Assessing Socio-Economic Vulnerability to Climate Change in California

Matthew Heberger
Pacific Institute, Oakland, California
February 1, 2013

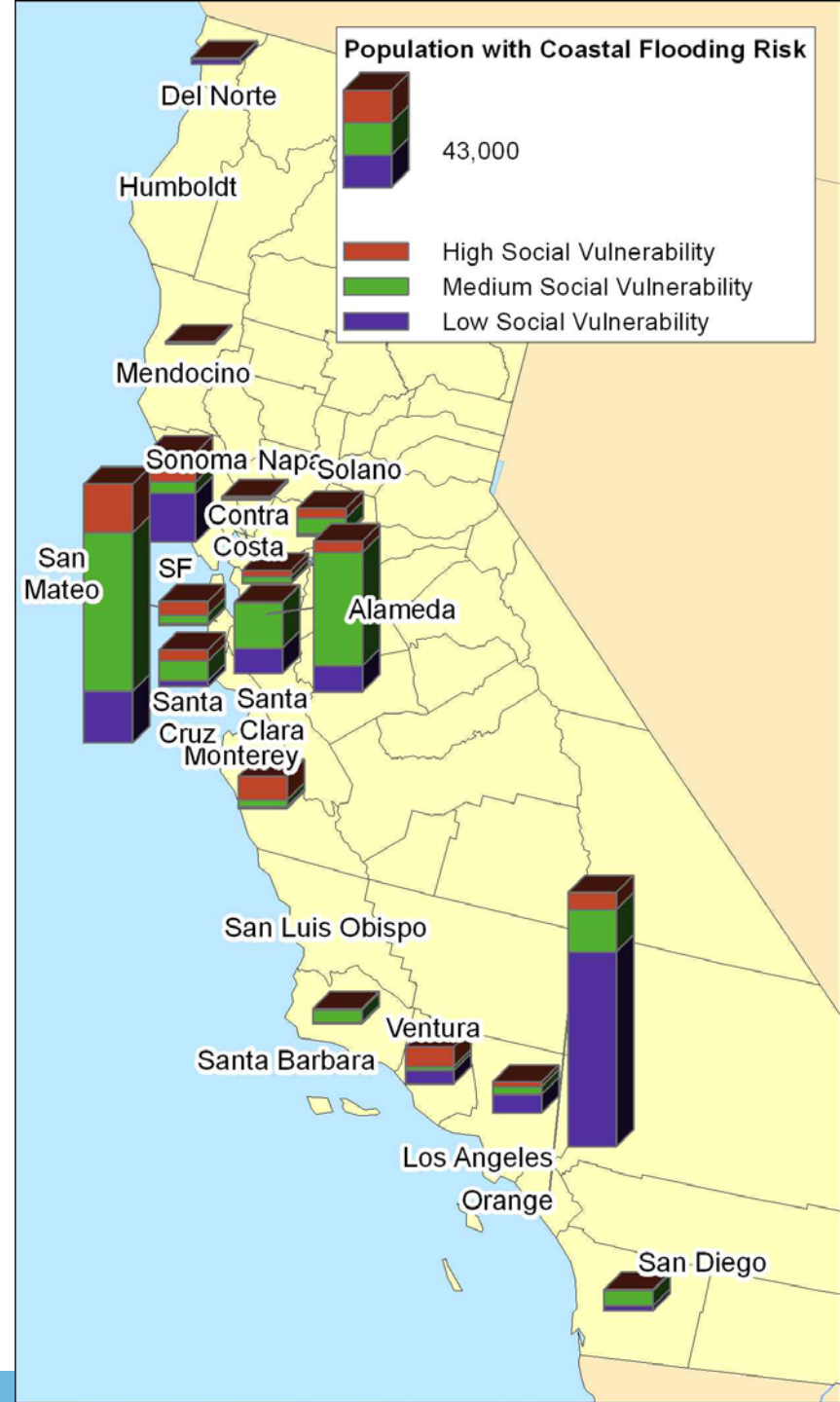Pacific Institute

Talk Outline

- How can we quantitatively assess **social vulnerability**?

- How can we translate results from climate models into impacts to **humans** and **society**?

- How did we combine information on climate change **and** social vulnerability?

Pacific Institute
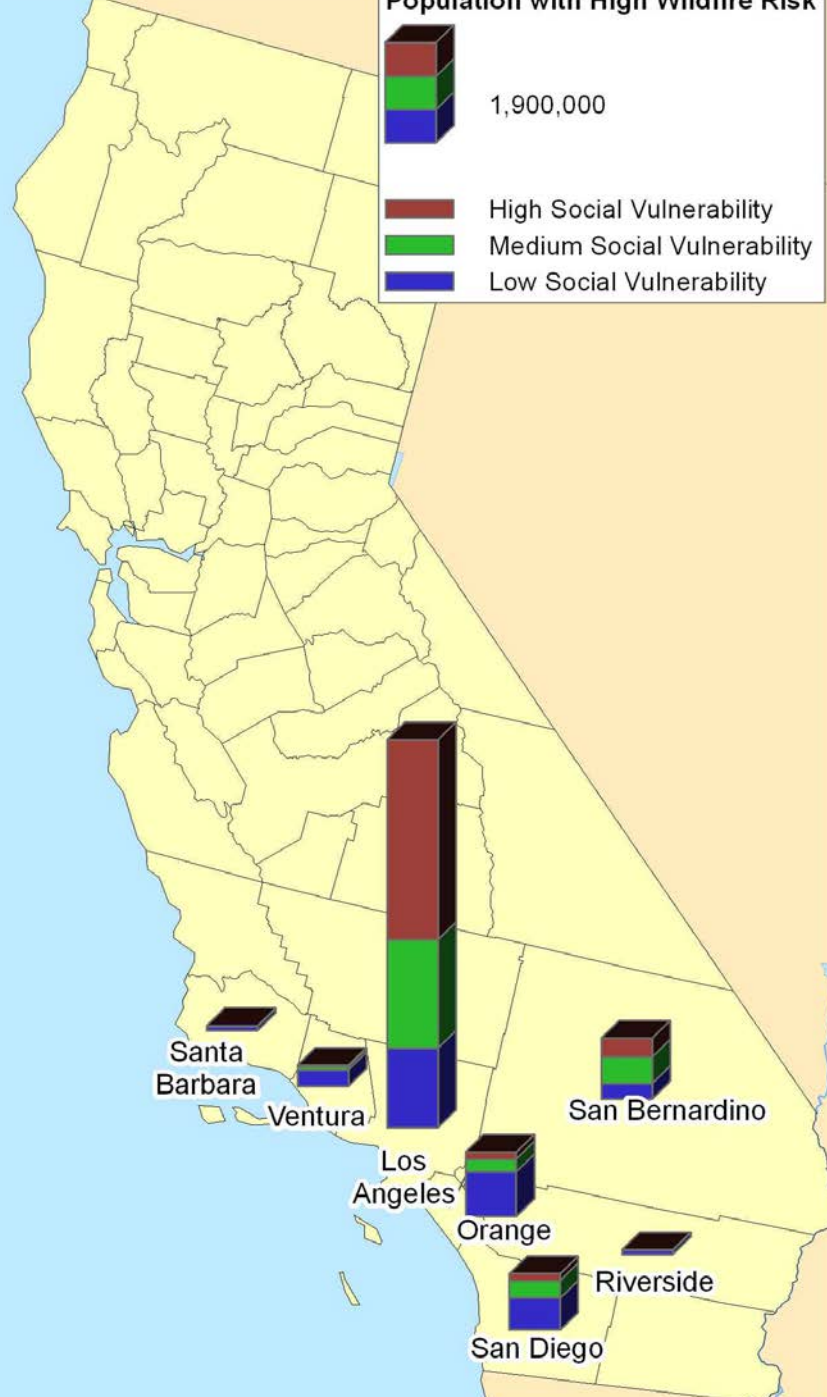
Project Background

- Part of the California Climate Change **Biennial Assessment** ordered by Governor Schwarzenegger in 2005, analyzing climate impacts to the state

- Dozens of **peer-reviewed studies** have been published covering oceans, coasts, water supply, agriculture, and more

- Our 2009 study of sea-level rise found large **low-income** and **minority** populations are at risk

- The 2011 round of studies move past climate impacts towards **vulnerability** and **adaptation**.
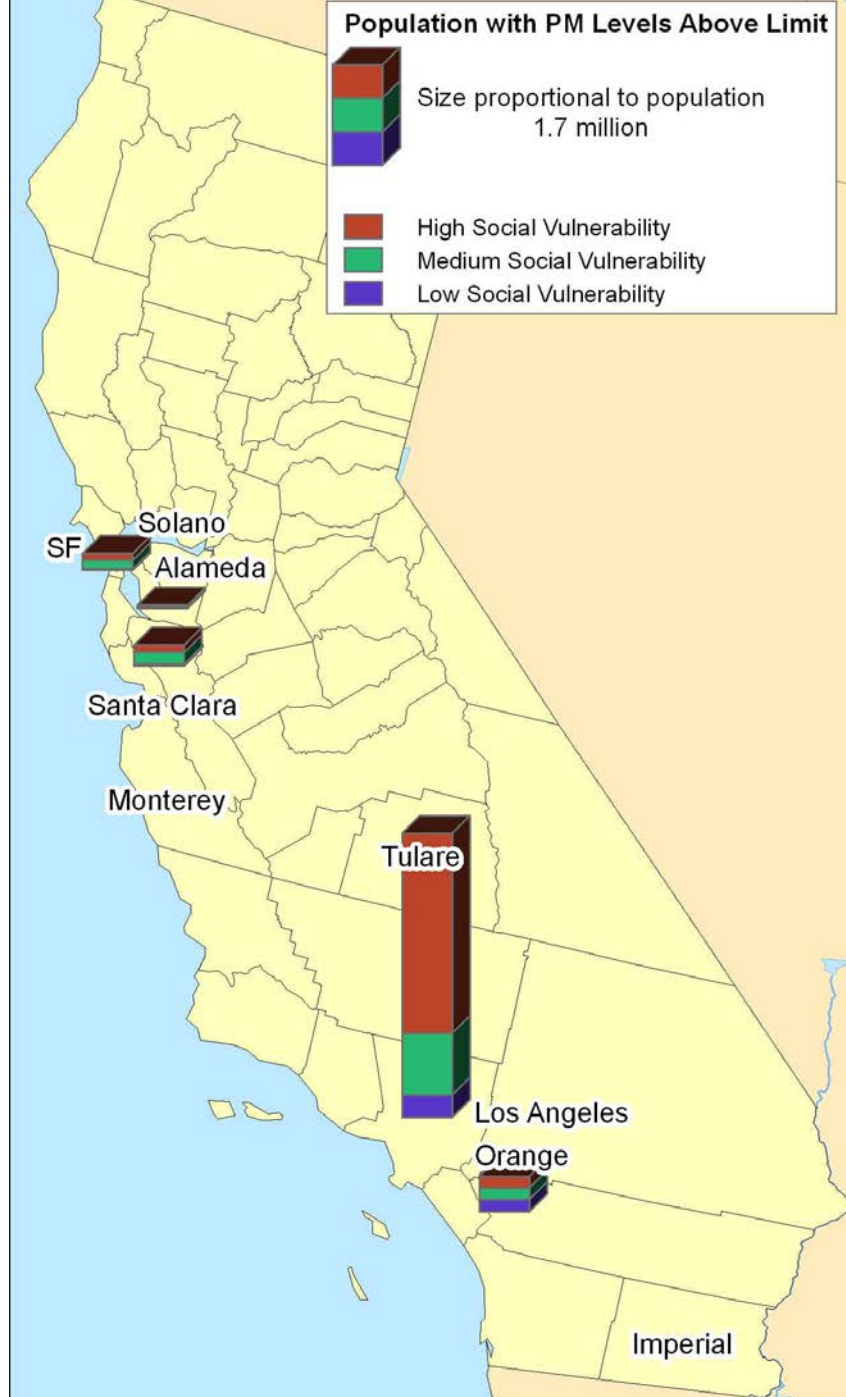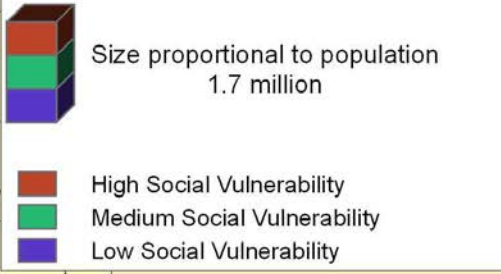
Pacific Institute

Findings

- Maps of the population most vulnerable to climate-related impacts

- Combines information on climate impacts and social and economic vulnerability

- We looked at flooding, heat stress, air quality, and wildfire risk

Population with High Wildfire Risk

1,900,000

High Social Vulnerability
Medium Social Vulnerability
Low Social Vulnerability

Santa Barbara
Ventura
Los Angeles
Orange
San Bernardino
Riverside
San Diego

Population with PM Levels Above Limit

Size proportional to population
1.7 million

High Social Vulnerability
Medium Social Vulnerability
Low Social Vulnerability

SF
Solano
Alameda
Santa Clara
Monterey
Tulare
Los Angeles
Orange
Imperial

Exposure × Vulnerability = Risk

Louis Jones, 81, and Catherine McZeal, 62, walk toward the Superdome in the days after Hurricane Katrina

Factors Influencing Vulnerability and Resilience

Vulnerability Factors – individual or community characteristics that **reduce** the ability to adapt to or cope with climate change impacts once exposed (e.g. for flooding, having a disability)

Resilience Factors – individual or community characteristics that **increase** the ability to adapt to or cope with climate change impacts once exposed (e.g. for flooding, having emergency food/water supplies)

Pacific
Institute

Population Vulnerable to Flooding in California (with 1.4 m sea level rise)

Vulnerability Factor	Number of People
Total Population at Risk	480,000
Non English speakers	41,000
No vehicle	45,000
Low-Income	125,000
Persons of color	208,000
Renters (vs. Homeowners)	269,000

Social Vulnerability to Environmental Hazards

Legend:
- High (Top 20%)
- Medium
- Low (Bottom 20%)

0 125 250 500 Miles

N
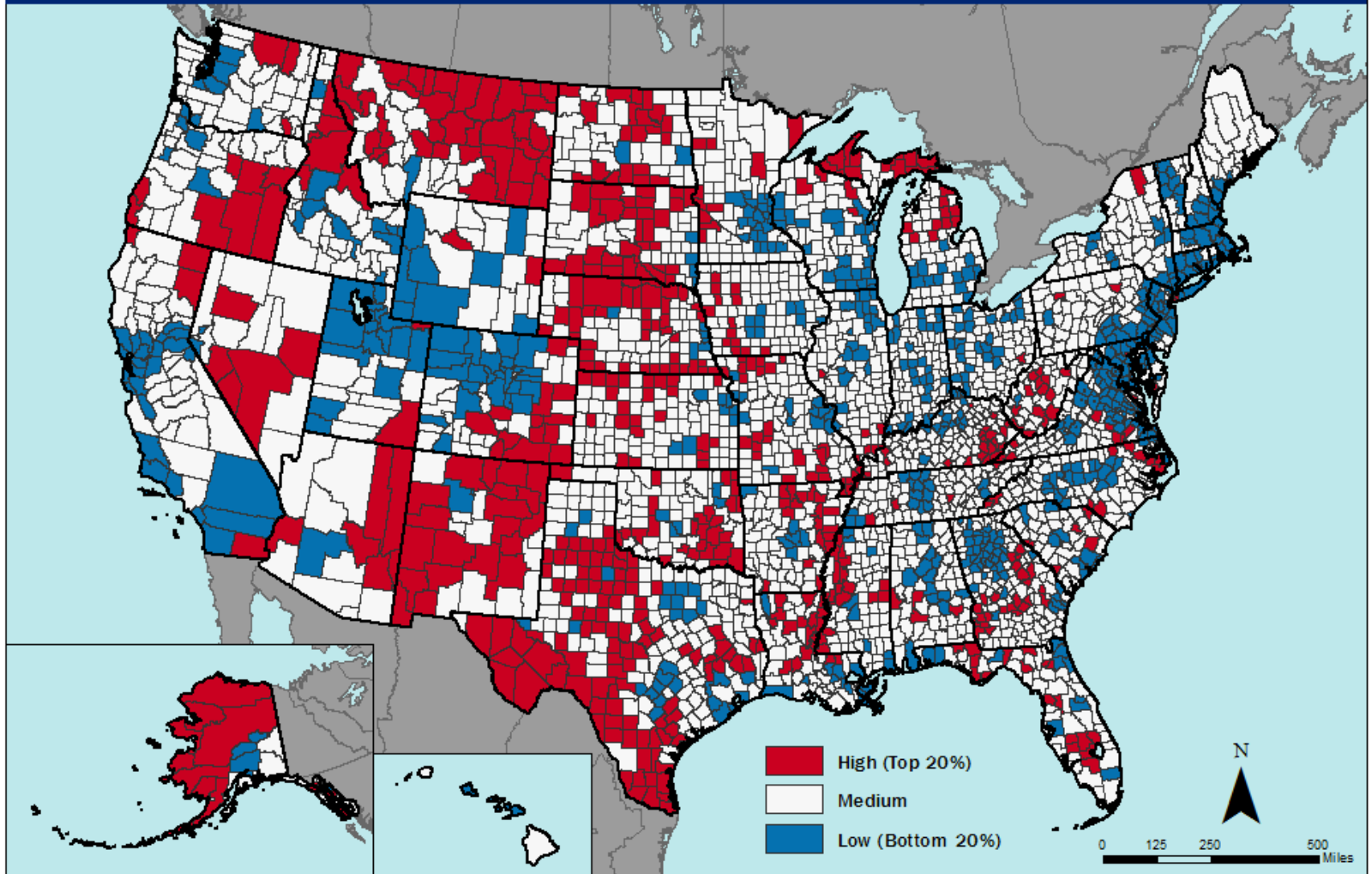
Social Vulnerability Index 2006-10
Based on U.S. Census 2010 & American Community Survey, 2006-2010

HVRI

Mapping the Social Vulnerability Index (SOVI)

- Developed by social scientists at Univ. of South Carolina in 1999

- SOVI is a metric to compare the vulnerability of different areas

- "Synthesizes 32 socioeconomic variables, which the research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards"

- Quantifies social vulnerability using available data, mostly from the US Census, including income, race, unemployment, and others.

Pacific Institute's Modified "Climate Vulnerability Index"

- Developed using more high-resolution data for Census Tracts in **California**

- Variables measure each **individual** vulnerability factor we have identified (unless data is unavailable)

- Combines vulnerability indicators into **one single** overall climate vulnerability score (equal weighting for each)

- Includes **new datasets** on air conditioner ownership, childhood obesity, percent tree cover, pre-term births, number of outdoor workers, and others.

Variables Included in our "Climate Vulnerability Index"

Living Alone over 65

Population under 18

Renters

Households speaking little English

People of Color

Low Income

Population without HS Diploma

Living in Group Quarters

Unemployed

Women giving birth in last 12 mos.

Outdoor Workers

Foreign Born

Lack Access to Grocery Stores

Overweight/Obese Youth
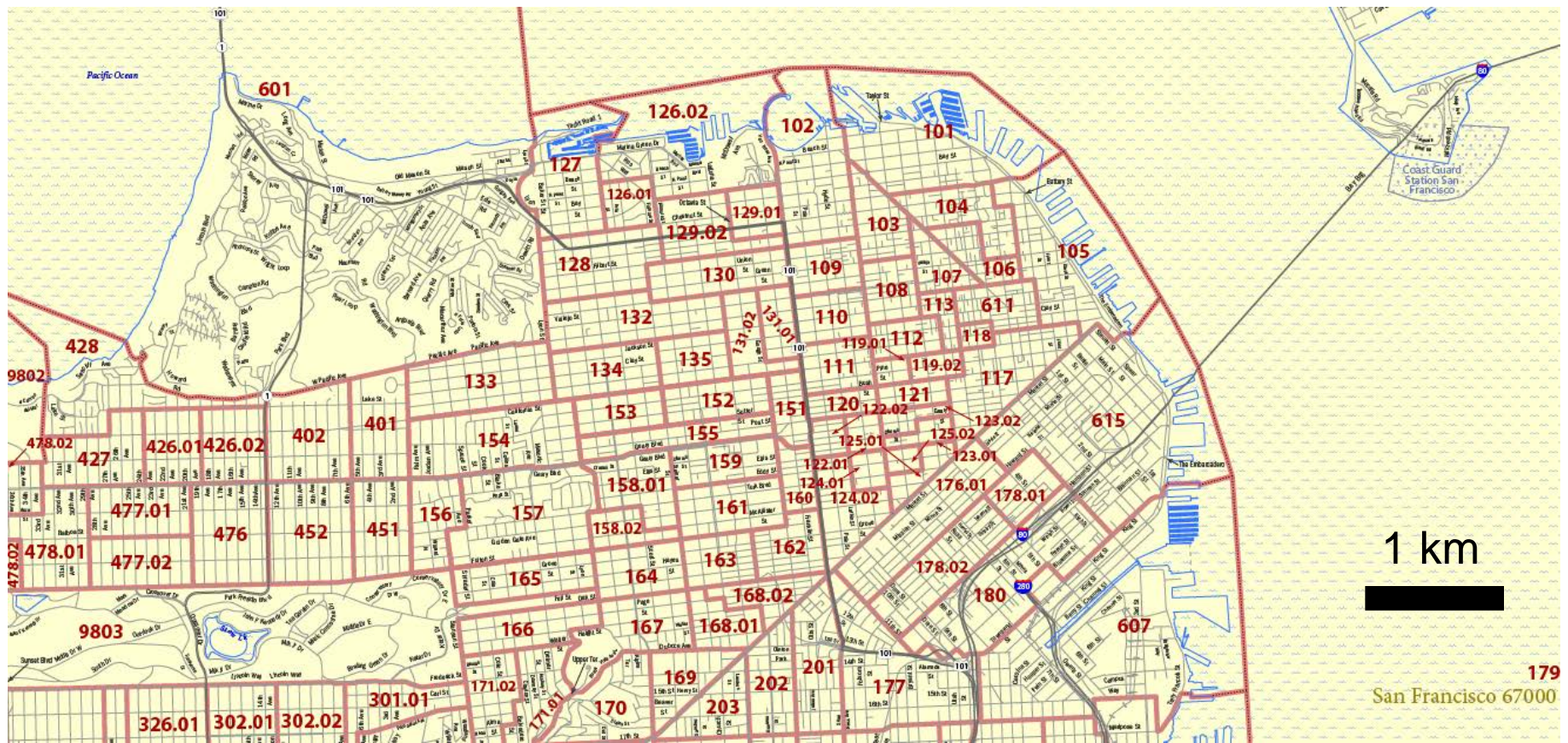
Impervious Land Cover

Treeless Area

Households without a Vehicle

Pre-term Birth Rate

Households without Air Con.

Census Tracts

- 7,115 tracts in California
- Average 1,500 people in each

Pacific Institute: Reports   ×   Map: Social Vulnerability to Climate Chan... ×   +

pacinst.org/reports/climate_vulnerability_ca/maps/   ☆ ▽ C   🔍 ▾ Google

# Mapping Social Vulnerability to Climate Change in California

The map on this page shows the modified *Social Vulnerability Index* for Census Tracts in California. This index was created by researchers at the Pacific Institute to better understand Californians' social vulnerability to climate change-related impacts, such as natural disasters or increased heat stress. Vulnerability is defined as the susceptibility of a population to harm from exposure to a hazard, and its ability to prepare for, respond to, and recover from hazards.

Find more information about our methods here. For full details on data sources and methods, see our report *Social Vulnerability to Climate Change in California* (Cooley et al. 2012).

For a map of each of the 19 factors displayed individually, click here.

NOTE: *If the map says "Data may still be loading" you will need to either zoom into the map, or reload the page. You should only see this message once for each map.*

Opacity: [====○====]   50%
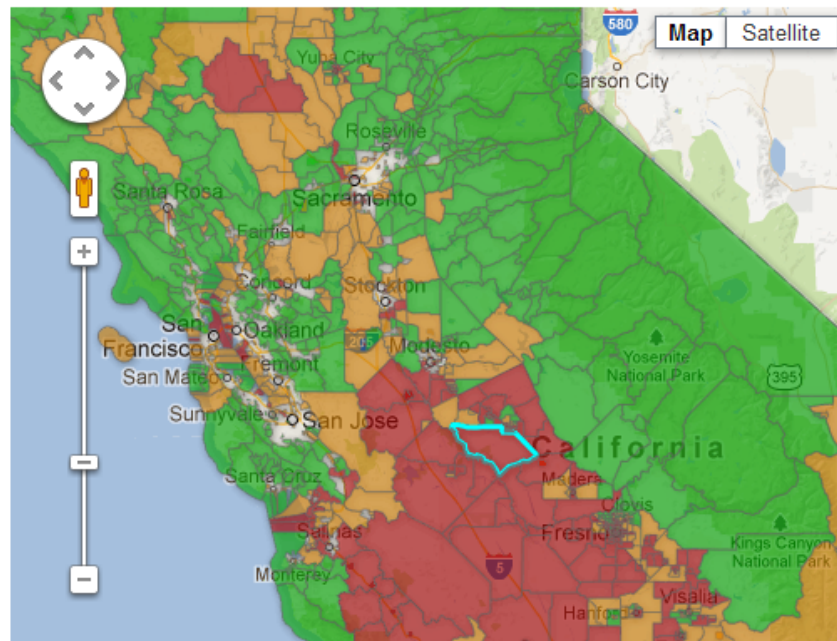
Tract: 06047000901
Population in 2000: 3,911
Number of Households: 1,151
Vulnerability Level: High
Social Vuln Score (-2 to +2): 0.22

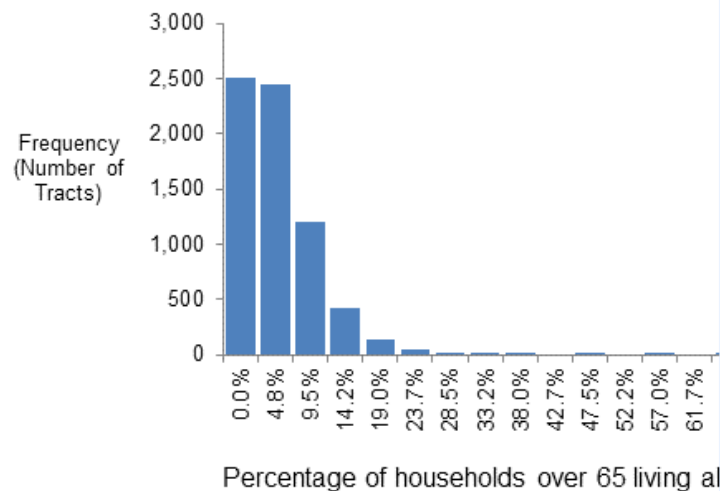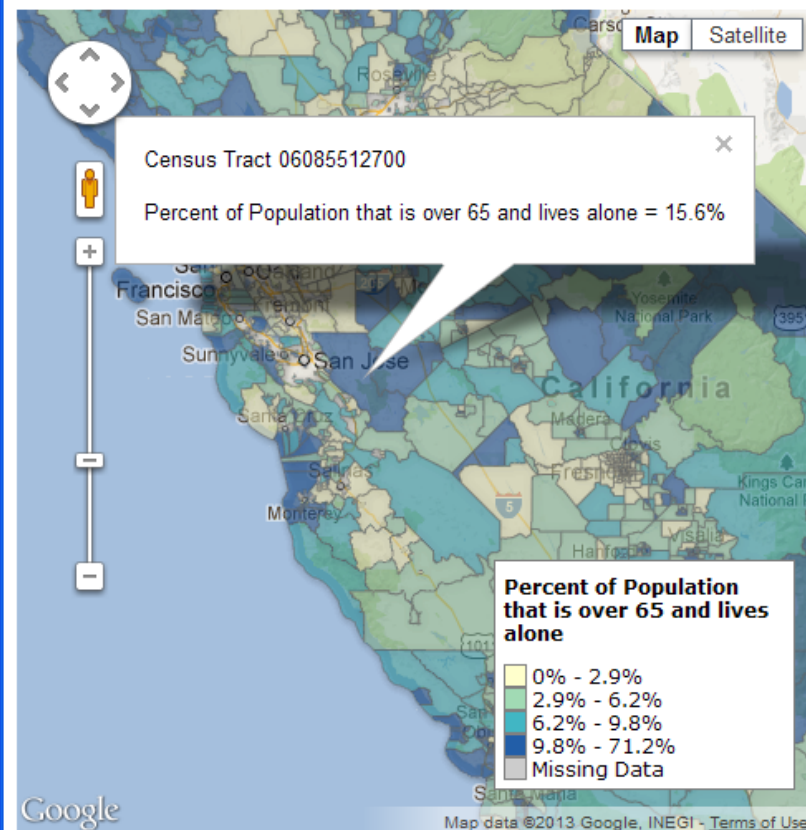| Factors ⬍	Value ⬍	Z-score ⬍
Living Alone over 65	6%	-0.13
Population under 18	37%	1.46
Renters	58%	0.66
Households speaking little English	23%	0.23
People of Color	48%	-0.28
Low Income	40%	0.40
Population w/o High School Diploma	37%	0.97
Living in Group Quarters	0%	-0.24
Unemployed	6%	0.24
Women giving birth last 12 mos.	6%	0.23
Outdoor Workers	31%	2.65

in California (Cooley et al. 2012).

For a map of the Social Vulnerability Index, which combines these 19 factors into a single indicator, click here.

NOTE: *If the map says "Data may still be loading" you will need to either zoom into the map, or reload the page. You should only see this message once for each map.*

Show on map: Living Alone over 65   Opacity: 50%

Map   Satellite

Census Tract 06085512700

Percent of Population that is over 65 and lives alone = 15.6%

Frequency
(Number of
Tracts)

3,000

2,500

2,000

1,500

1,000

500

0

0.0% 4.8% 9.5% 14.2% 19.0% 23.7% 28.5% 33.2% 38.0% 42.7% 47.5% 52.2% 57.0% 61.7%

Percentage of households over 65 living al

Percent of Population that is over 65 and lives alone

0% - 2.9%
2.9% - 6.2%
6.2% - 9.8%
9.8% - 71.2%
Missing Data

Google

Map data ©2013 Google, INEGI - Terms of Use

zotero

Our Research Involved Community Participation from the Beginning

- Why? Local governments and community organizations are **important partners**, because will be the first to respond to many climate-related impacts

- Community participation helps make the research **relevant** and **meaningful**. They are more likely to accept the science if they played a part in developing it.

- We collaborated with the Oakland Climate Action Coalition: 30 community, environmental, labor, and other organizations

- Our partners provided input on the **analytical methods** and **data** for the analysis; they also told us what **outputs** would be useful to them in doing outreach and education

Pacific Institute

Project Partners

- Oakland Climate Action Coalition
- City of Oakland

Funding Support from:
- California Energy Commission – Public Interest Energy Research (PIER) Program
- San Francisco Foundation
- East Bay Community Foundation
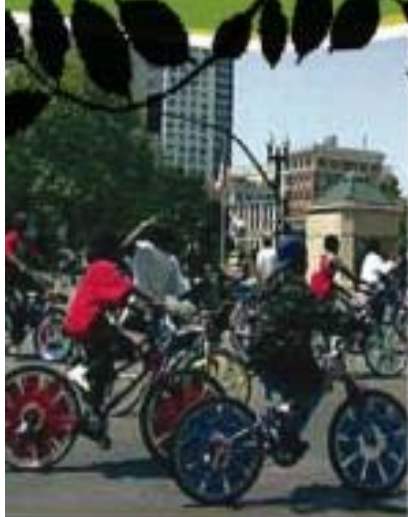
Our Partners were *not* drawn in by this kind of information:
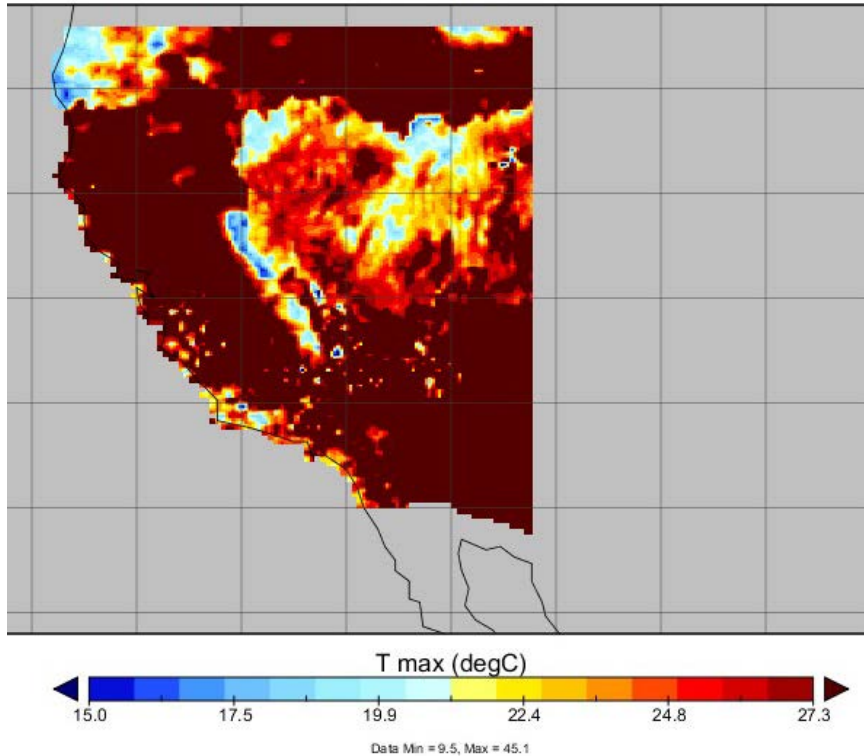

Small-scale gridded climate model output
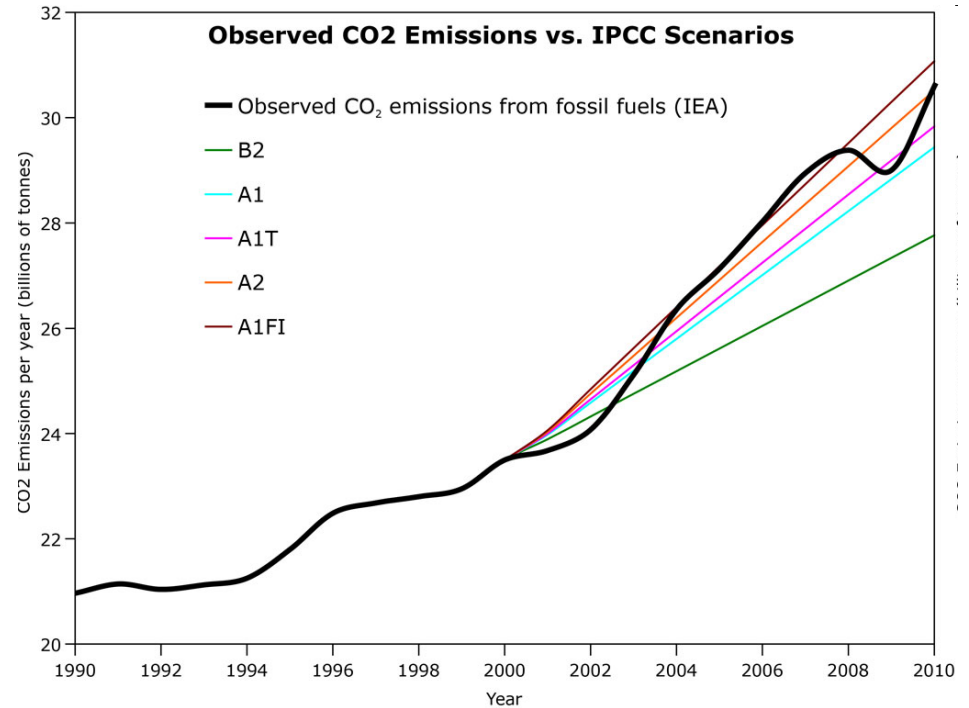
Time series of projected emissions, temperatures, etc.

More Effective:
Overlays on Aerial Photos, Zoomed to city or neighborhood
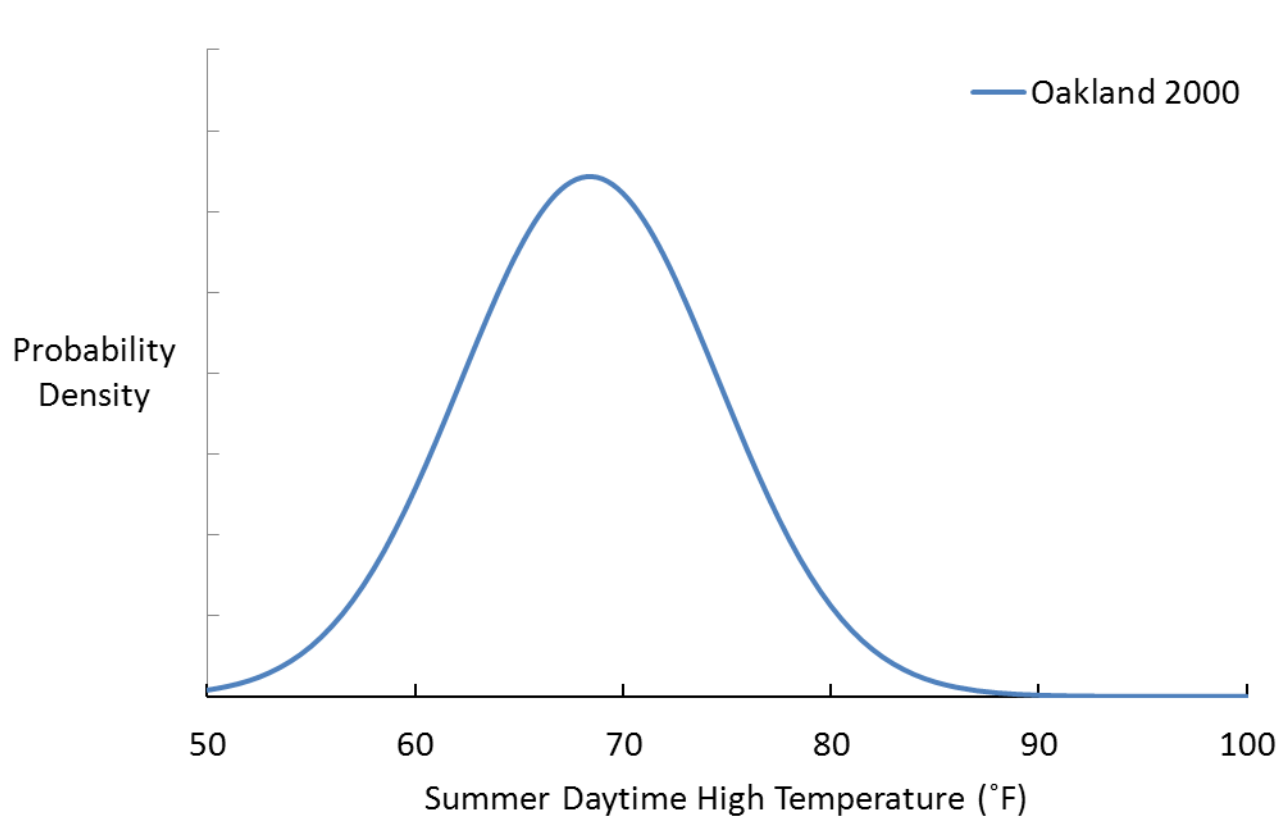
Live Oak

Santa Cruz

Twin Lakes

Current Coastal Base Flood
(approximate 100-year flood extent)

Sea Level Rise Scenario
Coastal Base Flood + 1.4 meters (55 inches)

Landward Limit of
Erosion High Hazard Zone in 2100

Coastal Zone Boundary

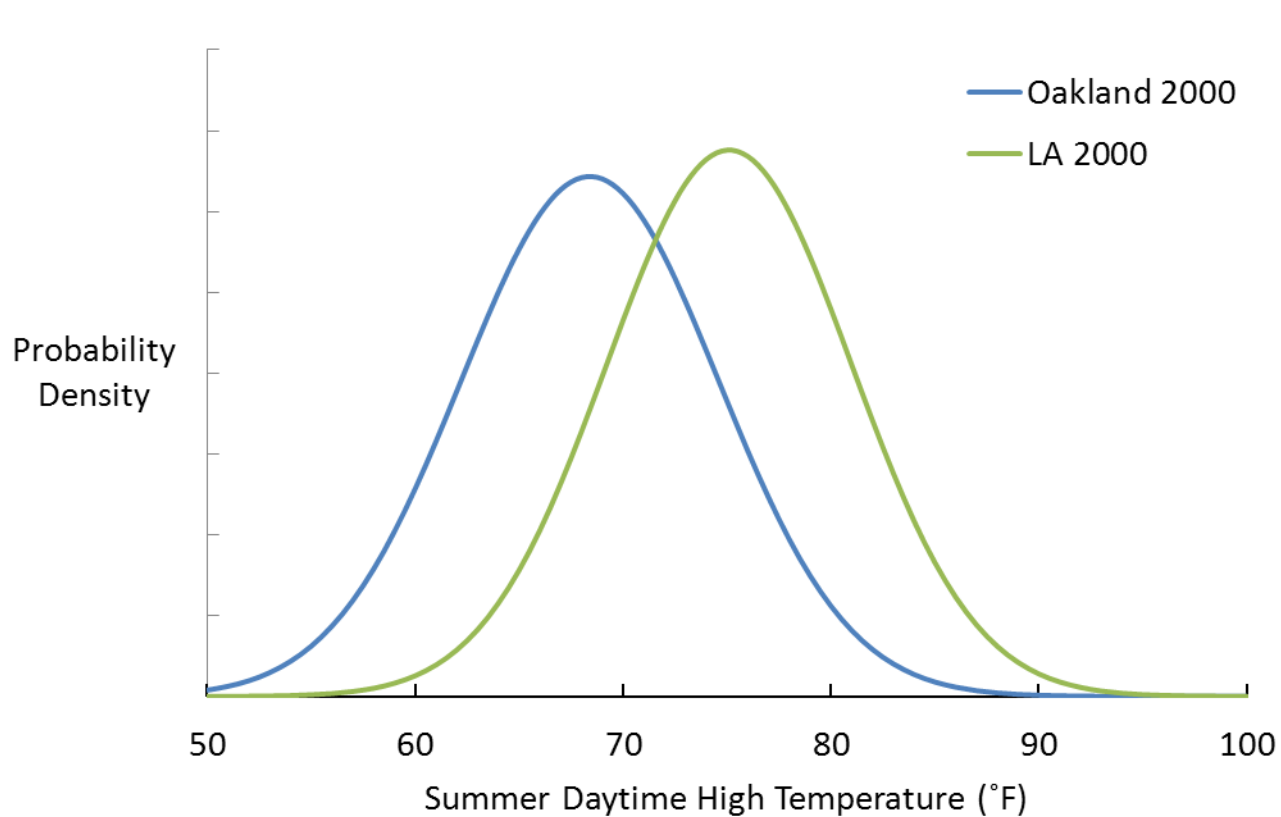Number of days exceeding 105 °F
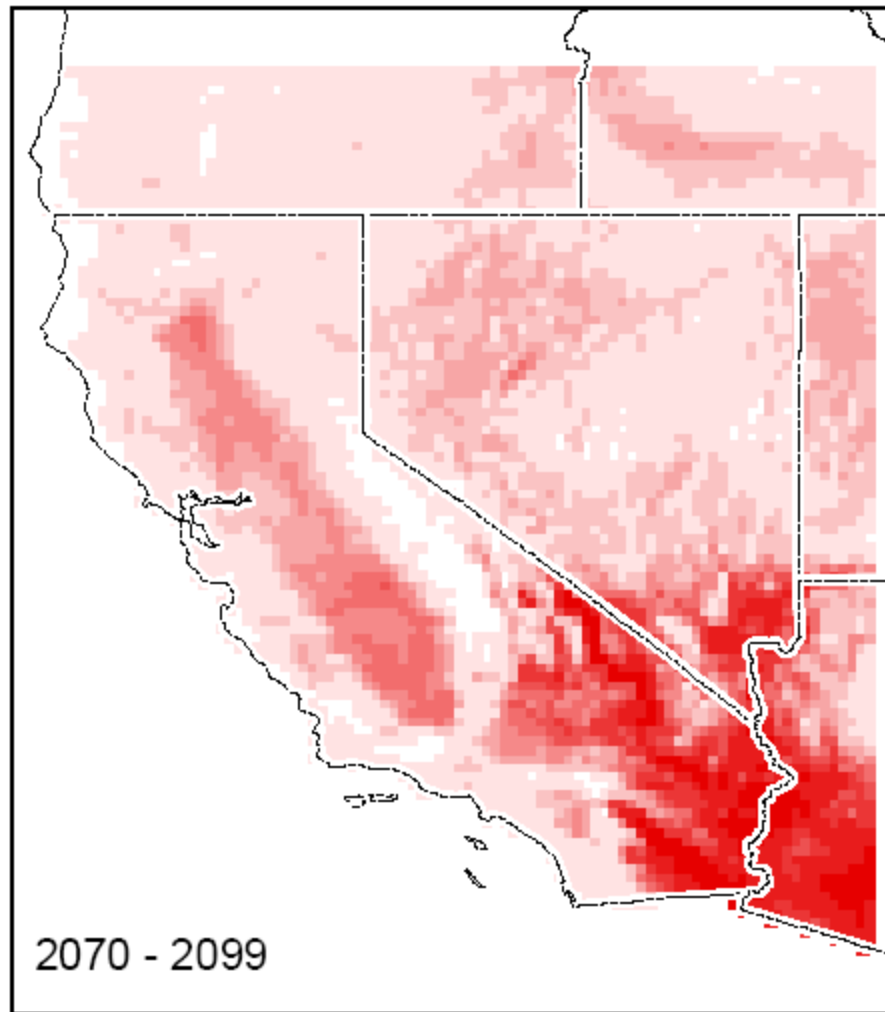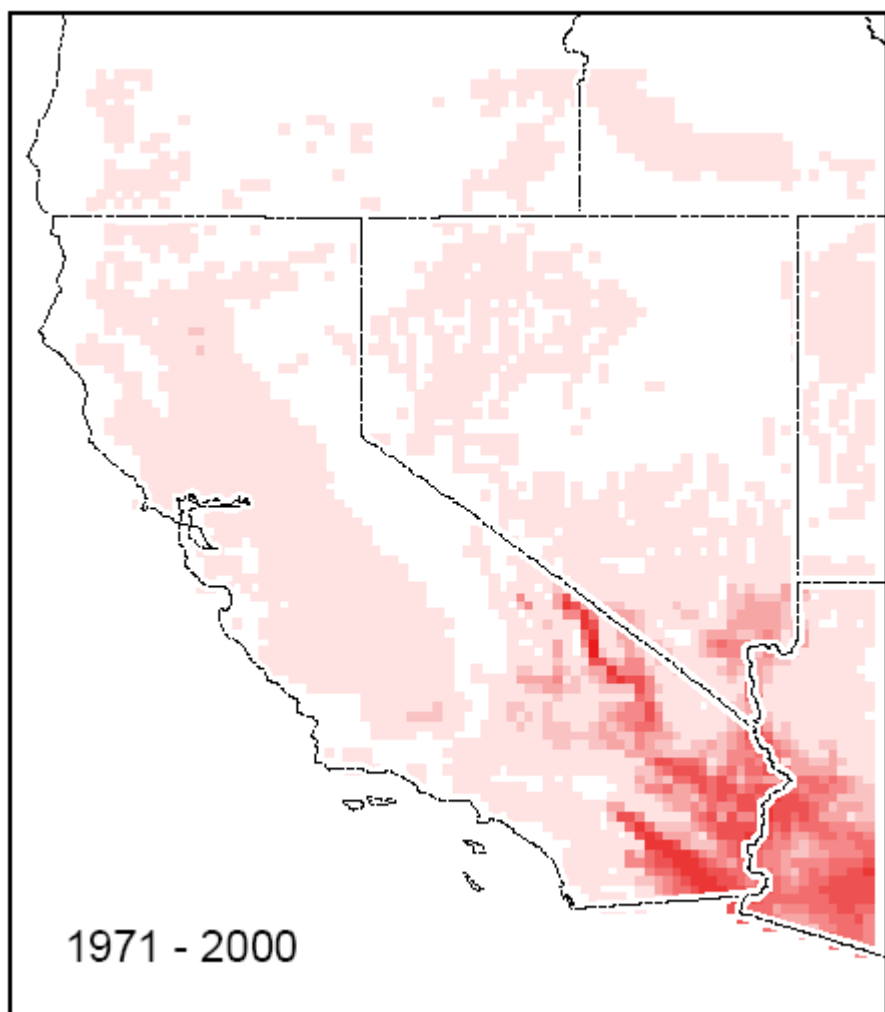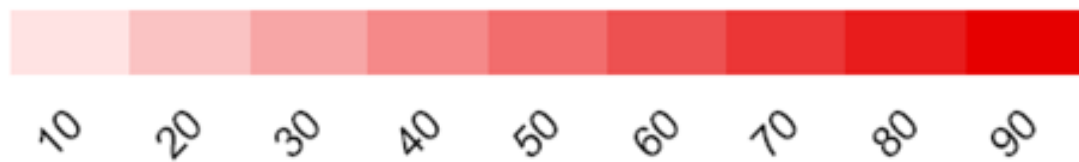
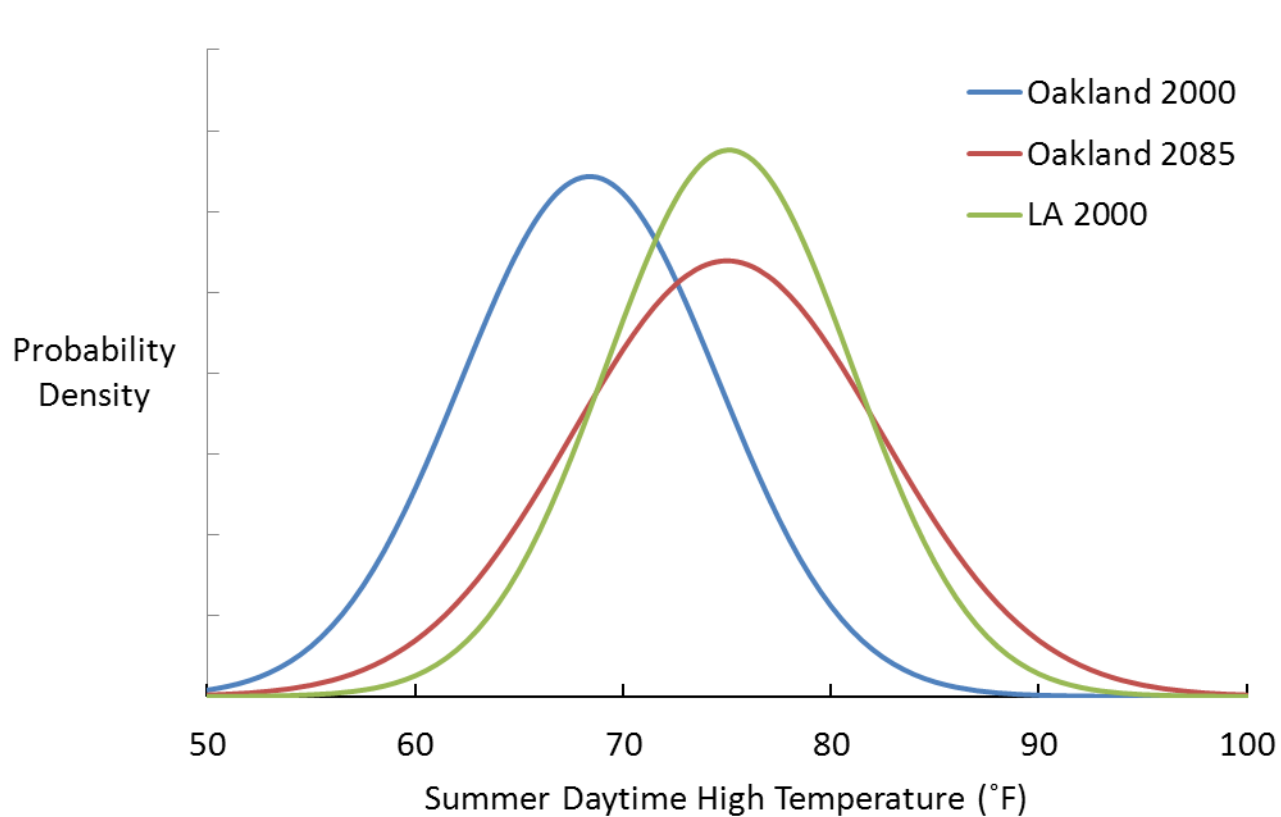10 20 30 40 50 60 70 80 90

1971 - 2000

2070 - 2099

Summer Temperature Distribution

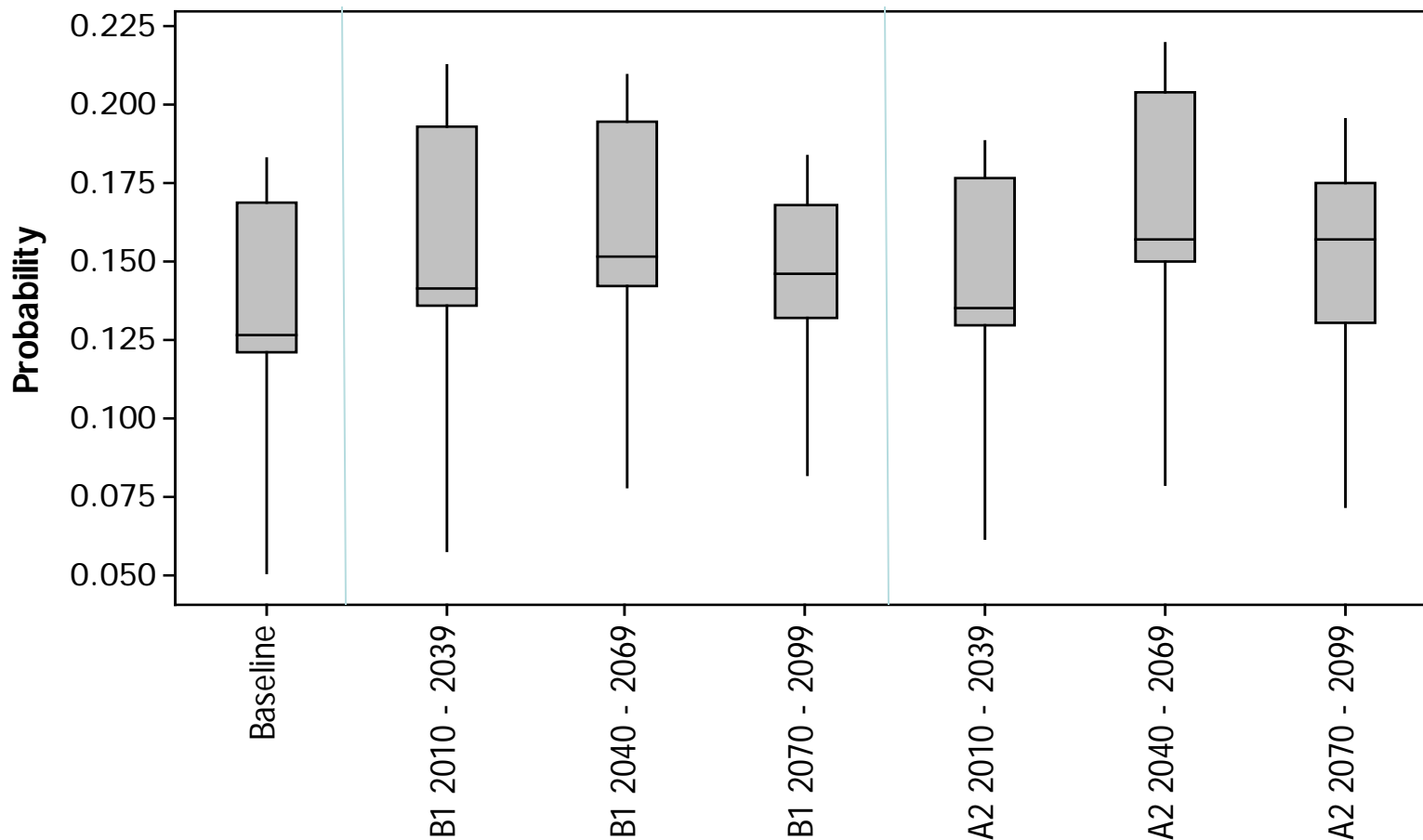# Summer Temperature Distribution

Summer Temperature Distribution

Alameda County's Summertime Temperatures will feel like...

Another graphic/summary that did not really work

Probability of one or more fires in a 30-year period in the county.

Fire Risk - Present

Baseline (1971 - 2000)

Probability of one or more fires over 30-year period

< 5% 10% 15% 20% 25% 30% 35% 40% 45% >45%

Sonoma Napa Marin San Francisco Contra Costa San Joaquin Tuolumne Alameda Stanislaus San Mateo Santa Clara Merced Santa Cruz
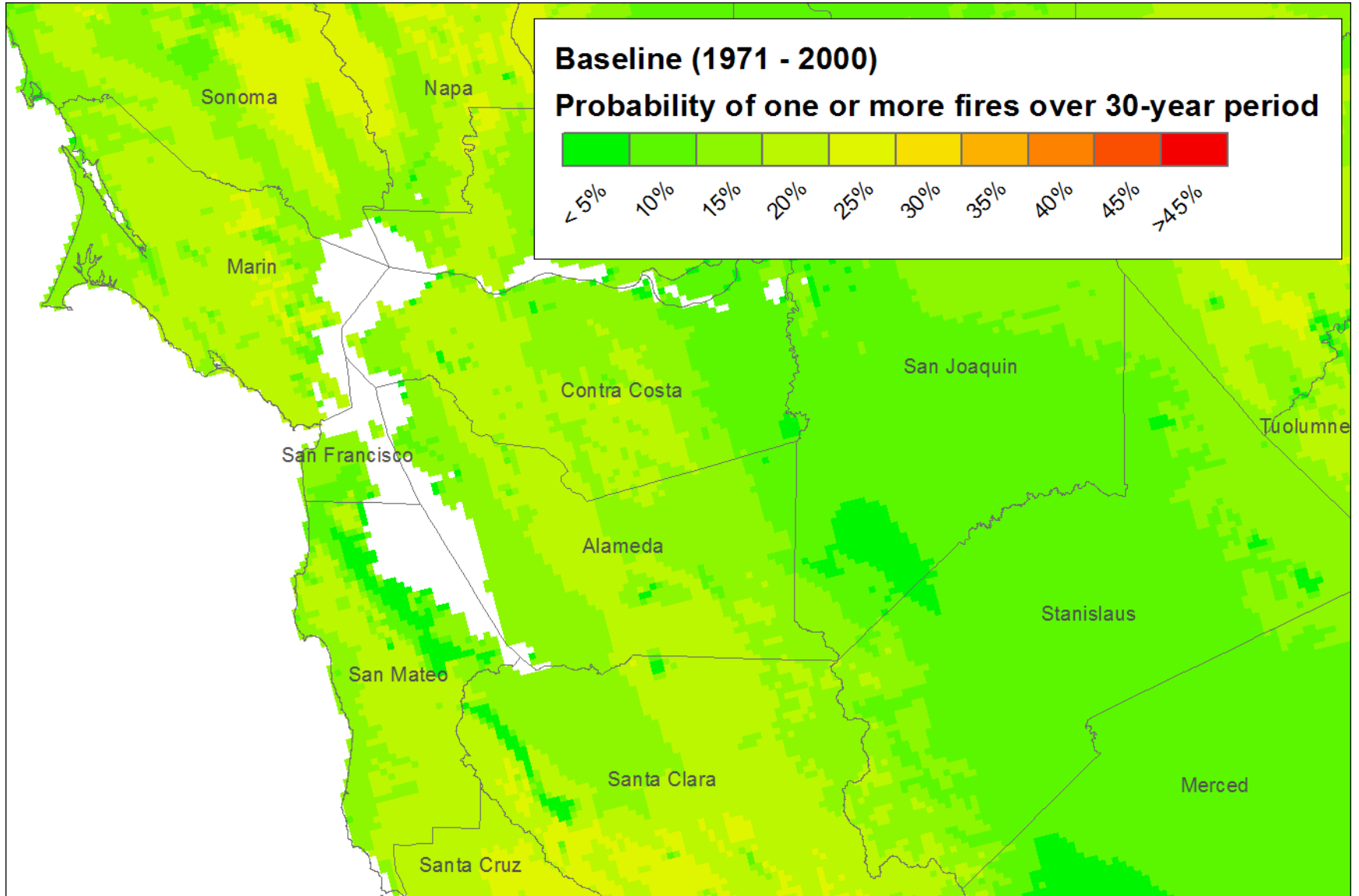
Fire Risk – Mid-Century

Fire Risk – End of Century

Future (2070 - 2099)

Probability of one or more fires over 30-year period

< 5% 10% 15% 20% 25% 30% 35% 40% 45% >45%
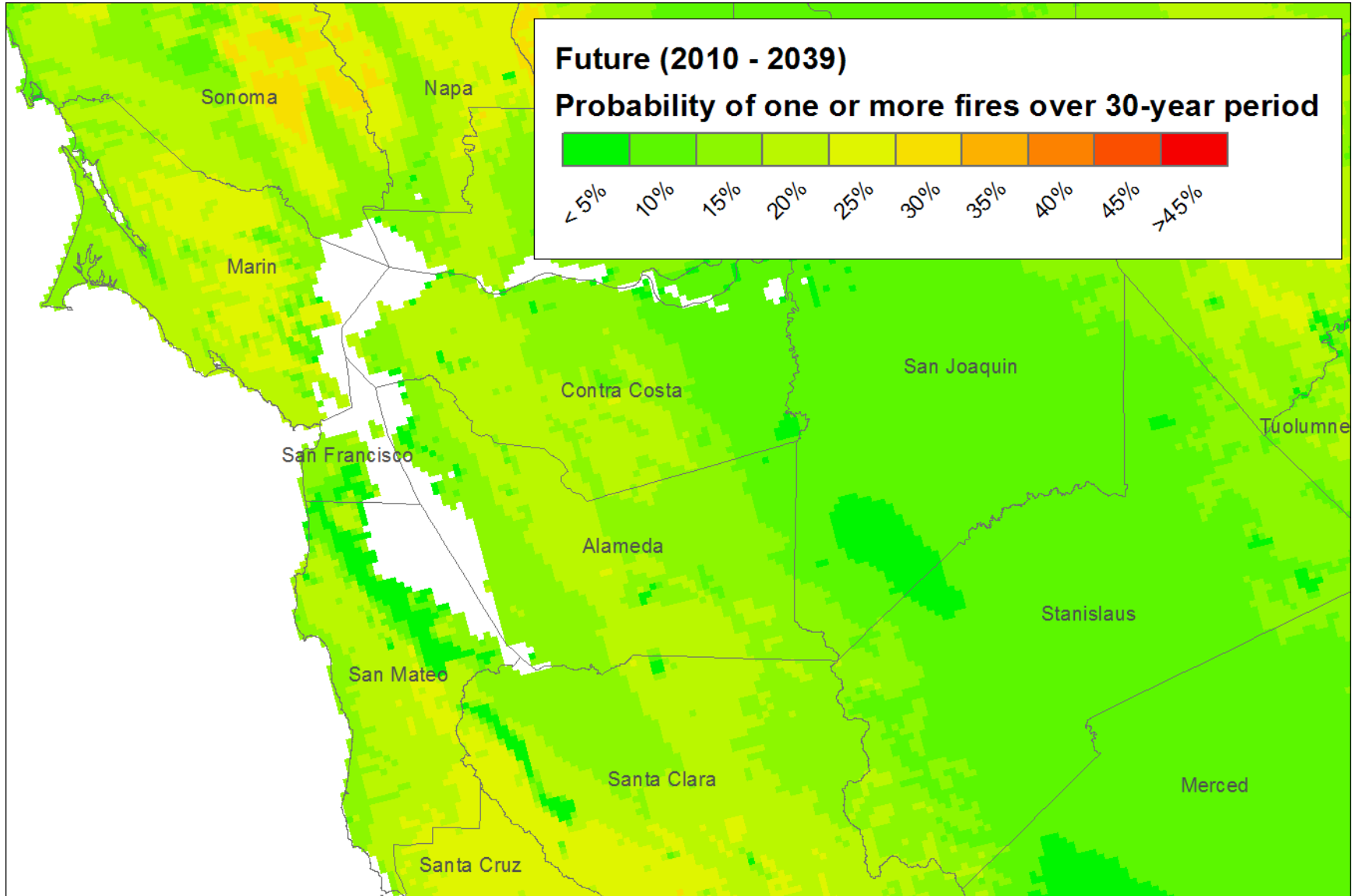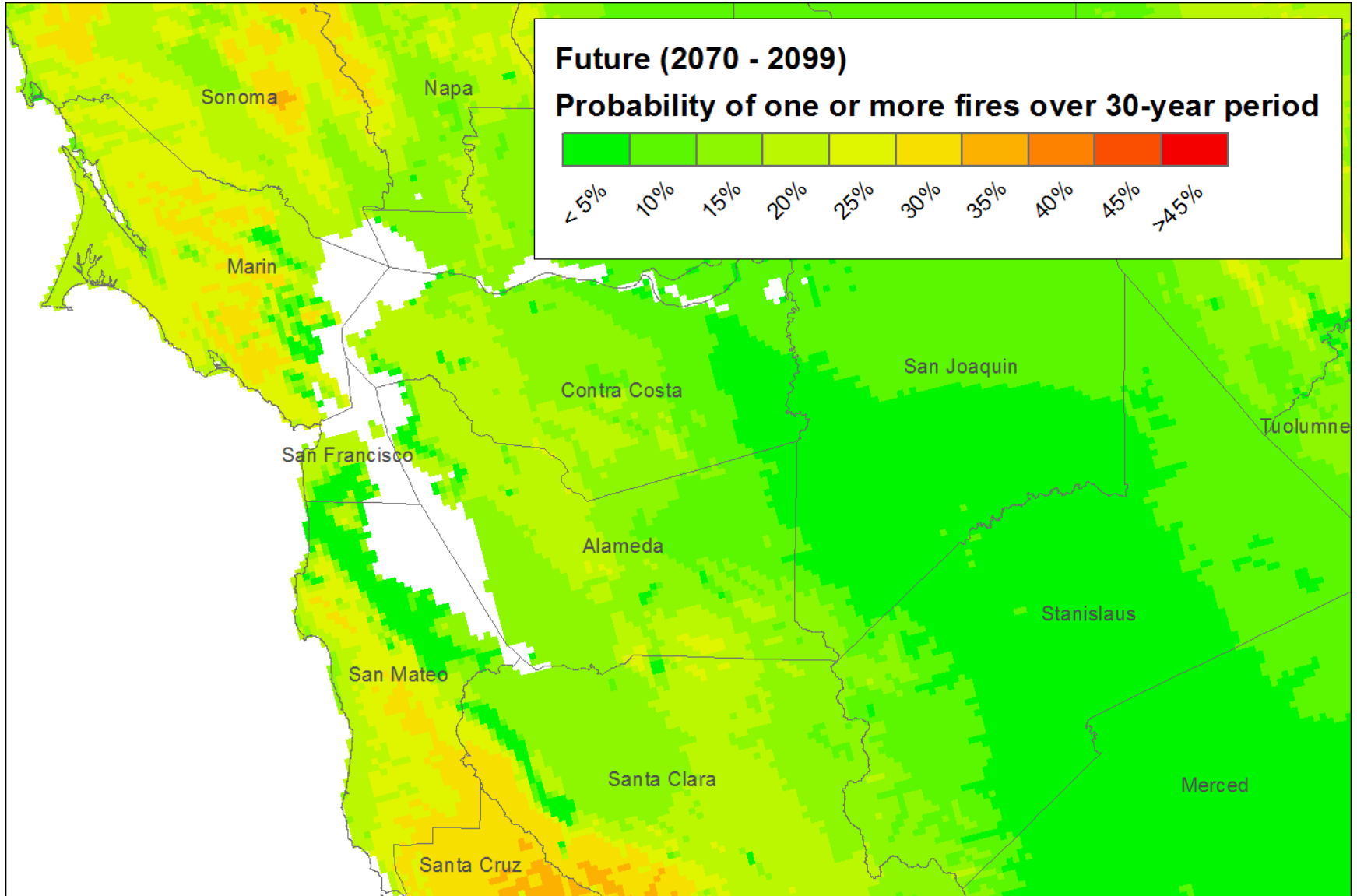
Change in Fire Risk: near term

Change in probability of one or more fires over 30-year period (2010 - 2039)

< 0%   5%   10%   15%   20%   25%
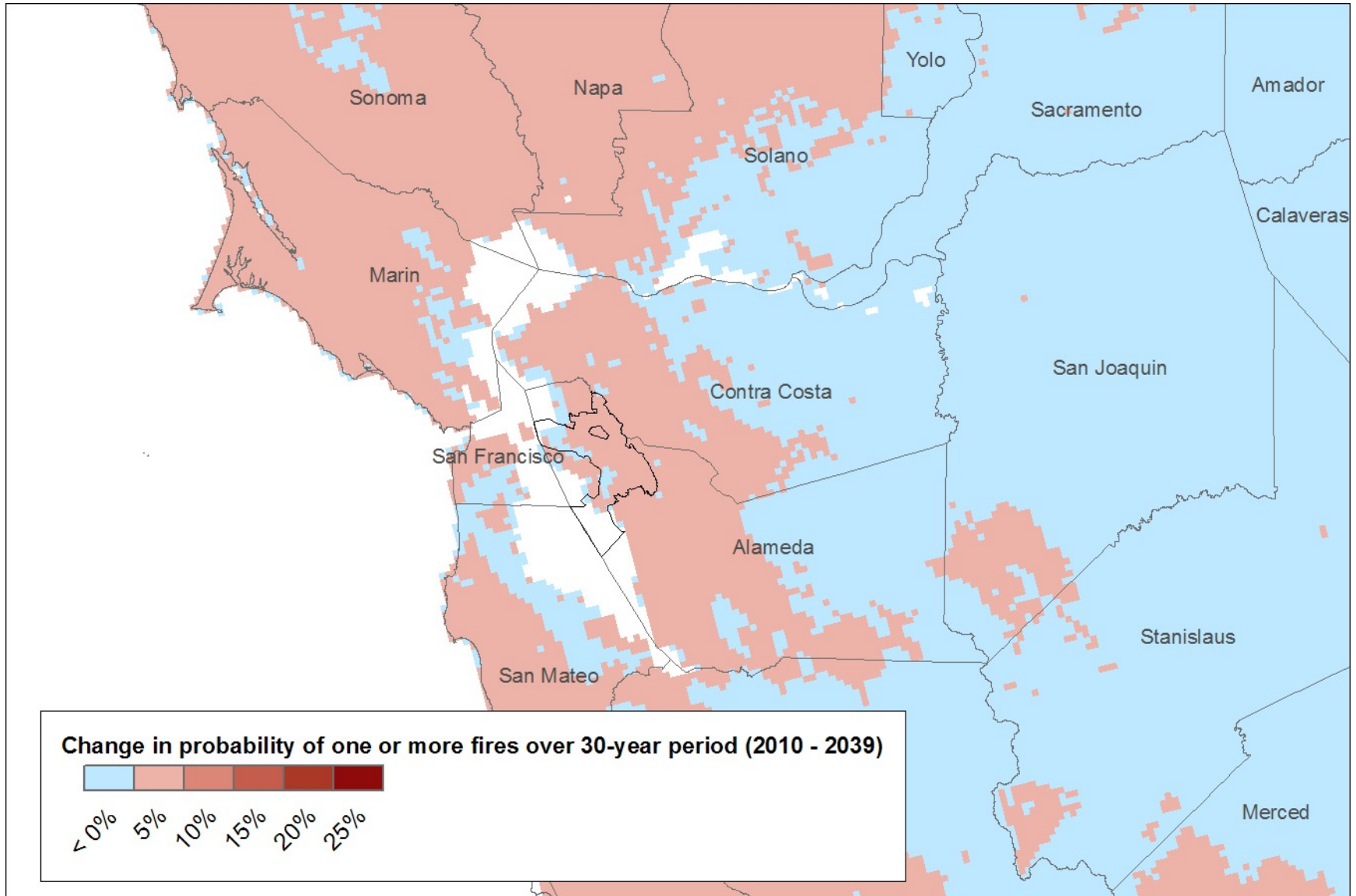
Change in fire risk: century's end

Change in probability of one or more fires over 30-year period (2010 - 2039)

< 0%   5%   10%   15%   20%   25%
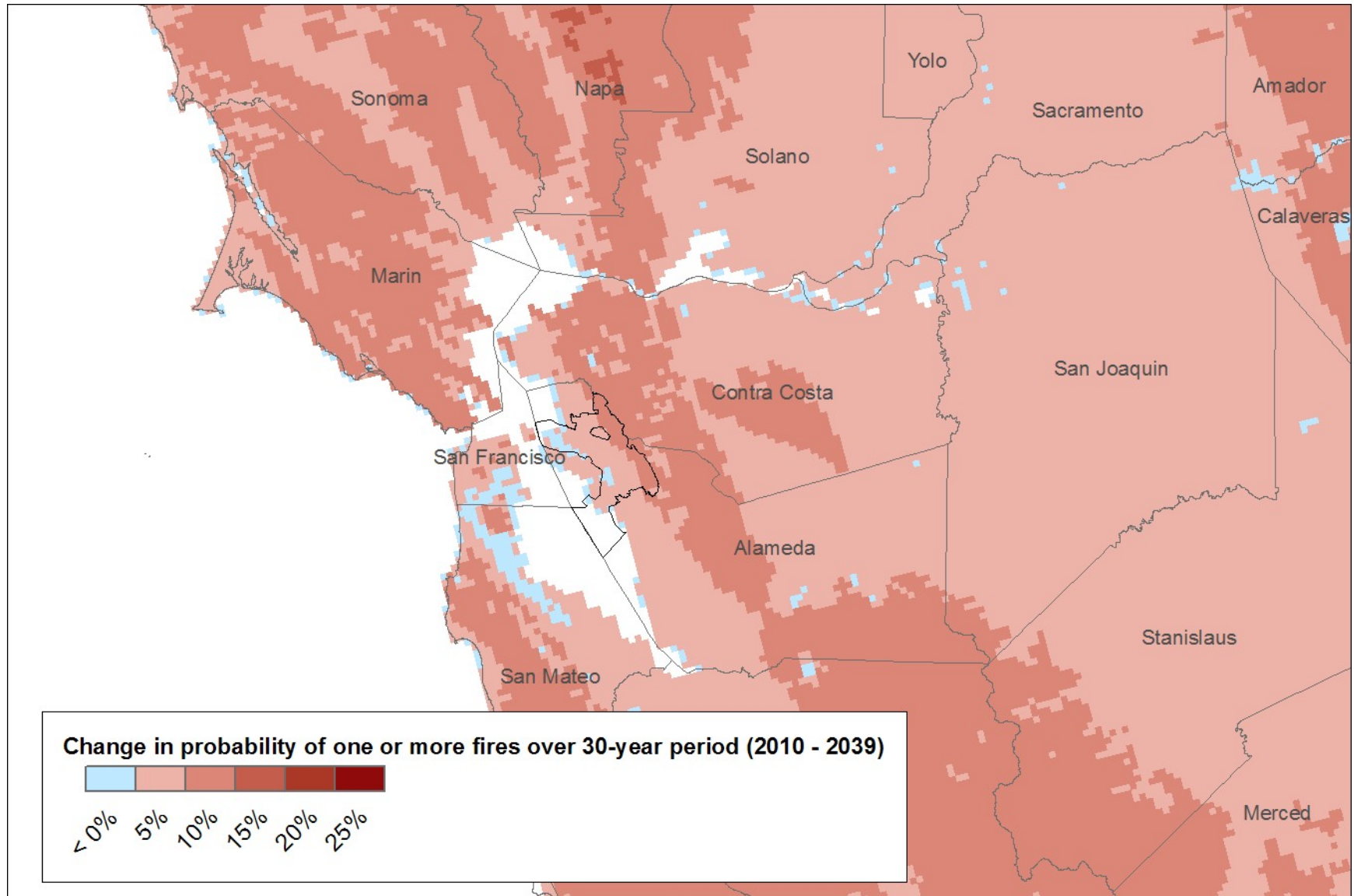
Changes to Air Quality

2000 - 2006

2047 - 2053
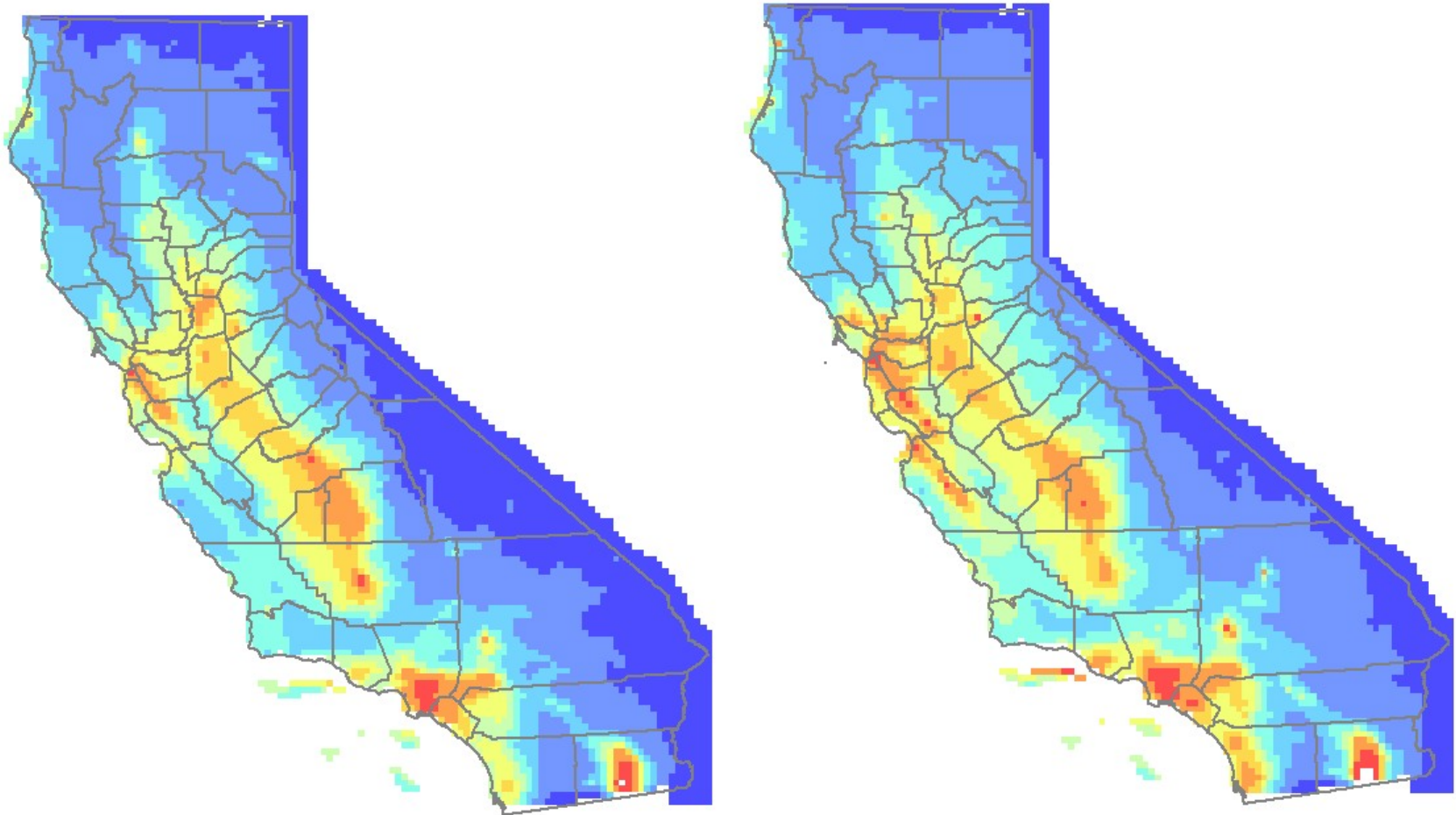
Average PM2.5 Concentration (µg/m³)

<1   2   3   4.5   6   8   10   15   25

Exposure to Airborne Particulates

2000 - 2006

2047 - 2053
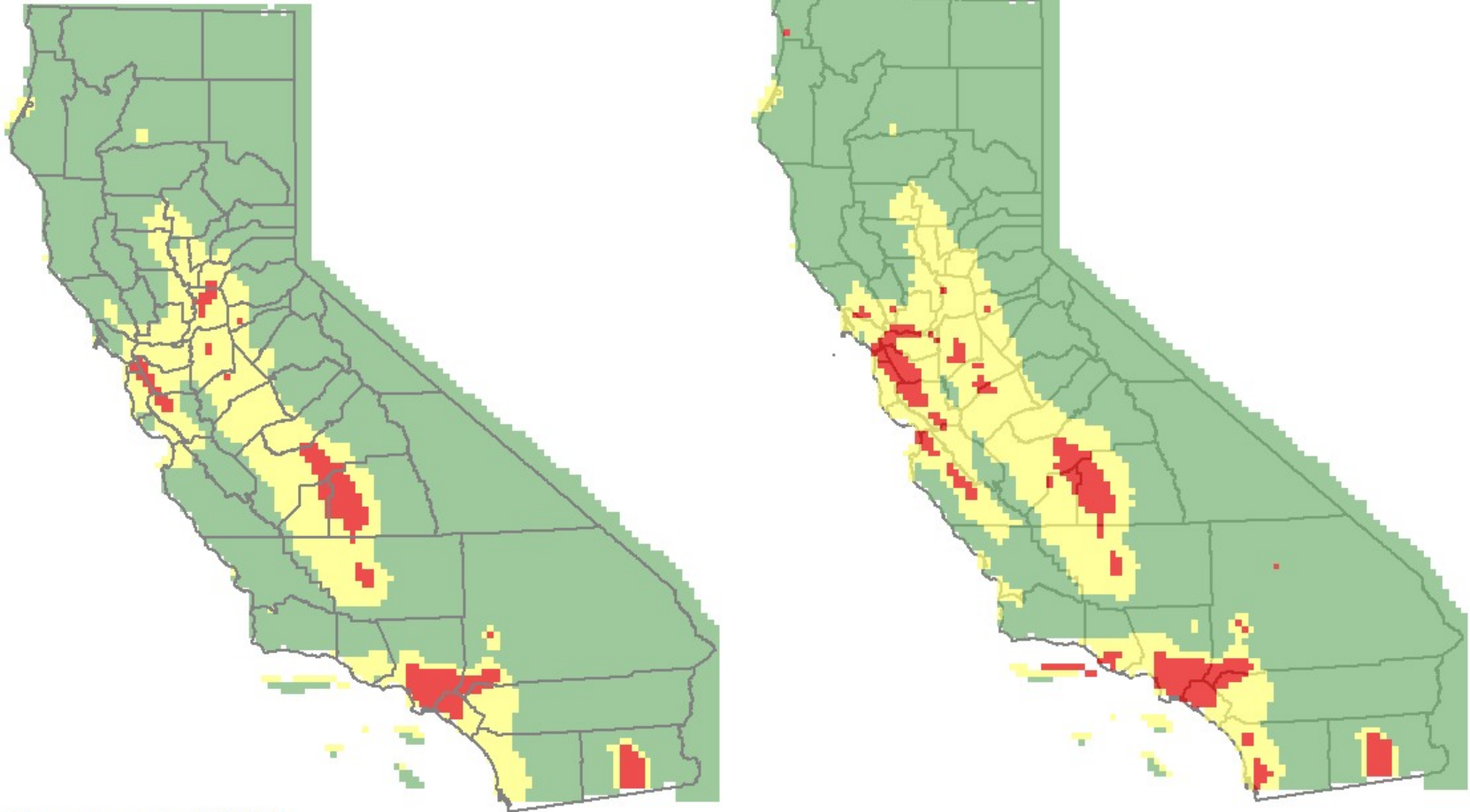
Exposure to PM2.5

Low (avg < 5 µg/m³)

Medium (5 - 10 µg/m³)

High (avg > 10 µg/m³)

Results will aid planning, point out areas for more detailed analysis
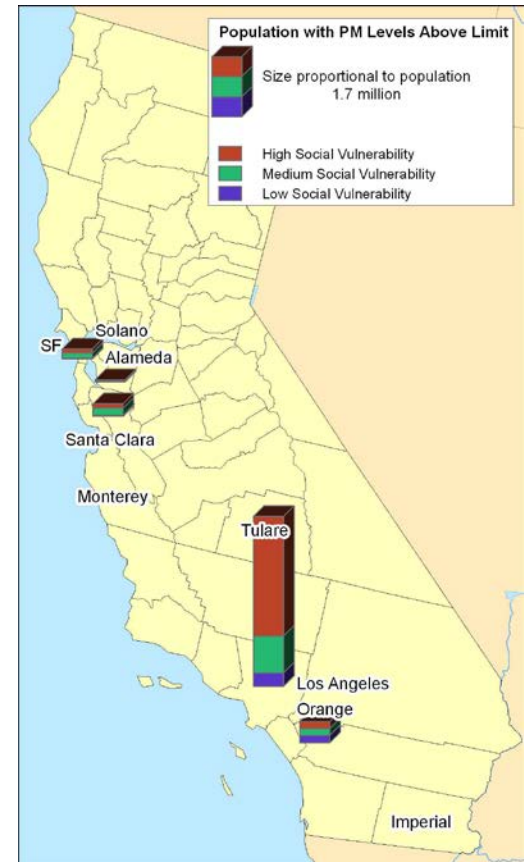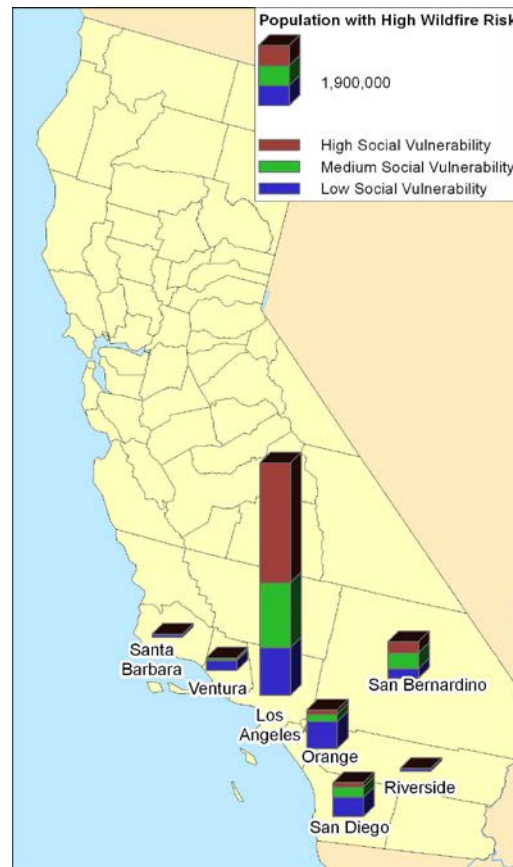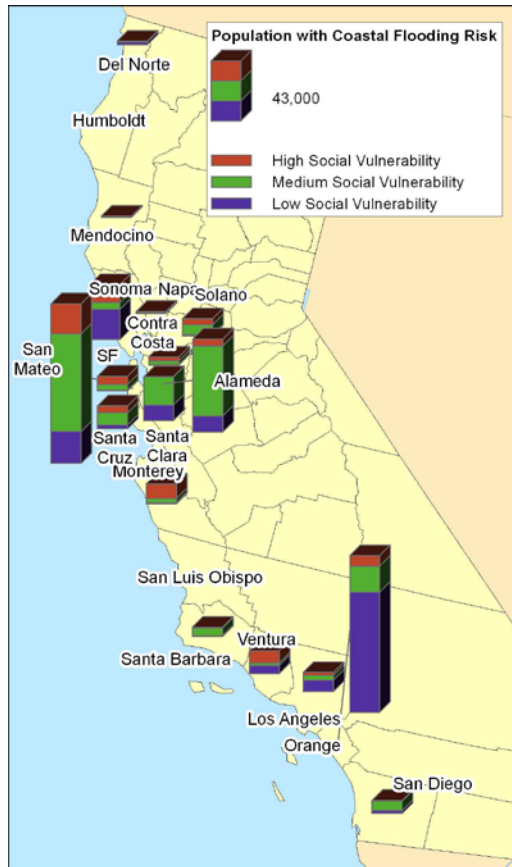
Conclusions

- California's climate impacts studies have produced a tremendous amount of **valuable science** and underscored the importance of climate change to the state.

- An ongoing challenge is to **translate** this information, to make it useful to local government and decision makers

- While it may not be their #1 priority, community organizations are interested in climate change and **want to know more**. They will not hesitate to tell you what works and what does not!

Pacific Institute

Some Lessons Learned in Promoting Adaptation Planning

- Maps make it real

- Lead with impacts to justify mitigation and guide adaptation

- Many people have experienced climate impacts, but by another name: asthma attacks, heat waves, …

- There are many "no regrets" actions: building community resilience and improving emergency response will help in other situations (earthquake, tsunami, flu pandemic…)

Pacific Institute

Resources for Assessing Exposure and Vulnerability in your Community

Pacific
Institute

Methods

- California Climate Adaptation Planning Guide: http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html

- Detailed description of data and methods for conducting a GIS-based analysis of exposure and vulnerability to sea level-rise induced flooding: Heberger, M. and E. Moore, 2012. *Adapting to Rising Tides: Vulnerability to Sea Level Rise in Select Communities in the San Francisco Bay Region.* San Francisco Bay Conservation and Development Commission. http://www.adaptingtorisingtides.org/wp-content/uploads/2012/09/AppendixD-SocioEconomic-Analysis-sm.pdf

- *Community-Based Climate Adaptation Planning: Case Study of Oakland, California.* CEC-500-2012-038. California Energy Commission, 2012. http://www.pacinst.org/reports/oakland_climate_adaptation/index.html (Of particular interest **is Appendix A: Summary of Adaptation Strategies**, which lists 50 adaptation strategies, including advantages, disadvantages, and how they can be implemented.)

Pacific Institute

Social Vulnerability

- SOVI Index mapped by **county** by the Hazards and Vulnerability Research Institute at the University of South Carolina. Data and maps available here: http://webra.cas.sc.edu/hvri/products/sovi.aspx

- SOVI calculated and mapped for **Census 2000 Block Groups**. Available for coastal states (including Great Lakes, Alaska, and Hawaii) http://www.csc.noaa.gov/digitalcoast/data/sovi

- Pacific Institute's 2012 modified California Social Vulnerability to Climate Change Impacts, calculated for all **Census 2000 Tracts in California**, data and maps available at: http://pacinst.org/reports/climate_vulnerability_ca/maps/

Pacific Institute

Extreme Heat

- Downscaled climate model simulations for California: data and maps available at:
  http://cal-adapt.org/tools/#temperature
  - (Decadal average temperatures, degrees of change, monthly averages charts)
  - "Extreme Heat Tool shows:
    Number of extreme heat days by year
    Number of heat waves by year, duration of heat waves

- Detailed data from the Pacific Institute's 2012 Study of Climate Vulnerability in California: GIS data downloads:
  http://pacinst.org/reports/climate_vulnerability_ca/data.html
  - Number of extreme heat days (above a local high-temperature threshold, or a value of 105°F)
  - Exceedances of an historical high-temperature threshold: (95th historical percentile of max temperatures based on daily temperature maximum data between 1961-1990.)

Pacific Institute

Coastal Flooding

- Online maps: http://cal-adapt.org/sealevel/
- More maps + GIS data downloads: http://www.pacinst.org/reports/sea_level_rise/
- San Francisco Bay: http://cascade.wr.usgs.gov/data/Task2b-SFBay/
- NOAA's Sea Level Rise and Coastal Flooding Impacts Viewer: http://www.csc.noaa.gov/digitalcoast/tools/slrviewer
- San Francisco Bay Conservation and Development Commission's Adapting to Rising Tides Project, maps and data for portions of the SF Bay shoreline only: http://www.adaptingtorisingtides.org/

Pacific Institute

Wildfires & Air Quality

Wildfires

- Maps of projections from a 2009 modeling study by Westerling et al. at UC Merced: http://cal-adapt.org/fire/

- Projections from a 2011 study by Krawchuk and Moritz at UC Berkeley), converted to shapefile format by the Pacific Institute. Gridded data showing the probability of one or more fires over a 30-year period for present day, mid-century, and end of century. http://pacinst.org/reports/climate_vulnerability_ca/data.html

Air Quality

- GIS layers showing current and projected annual average particulate matter (PM2.5) concentration. Data described in the 228-page report: Kleeman, M. J., S. Chen, and R. A. Harley. 2010. *Climate Change Impact on Air Quality in California*. Report to the California Air Resources Board. Sacramento, California. http://pacinst.org/reports/climate_vulnerability_ca/data.html

Pacific Institute