

California Building Resilience Against Climate Effects (CalBRACE) Project

Short Title: Tree canopy

Full Title: Percent of the land area not covered by tree canopy

CalBRACE Domain: Adaptive Capacity

Why is this important to health?

High temperatures and the risk of heat waves pose a serious public health concern. Increasing temperatures in urban areas can cause the urban heat island effect (a phenomenon in which urban areas are warmer than the surrounding non-urban areas). Urban greening, such as parks and trees, may have a local cooling effect through shade and evapotranspiration.¹ Green spaces have also been shown to lessen flood risk and increase community safety, while simultaneously promoting an active lifestyle.²⁻⁴ Unfortunately, the impacts of historical urban residential segregation and lack of tree planting may lead to some racial/ethnic minority communities having less tree canopy and higher potential risks to heat exposure.⁵ Communities of color have both higher heat-related morbidity and mortality and lower access to air conditioning. Heat-associated mortality is two times higher in African Americans compared to Whites, and 64 percent of this disparity is attributable to central air conditioning prevalence.⁶

Summary of Evidence for Climate and Health

A systematic review of evidence linking urban greening and the air temperature of urban areas has shown that green sites are generally cooler than non-green sites. Meta-analysis showed that parks, on average, were 0.94° C cooler in the day. Planting trees and vegetation properly near buildings can also save up to 25% of a household's energy consumption. Evidence links tree canopy coverage to positive health outcomes from reduced exposure to ultraviolet radiation, reduced urban heat islands, and mitigation of air pollution (i.e., decreased particulate matter which in turn reduces heart disease, respiratory illness, and lung cancer).¹ Tree canopy coverage creates environments that reduce stress and neighborhood violence.¹ Research has shown a positive effect from a natural, green environment on physical health, mental health, and longevity.²

Key References:

1. Martineau C. Public Health Benefits of Urban Trees. Palo Alto, CA: Canopy; 2011.
2. Tzoulas K, Korpela K, Venn S, et al. Promoting ecosystem and human health in urban areas using Green infrastructure: A literature review. *Landscape and Urban Planning*. 2007; 81: 167-178.
3. Stair P, Wooten H, Raimi M. How to Create and Implement Healthy General Plans: A Toolkit for Building Healthy, Vibrant Communities Through Land Use Policy Change. Oakland, CA: Public Health Law & Policy; 2012.
4. Wilby RL. A Review of Climate Change Impacts on the Built Environment. *Built Environment*. 2007; 33(1): 31-45.
5. Jesdale BM, Morello-Frosch R, Cushing L. The Racial/Ethnic Distribution of Heat Risk-Related Land Cover in Relation to Residential Segregation. *Environ Health Perspect*. 2013; 121: 811-817.
6. O'Neill MS, Zanobetti A, Schwartz J. Disparities by race in heat-related mortality in four US cities: the role of air conditioning prevalence. *Journal of Urban Health*. 2005; 2: 191-197.

What is the Indicator?

Detailed Definition

- Indicator (percent) = % Area without tree canopy coverage × (population or area weight)
- Stratification: 8 race/ethnicity strata (African American, American Indian/Native Alaskan, Asian, Latino, Multiple, Native Hawaiian and Other Pacific Islander, White, Total) and 2 weight strata (area-weighted and population-weighted)
- Interpretation: Climate resilient communities will have lower values of areas without tree canopy coverage

Data Source and Methodology

- [Tree canopy coverage data](http://www.mrlc.gov/nlcd11_data.php) from Multi-Resolution Land Characteristics Consortium, National Land Cover Database (NLCD) 2011 (http://www.mrlc.gov/nlcd11_data.php).
 - Years available: 2011 (2001 is available but is not comparable to 2011)
 - Geographies available: United States
- 2010 U.S. Census Blocks, [U.S. Census Bureau Redistricting File for California](http://www2.census.gov/census_2010/01-Redistricting_File--PL_94-171/California/) (http://www2.census.gov/census_2010/01-Redistricting_File--PL_94-171/California/).
 - Years available: 2010
 - Geographies available: census block, census tract, city, county, county division, region (derived), state

Percent tree canopy cover and its standard error were obtained for 30 x 30 meter grids for the State of California from the U.S. Forest Service Tree Canopy analytical file of the NLCD. The grids, represented as raster layers for geospatial software, were imported into ArcMap and the zonal statistics tool was used to calculate average tree canopy coverage by census block, excluding water areas. Population weighted averages (by race/ethnicity) and area weighted averages were obtained for census tracts, places, counties, county divisions, and regions. The average standard error for census blocks for all the pixel values was calculated using an approximate standard error formula. Weighted averages of the standard errors were obtained for tracts, places, counties, county division, and regions. The relative standard error, confidence interval, deciles, and relative risk were calculated. Regions in the HCI Project were based on counties of metropolitan transportation organizations as reported in the [2010 California Regional Progress Report](#) and regions in the CalBRACE project are based on county aggregations in the [Adaptation Planning Guide Understanding Regional Characteristics](#).

Limitations

The NLCD can underestimate (approximately 10% on average) tree canopy coverage at the local level. A small percentage of census blocks have areas smaller than raster grid areas which decreases the accuracy of the tree coverage area estimates. The impacts of specific greening interventions on the wider urban area, and attribution to greening alone, are difficult to determine due to uncontrolled confounding factors. Tree canopy can retain heat at night and tree species have been shown to vary in their ability to reduce air temperature.

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Examples of Maps, Figures, and Tables:

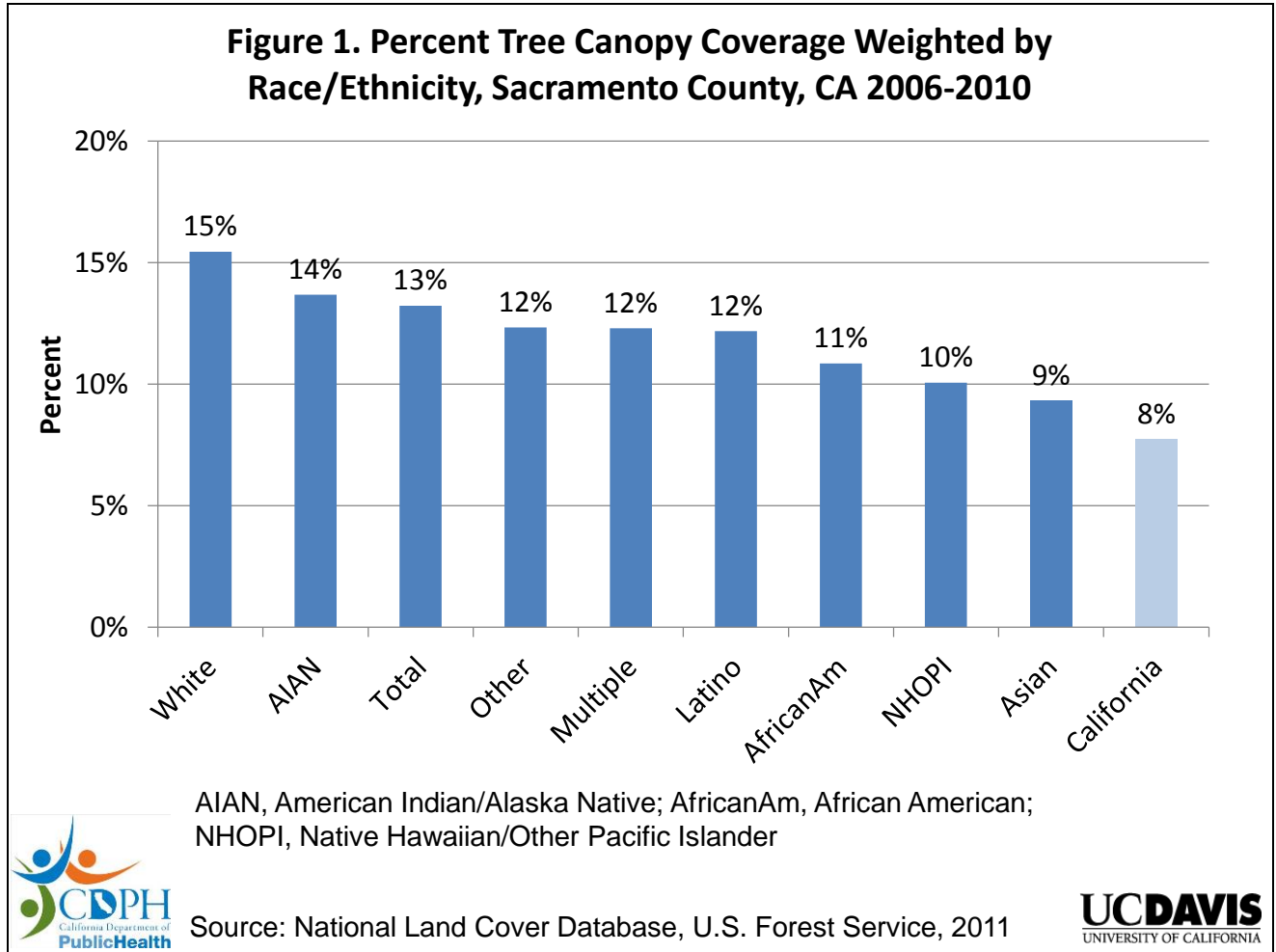
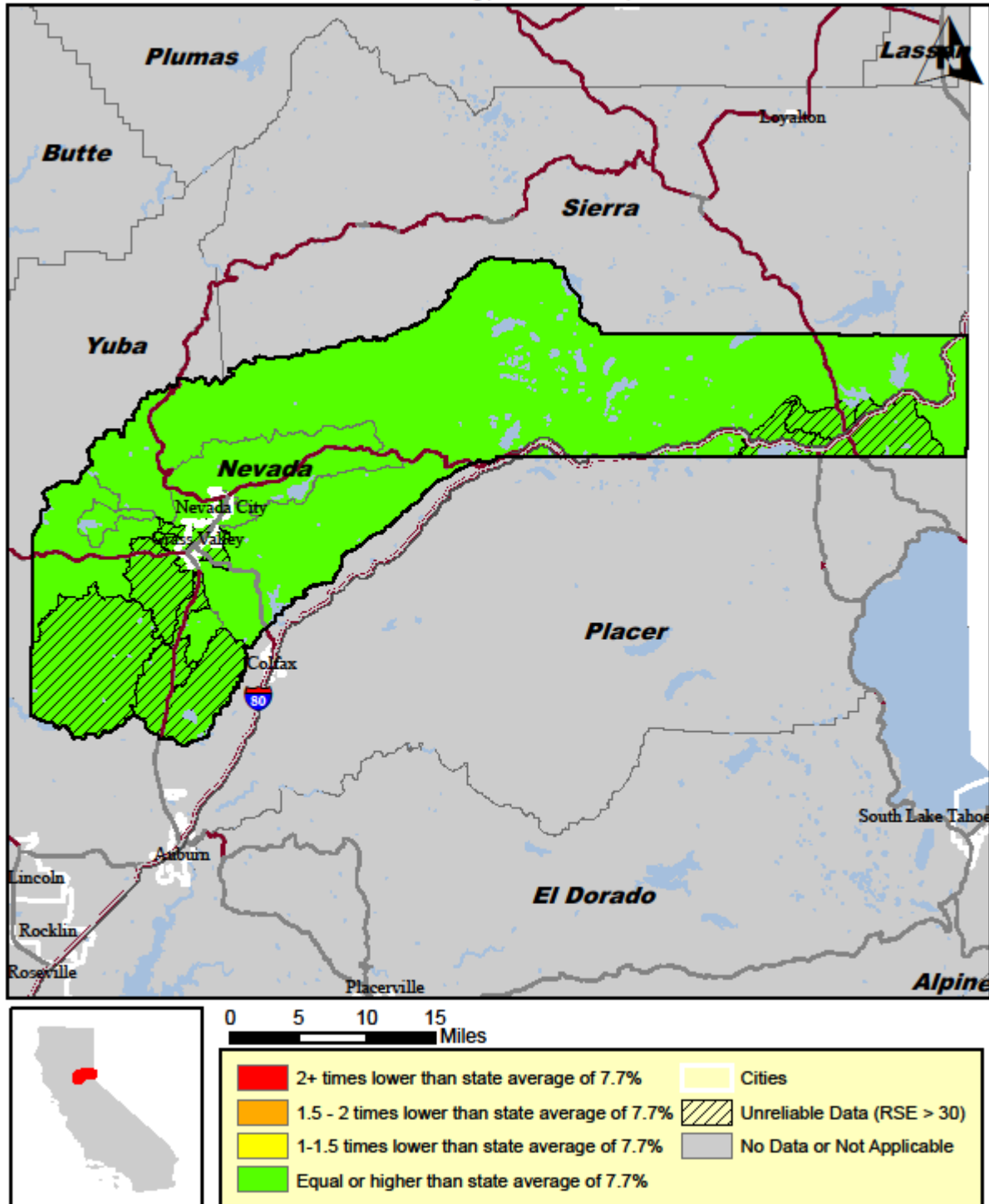


Table 1. Population-weighted Percent Tree Canopy Coverage by Cities/Towns (Population > 10,000), Sacramento County, California, 2011

Name	Tree Canopy Coverage (%)	City Population
Antelope	11	45,770
Arden-Arcade	19	92,186
Carmichael	23	61,762
Citrus Heights	19	83,301
Elk Grove	6	153,015
Fair Oaks	29	30,912
Florin	8	47,513
Folsom	13	72,203
Foothill Farms	14	33,121
Galt	8	23,647
La Riviera	16	10,802
Lemon Hill	13	13,729
North Highlands	13	42,694
Orangevale	22	33,960
Parkway	12	14,670
Rancho Cordova	12	64,776
Rio Linda	7	15,106
Rosemont	13	22,681
Sacramento	13	466,488
Vineyard	5	24,836
Sacramento County	13	1,426,490
California	8	37,253,956

Source: U.S. Census 2010. National Land Cover Database, U.S. Forest Service, 2011

Map 1: Population-weighted Tree Canopy Coverage by Census Tracts, Nevada County, California, 2011



Source: National Land Cover Database, U.S. Forest Service, 2011

Analysis by CDPH and UC Davis