Climate Change & Health Vulnerability Indicators

Public Health Workgroup

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Climate Change and Health Vulnerability Indicators for California (CCHVIs)

ENVIRONMENTAL EXPOSURES

Magnitude, frequency, and duration of environmental or climate related factors that directly affect human health

POPULATION SENSITIVITY

Physiological and socio economic factors which directly or indirectly affect the degree to which a population is impacted by climate change

ADAPTIVE CAPACITY

Responses and adjustments to the impacts of climate change, including the capacity to moderate damages, take advantage of opportunities, and cope with consequences

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Climate Change and Health Vulnerability Indicators for California (CCHVIs)

Environmental Exposures:

- Heat
- Air Quality
- Drought
- Wildfires
- Sea Level Rise

Adaptive Capacity:

- Air Conditioning Ownership
- Tree Canopy
- Impervious Surfaces
- Public Transit Access

Population Sensitivity:

- Children and Elderly
- Poverty
- Education
- Race and Ethnicity
- Outdoor Workers
- Vehicle Ownership
- Linguistic Isolation
- Disability
- Health Insurance
- Violent Crime Rate

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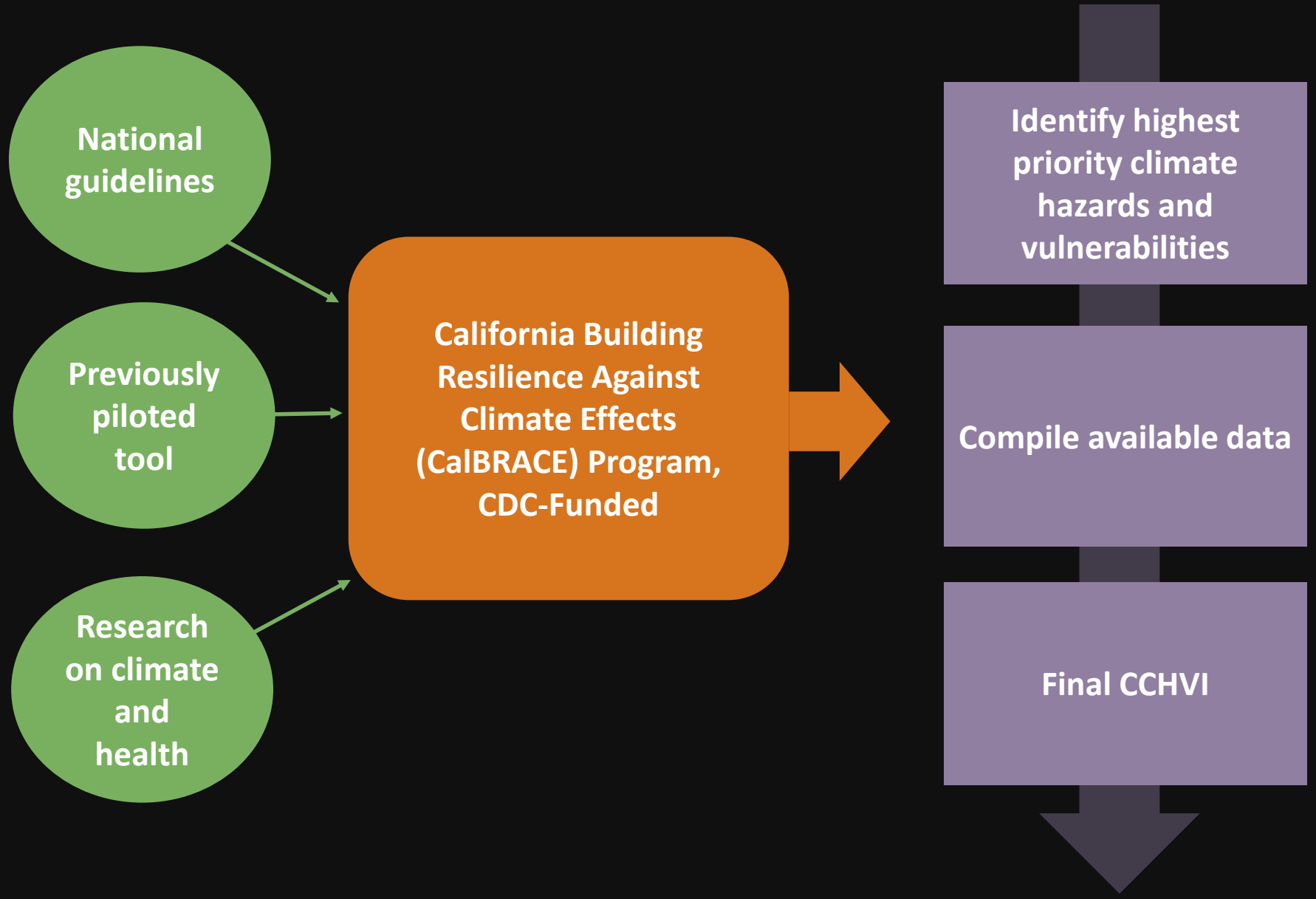
Development of the CCHVIs



Climate Change & Health Vulnerability Indicators

ENVIRONMENTAL EXPOSURES	Extreme Heat Days	Projected number of extreme heat days[1]
	Air Quality ($PM_{2.5}$)	Three-year annual mean concentration of particulate matter ($PM_{2.5}$)[3, 6]
	Air Quality (ozone)	Three-year ozone concentration exceedance above state standard[3, 6]
	Wildfires	Percent of population currently living in high risk fire hazard zone*[4, 6]
	Sea Level Rise (in coastal areas)	Percent of population living in 100-year flood zone and 55 inches of sea level rise*[2, 6]
POPULATION SENSITIVITY	Children	Percent of population aged less than 5 years[6]
	Elderly	Percent of population aged 65 years or older[6]
	Poverty	Percent of population whose income in the past year was below poverty level*[7]
	Education	Percent of population aged ≥ 25 years with less than high school educational attainment*[7]
	Outdoor Workers	Percent of population employed and aged ≥ 16 years working outdoors*[7]
	Vehicle Ownership	Percent of occupied households with no vehicle ownership*[7]
	Linguistic Isolation	Percent of households with no one aged ≥ 14 years speaking English*[7]
	Physical Disability	Percent of population with physical disability (ambulatory disability)*[8]
	Mental Disability	Percent of population with mental disability (cognitive disability)*[8]
	Health Insurance	Percent of population without health insurance*[9]
	Violent Crime Rate	Number of violent crimes per 1,000 residents[10]
ADAPTIVE CAPACITY	Air Conditioning	Percent of households without air conditioning*[11, 6]
	Tree Canopy	Percent of area not covered by tree canopy*[12, 6]
	Impervious Surfaces	Percent of area covered by impervious surfaces*[12, 6]

**Indicator is weighted by population, which means the value of the indicator will be higher or lower depending on population density in the locality.*

Data Sources:

1: CalAdapt, Scripps Institute of Oceanography (projected 2050, 2090), accessed 12/2016
2: CalAdapt; Pacific Institute; U.S. Geological Survey (USGS) (projected 2100), accessed 12/2016
3. California Air Resources Board (2009-2011); CalEnviroScreen 2.0 (2009-2011) 4: California Department of Forestry and Fire (CAL FIRE) (2007)
6: U.S. Decennial Census by U.S. Census Bureau(2010)
7: American Community Survey (ACS) by U.S. Census Bureau(2006-2010)
8: American Community Survey (ACS) by U.S. Census Bureau, (2008-2012)
9: American Community Survey (ACS) by U.S. Census Bureau, (2009-2013, 2011-2013)
10: Uniform Crime Reports from U.S. Federal Bureau of Investigation (2013)
11: Residential Appliance Saturation Survey (RASS) (2009)
12: National Land Cover Database (NLCD) (2011)

http://bit.ly/calbrace

California Department of PublicHealth

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CALIFORNIA BUILDING RESILIENCE AGAINST CLIMATE EFFECTS (CALBRACE)

CalBRACE: Preparing for Climate Change in California - A Public Health Approach

Project Goals

The goals of the CalBRACE project are to enhance the California Department of Public Health's (CDPH) capability to plan for and reduce health risks associated with climate change. The program provides resources and technical assistance for the state and local public health departments to build climate adaptation capacity and enhance resilience at the local and regional levels. CalBRACE is funded by the Center for Disease Control (CDC) and joins 15 other states and two cities across the United States that are also conducting climate adaptation planning efforts from a public health perspective through the CDC Climate Ready States and Cities Initiative.

Why is CalBRACE needed?

Efforts are underway to identify and understand how climate change is affecting our health and to enhance preparedness and resilience to the specific threats and changes posed by climate change at the state and local level. Climate change threatens our health now and will continue to impact our way of life. We can already see some of these changes today in California, including increased temperatures, drought, extreme storms, wildfires, rising sea

https://www.cdph.ca.gov/Programs/OHE/Pages/CalBRACE.aspx#

https://bit.ly/calbrace

Air Quality (Ozone)	Three-year ozone concentration exceedance above state standard	ozone data (XLSX)	ozone narrative
Drought	Palmer Drought Severity Index for August 2014	drought data	drought narrative
Wildfires	Percent of population currently living in high fire risk hazard zone	wildfire data (XLSX)	wildfire narrative
Sea Level Rise	Percent of population living in 100-year flood zone and 55 inches of sea level rise	sea level rise data (XLSX)	sea level rise narrative

Population Sensitivity Domain

Sensitivity refers to the physiological and socio-economic factors which directly or indirectly affect the degree to which a population is impacted by climate-related changes.

Indicator Short Name	Indicator Definition	Excel Data	Narrative (PDFs)
Children	Percent of population aged less than 5 years	children data (XLSX)	children narrative
Elderly	Percent of population aged 65 years or older	elderly data (XLSX)	elderly narrative
Poverty	Percent of population whose income in the past year was below poverty level	poverty data (XLSX, 14.3MB)	poverty narrative
Education	Percent of population aged >=25 years with less than high school educational attainment	education data (XLSX, 8.2MB)	education narrative
Race and Ethnicity	Percent of population of color	race/ethnicity data (XLSX)	race/ethnicity narrative

Indicator Data
https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx

California Building Resilience Against Climate Effects (CalBRACE) Project

Short Title: Current drought risk
Full Title: Palmer Drought Severity Index

CalBRACE Domain: Environmental Exposures

Why is this important to health?

Increasing temperatures and changes in precipitation may lead to longer, more severe droughts. Even in non-drought conditions, increases in air temperature can lead to unusual and excessive drying of soil and vegetation, exacerbating drought conditions. Higher temperatures also cause earlier snowmelt and less snowpack.[1] By 2050 California is projected to have a loss of at least 25 percent of the Sierra snowpack, an important source of urban, agricultural, and environmental water.[2] The public health impacts of drought are many, including deterioration of the quality and quantity of drinking water and food, reduction of the air quality due to increased wildfires and dust storms, and diminished living conditions due to scarce energy, sanitation, and increased incidence in disease and illness.[1] Decreased water access can lead to less hand washing and other personal hygiene practices, which can increase the risk of infections.[3, 4] As water flow decreases due to shortages, the concentration of pollutants and contaminants in water may increase.[3] Drought decreases crop yields causing both food shortages and price increases to food and water.[4] Higher food prices can lead to food insecurity, obesity, and malnutrition in households with low income.[4, 5] The economic hardship associated with increased food prices and lack of adequate water for operations can cause psychological distress and other negative behavioral impacts.[1, 4] Those impacted most by the health impacts of drought may include the elderly, children, individuals of low socioeconomic status, rural communities, populations living in nursing homes, hospitalized patients, those who rely on electrical equipment to survive, farmers, and agricultural workers.[3-5]

Summary of Evidence for Climate and Health

Dust storms associated with drought conditions have been associated with increased incidence of San Joaquin Valley Fever, a fungal disease.[4] Climate change alters the range, biogeography, and growth of microbes and the vectors of food, water, and vector-borne illnesses.[1, 4] Changes in aquatic environments could increase harmful algal blooms and lead to increases in foodborne and waterborne illnesses.

Key References:

1. 2009 California Climate Adaptation Strategy: A Report to the Governor of the State of California in Response to Executive Order S-13-2008: California Natural Resources Agency; 2009.
2. Climate Change in California: California Department of Water Resources; 2007.
3. U.S. Environmental Protection Agency Centers for Disease Control and Prevention, National Oceanic and Atmospheric Agency, and American Water Works Association. When every drop counts: protecting public health during drought conditions— a guide for public health professionals. Atlanta, GA: U.S. Department of Health and Human Services; 2010.

4. Stanke C, Kerac M, Prudhomme C, et al. Health Effects of Drought: a Systematic Review of the Evidence. *PLOS Currents Disasters*. 2013; 1.
5. Friel S, Berry H, Dinh H, et al. The impact of drought on the association between food security and mental health in a nationally representative Australian sample. *BMC Public Health*. 2014; 14.

What is the indicator?

Detailed Definition

- Indicator (index) = Palmer Drought Severity Index
- Interpretation: Vulnerable communities will have higher level of current drought risk

Data Description and Methodology

- Data were downloaded from the WestWide Drought Tracker http://www.wrcc.dri.edu/wwdt/index.php .
  - Years available: monthly, 2014 data was downloaded
  - Geographies available: United States

Palmer Drought Severity Index (PDSI) uses temperature and precipitation data to determine the accumulated water excess or deficit; it considers water supply (precipitation), demand (evapotranspiration driven by temperature) and loss (runoff). Fixed soil characteristics are supplied independently by incorporating the available water holding capacity of the top 250 cm of the soil acquired from the State Soil Geographic Data Base. Values are referenced to the local climate so that PDSI in different climates can be more readily compared. Palmer Drought Severity Index (PDSI) raster data were obtained from the WestWide Drought Tracker project, University of Idaho Desert Research Institute, which utilizes data from the PRISM Climate Mapping Program, Oregon State University. PRISM (Parameter-elevation Regressions on Independent Slopes Model) is an analytical tool that uses point data, a digital elevation model, and other spatial data sets to generate fine scale (4-km, 2.5 arc-minutes) grid-based estimates of monthly precipitation and temperature from 1895-present. PRISM uses point measurements of climate data and a digital elevation model of terrain and is constantly updated to map climate in the most difficult situations, including high mountains, rain shadows, temperature inversions, coastal regions, and associated complex meso-scale climate processes. WestWide Drought Tracker project utilizes the AN81m and AN81d PRISM datasets (*http://www.prism.oregonstate.edu/*).

Limitations

Only monthly estimates of regionally calibrated PDSI values are available. August 2014 was chosen to provide the best time window snapshot to account for interannual variability as it both accounts for the precipitation that fell in the previous winter season and the impacts of warming in the spring and summer season. The August 2014 PDSI values only reflect the drought risk within August 2014 and areas of greatest impact may geographicaly vary across drought events. PDSI values may lag emerging droughts by several months are are well suited for mountainous land or areas of frequent climatic extremes. PDSI values have an unspecified built-in time scale that can be misleading. Snow and its effects are not represented in this analysis. (http://drought.unl.edu/Planning/Monitoring/ComparisonofIndicesIntro/PDSI.aspx)

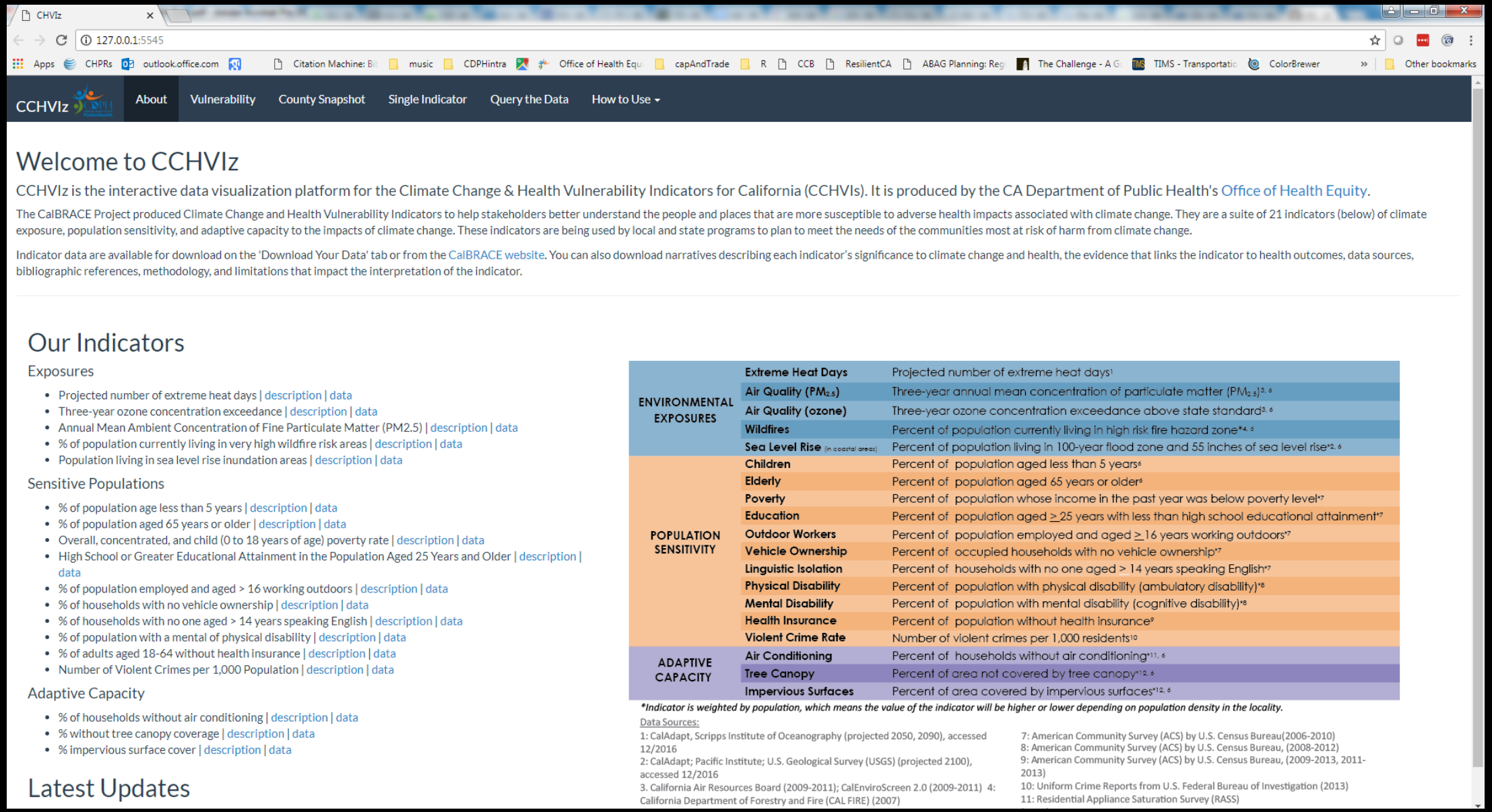
Indicator Narratives
https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx

CalBRACE - 2017 Climate Change and Health Profile Reports

The Climate Change and Health Profile Reports are designed to help counties in California prepare for the health impacts related to climate change through adaptation planning. The reports present projections for county and regional climate impacts, the climate-related health risks, and local populations that could be vulnerable to climate effects. The information is based on available science compiled from previously published, state-sponsored research and plans. We invite local public health agencies in California and their partners to use these reports to inform their efforts to address climate change and public health in their unique counties and regions.

These reports were developed by the California Department of Public Health – Office of Health Equity's CalBRACE Project with funding from Cooperative Agreement 5UE1EH001052 with the Federal Centers for Disease Control and Prevention(CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the CDC or the US Department of Health and Human Services.

County Health Profile Reports
https://www.cdph.ca.gov/Programs/OHE/Pages/ClimateHealthProfileReports.aspx



CCHVIz - https://discovery.cdph.ca.gov/ohe/CCHVIz/

Vulnerability

CHVIz

https://vargo.shinyapps.io/chiviz/

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Vulnerability

Visualize California Counties based on levels of both an exposure variable and a population sensitivity variable.

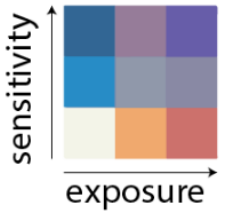
The plot illustrates the intersection of hazard (from an aspect of climate change) and sensitivity (from circumstances of the population or place that tend to increase susceptibility to the hazards of climate change). Counties are assigned to the bottom (least), middle, or top (most) third for both exposure and sensitivity. The most vulnerable counties appear in top and right-most portions of the figure. Points are sized according to the population living in that county. Hover over points for the county name, population, and indicator values.

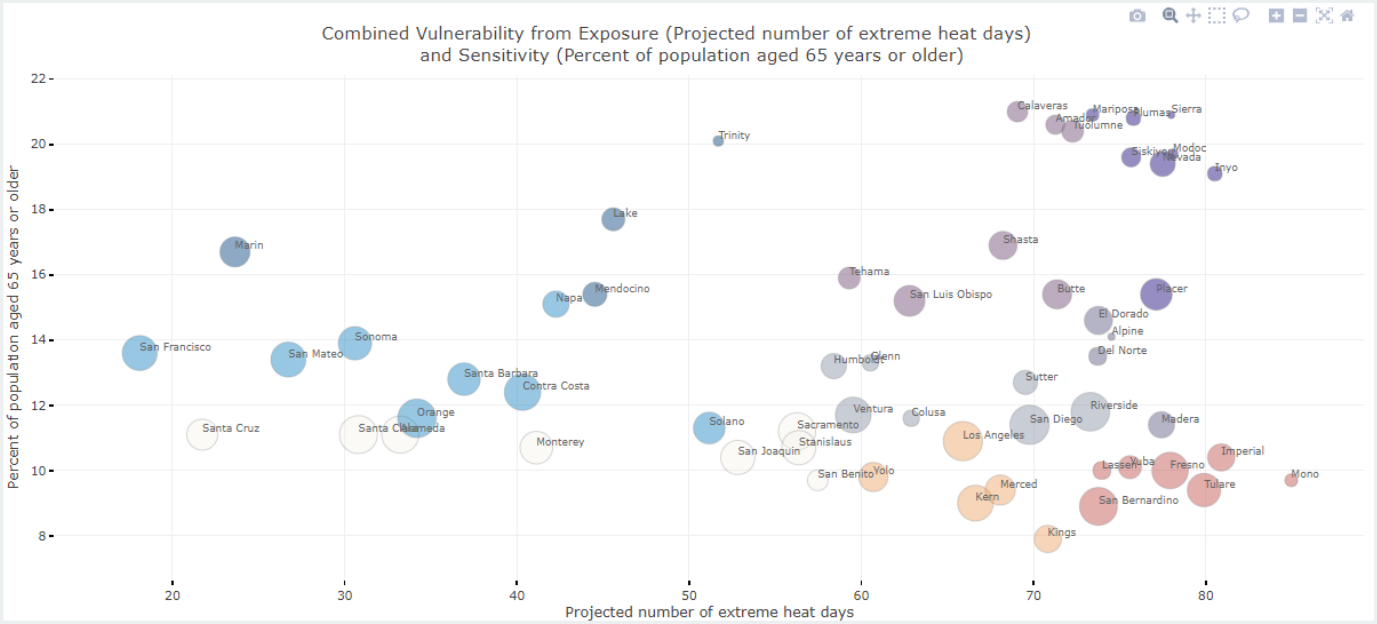
Some examples of important combinations to consider are

- Heat + elderly / outdoor workers / health insurance / air conditioning / tree canopy / impervious surfaces
- Ozone + children
- PM2.5 + children
- Wildfire + elderly / disability

Exposure Indicator: Projected number of extreme heat days

Sensitivity Indicator: Percent of population aged 65 years or older





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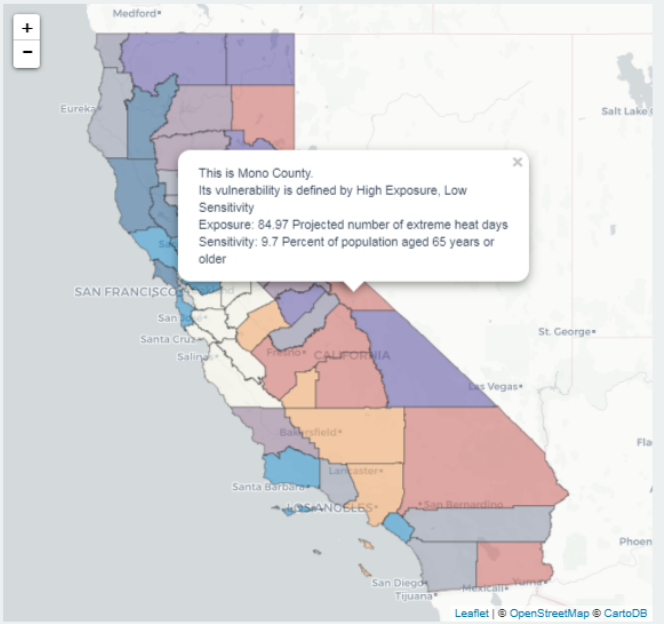

Download the data in this Map

County Snapshot

CHVIz

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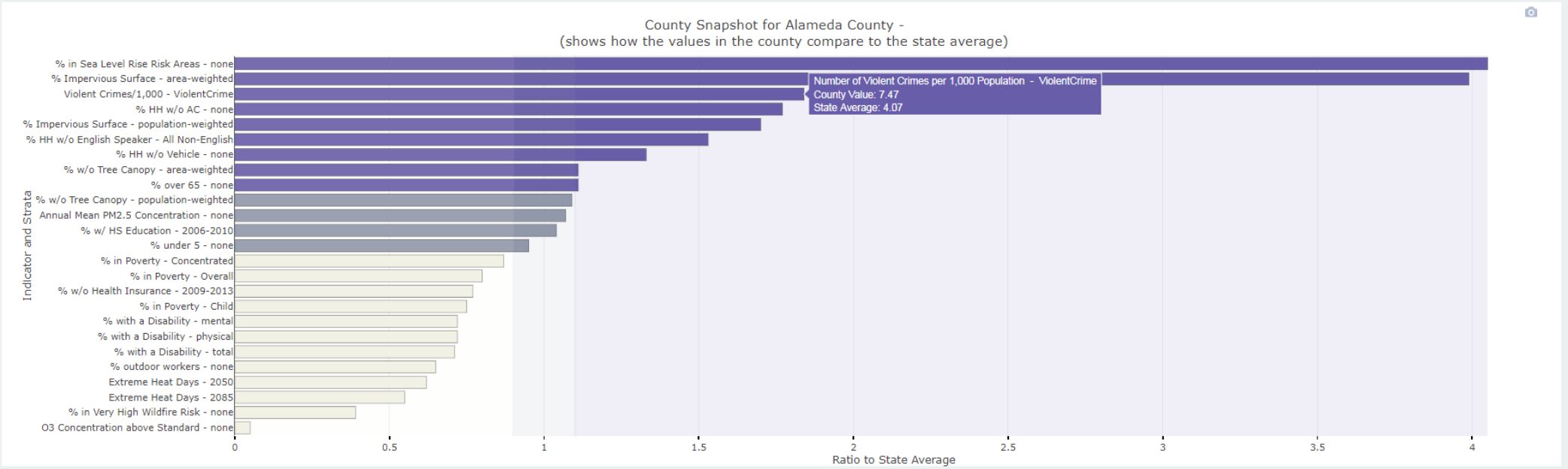
County Snapshot

This plot shows how the selected county compares to the state average for each indicator.

Using a simple ratio of the county's value to the California average value for each indicator, you can see where this particular county experiences greater climate and health risks than other parts of the state. You can also identify which factors represent areas to focus adaptation efforts and which represent areas of strength.

Select a County: Alameda

Download County Health Profile



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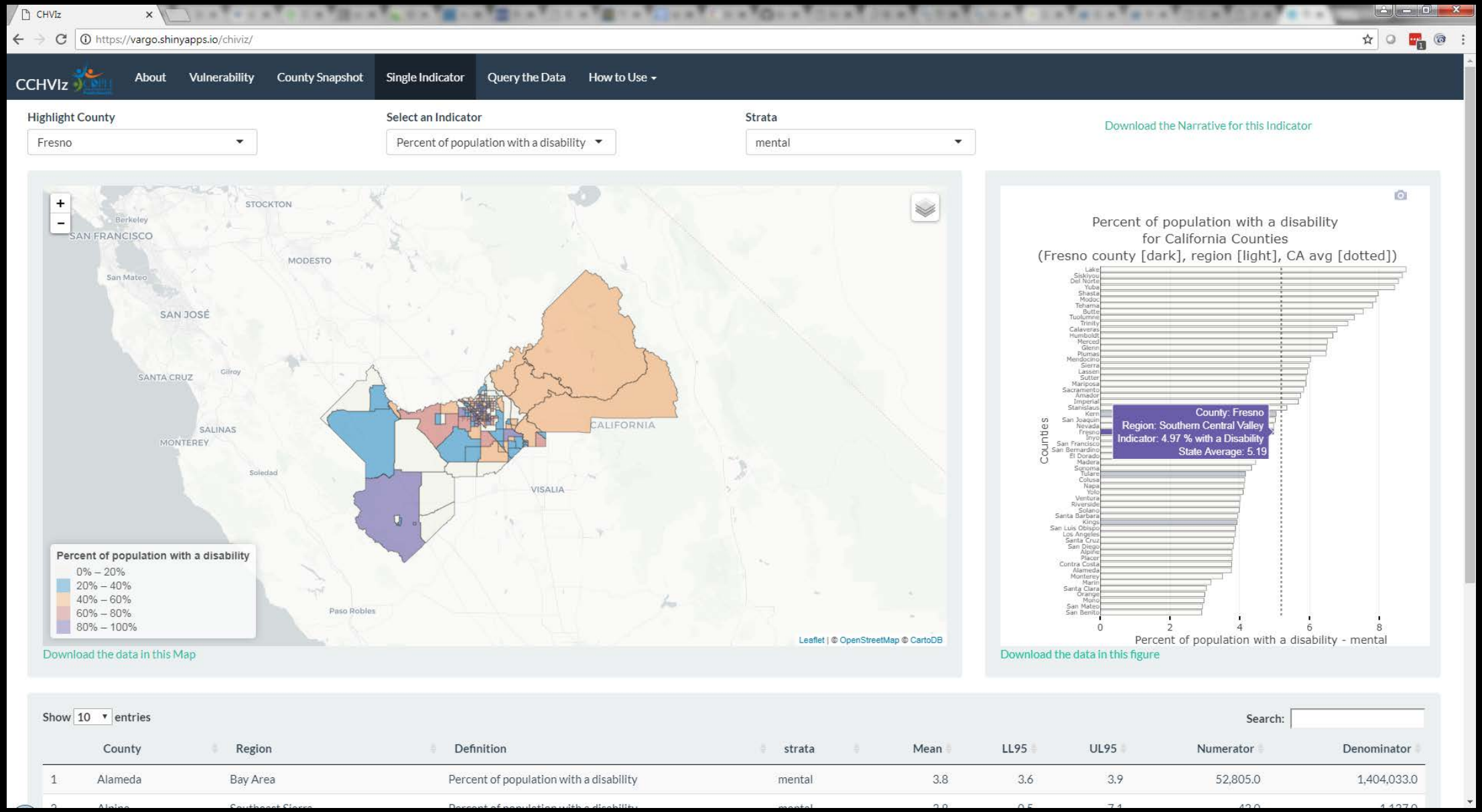
	County	Region	Indicator	Strata	Value	CA_avg	Category
1	Alameda	Bay Area	Percent of households without air conditioning	none	64.3	36.4	above CA average
2	Alameda	Bay Area	Percent without tree canopy coverage	area-weighted	83.4	74.9	above CA average
3	Alameda	Bay Area	Percent without tree canopy coverage	population-weighted	91.5	84.1	around CA average

Single Indicator Data



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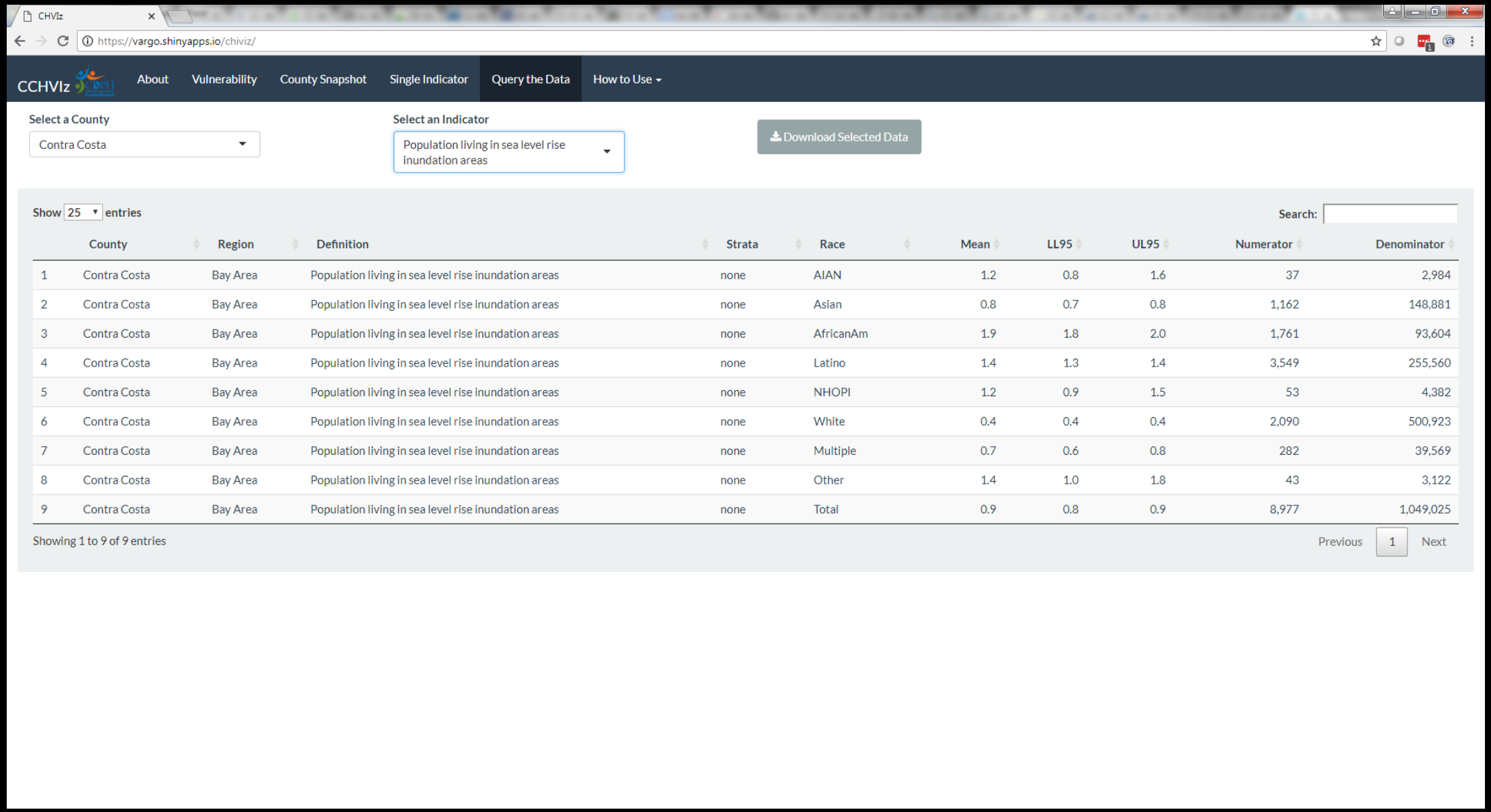

	County	Region	Definition	Strata	Race	Mean	LL95	UL95	Numerator	Denominator
1	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	AIAN	1.2	0.8	1.6	37	2,984
2	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	Asian	0.8	0.7	0.8	1,162	148,881
3	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	AfricanAm	1.9	1.8	2.0	1,761	93,604
4	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	Latino	1.4	1.3	1.4	3,549	255,560
5	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	NHOPI	1.2	0.9	1.5	53	4,382
6	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	White	0.4	0.4	0.4	2,090	500,923
7	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	Multiple	0.7	0.6	0.8	282	39,569
8	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	Other	1.4	1.0	1.8	43	3,122
9	Contra Costa	Bay Area	Population living in sea level rise inundation areas	none	Total	0.9	0.8	0.9	8,977	1,049,025

CCHVIz

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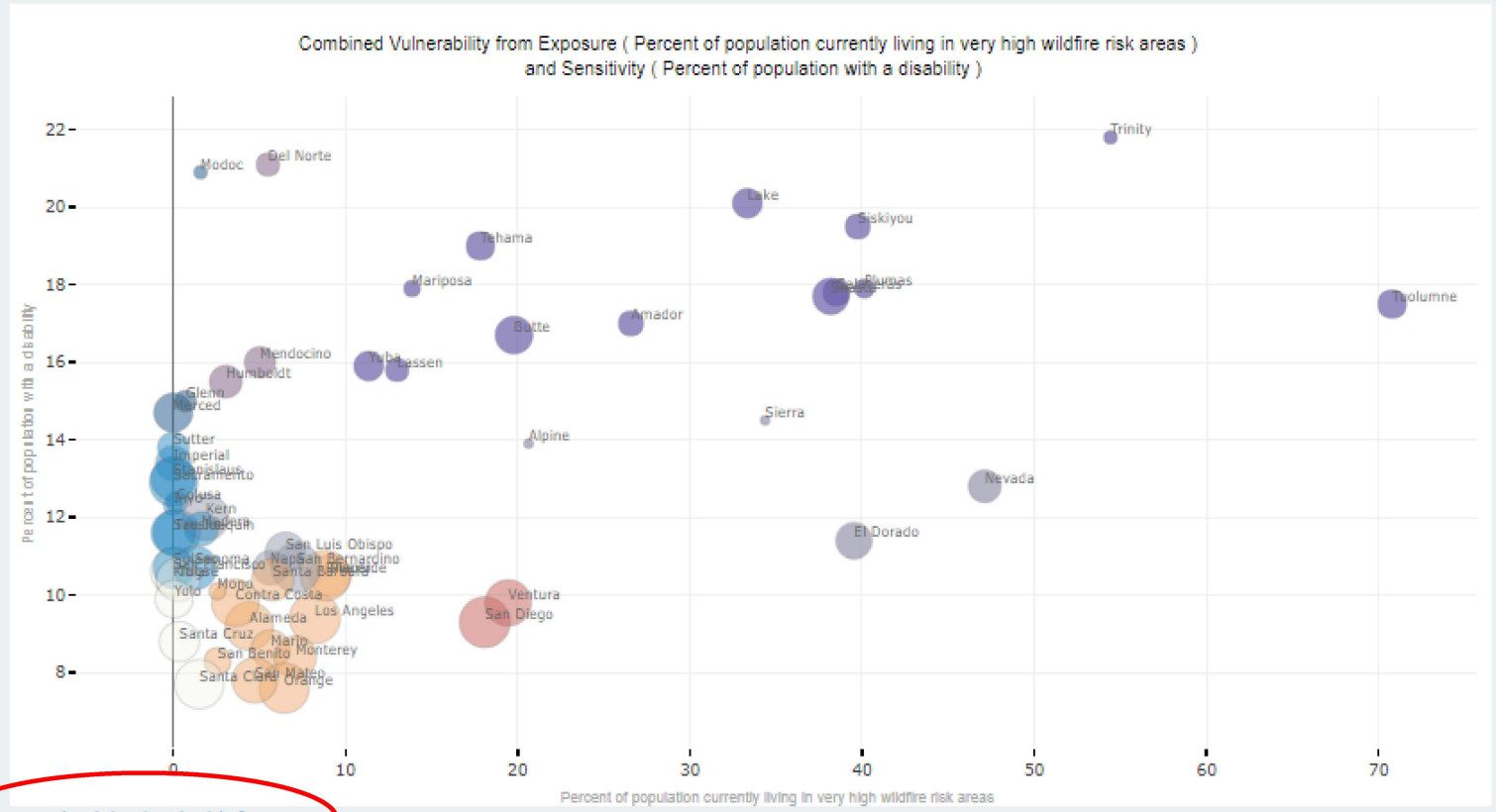
- PM2.5 + children
- Wildfire + elderly / disability



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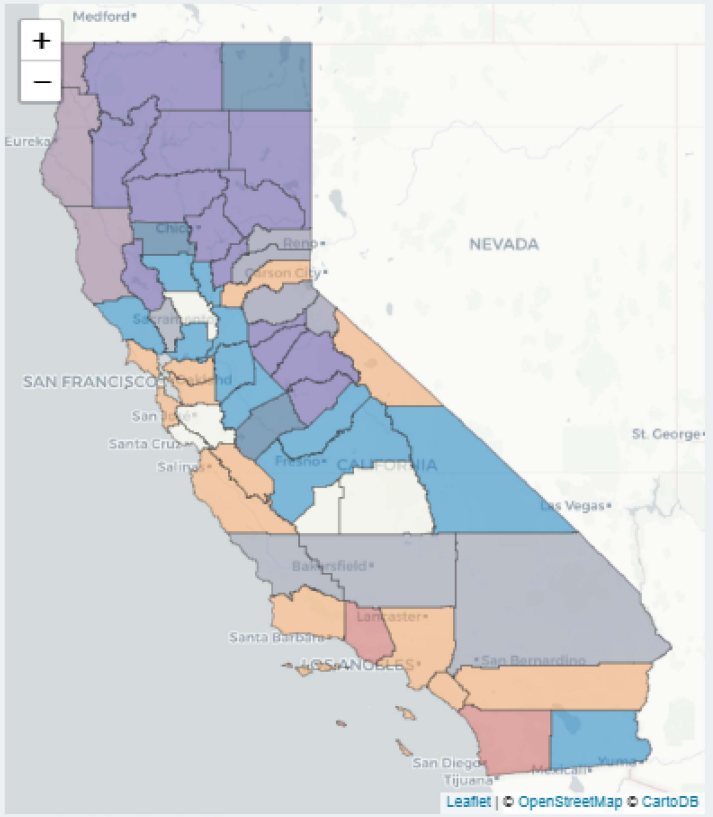

Download the data in this Map

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