CALIFORNIA'S FOURTH
CLIMATE CHANGE
ASSESSMENT

Climate Justice Report

Coordinating Agencies:

GOVERNOR'S OFFICE OF PLANNING AND RESEARCH · STATE OF CALIFORNIA ·

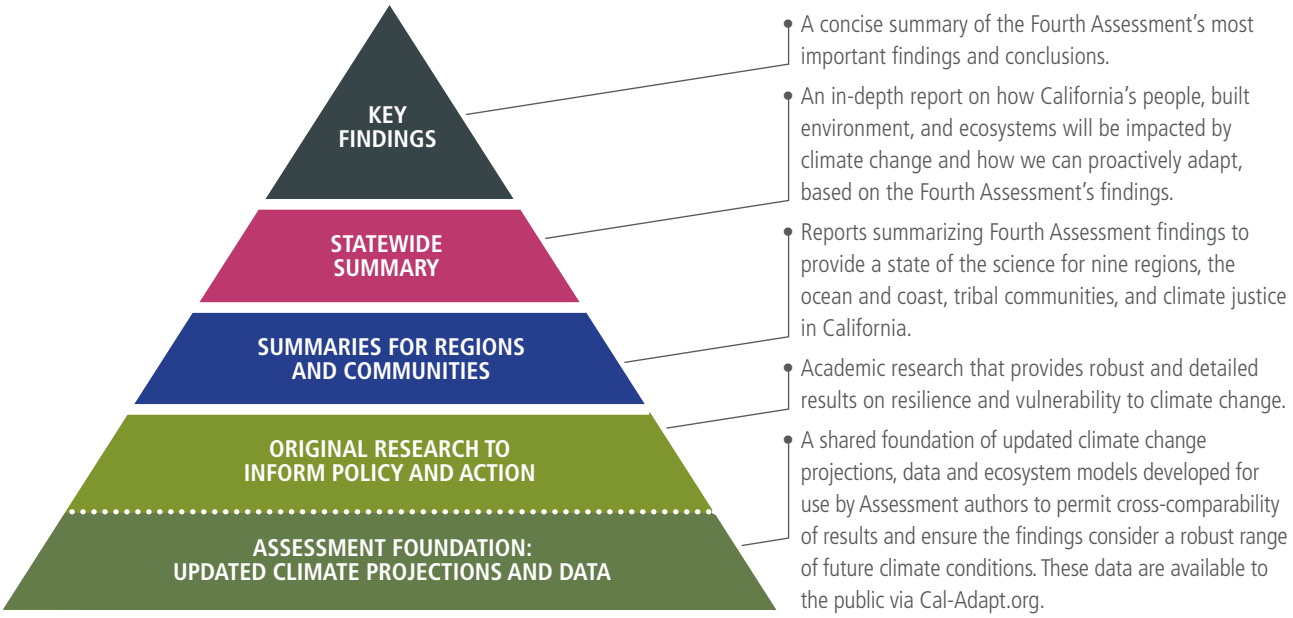
STATE OF CALIFORNIA ENERGY COMMISSION

CALIFORNIA natural resources AGENCY

Introduction to California's Fourth Climate Change Assessment

California is a global leader in using, investing in, and advancing research to set proactive climate change policy, and its Climate Change Assessments provide the scientific foundation for understanding climate-related vulnerability at the local scale and informing resilience actions. The Climate Change Assessments directly inform State policies, plans, programs, and guidance to promote effective and integrated action to safeguard California from climate change.

California's Fourth Climate Change Assessment (Fourth Assessment) advances actionable science that serves the growing needs of state and local-level decision-makers from a variety of sectors. This cutting-edge research initiative is comprised of a wide-ranging body of technical reports, including rigorous, comprehensive climate change scenarios at a scale suitable for illuminating regional vulnerabilities and localized adaptation strategies in California; datasets and tools that improve integration of observed and projected knowledge about climate change into decision-making; and recommendations and information to directly inform vulnerability assessments and adaptation strategies for California's energy sector, water resources and management, oceans and coasts, forests, wildfires, agriculture, biodiversity and habitat, and public health. In addition, these technical reports have been distilled into summary reports and a brochure, allowing the public and decision-makers to easily access relevant findings from the Fourth Assessment.



All research contributing to the Fourth Assessment was peer-reviewed to ensure scientific rigor as well as, where applicable, appropriate representation of the practitioners and stakeholders to whom each report applies.

For the full suite of Fourth Assessment research products, please visit: www.ClimateAssessment.ca.gov

Climate Justice Report

The Climate Justice Summary Report is part of a series of 12 assessments to support climate action by providing an overview of climate-related risks and adaptation strategies tailored to specific regions and themes. Produced as part of California's Fourth Climate Change Assessment through a pro bono initiative by leading climate experts, these summary reports translate the state of climate science into useful information for decision-makers and practitioners to catalyze action that will benefit regions, the ocean and coast, frontline communities, and tribal and indigenous communities.

The Climate Justice Summary Report presents an overview of climate science, specific strategies to adapt to climate impacts, and key research gaps needed to spur additional progress on safeguarding California's frontline communities from climate change.

Climate Justice Authors

COORDINATING LEAD AUTHOR

Michelle Roos,
E4 Strategic Solutions

CONTRIBUTING AUTHORS

Kathy Pope,
E4 Strategic Solutions

Roseann Stevenson,
E4 Strategic Solutions

Acknowledgement: Preparation of this report was supported by Resources Legacy Fund.

STAKEHOLDER ADVISORS

Paloma Aguirre
Wildcoast/Costa Salvaje

Carl Anthony
Breakthrough Communities

Colin Bailey
The Environmental Justice Coalition for Water

Jordyn Bishop
The Greenlining Institute

Veronica Garibay
Leadership Counsel for Justice and Accountability

Nahal Ghoghaie
The Environmental Justice Coalition for Water

Carolina Martinez
Environmental Health Coalition

Sona Mohnot
The Greenlining Institute

Manuel Pastor
USC Program for Environmental Quality & Regional Equity

Mari Rose Taruc
Filipino/American Coalition for Environmental Solidarity (FACES)

Stephanie Villegas
Rural Community Assistance Corporation

Lucas Zucker
Central Coast Alliance United for a Sustainable Economy (CAUSE)

ADDITIONAL REVIEWERS

Hannah Doress
Shore Up Marin

Colin Miller
Oakland Climate Action Coalition

Paloma Pavel
Earth House, Breakthrough Communities

Amee Raval
Asian Pacific Environmental Network

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"No group of people should disproportionately bear the burden of climate impacts or the costs of mitigation and adaptation."

—*"Social Vulnerability to Climate Change in California: A White Paper from the California Energy Commission's California Climate Change Center,"*
H. Cooley, E. Moore, M. Heberger, and L. Allen (Pacific Institute)

"While all Californians are impacted by climate change, climate change does not affect all people in the same way. These frontline communities are particularly vulnerable to the impact of climate and environmental changes because of decades-long, pervasive socio-economic conditions that are perpetuated by systems of inequitable power and resource distribution. Those systems, in turn, are the result of intentional decisions by people in positions of power and deeply institutionalized racism and class bias. These conditions and systems have left California's frontline communities with unsafe, unhealthy neighborhoods and limited access to quality education, public services, and economic opportunities."

— *"Advancing Climate Justice in California,"*
Climate Justice Working Group

Executive Summary

This report summarizes existing academic research and research from California's Fourth Climate Change Assessment in the form of a literature review of climate adaptation as it relates to climate justice in California and as an initial resource for further strengthening adaptation efforts. Climate justice is defined as "the concept that no group of people should disproportionately bear the burden of climate impacts or the costs of mitigation and adaptation" (Cooley 2012). Climate adaptation is minimizing the impacts of climate change by counteracting climate impacts or reducing the vulnerability of populations to these impacts. This synthesis report includes terms and definitions that are key to understanding climate justice and adaptation. It reviews mapping tools and indices that help identify the most vulnerable communities in relation to current and projected climate impacts. It also reviews literature on how existing social, economic, and environmental inequalities create communities who are and will continue to be disproportionately impacted by climate change. It also highlights climate adaptation strategies, with summaries of case studies and innovative programs that are attempting to increase the resiliency of the most vulnerable communities. This report identifies gaps in peer-reviewed literature and the state's ongoing Climate Change Assessment to better address climate adaptation for those most vulnerable and to promote climate justice in California. This study aims to encourage further discussion among stakeholders, community leaders, and climate scientists to address these pressing concerns.

HIGHLIGHTS

- For purposes of this report, climate justice is defined as "the concept that no group of people should disproportionately bear the burden of climate impacts or the costs of mitigation and adaptation" (Cooley 2012).
- Climate adaptation is minimizing the impacts of climate change by counteracting climate impacts or reducing the vulnerability of populations to these impacts.
- CalEnviroScreen 3.0, California's Healthy Places Index, Cal-Adapt, and CalBRACE are mapping tools that can be used to better identify climate-vulnerable populations, but a broader variety of tools and indices with greater detail is needed.
- There are numerous social, economic, and environmental factors that impact climate vulnerability in unique and overlapping ways. These include:
    - Race/Ethnicity;
    - Lack of access to financial resources;
    - Urbanization (heat island effect);
    - Existing disproportionate impacts from other pollutants;
    - Existing high rates of health issues and lack of access to good health care;
    - Disparities in education and limited English proficiency (LEP);
    - Employment in jobs and industries that will be disproportionately impacted by climate change (e.g., agricultural, tourism, and domestic jobs) and outdoor jobs in general that increase exposure to climate change impacts;

  - Lack of access to air conditioning and transportation;
  - Lack of social capital: political involvement, civic representation, and isolation; and
  - Citizenship and immigration status.
- The cumulative and synergistic nature of multiple social, economic, and environmental factors can limit a person's and community's ability to prepare for, respond to, and cope with climate change. This cumulative, disproportionate adverse impact was documented during a series of California wildfires in the fall and early winter of 2017/2018.
- The state of California, along with environmental justice, health equity, and advocacy organizations are currently working diligently to equitably adapt to climate change, with numerous case studies and innovative programs that identify, work with, and increase the adaptive capacity of the most vulnerable populations and communities.
- Few projects in California's Fourth Climate Change Assessment address issues of climate justice; this report primarily summarizes existing research separate from the state's Climate Change Assessment.
- Knowledge gaps in peer-reviewed literature and potential areas for future research include, but are not limited to:
  - Better mapping tools and indices to identify climate-vulnerable communities and populations;
  - Greater analysis of the impacts of the California Air Resources Board's cap-and-trade program from a California climate justice perspective;
  - Metrics to measure and achieve climate resilience for vulnerable communities and populations;
  - Mechanisms to combat direct and indirect involuntary displacement while responding to and preparing for climate change;
  - Research into achieving a just transition into a carbon-neutral economy; and
  - Ways to codify community involvement of those most vulnerable to climate change early and often in every aspect of climate adaptation.

Introduction

California is a global leader in climate mitigation, adaptation, and resilience, and has established the most ambitious greenhouse gas (GHG) emissions reduction targets in North America. California has maintained that states cannot and will not wait for the federal government to act on these issues. In April 2015, Governor Edmund G. Brown, Jr. signed Executive Order B-30-15, creating a GHG target 40% below 1990 levels by 2030. In 2016, the California Legislature passed and Governor Brown signed Senate Bill 32, putting those targets into law. These GHG emission reductions will put the state on a trajectory to achieve an 80% reduction by 2050. This is consistent with the scientific consensus on the scale of emissions reductions needed to stabilize atmospheric greenhouse gas concentrations at 450 parts per million carbon dioxide equivalent and reduce the likelihood of catastrophic climate change.

That said, California is already facing and will continue to face significant impacts from climate change. These impacts range from frequent and extreme instances of wildfires, drought, heat waves, floods, air and water quality concerns, sea level rise and coastal erosion, and the spread of infectious diseases, among others. While all Californians will suffer from these impacts, some people will suffer more. Vulnerable populations include but are not limited to: low-income individuals and families; people of color; women; the young; the elderly; people with disabilities; people with existing health issues, including mental health issues; people with limited English proficiency (LEP); immigrants and refugees; agricultural workers and day laborers; traditional native communities; people who are or have been incarcerated; people without a high school education; and other groups. These populations not only feel the immediate impacts of climate change more significantly, but also have the least resources to adapt to climate changes.

Climate Change Assessments have primarily been dedicated to identifying and estimating the impacts of climate change; less research has focused on how to implement climate adaptation strategies and build climate resilience for and with vulnerable communities. "While disaster events may not discriminate, impacts on human populations are shaped by intervening conditions that determine the human impact of the event and the specific needs for preparedness, response, and recovery" (Cooley 2012). Adaptation strategies must account for and include people and communities that face socioeconomic and political barriers to prepare for, adapt to, and recover from the effects of climate change.

> "While all Californians are impacted by climate change, different groups are affected in unique and overlapping ways. Certain communities and groups are in a better position to respond, recover, and adjust as these changes occur, while others are more vulnerable. In many cases, the most vulnerable are the same communities that already experience social, racial, health, and economic inequities. Building a resilient California requires increasing the capacity of communities and people to be able to withstand and recover from climate-related disruptions, and learning to adapt in the face of this change" (CNRA 2018).

A recent example of climate vulnerability can be seen in the Southern California wildfires. Lucas Zucker, the Policy and Communications Director for CAUSE (Central Coast Alliance United for a Sustainable Economy), a grassroots organization dedicated to social, economic, and environmental justice in California's Central Coast region, was interviewed on "Democracy Now!" in December 2017. In the interview he discussed how California wildfires in the fall and early winter of 2017/2018 burdened agricultural workers in multiple ways. In many cases, the workers were low income and could not afford to stop working during the wildfires, regardless of whether smoke inhalation or other impacts made them sick. Many, especially those not fluent in English, faced barriers to obtaining both protective gear and knowledge regarding the risks of exposure, as well as an understanding of their legal rights and available protections. Some did not possess full citizenship status, a factor that dissuaded them from seeking more information and prevented them from receiving restitution. And many workers faced all or a combination of the above circumstances, yet continued to work in physically demanding jobs, potentially exposing themselves to even greater environmental risks during the cleanup and rebuilding of the area (Zucker 2017). Stories like these illustrate the adverse impacts to underserved populations, and also contextualize the social, economic, and environmental factors that are related to an individual's and community's vulnerability and resilience to climate change.

Socioeconomic factors are climate-impact multipliers, making communities that already face inequities more vulnerable. Therefore, there is a great need to develop social and economic resilience, capacity for responding, and venues for meaningful public engagement in those communities most burdened by the impacts of climate change.

Definitions

This report is focused on issues of climate justice as they relate to climate adaptation. This section provides some background and definitions on these topics.

There are two main responses to climate change: mitigation and adaptation. ***Climate Mitigation*** is reducing the causes of climate change, for example, by reducing greenhouse gas emissions or removing them from the atmosphere. ***Climate Adaptation*** is minimizing the impacts of climate change by counteracting climate impacts or reducing vulnerability of populations to these impacts. Examples of climate adaptation include updated building codes to withstand anticipated extreme weather events and emergency response plans to protect populations from environmental disasters due to climate change.

Climate Justice is defined as "the concept that no group of people should disproportionately bear the burden of climate impacts or the costs of mitigation and adaptation" (Cooley 2012).

Adaptive Capacity is "the ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities or to cope with the consequences" (Mazur 2010). ***Climate Resilience*** is similarly defined as "the amount of change a system can undergo without changing state" (IPCC 2001). In other words, adaptive capacity and climate resilience embody the strength to persevere during climate change.

Climate Risk is defined as "a function of exposure and vulnerability" (Cooley 2012). ***Climate Vulnerability*** also reflects both the sensitivity to exposure as well as coping capacity (Moss 2002) (Cutter 2009). ***Social Vulnerability*** is similarly "the susceptibility of a given population to harm from exposure to a hazard, directly affecting its ability to prepare for, respond to, and recover" (Cutter 2009) (Cooley 2012). In all of these cases, however, risk and vulnerability relate to the physical impacts of climate change as well as the social, economic, and environmental factors that make adaptation more difficult.

In 1999, after five previous environmental justice bills had been passed in the Legislature and vetoed by Governor Pete Wilson, California adopted its first environmental justice statute by enacting SB 115 (Solis). ***Environmental Justice*** is defined in state statute as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies" (California Government Code Section 65040.12(e) 1999). However, the environmental justice movement began long before the 1999 statute was enacted; community-led struggles for environmental justice began as early as the 1960s. A defining event occurred in 1982 when North Carolina's Governor James Hunt advocated for the disposal of contaminated soil from Ward Transformer Company to a landfill in the low-income, rural, and predominantly African American community of Afton, North Carolina. The organized street protests and legal challenges in response to the Governor's decision garnered national attention and ignited the birth of a nationwide environmental justice movement. Years later, this movement would define the principles for environmental justice, included below (Skelton 2016).

PRINCIPLES OF ENVIRONMENTAL JUSTICE

Delegates to the First National People of Color Environmental Leadership Summit held on October 24-27, 1991, in Washington, DC, drafted and adopted 17 principles of Environmental Justice. Since then, The Principles have served as a defining document for the growing grassroots movement for environmental justice.

PREAMBLE

WE, THE PEOPLE OF COLOR, gathered together at this multinational People of Color Environmental Leadership Summit, to begin to build a national and international movement of all peoples of color to fight the destruction and taking of our lands and communities, do hereby re-establish our spiritual interdependence to the sacredness of our Mother Earth; to respect and celebrate each of our cultures, languages and beliefs about the natural world and our roles in healing ourselves; to ensure environmental justice; to promote economic alternatives, which would contribute to the development of environmentally safe livelihoods; and, to secure our political, economic and cultural liberation that has been denied for over 500 years of colonization and oppression, resulting in the poisoning of our communities and land and the genocide of our peoples, do affirm and adopt these Principles of Environmental Justice:

1) **Environmental Justice** affirms the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be free from ecological destruction.
2) **Environmental Justice** demands that public policy be based on mutual respect and justice for all peoples, free from any form of discrimination or bias.
3) **Environmental Justice** mandates the right to ethical, balanced and responsible uses of land and renewable resources in the interest of a sustainable planet for humans and other living things.
4) **Environmental Justice** calls for universal protection from nuclear testing, extraction, production and disposal of toxic/hazardous wastes and poisons and nuclear testing that threaten the fundamental right to clean air, land, water, and food.
5) **Environmental Justice** affirms the fundamental right to political, economic, cultural and environmental self-determination of all peoples.
6) **Environmental Justice** demands the cessation of the production of all toxins, hazardous wastes, and radioactive materials, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production.
7) **Environmental Justice** demands the right to participate as equal partners at every level of decision-making, including needs assessment, planning, implementation, enforcement and evaluation.
8) **Environmental Justice** affirms the right of all workers to a safe and healthy work environment without being forced to choose between an unsafe livelihood and unemployment. It also affirms the right of those who work at home to be free from environmental hazards.
9) **Environmental Justice** protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as quality health care.

PRINCIPLES OF ENVIRONMENTAL JUSTICE – CONTINUED

10) **Environmental Justice** considers governmental acts of environmental injustice a violation of international law, the Universal Declaration of Human Rights, and the United Nations Convention on Genocide.
11) **Environmental Justice** must recognize a special legal and natural relationship of Native Peoples to the U.S. government through treaties, agreements, compacts, and covenants affirming sovereignty and self-determination.
12) **Environmental Justice** affirms the need for urban and rural ecological policies to clean up and rebuild our cities and rural areas in balance with nature, honoring the cultural integrity of all our communities, and provided fair access for all to the full range of resources.
13) **Environmental Justice** calls for the strict enforcement of principles of informed consent, and a halt to the testing of experimental reproductive and medical procedures and vaccinations on people of color.
14) **Environmental Justice** opposes the destructive operations of multi-national corporations.
15) **Environmental Justice** opposes military occupation, repression and exploitation of lands, peoples and cultures, and other life forms.
16) **Environmental Justice** calls for the education of present and future generations, which emphasizes social and environmental issues, based on our experience and an appreciation of our diverse cultural perspectives.
17) **Environmental Justice** requires that we, as individuals, make personal and consumer choices to consume as little of Mother Earth's resources and to produce as little waste as possible; and make the conscious decision to challenge and reprioritize our lifestyles to ensure the health of the natural world for present and future generations.

The goal of ***Just Transition*** is to transition from a fossil fuel based/extraction economy to a green/sustainable economy. Inherent in that transition is the need to create a "just economy." Caroline Farrell, the Executive Director of the Center on Race, Poverty & the Environment, proposes this framework learned from the environmental justice movement to achieve a truly just transition: "(1) creating, implementing, and enforcing explicitly equitable public policy based on distributive, procedural, and social justice; (2) creating mechanisms for meaningful participation at the outset from the people affected by the transition;

Excerpt from Climate Justice Alliance's Just Transition Principles:

"Just Transition is a vision-led, unifying and place-based set of principles, processes and practices that build economic and political power to shift from an extractive economy to a regenerative economy. This means approaching production and consumption cycles holistically and waste free. The transition itself must be just and equitable; redressing past harms and creating new relationships of power for the future through reparations. If the process of transition is not just, the outcome will never be. Just Transition describes both where we are going and how we get there" (King 2016).

and (3) taking a social justice or holistic approach to the transition that addresses the political, economic, and social inequities of the fossil fuel economy" (Farrell 2012).

The ***Climate Gap*** describes how people of color and low-income populations will be both the first ones impacted by climate change as well as the least capable of adapting to the resulting impacts (Lin 2009) (Pastor 2010) (Kersten 2012). A series of analyses—"The Climate Gap: Inequalities in How Climate Change Hurts Americans & How to Close the Gap," 2009; "Minding the Climate Gap: What's at Stake if California's Climate Law Isn't Done Right and Right Away," 2010; and "Facing the Climate Gap: How Environmental Justice Communities are Leading the Way to a More Sustainable and Equitable California," 2012—explore the climate gap and describe "the disproportionate and unequal impact the climate crisis has on people of color and the poor" (Morello-Frosch 2009), as well as how "those who are least able to anticipate, cope with, resist and recover from the worst consequences will be the first to face the brunt of climate change hazards" (Kersten 2012).

Although this paper primarily relies on peer-reviewed literature and government documents, climate justice requires working with communities and responding to the lived experiences of vulnerable populations. As such, with support from the Resources Legacy Fund, the Climate Justice Working Group (CJWG) convened environmental justice, public health, and social equity leaders to develop recommendations to ensure that Safeguarding California 2018, California's climate adaptation strategy, would be "responsive to environmental justice and climate equity concerns" (CJWG 2017). As part of that effort, CJWG defined ***Climate Justice*** as "ensuring that the people and communities who are least culpable in the warming of the planet, and most vulnerable to the impacts of climate change, do not suffer disproportionately as a result of historical injustice and disinvestment" (CJWG 2017). The CJWG defined ***Frontline Communities*** as:

> Communities that experience continuing injustice—including people of color, immigrants, people with lower incomes, those in rural areas, and indigenous people—[and] face a legacy of systemic, largely racialized, inequity that influences their living and working places, the quality of their air and water, and their economic opportunities. Climate justice requires California leaders to acknowledge that these frontline communities are experts in creating solutions to protect and preserve our air, water, land, and communities, despite their historical exclusion from decision-making and from public resources and services. Climate justice requires California leaders to provide public resources and services to frontline communities to engage and assist them in developing technologies, policies, professions, services, and projects for addressing the causes and impacts of climate change and healing from historical injustices (CJWG 2017).

CLIMATE JUSTICE WORKING GROUP: VISION, PRINCIPLES, AND POLICY AND FUNDING RECOMMENDATIONS TO GUIDE CALIFORNIA'S ADAPTATION EFFORTS THROUGH 2025

VISION

By 2030, we envision a resilient California where our most vulnerable communities are ready to respond to the physical, environmental, economic and health impacts brought on by climate change, and thrive after climate events. California must proactively bring public and private investments into vulnerable communities to foster robust and thriving communities that are engaged, healthy, just, economically viable, and safe from environmental threats.

GUIDING PRINCIPLES

1. Actively engage frontline communities in research, planning, implementation, education, and decision making about potential climate change impacts and about the development, funding, implementation, and evaluation of adaptation and resilience policies. Create enabling conditions for frontline communities' early, continuous, and meaningful participation in the development of adaptation policy and funding decisions. Partner with local leaders and community-based organizations to enhance the effectiveness of adaptation research and innovation, education, decision making, and policy implementation. This overarching principle applies to all of the subsequent climate justice principles and recommendations.
2. Identify and reduce frontline communities' vulnerabilities to climate change, with a focus on physical, economic, and quality-of-life factors.
3. When planning for infrastructure investments, prioritize actions that increase the resilience of essential facilities and associated services that provide health care, food, drinking water, evacuation routes, and emergency shelter for frontline communities. Reduce community health and safety risks from potential damage to sensitive facilities such as water treatment plants, hazardous waste facilities, and power plants and transmission lines.
4. Promote adaptation policies, funding decisions, and implementation actions that increase training, employment, and economic development opportunities among frontline communities. Where applicable, prioritize opportunities that advance a "just transition" from dependence on fossil fuels and further enhance community resilience to the impacts of climate change.
5. Promote and support regional and local adaptation efforts that generate multiple benefits across sectors.
6. During planning and implementation of land use and community development decisions, consider and avoid negative consequences of actions, including displacement, that could inadvertently increase frontline communities' and individuals' climate vulnerability.
7. Promote adaptation co-benefits of toxic chemical and greenhouse gas reduction policies by supporting those that also reduce frontline communities' climate vulnerability and enhance their resilience.
8. Ensure that adaptation policies, funding decisions, and implementation actions comply with relevant laws and policies that are designed to protect and advance civil rights and environmental justice.

CLIMATE JUSTICE WORKING GROUP: VISION, PRINCIPLES, AND POLICY AND FUNDING RECOMMENDATIONS TO GUIDE CALIFORNIA'S ADAPTATION EFFORTS THROUGH 2025 – CONTINUED

9. Promote local, regional, and state agency transparency, accountability, and adaptive management by developing and applying easy-to-understand climate justice metrics, data and information resources, and annual reporting protocols.
10. Identify needed funding, establish needed funding mechanisms, and allocate adequate funding to support adaptation policy development, implementation, and evaluation in frontline communities.

POLICY AND FUNDING RECOMMENDATIONS

- By 2020, California state agencies should complete regional cross-sector vulnerability assessments that:
    - Provide for frontline community members to participate meaningfully in processes of information-gathering, research, analysis, and review.
    - Identify and prioritize climate change-related threats to the region's frontline communities.
    - Assess how existing critical infrastructure and public services will handle changing conditions, and how the state can strengthen existing infrastructure and services, and develop new infrastructure and services, to enhance climate resilience and prevent displacement.
    - Determine how state agencies will integrate their climate justice policy development, planning, and implementation activities.
    - Provide direction and resources, such as funding and capacity building, to local and regional agencies on integrating climate justice in planning efforts, policy development and implementation, and distribution of resources. Ensure these local and regional agencies are also engaging frontline communities in their research, planning, implementation, and decision-making.
- By 2020, California state agencies should establish regional goals, targets, and implementation strategies for building climate resilience in frontline communities. These elements should be integrated into the state's 2020 climate change adaptation strategy. Areas of focus should include, but not be limited to:
    - Access to economic opportunities.
    - Access to public health facilities and services.
    - Access to safe and affordable drinking water and healthy food.
    - Access to affordable housing.
    - Access to natural resources, parks, and recreational opportunities.
    - Access to transportation.
    - Access to public funds and technical assistance.
    - Regional equity metrics that enable annual evaluation of progress toward resilience for frontline communities.

CLIMATE JUSTICE WORKING GROUP: VISION, PRINCIPLES, AND POLICY AND FUNDING RECOMMENDATIONS TO GUIDE CALIFORNIA'S ADAPTATION EFFORTS THROUGH 2025 – CONTINUED

  - Estimates of funding needed to achieve climate justice for frontline communities in each region.
- By 2020, based on the regional assessments, updated adaptation strategy, and funding estimates, California should immediately identify additional funding and funding mechanisms needed to achieve climate justice and equity for frontline communities.
- By 2020, California should identify, raise, and invest at least $1 billion, and by 2025, at least $10 billion through appropriate funding sources to:
  - Ensure frontline community members are involved in all aspects of climate adaptation and resilience policy research, development, planning, decision making, implementation, and evaluation.
  - Complete, for each region, community emergency preparedness plans, including maps and strategies for providing relocation and community services to frontline communities in case of disasters.
  - Make critical infrastructure and public service improvements in frontline communities consistent with regional assessments, goals, targets, and implementation strategies.
  - Develop an adequate supply of affordable, energy efficient housing in low-income and frontline communities.
  - Support a just transition to a non-extractive, clean energy economy in ways that provide multiple benefits to frontline communities, including job training, targeted employment, and generation of wealth and health.

Similarly, the Movement Generation Justice & Ecology Project, an organization "rooted in vibrant social movements led by low-income communities and communities of color committed to a Just Transition away from profit and pollution and towards healthy, resilient and life-affirming local economies," defines ***resilience*** as:

> "the capacity of a system (whether a community or an economy) to maintain an intact core identity in the face of change and a state of dynamic balance within which change can be avoided or recovered from without a fundamental transition to a new form. The degree to which change is fundamentally disruptive is inversely related to resilience…. [Resilience] can bridge mitigation and adaptation, and economy and ecology, and can help us create more social cohesion, inclusion, power and participation and more holistic and systemic interventions" (Movement Generation 2015).

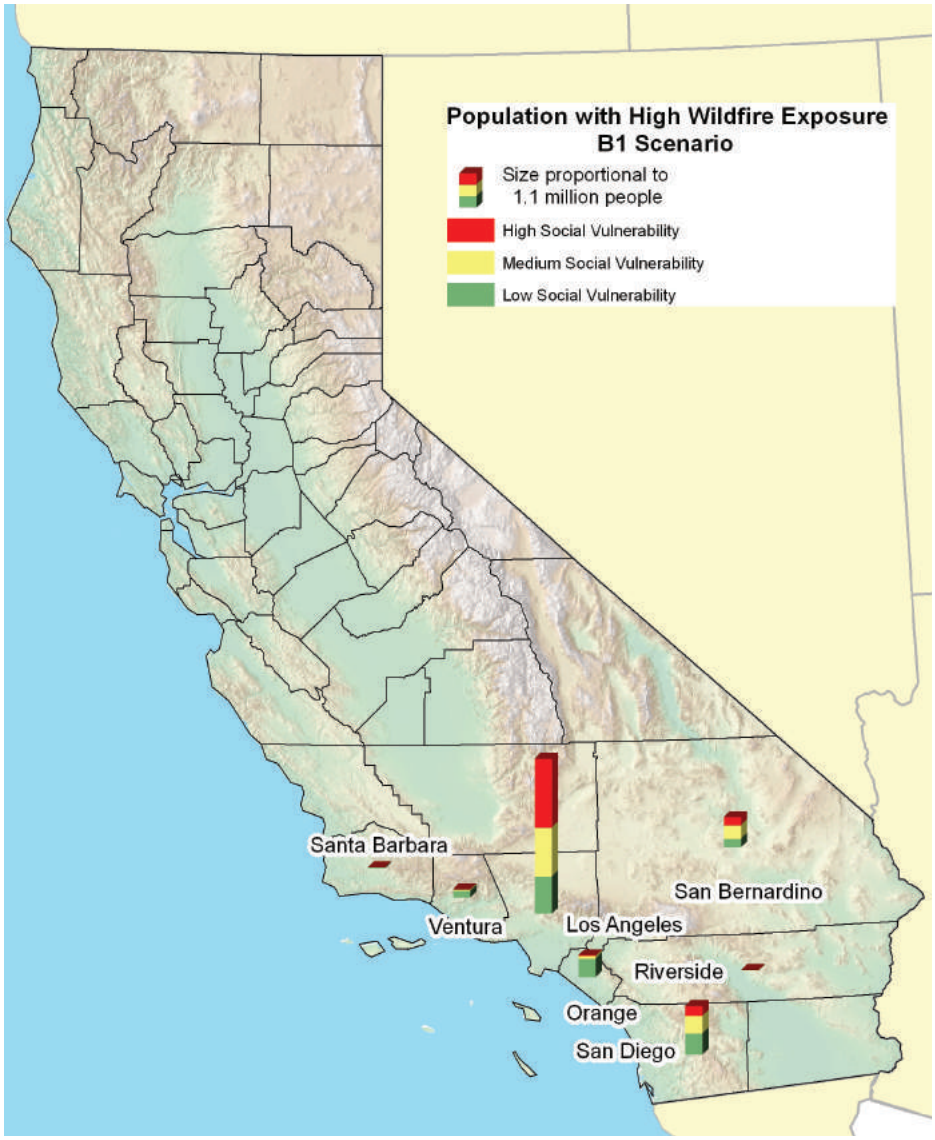
Pathways to Resilience: Transforming Cities in a Changing Climate provides yet another definition of ***resilience***: "Our vision of climate resilience is not about 'bouncing back.' Instead, it is about bouncing forward to eradicate the inequities and unsustainable resource use at the heart of climate crisis" (Debacker 2015).

Measuring Climate Risk: Indices, Mapping Tools, and Projections

Identifying and mapping communities in relation to current and anticipated climate risks (e.g., high social vulnerability or high exposure to climate impacts) is an essential part of the scientific foundation for understanding the state's changing conditions related to climate change. That said, there are significant limits to most mapping tools, especially because they are often not vetted with local communities. For this paper, we searched for an interactive mapping tool for laypeople that incorporates risk from projected climate change, along with existing and projected environmental health risks and current and projected socioeconomic data, including climate resilience/adaptive capacity, but were unable to find one.

There are, however, a few static maps that are very informative. In a 2012 study by the Pacific Institute for the California Energy Commission and the California Natural Resources Agency, the authors developed a new climate vulnerability index and mapped it with projected exposure to extreme heat, particulate matter, coastal flooding, and wildfire to identify areas with high climate risk (Cooley 2012). The authors' vulnerability index combined 19 weighted

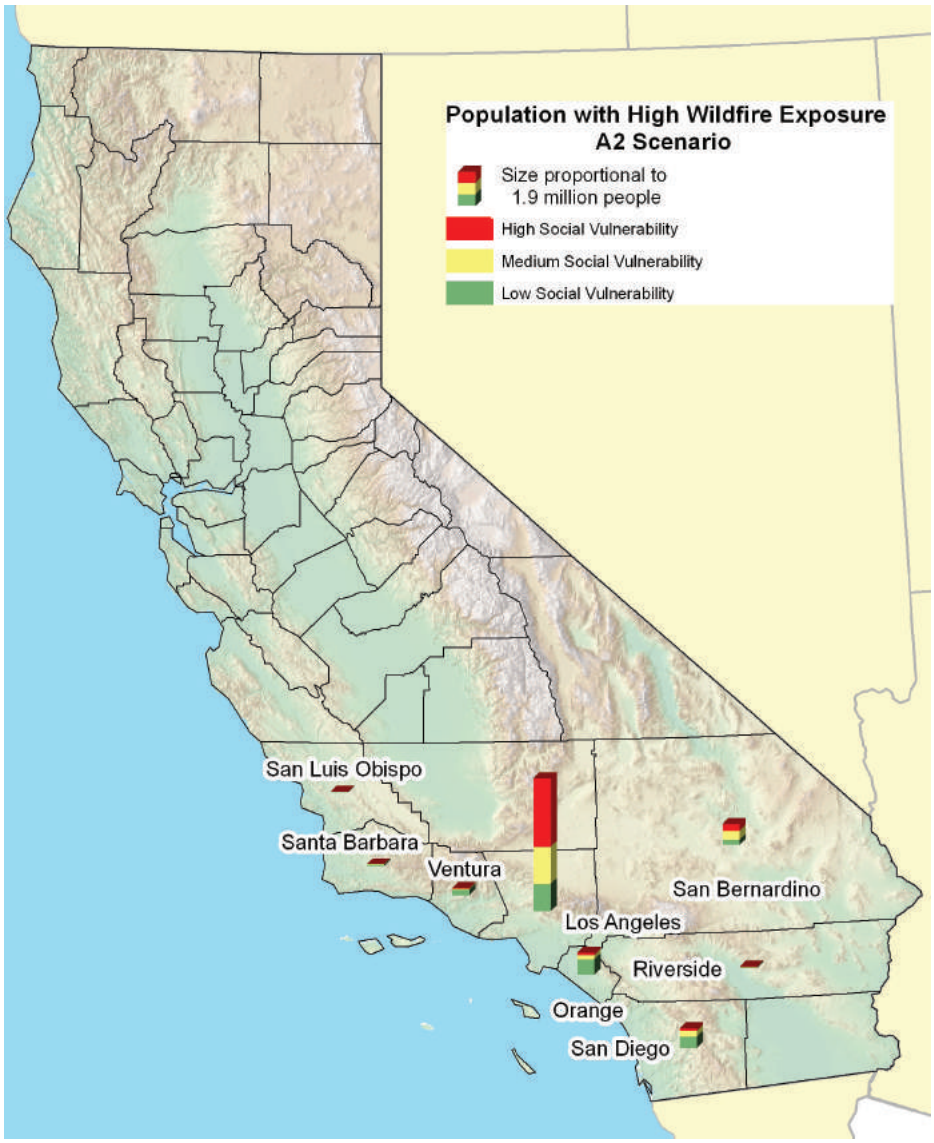
MAP 1 | SOCIAL VULNERABILITY OF POPULATION WITH HIGH, MEDIUM, AND LOW WILDFIRE EXPOSURE UNDER THE B1 SCENARIO BY THE END OF THE CENTURY, BY COUNTY (COOLEY 2012)



This map shows how many people with low (below 33rd percentile), medium (between the 33rd and 66th percentile), and high (above 66th percentile) social vulnerability are projected to be impacted by wildfires under climate scenario B1.

factors concerning a community's ability to adapt to climate change, including households with no air conditioning, population over 25 without a diploma, population born outside the U.S., impervious areas, residents living in institutions (including institutions like correctional facilities, nursing homes, mental hospitals, college dormitories, military barracks, group homes, missions, and shelters), households with limited English, households with no vehicle, people of color, households in poverty, pre-term births, renter-occupied households, population over 65 and living alone, tree canopy cover, population under 18, unemployment, residents that have jobs working outdoors (agriculture, forestry, mining, or construction), pregnancy, food access, and youth fitness. Because of data gaps, the paper was unable to include factors such as diabetes, homelessness, and immigration status, all factors which impact a person's vulnerability (Cooley 2012). Maps 1 and 2 show how many people with low (below 33rd percentile), medium (between the 33rd and 66th percentile), and high (above 66th percentile) social vulnerability are projected to be impacted by wildfires under two different climate scenarios (B1 and A2, respectively) in each California county. Although this study sheds light on climate risk, the tool is not yet readily available. The maps and

MAP 2 | SOCIAL VULNERABILITY OF POPULATION WITH HIGH, MEDIUM, AND LOW EXPOSURE TO WILDFIRE UNDER THE A2 SCENARIO BY THE END OF THE CENTURY, BY COUNTY (COOLEY 2012)



This map shows how many people with low (below 33rd percentile), medium (between the 33rd and 66th percentile), and high (above 66th percentile) social vulnerability are projected to be impacted by wildfires under climate scenario A2.

climate scenarios are static, and limited to only those shown in the paper. In addition, the climate scenarios (B1 and A2) are now outdated.

In addition, the California Governor's Office of Emergency Services (Cal OES) recently released the Draft 2018 California State Hazard Mitigation Plan, which includes updated Geographic Information System (GIS) Risk Assessment Modeling. The social vulnerability index that they use for these models incorporates a weighted value of the following indicators: poverty/income, disabilities, food access, education, linguistic isolation, vehicle availability, age, minority status, long-term care facility residents, housing tenure, and gender (see Figure 1) (Cal OES 2018).

Using this index they mapped:

- relative population/social vulnerability (see Map 3),
- relative population/social vulnerability and areas at high risk of flood (see Map 4),
- relative population/social vulnerability and areas at high risk of wildfires (see Map 5), and
- relative population/social vulnerability and estimated number of heat days in 2050 for selected cities (see Map 6).

Cooley (2012) and Cal OES (2018) use a particular set of influences to create a social vulnerability index and map different projected climate impacts, but there are additional definitions, indices, projections, and mapping tools readily available, each with its own strengths and weaknesses. Recognizing that none are perfect, these tools (as well as future tools) may help guide more effective policies and improve emergency response planning to achieve climate justice. The following is a short overview of some of the tools that attempt to identify and map communities that are most vulnerable to climate change.

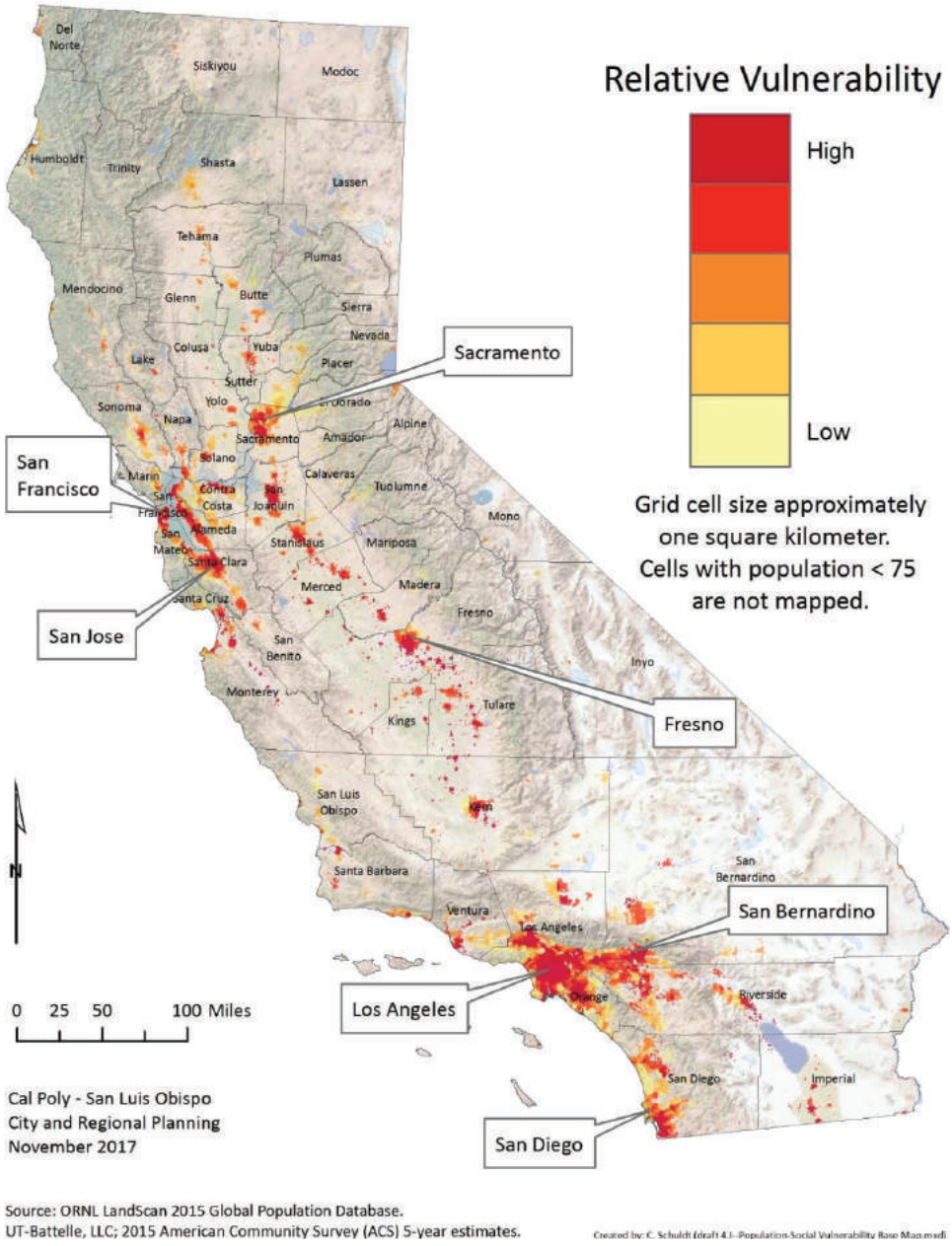
FIGURE 1 | SOCIAL VULNERABILITY MODEL WEIGHTS INDICATOR

APPENDIX TABLE M.2: SOCIAL VULNERABILITY MODEL WEIGHTS

INDICATOR	MODEL WEIGHT
Poverty/Income	0.190
Disabilities	0.126
Food Access	0.105
Education	0.093
Linguistic Isolation	0.090
Vehicle Availability	0.087
Age	0.072
Minority Status	0.071
Long-term Care Facility Residents	0.069
Housing Tenure	0.054
Gender	0.043

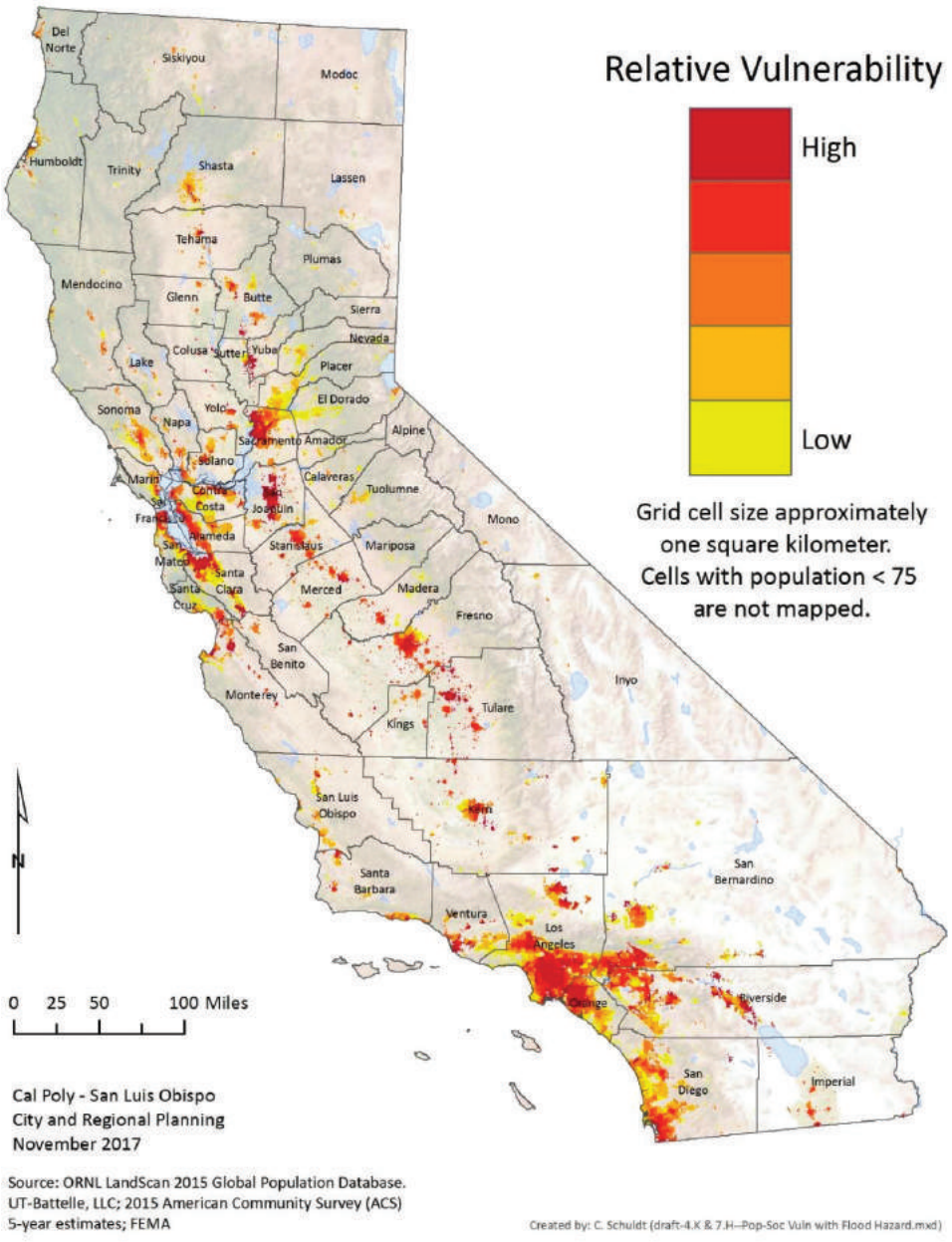
Higher values correspond to higher vulnerability, with values for each variable between a minimum of zero and a maximum of one (Cal OES 2018).

MAP 3 | RELATIVE POPULATION/SOCIAL VULNERABILITY (CAL OES 2018)



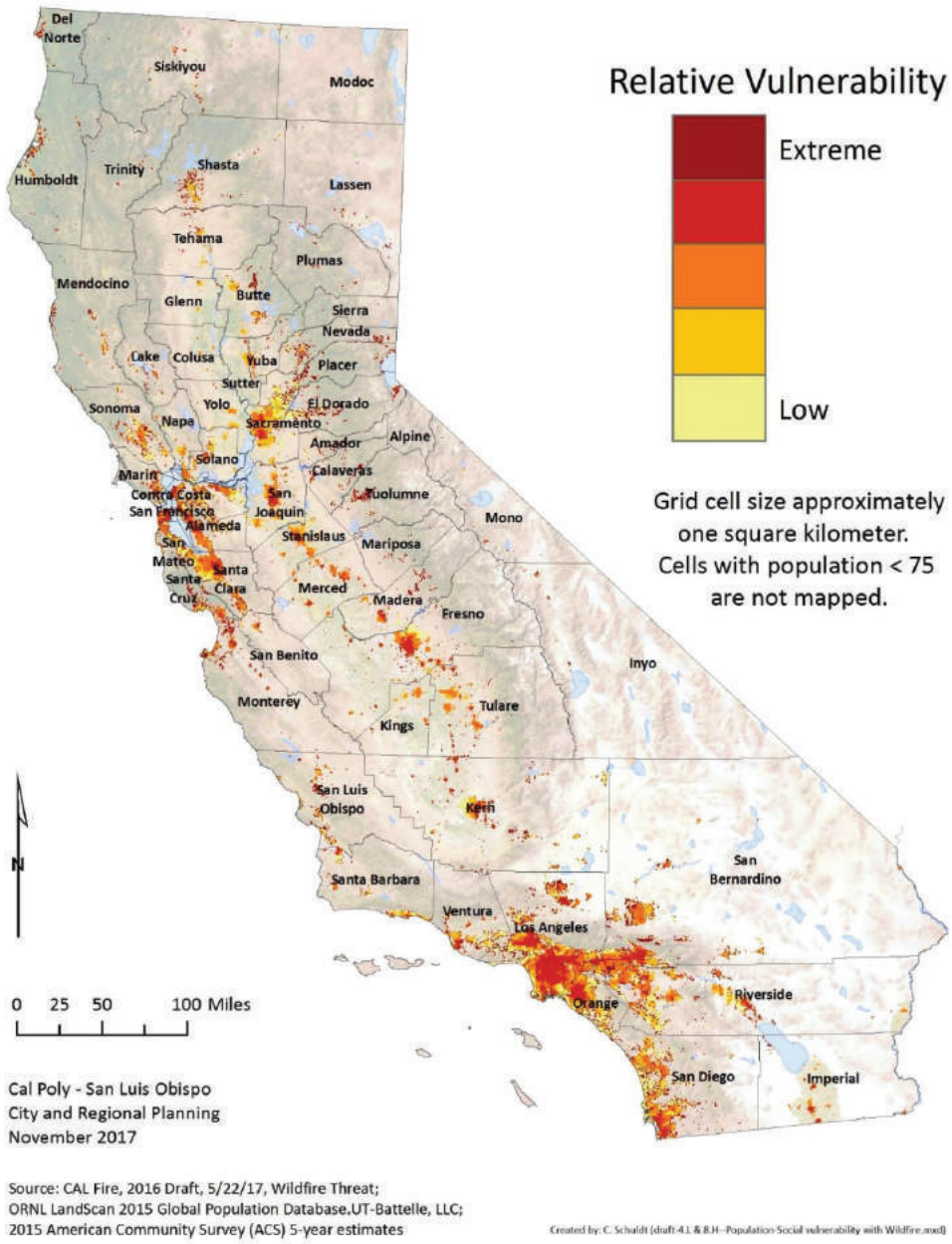
This map shows combined population density and social vulnerability.

MAP 4 | RELATIVE POPULATION/SOCIAL VULNERABILITY WITH FLOOD HAZARD (CAL OES 2018)



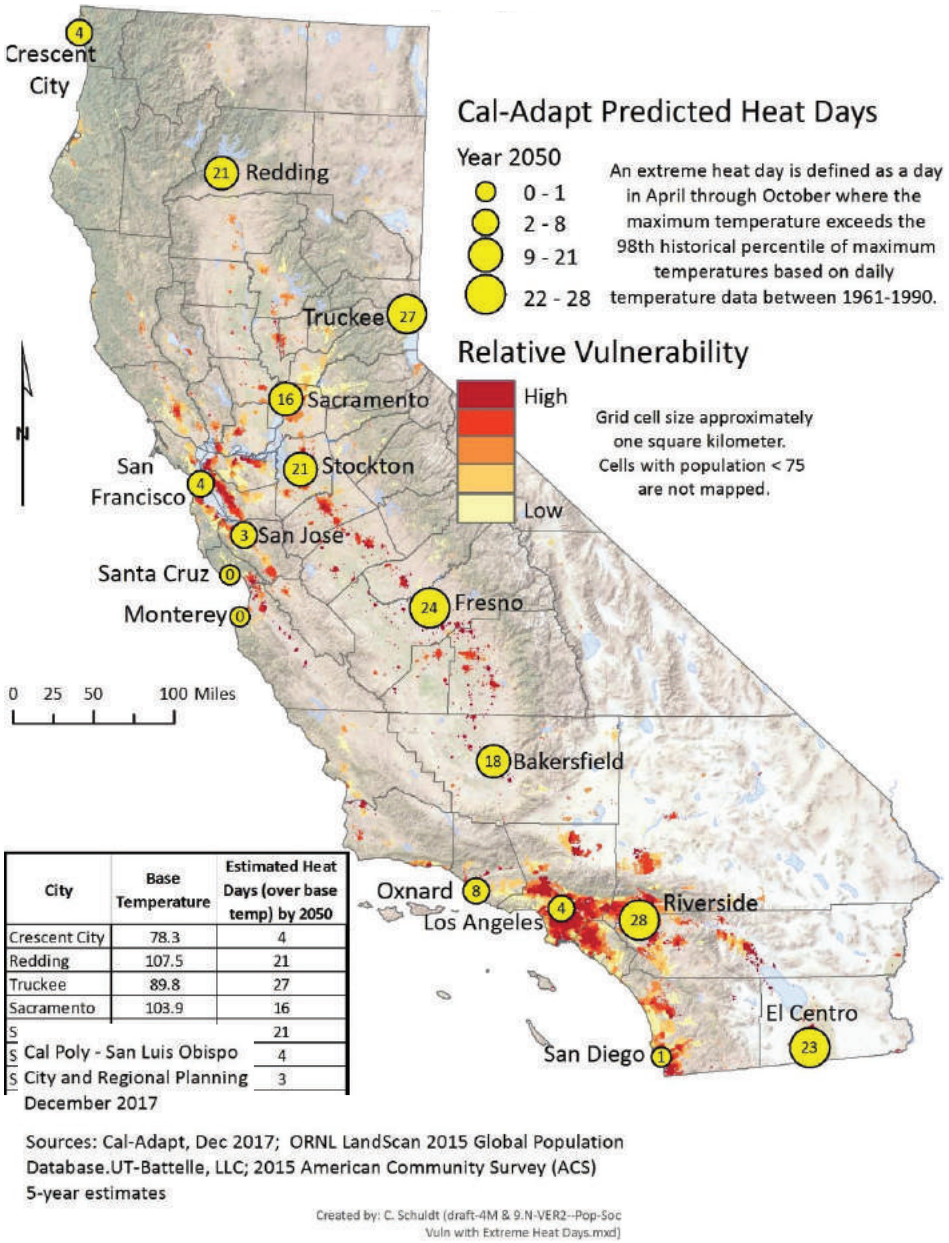
This map shows population/social vulnerability in areas with high risk of flood hazards.

MAP 5 | RELATIVE POPULATION/SOCIAL VULNERABILITY WITH WILDFIRE HAZARD (CAL OES 2018)



This map shows population/social vulnerability in areas of high risk of wildfire hazards.

MAP 6 | SOCIAL VULNERABILITY BASE MAP WITH ESTIMATED NUMBER OF HEAT DAYS BY 2050 FOR SELECTED CITIES (CAL OES 2018)



City	Base Temperature	Estimated Heat Days (over base temp) by 2050
Crescent City	78.3	4
Redding	107.5	21
Truckee	89.8	27
Sacramento	103.9	16
S		21
S Cal Poly - San Luis Obispo		4
S City and Regional Planning		3

December 2017

City	Base Temperature	Estimated Heat Days (over base temp) by 2050
Crescent City	78.3	4
Redding	107.5	21
Truckee	89.8	27
Sacramento	103.9	16
Stockton	102.2	21
San Francisco	87	4
San Jose	95.6	3
Santa Cruz	93.1	0
Monterey	87.3	0
Fresno	106.3	24
Bakersfield	107.7	18
Oxnard	88.9	8
Los Angeles	95.5	4
Riverside	103.6	28
San Diego	89	1
El Centro	113.7	23

This map shows population/social vulnerability with estimated number of extreme heat days by 2050 in selected cities.

Tools for Mapping and Indices

CALENVIROSCREEN AND DISADVANTAGED COMMUNITIES

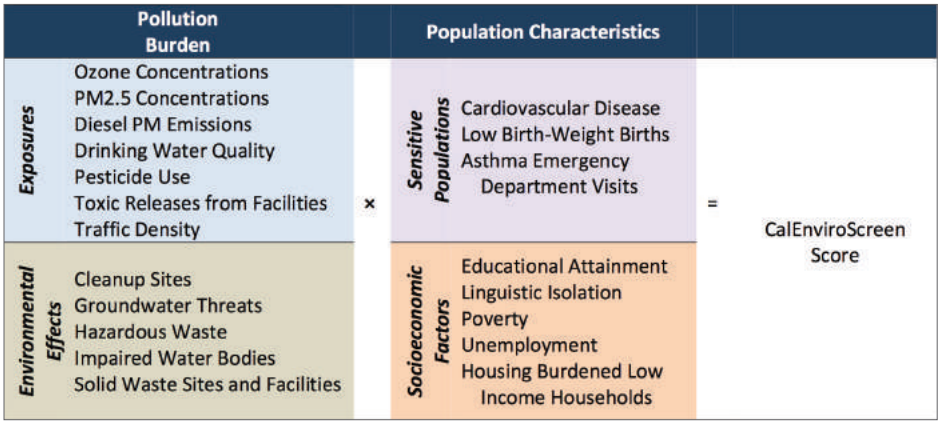
California Communities Environmental Health Screening Tool Version 3.0, CalEnviroScreen (CES), "is a mapping tool that identifies census tracts that are most affected by many sources of pollution, and where people are often especially vulnerable to pollution's effects" (OEHHA 2017). CES weighs and combines 20 indicators to create a single CES score for each census tract, with higher scores indicating communities at greater risk due to environmental burdens, existing health issues, and socioeconomic challenges. CES uses 12 indicators of pollution burden subdivided into exposures and environmental effects, and 8 population characteristics subdivided into sensitive populations and socioeconomic factors (see Figure 2) (CalEPA 2017). An interactive map of CES scores can be found here, with an interactive map of each individual indicator in isolation—such as ozone or linguistic isolation—available lower down on the page. Out of the approximately 8,000 census tracks, 22 are not given a CES score because of unavailable or unreliable public health and socioeconomic data, or because less than 50 non-incarcerated people live there.

California Senate Bill (SB) 535 (de León 2012) required that CalEPA identify disadvantaged communities in the state, and also that at least 25% of Greenhouse Gas Reduction Fund (GGRF, proceeds from California's greenhouse gas cap-and-trade program) allocations be to projects that benefit disadvantaged communities, with at least 10% allocated to projects located within disadvantaged communities. California Assembly Bill (AB) 1550 (Gomez 2016) increased and changed the required allocations to:

- a minimum of 25% of funds allocated must benefit disadvantaged communities;
- an additional minimum of 5% of funds allocated must be located within and benefiting individuals living in low-income communities or fund projects benefiting low-income households statewide; and
- an additional minimum of 5% of funds allocated must fund projects located within and benefiting individuals living in low-income communities, or benefiting low-income households, that are within ½ mile of a disadvantaged community.

CalEPA used CES to determine what defined a disadvantaged community. They designated the top 25% of ranked census tracts

FIGURE 2 | CALENVIROSCREEN 3.0 INDICATOR AND COMPONENT SCORING



CalEnviroScreen 3.0 uses 12 pollution burden indicators, subdivided into exposures and environmental effect, and 8 population characteristics, subdivided into sensitive populations and socioeconomic factors (CalEPA 2017).

as disadvantaged, along with census tracts that scored in the highest 5% of pollution burden but were not given a CES score because of unavailable or unreliable data. Here is an interactive map of CES with all of the designated disadvantaged census tracts. Low-income communities are defined as census tracts that are at or below 80% of the statewide median income, or at or below the threshold designated as low income by the California Department of Housing and Community Development (CARB 2017). Here is an interactive map that indicates SB 535 disadvantaged communities, AB 1550 low-income communities, communities that are both, and AB 1550 low-income communities within a half mile of a SB 535 disadvantaged community.

CES has received both positive and negative feedback, with new versions incorporating updated data sets to existing indicators and updated research to justify the addition and deletion of indicators. CES is also bound by legal considerations. For example, although the California environmental justice statute provides for fair treatment regardless of race, Proposition 209 concerns eliminated the possibility of using race as an indicator in these initial iterations of CES to direct state funding. That said, race/ethnicity and age can be viewed for each individual census tract on the mapping tool. In addition, the interactive CES mapping tool does not factor in projected climate impacts, nor does it identify tribal government land.

CALIFORNIA HEALTHY PLACES INDEX

California's Healthy Places Index (HPI) is "a composite index to identify cumulative health advantage in California" (PHASoCal 2018). The HPI weighs and combines 25 community characteristics to create a single

SB 535 LAW

One of the first free solar installations for a low-income family in Fresno under the SB 535 law (de Leon 2012) that dedicates California Climate Investments for disadvantaged communities (photo courtesy of Mari Rose Taruc).

HPI score, with higher scores indicating communities that are healthier (and more resilient to climate change). The 25 characteristics are divided into 8 Policy Action Areas (Economic, Education, Housing, Health Care Access, Neighborhood, Clean Environment, Transportation, and Social factors), each of which has its own sub-score (see Figure 3) (HPI 2018).

The interactive HPI map enables users to view the HPI percentiles of all census tracts and also allows users to view maps of any individual HPI indicator score or any individual additional characteristic (decision support layer). These "decision support layer" characteristics include climate change exposures (including extreme heat days, population in sea level rise inundation area, and wildfire risk), climate change social vulnerability (including foreign born, outdoor worker, children, and the elderly), and climate change adaptive capacity (including air conditioning, transit access, and urban heat island index). This climate-related data is not incorporated into the HPI index score, and users cannot overlay these characteristics on top of each other using the mapping tool. They can, however, download and access the raw data in XLXS or CSV.

Similar to CES, the HPI index does not factor in race/ethnicity, because "California's Prop 209 prohibits allocating certain kinds of public resources based on race and ethnicity" (HPI 2018), and this would limit the allowable uses of the HPI index. That said, there is a version of HPI called "HPI+Race" that includes a measure of racial inequities. Here is a map of that data. Like CES, neither HPI nor HPI+Race identifies tribal government land.

FIGURE 3 | CALIFORNIA'S HEALTHY PLACES INDEX (HPI) COMMUNITY CHARACTERISTICS AND WEIGHTS

Action Areas	Economic	Social	Education	Transportation	Neighborhood	Housing	Clean Environment	Healthcare
Weight (fraction)	.32	.10	.19	.16	.08	.08	.05	.05
Indicators	Employed	Two Parent Households	In Preschool	Automobile Access	Retail Density	Low-Income Renter (Severe Housing Cost Burden)	Ozone	Insured
	Income	Voting in 2012	In High School	Active Commuting	Park Access	Low-Income Homeowner (Severe Housing Cost Burden)	PM 2.5	
			Bachelor's Education or Higher		Tree Canopy	Housing Habitability	Diesel PM	
					Supermarket Access	Uncrowded Housing	Water Contaminants	
					Alcohol Outlets	Homeownership		

The 8 Policy Action Areas of HPI, each of which has its own sub-score (HPI 2018)

Prior to HPI, there was a Health Disadvantage Index (HDI) and an interactive map, where higher scores corresponded to less healthy (and less climate resilient) communities (see Figure 4) (Bhatia 2016). HPI has now replaced HDI and has the most up-to-date maps and data.

FIGURE 4 | HEALTH DISADVANTAGE INDEX (AND WEIGHTS)

Economic Resources	Social Resources	Educational Opportunity	Health Outcomes	Environmental Hazards	Complete Neighborhoods
50	**15**	**10**	**10**	**10**	**5**
Poverty	High school educational attainment	Residents whose age makes them eligible for, but not enrolled in, preschool	Population disabled	Pedestrian injuries	Supermarket access
Crowding	Linguistic isolation	High School	Low birth weight births	PM 2.5 concentration	Park access
Housing cost	Renter occupied		Years of life lost	Traffic density	Retail density
Unemployment rate	Voting		Asthma ER visits		Transit service
No auto access	Single-parent households				
Median income					
Uninsured					
No kitchen					

Prior to the Healthy Places Index, there was the Health Disadvantage Index, where a higher score indicated a less healthy community (Bhatia 2016).

CAL-ADAPT

Cal-Adapt "has been designed to provide access to the wealth of data and information that has been, and continues to be, produced by the State of California's scientific and research community. The data available on this site offers a view of how climate change might affect California at the local level" (Cal-Adapt n.d.). Users can work with maps and other visualization tools, access climate data, and share information online with the Cal-Adapt community.

Cal-Adapt does include CES layers, but does not enable the user to visualize the most climate-vulnerable communities. Rather, Cal-Adapt enables the user to see the CES tracts, select one or more specific tracts (for example, all of the most disadvantaged or a single disadvantaged tract), and then download Cal-Adapt indicator data for those tracts. As a result, Cal-Adapt's maps do not incorporate any socioeconomic conditions, including existing pollution burden, health conditions, or income.

Cal-Adapt's utility could be enhanced by connecting it to the Adaptation Capability Advancement Toolkit, which is based on the Capability Maturity Model (CMM) process improvement framework. The Adaptation Capability Advancement Toolkit includes three parts: (1) a CMM Matrix that describes key capabilities, (2) Self-Assessment Checklists that enable the user to assess their local government agency's capabilities, and (3) a Roadmap of suggested actions to advance capabilities and external resources to aid in this process. The state could identify climate data and other Cal-Adapt outputs that could be incorporated into the Roadmap, such as vulnerability assessments and climate stressor monitoring (Kay 2018).

CALBRACE

The California Building Resilience Against Climate Effects (CalBRACE) Project has created indicators, data, and narratives to assess exposures, social vulnerability, and adaptive capacity. These include environmental exposure indicators (such as ozone, fine particulate matter, extreme heat days, wildfires, and sea level rise), population sensitivity indicators (such as children, elderly, race/ethnicity, linguistic isolation, violent crime rate, and health insurance), and adaptive capacity indicators (such as tree canopy, impervious surfaces, air conditioning, and public

transit access). With these indicators and this data, CalBRACE created Climate Change and Health Profile Reports for all California counties. "The assessment data can be used to screen and prioritize where to focus deeper analysis and plan for public health actions to increase resilience" (CDPH 2018).

Although the CalBRACE data incorporates climate impacts and climate vulnerability, each indicator is isolated and there is no combined weighted score or other means to synthesize all of the exposures, vulnerability, and adaptive capacity into one map. There are also no interactive maps, only the raw data. However, the California Department of Public Health's Office of Health Equity will be releasing an interactive data visualization platform for the Climate Change & Health Vulnerability Indicators for California.

Side-by-side Climate Change Projections with CES and HPI

Recognizing that no one index or mapping tool is perfect, different indices are presented to see how they compare to each other. Figure 5 (produced by Jason Vargo 2018) is a side-by-side comparison showing the different factors

FIGURE 5 | COMPARING CALENVIROSCREEN AND HEALTHY PLACES INDEX INDICATORS

CalEnviroscreen 3.0

Domain	Component	Indicator
Pollution Burden	Exposure	Ozone concentrations PM2.5 concentrations Diesel PM Emissions Drinking water quality Pesticide use Toxic releases from facilities Traffic density
	Environmental Effects	Toxic cleanup sites Groundwater threats Hazardous waste Impaired water bodies Solid waste sites and facilities
Population Characteristics	Sensitive Populations	Cardiovascular Disease Low birth-weight births Asthma emergency department visits
	Socioeconomic	Educational Attainment Linguistic isolation Poverty Unemployment Housing burdened low-income households

CalEnviroScreen 3.0
20 indicators >>
4 components >>
2 burdens >>
1 score

Statewide census tracts ranked by percentile and averaged to obtain component scores. Component scores are combined to burden scores (0-10). Burden scores are multiplied together (0-100).

Healthy Places Index

Component	Indicator	Weight
Clean Environment	Ozone PM 2.5 Diesel PM Water Contaminants	5.2%
Neighborhood	Retail Density Park Access Tree Canopy Supermarket Access Alcohol Outlets	7.7%
Economic	Employed Income	31.9%
Social	Two Person Household Voting in 2012	10.4%
Housing	Severe Housing Cost Burden (Renter and Homeowner) Housing Habitability Housing Crowding Homeownership	5.2%
Education	In Preschool In Highschool Bachelor's Education or Higher	18.7%
Transportation	Automobile Access Active Commuting	15.5%
Healthcare	Health Insurance	5.2%

Healthy Places Index
24 indicators >>
6 domains >>
1 index

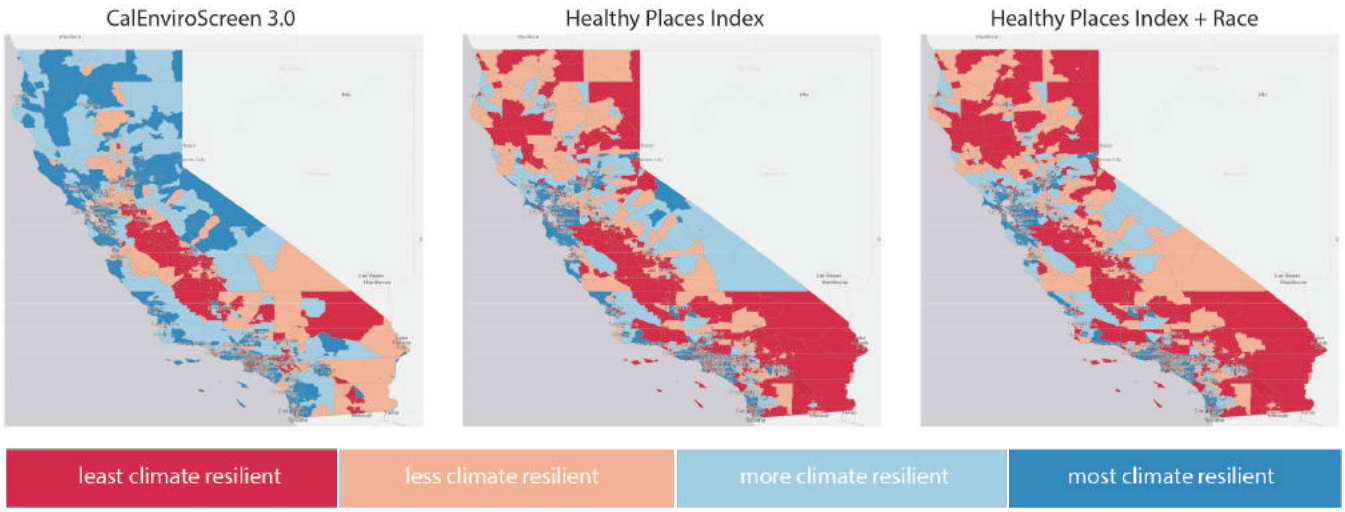
Indicators available at census tract scales.Domains are weighted toward final index value based on association with life expectancy at birth.

A side-by-side comparison of CalEnviroScreen 3.0 and Healthy Places Index, showing the different factors included in each (produced by Jason Vargo 2018)

included in the CES 3.0 and HPI scores.

Here (CES), here (HPI), and here (HPI+Race) are isolated maps of each of the data—Map 7 shows all 3 maps side by side. Red signifies the least climate resilient communities on all 3 maps. On the CES map, red is the top 25th

MAP 7 | SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



Side-by-side comparison of CES, HPI, and HPI+Race maps, where red signifies the least climate resilient in all three. On the CES map, red is the top 25th percentile (most disadvantaged), and on the HPI maps, red is the bottom 25th percentile (least healthy).

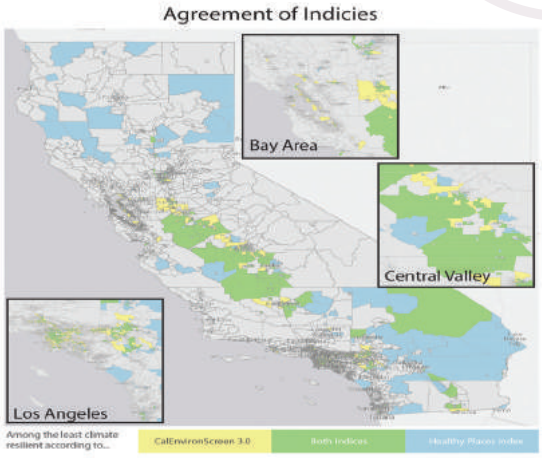
percentile (most disadvantaged), and on the HPI maps, red is the bottom 25th percentile (least healthy).

Map 8 compares both CES and HPI maps and shows which census tracts are indicated as least climate resilient in both (green), which are indicated as least resilient only in CES (yellow), and which are indicated as least resilient only in HPI (blue).

Maps 9, 10, and 11 show more detailed side-by-side comparisons of CES, HPI, and HPI+Race maps for the Bay Area, Los Angeles, and the San Joaquin Valley respectively.

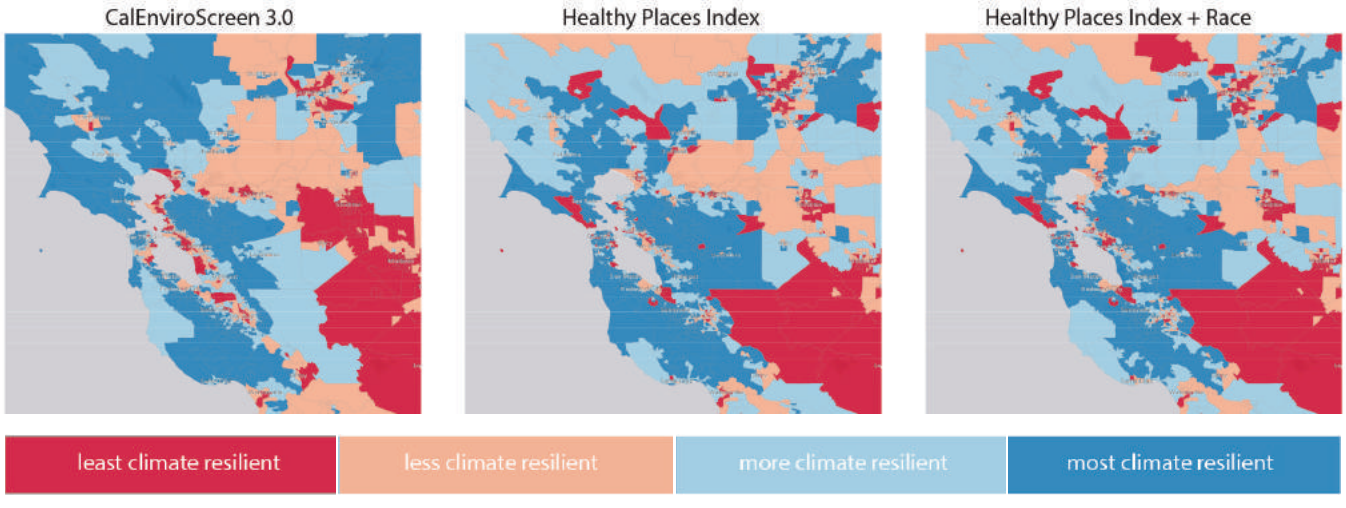
See Knowledge Gaps below for areas ripe for additional research. For now, here are some comparisons.

MAP 8 HEALTHY PLACES INDEX AND CALENVIROSCREEN 3.0 COMPARISON MAP (PRODUCED BY JASON VARGO 2018)



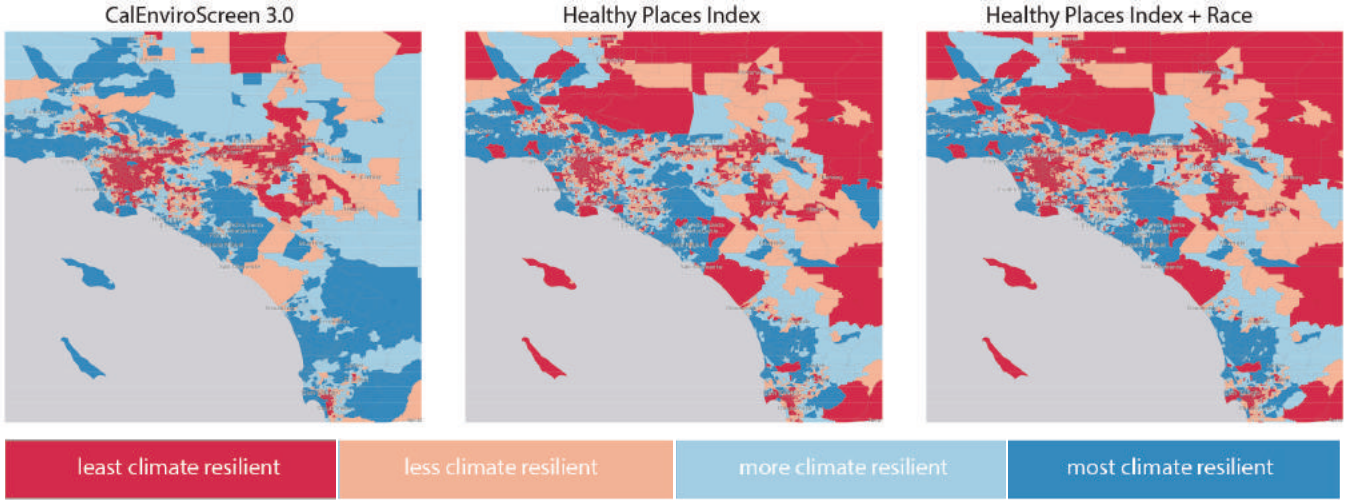
Map comparing CES and HPI maps, where census tracts that are least climate resilient in both CES and HPI are green, census tracts that are least resilient only in CES are yellow, and census tracts that are least resilient only in HPI are blue.

MAP 9 | BAY AREA: SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



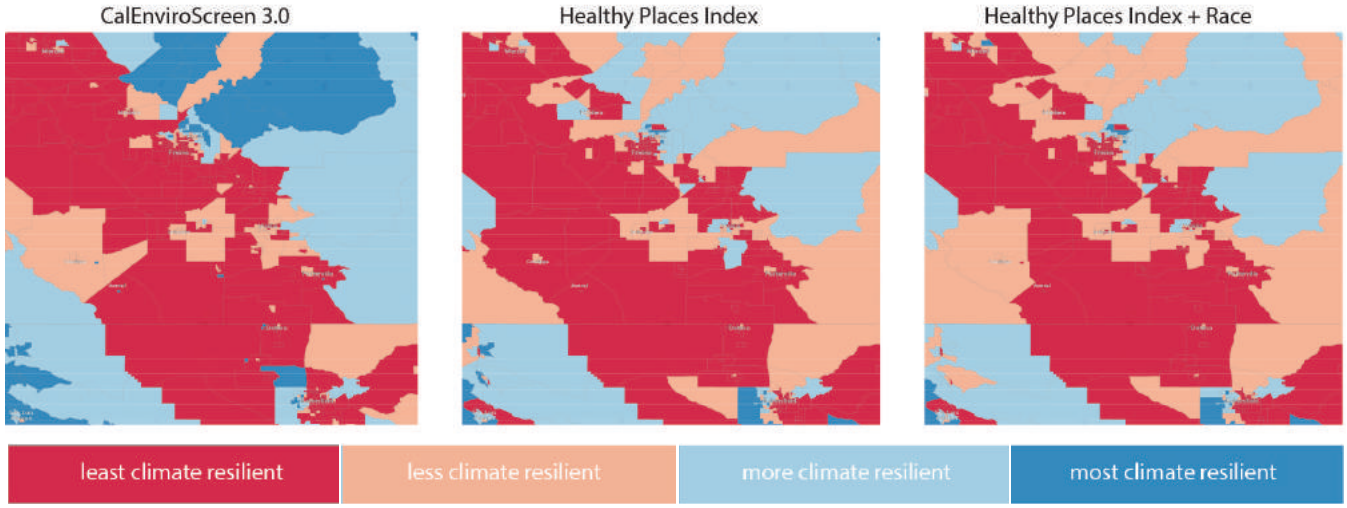
Close-up of the Bay Area: side-by-side comparison of CES, HPI, and HPI+Race maps, where red signifies the least climate resilient in all three. On the CES map, red is the top 25th percentile (most disadvantaged), and on the HPI maps, red is the bottom 25th percentile (least healthy).

MAP 10 | LOS ANGELES: SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



Close-up of Los Angeles: side-by-side comparison of CES, HPI, and HPI+Race maps, where red signifies the least climate resilient in all three. On the CES map, red is the top 25th percentile (most disadvantaged), and on the HPI maps, red is the bottom 25th percentile (least healthy).

MAP 11 | SAN JOAQUIN VALLEY: SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)

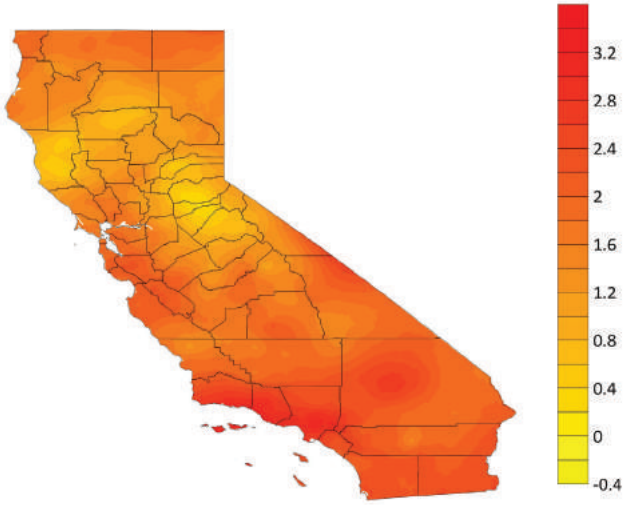


Close-up of the San Joaquin Valley: side-by-side comparison of CES, HPI, and HPI+Race maps, where red signifies the least climate resilient in all three. On the CES map, red is the top 25th percentile (most disadvantaged), and on the HPI maps, red is the bottom 25th percentile (least healthy).

TEMPERATURE TRENDS IN CALIFORNIA

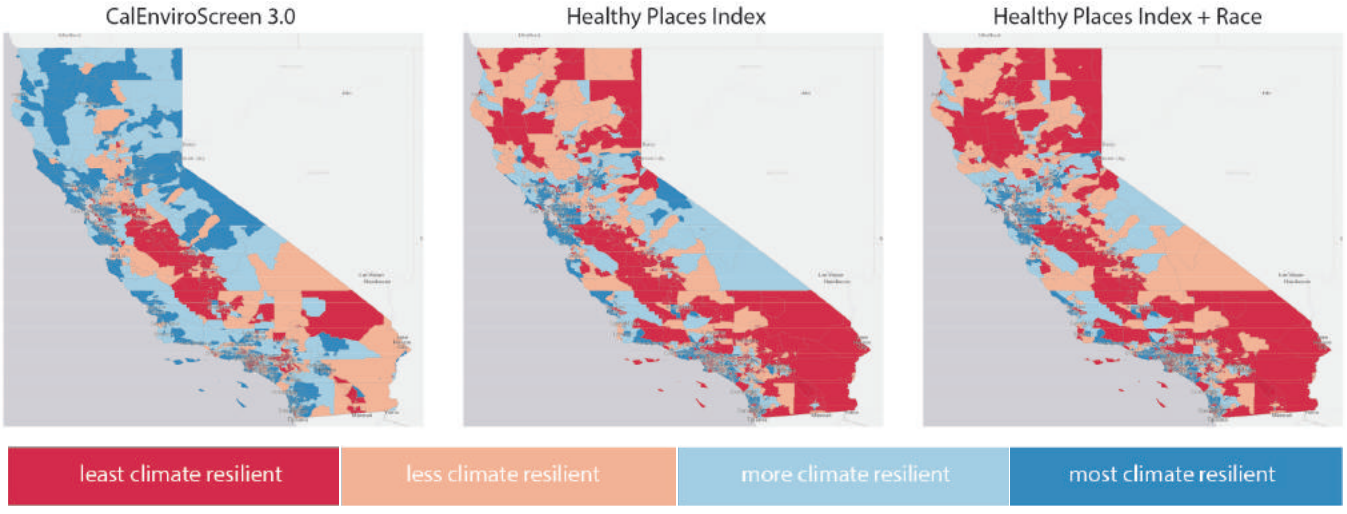
Map 12 (Vose 2017) shows observed changes in annual temperatures (°F). Changes are the difference between the average for present day (1986-2016) and the average for the first half of the last century (1901-1960). When compared with Map 7, there is significant overlap between disadvantaged communities (CES) and unhealthy communities (HPI and HPI+Race), meaning that some of the communities least able to adapt to climate change will be the hardest hit by temperature increases.

MAP 12 | TEMPERATURE TRENDS: OBSERVED CHANGES IN ANNUAL TEMPERATURES (°F).



Changes are the difference between the average for present day (1986-2016) and the average for the first half of the last century (1901-1960). Data based on (Vose 2017).

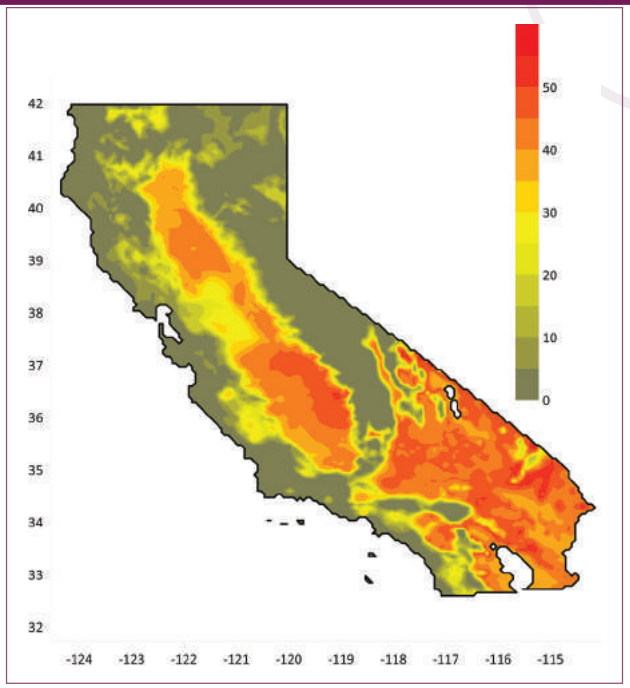
MAP 7 | SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



EXTREME TEMPERATURES

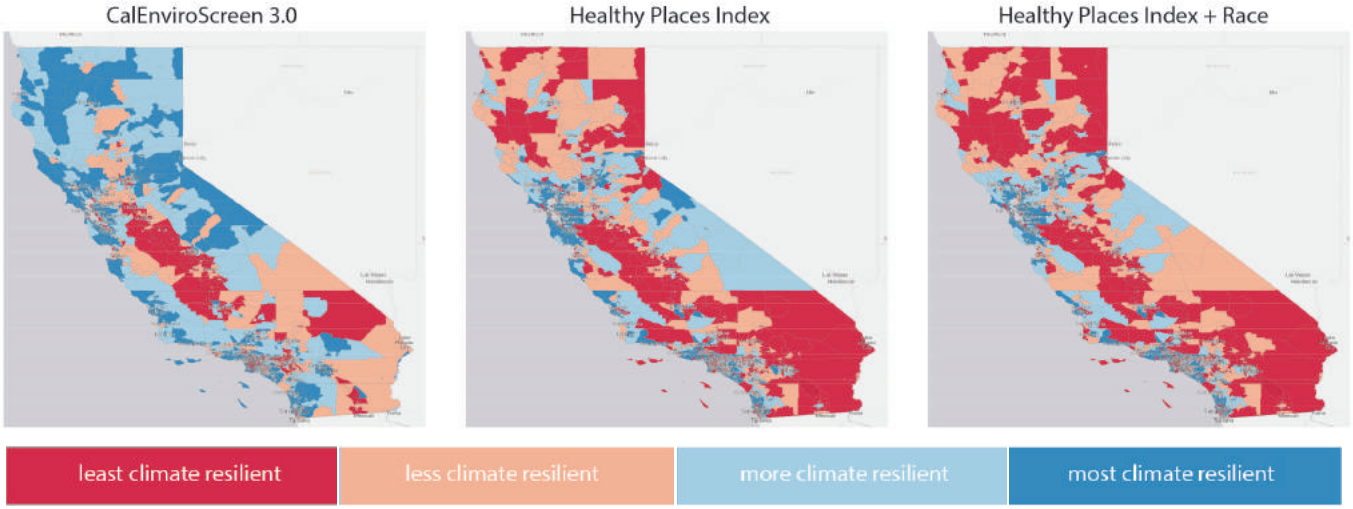
Map 13 shows average number of days per year for RCP 8.5 (a modeling scenario with comparatively high GHG emissions) with daily maximum temperatures higher than 100°F between 2040 and 2060. When compared with Map 7, there is significant overlap between disadvantaged communities (CES) and unhealthy communities (HPI and HPI+Race), meaning that some of the communities least able to adapt to climate change will be the hardest hit by extreme temperatures.

MAP 13 | EXTREME TEMPERATURE PROJECTIONS



Average number of days per year for RCP 8.5 with daily maximum temperatures higher than 100°F between 2040 and 2060 (netCDF from David W. Pierce)

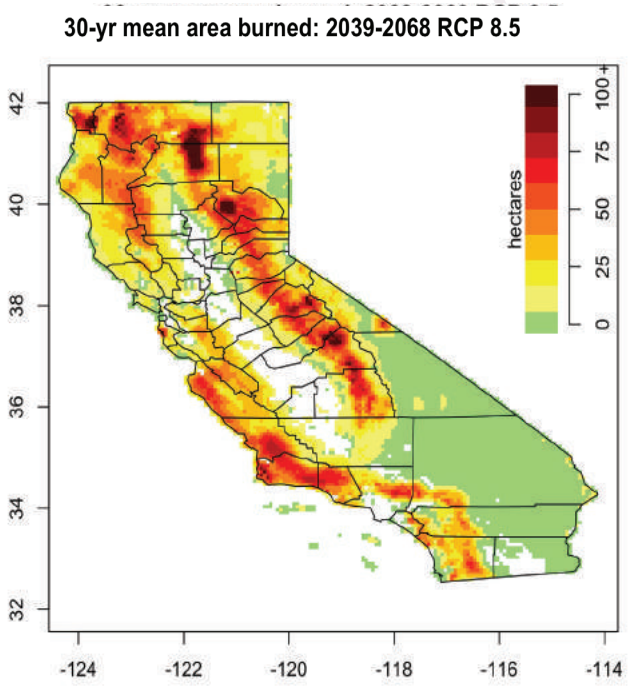
MAP 7 | SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



WILDFIRES

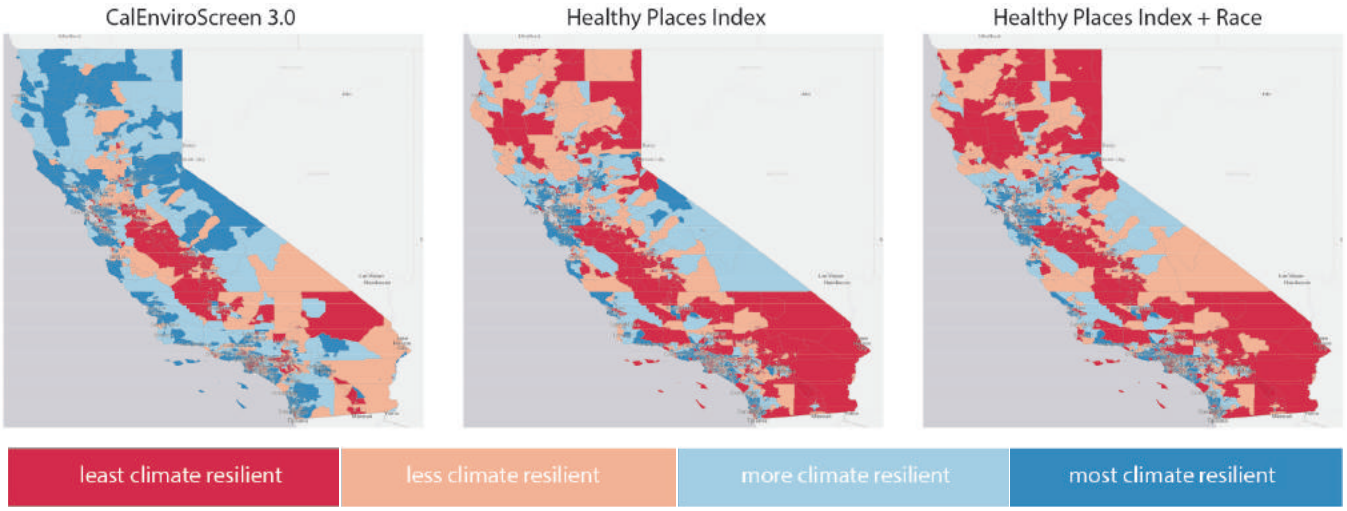
Map 14 (Franco 2018) shows mean area burned for 30-year period for RCP 8.5 with average cumulative CO_2 emissions. When compared with Map 7, there is significant overlap between disadvantaged communities (CES) and unhealthy communities (HPI and HPI+Race), meaning that some of the communities least able to adapt to climate change will be the hardest hit by wildfires.

MAP 14 | WILDFIRE PROJECTIONS



Mean area burned for 30-year period for RCP 8.5 with average cumulative CO^2 emissions (Franco 2018)

MAP 7 | SIDE-BY-SIDE COMPARISON OF CALENVIROSCREEN 3.0, HEALTHY PLACES INDEX, AND HEALTHY PLACES INDEX + RACE (PRODUCED BY JASON VARGO 2018)



Critical Social, Economic, and Environmental Factors Related to Climate Vulnerability and Adaptive Capacity

A literature review reveals that social, economic, and environmental factors impact climate vulnerability and therefore climate adaptation, highlighting the need to analyze these factors in climate change research. Many of these population characteristics are mentioned in the introduction. They include, but are not limited to:

- Communities of color, low-income groups, people with LEP, and certain immigrant groups (especially those who are undocumented) (USGCRP 2016);
- Women, the elderly, children, and those who are disabled or have a disabled family member (Hajat 2003) (Brodie 2006) (Cooley 2012);
- "Income, educational level, social isolation, and health status" (Mazur 2010); and
- Other factors, such as:
    - having substandard living conditions;
    - being subject to poor environmental conditions;
    - having limited access to services;
    - being uninsured or underinsured;
    - lacking access to health care;
    - lacking access to transportation;
    - living on the upper floors of tall buildings;
    - living in areas with lots of impervious surfaces and little tree cover;
    - lacking ways to cool down;
    - being food insecure;
    - lacking adequate medications; and
    - being a tenant or renter.

As mentioned earlier, Cooley identifies and studies 19 factors, or indicators, of climate vulnerability (Cooley 2012). This synthesis report takes a closer look at the following 10 factors, chosen because of their connection to issues of climate justice and climate adaptation. This is not a comprehensive list of factors related to vulnerability, but rather a deeper dive into understanding the connection between a few social, economic, and environmental factors and climate adaptation.

- Race/Ethnicity;
- Lack of access to financial resources;
- Urbanization (heat island effect);

- Existing disproportionate impacts from other pollutants;
- Existing high rates of health issues and lack of access to good health care;
- Disparities in education and LEP;
- Employment in jobs and industries that will be impacted by climate change (e.g., agricultural, tourism, and domestic jobs) and outdoor jobs in general that increase exposure to climate change impacts;
- Lack of access to air conditioning and transportation;
- Lack of social capital: political involvement, civic representation, and isolation; and
- Citizenship and immigration status.

It is also important to note how individuals and communities are often impacted by more than one of these factors simultaneously and that many of these factors are interconnected. For example, an individual may be low income, and thus have limited access to health care and health insurance, which causes or exacerbates existing health issues, all of which may put them at greater risk to extreme temperatures. If they also have limited access to transportation and air conditioning, they have even less adaptive capacity. All of these factors make climate adaptation more difficult.

Race/Ethnicity

Race and ethnicity, which are often associated with socioeconomic climate risk factors such as low income, high rates of existing health issues, and the heat island effect, are indicators of climate vulnerability and present special considerations for climate adaptation. Communities of color and ethnic minorities are consistently found to have less capacity to adapt to climate change.

Research shows that communities of color and ethnic minorities are more vulnerable to disasters than the rest of the population (Perry 1986) (Phillips 1992) (Blanchard-Boehm 1997) (Hajat 2003) (Cooley 2012). Much of that research focuses on high heat, or extreme heat, where there is a correlation between race and ethnicity and an increased risk of illness or death for African Americans (Whitman 1997) (Ishigami 2007) (Basu January 2008) (Cooley 2012) and other communities of color (Reid 2009) (Cooley 2012).

Excerpt from The Process of Disaster: Environmental Justice Discourse and Spike Lee's *When the Levees Broke* by Ali Brox, University of Kansas:

"[Spike] Lee's 2006 film [When the Levees Broke: A Requiem in Four Acts] represents a recent example of environmental justice discourse that challenges the way people conceive of 'natural' disasters. Instead of treating Katrina as a singular event, Lee encourages viewers to think about the hurricane as a process…By framing the disaster as a process, Lee represents a different environmental sensibility than many viewers may be accustomed to; he contests the notion that Hurricane Katrina was 'natural' or an 'act of God' and instead highlights the institutions, policies, and socioeconomic conditions that exacerbate the effects of the climatic disturbance on the human residents of New Orleans and the Gulf Coast" (Brox 2015).

One study found that "African Americans in Los Angeles are nearly twice as likely to die from a heat wave as other Angelinos" (Kersten 2012). During the 1995 Chicago heat wave, a study indicated that African American mortality was 50% higher than among Whites (Whitman 1997) (Cooley 2012). In another study, non-Hispanic Blacks were 2.5 times more likely to die from extreme heat than non-Hispanic Whites, and non-Hispanic Blacks were 2 times more likely to die from extreme heat than Hispanics (Berko 2014) (USGCRP 2016). One theory as to why the death rate for Hispanics is not as a high as that of non-Hispanic Blacks is that Hispanics often live with extended families and have stronger social structures (Mulvaney-Day 2007), and that people, particularly the elderly, who are isolated are more at risk of heat-related mortality (Tomaka 2006).

In addition, it is important to note how communities of color are perceived and helped (or not helped) after a climate disaster. For example, during Hurricane Katrina, news outlets labeled black individuals as "looting" and white individuals as "finding" food from grocery stores (Jones 2005). And after Hurricane Maria, President Trump claimed Puerto Ricans "want everything done for them" (Trump 2017). Racial profiling and disproportionate police violence towards people of color are also barriers to receiving assistance after a climate disaster and further decrease a community's climate resilience.

It is difficult to isolate race and ethnicity as a cause of increased climate vulnerability versus inequities resulting from other socioeconomic factors. Racism and discrimination often lead to lower socioeconomic status, and with that comes a lack of resources available to prepare for, cope with, and recover from climate impacts. In addition, lower socioeconomic status is associated with increased rates of asthma, cardiovascular disease, and other illnesses, which can be exacerbated by climate change. Living under the chronic stress of racism also impacts people's health, making them less resilient to climate change (APA n.d.). Increased vulnerability of communities of color to heat-related events could be attributed to existing health conditions, poverty, lack of air conditioning, and living in highly paved urban areas suffering from the heat island effect (McGeehin 2001) (Cooley 2012).

Regardless, in California, race and ethnicity are particularly important factors to consider, as "demographic changes already underway will increase the size of vulnerable populations…in the coming decades" (Maizlish 2017), and climate change will have greater and greater impacts.

Lack of Access to Financial Resources

A lack of access to economic resources, which is often associated with race and other socioeconomic climate risk factors such as high rates of existing health issues, disparities in education, and citizenship/immigration status, is an indicator of climate vulnerability and presents special considerations for climate adaptation. Poverty is associated with increased vulnerability to climate change because climate

Excerpt from *Shock Waves: Managing the Impacts of Climate Change on Poverty*

"Poor people are disproportionately affected—not only because they are often more exposed and invariably more vulnerable to climate-related shocks but also because they have fewer resources and receive less support from family, community, the financial system, and even social safety nets to prevent, cope, and adapt. Climate change will worsen these shocks and stresses, contributing to a decoupling of economic growth and poverty reduction, thereby making it even harder to eradicate poverty in a sustainable manner" (Hallegatte 2016).

adaptation and resilience require access to a certain level of financial resources.

This increased vulnerability includes not having money to buy insurance to recover from, or higher-quality housing to withstand, a climate-related disaster; not having the financial means to evacuate during a climate-related disaster; and not having the money to pay for air conditioning during a period of extreme heat (Bolin 1986) (Blanchard-Boehm 1997) (Fothergill 2004) (Poumadère 2005) (Harlan 2006) (Reid 2009) (Heberger 2009) (Cooley 2012). In a devastating but not unique example, during a 1980 heat wave in the Midwest, low-income residents died because they did not use the fans given to them as part of emergency relief efforts because they could not afford to pay higher utility bills (Fothergill 2004) (Cooley 2012).

Homeownership has significant financial benefits, giving a family more financial resources to pull from in order to adapt to climate change. Almost 64% of Whites own their own homes, whereas only 35% of Blacks do, and average home values in California are $400,000 for Whites, and $300,000 and $250,000 for Blacks and Latinos, respectively (Advancement Project California 2017). Having more income available after housing expenses also gives other benefits, including a greater ability to pay for air conditioners, access to personal transportation in evacuation scenarios, and the ability to meet increased expenses during the aftermath of a disaster. "Asian and White homeowners have nearly $25,000 more income left after paying for housing costs when compared to Blacks, Native Americans, Pacific Islanders, and Latinos" (Advancement Project California 2017). And although "renters have less income left over after paying for housing than owners…White renters have nearly 3 [times] more income left over than Black renters" (Advancement Project California 2017).

There is a strong correlation between race and poverty. For example, over the last 30 years, poverty rates for Black children have risen in California, and "almost 25% of Black and Native American households live below poverty, whereas 10% of White households do" (Advancement Project California 2017). Economic opportunities are also lacking: 10% of Whites are officials or managers, whereas only 3% of Latinos are (Advancement Project California 2017).

Urbanization (Heat Island Effect)

The heat island effect, which is often associated with race and other socioeconomic climate risk factors such as low income, existing health disparities, and lack of access to climate adaptation strategies, is an indicator of climate vulnerability and presents special considerations for climate adaptation. Communities suffering from the heat island effect experience higher temperatures without climate change and may be, therefore, less able to adapt to even higher temperatures from climate change.

Urban areas with few or no trees and an abundance of "heat-trapping impervious surfaces such as roads,

Excerpt from Carl Anthony's Foreword to *Climate Justice: Frontline Stories from Groundbreaking Coalitions*

"The majority of the world's people are living in poverty, being uprooted and forced away from the land and into the cities in search of livelihoods. Already at risk, these populations are placed in greater danger by the current global climate crises" (Anthony 2017).

buildings and parking lots" (Kersten 2012) experience a phenomenon called the urban heat island effect. The urban heat island effect is "where manmade surfaces absorb sunlight during the day and then radiate the stored energy at night as heat" (USGCRP 2016). These resulting heat islands have temperatures higher than surrounding areas, increasing the risk of heat-related illness or death (CNRA 2009) (Mazur 2010). This poses a particularly dangerous situation for urban communities attempting to adapt to climate change, as extreme heat events will increase in frequency and severity. In addition, heat islands create higher demand for electricity (for air conditioners and fans and increased time indoors), which increases utility costs in oftentimes low-income areas, and increases air pollution in oftentimes already polluted areas, furthering risks to public health (EPA n.d.). At the same time, electricity infrastructure is vulnerable to rising air temperature, and the risks of power failure can be greater in some areas with disadvantaged populations. For example, in the Los Angeles area, East El Monte and Pomona are the most at risk of service interruptions due to substation overloading (Burillo 2018).

Low-income communities and communities of color are often concentrated in urban areas (Mazur 2010) (USGCRP 2016). This is particularly true in California. Cooley (2012) cited studies showing "a positive correlation between poverty and high amounts of impervious surfaces in a community, and a negative correlation between poverty and tree cover in urban areas of California. This suggests that low-income populations are disproportionately exposed to the heat island effect of urban areas" (Shonkoff 2009) (Shonkoff 2011) (Cooley 2012). Another analysis of the metropolitan areas of Los Angeles, Sacramento, San Diego, and San Francisco found increasingly greater proportions of low-income residents and people of color reside in neighborhoods with increasing impervious cover and decreasing tree canopy (Morello-Frosch 2008) (Morello-Frosch 2009).

These communities are further endangered because they are less likely to have adaptation strategies in place, such as air conditioning (and the money to pay for air conditioning), access to cooling centers, and cars to escape the heat. They also have higher rates of existing health issues such as asthma and cardiovascular diseases and less access to health insurance and affordable emergency health care (Semenza 1996) (Luber 2008) (Younger 2008) (CDC 2011) (Kersten 2012) (CDC 2013) (DHHS 2014) (USGCRP 2016). These socioeconomic and health conditions result in increased incidences of disease and death from extreme heat in low-income communities and communities of color, hindering their chances of climate adaptation (Luber 2008) (Basu January 2008) (Lin 2009) (USGCRP 2016). For example, a study of 9 counties in California from May to September of 1999-2003 found that heat-related mortality rates were higher for African Americans than Hispanics and Whites, possibly due to vulnerability factors such as lack of air conditioning and existing health conditions (Basu January 2008) (Mazur 2010).

Existing Disproportionate Impacts from Other Pollutants

Existing disproportionate impacts from other pollutants, which is often associated with race and other socioeconomic climate risk factors such as low income and existing health disparities, is an indicator of climate vulnerability and presents special considerations for climate adaptation. Populations who are already exposed disproportionately to air pollution, water pollution, and contaminated land are less able to prepare for, adapt to, and recover from climate change. In addition, climate disasters can further expose local communities to releases of pollutants to the land, water, or air, including toxic emissions from fires.

The environmental justice movement began as a response to the disproportionate siting of hazardous waste landfills in communities of color and low-income communities. Predominantly wealthy and white communities had (and continue to have) access and resources to prevent these sitings. As a result of exclusionary and discriminatory policies and inequitable investments, predominantly low-income communities and communities of color suffer disproportionately from concentrated levels of pollution and greater environmental health impacts (Saha 2005) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). Another study found "African Americans and Latinos are more likely to live, play, or go to school near hazardous land uses like railroad facilities, ports, airports, and refineries" (Advancement Project California 2017). Low-income communities and communities of color have a higher percentage of the most toxic sites (Collins 2016) (Cushing 2016) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017).

California has some of the worst concentrations of air pollution in the country, particularly in and around Los Angeles and in the Central Valley. Fine particulate matter (PM2.5) is a major threat to health, contributing to asthma, heart disease, and other ailments. California cities make up 6 of the top 9 cities in the country with the highest Short-Term Particle Pollution (24-hour PM2.5); 8 of the top 10 cities in the country most polluted by Year-Round Particle Pollution (Annual PM2.5); and 7 of the top 8 of the 25 Most Ozone-Polluted Cities (ALA 2017). "An estimated 14 million current residents live in these highly impacted areas, half of whom also live in areas with high social vulnerability" (Cooley 2012).

Exposure to ozone and PM2.5, as well as toxics and heavy metals, are associated with increased incidences of and exacerbated irritations and infections, asthma and asthma exacerbation, lung cancer, high blood pressure, cardiovascular disease, visits to emergency rooms, and hospitalizations and death (Norris 1999) (Lin 2002) (Kampa 2008) (Ostro 2009) (Cooley 2012) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). Children, the elderly, people who work outdoors, and people with existing health issues such as lung disease, cardiovascular issues, or asthma are the most vulnerable to air pollution.

African Americans are more likely to live in areas with high levels of PM2.5 and ozone (Miranda 2011) (Clark 2014) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). In addition, Asians and Latinos are more than 50% more likely than Whites to live in counties that exceed the federal standards for PM2.5 and ozone (Yip 2011) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). The Central Valley, which is home to high concentrations of low-income communities and communities of color, has elevated concentrations of PM2.5 from agriculture (Keeler 2002) (Fourgères 2007) (Cooley 2012). The Central Valley also contains 5 of the top 8 counties in the country with the highest concentrations of ozone (ALA 2017), increasing the risk of illness to the general population while particularly increasing the risk of acute illness to farm workers (Fourgères 2007) (Cooley 2012).

Low-income communities and communities of color are also more likely to consume fish from contaminated sources of water, in part because these communities are often near contaminated water, but also because of language cultural and economic barriers. Power plant discharges contaminate water, which contaminate fish, exposing communities to toxic heavy metals such as selenium, lead, and arsenic (EPA 2015) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). Power plants also discharge polycyclic aromatic hydrocarbons (PAHs) and bromide which, along with heavy metals, are endocrine disruptors, reproductive toxins, and carcinogens (Srogi 2007)

(Tchounwou 2012) (PERI and Food & Water Watch 2013) (Regli 2015) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017).

Although fish consumption advisories are often written in English and Spanish, they are sometimes inaccessible to non-Spanish speaking immigrant communities in California. In addition, to save money and to honor their culture, many low-income communities and communities of color rely on homegrown vegetables and subsistence-fished seafood. This was particularly concerning for Laotian communities in Richmond in the late 1990s, where fish were found to have high concentrations of mercury, dioxin, and polychlorinated biphenyls (PCBs). Laotian subsistence farmers and fishers, many of whom read only Laotian, were dangerously unaware of the toxicity of their food because pollution advisories were not always presented in this language (Tai 1999).

Existing High Rates of Health Issues and Lack of Access to Good Health Care

Existing high rates of health issues and lack of access to good health care, which are often associated with race and other socioeconomic climate risk factors such as low income, LEP, and citizenship/immigration status, are indicators of climate vulnerability and present special considerations for climate adaptation. Individuals with higher rates of disease are more vulnerable to climate change, and those with inadequate access to health care are less able to adapt to and recover from climate change.

Communities of color, low-income communities, people with LEP, and certain immigrant groups (especially those who are undocumented) have higher rates of chronic medical conditions, such as cardiovascular and kidney disease, diabetes, asthma, and chronic obstructive pulmonary diseases (COPD) (CDC 2012) (CDC 2013) (Blackwell 2014) (USGCRP 2016), which may be worsened with climate change (Semenza 1996) (McGeehin 2001) (Luber 2008) (Basu January 2008) (Lin 2009) (USGCRP 2016). Diabetes, psychiatric illness, and cardiovascular disease all increase vulnerability to extreme heat (Schwartz 2005) (Reid 2009) (Naughton 2002) (Poumadère 2005) (Cooley 2012).

Low-income African American children have higher rates of asthma than White children (Smith 2005) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). In California, childhood asthma rates are 17% for African Americans and 17% for Native Americans/Alaska Natives, compared with 10% for Whites. This trend continues for adults, where 13% and 10% of Native Americans/Alaska Natives and African Americans, respectively, have asthma, compared with 9% of Whites (Meng 2007).

African Americans have higher rates of hypertension (41.3%) than Whites (28.6%), and are almost 2.5 times more likely to die prematurely from a stroke (Gillespie 2013) (Food & Water Watch and Greenaction for Health & Environmental Justice 2017). Almost 12% of babies born to African American mothers in California are low birth weight as compared to 6% of babies born to White mothers. According to Wong (2002), even "when adjusted for age, gender and level of education, the number of potential life-years lost from all causes of death was found to be 35% greater for Blacks than for Whites in the United States" (USGCRP 2016).

One of the reasons that low-income communities and communities of color have greater rates of health issues is due to lower rates of health insurance (Shonkoff 2009) (Cooley 2012). In California, people of color make up a majority of uninsured Californians. Blacks, Latinos, Native Americans, and Pacific Islanders are often uninsured

due to affordability, employment, and citizenship/immigration status, resulting in a lack of access to basic health care services. This lack of access results in higher rates of adverse birth outcomes and chronic health conditions (Advancement Project California 2017). Not only do vulnerable populations lack insurance, but they also may lack access to medical care and be unable to afford medications or other treatments (Blackwell 2014) (DHHS 2014) (USGCRP 2016).

Another potential factor is increased levels of stress, particularly chronic stress from poverty and other stressors (APA 2011) such as "discrimination, neighborhood stress, daily stress, family stress, acculturative stress, environmental stress and maternal stress" (Djuric 2008) (NIH 2011) (APA 2011). In addition, people who are already low income are more likely to suffer psychological impacts after a disaster, such as a climate-related disaster (Bolin 1986) (Bolin 1993) (Fothergill 2004) (Cooley 2012). Due to the hormones that are released during stress, and the additional burden that places on the body, stress may age the immune system prematurely and could increase the risk of illness and age-related diseases (Djuric 2008) (Geronimus 2010) (APA 2011).

Disparities in Education and Limited English Proficiency (LEP)

Existing disparities in education and LEP, which are often associated with race and other socioeconomic climate risk factors such as low income, lack of social capital, and citizenship/immigration status, are indicators of climate vulnerability and present special considerations for climate adaptation. These factors make it more difficult for communities to adapt to climate change because they are less informed about the risks of climate change and are less able to understand (or even receive) instructions during climate-related disasters.

In California, Black and Latino rates of third grade math proficiency are 22% and 28% respectively, compared to Asian (72%) and White (58%) rates (Advancement Project California 2017). Black and Latino rates of third grade English proficiency are 23% and 25% respectively, compared to Asian (65%) and White (55%) rates (Advancement Project California 2017). Black high school graduation rates are 70.8% compared to White rates, which are 88%. (Advancement Project California 2017). Black students are suspended at a rate more than triple those of their White counterparts (Advancement Project California 2017). Indicators such as school performance, graduation rates, and suspension rates may serve as useful factors in a full accounting of a community's resilience to changing climate conditions.

In 2013, 27% of the national LEP population lived in California, the largest percent of any state. In addition, 6.8 million people, or 19% of all Californians, had LEP (Zong 2015). Language barriers, along with lack of connection to public agencies and fear of the government, all increase climate vulnerability (Wang 2008) (Cooley 2012).

Employment in Jobs Impacted by Climate Change

Agricultural, tourism, and domestic jobs, and outdoor jobs in general, which are often associated with race and other socioeconomic climate risk factors such as low income, LEP, lack of social capital, and citizenship/immigration status, are indicators of climate vulnerability and present special considerations for climate adaptation. Having a job that is directly dependent on the climate (weather, natural resources, stability) makes a person extremely vulnerable to climate change and decreases their capacity to adapt.

Low-income and minority populations in California are represented in large numbers in agricultural, tourism, and domestic jobs, all of which are particularly vulnerable to the impacts of climate change. Economic studies estimate that drought led to the loss of 17,100 jobs in 2014, 21,000 jobs in 2015, and 4,700 jobs in 2016 (Howitt 2014) (Howitt 2015) (Medellin-Azuara 2016) (Greene 2018). These job losses were inclusive of both direct seasonal farm jobs and indirect jobs from the goods and services demands for agriculture. Droughts are common in California, and are likely to become more severe and more frequent due to higher temperatures, decreased soil moisture, declining groundwater resources, and decreases in mountain snowpack (Cayan 2010) (Greene 2018). Drought impacts employment, water security, food security, and health of rural residents; these impacts and vulnerabilities are uneven and localized. How social and physical processes interact to create drought vulnerability is poorly understood, especially with regards to disadvantaged communities.

Extreme weather events, wildfires, and coastal flooding are just some of the impacts of climate change that will negatively impact agriculture, tourism, and domestic profitability in California. Commercial and subsistence farmers and fisherman will be less able to support themselves, and may be less able to transition to other livelihoods. Because of their reliance on subsistence resources and traditional cultural practices that rely on native plants and animals, Native Americans may also be significantly impacted. Tourism jobs will also diminish with climate change, especially in California's coastal and mountain regions (IPCC 2007) (UNWTO 2007)(Morello-Frosch 2009). Domestic workers (including nannies, home health aides, housekeepers, gardeners, and cooks) are vulnerable to climate change in many ways. These include sudden loss of employment when their employers relocate, lose power, or are less financially stable because of climate change. Because they are often paid off the books, they aren't afforded the same protections as other workers and remain invisible and unaccounted for in rehabilitative efforts after a climate emergency.

Those who work outdoors, including those in agricultural, lawn/garden care, construction, and electricity and pipeline utility, are often the most physically vulnerable to the impacts of climate change. Not only are they exposed to extreme temperature, but also they are often exposed while physically exerting themselves, increasing their risk of illness (Balbus 2009) (Lundgren 2013) (Arbury 2014) (USGCRP 2016). Day laborers are extremely vulnerable to climate change because in addition to the issues mentioned earlier, they have very little work stability.

In California, 99% of agricultural workers are Hispanic, over 90% come from Mexico, 60% are undocumented, over 20% earn incomes below the federal poverty level, and many have LEP and no health insurance (Martin 2016) (Aguirre International 2005) (Mazur 2010). They are exposed to extreme heat in the summer months (Mazur 2010), increasing their risk of heat-related illness (Maizlish 2017). Not only do they work in the hottest months of the year, but in some of the hottest counties. For example, tomatoes and melons are cultivated in Imperial County and Fresno County, where average maximum temperatures in July are 107.6°F and 99.3°F, respectively (CDFA 2009) (WRCC 2009) (Mazur 2010). Nationally, between 1992 and 2006, agricultural workers died from heat stroke almost 20 times the rate of the general population, 20% of those who died were Mexican or Central American (MMWR 2008) (Cooley 2012), and 9% of those who died were in California (CDC 2008) (Mazur 2010). Many of these workers are denied critical labor and occupational health protections under the law, increasing their vulnerability to illness and death (Cooley 2012). Workers may be wearing extra clothing or equipment to protect themselves from pesticide exposure or may not take needed breaks because they are paid by the weight or number of the crops picked, further increasing their risk of heat-related illness or death (CDC 2008) (Mazur 2010).

Lack of Access to Air Conditioning and Transportation

Lack of access to air conditioning and transportation, which is often associated with climate risk factors such as low income, LEP, lack of social capital, and citizenship/immigration status, are indicators of climate vulnerability and present special considerations for climate adaptation. Two basic climate adaptation strategies are cooling down from an extreme heat event by turning on the air conditioning and getting in a vehicle to evacuate from a climate-related emergency such as a flood, wildfire, or extreme heat. Those who don't have access to these adaptation strategies experience high climate vulnerability.

In 2009 in California, an estimated 36% of all homes (owner occupied and rented) did not have air conditioning (Maizlish 2017), and in 2010 approximately 8% did not own a vehicle that could be used for evacuation (Maizlish 2017). Even with access to transportation, not having one's own vehicle deters people from evacuating during an emergency (Brodie 2006) (Cooley 2012).

For low-income residents, electric bills make up a greater percentage of their expenses when compared to wealthier individuals, often making it prohibitively expensive to use air conditioning or fans, even if they have them (Mazur 2010). Those who can't afford air conditioning or higher utility bills from using fans may also live in a high crime area, and be afraid to open their windows to cool down (Blum 1998) (Cooley 2012). Although some programs do exist to provide air conditioners, fans, and electric bill subsidies, those who need it the most may be too socially isolated (because of income, language, cultural, and other barriers, etc.) to know and take advantage of them (Heat Adaptation Workgroup 2013). Native Americans are less likely to have access to electricity than the general population, putting them further at risk (Houser 2001) (Cooley 2012). Those with existing health conditions and the very young or the very old are less able to recover from extreme heat events or adapt to higher temperatures than the general population (Heat Adaptation Workgroup 2013).

Not having air conditioning or not having the money to pay to use air conditioning or fans (Reid 2009) (Cooley 2012), coupled with not having access to transportation to escape the heat or get to a cooling center (Shonkoff 2009) (Cooley 2012), further decreases one's ability to adapt to climate change.

Lack of Social Capital: Political Involvement, Civic Representation, and Isolation

Lack of social capital—including lack of political involvement, lack of civic representation, and isolation—is often associated with race and other socioeconomic climate risk factors such as low income, LEP, and citizenship/immigration status, which are indicators of climate vulnerability and present special considerations for climate adaptation. Social capital is defined as the networks and relationships that create trust, reciprocity, mutual aid, and cooperation in a society (Kawachi 1999) (Dynes 2006) (Maizlish 2017). Social capital is critical to climate adaptation because connectivity (sometimes referred to as community) is critical to climate adaptation. People need to be represented by decision-makers, able to receive information and instructions, and connected to resources to protect and rebuild their lives and assets.

One source of social capital—or social cohesion—is in part from social infrastructure such as sidewalks, community centers, parks, and commercial spaces. These enable people to connect with one another, develop relationships, and take care of each other during climate-related disasters. Areas with broken down sidewalks and a lack of safe public

spaces discourage people from going outdoors and connecting with their neighbors. This social network has been shown to be the difference between life and death for elderly people in a heat wave (Klinenberg 2015).

Another source of social capital comes from higher levels of political participation (Braveman 2011) (Gilbert 2013) (Maizlish 2017). Voting is one of the key tools to engage in politics. Yet lawmakers have prevented and continue to prevent or discourage people of color from voting, from the Jim Crow era until today (Advancement Project California 2017). "Significant racial disparities exist in midterm and presidential elections" (Advancement Project California 2017), and although "higher voter turnout in presidential elections somewhat narrows the racial disparity in turnout," it doesn't completely eliminate it (Advancement Project California 2017).

"Descriptive representation, in which an elected official demographically resembles her/his constituents" is another measure of social capital, because it can "result in more equitable representation of a community's needs and interests" (Advancement Project California 2017). In California, "White representation among elected officials is more than double that of all other races" (Advancement Project California 2017).

Another measure of lack of social capital is social isolation, which can come in many forms, including living in a rural area, being institutionalized, or having LEP. Living alone can have devastating consequences during a heat wave. For example, 919 people died in their homes during the 2003 Paris heat wave. Of the 452 of those who died that were sent to the Institut Médico-légal for an autopsy, 92% of them lived alone (Poumadère 2005) (Cooley 2012). In climate emergencies, such as wildfires, living in rural areas greatly increases emergency response times, making those individuals much more vulnerable (Moser 2010) (Cooley 2012). Institutionalized populations are socially isolated from their families and are less able themselves to tap into resources outside of their institutions. During the Houston floods in 2017, some institutions, such as hospitals, nursing homes, or prisons were not properly prepared for evacuations, leaving those populations more vulnerable to climate change-induced flooding. Isolation can also come from lack of media access, lack of community network or neighborhood connections, and LEP, all of which have been associated with an increase in risk of illness or death from extreme heat (Harlan 2006) (Poumadère 2005) (Naughton 2002) (Semenza 1996) (Cooley 2012).

In addition, the psychological trauma resulting from climate disasters further contributes to the erosion of social capital: "Within community, wellbeing is a sub-process in which climate change erodes physical environments which, in turn, damage social environments" (Berry 2010). Climate impacts will destabilize regions by displacing people, leading to increased population densities and greater tension over limited resources (Rudolph 2015) (Reuveny 2007) (Maizlish 2017), increasing violent crimes (Ranson 2014) (Maizlish 2017), and further decreasing community resilience (Maizlish 2017).

Citizenship and Immigration Status

Refugees, undocumented immigrants, and those with seasonal worker visas are often associated with race and other socioeconomic climate risk factors such as low income, LEP, and lack of social capital, which are indicators of climate vulnerability and present special considerations for climate adaptation. These factors make it more difficult for individuals with citizenship/immigration status concerns to adapt to climate change because they are often either afraid of seeking help or unable to qualify for federal assistance, such as assistance from the Federal Emergency Management Agency (FEMA).

People with citizenship/immigration concerns or those with LEP often have limited access to health care and other social services, and they may be more hesitant to seek medical help because of language or cultural barriers or lack of access to government benefits (Ortega 2007) (Fuentes-Afflick 2009) (Vargas Bustamante 2010) (Maldonado 2013) (Eneriz-Wiemer 2014) (Riera 2014) (USGCRP 2016). The California Health and Safety Code Section 131019.5 includes immigrants and refugees as vulnerable populations.

Cross-sectional Example: Wildfires

All of the critical social, economic, and environmental factors mentioned above hinder a populations' ability to adapt to climate change. This section uses wildfires as an example to illustrate how these social, economic, and environmental factors are interconnected and how they can impact vulnerable communities.

As temperatures continue to rise with climate change, large wildfires (1,000 acres and greater) and fire season length are also increasing in the western United States, and in California specifically (Cayan 2006) (OEHHA 2009) (Mazur 2010) (OEHHA 2018). The impacts of recent wildfires in the fall and early winter of 2017/2018 were disproportionately devastating to many vulnerable populations because the cumulative and synergistic nature of many of these factors limits a community's ability to prepare for, respond to, and cope with climate change.

These factors include:

- **Race/Ethnicity:** African Americans and Latino Americans indicate they need help to evacuate before a disaster 7% and 10% of the time, compared to 3% for Caucasians (Harvard 2006) (Ballen 2009) (Mazur 2010).
- **Lack of access to financial resources:** "Low-income households are less likely to live in homes that meet or exceed building codes, have non-flammable roofing or have a defensible space free of flammable material. They are more likely to lose most or all of their assets in a fire and are less likely to have adequate insurance to cover the cost of rebuilding or replacing personal property" (Mazur 2010).
- **Existing disproportionate impacts from other pollutants:** Wildfires add additional pollutants, most importantly PM2.5, to areas that already exceed state and federal standards, putting an additional burden on these communities. They can also cause industrial fires, exposing local populations to chemical hazards.
- **Existing high rates of health issues and lack of access to good health care:** Communities "may be more susceptible to the adverse health impacts of exposure to smoke because of poor health or limited access to health care" (Mazur 2010).
- **Disparities in education and LEP:** Those with less access to education and less fluency in English will be less capable of understanding their risks, may not understand how to take health and safety precautions, and may not understand evacuation instructions.
- **Agricultural, tourism, and domestic jobs and outdoor jobs in general:** Wildfires decrease opportunities and profitability in agricultural, tourism, and domestic work, and expose those who work outside to air pollution during the fires. In addition, during the cleanup and rebuilding after the fires, these same laborers may be exposed to toxic materials and dangerous working conditions.

- **Lack of access to transportation and air conditioning:** Access to transportation is critical during wildfire evacuations. Air conditioning is also very important, especially when people are advised to stay inside and to keep their windows shut.
- **Lack of social capital: political involvement, civic representation, and isolation**: Those with less civic representation often have substandard emergency response resources (Niemi 2001) (Lynn 2005) (Mazur 2010) and slower emergency response times. Wildfires often impact rural areas, which also have slower emergency response times (Moser 2010) (Cooley 2012). Native Americans and undocumented migrant workers are often "invisible" and very vulnerable (Davis 2007) (Kelly 2007) (Mazur 2010).
- **Citizenship/Immigration status concerns:** Not only are people with citizenship/immigration status concerns often afraid to seek help and restitution during and after a wildfire for fear of deportation or are unable to connect with disaster-relief services because of language barriers, but also many do not qualify for federal assistance programs such as FEMA.

Climate Adaptation Strategies

Social Systems and Build Environment

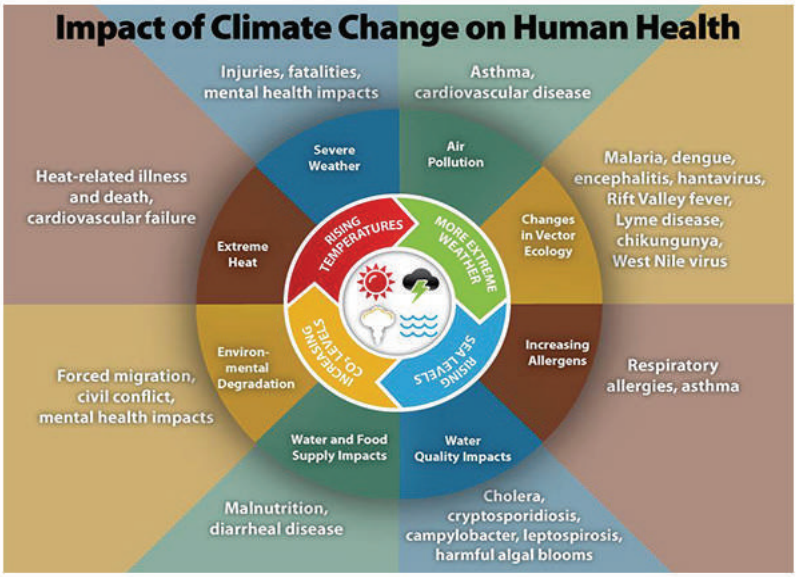
PUBLIC HEALTH

Climate change is having and will continue to have serious impacts on public health, from increases in the rate and severity of asthma and cardiovascular disease cases to forced migration, civil conflict, and mental health impacts. See Figure 6 (CDC 2014).

As mentioned above, social, economic, and environmental factors inform the level of exposure to climate change for an individual and community as well as their respective capacity to adapt to climate change. Figure 7 (USGCRP 2016) shows how health outcomes from climate change are thus amplified and multiplied by socioeconomic factors.

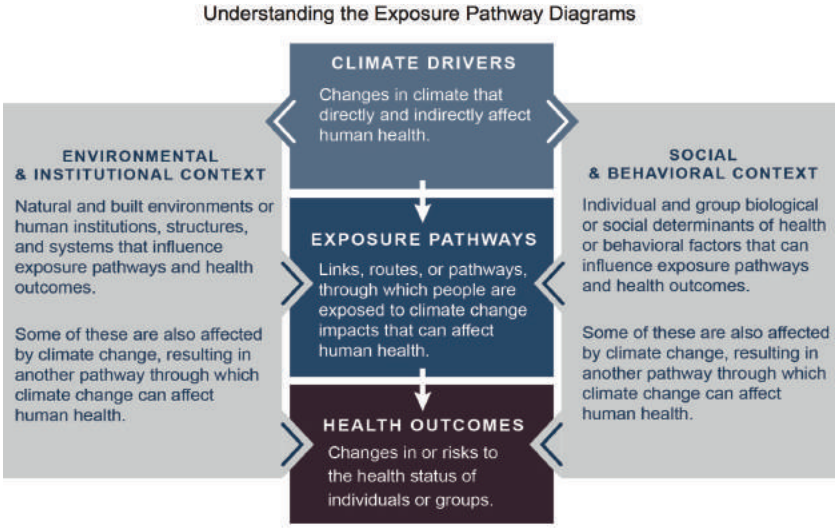
In 2012, approximately 42% of low-income residents in California "did not have reliable access to a sufficient amount of affordable, nutritious food (called food insecurity)" (Maizlish 2017). Climate change will further impact food production and distribution systems, impacting communities that are already food insecure, making food less affordable, and increasing obesity and malnutrition in low-income households (Luber 2014) (Maizlish 2017). Climate change will cause water intrusion into buildings, creating an environment at risk of mold and indoor air quality issues. People with existing health conditions, those living in poorly constructed residences, and people unable to afford to abate mold will be more severely impacted and less able to adapt (Luber 2014) (Maizlish 2017). Climate change will

FIGURE 6 | IMPACT OF CLIMATE CHANGE ON HUMAN HEALTH



Climate change has serious impacts on public heath (CDC 2014).

FIGURE 7 | UNDERSTANDING THE EXPOSURE PATHWAY DIAGRAMS



The Climate Change and Health diagram shows how health outcomes from climate change are amplified and multiplied by environmental and socioeconomic factors (USGCRP 2016).

cause extreme weather events that can physically damage important resources such as "[h]ealth care facilities, water treatment plants, and roads for emergency responders and transportation for health care personnel" (Maizlish 2017), decreasing their capacity to protect public health. Those who already have limited health care, are isolated from emergency response facilities, and lack the financial resources to relocate will be less able to recover (Maizlish 2017).

Health Impacts of Heat

The health impacts of increasing temperatures and extreme heat events have been studied extensively, and are associated and correlated with socioeconomic factors, both intrinsic and extrinsic. "Intrinsic factors are those that are inherent to the individual, such as age or medical condition, while extrinsic factors are those that are external to the individual, such as living conditions or access to transportation" (Cooley 2012). Both sets of these factors determine climate vulnerability. "[W]hile warmer temperatures will impact everyone in California…[l]arge numbers of socially vulnerable populations…are concentrated in Los Angeles, Orange, San Diego, and San Bernardino counties. Additionally, some counties have smaller numbers of highly vulnerable populations but a much larger percent of their total population are highly vulnerable" (Cooley 2012).

Heat-related illnesses can range from mild heat stress to fatal heat stroke, and include the exacerbation of existing health conditions for those who are medically fragile, chronically ill, or otherwise vulnerable (Bouchama 2007) (Basu January 2008) (Maizlish 2017). "Increased heat also intensifies the photochemical reactions that produce smog and ground level ozone and PM2.5, which contribute to and exacerbate respiratory disease in children and adults. Increased heat and carbon dioxide enhance the growth of plants that produce pollen, which are associated with allergies" (Maizlish 2017). Rising temperatures also exacerbate the heat island effect and increase local urban temperatures (Maizlish 2017).

Climate-related heat events are often particularly dangerous for climate-vulnerable populations, including the very young, the very old, and African Americans. Pulling from Medicare billing records from 109 cities in the United States from 1992-2006, Gronlund found that extreme heat is associated with a 3% increase in hospital admissions over the subsequent 8 days for people 65 years and older (Gronlund 2014). Using that same data in a subsequent study, Gronlund evaluated extreme heat and hospitalization for renal, heat, and respiratory diseases for people 65 years and older (Gronlund 2016) and found a stronger association with African Americans, ages 78 years and older, in ZIP codes with lower educational attainment or older housing, and in cities with lower rates of air conditioning.

As for the correlation between heat events and death, a study of 9 counties in California during the warm season (May to September) from 1999 to 2003 found that each 10°F increase in same-day mean apparent temperature was associated with a 2.3% increase in non-accidental mortality and a 2.6% increase in cardiovascular mortality. There were also elevated risks of death for people 65 years old or older (2.2%), infants 1-year old or less (4.9%), and African Americans (4.9%). There was also no evidence found for confounding by criteria air pollutants such as PM10 and ozone (Basu September 2008) (Basu January 2008).

A 2009 study in California based on 36 relevant epidemiologic studies published in PubMed between 2001-2008 found that elevated apparent temperature was associated with increased mortality from respiratory, cerebrovascular, and cardiovascular diseases, especially ischemic heart disease, congestive heart failure, and myocardial infarction. In this study there was some evidence for confounding by PM10 and ozone, and African Americans, women, those with

lower socioeconomic status, and several age groups (particularly the elderly over 65 years of age as well as infants and young children) were identified as more vulnerable to risk of death from heat (Basu 2009).

A 2015 California study found that during the warm seasons (May-October) between 1999-2011, each 10°F increase for the average of same-day and previous 3 days apparent temperature was associated with a 4.4% increase in all-cause mortality, 13.3% increase in death for African American infants, and a 23.7% increase in African American fetal deaths (Basu 2015) (All-cause mortality is death due to a specific exposure or condition during a specific time frame, whereas fetal death is miscarriage). In a 2016 study in California, during the warm season (May-October), 1999-2009, each 10°F increase in apparent temperature found a 10.4% increased risk of stillbirth, where risk was greater for younger mothers, less educated mothers, and male fetuses (Basu 2016).

A 2017 study of 12,466 preterm delivery cases occurring between 1995-2009 found an 11.6% increase in spontaneous preterm delivery for every 10°F increase in the average apparent temperature over the week before delivery during the warm season, and a 6.2% increase during the cold season (Avalos 2017). There were greater risks for mothers who were younger, Black, Hispanic, underweight, smoked or consumed alcohol during pregnancy, or had pre-existing/gestational hypertension, diabetes, or preeclampsia (Basu April 2017).

A 2017 study in 16 different climate zones in California from 2005-2013 found that each 10°F increase in same-day mean apparent temperature was associated with an increase in ER visits for mental health disorders (4.8%), self-injury/suicide (5.8%), and intentional injury/homicide (7.9%), with the greatest risks observed for Hispanics, Whites, 6-18 year olds, and females (Basu August 2017). A study based on a survey of 1.8 million Americans, from 2008-2013 found significantly increasing temperatures reduced emotional well-being, and more strongly impacted less educated and older Americans (Noelke 2016).

Health Impacts of Poor Air Quality/Air Pollution

Climate change is associated with increased air pollution and increasingly poor air quality, which increases the incidence and severity of asthma, allergies, chronic obstructive pulmonary diseases (COPD), and other cardiovascular and respiratory diseases. Those most vulnerable, and thus least able to adapt, include children, the elderly, people with respiratory diseases, low-income residents, and those who are active outdoors, including people who work outdoors (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017).

Health Impacts of Wildfires

Climate change is associated with increased incidences of and severity of wildfires. Wildfires put people at risk of injuries and death from burns and smoke inhalation; eye and respiratory illnesses due to air pollution; exacerbation of asthma, allergies, COPD, and other cardiovascular and respiratory diseases; erosion and landslides after wildfires; and displacement and loss of homes. Those most vulnerable, and thus least able to adapt, include people with respiratory diseases (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017) as well as people who are low income, work outdoors, and lack social capital through physical or language isolation.

Health Impacts of Severe Weather, Extreme Rainfall, Floods, Water Issues

Climate change is associated with severe weather, extreme rainfall, floods, and water quality and quantity issues. These cause a loss of housing and livelihood; death from drowning; injuries; "damage to potable water, wastewater, and irrigation systems, resulting in [a] decrease in quality/quantity of water supply and disruption to agriculture" (Maizlish 2017); and water- and food-borne diseases from sewage overflow. Based on results from the Coastal Storm Modeling System, or *CoSMoS*, designed by the United States Geological Survey with leading scientists worldwide to assess the coastal impacts of climate change, 250,000 Southern California residents could be exposed to flooding as the result of storm, sea level rise, and coastal changes by the end of the 21st century. (Barnard 2018). Those most vulnerable, and thus least able to adapt, include coastal residents, residents in flood-prone areas, the elderly, children, and low-income residents (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017).

Health Impacts of Agricultural Changes

Climate change is associated with agricultural changes. These cause "changing patterns and yields of crops, pests, and weed species, resulting in higher prices for food and food insecurity, hunger, and malnutrition" (Maizlish 2017), and "changes in agriculture/forestry, leading to lost or displaced jobs and unemployment" (Maizlish 2017). Those most vulnerable, and thus least able to adapt, include agricultural workers, rural community residents, low-income residents, the elderly, and children under the age of 5 (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017).

Health Impacts of Drought

After a series of recent multi-year droughts (including 2006-2010 and 2012-2017), California may be entering another drought period in 2018 (Fountain 2018). Droughts can decrease food and water supplies causing hunger and malnutrition, higher costs of food and conflicts over food, food- and water-borne disease, and new contagious and vector-borne disease (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017).

Droughts and fire suppression practices increase the risks of wildfires, which can significantly impact human health from landslide, mudslide, and sediment runoff reducing water quality, and increase smoke, ash, and fine particles that cause respiratory and cardiovascular incidents. Dust storms from droughts are associated with increased incidents of Valley Fever (Luber 2014) (Maizlish 2017), which is a fungal lung infection caused by "inhaling spores of Coccidioides spp" (Gorris 2018). Those most vulnerable, and thus least able to adapt, include low-income residents, the elderly, and children (Drechsler 2006) (Karl 2009) (Gould 2012) (CDC 2014) (Maizlish 2017).

Innovative Solutions/Case Studies

- One practice that improves climate resilience, improves public health by reducing air pollution, counteracts the urban heat island effect, and provides employment and environmental education for local residents is tree planting. Tree planting also improves the physical beauty of a neighborhood, promoting mental health and well-being

and giving people a sense of pride. In the state of California, there are over 50 non-profit tree planting organizations (California Releaf 2011) (Kersten 2012), but very few of them are located in communities of color or low-income communities. Urban Releaf is a community-based organization that employs local residents to plant trees in low- and moderate-income neighborhoods that have little or no tree canopy and educates the community about environmental stewardship (Kersten 2012).

- The California Alternate Rates for Energy (CARE) Program, which is administered by The California Public Utilities Commission, enables low-income participants to receive a 30-35% discount on their electric bill and a 20% discount on their natural gas bill. This program provides critical assistance to those who have fans and air conditioners, but can't afford to turn them on during a heat event.

URBAN RELEAF

Urban ReLeaf holds a tree naming ceremony at Northridge San Fernando Elementary School (photo courtesy of Urban ReLeaf). Urban ReLeaf educates communities about environmental stewardship while employing residents of low- and moderate-income neighborhoods to plant trees in their communities.

- "Climate Change, Health, and Equity: Opportunities for Action," prepared by the Public Health Institute and the Center for Climate Change and Health, is a helpful resource to assist local health departments to integrate climate change and health equity into their programs and functions. This report not only provides a conceptual framework linking health inequities and climate change, but also recommends how the public health sector and the climate change sector can work together to reduce health inequities and improve resilience to climate change impacts (Rudolph 2015).
- The online interactive tool, California Heat Assessment Tool (CHAT), has been developed to support the inclusion of extreme heat considerations into long-term policy and planning decisions throughout California. Without targeted interventions, vulnerable populations will suffer significant impacts as heat waves increase in severity, duration, and frequency. CHAT is a unique tool because it identifies trends in future heat health events (HHE) based on the most up-to-date climate projections in addition to historical health data, which may help planners and policymakers identify areas of high relative change and social vulnerability in order to steer climate preparedness and action toward the most vulnerable communities. Health-informed heat wave thresholds, supplemented with census-level heat vulnerability maps, will provide California planners and public health officials a baseline from which to judge the influence of climate change on heat vulnerability and health outcomes (Steinberg 2018).

- The Montclair Community Fruit Park provides fresh fruit to the predominantly Latino community in San Bernardino county, whose median household income is nearly 20% below the statewide average. Montclair residents lack fresh, healthy food options, and this free resource helps to reduce air pollution, improve the health and wellness of the community, and build climate resilience (Sanchez 2015).
- Rooted in Resilience's Green Your City program provides resources for and facilitates greening efforts to improve access to clean water and healthy fruits and vegetables via "Use Your Roofs," "Scraps to Soil," and Solution Series Guides on Chicken Coops, Greywater Systems, Rainwater Harvesting, Rooftop Gardens, and Urban Farming and Gardening.

USE YOUR ROOFS, PART OF ROOTED IN RESILIENCE'S GREEN YOUR CITY PROGRAM

Use Your Roof builds greater ecological balance and resilience in communities (photo courtesy of David Hanks Photography/davidhanks.org).

- Climate impacts on the health of outdoor workers are significant. Heat-related deaths among farmworkers as well as construction, landscaping, and oil and gas extraction workers are often due to preventable heat stroke. The Labor Occupational Health Program (LOHP) works on ways to educate workers and their employers about California's Heat Illness Prevention Standard (GISO 3395), which requires that employers provide plenty of water, shade to rest and cool down, training, and adequate emergency plans. Other examples of organizations working to educate and protect outdoor workers include Climate Workers, which is "a membership organization of rank-and-file workers—union and non-union—and labor organizers that is building a worker-led, grassroots labor movement for climate justice in the Bay Area" (Climate Workers n.d.).

ENERGY

Climate change has the potential to have devastating impacts on California's energy infrastructure, even though it was designed to withstand the state's historically variable and often volatile weather events. Climate change will increase the rate of occurrence and the severity of temperature changes, storms, wildfires, and sea level rise, which could then "decrease the efficiency of thermal power plants and substations, decrease the capacity of transmission lines, render hydropower less reliable, spur an increase in electricity demand, and put energy infrastructure at risk of flooding" (CNRA January 2018).

The ability of vulnerable communities to adapt to these threats will be hindered by various socioeconomic conditions. For example, those with less access to financial resources are less able to relocate during a blackout, those with

existing health conditions are less likely to stay healthy without power, and those located near flooded power plants are more likely to be exposed to potential toxics or other health hazards after an emergency weather event.

In addition, more low-income residents rent apartments or other housing than the general population. These low-income apartment renters have insufficient access to capital; reside in older, less maintained buildings; and live in communities that are already crowded, remote, or underserved, leaving them less able to adapt to climate change. They are also less likely to benefit from traditional clean/renewable energy or energy-efficiency incentive programs, and have fewer incentives to make repairs, to properly insulate their rented housing, or install solar panels, as described in the SB 350 Low-Income Barriers Study, Part A: Overcoming Barriers to Energy Efficiency and Renewables for Low-Income Customers and Small Business Contracting Opportunities in Disadvantaged Communities.

Innovative Solutions/Case Studies

- The Multifamily Affordable Solar Housing Program (MASH) provides assistance "for renters to access and benefit from solar projects through bill savings as well as other economic benefits, such as local hiring provisions" (CJWG 2017), and the Single Family Affordable Solar Housing Program (SASH) "provides up-front rebates to help low-income homeowners served by investor-owned utilities access the benefits of solar power" (CNRA 2018). Both programs assist with adaptation and resilience.
- California's Low-Income Weatherization Program (LIWP) "installs solar photovoltaics (PV), solar hot water heaters, and energy efficiency measures in eligible low-income single family and multi-family dwellings in disadvantaged communities to reduce GHG emissions and save energy" (CDCSD 2017). The program also includes workforce development opportunities, furthering climate resilience.
- Strategic Concepts in Organizing and Policy Education (SCOPE) and Los Angeles Conservation Corps (LACC) were two of the first community-based green jobs creation organizations in California. They work to reduce energy consumption and create jobs for disinvested populations, both critical pieces of resilience (Kersten 2012).
- The Rising Sun Energy Center was founded in 1994 as a renewable energy education center and "has since evolved into the leading green training, employment, and residential efficiency organization that it is today" (Rising Sun Energy 1994). Rising Sun operates the California Youth Energy Services (CYES), which hires and trains youth to provide no-cost energy and water efficiency services (such as LEDs and low-flow showerheads) to residents throughout Northern California. They also operate Green Energy Training Services (GETS), which "provides job training, case management, and job placement

STRATEGIC CONCEPTS IN ORGANIZING AND POLICY EDUCATION

SCOPE was one of the first community-based organizations to create green jobs in California (photo courtesy of Erick Huerta, SCOPE).

support to low-income adults who enter the program with barriers to successful employment. Participants, who pay nothing to participate, gain the skills they need to enter careers in construction and solar industries" (Rising Sun Energy 1994).

TRANSPORTATION

Climate change is projected to have devastating impacts on California's transportation infrastructure, from sea level rise and coastal erosion, to extreme temperatures and increased precipitation. Transportation systems and hubs near or at sea level are at risk of floods, and roads and railroad tracks are at risk of needing increased maintenance or even failure. In 2017, severe flooding, landslides, and coastal erosion caused over $1.2 billion in highway damages statewide (Caltrans 2017). Although it does not reference environmental justice or climate justice, in December of 2017, Caltrans released its first Climate Change Vulnerability Assessment (for District 4, the Bay Area), "an effort by the department to understand how and where the future effects of climate change may impact the State Highway System and its users" (Caltrans 2017). This is the first of 12 such assessments to cover each district in the state and speaks to the significant impacts climate change has and will have on transportation in the state.

Vulnerable communities' climate resilience, or ability to adapt to these impacts, will be hindered by various socioeconomic conditions. Low-income residents have a lower rate of car ownership than the general population and less access to financial resources, and therefore have fewer transportation options to get to school, work, or health care facilities. Low-income residents rely heavily on public transportation, even during extreme weather events and emergencies. During climate disasters, such as Hurricane Katrina (New Orleans, 2005) and Hurricane Harvey (Houston, 2017), people who had cars were able to evacuate while many of those without (who also suffered from limited public transportation options) were often unable to leave (Dyson 2006).

Innovative Solutions/Case Studies

- The San Bernardino Transit Center (SBTC) is preparing for hotter days (and their increased incidences) due to climate change by offering "shelter, purified water fountains, and air-conditioning to over 6,000 passengers per day. It also provides a break room complete with lockers and showers for bus drivers" (CNRA 2016). This type of investment will enable it to be a centrally located resource during a climate emergency, building local resilience and adaptation.
- AB 805 (Gonzalez Fletcher, 2017) reforms the Board voting structure of the consolidated agency San Diego Association of Governments (SANDAG), as well as the San Diego Metropolitan Transit System (MTS) and North County Transit District (NCTD). Signed into law October 2017, AB 805 reimagines San Diego's transportation system as one that reflects proportional representation based on population. This law also takes a holistic approach to the issue of transportation leadership in San Diego. AB 805 requires project-labor agreements with contractors on new transportation projects, allows MTS and NCTD to pursue their own tax increases for the first time, and requires SANDAG to report annually to the Legislature on public transit issues, among other innovative strategies. This type of bill demonstrates the potential impact of a state-level bill for local transportation issues (Bowen 2017).
- RISER SF Bay, Resilient Infrastructure as Seas Rise, is a research project of University of California (UC), Berkeley, UC Davis, USGS, New York University, and the National Science Foundation, focusing on "how the interaction of environmental forcing with the shoreline infrastructure disrupts the transportation network, and

how both of these networks influence the governance network that makes planning decisions about the infrastructure. In the context of coastal flooding, this work will provide insights into how governance institutions and networks are prepared, or can be better prepared, to make effective decisions about infrastructure planning and operation" (Berkeley Engineering Riser SF Bay 2017).

- Although only a small portion of total state transportation funding, the Low Carbon Transit Operations Program (LCTOP) and the Active Transportation Program (ATP) at the California Department of Transportation assist climate-vulnerable communities to adapt and become more resilient. LCTOP provides operating and capital assistance for transit agencies to reduce GHG and improve mobility, with a priority on serving disadvantaged communities. ATP increases active modes of transportation. To meet SB 535 requirements, agencies that serve designated disadvantaged communities must use at least 50% of their allocated funds for projects that will benefit disadvantaged communities.
- In 2014, CalVans launched an Agricultural Workers Vanpool Expansion program to provide agricultural workers with safe and reliable vans to drive themselves and others to work. The program reduces GHG emissions, increases agricultural worker mobility and safety, and enables disadvantaged communities to save money and build climate resilience.

LAND USE AND COMMUNITY DEVELOPMENT

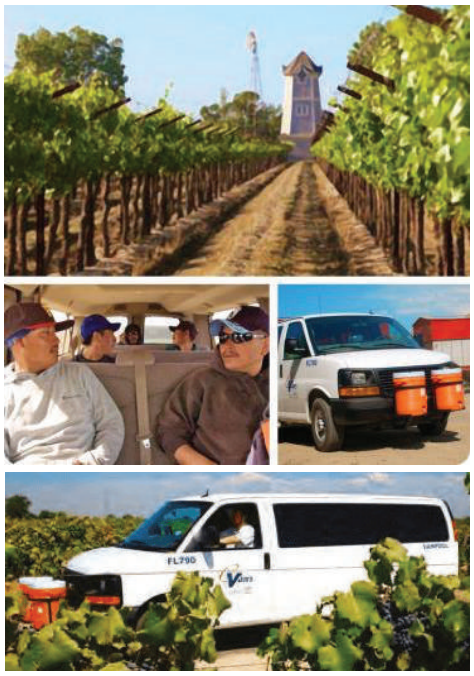
Climate change will put additional stresses on communities' access to basic needs (including food, shelter, and health care) and social isolation (from inadequate land use planning, infrastructure, language barriers, etc.), preventing people from reaching out to one another to prepare for, respond to, and recover from climate events.

Low-income communities and communities of color are often left out of land use planning and decision-making, and may be excluded from climate resilient community planning. These vulnerable communities already "lack access to hospitals, clinics, healthy food, supermarkets, and other environmental resources. Historically, white suburban development has been prioritized while densely populated, inner city infrastructures were defunded. This resulted in increased geographic segregation that exacerbated unequal public,

ACTIVE TRANSPORTATION PROGRAM

Cyclists take part in a state BikeShare event at the State Capital (photo courtesy of The California Department of Transportation).

CALVANS



CalVan's Agricultural Workers Vanpool provides workers with safe, reliable transportation (photo courtesy of CalVans).

federal, and state investments for urban, low-income people" (Advancement Project California 2017). In addition, communities and individuals with less social capital, including those who are disconnected to political power or who are isolated by language, culture, or citizenship/immigration status, may not be sufficiently connected to institutions and agencies that can help them after a climate event. Finally, climate disasters exacerbate all of these issues. Climate disasters destroy housing stock, increasing rates of gentrification; separate communities, leaving them more socially and politically isolated; and displace limited government resources to those who have more power and more wealth.

Innovative Solutions/Case Studies

- On April 29, 2015, Governor Brown signed Executive Order B-30-15, which said that "Priority should be given to actions that both build climate preparedness and reduce greenhouse gas emissions," and "Actions should protect the state's most vulnerable populations." A Technical Advisory Group developed guidance to support the implementation, which included an Equity Checklist "to ensure that plans and investments identify and protect the State's most vulnerable populations" (OPR 2017).
- AB 2722 (Burke, 2016) created the Transformative Climate Communities Program "to award competitive grants to specified eligible entities for the development and implementation of neighborhood-level transformative climate community plans that include greenhouse gas emissions reduction projects that provide local economic, environmental, and health benefits to disadvantaged communities" (AB 2772, Burke 2016) through a multi-stakeholder, community engagement process.
- SB 1000 (Leyva, 2016) "requires general plans to include an environmental justice element that identifies objectives and policies to reduce the unique or compounded health risks in disadvantaged communities, to promote civil engagement in the public decision-making process, and prioritize improvements and programs that address the needs of disadvantaged communities" (CJWG 2017).

Abstract from *Dying Alone: The Social Production of Urban Isolation* by Eric Klinenberg:

"In July 1995 over 700 Chicago residents, most of them old and impoverished, died in a short but devastating heat wave. As part of a 'social autopsy' of this disaster that goes beyond natural factors to uncover the institutional forces that made the urban environment suddenly so lethal, this article examines the social production and lived experience of everyday urban isolation. Accounts from ethnographic investigations in the affected neighborhoods and of the city agencies entrusted with dealing with the issue are used to highlight four key conditions: (1) the increase in the number and proportion of people living alone, including seniors who outlive or become estranged from their social networks; (2) the fear of crime and the use of social withdrawal and reclusion as survival strategies; (3) the simultaneous degradation and fortification of urban public space, particularly in segregated neighborhoods that have lost major commercial establishments and other attractions that entice people out of their homes; (4) the political dysfunctions stemming from social service programs that treat citizens as consumers in a market for public goods despite a growing population of residents who lack access to the information and network ties necessary for such 'smart shopping' for city support. Together, these conditions create a formula for disaster that the 1995 heat wave actualized for the city of Chicago and might yet recur in other US metropolises" (Klinenberg 2001).

- The Westside Specific Plan in National City seeks to "comprehensively address environmental and land use issues and to offer opportunities for more cohesive land use patterns and future development and redevelopment…reflecting vision and aspirations of the community" (National City 2010).
- Rural Community Assistance Corporation (RCAC) provides training, technical, and financial resources for rural communities to better prepare for and recover from climate change impacts, including wildfires, droughts, and increasing temperatures. RCAC offers no- or low-interest loans for housing, environmental infrastructure, community facilities, small businesses, and household wells. RCAC has provided many loans for wells in the Central Valley for families facing water shortages. RCAC also offers workshops and webinars to help rural communities leverage other resources, such as the Tribal Housing Excellence Academy to increase financial literacy in Native American communities (CNRA 2016).
- Urban Habitat, 6 Wins for Social Equity Network (6 Wins), Public Advocates, and others developed the Equity, Environment and Jobs (EEJ) "as an alternative to the planning scenario created by regional agency staff and elected officials. Working with members of the Transportation Justice Working Group, [they] created a plan that was supported by over forty Bay Area organizations. It shifted over $8 billion from highways and transit capital projects to transit service improvements for those who rely most on public transportation. This included $3.3 billion for more transit service (37% more transit service than the plan proposed by staff), funding for a free regional youth bus program, and the restoration of bus service for transit-dependent populations. The EEJ also increases affordable housing across the Bay Area, especially in communities with good air quality, jobs, quality schools, and parks" (Urban Habitat 2018).
- The California Center for Civic Participation runs Green Focus, a 6-month program for high school students in Sacramento to learn about environmental policies and laws and explore careers in the environmental field. Students participate in activities, hear from speakers, do green-job shadowing, visit legislators, and attend workshops. This not only builds the capacity of the individual students, but also the capacity of their communities.
- "Measures Matter: Ensuring Equitable Implementation of Los Angeles County Measures M & A" offers a framework for both conversation and

RURAL COMMUNITY ASSISTANCE CORPORATION

RCAC provides many no- and low-interest well loans in the Central Valley for families facing water shortages (photo courtesy of RCAC).

THE CALIFORNIA CENTER FOR CIVIC PARTICIPATION: GREEN FOCUS

Green Focus participants learn about environmental policies and laws, and explore environmental careers (photo courtesy of Anthony Vincent).

action on how to integrate equity into planning and economic growth, using Measures M and A in Los Angeles as case studies. The report recommends eight principles, including early equity participation, inclusion of equity guidelines for government spending, and ongoing outcomes and process evaluation (Carter 2018).

- The City of Oakland engaged in a multi-stakeholder (including green business groups, social justice organizations, and environmental stakeholders) community-based process to create, assess the progress of, and update the City of Oakland Energy and Climate Action Plan (ECAP). The ECAP identifies and prioritizes actions for the City to reduce energy consumption and GHG emissions (City of Oakland California 2012).

EMERGENCY MANAGEMENT

Climate change will increase the frequency and severity of climate emergencies, such as droughts, floods, wildfires, and extreme heat. Vulnerable communities' resilience, or ability to adapt to these threats, will be hindered by various socioeconomic conditions.

For example, individuals who don't have air conditioning or personal vehicles may not be able to cool down or vacate the area during an extreme heat event or other emergency. Those who rely on food banks, health care facilities, shelters, or churches may not be able to access these resources for long periods of time after flooding. Damage to power plants, wastewater treatment plants, and hazardous waste facilities may expose residents who live close to these facilities to pathogens and hazardous chemicals or fumes. Outdoor workers may work in unsafe conditions either because they are not told of the dangers or because they stay on the job for income. Renters are less likely to have insurance, and low-income households are less likely to purchase emergency preparedness materials. People living in substandard housing will be less protected during an emergency, and emergency services are often less effective in disadvantaged communities. Households with LEP may not be able to understand emergency instructions, or might not listen to emergency evacuation instructions because of fears regarding their citizenship/immigration status.

Innovative Solutions/Case Studies

- A major chemical explosion in March 1999 at the Chevron oil refinery in Richmond, California, followed by two more leaks in June and July revealed Contra Costa County's inadequate emergency response system and the daily health risks faced by residents living in this industrial zone. Many of the area's residents were poorly informed of emergency safety procedures, including the "shelter-in-place" information, and among those most impacted were LEP residents and children. In response to this, the Laotian Organizing Project (LOP) launched a campaign targeting Contra Costa County's Health Services and the Internal Operations Committee of Contra Costa County's Board of Supervisors to implement a multilingual emergency phone-alert system. After a lengthy campaign, the County committed to establishing such a system, and LOP won an historic victory.

SUMMER HEAT RICHMOND MARCH

Thousands rallied for climate justice at the 2013 Summer Heat Richmond March in front of Chevron Oil Refinery (photo courtesy of Jessica Nuti).

- The Blue Lake Rancheria, a federally recognized tribe in rural Humboldt County, is building its resilience to climate change through numerous adaptation investments. Climate change impacts are amplified on these tribal lands because of geographic isolation, roads that are prone to landslides, and tenuous connections to outside electricity, natural gas, and communication grids. With funding and partners, the tribe now has a microgrid that enables them to supply their own power during emergencies (Bird 2018). The project also reduces GHG emissions, reduces PM10 emissions, increases employment (10%), saves money ($250,000/year), and improves climate resilience and emergency preparedness (Ganion 2017).
- Cal OES's MyPlan Internet Mapping Tool website is a site for local planners and other professionals working for local communities to create community-scale hazard maps for their Local Hazard Mitigation Plans.
- During the Thomas Fire (December 2017-January 2018), which severely impacted Ventura and Santa Barbara Counties, CAUSE, Mixteco Indigena Community Organizing Project (MICOP), and Future Leaders of America (FLA) worked closely to organize vulnerable communities who were being left out of disaster response activities. Volunteers distributed N95 protective masks to thousands of farmworkers laboring outdoors in the wildfire smoke, and supporters called Cal OSHA to demand they reopen their offices and issue protections for workers breathing in the toxic air. They worked with elected representatives to push local agencies to translate crucial emergency information about evacuation orders, safety warnings, emergency shelters, and road closures into Spanish, and led distribution of N95 masks and bottled water on Ventura's Westside, where thousands of people remained despite mandatory evacuation orders. CAUSE, MICOP, FLA, and the McCune Foundation created the 805 Undocufund "to assist local undocumented immigrant individuals and families who have been economically impacted by the Thomas Fire and the mudslides in its aftermath and are excluded from many relief programs such as FEMA assistance and Disaster Unemployment Assistance" (805UNDOCUFund 2017).

BLUE LAKE RANCHERIA CASINO AND MICROGRID

The Blue Lake Rancheria Microgrid improves the tribe's climate resilience and emergency preparedness, while reducing GHG and PM10 emissions, saving money, and increasing employment (photo courtesy of Siemen's/http://siemenusa_synapticdigital.com).

CAUSE VOLUNTEERS

CAUSE volunteers distribute protective N95 face masks to exposed field workers during the California wildfires in the fall/early winter of 2017/2018 (photo courtesy of CAUSE).

Natural and Managed Resource Systems

BIODIVERSITY AND HABITAT

Climate change will have significant impacts on California's biodiversity and habitat. A recent study found that 16 of 29 vegetation communities statewide are highly or nearly highly vulnerable to climate change (Thorne 2016) (CNRA 2018). In addition, these ecosystems provide a critical means to mitigate climate through carbon sequestration.

Vulnerable communities are rarely discussed in biodiversity and habitat conservation efforts, and adaptation strategies adequately include consideration of tribal communities, rural populations living in or around at-risk habitat, or people working outdoors on conservation sites. Tribal communities often have cultural and religious ties to local plants and may not be able to adapt to their disappearance. Rural populations may depend on local habitat for firewood, foraging, or even their livelihood. In addition, as extreme heat events, wildfires, and flooding increase in rate and severity, those working outdoors to protect biodiversity and habitat are exposed to increased health risks.

Innovative Solutions/Case Studies

- The Sierra Native Alliance and the Native Youth Conservation Corps (NYCC) are working with conservation partners to "restore mountain meadow groundwater storage capacity, expand and increase wildlife habitat connectivity, preserve valuable cultural resources, and improve ecosystem function and resilience to climate change through consistent community stewardship efforts. NYCC integrates Traditional Ecological Knowledge (TEK) into headwaters management, restoring aspen groves, floodplains and riparian zones along major tributaries in the region as well as improving seven mountain meadows" (CNRA 2016). The mountain meadows are also home to plants that provide food, medicine, and materials that have cultural significance for some tribes.
- The California Natural Resources Agency, the California Department of Food and Agriculture, California Environmental Protection Agency, and California Air Resources Board are jointly drafting the California 2030 Natural and Working Lands Climate Change Implementation Plan to "identify the scope and scale of activities that California can undertake to mitigate [climate change] disturbances and enhance the resilience of natural and working lands, increasing their ability to sequester carbon and provide health, social, economic, and environmental benefits" (CARB 2018). They have also presented a draft of the California Natural and Working Lands Carbon and Greenhouse Gas Model (CALAND) to "quantify and compare the changes in landscape carbon and associated GHG due to different management options in the context of the entire CA landscape" (Di Vittorio 2017). One of the key elements will be to see how this can create economic opportunity for those working on or living near these conservation efforts to build resilience.

CAL FIRE URBAN AND COMMUNITY FORESTRY

Cal Fire's Urban and Community Forestry Division focuses funding directly to underserved and disadvantaged communities across California (photo courtesy of CAL FIRE).

- The Sustainable Agricultural Lands Conservation (SALC) Program "complements investments made in urban areas with the purchase of agricultural conservation easements, development of agricultural land strategy plans, and other mechanisms that result in GHG reductions and a more resilient agricultural sector," using funds from the California Climate Investment Fund (CA Dept of Conservation n.d.).
- On the urban front, CAL FIRE Urban and Community Forestry creates and restores species' habitat and partners with other organizations to provide environmental education and jobs for locals.

FORESTS

Climate change has and will continue to have impacts on California's forests. California forests were maintained by low-intensity, frequent fire (Stephens 2007) (CNRA January 2018), but fire suppression in the last several decades has caused overgrown forests, which are less resilient to climate change impacts like drought, large and severe wildfires, and disease (Mallek 2013) (CNRA January 2018). In addition, droughts and warmer temperatures have exacerbated tree death from bark beetles (CNRA January 2018).

Vulnerable communities need to be considered in forest adaptation planning not only because of the same issues mentioned in the biodiversity and habitat section above, but also because of the importance of urban forests and that "nearly two-thirds of California's developed water supply originates from the streams and rivers of the Southern Cascades and Sierra Nevada mountain regions" (CNRA January 2018).

Innovative Solutions/Case Studies

- Funded by the United States Forest Service's Urban and Community Forestry Program and the California Climate Investments from the Greenhouse Gas Reduction Fund, the California Department of Forestry and Fire Protection, the City of Brawley, Brawley High School District, the City of Imperial, the City of Calexico, and the City of Holtville will plant 1,400 trees in predominantly disadvantaged communities in the Imperial Valley. Like other tree planting projects, the Imperial Valley Urban Forest Project offers economic opportunities for locals and community involvement to build resilience, and more tree canopy to combat the heat island effect in urban areas to adapt to climate change (CNRA January 2018).

AMIGOS DE LOS RIOS

Amigos de los Rios volunteers plant trees and plants in a community garden and playground to help counteract the heat island effect and sequester carbon (photo courtesy of Amigos de los Rios).

URBAN GREENING PROGRAM

A rubber sidewalk installation, utilizing recycled post-consumer tire rubber, is part of an Urban Greening project for the Compton Unified School District (photo courtesy of Urban Greening Program and Radiant Media Solutions).

- In southern California, local non-profit Amigos de los Rios, with grants from CAL FIRE and the California Natural Resources Agency, has begun planting 1,100 trees to replace the hundreds of trees killed by bark beetles in a park in South El Monte in the San Gabriel Valley. The trees will cool urban areas, counteracting the heat island effect, and will sequester carbon.
- In November 2017, the California Natural Resources Agency announced $76 million in funding for 39 green infrastructure projects through the Urban Greening Program. The grants support projects that decrease energy consumption, reduce vehicle miles traveled, convert built environments into green spaces, reduce greenhouse gases by sequestering carbon, and provide opportunities for walking, biking, and recreation. Ninety-two percent of the funding was awarded to projects in disadvantaged communities.

OCEAN AND COAST

Climate change has and will continue to have significant impacts on the California coast, including sea level rise, storms, coastal erosion, beach loss, and ocean acidification. Almost 75% of the state's population lives along the coast (Kildow 2016), including many people with high climate vulnerability.

In the Los Angeles region, most of those projected to be impacted by sea level rise and flooding do not exhibit high social vulnerability, except for Ventura County, where more than half the population does. In the San Francisco Bay Area, however, more than half of those at risk of sea level rise impacts have high social vulnerability. This is because the most valuable properties in Los Angeles are generally along the coast, whereas the wealthier residents in the Bay Area live in the hills (Cooley 2012).

The resilience of vulnerable communities will be hindered by various socioeconomic conditions. For example, low-income individuals will have a harder time recovering from sea level rise because they will have fewer resources for home repairs, may be living in homes that are less structurally sound, and may depend on social services that will be unavailable to them after a flood. They may also lack personal transportation to evacuate, be renters, and lack insurance. They may experience compounding vulnerabilities such as existing health conditions, work that relies on the ocean or coastal environment, or LEP. "[A]ge, health status, socioeconomic status, race/ethnicity, and occupation are key risk factors that individually and collectively affect a population's vulnerability to health impacts from coastal flooding" (USGCRP 2016).

Innovative Solutions/Case Studies

- CAUSE has a mission "to build grassroots power to invoke social, economic, and environmental justice for the people of California's Central Coast Region through policy research, leadership development, organizing, and advocacy. CAUSE defines the Central Coast Region as the counties of Ventura, Santa Barbara, San Luis Obispo, Santa Cruz, Monterey and San Benito" (CAUSE n.d.). In Oxnard they are "working towards a vision of removing industrial infrastructure from its

CAUSE VOLUNTEER AT SANTA CLARA RIVER

The Santa Clara River in Western Ventura County is one of the most endangered rivers in the country. CAUSE encourages local residents to become involved in public hearings, neighborhood outreach, and the restoration work needed to make this river vital again (photo courtesy of CAUSE).

coast and replacing it with restored wetlands habitat, which can help buffer rising seas that threaten our city, which is a low-lying coastal area" (CNRA 2016). In Santa Paula, they are "working to create a river parkway, with public access for local residents, while pushing for sustainable water management that would bring back the river's natural flow and promote resilience in the face of drought" (CNRA 2016). CAUSE is also building resilience by encouraging "hundreds of members of these low-income communities of color to participate in public hearings, neighborhood outreach, restoration work, and local advocacy" (CNRA 2016).

- In California, a Technical Advisory Committee was created from local, state, and federal government agencies, non-governmental organizations; and environmental consulting firms, and asked to select projects to use as case studies of natural shoreline infrastructure to aid coastal planners, local governments, and others involved in making decisions and working toward solutions for climate-related coastal hazards. In addition, an emphasis was placed on connecting vulnerable communities with their shoreline to increase an understanding of risks and investment in preserving public access by using natural approaches. A promising example of these projects is Seal Beach National Wildlife Refuge Thin-layer Salt Marsh Sediment Augmentation Pilot Project, where "[i]n early 2016 over the course of 4 months, the team raised the site elevation by about 8.5 inches, and vegetation and channels are already developing on the site" (Judge 2017).

SEAL BEACH NATIONAL WILDLIFE REFUGE SALT MARSH SEDIMENT AUGMENTATION PROJECT

The Salt Marsh Sediment Augmentation Project is a novel adaptation strategy for wetland resilience to sea level rise (photo courtesy of USGS).

AGRICULTURE

Climate change has and will continue to have significant impacts on agriculture in California, from higher temperatures, heat waves, droughts, and wildfires. Climate change will impact the prevalence of pests and diseases, and the location and type of food crops and livestock production. California's Central Valley comprises 1% of farmland in the United States, but produces 25% of the country's food, including 40% of fruits, nuts, and other table foods nationally. Climate change in California will have significant national impacts on food pricing, diversity, quantity, and quality.

Vulnerable communities' resilience, or ability to adapt to climate impacts to agriculture, will be hindered by various socioeconomic conditions. For example, agricultural workers will be some of the first impacted by declining income and more dangerous working conditions, and as food prices go up and quality goes down, low-income residents will have even less access to healthy options.

"Drought Vulnerability of Rural Communities in California's San Joaquin Valley" examines drought vulnerability in rural farmworker communities in California's San Joaquin Valley. Findings demonstrate that drought impacts and vulnerabilities are uneven, localized, embedded in lived experiences, and dynamic over time. Increased representation and participation of disadvantaged communities in water resource and drought planning is needed to address drought vulnerability (Greene 2018).

STATE WATER EFFICIENCY AND ENHANCEMENT PROGRAM (SWEEP)

The Tchieng family farm in Fresno, CA, received a SWEEP grant to change from furrow irrigation to a drip system, which prevents flooding crops and saves water (photo courtesy of SWEEP).

Innovative Solutions/Case Studies

- The State Water Efficiency and Enhancement Program (SWEEP) provides funding to improve the water and energy efficiency of on-farm irrigation, building resilience in agriculture. "Projects include soil, plant, and weather stations to assist farmers in scheduling irrigation, solar panel installation, and micro-irrigation (drip) system conversion" (CNRA 2016). In their May 2016 Progress Report, they reported that 37% of their projects were located in disadvantaged communities.
- Líderes Campesinas was founded to empower and develop the leadership skills of campesinas (women farmworkers). With eight chapters across the state, the multi-issue organization provides trainings and educational workshops on working conditions (including heat stroke and labor laws) and women's health (including domestic violence and diabetes). Created by and for campesinas, they train members to become agents of change. With respect to climate change adaptation, they are building resilience by educating farmworkers about heat-related illness, advocating for improved access to transportation, and building resilience for extreme heat events (Kersten 2012).
- The United Farm Workers have a long history of empowering farm workers and protecting them against environmental harm. They continue their legacy with research, campaigns, and information sharing in English and Spanish to protect farmworkers from climate disasters and improve their climate resilience.

WATER

Climate change will continue to exacerbate issues related to water quantity, quality, and infrastructure in California. These impacts stem from declining snowpack, earlier snow melt, more annual precipitation in the form of rain rather than snow, increased number and severity of droughts and flooding, changes in the timing and volume of peak runoff, and resulting impacts on the quality and availability of water (CDWR 2017) (CNRA January 2018). Water resources are at risk from water pollution, erosion, flooding, risks to water infrastructure, loss of habitat, coastal impacts, and ocean acidification (CNRA January 2018).

Various existing socioeconomic conditions will hinder vulnerable communities' resilience, or ability to adapt to these threats. For example, populations that already have less social or political capital are not sufficiently involved in water planning or management activities. Low-income communities and communities of color are already disproportionately impacted by water pollution and run the risk of being exposed to additional pollution. In the San Joaquin Valley, tens of thousands of people living in Disadvantaged Unincorporated Communities (DUCs) often have polluted drinking water or no drinking water. In addition, there are racial and ethnic disparities in access to safe drinking water in these areas. Just under half (48.9%) of the total population in the San Joaquin Valley is Hispanic, but 67.9% of residents in DUCs are Hispanic (London 2018). Nationally, climate change impacts on water infrastructure, along with sanitation and water quality as well as infrastructure upgrades, are projected to increase water rates significantly over the next five years, potentially making water bills unaffordable to over one-third of U.S. households (Mack 2017).

Climate adaptation practitioners, policy-makers, and scientists commonly assume that adaptation is local, placing responsibility to adapt onto local governments, water utilities, and other local-level resource managers (Measham 2011) (Baker 2012) (Nalau 2015). However, leaving small systems to adapt to climate change on their own is not a viable option because the impacts of climate change are happening at a faster rate than models had projected and local managers differ widely in their ability to adapt, and managers serving more marginalized populations tend to have a lower capacity to adapt, with managers serving more marginalized populations tending to have lower adaptive capacity. These barriers compound risks to households unable to afford coping measures during droughts and other extreme events by limiting the availability of drinking water. Advancing equitable social adaptation requires additional levels of assistance for those local managers of water systems with lower adaptive capacity (Shi 2016). Because the majority of small, self-sufficient water systems serve rural, low-income communities in the state, and often have relatively low technical, managerial, and financial capacity, there is a need to assist small, self-sufficient systems prepare for climate change and future droughts (Ekstrom 2018).

Because droughts will be more frequent and intense in the future, the State Water Resources Control Board, a key water decision-maker with important water rights administration and oversight responsibilities, can set the stage for more timely and effective in-drought decision-making by engaging in sufficient pre-drought planning. Shifting from reactive adaptation in the midst of droughts to more anticipatory adaptation based on drought contingency planning will lead to more effective drought response (Green Nylen 2018).

Groundwater is an essential water supply source during droughts when surface water supplies are reduced. During the 1976 drought, it was primarily the state's groundwater resources that prevented a potential disaster (ACE 1993). Groundwater overdraft continues to increase and is significantly is impaired in several basins. Climate change, with more frequent and extreme droughts, will exacerbate groundwater storage declines. Drought planning and groundwater

planning rarely intersect. There are limited examples of long-term successful groundwater management strategies that account for drought under climate change, but case studies demonstrate that innovative sustainable groundwater management strategies to increase drought resilience under climate change are increasing (Langridge 2018).

Innovative Solutions/Case Studies

- Bay Area Integrated Regional Water Management (IRWM) Plan Disadvantaged Community Involvement Program has initiated a holistic approach to community water assessment. It examines numerous water-related impacts from climate change such as drought; water supply; water quality, affordability, and reliability; sea level rise; salt water intrusion; and flood, as they relate to community health, economic opportunity, education, transportation and other infrastructure, wealth accumulation, and public policy.
- In November 2017, the Greater Monterey County Regional Water Management Group voted to approve the Integrated Plan to Address Drinking Water and Wastewater Needs of Disadvantaged Communities in the Salinas Valley and Greater Monterey County IRWM Region to address the need for community-specific technical assistance for problem and solution identification, project and financial planning, and community leadership development, as part of a community-based planning process to address vulnerability to drought and groundwater contamination.
- RCAC, through the California Household Well Loan Program, has provided over $1 million in low-interest loans and grants to homeowners whose wells have gone dry due to multiple multi-year droughts in California. In addition to money for repairing, refurbishing, and replacing the wells, RCAC is also providing operations and maintenance training and well assessments to identify threats to water safety to build further resilience.
- The unincorporated community of East Porterville is predominantly low income and Latino, and reliant on private wells (London 2018). Located in Tulare County, it was the earliest and hardest hit by the drought. "Hundreds of households lost access to clean, running water as a result of dry wells, or faced deteriorating water quality from increasing nitrate contamination" (CNRA January 2018). Through Proposition 1 grants and loan forgiveness, the State Water Resources Control Board, Department of Water Resources, the California Office of Emergency Services, and the governments of Tulare County and the City of Porterville worked together to connect to the public water system, building their resilience to climate change (CNRA January 2018).
- The Community Water Center coordinates and provides staff to the Asociación de Gente Unida por el Agua (People United for Water, or AGUA), a grassroots coalition of 54 members from 24 impacted communities and 11 non-profits, working on water quality improvement in the Central Valley. AGUA includes youth members who have formed "Youth for AGUA" to both assist AGUA and organize in schools. AGUA has had many local and state-wide victories, including helping to pass the Human Right to Water Bill, AB 685 (2012), making California

RURAL COMMUNITY ASSISTANCE CORPORATION

A RCAC staff member conducts a well assessment to identify threats to water safety (photo courtesy of RCAC).

the first state to legislatively recognize the human right to water. They have also insured that new laws include provisions to benefit disadvantaged communities and that public health notifications are translated into multiple languages (Kersten 2012).

- Katella High School in Anaheim is a disadvantaged school, where 84% of the children qualify for Free and Reduced Price Lunch. Through a Drought Response Outreach Program for Schools (DROPS) grant from the State Water Resources Control Board, they implemented a project "designed to capture and infiltrate approximately 6 acre-feet per year of storm water and dry weather flows, replaced existing impervious surfaces with permeable pavers, vegetated bioswales, rain gardens, and native, water-wise gardens" (CNRA January 2018). The added vegetation reduces the urban heat island effect, reduces the risk of flooding, and conserves water. The school also conducts education and outreach about the project (CNRA January 2018).

Knowledge Gaps in Peer-Reviewed Works

More Robust Mapping Tools

As mentioned in other parts of this assessment, future research could explore an interactive mapping tool that incorporates risk from projected climate change, along with existing and projected environmental health risks, and current and projected socioeconomic data, including climate resilience and adaptive capacity. It's important to note that demographics and other socioeconomic conditions are rapidly changing in California and will continue to do so; input data should reflect this.

It is also important to have a regional lens for mapping from a climate justice perspective. The majority of adaptation planning occurs at the level of local governments or regional planning agencies and thus more detailed assessments of local impacts and specific vulnerabilities are needed alongside statewide mapping and comparisons in order to inform potential responses. Moreover, many of the current structures in place to address climate impacts are occurring regionally. For example, the Bay Area Regional Collaborative and agencies like the SF Bay Conservation and Development Commission (BCDC) address regional climate issues like sea level rise in the Bay Area. A tool that can be adapted to display regionally specific data and rank census tracts by region (by Metropolitan Planning Organization or Council of Governments) would be useful to reflect these regional differences and support decision-making at various levels of government.

This paper did not explore some of the vulnerable populations in the definition from the California Health and Safety Code Section 131019.5, such as individuals with disabilities; children; youth and young adults; seniors; or Lesbian, Gay, Bisexual, Transgender, Queer, and Questioning (LGBTQ+) communities. Homeless LGBTQ+ and LGBTQ+ communities of color are particularly vulnerable populations and face significant and unique obstacles to adapting to climate change. Also, this synthesis report did not connect the 10 vulnerability factors explored to potential sources of available and statewide data.

None of the mapping tools that this paper explored looked at where vulnerable communities worked during the day as opposed to where they lived. This is particularly relevant for agricultural, tourism, and domestic workers whose livelihood is especially dependent on climate, and who may not be included in remediation or rebuilding after a climate event (or climate resilience preparations) because they don't live in the same place that they work.

Ideally, a mapping tool would use a more comprehensive set of factors, weighted and combined into a single index/score that could be compared across cities and counties. In addition, a non-technical user would be able to use "sub-indexes" made up of a subset of handpicked indicators that would also be weighted and combined into a single score. Recognizing that mapping tools are often imperfect, ideally maps would be vetted by community and non-profit organizations and government agencies and possibly presented in small workshops in order to maximize their understanding and applications.

Analyzing the Impacts of California's Cap-and-Trade Program

While California's GHG cap-and-trade program has been held up as an example for the nation on how funds generated (California Climate Investments) can be used to further environmental justice, it has also been highly criticized by environmental justice organizations. Communities of color and low-income communities have been and continue to be concerned that cap-and-trade allowances are too high and therefore cap and trade will not achieve the same rate or scale of GHG emissions reductions as traditional command and control strategies. They are concerned that GHG emissions reductions, when and if they do occur, will not benefit low-income communities and communities of color to the same degree as other communities. They are concerned that this will further perpetuate the disproportionate burden placed on these communities (hot spots), because GHG emissions are often correlated with particulate matter and toxic air emissions in addition to other potential hazards from potential climate emergencies (Kersten 2012). They are also concerned that they are being forced to accept cap and trade as the only way to get much needed funding, whereas a carbon tax or other mechanism could achieve greater community protections while also generating revenues.

"A Preliminary Environmental Equity Assessment of California's Cap-and-Trade Program" found that "preliminary evidence suggests that in-state GHG emissions from regulated companies have increased on average for several industry sectors and that many emissions reductions associated with the program were linked to offset projects located outside of California. Large GHG emitters that might cause the most public health concern were the most likely to use offset projects to meet their obligations under the cap-and-trade program" (Cushing 2016). The authors suggest that additional research is needed on this topic, and that "[s]teeper in-state GHG reductions can be expected going forward if the use of offsets were to be restricted and the opportunity to reduce emissions by replacing imported electricity with in-state generation becomes exhausted" (Cushing 2016).

Examples of potential future research in this area could include measuring particulate matter and toxic reductions (or lack of reductions) in hot spots as a result of California's cap-and-trade program and identifying other means to raise significant capital for California Climate Investments and other funds focused on disadvantaged communities.

Measuring and Achieving Resilience

We currently lack metrics to determine the success of equitable climate adaptation strategies, leaving several questions unanswered. How do we determine when a community is climate "resilient?" Furthermore, how do we determine who pays for and who benefits from adaptation efforts? How do the costs and benefits of proposed climate adaptation strategies (such as seawalls, water tunnels, high-speed rail) that disproportionately benefit wealthier communities compare to the costs/benefits of adaptation strategies that are being advocated for by disadvantaged communities (such as public transit, microgrids, tree plantings, and rainwater collection)? Also, where does funding for climate adaptation strategies come from? Are some costs disproportionately felt by disadvantaged communities whose social services or other assistance are decreased to fund these actions? To ensure funding and investment in adaptation/resilience work is effective and meaningful, we need clear goals to define what success looks like, and metrics to measure success.

A helpful resource/starting point on this topic is the Advancing Equity in California Climate Policy: A New Social Contract for Low-Carbon Transition, from the Center for Labor Research and Education Donald Vial Center on

Employment in the Green Economy University of California, Berkeley, which proposes a "Climate Policy Equity Framework" to:

- "Articulate equity principles and goals to guide policy design;
- Present key criteria to analyze how close a particular climate policy or program comes to meeting these equity goals; and
- Propose indicators that point the way to mechanisms and strategies to advance climate equity" (Zabin 2016).

Combating Direct and Indirect Involuntary Displacement

Climate disasters displace individuals, and those with fewer resources are least able to recover from or adapt to this displacement. Affected people include those from communities in California as well as those affected internationally who come to California fleeing drought, heat, flooding, and other climate impacts. How can we build communities to be more resilient so that displacement (or at least permanent) displacement does not occur? How can we improve the resiliency of those fleeing climate disasters and coming to California, who now face additional risks from climate change and have few resources to adapt to it?

In addition, an unintended but not uncommon challenge in building community resilience and adaptive capacity is the risk of involuntary displacement resulting from gentrification. If investments in infrastructure in a community merely lead to displacing current residents and attracting less vulnerable populations, is this success? Are there lessons learned from smart growth, brownfield redevelopment, and sustainable development that can be applied to climate justice to prevent displacement?

Achieving a Just Transition

Another key area for future research includes how best to invest in vulnerable communities to achieve a just transition. Climate adaptation provides an opportunity to explore how to transition workers from fossil fuel-based jobs to climate-friendly employment. Van Jones' *The Green Collar Economy: How One Solution Can Fix Our Two Biggest Problems* proposes that investments in low- and medium-skill jobs that help conserve energy or use cleaner energy sources would create domestic and local jobs, improve public health and the environment, and create an equitable and sustainable future for our country (Jones 2008).

Community Involvement, Early and Often

Based on decades of working with the most vulnerable communities, climate justice advocates advise that the key to building resilience is to involve the local community as early in the process as possible, and to prioritize public participation and open dialogue often. They attest that community engagement must include community empowerment and community leadership in equitable partnership with public agencies and local government. "It's a bottoms-up approach that is both building a new policy platform and engaging new constituencies in the fight to protect the planet" (Kersten 2012).

Examples of such approaches, frameworks, and toolkits include:

- *Measures Matter: Ensuring Equitable Implementation of Los Angeles County Measures M & A* (Carter 2018) which offers a framework for both conversation and action on how to integrate equity into planning and economic growth, using Measures M and A in Los Angeles as case studies. The report recommends eight principles:
    - Drive with equity from the start;
    - Support grassroots groups and leadership development;
    - Share decision-making among residents, cities, and agencies;
    - Take a collaborative approach to training and technical assistance;
    - Attach equity guidelines to government dollars;
    - Advance a broad regional economic and health equity platform;
    - Integrate and lead across silos; and
    - Conduct ongoing outcomes and process evaluation.
- *Community-Driven Climate Resilience Planning: A Framework Version 2.0* (Gonzalez 2017) which offers a "living framework," which includes:
    - Co-Development of Planning Model;
    - Power Building;
    - Visioning;
    - Problem Definition;
    - Building Capacity for Integrated Issue Analysis;
    - Assessing Community Vulnerability and Assets;
    - Solutions Development;
    - Interventions to Keep Public Planning Processes on Track.
- *Rooted in Resilience's Community Resilience Toolkit 2.0*, a four-part series for communities, municipal planners, and others that includes:
    - Climate Risk and Job Opportunity Assessment;
    - Local Resilience Assessment;
    - Roots of Equity and Resilience; and
    - Creating Your Plan for Change.

There are countless other such examples—many developed and implemented in California—providing critical guidance, but there appears to be a lack of external evaluation and synthesis of these efforts. Can these approaches to intentionally integrate equity and community involvement into climate adaptation strategies be further piloted, measured for success, and refined and codified at the state level? What data can be pulled from the applications of these models to show the benefits of community engagement and leadership and make engagement standard practice?

Conclusion

This summary report provides a literature review of existing academic research on climate adaptation as it relates to climate justice in California. The report:

- reviewed terms and definitions key to understanding climate justice and adaptation, while recognizing how academics and frontline communities define terms differently;
- highlighted existing mapping tools and indices that help identify the intersection between current and projected climate-vulnerable communities and current and projected climate impacts;
- reviewed literature on how existing social, economic, and environmental inequalities create communities who are and will continue to be disproportionately impacted by climate change, and on how these communities are more vulnerable to the impacts of climate change;
- presented emerging climate adaptation strategies, with summaries of and links to case studies and innovative programs that are attempting to increase the resiliency of vulnerable populations; and
- suggested areas for additional peer-reviewed research to better address climate adaptation for vulnerable populations and to promote climate justice in California.

The report's findings underscore how existing and historic disparities negatively impact a community's and individual's climate adaptive capacity and resilience. These disparities include a lack of access to:

- equal protection from climate impacts due to institutionalized racism;
- financial resources to protect oneself and recover from climate impacts;
- green spaces to absorb climate impacts and create a refuge from those impacts;
- a baseline of clean air, clean water, and clean land;
- good health, health insurance, and health care;
- decent education and information in a language they can understand;
- jobs that are more resilient to climate change and that can protect workers from the immediate and direct impacts of climate change;
- basic resources to adapt to climate change such as air conditioning or transportation;
- inclusion in the decision-making process, representation in government, and a community able to support each other during difficult times; and
- basic protections under the law because of citizenship/immigration status.

That said, the report's findings also highlight many innovative, often community-led, California-based efforts to build climate adaptive capacity in low-income communities and communities of color. These examples can serve as resources to encourage government processes to include communities as equitable partners in the planning for and recovering from climate impacts.

Few academic reports coming out of California's Fourth Climate Change Assessment focus on issues pertaining to climate justice. This study aims to encourage future climate assessments to bring further investment into researching and addressing climate justice and climate adaptation in California's low-income and disadvantaged communities.

Angela Glover Blackwell describes a phenomenon called "the curb cut effect" that describes how numerous individuals have benefitted from "curb cuts" in sidewalks that enable people in wheelchairs to move more easily across the street. Not only did people in wheelchairs benefit from curb cuts, but also people pushing heavy carts, wheeling luggage, pushing strollers, skateboarders, and runners. These positive externalities to curb cuts (and ramps and automated doors and other accessibility improvements) improved the lives of all of us. It is not a zero-sum game. When the U.S. "targets support where it is needed most—when we create the circumstances that allow those who have been left behind to participate and contribute fully—everyone wins. The corollary is also true: When we ignore the challenges faced by the most vulnerable among us, those challenges, magnified many times over, become a drag on economic growth, prosperity, and national well-being" (Glover Blackwell 2017). Research into building climate resilience in our most vulnerable populations will improve the entire state of California's ability to adapt to climate change.

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