TECHNICAL REPORT AND USER GUIDE

Authorship
This report was produced by the UCLA Luskin Center for Innovation, in collaboration with the Public Health Alliance of Southern California.

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Acknowledgments
We acknowledge the Gabrielino/Tongva peoples as the traditional land caretakers of Tovaangar (the Los Angeles basin and Southern Channel Islands). As a land grant institution, we pay our respects to the Honuukvetam (Ancestors), ‘Ahiihirom (Elders) and ‘eyoohiinkem (our relatives/relations) past, present and emerging.

Thank you to Nick Cuccia for editing and designing this report.

Disclaimer
The views expressed herein are those of the authors and not necessarily those of the University of California, Los Angeles as a whole.

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Background

The California Healthy Places Index (HPI): Extreme Heat Edition is a tool developed by the Public Health Alliance of Southern California in partnership with the UCLA Luskin Center for Innovation. The tool provides datasets on projected heat exposure for California, place-based indicators measuring community conditions and sensitive populations. It also provides a list of state resources and funding opportunities that can be used to address extreme heat.

The Extreme Heat Edition of the HPI is a flexible tool that can be used to understand underlying heat vulnerability and resilience characteristics of a community, to identify resources to mitigate adverse effects of extreme heat and to prioritize the delivery of resources and programs.

This report provides technical information on each of the indicators included in the California Healthy Places Index (HPI): Extreme Heat Edition. It also provides example use-cases of the tool.

Datasets

The following variables are datasets included within the tool. These represent heat exposure, population and community sensitivity, as well as adaptive capacity variables relevant to extreme heat.

Variable	Unit	Definition	Year	Source
Heat Exposure Datasets				
DaysAbove90F_2035_2064	# days	Projected number of annual days above 90F in Mid-Century (2035 - 2064) under the RCP 8.5 scenario, using data from California's four priority global climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5).	2035 - 2064	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
DaysAbove90F_2070_2099	# days	Projected number of annual days above 90F in End of Century (2070 – 2099) under the RCP 8.5 scenario, using data from California's four priority global climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5).	2070 - 2099	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
DaysAbove100F_2035_2064	# days	Projected number of annual days above 100F in Mid-Century (2035 - 2064) under the RCP 8.5 scenario, using data from California's four priority global climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5).	2035 - 2064	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
DaysAbove100F_2070_2099	# days	Projected number of annual days above 100F in End of Century (2070 – 2099) under the RCP 8.5 scenario, using data from California's four priority global climate models (HadGEM2-ES, CNRM-CM5, CanESM2, MIROC5).	2070 - 2099	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
EH_RCP8.5_2035_2064	# days	Projected number of annual extreme heat days in Mid-Century (2035 - 2064) under the RCP 8.5 scenario. Defined as the projected number of days above the 98th percentile of daily maximum temperatures (based on observed historical data from 1961 – 1990 between April and October).	2035-2064	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
EH_RCP8.5_2070_2099	# days	Projected number of annual extreme heat days in End of Century (2070 – 2099) under the RCP 8.5 scenario. Defined as the projected number of days above the 98th percentile of daily maximum temperatures (based on observed historical data from 1961 – 1990 between April and October).	2070 - 2099	CalAdapt_CanESM2_CNRM CM5_HadGEM2-ES_MIROC5_LOCA_RCP8.5
Index Scores				
HPI		The Healthy Places Index combines 25 community characteristics, based on the social determinants of health, into a single score for each California census tract.	2022	Healthy Places Index 3.0, Public Health Alliance of Southern California
CES30Score		CalEnviroScreen 3.0 Score	2018	CalEnviroScreen 3.0
Economic				
lt80pct_mhi		Whether the majority of households in this census tract make <80% of the Median Household Income in 2015 (Yes/No)	2011-2015	American Community Survey Table ACS_15_5YR_DP03
Poverty200perc	%	Percent of individuals earning less than 200% of federal poverty level	2014 - 2018	ACS_18_5YR_S1701
MedianIncome	dollar	Median household income	2014 - 2018	ACS_18_5YR_S1901

Variable	Unit	Definition	Year	Source
Environment				
dieselpm	kg/day	Spatial distribution of gridded diesel PM emissions from on road and non-road sources for a 2012 summer day in July (kg/day)	2017	CalEnviroScreen 3.0
pm25	µg/m3	Annual mean concentration of PM2.5 (average of quarterly means, µg/m3), over three years (2012 to 2014)	2017	CalEnviroScreen 3.0
ozone	ppm	Mean of summer months (May-October) of the daily maximum 8-hour ozone concentration (ppm), averaged over three years (2012 to 2014).	2017	CalEnviroScreen 3.0
impervsurf_pct	%	Percent of impervious surface in designated geography compared to total land cover	2011	NLCD2011
ParkAcres_per1000	acres / 1,000 residents	Number of park acres per 1,000 residents	2015	CSP_2015_ParkAccess
treecanopy	%	Population-weighted percentage of the census tract area with tree canopy	2011	CDPH/National Land Cover Database
UHII	degree-hr	Urban heat island index: sum of 182 day temp. differences (degree-hr) between urban and rural reference	2015	CalEPA
Housing				
Homeownercost 50plus	%	Percent of households paying ≥50% of their income on mortgage payments	2014 - 2018	ACS_18_5YR_B25091
Rentcost50plus	%	Percent of households paying ≥50% of their income to rent	2014 - 2018	ACS_18_5YR_B25070
aircon_pct	%	Percent of households with air conditioning	2009	RAS 2009
No_kitchen	%	Percent of housing units lacking complete kitchen facilities	2014 - 2018	ACS_18_5YR_B25051
No_plumbing	%	Percent of housing units lacking complete plumbing facilities	2014 - 2018	ACS_18_5YR_B25047
Crowding	%	Percent of households with more than 1 occupant per room	2014 - 2018	ACS_18_5YR_S2501
Housebuild1940	%	Percent of housing units built before 1940	2014 - 2018	ACS_18_5YR_B25034
MobileHomes	%	Percent of households living in mobile homes	2014 - 2018	ACS_18_5YR_B25024
RV_Van_Boat	%	Percent of households living in RV, van or boat	2014- 2018	ACS_18_5YR_B25024
AllHUDunits_17	per mil	Number of housing units subsidized by any HUD program, for every 1,000 housing units	2017	2017 HUD Picture of Subsidized Households / ACS_17_5YR_B25002
LIHTC_HU_18	per mil	Number of active Low-Income Housing Tax Credits units for every 1,000 housing units	2018	2018 National Housing Preservation Database / ACS_18_5YR_B25002

Variable	Unit	Definition	Year	Source
HCVunits_17	per mil	Housing Choice Voucher units, for every 1,000 housing units	2017	2017 HUD Picture of Subsidized Households / ACS_17_5YR_B25002
PHunits_17	per mil	Number of public housing units, for every 1,000 housing units	2017	2017 HUD Picture of Subsidized Households / ACS_17_5YR_B25002
OtherHUDunits_17	per mil	Number of housing units subsidized through the Section 8 moderate rehabilitation; Section 8 project-based rental assistance; rent supplement; rental assistance payment; Section 236; Section 202 for the elderly; or Section 811 for persons with disabilities, for every 1,000 housing units	2017	2017 HUD Picture of Subsidized Households / ACS_17_5YR_B25002
Transit				
Activetransport	%	Percent of workers (16 years and older) who commute to work by transit, walking or cycling	2014 - 2018	ACS_18_5YR_B08301
No_vehicle	%	Percent of households without access to a vehicle	2014 - 2018	ACS_18_5YR_S2504
Demographic Projections				
ProjectedPop_2050_5to14	%	Projected percent of population aged between 5-14 in 2050	2050	CDF_20_projectedpop
ProjectedPop_2050_65plus	%	Projected percent of population aged 65 and older in 2050	2050	CDF_20_projectedpop
Projected_pop_under5_2050	%	Projected percent of population aged under 5 in 2050	2050	CDF_20_projectedpop
ProjectedPop_2050_total	%	Projected percent change in population by 2050	2050	CDF_20_projectedpop
ExposedWorkers_2026	%	Projected percent of workers in “high environmental exposure occupations” (over 50% of time spent in a place that is not an indoor, air-conditioned space) in 2026	2026	CA_EDD2026 & DOL_ONET2019
Mothers / Infants				
Age_under5	%	Percent of population <5	2014 - 2018	ACS_18_5YR_S0101
PretermBirths	%	Percent of singleton births delivered preterm (<37 weeks of gestation)	2015	CEHTP_2015_MIH
Older Adults				
Perc65plus	%	Percent of population aged 65 or older	2014 - 2018	ACS_18_5YR_S0101
Poverty65	%	Percent of population 65 years and older with incomes below the poverty level	2014 - 2018	ACS_18_5YR_S1701
Language65	%	Percent of population 65 years and older who speak English “not well” or “not at all”	2014 - 2018	ACS_18_5YR_B16004
Livealone65	%	Percent of population 65 years and older living alone	2014 - 2018	ACS_18_5YR_B09020
Nonwhite65	%	Percent of population 65 years and older who are non-White	2014 - 2018	ACS_18_5YR_B01001_B01001H
Disability65	%	Percent of population 65 years and older with disabilities	2014 - 2018	ACS_18_5YR_B18101
Perc75plus	%	Percent of Population aged 75 or older	2014 - 2018	ACS_18_5YR_S0101
Other				
Disability	%	Percent of population with a disability	2014 - 2018	ACS_18_5YR_S1810

Variable	Unit	Definition	Year	Source
Ltd_english	%	Percent of households with limited English speaking status	2011 - 2015	ACS_15_5YR_B16002
Incarcerated Count	# people	Estimated count of individuals in state prisons (institutions and camps) and county jails as of June 2020. Only at County Level	2020	BSCC_CDCR_20
Race / Ethnicity				
AIAN	%	Percent of population that is American Indian / Alaskan Native alone	2014 - 2018	ACS_18_5YR_B02001
Asian	%	Percent of population that is Asian alone	2014 - 2018	ACS_18_5YR_B02001
Black	%	Percent of population that is Black or African American alone	2014 - 2018	ACS_18_5YR_B02001
Latino	%	Percent of population that is Hispanic or Latino	2014 - 2018	ACS_18_5YR_B03003
NHOPI	%	Percent of population that is Native Hawaiian or Other Pacific Islander alone	2014 - 2018	ACS_18_5YR_B02001
Other_race	%	Percent of population that is of some other races	2014 - 2018	ACS_18_5YR_B02001
Two_or_more_races	%	Percent of population that is of two or more races	2014 - 2018	ACS_18_5YR_B02001
White	%	Percent of population that is White alone	2014 - 2018	ACS_18_5YR_B02001
Workers				
ExposedWorkers_2016	%	Percent of workers in “high environmental exposure occupations,” defined as occupations in which over 50% of time is spent in a place that is not an indoor, air-conditioned space.	2016	CA_EDD2016 & DOL_ ONET2019
Youth				
YouthAsthmaEDvisits	visits / 10,000 residents	Age-adjusted rate of asthma emergency room visits for youth	2017	OSHPD_17_asthmaED
Age5_14	%	Percent of population aged between 5-14	2014 - 2018	ACS_18_5YR_S0101
frm_pct	%	Percent of K-12 students eligible for the Free & Reduced Meal Program in all school sites located in this census tract	2015-2016	California Department of Education
Health				
Asthma ER Admissions	visits /10,000 residents	Spatially modeled, age-adjusted rate of emergency department (ED) visits for asthma per 10,000	2011 - 2013	CalEnviroScreen 3.0
Heart Attack ER Admissions	visits /10,000 residents	Spatially modeled, age-adjusted rate of emergency department visits for acute myocardial infarction per 10,000	2011 - 2013	CalEnviroScreen 3.0
Chronic Kidney Disease	%	Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have kidney disease	2016	CDC 500 Cities / BRFSS
Diagnosed Diabetes	%	Percent of adults aged ≥18 years who report ever been told by a doctor, nurse, or other health professional that they have diabetes other than diabetes during pregnancy	2016	CDC 500 Cities / BRFSS
Stroke	%	Percent of adults aged ≥18 years who report ever having been told by a doctor, nurse, or other health professional that they have had a stroke	2016	CDC 500 Cities / BRFSS

Resources

The following are a list of resources included within the tool. These represent funding opportunities in California that could be used to address the issue of extreme heat.

State Programs / Funding Resources	Utility Financial Assistance	AC Replacement and Repair	Weather-ization	Urban Greening	Cool Roofs	Shade Structures	Solar PV	Planning to Address Extreme Heat
FOR HOUSEHOLDS (1)								
Low-Income Weatherization Program (LIWP)		X	X		X		X	
Low Income Home Energy Assistance Program (LIHEAP)	X	X	X					
Weatherization Assistance Program (WAP)			X					
Disadvantaged Communities- Single-family Solar Homes (DAC-SASH)							X	
Solar on Multifamily Affordable Housing (SOMAH) program							X	
Energy Savings Assistance Program (ESA)			X					
California Alternate Rates for Energy (CARE) Family Rate Assistance Program	X							
Medical Baseline	X							
FOR WORKPLACES (2)								
Cal/OSHA Heat Illness Prevention Program								X
FOR SCHOOLS (3)								
School Facility Program Modernization Grants		X	X					
Urban Greening (UG)				X				
Environmental, Enhancement & Mitigation Program (EEM)				X				
FOR LOCAL GOVERNMENTS OUTDOOR PUBLIC SPACES (4)								
Urban and Community Forestry Program (UCF)				X				
Urban Greening (UG)				X				
Environmental Enhancement & Mitigation Program (EEM)				X				

State Programs / Funding Resources	Utility Financial Assistance	AC Replacement and Repair	Weather-ization	Urban Greening	Cool Roofs	Shade Structures	Solar PV	Planning to Address Extreme Heat
Statewide Park Development and Community Revitalization Program (SPP)				X	X	X		
Regional Park Program (RPP)				X	X	X		
Rural Recreation Tourism and Economic Enrichment Investment Program (RRT)				X	X	X		
Recreational Infrastructure Revenue Enhancement Program (RIRE)				X	X	X		
Transformative Climate Communities (TCC)		X	X	X	X	X	X	X
FOR LOCAL GOVERNMENTS-TRANSIT (5)								
Active Transportation Program (ATP)						X		X
Low Carbon Transit Operations Program (LCTOP)						X		
CalSTA Transit and Intercity Rail Capital Program (TIRCP)						X		
Caltrans: State Transportation Improvement Program (STIP)						X		
Transformative Climate Communities (TCC)		X	X	X	X	X	X	X
FOR LOCAL GOVERNMENTS- HOUSING AND PLANNING GRANTS (6)								
Affordable Housing and Sustainable Communities (AHSC) Grant Program				X	X	X	X	
Caltrans Transportation Planning Grant Program Sustainable Communities and Strategic Partnership Grant				X		X		X
Transformative Climate Communities (TCC)		X	X	X	X	X	X	X
FOR TRIBAL GOVERNMENTS (7)								
Tribal Government Challenge Planning Grant Program								
California Environmental Protection Agency (CalEPA) Environmental Justice (EJ) Small Grants Program								
Transformative Climate Communities Program (TCC)		X	X	X	X	X	X	X

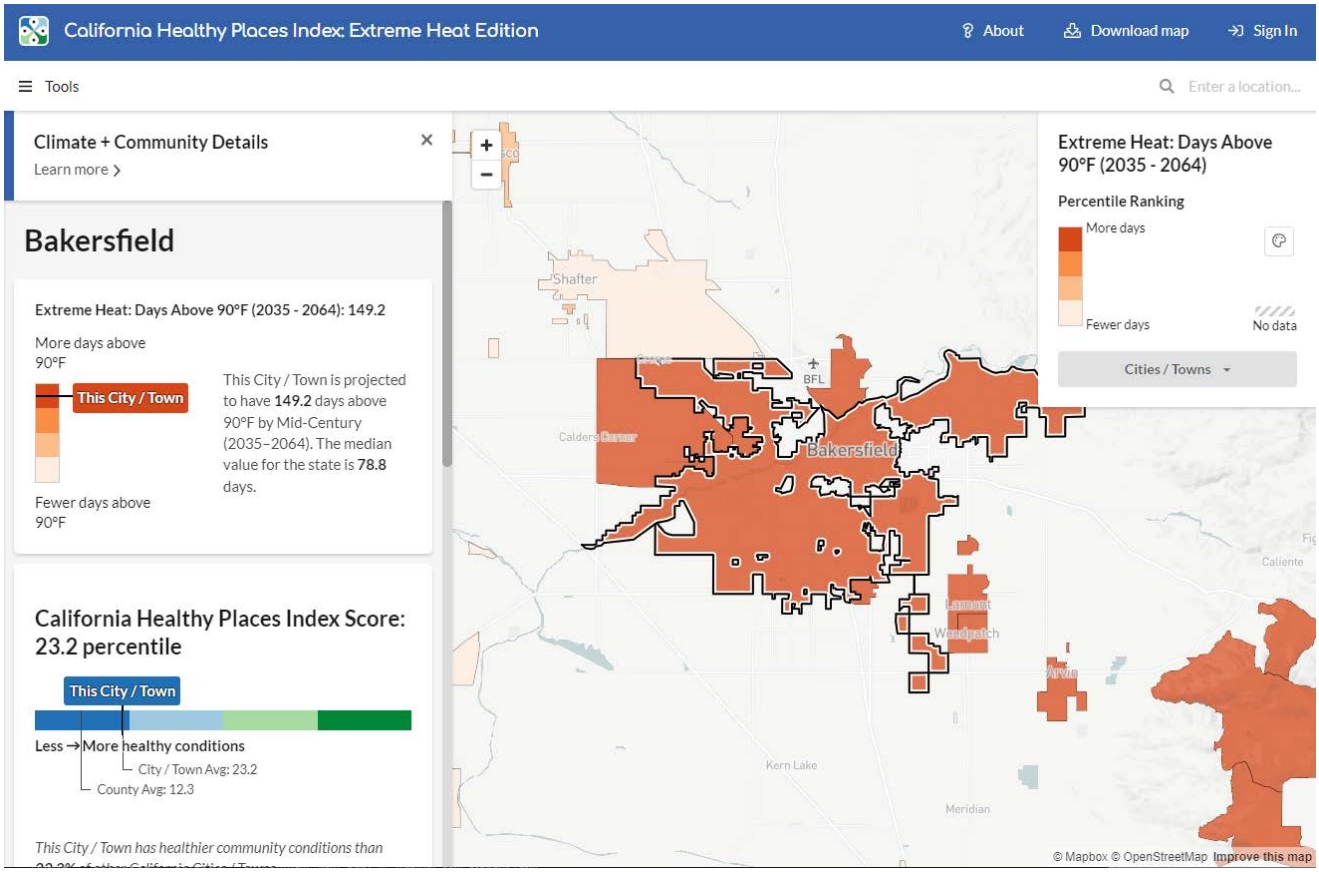
State Programs / Funding Resources	Utility Financial Assistance	AC Replacement and Repair	Weather-ization	Urban Greening	Cool Roofs	Shade Structures	Solar PV	Planning to Address Extreme Heat
Affordable Housing and Sustainable Communities (AHSC) Grant Program				X	X	X	X	
Active Transportation Program (ATP)						X		X
Caltrans Transportation Planning Grant Program - Sustainable Communities and Strategic Partnerships Grant				X		X		X
STATE ENVIRONMENTAL INITIATIVES (8)								
California Environmental Protection Agency (CalEPA) Environmental Justice (EJ) Small Grants Program								
Urban and Community Forestry Program (UCF)				X				
Urban Greening (UG)				X				
Environmental, Enhancement & Mitigation Program (EEM)				X				
Statewide Park Development and Community Revitalization Program (SPP)				X	X	X		
Regional Park Program (RPP)				X	X	X		
Active Transportation Program (ATP)						X		X
Low Carbon Transit Operations Program (LCTOP)						X		
Transformative Climate Communities Program (TCC)		X	X	X	X	X	X	X

Examples of Use Functions

Below are examples of features that can be used within the tool.

Climate and Community Details: Accessing Data for Specific Geographic Boundaries

The datasets within the tool can be accessed by various geographic boundaries, including: Census tracts, ZCTAs, cities/towns, unincorporated areas, counties, medical service study areas, elementary school districts, state and federal legislative districts, core based statistical area, and metropolitan planning organization. In the example below, the datasets on projected extreme heat days are visible for the City of Bakersfield. The tool also displays where the City of Bakersfield ranks for a particular dataset compared to all other cities in the state. For example, Bakersfield is anticipated to experience 149 days above 90F by mid-century (2035-2064), which places it in the 88th percentile compared to other cities. The tool uses a Cal-Adapt r package to aggregate raster data of climate variables (i.e., days over 90F, days over 100F) to mean values at various jurisdictions (Census tracts). The tool can portray every census tract in California or a subset either by census tract code or by region if predefined.



Climate data is a pertinent piece of this tool. There are a number of variables based on climate projections, specifically, Representative Concentrations Pathways (RCP), which take into account current trends in greenhouse gas concentrations and projects out to climate windows in the next century. In addition to temperature (min, mean and max) the RCP data also can provide projected dew points, wind speed, precipitation, and humidity. These values can also be provided at a monthly temporal resolution or a seasonal resolution (June, July, August). Two scenarios are used under investigation. Scenario 1 is RCP 4.5 and is representative of a stabilization of radiative forcing before the end of the century. The stabilization level is thought to be 4.5 W/m2 (watts per square meter), while RCP 8.5 is often considered to be a “business as usual” scenario with no intervention or change in behavior (NOAA).

The values for each designated jurisdiction (census tract, block group) are aggregated within a Cal-Adapt R software leveraged within the HPI tool. Zonal statistics are collected and averaged across each zone. Below is an example of the process where a U.S. Census Block group is overlaid on top of an RCP 8.5 late century temperature projection raster where the raster values are averaged and the result is a single value of 43°C for the entire block group.

FIGURE 1: The aggregation process within the Cal-Adapt tool that takes raster data values and averages them over a designated boundary file such as census block groups.

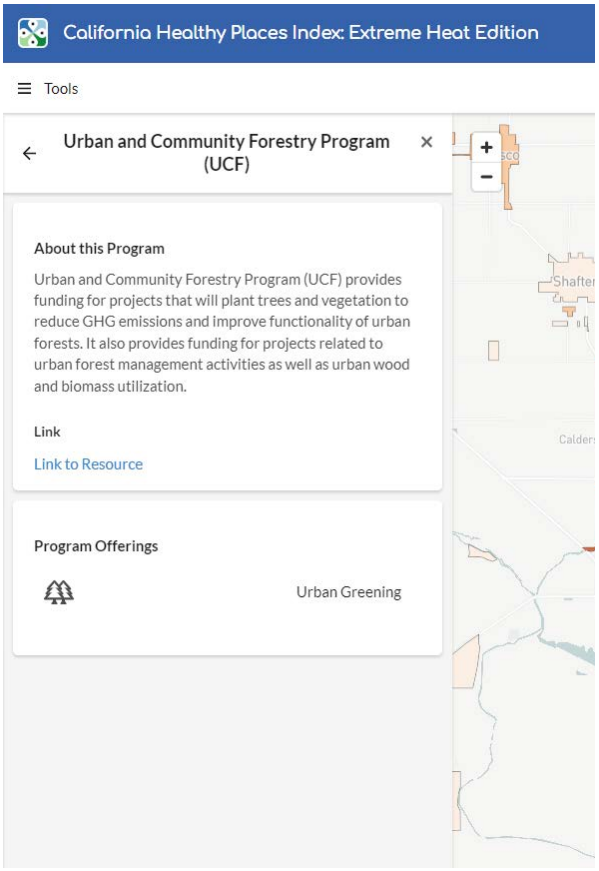
This tool also has a wide range of variable combinations including which global climate model which derived which variables (table below). The CMIP5 downscaling typically takes an average of all climate models. The time frame under investigation can be a single day, a month, a calendar year or a 30-year climate window. The geographical boundaries are also very flexible and can be as large as counties, or as individualized as watershed units.

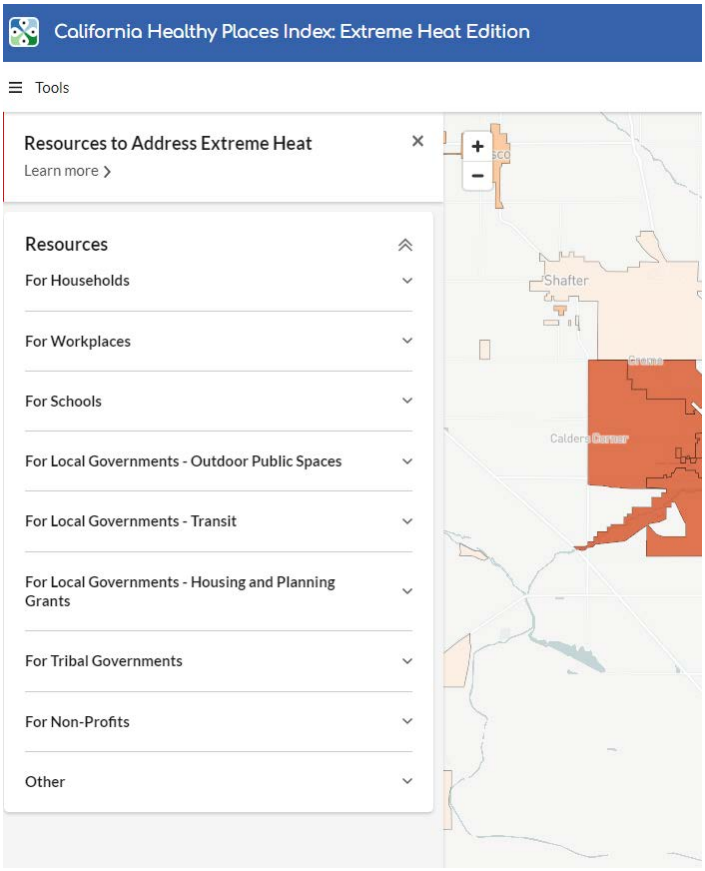
GCMS	Scenarios	Time frame	Geographical Boundary
HadGEM2-ES	RCP 4.5	Day	Census Tracts
CNRM-CM5	RCP 8.5	Month	Counties
CanESM-2	Historical	Year	Congressional Districts
MIROC-5		30-Year Average	Watershed Units (HUC10)
ACCESS1-0			Climate Regions
CCSM4			Integrated Regional Water Management (IRWM) Regions
CESM1-BGC			Census Designated Places
CMCC-CMS			
GFDL-CM3			
HadGEM2-CC			
ens32avg			
ens32max			
ens32min			

The tool works by creating a function that connects with the Cal-Adapt API specifying a specific request identifying which variable, region, global climate model and time period. The tool offers a lot of flexibility and with its exporting capabilities can be manipulated further in any GIS software post processing.

Resources to Address Extreme Heat

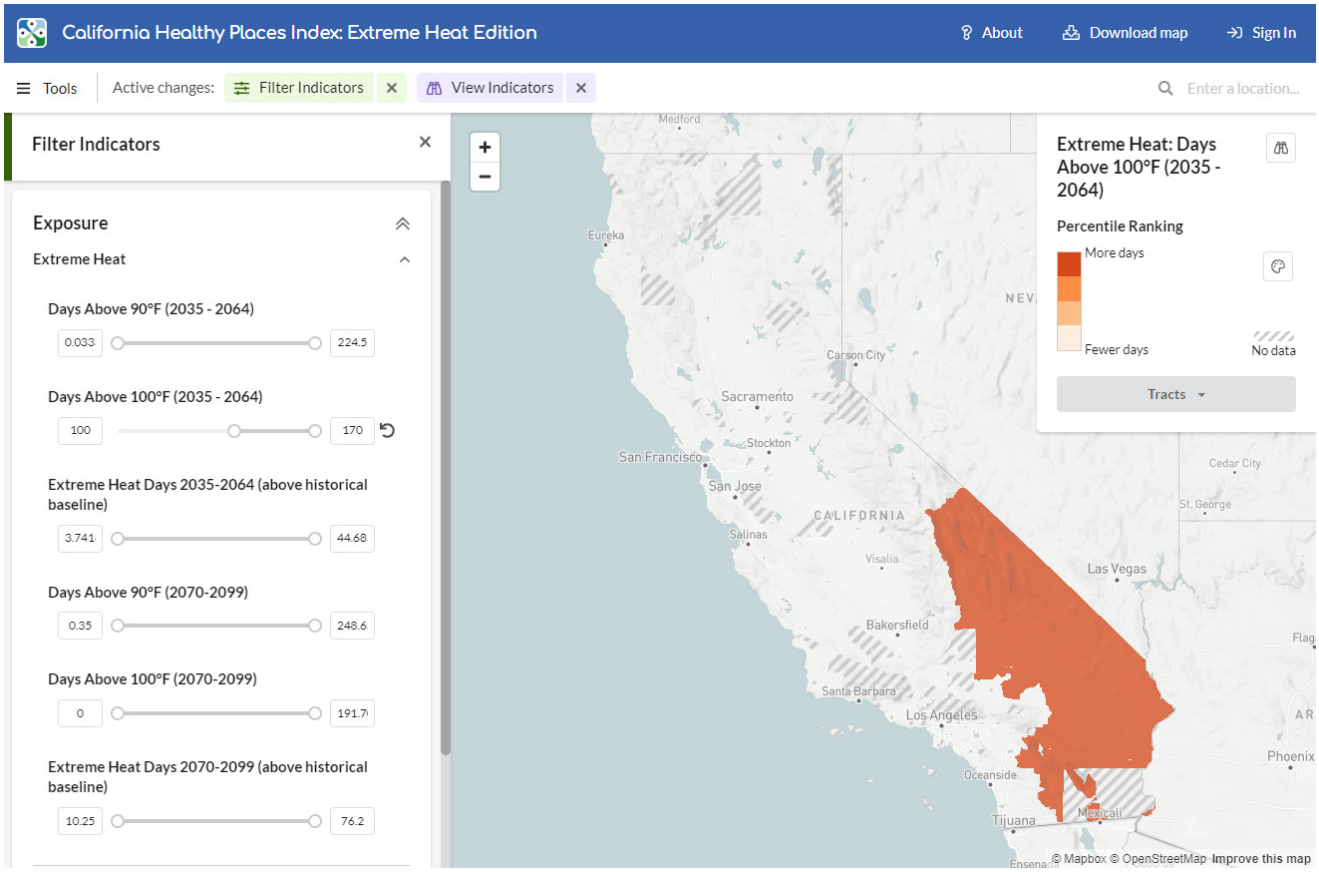
This feature allows users to identify programs and funding opportunities to address extreme heat. The resources are organized by the potential user (e.g., households, workplaces, schools, local governments, tribal governments and nonprofits). Each resource is identified by the heat-related measure it can offer, for instance air-conditioning replacement or repair, weatherization, solar PV, urban greening and others.





Filter Indicators

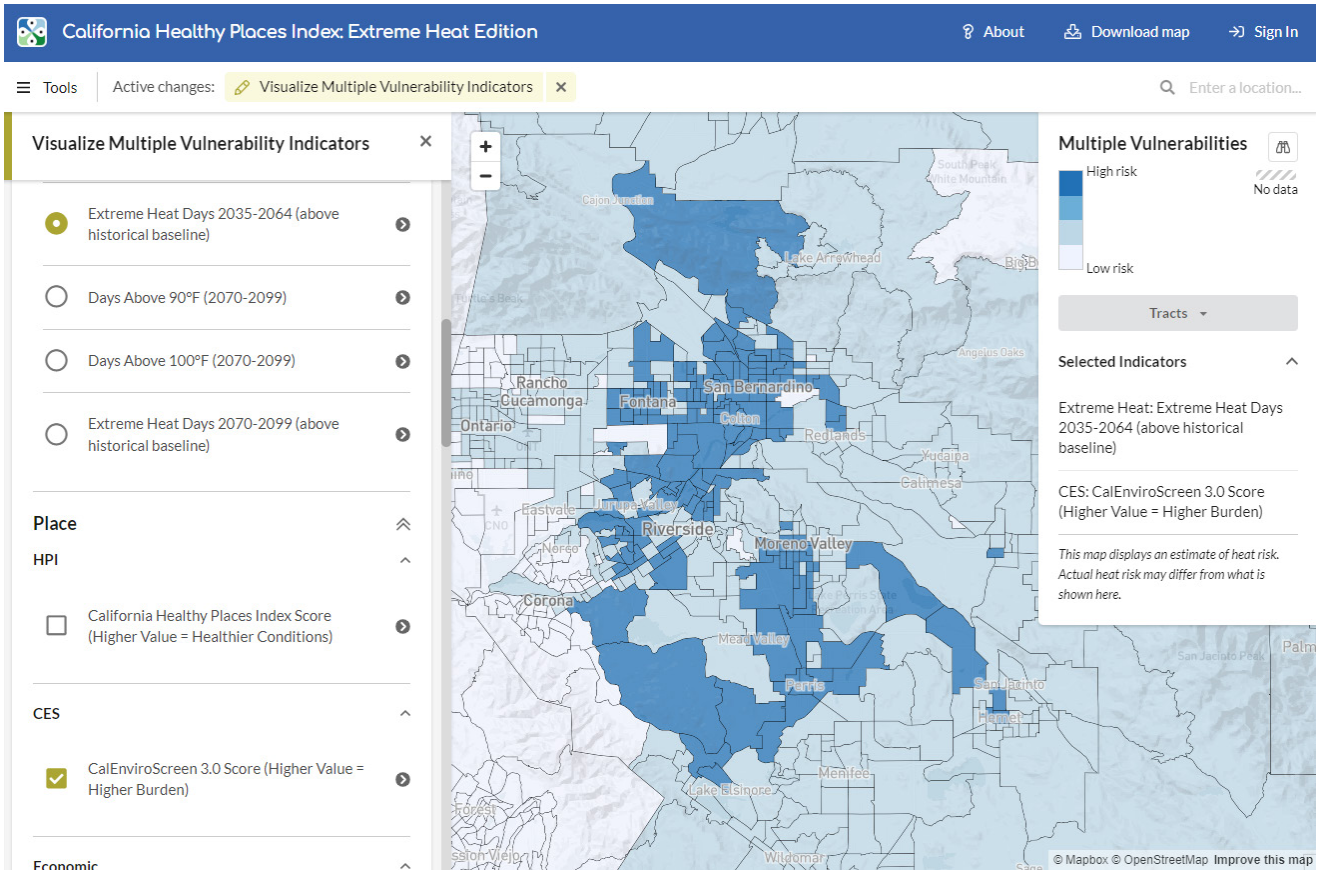
The Filter Indicators feature can be used to create unique parameters for datasets and visualize geographies that meet these parameters. For example, in the visualization below, we filtered the "Days above 100F (2035-2064)" dataset to only visualize census tracts throughout the state that are projected to experience more than 100 days of such temperatures throughout the year. We see that these tracts are located on the southeastern-most edge of the state. This filtering feature can be used to create custom parameters for all datasets in the tool and can be used to filter multiple indicators at once.



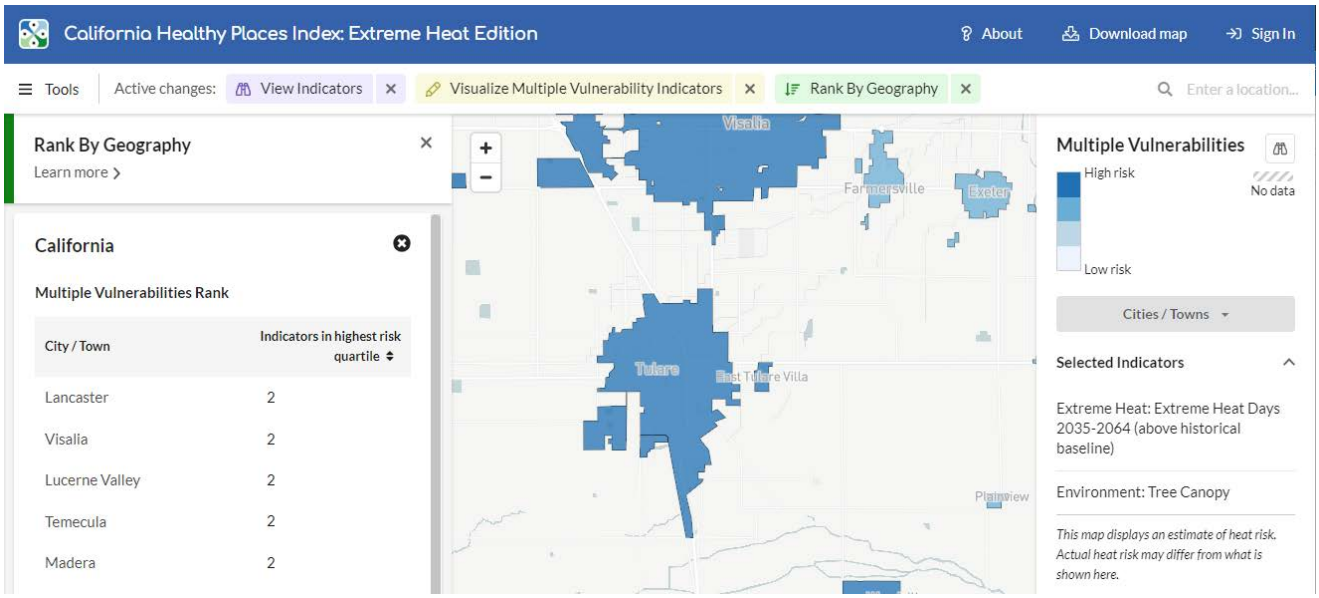
Visualize Multiple Vulnerability Indicators

The tool can be used to visualize the intersection of heat exposure and selected vulnerability indicators. By selecting a heat exposure indicator and one or more vulnerability indicators, users can visualize the intersection of these conditions. For all datasets, values are given percentile ranks for all geographic boundaries. These percentile ranks are divided into four groups (quartiles). When an indicator is selected, the geographies falling into the top quartile of risk for that indicator are visualized on the map. As more indicators are selected, geographies with a higher concentration of indicators within the top quartile of risk are shown in darker colors.

In the example below, we can see parts of Riverside County (census tracts) that are both anticipated to see the highest number of extreme heat days in mid-century (quartile) compared to other census tracts throughout the state and also have CalEnviroScreen 3.0 scores that are within the top quartile compared to all other census tracts throughout the state.

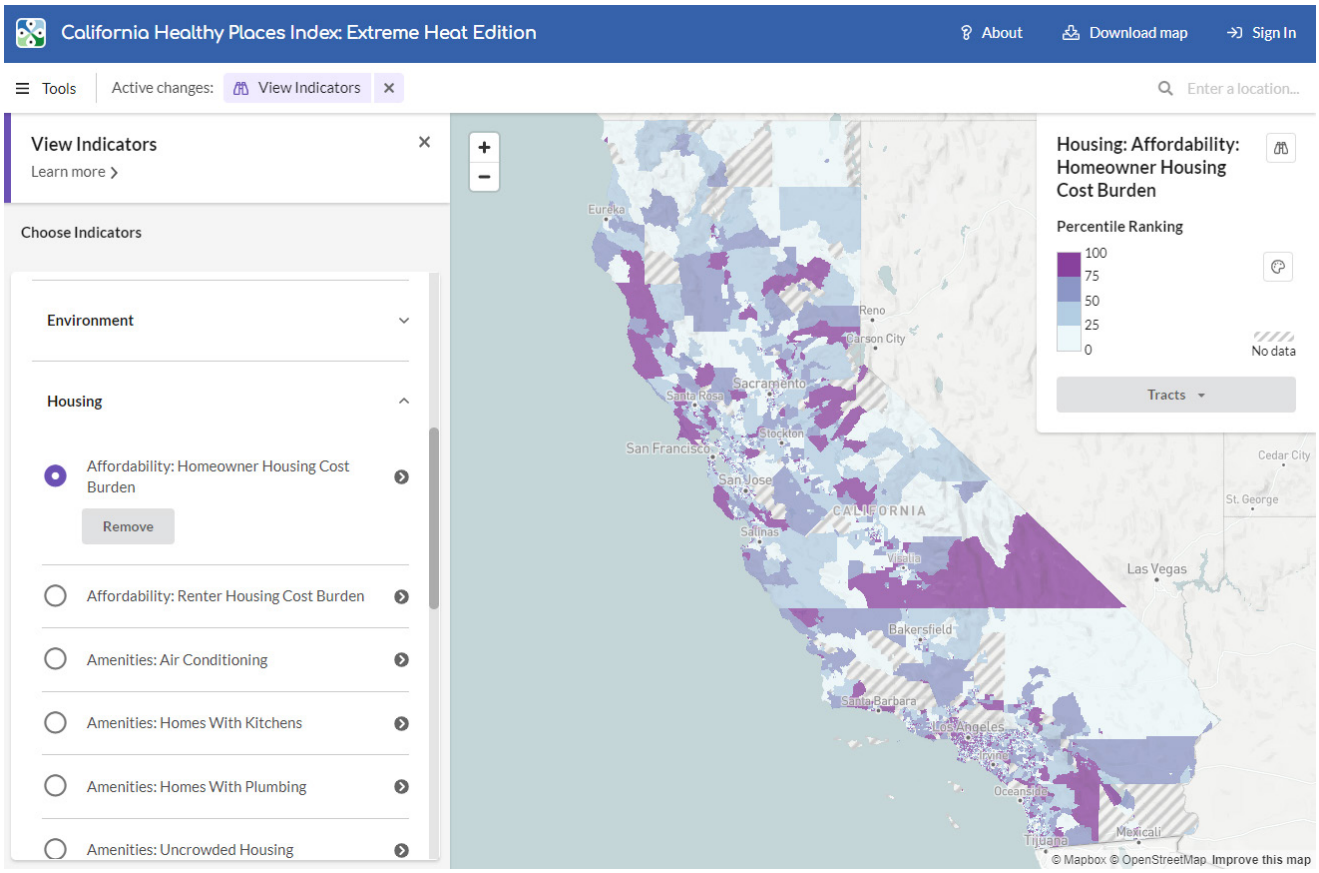


In the example below, we can see various cities within Fresno, Tulare and Kings counties. Using the "Visualize Multiple Vulnerabilities" feature, we are able to identify the cities that are anticipated to see the highest number of extreme heat days in mid-century (quartile) compared to other cities throughout the state, and also have the lowest percent tree canopy compared to other cities throughout the state. We are also able to identify a list of these cities for which this condition is true, but using the "Rank by Geography" feature.



View Indicators: Accessing and Visualizing Datasets Across the State

Any datasets within the tool can be visualized for the entire state. In the example below, we can see data on homeowner housing cost burdens throughout the state, by census tract.

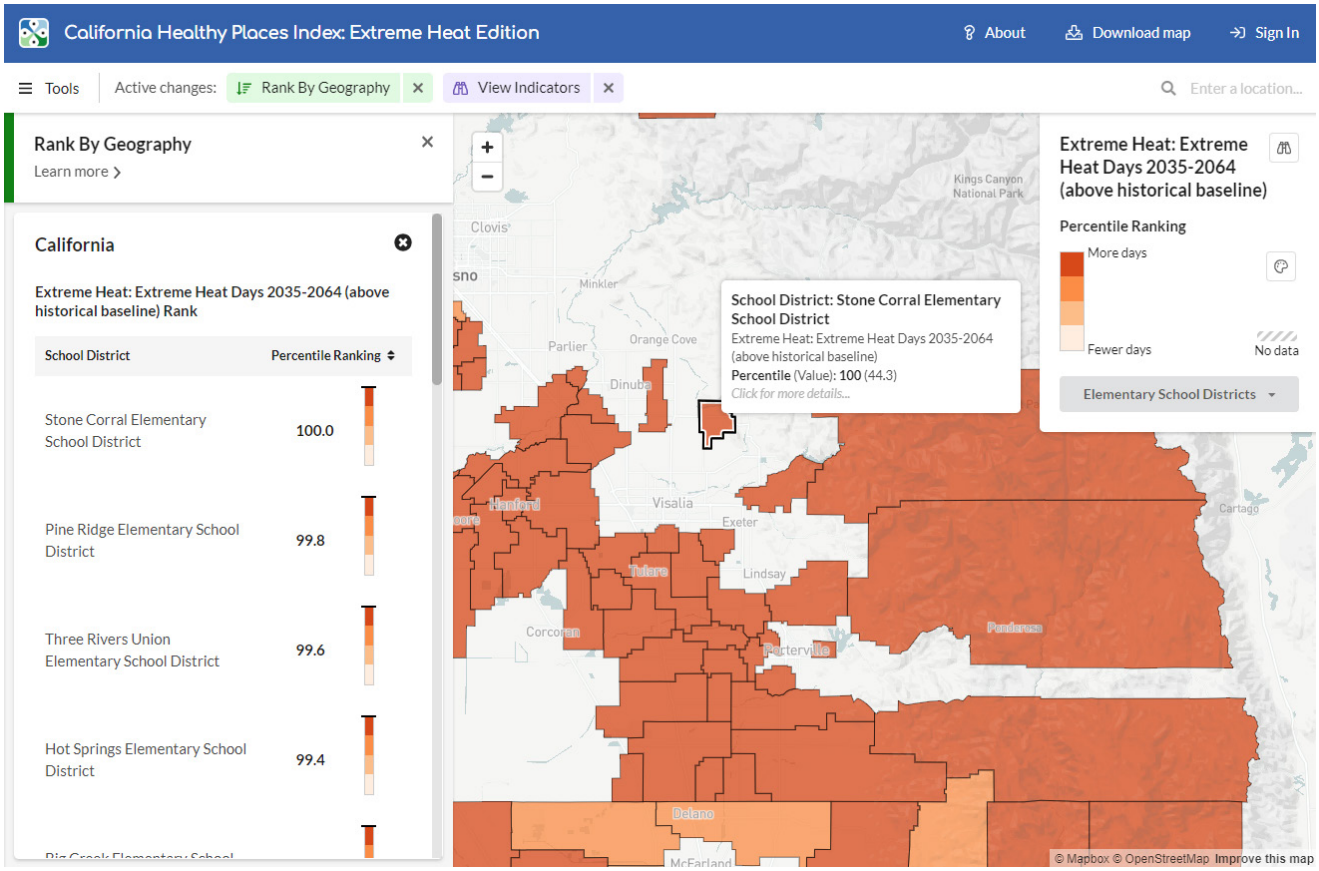


Pool Geographies

This feature can be used to select multiple geographic units (“to pool”) and to access information on datasets for this pooled grouping of geographies. Geographies include: Tracts, ZCTAs, cities/towns, unincorporated areas, counties, medical service study areas, elementary school districts, state and federal legislative districts, core based statistical area, and metropolitan planning organization

Rank Geographies

This feature can be used to rank geographies by a selected dataset. It can also be used in conjunction with the “Visualize Multiple Vulnerability Indicators” feature. For example, in the visualization below, we can see the dataset “Extreme Heat Days (2035-2064)” by elementary school districts throughout the state, as well as a ranking of these districts by the dataset (percentile). We see Stone Corral Elementary School District, which is anticipated to see approximately 44 extreme heat days per year in mid-century, ranks the highest of all school districts for this metric.



Conclusion

THE HPI tool extracts data from multiple online API’s for both social demographic and biophysical data. Accompanying this document is an HPI variable documentation sheet that defines the climate variables used within this tool.

Manual downloads of this data are also available on the Cal-Adapt website.