings for each county, then re-scoring from 1 to 5. If a data point were missing for a tract, it was not calculated in the average across indicator rankings.

**Table 1: Data Elements for Climate Change Vulnerability Screening Tool, Summarized at the Census Tract Level**

| Element | Source |
|---|---|
| *Measures of Exposure* | |
| Wildfire Threat | CA Department of Forestry, CAL FIRE (2003) |
| Flood Risk | Federal Emergency Management Agency (Fresno 2009, LA 2008) |
| Susceptibility to flooding due to sea level rise | Pacific Institute 2009 (LA only) |
| *Measures of Population Sensitivity* | |
| Proportion of elderly living alone | U.S. Census (2000) |
| Car Ownership | U.S. Census (2000) |
| *Measures of Adaptive Capacity* | |
| Air Conditioning Ownership | CA Energy Commission (2009) |
| Tree Canopy | National Land Cover Database (2001) |
| Impervious Surfaces | National Land Cover Database (2001) |
| Public Transit Routes | Southern CA Association of Governments (2011); Council of Fresno County Governments (2011) |

### *Measures of Exposure*

Data on wildfire threat were available from the CAL FIRE Fire and Resource Assessment Program (FRAP) (California Department of Forestry and Fire Protection 2011). CAL FIRE's Wildland Urban Interface (WUI) data describes wildfire threat to developed areas, ranking 100 meter cells from "little to no threat" to "extreme threat". Categorical rankings from CAL FIRE were assigned values of 1 (no threat) to 5 (extreme threat) and used to calculate area weighted averages for each census tract. These averages were then ranked into quintiles and scored 1 (lower fire threat) to 5 (higher fire threat).

Flood risks were obtained from the Federal Emergency Management Agency's (FEMA) Digital Flood Insurance Rate Maps (DFIRM) (FEMA 2011). Flood risk categories include 'areas of minimal risk' (outside the 500 year flood zone), 'areas of moderate risk' (within 500 year and 100 year flood zones), and 'areas of increased risk' (within the 100 year flood zone). Each category was assigned a value of 1, 3, or 5, respectively. DFIRM maps were then overlaid with census tract polygons from each county, and an area weighted average was calculated for each tract. These averages were ranked into quintiles and scored 1 (low flood risk) to 5 (high flood risk).

Population susceptibility to coastal flooding due to sea level rise was included for Los Angeles County, but excluded for landlocked Fresno County. Projections on the impact of coastal flooding were obtained from the Pacific Institute (Pacific Institute 2009). Projections from the Pacific Institute assume a 1.4 m rise in sea level, and assess the proportion of individuals in each census tract to be inundated by rising coastal waters. Non-impacted tracts in Los Angeles

County were assigned a zero for the proportion of population impacted. Census tracts were ranked 1 (no impact from sea rise) to 5 (high impact from sea rise).

### Measures of Population Sensitivity

The proportion of elderly living alone highlights a community vulnerable to extreme weather events—particularly heat—and other emergencies. Data were gathered from the U.S. Census 2000 for the percent of households within a tract consisting of an individual age 65 years and older living alone. The census tracts were ranked into quintiles and scored 1 (lower proportion of elderly living alone) to 5 (higher proportion of elderly living alone).

The proportion of households per census tract with at least one car was collected from U.S. Census 2000 data. The proportions for each census tract were ranked into quintiles and scored 1 (higher proportion of households with at least one car) to 5 (lower proportion of households with at least one car).

### Measures of Adaptive Capacity

Data on the prevalence of central AC ownership (excluding swamp coolers and window cooling units) were obtained from the California Energy Commission (CEC), based on the 2009 Residential Appliance Saturation Survey (CEC 2010). Data from the CEC were reported at the ZIP code level. To compensate for a low sample size and incomplete coverage of the survey, data were smoothed using a spatial empirical Bayes model using 2009 ESRI ZIP codes. The model assumed a beta distribution for AC prevalence and uses the weighted count of respondents with and without AC in each ZIP code as inputs. For each ZIP code i, the 'prior distribution' is calculated using all of the respondents in ZIP codes adjacent to i, and the 'posterior distribution' is the prior distribution updated by the counts in ZIP code i itself. ZIP code level AC prevalence was then transferred to the tract level using an area weighted average and projected onto U.S. Census 2000 census tracts for Los Angeles and Fresno counties to derive tract-level estimates for AC ownership. These estimates were then ranked into quintiles and scored 1 (higher AC ownership) to 5 (lower AC ownership).

Data on land cover characteristics were collected from the United States Environmental Protection Agency's (U.S. EPA) 2001 National Land Cover Data (U.S. EPA 2001). Data included tree canopy and impervious surface characteristics. For each data set, the percent of land coverage based on 30 meter raster pixel values was averaged across Census 2000 block groups. Using population weighted averages, the values were summarized at the census tract level. Both tree canopy coverage and impervious surface averages were ranked into quintiles and scored 1 (high canopy coverage; low impervious surfaces) to 5 (low canopy coverage; high impervious surfaces).

Spatial data on bus and light rail lines were collected from the Southern California Association of Governments (SCAG 2011) and from the Council of Fresno County Governments (Fresno COG 2011). All transit lines, covering multiple transit jurisdictions and/or agencies for each county were overlaid with U.S. Census 2000 census tracts. A simple indicator of transit access was created by counting the number of unique transit routes per census tract, without regard to transit stops, the type of service (e.g. bus or rail), or headway times. The route counts per census tract were ranked into quintiles and scored 1 (greater number of transit routes) to 5 (fewer transit routes).

### Measures of Cumulative Impact

We used the Environmental Justice Screening Method (EJSM) developed by Sadd et al. (2011) to develop measures of cumulative impacts. This method uses a set of 23 health, environmental, and social indicators organized into three categories: 1) hazard proximity and land use, 2) air pollution exposure and health risk, and 3) social and health vulnerabilities (Table 2).

To create the final composite climate change population vulnerability score for each census tract, the scores of each indicator were averaged for each census tract. The average scores were then divided into quintiles and re-ranked 1 to 5, representing a final composite score for population vulnerability to climate change. This score is also then added as a fourth category to the EJSM, for a total Cumulative Impact score of 4 to 20 (possible scores of 1 to 5 for each of the four categories).

Validation of the screening method was conducted using emergency room data from a recent extreme weather event—the 2006 California heat wave. Heat related emergency room visits (data from the California Office of Statewide Health Planning and Development) were compiled at the ZIP code level for the time period during the heat wave (July 15–August 1, 2006) and compared to heat related visits in a reference period (July 8–14 and August 12–22, 2006). Climate change population vulnerability scores from each census tract were averaged across host ZIP codes based on census tract centroids. These subsequent ZIP code level vulnerability scores were then ranked into quintiles. Relative risks for heat related emergency room visits were calculated for each vulnerability score.

Data from the U.S. Census 2000 on race/ethnicity and household income at the census tract level were used to examine disparities in climate change vulnerability.

**Table 2: Data Elements for Environmental Justice Screening Method (Sadd et al. 2011)**

| INDICATOR | GIS SPATIAL UNIT | SOURCE |
|---|---|---|
| *Sensitive land use indicators* | | |
| Childcare facilities | Land use polygons | SCAG (2005) |
| | Buffered points | Dun and Bradstreet, by Standard Industrial Code (SIC) 8350 & 8351 (2006) |
| Healthcare facilities | Land use polygons | SCAG (2005); CA Spatial Information Library |
| Schools | Land use polygons | SCAG (2005) |
| | Buffered points | CA Department of Education (2005) |
| Urban playgrounds | Land use polygons | SCAG (2005) |
| Senior housing | Buffered points | Dun and Bradstreet, by SIC 8361 (2006) |
| *Hazardous facilities/land uses* | | |
| Facilities in the CA Community Health Air Pollution Information System (CHAPIS) | Point locations | CA Air Resources Board (CARB) (2001) |
| Chrome-platers | Point locations | CARB (2001) |
| Hazardous waste sites | Point locations | CA Department of Toxic Substances Control (2004) |

| | | |
|---|---|---|
| Railroad facilities | Land use polygons | SCAG (2005) |
| | Line features | National Transportation Atlas Database (NTAD) (2001) |
| Ports | Land use polygons | SCAG (2005) |
| Airports | Land use polygons | SCAG (2005) |
| | Line features | NTAD (2001) |
| Refineries | Land use polygons | SCAG (2005) |
| Intermodal distribution | Land use polygons | SCAG (2005) |
| | Line features | NTAD (2001) |
| *Health risk and exposure indicators* | | |
| Risk Screening Environmental Indicators (RSEI) toxic concentration hazard score | Census tract | U.S. EPA (2005) |
| National Air Toxics Assessment respiratory hazard for air toxics | Census tract | U.S. EPA (1999) |
| Estimated cancer risks from modeled ambient air toxics concentrations | Census tract | CARB (2001) |
| $PM_{2.5}$ estimated concentrations | Census tract | CARB (2004–06) |
| Ozone estimated concentrations | Census tract | CARB (2004–06) |
| *Social and health vulnerability indicators* | | |
| % people of color | Census tract | U.S. Census (2000) |
| % below 2x the national poverty level | Census tract | U.S. Census (2000) |
| % living in rented households | Census tract | U.S. Census (2000) |
| median housing value | Census tract | U.S. Census (2000) |
| % >24 yrs with <high school degree | Census tract | U.S. Census (2000) |
| Age of residents—% <5 yrs. | Census tract | U.S. Census (2000) |
| Age of residents—% >60 yrs. | Census tract | U.S. Census (2000) |
| Linguistic isolation | Census tract | U.S. Census (2000) |
| Voter turnout | Census tract | UC Berkeley Statewide Database (2000) |
| Birth outcomes—% preterm and small for gestational age | Census tract | CA Department of Public Health (1996–2003) |

## Results

### *Climate Change Vulnerability and Cumulative Impacts*

Final climate change vulnerability scores by census tract for Fresno and Los Angeles counties are shown in Figures 2 and 3, respectively. Both counties show elevated risks in urban areas. The western portion of Fresno County was also identified as having high vulnerability to climate change threats, primarily due to low AC and car ownership, as well as low tree canopy coverage. In Los Angeles County, highlighted areas of risk also were found along coastal areas, largely from risks due to sea level rise, but also partially attributable to poor public transit, wildfire risk, and a large proportion of elderly living alone.

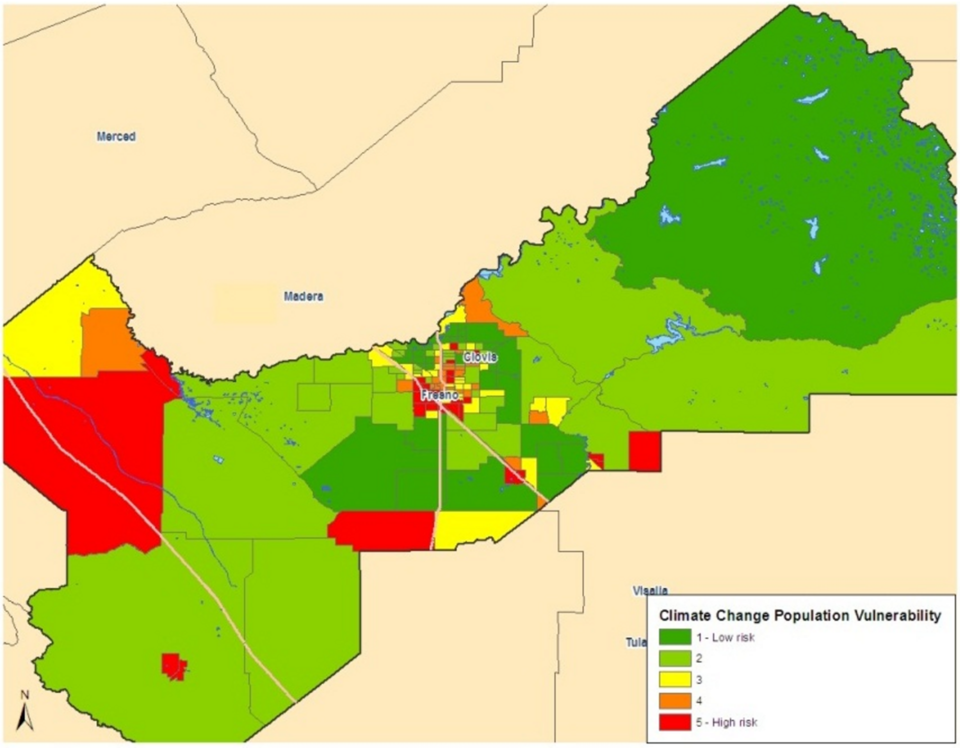

*Figure 2: Final Climate Change Population Vulnerability Scores, Fresno County, CA*

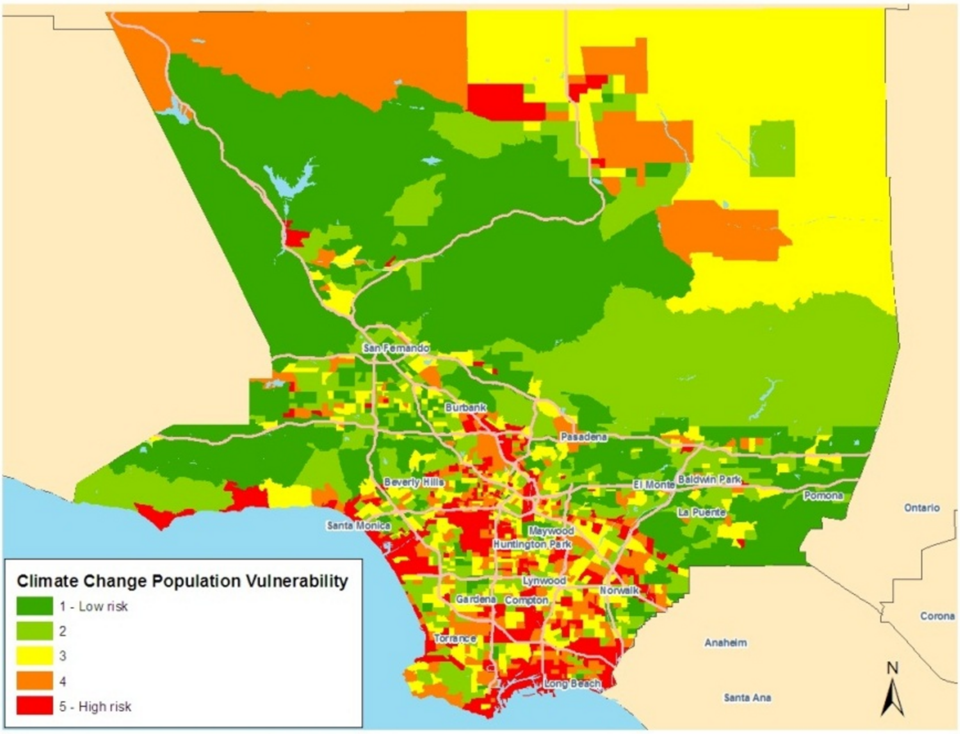

*Figure 3: Final Climate Change Population Vulnerability Scores, Los Angeles County, CA*

Figures 4 and 5 show the distribution of EJSM scores with the climate change score incorporated for the two counties. For both counties, by incorporating cumulative impacts into the climate change score, the risk is more concentrated in urban areas. In Fresno County, the western census tracts are no longer areas at highest risk. In Los Angeles County, the coastal census tracts are no longer areas at highest risk.

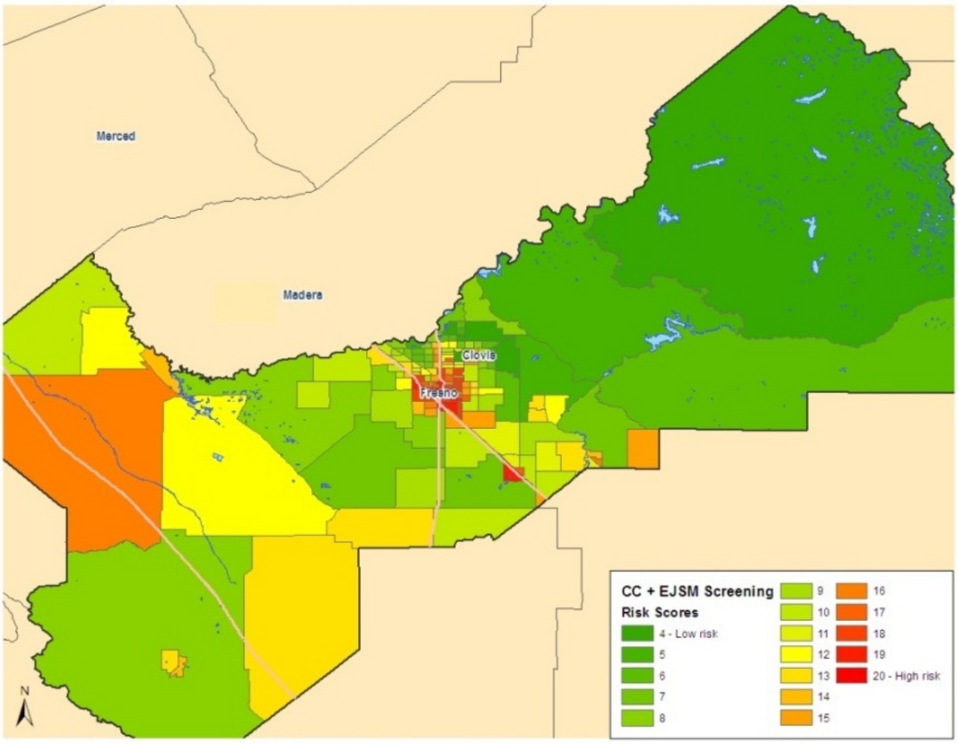

*Figure 4: Cumulative Impacts Plus Climate Change Vulnerability Scores, Fresno County, CA*

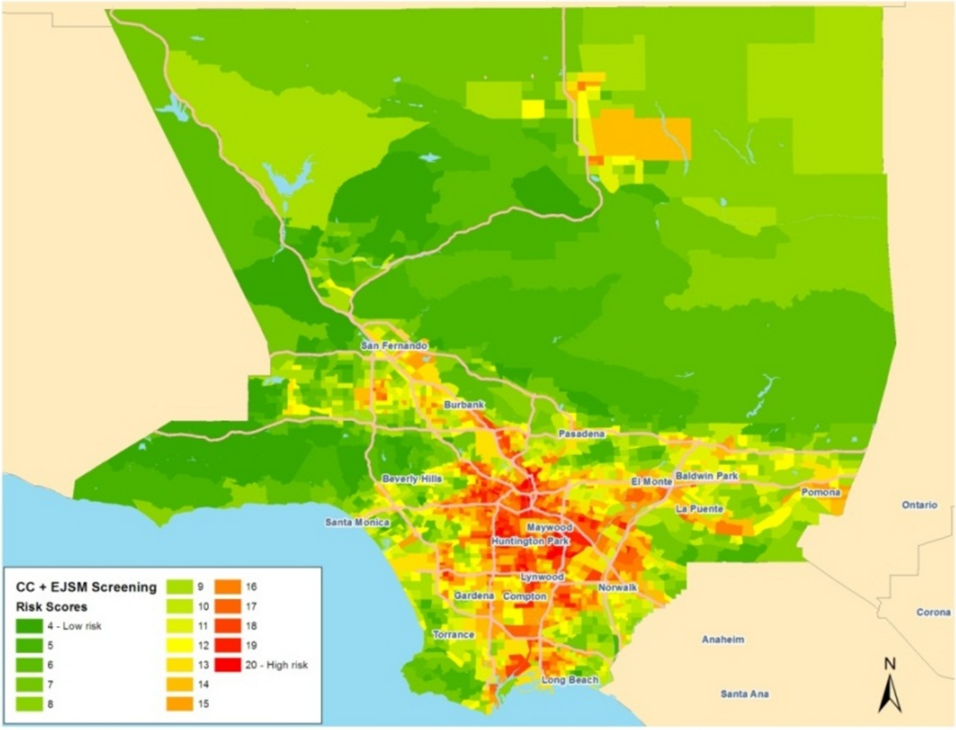

*Figure 5: Cumulative Impacts Plus Climate Change Vulnerability Scores, Los Angeles County, CA*

### *Racial and Income Disparities*

Figures 6 and 7 show the distribution of race/ethnicity by climate change vulnerability score in Fresno and Los Angeles counties, respectively. In Fresno County, 49% of African Americans and 45% of Latinos reside in the two highest risk categories for climate change vulnerability, compared to just 26% of Fresno's White population. A dose-response pattern was evident (except for the 4th category). African-Americans were 8.6 times more likely than Whites to reside in census tracts ranked with the highest vulnerability (OR=8.59 (8.27, 8.93)); Latinos were 4.7 times more likely than Whites (OR=4.73 (4.65, 4.81)).

In Los Angeles County, 46% of African Americans and 36% of Latinos reside in the two highest risk categories (those tracts with scores of 4 or 5), while 30% of Whites live in these high risk census tracts. However, a dose-response pattern was not evident in the intermediate risk categories. African-Americans were almost four times more likely than Whites to reside in census tracts ranked with the highest vulnerability than the lowest vulnerability (OR=3.93 (3.90, 3.96)); Latinos were almost twice as likely than Whites (OR=1.85 (1.84, 1.86)).

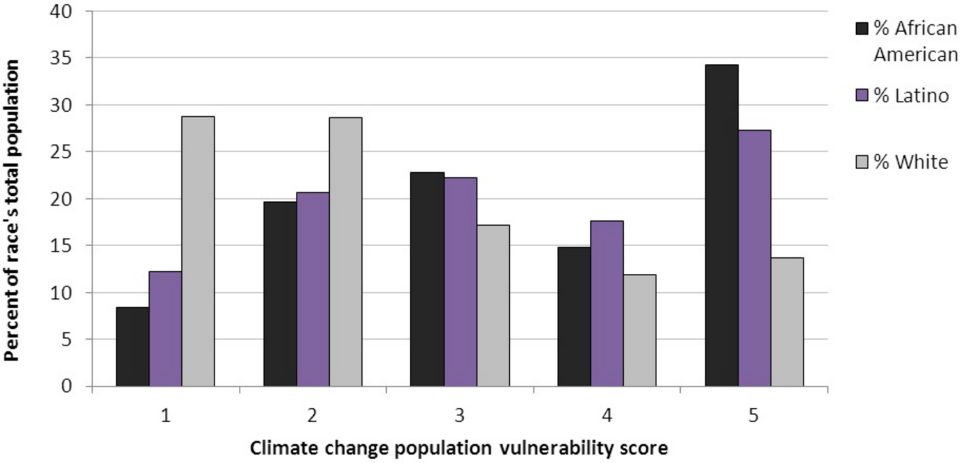

*Figure 6: Race/Ethnic Distribution of Climate Change Vulnerability Scores in Fresno County, CA*

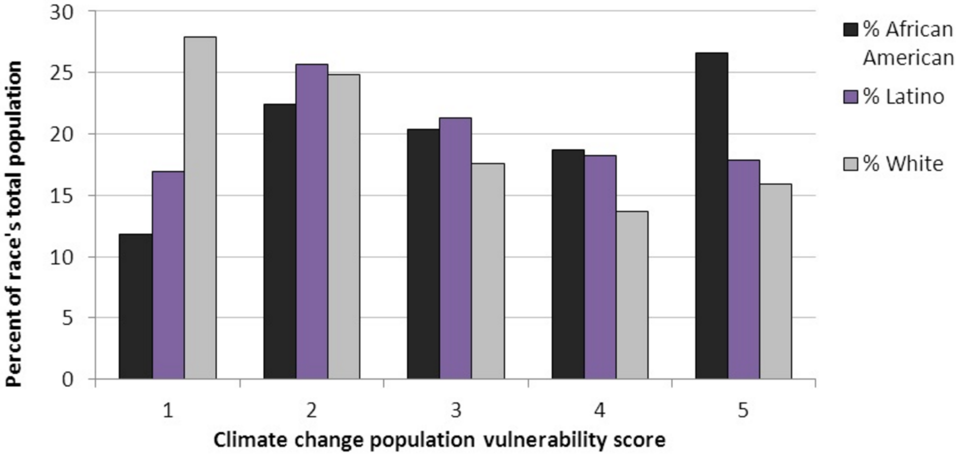

*Figure 7: Race/Ethnic Distribution of Climate Change Vulnerability Scores in Los Angeles County, CA*

A clear dose-response pattern was evident for average household income in relation to climate change vulnerability scores in both counties (Figures 8 and 9). In Fresno County, the average median household income in the lowest risk category was $54,320, compared to $24,377 (55% lower) in the highest risk category. In Los Angeles County, average income was about 40% lower comparing the lowest risk to the highest risk category ($36,967 compared to $60,172).

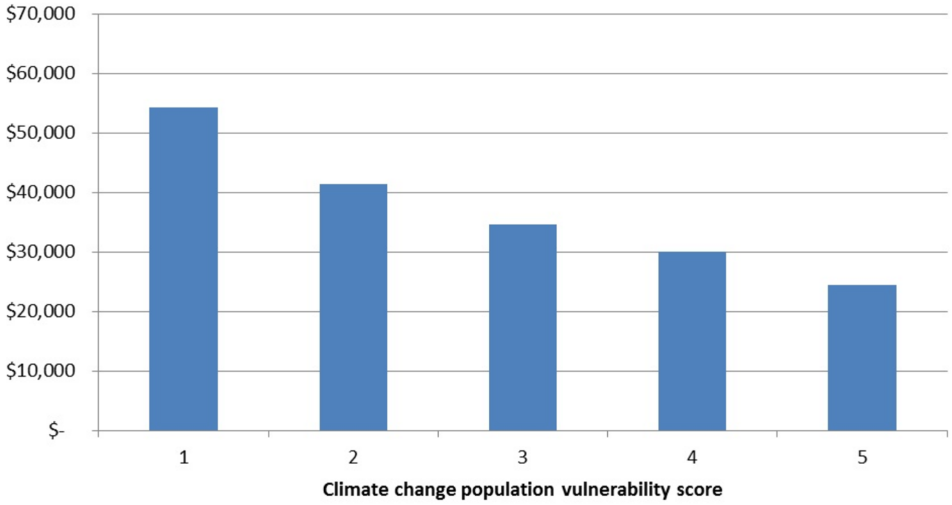

*Figure 8: Average Median Household Income in Census Tracts by Climate Change Vulnerability Score, Fresno County, CA*

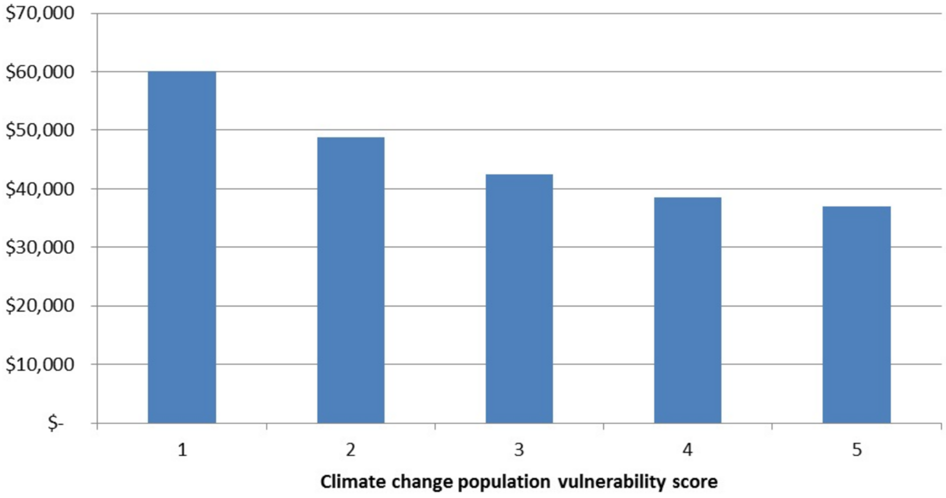

*Figure 9: Average Median Household Income in Census Tracts by Climate Change Vulnerability Score, Los Angeles County, CA*

## Validation Exercise

Examination of rate ratios of heat illness emergency room visits during the 2006 heat wave compared to a reference period did not reveal a dose-response pattern by climate change vulnerability ranking. However, census tracts in the highest risk category were 44% more likely to have emergency room visits for heat illness during the heat wave than the lowest risk category

(OR=1.44 (0.65, 3.22)) (Table 3). A low number of events limited the precision of the estimates of this analysis.

**Table 3: Rate Ratios of Emergency Room Visits for Heat Illness During the 2006 CA Heat Wave Compared to a Reference Period by Climate Change Vulnerability Score**

| Climate change vulnerability score | ER visits during 2006 heat wave | ER visits during reference period | Rate ratio (95% C.I.) |
|---|---|---|---|
| 1 | 97 | 20 | 1 (reference) |
| 2 | 116 | 20 | 1.20 (0.58, 2.48) |
| 3 | 100 | 20 | 1.03 (0.50, 2.14) |
| 4 | 90 | 18 | 1.03 (0.48, 2.19) |
| 5 | 98 | 14 | 1.44 (0.65, 3.22) |

## Discussion

Disparities from climate change impacts have been discussed on a global scale in terms of population density (Samson et al. 2009), race/ethnicity, and income (Frumkin et al. 2008). On a national scale, the focus has been on the elderly and children (Patz et al. 2001), and in California, on vulnerable communities in general (Morello-Frosch et al. 2009). There has been less work, however, developing local-level tools to screen for broader climate change impacts on population vulnerability. The development of screening tools is a public health priority for highlighting local needs and efficiently targeting resources to communities most likely to be impacted by climate change. California Governor Jerry Brown recently signed into law Senate Bill 535 (De León), requiring a minimum of 10 percent of the potential revenue (estimated to be up to $1 billion) generated by the cap-and-trade program to be directed to disadvantaged communities to reduce pollution and develop clean energy. It also requires the California Environmental Protection Agency to develop a method for identifying communities for investment in these areas. We present here a method that may be used for such purposes, by utilizing the three main categories of population vulnerability (exposure, population sensitivity, and adaptive capacity), and applying them to two California counties.

Shonkoff et al. (2012) have argued that health impacts from climate change will disproportionately affect minority populations and low-income neighborhoods, and have made the explicit link between environmental justice and climate health hazards. Our method found that the most vulnerable communities generally resided in the urban areas in both counties, and in rural areas which lack access to public transportation and have a high proportion of isolated elderly. In coastal communities, areas that are at high risk of sea level rise also lack access to transportation and have a high concentration of elderly populations. When coupling the climate change vulnerability score with an existing cumulative impact score developed by Sadd et al., the higher risk communities shift back to the urban areas, in part reflecting the additional weighting of percentage of persons of color and poverty (social and health vulnerabilities). This suggests that when taking into account the additional stressors that cumulative impacts may have on communities, urban areas should be targeted by public agencies in adaptation planning. This will become more important as more vulnerable individuals continue to move from rural to urban areas (United Nations Population Fund 2007).

When analyzing demographic data, we found striking disparities in race/ethnic and income distributions by climate change vulnerability risk score. In Fresno County, African-Americans were 8.6 times more likely than Whites to reside in the high risk areas compared to the low risk areas (Latinos were 4.5 times more likely). A similar disparity was found in Los Angeles County. There was a clear income disparity between those living in high risk areas compared to low risk areas. Median household incomes were 55% lower in high risk areas compared to low risk areas in Fresno County, and 40% lower in Los Angeles County.

We attempted to validate our method by examining the rate ratios for emergency room visits for heat illness during the 2006 heat wave in California by risk categories. Although we did not observe a dose-response pattern, we found that individuals living in the highest risk areas were 44% more likely (although not statistically significant) than those living in the lowest risk areas to have emergency room visits for heat illness during the heat wave compared to a reference period. Therefore, the screening tool did exhibit a threshold signal of elevated risk in the highest risk category. Due to the small numbers, these estimates were not precise. It is also important to point out that our climate change vulnerability score includes other climate change risks, not just heat-related risks.

There were some limitations of this study. First, we could not incorporate additional components of vulnerability, such as environmental education and social networks into our index due to a lack of available data. Second, many of the measures we used were not adjusted for future climate change risks, such as wildfire and flooding risk. FEMA is currently updating their digital flood risk maps to adjust for future climate variability (Lehmann 2009). Therefore, this method captures existing population vulnerabilities in general, and does not capture projected future impacts. Additionally, manipulating and merging geospatial data across diverse data sources presents many challenges, particularly when working with sub-county data. Sub-county data are often not available, particularly in more rural counties. For example, data on transit systems will vary from county to county in accessibility, and will likely exist in varying degrees of quality and spatial resolution.

Despite the limitations listed above, this general approach to screening for population vulnerabilities to climate change has several strengths. First, the indicator was developed with data that were readily available on publicly accessible web sites (with the exceptions of air conditioning ownership and Fresno County transit lines, which were easily requested). No original data collection was needed, and data exist for potential users—such as city planners or local health departments—to adopt a similar model most applicable to their work. In addition, because many of these same data sets are collected nationally and updated regularly, similar screening tools could be developed and kept current in other states or regions of the country. Second, this method—built upon the EJSM model tested and used by Sadd et al.—is very simple and transparent. This allows other groups to adopt this screening tool as is, or to assign weights to certain indicators in order to best assess the risks that are of the greatest concern in their communities. Sadd et al. found that this model was most easily understandable and adaptable by a wide variety of potential users, including regulatory agency officials and community organizations.

Several steps could be taken to improve the accessibility and usability of this method. First, input from local health departments, community groups, planning groups, and other relevant stakeholders would help in reviewing and revising the screening tool, as well as communicating results from the tool. Second, efforts could be made to include the data in a dynamic online mapping tool allowing stakeholders to interactively change weights, turn data layers off and on, and zoom in and out of specific areas. This would greatly increase accessibility.

## Conclusion

In this study of two California counties, we found disparities by income and race/ethnicity in areas likely to be impacted by climate change risks. Local health departments, urban planners, and policy makers should take into account factors such as population sensitivity and adaptive capacity when conducting climate impact assessments or preparing for adaptation policies. Greater attention to policies that increase transportation options and tree canopy in high risk areas would reduce climate hazard inequities, for example.

Public agencies must begin considering the health impacts of climate change in their hazard assessment models. As revenues are generated from greenhouse gas mitigation policies, funding should be directed to these communities to increase resilience and improve baseline health outcomes. A tool such as the one presented here offers some direction on how to efficiently and effectively target communities with the greatest needs. By leveling the playing field, we will be able to reduce health outcome disparities related to climate change.

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## ABOUT THE AUTHORS

*Dr. Paul English:* Dr. English is currently State Environmental Epidemiologist and Branch Science Advisor for the California Department of Public Health, where he serves as a content expert in climate change and health. Dr. English has focused on conducting population vulnerability assessments for climate change, in particular the effects of heat waves. He also served as principal investigator of a Health Impact Assessment of California's cap and trade regulations to reduce greenhouse gas emissions. He has served as an advisor to the World Health Organization in developing climate-sensitive health indicators and was an invited expert for the Indian Institute of Public Health on addressing heat-health vulnerability. Dr. English received his master's in public health and doctorate in epidemiology at the University of California, Berkeley. He has over 16 years of experience working in environmental public health for the State of California and has published extensively in the peer-reviewed literature.

*Max Richardson:* California Department of Public Health, USA

*Rachel Morello-Frosh:* University of California, USA

*Manuel Pastor:* University of Southern California, USA

*James Sadd:* Occidental College, USA

*Galatea King:* CA Dept of Public Health, USA

*William Jesdale:* University of California, USA

*Michael Jerrett:* University of California, USA