Climate Change &
Health Vulnerability Indicators

Public Health Workgroup
February 4, 2019

Jason Vargo
Scientist
Climate Change & Health Equity Program
Jason.Vargo@cdph.ca.gov
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
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
Development of the CCHVIs

- National guidelines
- Previously piloted tool
- Research on climate and health

California Building Resilience Against Climate Effects (CalBRACE) Program, CDC-Funded

Identify highest priority climate hazards and vulnerabilities

Compile available data

Final CCHVI
<table>
<thead>
<tr>
<th><strong>ENVIRONMENTAL EXPOSURES</strong></th>
<th><strong>POPULATION SENSITIVITY</strong></th>
<th><strong>ADAPTIVE CAPACITY</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Heat Days</td>
<td>Projected number of extreme heat days&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Air Conditioning</td>
</tr>
<tr>
<td>Air Quality (PM&lt;sub&gt;2.5&lt;/sub&gt;)</td>
<td>Three-year annual mean concentration of particulate matter (PM&lt;sub&gt;2.5&lt;/sub&gt;)&lt;sup&gt;2, 6&lt;/sup&gt;</td>
<td>Tree Canopy</td>
</tr>
<tr>
<td>Air Quality (ozone)</td>
<td>Three-year ozone concentration exceedance above state standard&lt;sup&gt;3, 6&lt;/sup&gt;</td>
<td>Impervious Surfaces</td>
</tr>
<tr>
<td>Wildfires</td>
<td>Percent of population currently living in high risk fire hazard zone&lt;sup&gt;4, 6&lt;/sup&gt;</td>
<td>Wildfires</td>
</tr>
<tr>
<td>Sea Level Rise</td>
<td>Percent of population currently living in high risk fire hazard zone&lt;sup&gt;4, 6&lt;/sup&gt;</td>
<td>Vehicle Ownership</td>
</tr>
</tbody>
</table>

*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)
5: U.S. Decennial Census by U.S. Census Bureau(2010)
8: American Community Survey (ACS) by U.S. Census Bureau, (2008-2012)
11: Residential Appliance Saturation Survey (RASS) (2009)
12: National Land Cover Database (NLCD) (2011)

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
### 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.

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

**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 risk important to health?

Increasing temperatures and changes in precipitation may lead to longer, more severe droughts. Droughts 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 snowmelt and less snowpack. 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. 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. Decreased water access can lead to less hand washing and other personal hygiene practices, which can increase the risk of infections. As water flow decreases due to droughts, the concentration of pollutants and contaminants in water may increase. Drought decreases crop yields causing both food shortages and price increases to food and water. Higher food prices can lead to food insecurity, obesity, and malnutrition in households with low income. The economic hardship associated with increased food prices and lack of adequate water for operations can cause psychological distress and other negative behavioral impacts. These impacted 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, tenants, and agricultural workers.

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 lung disease. Climate change alters the range, biogeography, and growth of vectors and the vectors of food, water, and vector-borne illnesses. Changes in aquatic environments could increase harmful algal blooms and lead to increases in foodborne and waterborne illnesses.

Key References:
2. Climate Change in California: Summary of Recent Research. 2007.

Indicator Narratives
https://www.cdph.ca.gov/Programs/OHE/Pages/CC-Health-Vulnerability-Indicators.aspx
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
The CalBRACE Project produced Climate Change and Health Vulnerability Indicators to help stakeholders better understand the people and places that are more susceptible to adverse health impacts associated with climate change. They are a suite of 21 indicators (below) of climate exposure, population sensitivity, and adaptive capacity to the impacts of climate change. These indicators are being used by local and state programs to plan to meet the needs of the communities most at risk of harm from climate change.

Indicator data are available for download on the ‘Download Your Data’ tab or from the CalBRACE website. You can also download narratives describing each indicator’s significance to climate change and health, the evidence that links the indicator to health outcomes, data sources, bibliographic references, methodology, and limitations that impact the interpretation of the indicator.

**Our Indicators**

### Exposures
- Projected number of extreme heat days
- Three-year ozone concentration exceedance
- Annual Mean Ambient Concentration of Fine Particulate Matter (PM2.5)
- % of population currently living in very/ high wildfire risk areas
- Population living in sea level rise inundation areas

### Sensitive Populations
- % of population age less than 5 years
- % of population age 65 years or older
- % of population employed and aged 16-64 working outdoors
- % of households with no vehicle ownership
- % of households with no one aged 0-14 years speaking English
- % of population with a mental or physical disability
- % of adults aged 16-64 without health insurance
- Number of Violent Crimes per 1,000 Population

### Adaptive Capacity
- % of households without air conditioning
- Tree Canopy

**Data Sources:**
1. California Air Resources Board (2009-2011); CalEnviroScreen 2.0 (2009-2011)
2. California Department of Forestry and Fire Protection (CALS), accessed 12/2016
3. CALAdapt, Scripps Institution of Oceanography (projected 2050, 2090), accessed 12/2013
4. CSIM, Statewide Climate Model (projected 2090), accessed 12/2013
5. C. California Department of Public Health, Office of Health Promotion and Disease Prevention (2013)
7. American Community Survey (ACS) by U.S. Census Bureau, (2008-2012)
8. American Community Survey (ACS) by U.S. Census Bureau, (2009-2013)
11. Residential Appliance Saturation Survey (RASS)

**CCHViz** - https://discovery.cdph.ca.gov/ohe/CCHViz/
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/impermeable surfaces
- Ozone + children
- PM2.5 + children
- Wildfire + elderly/disability

Combined Vulnerability from Exposure (Projected number of extreme heat days) and Sensitivity (Percent of population aged 65 years or older)
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.

### Alameda County

#### Bay Area

- **Stata**
  - none

#### CA_avg Category

- **Value**
  - 74.9 above CA average
  - 36.4 above CA average
  - 43.4 above CA average

#### Download County Health Profile
Single Indicator Data

- **Highlighted County**: Fresno
- **Selected Indicator**: Percent of population with a disability
- **Strata**: Mental

Map showing the percent of population with a disability for California Counties. The map highlights the county with a focus on mental disability. The data table includes information on Counties, Regions, Definition, Strata, Mean, LL95, UL95, Numerator, and Denominator.
<table>
<thead>
<tr>
<th>County</th>
<th>Region</th>
<th>Definition</th>
<th>Strata</th>
<th>Race</th>
<th>Mean</th>
<th>LL95</th>
<th>UL95</th>
<th>Numerator</th>
<th>Denominator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>AIAN</td>
<td>1.2</td>
<td>0.8</td>
<td>1.6</td>
<td>37</td>
<td>2,984</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>Asian</td>
<td>0.8</td>
<td>0.7</td>
<td>0.8</td>
<td>1,162</td>
<td>148,881</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>AfricanAmerican</td>
<td>1.9</td>
<td>1.8</td>
<td>2.0</td>
<td>1,761</td>
<td>93,604</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>Latino</td>
<td>1.4</td>
<td>1.3</td>
<td>1.4</td>
<td>3,549</td>
<td>255,540</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>NHAPI</td>
<td>1.2</td>
<td>0.9</td>
<td>1.5</td>
<td>53</td>
<td>4,282</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>White</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>2,090</td>
<td>500,923</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>Multiple</td>
<td>0.7</td>
<td>0.6</td>
<td>0.8</td>
<td>282</td>
<td>29,569</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>Other</td>
<td>1.4</td>
<td>1.0</td>
<td>1.8</td>
<td>43</td>
<td>3,122</td>
</tr>
<tr>
<td>Contra Costa</td>
<td>Bay Area</td>
<td>Population living in sea level rise inundation areas</td>
<td>none</td>
<td>Total</td>
<td>0.9</td>
<td>0.8</td>
<td>0.9</td>
<td>8,977</td>
<td>1,049,025</td>
</tr>
</tbody>
</table>
Combined Vulnerability from Exposure (Percent of population currently living in very high wildfire risk areas) and Sensitivity (Percent of population with a disability)

Download the data in this figure
Climate Change & Health Vulnerability Indicators

Jason Vargo
Scientist
Climate Change & Health Equity Program
Jason.Vargo@cdph.ca.gov

Public Health Workgroup
February 4, 2019

Climate Change and Health Equity Program
California Department of Public Health