Title

The Local Health Department Role in the California Climate Investments: An Opportunity to Integrate Public Health Sector Engagement in Climate Action Initiatives to Advance Environmental Health Equity

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Publication Date

2019

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA

Los Angeles

The Local Health Department Role in the California Climate Investments: An Opportunity to Integrate Public Health Sector Engagement in Climate Action Initiatives to Advance Environmental Health Equity

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Philosophy

in Environmental Health Sciences

by

Tamanna Rahman

2019

ABSTRACT OF THE DISSERTATION

The Local Health Department Role in the California Climate Investments:
An Opportunity to Integrate Public Health Sector Engagement in Climate Action Initiatives to Advance Environmental Health Equity

by

Tamanna Rahman
Doctor of Philosophy in Environmental Health Sciences
University of California, Los Angeles, 2019
Professor Hilary Godwin, Co-Chair
Professor Richard J. Jackson, Co-Chair

It is widely recognized that climate change poses a serious challenge to the field of public health due to the changing frequency and severity of impacts faced by local communities, however, addressing climate change provides the opportunity to implement solutions that build healthy and climate-resilient communities. The public health sector works closely with local governments and community partners to address health inequities of environmental change by developing and implementing policies and programs that prioritize health, and often these activities align with climate mitigation and adaptation measures. Local health departments (LHDs) are often at the front lines working with communities disproportionately affected by climate change, therefore the public health sector has a critical role to play in advancing and mobilizing support for health-based climate change strategies that improve health outcomes,

address inequities, and reduce greenhouse gas emissions. California's strategy to reinvest cap-and-trade funds into climate change mitigation and adaptation activities, known as the California Climate Investments (CCI), offers a significant opportunity for the public health sector to integrate health consideration into local climate mitigation and adaptation efforts, however, there has been limited public health sector engagement at the local level. The work presented here evaluates the CCI through a public health practice lens to identify opportunities to increase LHD engagement in the CCI at the local level to ensure that climate action strategies integrate public health consideration and promote environmental health equity. The first section covered in Chapters 2 and 3 provide a critical review of the literature on climate change vulnerability assessment frameworks to examine the potential climate change-related health impacts within the context of Los Angeles County to inform climate change adaptation planning. The next section covered in Chapter 4 and 5 focus on the CCI to identify opportunities to increase LHD engagement and integrate public health consideration in the implementation of CCI funded projects. First, selected CCI program guidelines and publicly available documents were coded and analyzed to examine the programmatic alignment between CCI program requirements and foundational LHD activities to identify opportunities for LHDs to engage and actively support partner organizations. Next, interviews were conducted with selected LHD personnel and key respondents to identify best practices of LHD engagement in urban greening and community forestry initiatives funded through the CCI. Document analysis and interviews demonstrated that there are opportunities for LHD engagement, however, barriers exist. Lack of information about LHD eligible to apply, limited requirements for LHD engagement, and insufficient awareness of LHDs about the CCI limit public health sector engagement at the local level. Recommendations to address these barriers include increasing outreach to LHDs, establishing a more robust role for

LHDs, increasing the climate adaptation component of the CCI programs to provide opportunity for greater LHD engagement. California's approach to implementing the cap-and-trade program and reinvesting auction proceeds in local climate action initiatives to benefit vulnerable communities provides a model for other jurisdictions. As other states look to cap-and-trade, it is critical that California pushes innovation and sets the example of how to effectively integrate public health sector engagement in all levels of climate action to reduce greenhouse gas emissions, help communities adapt to climate change, and advance environmental health equity so that communities can thrive and become climate-resilient.

The dissertation of Tamanna Rahman is approved.

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University of California, Los Angeles

2019

DEDICATION

To my family.

Thank you for always believing in me and supporting me when I needed it the most.

Love you very much.

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LIST OF COMMON ABBREVIATIONS

AB	Assembly Bill
AHSC	Affordable Housing and Sustainable Communities
ASTHO	Association of Territorial Health Officials
ATP	Active Transportation Program
BRACE	Building Resilience Against Climate Effects
CalBRACE	California Building Resilience Against Climate Effects
CalEPA	California Environmental Protection Agency
CAL FIRE	California Department of Forestry and Fire Protection
CARB	California Air Resources Board
CCI	California Climate Investments
CDC	Centers for Disease Control and Prevention
CDFA	California Department of Food and Agriculture
CDPH	California Department of Public Health
CDWR	California Department of Water Resources
CEHTP	California Environmental Health Tracking Program
CNRA	California Natural Resources Agency
CRSCI	Climate Ready States and Cities Initiative
DAC	Disadvantaged communities
GGRF	Greenhouse Gas Reduction Fund
GHG	Greenhouse gases
HDW	Healthy Design Workgroup
HiAP	Health in All Policies
HIA	Health impact assessment
IPCC	Intergovernmental Panel on Climate Change

LACDPH	Los Angeles County Department of Public Health
LHD	Local Health Department
NACCHO	National Association of County and City Health Officials
OEHHA	California Office of Environmental Health Hazard Assessment
PM	Particulate Matter
SB	Senate Bill
SGC	Strategic Growth Council
TCC	Transformative Climate Communities
UCF	Urban and Community Forestry
UG	Urban Greening
VMT	Vehicle miles traveled

ACKNOWLEDGEMENTS

I want to take this opportunity to thank all those who have helped me throughout my PhD journey. These past eight years have been the most challenging, but I am stronger, more resilient, and successful in my pursuit because of the support and contributions of the following.

First, I would like to thank Dr. Hilary Godwin and Dr. Richard Jackson for their guidance, mentorship, and constant encouragement. It is beyond my capacity to find the words to fully express the impact both have had on my graduate education and professional development as a public health practitioner. Dr. Godwin, with her compassion, patience, and insight has helped me overcome many challenges so that I could finally finish this chapter of my life (literally and figuratively!). Dr. Jackson, who has been an inspiration since that guest presentation in my undergraduate environmental health course at UC Berkeley, has greatly informed my view of public health practice. I will continue to carry the lessons and insights with me throughout my career as a public health practitioner. I am truly grateful for having the opportunity to learn from you both and to have you on my corner of the ring. Thank you both for your invaluable support and encouragement.

I also would like to thank my other committee members, Dr. JR DeShazo and Dr. Eisenman, for their insightful recommendations that helped to inform my research activity which helped to make a richer contribution to the field.

I would also like to thank Colleen Callahan and Dr. JR DeShazo for the opportunity to work with the UCLA Luskin Center on various projects which have largely informed my research. The topic for Chapters 2 and 3 were conceptualized by Colleen Callahan and Dr. JR DeShazo. While I conducted the literature review for Chapters 2 and 3, discussions with Colleen helped to frame the chapters. I am also grateful to Colleen for providing the initial organizational

structure for Chapters 2 and 3 of my dissertation. I am also grateful to have had the opportunity to participate on behalf of the UCLA Luskin Center, at the various local California Climate Investment workshops. While attending these events, I noted the opportunity for having more public sector engagement in this major project.

I would also like to thank Professor Gary Evans (Cornell University) for drafting sections of Chapter 3 pertaining to mental health impacts and behavioral responses associated to climate change. Professor Evans has contributed greatly to the field of environmental psychology and how physical environments impacts children's health and well-being. I am grateful to the US Forest Service for the funding that supported my work on the reports that became Chapters 2 and 3 of this thesis.

I am also deeply indebted to the individuals from the Long Beach Health Department, Long Beach Development Services, Los Angeles County Department of Public Health, Madera County Department of Public Health, Riverside County Department of Public Health, San Diego Department of Public Health, California Releaf, California Department of Forestry and Fire Protection, and the California Natural Resources Agency, whose insights helped to inform Chapter 5. I am truly grateful for the time they gave me from their busy schedules to talk about urban greening projects, the California Climate Investments, and the amazing work being done by local health departments. I met so many wonderful people through this experience.

I would also like to thank my friends and lifelong colleagues from the EHS Policy Group. A big thank you to Rebecca Greenberg for being a key resource for any departmental questions, but also being my therapist and friend ever since the time I started my MPH at UCLA. Thank you for always providing encouraging words.

It is common knowledge that pursuing a PhD is a challenging feat that only a small percentage of people experience. However, what is not common knowledge is the extent to which the constant psychological strain impacts an individual's emotional and mental health. I am grateful for the one-on-one and group therapy sessions available through UCLA's Counseling and Psychological Services (CAPS) and the weekly mindfulness classes available through UCLA's Mindful Awareness Research Center (MARC). These invaluable resources helped me gain the tools that I needed to cope and counteract the self-doubt and criticism with self-compassion and kindness. I am also thankful for the Yoga with Adriene Youtube channel, taught by Adriene Mishler, that has continuously reminded me that a little bit of yoga goes a long way. This process has not only been a phase of academic and professional development, but it has also been a key phase of personal growth.

And most importantly, I would like to thank my family. Abbu and Ammu, thank you for your unyielding support, believing that I could finish this, and for your prayers that have brought me so many blessings. Maisha, thank you for always knowing how to make me laugh, hearing me vent, and reminding me to "be a duck." I can count on you for anything. Mamoni, I wish we could have celebrated this accomplishment together, but I know you'll always be with me (*aadu-aadu*). Nana and Nanu, thank you for always giving me the strength to keep going. And Tawsique, thank you for being my cheerleader, for holding me steady when I spiraled, for giving me perspective, and for being my partner in this.

I am who I am today because of my experiences and because of the people who walked with me and stood by me in this journey. I am truly blessed.

VITA

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- "Public Health Leadership in Regional Climate Action Planning: Leveraging Academic-Government Partnerships in Los Angeles County" American Public Health Association Annual Meeting and Exposition, New Orleans, LA, November 18, 2014.

- "Key local and state policies and regulations related to climate change in Los Angeles and California" Los Angeles Department of Public Health for the *Climate and Health Workshop Series*, March 19, 2014.
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SELECTED PUBLICATIONS

- Meng, Y., **Rahman, T.**, & Pickett, M. (2015). *Californians with the Top Chronic Conditions: 11 Million and Counting.* California Health Care Foundation.
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OTHER SCHOLARLY WORKS

- Callahan, C., **Rahman, T.**, & DeShazo, J.R. (2015). *White Paper Chapter on A Review of Existing Frameworks for Climate Change Vulnerability Assessments*. Unpublished manuscript, Luskin Center for Innovation, University of California, Los Angeles, California, U.S.A.
- Callahan, C., **Rahman, T.**, Evans, G., & DeShazo, J.R. (2015). *White Paper Chapter on Human Health Impacts for a Climate Change, Water, and Environmental Justice Vulnerability Assessment Framework*. Unpublished manuscript, Luskin Center for Innovation, University of California, Los Angeles, California, U.S.A.

CHAPTER 1: INTRODUCTION AND OVERVIEW OF THE THESIS

"Climate change could be the biggest global health threat of the 21st century, but by working together, we can turn it into this century's greatest opportunity for public health

(Watts et al., 2017)*."*

INTRODUCTION

Key experts and researchers in climate science and the field of public health agree that climate change is a serious threat to human health. Although much still remains to be learned about the impacts of climate change on human health, the fact that climate change is a major public health threat has been observed by communities, globally and locally, and has been well-documented by climate and health experts (Bedsworth, Cayan, Franco, Fisher, & Ziaja, 2018; K. Ebi et al., 2018; Hathaway & Maibach, 2018; IPCC, 2015). Direct and indirect health impacts linked to climate variability are associated with rising temperatures, changes in precipitation patterns, more severe and frequent extreme weather events, and other disruptions to environmental processes (Wheeler & Watts, 2018). Direct health impacts are associated with exposure to hazards such as heat waves, storms, and drought, while indirect impacts may be associated with changing exposure to disease vectors, air and water pollution, food shortages, or other disruptions to other societal infrastructure on which people depend (Ebi et al., 2018; USGCRP, 2016).

Climate change impacts also add to the cumulative stresses currently faced by various communities, and over time, the compounding of these stresses tend to increase the challenges and harms these populations encounter (Andrulis, Siddiqui, Cooper, 2012; Luber et al., 2014).

Climate change related health impacts will vary across populations and communities due to differences in exposure, sensitivity, and adaptive capacity of individuals and groups. The populations that are typically more vulnerable or typically bear the unequal burden of climate change are economically disadvantaged, minority populations, children, elderly, and those with preexisting health conditions. Other populations also vulnerable include pregnant women, those with disabilities, individuals who disproportionately rely on emergency medical services, those living in poor or urban areas, immigrant groups (especially those with limited English proficiency), isolated populations, and workers in certain occupations (e.g., outdoor and agricultural workers) (Ebi et al., 2018; USGCRP, 2016). Already existing environmental health disparities, disproportionate exposure to multiple sources of pollution, and other inequities also tend to increase vulnerability (Shonkoff, Morello-Frosch, Pastor, & Sadd, 2009). In a series of reports analyzing the disparate impacts of climate change, what came to be known as "the climate gap," Morello-Frosch et al. found that lower income communities and communities of color were more impacted during extreme heat waves and were more likely to be exposed to poorer air quality, live in neighborhoods with heat-trapping infrastructure, have fewer amenities to mitigate higher temperatures (e.g., trees, park space), and more likely to be affected by the economic ramifications of climate change (Morello-Frosch, Pastor, Sadd, & Shonkoff, 2009). Because of the disproportionate impacts of climate change on already vulnerable populations, policies and strategies to address climate change need to take these impacts into consideration and aim to direct benefits to these vulnerable groups. An example of how climate change policy may consider directing benefits to vulnerable groups can be seen in California's strategy to address climate change.

CALIFORNIA'S STRATEGY TO ADDRESS CLIMATE CHANGE

California has traditionally led the nation in protecting and preserving the environment – and that trend has continued with the state's efforts to tackle climate change through aggressive multi-sector efforts. Whether through stricter vehicle standards for passenger vehicles (Assembly Bill 1493) or shifting towards renewable energy sources (Senate Bill 1078), the state has passed a number of laws to reduce GHG emissions in various sectors. These regulations have established the groundwork for the legislation that is at the center of the state's climate change strategy, the California Global Warming Solutions Act of 2006, or Assembly Bill (AB) 32. Through the goals and vision codified in AB 32, the state has committed to reducing GHG emissions to 1990 levels by 2020 and then to 80% below 1990 levels by 2050. In addition to requiring statewide GHG reductions, this regulation also requires the consideration of how the law's implementation will impact communities that are already adversely affected by air pollution. Additionally, this law requires that GHG reduction measures must be designed to direct public and private investments to the most disadvantaged communities throughout the state. AB 32 created a comprehensive plan, the Scoping Plan, to establish a multi-pronged approach to achieve the state's GHG reduction targets. The state is also taking action on climate change adaptation by implementing the Safeguarding California Plan, which is a roadmap for state agencies to safeguard communities throughout California from climate change impacts. With the implementation of these policies and others, the state is on track to meet AB 32 goals, however, California hopes to further the benefits gained from AB 32 by requiring statewide GHG emissions to reduce 40% below 1990 levels by 2030 with the passage of SB 32.

California's Cap-and-Trade Program

One of the strategies California is using to meet AB 32 goals and reduce GHG emissions is through the implementation of the Cap-and-Trade Program. The state's Cap-and-Trade Program is administered by the California Air Resources Board (CARB) which places a limit, or a cap, on GHG emissions (i.e., every metric ton of carbon dioxide equivalent emissions). Companies that emit more than their allotted allowances have to purchase more permits and/or "offsets" (emissions reductions offsite). Companies that emit less than their allotted allowance of emissions credits can trade or sell their allowances at quarterly auctions (Kingsley, 2015, pg 30). Over time, the cap lowers and businesses that reduce emissions can trade their surplus allowances, or tradeable permits, to other companies that find it more expensive to reduce emissions. These permits are traded and sold at quarterly auctions, and the proceeds from which are reinvested in GHG emission reduction strategies to further the goals of AB 32.

Low income communities and communities of color bear the most burden when it comes to being adversely impacted by the unintended consequences of environmental decisions and policies, and therefore environmental health consideration and public health sector engagement is needed to minimize adverse impacts and maximize health benefits. In 2010, the California Department of Public Health and the California Environmental Health Tracking Program (CEHTP) initiated a health impact assessment (HIA) of the state's cap-and-trade policy. While one of the key recommendations of this HIA was to direct community health investments from revenues to California's most vulnerable communities to support climate change adaptation and mitigation strategies (Richardson, English, & Rudolph, 2012). This idea of a "community benefit fund" was further explored by Pastor et al. where they recommended that funds collected from the auction or fees could target emissions reductions in neighborhoods that are in proximity to

environmental hazards, exposed to various air pollutants, and bear community-based social vulnerabilities (Shonkoff et al., 2009, pg 24). These recommendations and engagement by environmental justice and public health advocates helped to inform how the funds generated from the Cap-and-Trade Program would be used (Truong, 2014).

California Climate Investments: The Reinvestment of Cap-and-Trade Funds

California Climate Investments (CCI) is the statewide initiative that reinvests cap-and-trade funds into programs and projects that reduce GHG emissions and are intended to provide economic, environmental and public health co-benefits to all Californians. California Climate Investments implement programs within three priority areas: transportation and sustainable communities, clean energy & energy efficiency, and natural resources and waste diversion (California Air Resources Board, 2018). Some examples of programs and projects funded within these categories include: affordable housing developments, increased public transportation options, zero-emission vehicles rebates for low-income households, increased bike and pedestrian facilities, more sustainable agriculture, food waste reduction programs, tree planting, and wildfire preventions.[1] **Table 1.1** provides an overview of the various programs and the areas as on May 2019. The mechanism by which CCI programs award funding varies, but most programs award funding through competitive grant cycles. CCI programs been linked to public health co-benefits associated with increasing support to disadvantaged communities, improving water quality and supply, providing habitat protection, and increasing urban and rural greening

[1] An updated list of CCI programs is available at: http://www.caclimateinvestments.ca.gov/

and climate resilience. So how does the CCI reinvest these funds to impacted communities while mitigation GHG emissions and supporting adaptation measures?

The state's portion of the quarterly auctions proceeds are deposited into what is known as the Greenhouse Gas Reduction Fund (GGRF), which was legislatively established by the passage of a suite of legislations in 2012, one of them being AB 1532 (California Air Resources Board, 2018; State of California, 2012a). Other key legislations also established the framework for what gets funded, how the funding is appropriated, what benefits are provided, and to whom. The first quarterly auction of the Cap-and-Trade Program took place on November 14th, 2012, and to date, more than $8 billion dollars have been appropriated by the Legislature to State agencies implementing the GHG emission reduction programs and projects (California Air Resources Board, 2019a). The Governor and State Legislature appropriate funds from the GGRF to state agencies, referred to as "administering agencies," that develop and implement programs that aim to achieve AB 32 goals. **Table 1.1** provides a list of administering agencies and the corresponding programs they manage. The number and agencies may vary depending on budget appropriations and legislation.

The California Air Resources Board (CARB), in addition to providing guidance on reporting and quantification methods to ensure that administering agencies meet statutory requirements, CARB also provides set of guiding principles that are critical to the implementation of the CCI. These guiding principles are to ensure that the implementation of CCI programs abide by legislative requirements. According to the Funding Guidelines provided by CARB (California Air Resources Board, 2018), the CCI programs and projects are required to:

- "Facilitate GHG emissions reductions and further the purposes of AB 32 and related statutes
- Target investments in and benefiting priority populations, with a focus on maximizing disadvantaged community benefits.
- Maximize economic, environmental and public health co-benefits to the State.
- Foster job creation and job training, wherever possible.
- Avoid potential substantial burdens to disadvantaged communities and low-income communities.
- Ensure transparency and accountability and provide public access to program information." (Page 10).

The guidelines also include requirements for administering agencies to conduct outreach to help potential applicants to access funds, especially for priority populations. Such direct outreach efforts are needed to ensure community needs are addressed and to further maximize benefits, especially for disadvantaged communities.

Providing Benefits to Disadvantaged Communities and Low-Income Households

Reinvestment of cap-and-trade funds provides the opportunity to maximize health co-benefits associated with climate action for communities throughout California, especially those likely to be vulnerable to local climate impacts. Through legislations such as SB 535 (de Leon Chapter 830, Statutes of 2012) and AB 1550 (Gomez Chapter 369, Statutes of 2012), agencies administering the GGRF funds are required to reinvest a minimum portion of GGRF monies to projects that benefit disadvantaged communities, which includes low-income communities and

households (State of California, 2012c, 2016). Under SB 535, a minimum of 25 percent of the total investments are required to benefit disadvantaged communities; of that, a minimum of 10 percent is required to be located within and provide benefits to those communities (California Air Resources Board, 2018). SB 535 has since been modified under AB 1550 which now requires additional benefits to low-income households and communities statewide (State of California, 2016). These priority populations are identified using CalEnviroScreen, a tool developed by the Office of Environmental Health Hazard Assessment (OEHHA), which used environmental, health and socioeconomic indicators to rank all census tracts in California to identify areas disproportionately burdened by and vulnerable to multiple sources of pollutions (OEHHA, 2018). For projects implemented to date, 51% of investments are categorized as benefiting disadvantaged communities and 31% are located within disadvantaged communities (California Air Resources Board, 2019a).

Despite the innovative mechanism through which the State is reinvesting Cap-and-Trade Program funds to priority populations, key gaps still exist. An initial assessment of the CCI found that communities adjacent to heavy polluting facilities were not seeing reinvestments in their community and were being exposed to increased pollution (Cushing et al., 2016). CCI reinvestments in disadvantaged communities (DACs) were also found to not fully consider the serious health consequences that may exist in the short-term (Ganesh & Smith, 2018). Prioritizing the health consideration along with the environmental and economic co-benefits of the CCI strategies will address the current and future impacts of climate change (Ganesh & Smith, 2018). Additionally, the CCI strategies primarily focus on climate change mitigation whereas leading climate change authorities highlight the crucial need for climate change

adaptation as well, however, the implementation of adaptation strategies using CCI funds has been limited.

Recognizing that a certain degree of warming is inevitable and that some existing health threats will intensify, with new health threats emerging, health adaptation to climate change is essential. While climate change is a global issue, the health effects are local, and therefore the adaptation measures that are required should be based on the needs of the local population (Wheeler & Watts, 2018). In addition to the limited focus on climate change adaptation, there has also been limited public health sector engagement in the California Climate Investments at the local level. Despite the limited role in the CCI, the local public health sector is well-aligned to engage in climate change mitigation and adaptation planning that helps communities better prepare for, respond to, and build resilience to climate change impacts due to established public health sector practices.

PUBLIC HEALTH DEPARTMENTS' ROLE IN CLIMATE ACTION

Public health practitioners employ various strategies to implement effective health interventions, such as using an evidence-based approach that relies on data to inform actions, engaging with multiple sectors and the community, establishing protocol for responding to unexpected events or situations, and integrating appropriate evaluation mechanisms to assess the effectiveness of the interventions. Public health sector activity aligned with adaptation strategies have primarily focused on addressing the adverse health outcomes related to extreme heat events, increased air pollution, water- and food-borne diseases, vector- and rodent-borne diseases, and extreme weather events (Cheng & Berry, 2013). Therefore, aligning climate change adaptation strategies with opportunities to maximize health benefits and build resilience to help

communities better cope with climate change represent “no-regrets” options which can also maximize the resources invested in these efforts (Ebi et al., 2018; Wheeler & Watts, 2018).

The public health sector’s role in forecasting, preventing, reducing, managing, and responding to the health burden of climate change has been aligned with a few standard frameworks of public health practice. The three core functions of public health (assessment, policy development, and assurance) and the ten essential public health services define the responsibilities of local government public health systems and the services that are provided to ensure the health and well-being of the local community (CDC, 2018c). The 10 Essential Public Health Services includes: monitor health; diagnose and investigate; inform, educate, and empower; mobilize community partnerships; develop policies; enforce laws; link to and/or provide care; assure competent workforce, and evaluation and research. The essential public health services have been translated to integrate climate change adaptation into public health practice (Frumkin et al., 2008; Wheeler & Watts, 2018). The BRACE (“building resilience against climate effects”) framework, developed by the Centers for Disease Control and Prevention (CDC), aims to outline a process by which health departments can incorporate climate change consideration into their local planning and response activities, even when there is incomplete understanding of a complex system. The five-step BRACE framework integrates principles of adaptive management to allow for an iterative, learning-based approach allows for reassessment and evaluations to readjust interventions based on updated information (CDC, 2018a; Marinucci, Luber, Uejio, Saha, & Hess, 2014). BRACE also incorporates evidence-based public health practice and engages various stakeholders into the following iterative process: “(1) Forecasting climate impacts and assessing vulnerabilities; (2) Projecting the disease burden; (3) Assessing public health interventions. (4) Developing and implementing a climate and health

adaptation plan; and (5) Evaluating impact and improving quality of activities" (Marinucci et al., 2014).

The BRACE framework is well-suited for climate change adaptation and thus is being used by the CDC's Climate-Ready States and Cities Initiative (CRSCI) to build the capacity of local health departments. Through the CRSCI, sixteen states and two cities were awarded funding to pioneer the application of the BRACE framework (CDC, 2018b; G. D. Marinucci et al., 2014). The California Department of Public Health (CDPH), one of the selected state health departments, implemented the BRACE framework through the CalBRACE (California Building Resilience Against Climate Effects) project that focused on preparing for increasing temperature/extreme heat, wildfire, and sea level rise (including flooding). Through CalBRACE, the state funded ten local health departments (LHDs) and collaborated with the selected LHDs to develop capacity to address climate change as a public health issue in their communities (CDPH, 2018a).

The adaptation strategies initiated by California's local health agencies ranged from promoting active transportation, food security, forestry management, and also included campaigns to encourage individual and community action to reduce GHGs and make personal changes to increase resilience to climate change. For instance, the San Luis Obispo County Public Health Department implemented the first climate change and health communications project in the state with the "OutsideIn SLO: We Take Health and Climate Change Personally" campaign. This initiative aimed to raise awareness about the health implications of climate change as it was relevant to the local community and also included messaging to promote action to reduce the risks of climate change and improve people's health (Brown, 2016). Another CalBRACE recipient, the Los Angeles County Department of Public Health (LACDPH)

developed the "Five-Point Plan to Reduce the Health Impacts of Climate Change," which focuses on integrating climate change into current activities using existing resources to leverage the entire LACDPH workforce to undertake climate change work (Rhoades et al., 2014). The strategic priority areas include education, fostering climate change mitigation and adaptation strategies in the wider community, internal capacity building, and internal best practices to reduce GHGs (CDPH, 2018b). A fundamental component of the Five-Point Plan is to build the capacity of the public health workforce to address climate change. To develop this internal capacity, LACDPH partnered with the UCLA School of Public Health faculty and doctoral students to develop a curriculum for a climate change and health workshop series (Godwin & Heymann, 2015). This strategy has become a model for others to not only build internal capacity, but on how to better leverage local academic partners in climate change related work. In the scope of climate action strategies, local health departments have also been a key resource for obtaining health data to understand community vulnerabilities and health burdens, and also to inform decision-making. For example, the San Francisco Climate and Health Program's Heat Vulnerability Index is created to designate neighborhoods most susceptible to the health effects of extreme heat to inform heat response plans and to better direct prevention and intervention strategies, develop risk communication messaging to high-risk populations, site cooling facilities, and deploy other resources to at-risk communities (Brown, 2016).

To better address environmental health impacts and the public health concerns facing the communities they service, local health departments are also accessing resources from entities that provide technical assistance and trainings to better protect the public's health. The National Association of County and City Health Officials (NACCHO), the Association of State and Territorial Health Officials (ASTHO) and the American Public Health Association (APHA)

provide resources and educational materials on climate change for LHDs which include toolkits, webinars, and a forum to engage with other departments working on similar programs. For example, NACCHO's Climate Change toolkit includes resources for climate action planning to help LHDs better integrate climate change adaptation into their preparedness planning process and also build climate resilience (Brown, 2016). Some local health departments have started to expand their efforts are on strategies to work on climate change-focused initiatives that emphasize building healthy, equitable, sustainable and resilient communities which can better tackle the health effects of climate change through the implementation of place-based intervention strategies and policies that align with climate mitigation (e.g., active transportation and land use planning).

With what is being called Public Health 3.0, local health departments are expanding their role to focus on social determinants of health and advance health equity by working upstream (DeSalvo et al., 2016). The principle of Public Health 3.0 advances the "Health in All Policies" (HiAP) approach which is aimed at improving health outcome and health equity which in an approach to improve health outcomes and health equity through collaboration between public health practitioners and non-traditional partners to address the social determinants of health (Rudolph et al., 2013).

Despite the climate-related activities of the public health sector and the serious health consequences, key limitations and barriers to public health department involvement in climate action initiatives still exist. Additionally, without policies to address environmental health impacts on these vulnerable populations, climate change will likely reinforce and amplify current as well as future socioeconomic and health disparities, leaving low-income, minority and other vulnerable groups to face more severe impacts and more environmental health inequities. Taking

steps to address climate change and integrating a public health role is an opportunity to promote environmental justice and environmental health equity. An example of a policy that highlights the relationship between climate action measures and environmental health equity can be found in California's approach to tackling climate change.

OVERVIEW OF THE ORGANIZATION OF THE THESIS

This research presented in this thesis is a culmination of my work over the past five years in exploring topics under the umbrella of climate change and public health through an environmental health equity lens. Below, I provide an overview of the chapters presented in this thesis.

Collaboration with the UCLA Luskin Center and US Forest Service

Chapters 2 and **3** are the culmination of my work with the UCLA Luskin Center on a project led by the UCLA Luskin Center Director Dr. J.R. DeShazo and Deputy Director Colleen Callahan. With funding from the U.S. Forest Service, we conducted a review of frameworks for assessing climate change vulnerability from a public health perspective (**Chapter 2**). The literature review of vulnerability frameworks helped to informed **Chapter 3**, which examines the public health impacts of climate change in Los Angeles County. At the time that the work for this section **(Chapters 2 and 3**) of my thesis was conducted, there were a limited number of climate vulnerability assessments that considered social and health factors alongside the environmental impacts. Therefore, there was a need to identify and examine vulnerability assessment frameworks that factored in health and social vulnerability, especially at the local level. Vulnerability assessments can help to identify and prioritize strategies that address the

impacts of climate change and help vulnerable people and places reduce their exposure and sensitivity to climate change and improve their capacity to predict, prepare for, and avoid adverse impacts (Andrulis et al., 2012). Designing and implementing climate action measures without considering the potential health impacts on vulnerable populations, especially at the local level, may unintentionally exacerbate inequities by concentrating health benefits or harms in certain communities (Shonkoff et al., 2011); Houghton & English, 2014). According to the IPCC, assessments of vulnerability can improve understanding and evidence of linkages or interactions between climate and health within the assessment scope, serve as a baseline for monitoring disease risk, provide the opportunity for building capacity, and strengthen the case for investment in health protection (Ebi et al., 2006).

The review of vulnerability frameworks helped to inform **Chapter 3**, which presents the research that was conducted to identify the public health impacts of climate change most relevant to Los Angeles County. **Chapter 3** was an outcome of the collaboration between the UCLA Luskin Center, US Forest Service and other key experts. Dr. Gary Evans drafted the sections related to the behavioral and mental health impacts of climate change. **Chapter 3** presents the potential public health impacts associated with regional climate change projections for two geographically distinct communities in Los Angeles County. Vulnerability assessments, while not the only step in developing effective climate action measures, helps to frame our understanding of climate change and the complexity of the various issues and concerns that are linked to climate impacts. Identifying vulnerability assessment frameworks that integrate this complexity can potentially inform climate action strategies that maximize public health, socio-economic and environmental co-benefits for vulnerable populations and others. With consideration of the variation in the two communities, this chapter helped to highlight the crucial

role of environmental health experts in informing climate change mitigation efforts (e.g. active transportation, sustainable communities' strategy, reducing air pollution) and adaptation efforts to achieve population health outcomes, especially for populations that will be disproportionately impacted by climate change.

Since the preparation of **Chapters 2 and 3**, there has been additional research on vulnerability assessments in the context of climate change. Research on climate change vulnerability assessments have increased since 2014 and it is growing field of research (Zhang et al., 2018). Following the completion of **Chapter 2**, a number of reviews offered different categorizations and organizational structure for climate change related vulnerability assessment, and there have been a number of assessments conducted to examine climate vulnerability in relation to various factors (e.g., climate and environment, social and economic, and health) at the national and regional level (Berry et al., 2018; Debortoli et al., 2018; English & Richardson, 2016)There has also been critique of the use of vulnerability assessment to capture the complex interactions between the climate and society dynamics and the limited consideration of future, long-term impacts, and the relevance of vulnerability assessments in the decision-making process (Ford et al., 2018; McDowell et al., 2016; Zhang et al., 2018).

Alignment of California Climate Investments and LHD Activities

The California Climate Investment programs and its key legislations provide a model for the rest of the nation, demonstrating how climate action can further climate goals while also addressing environmental health inequities and improving public health outcomes. However, there is also an opportunity to demonstrate how the public health sector engagement can be formally integrated in climate change mitigation and adaptation efforts. Well-designed GHG

mitigation measures and climate adaptation strategies that integrate public health sector consideration can directly reduce health risks or indirectly improve health outcomes (e.g., decrease rates of obesity, respiratory illnesses, injury, certain chronic diseases, and improve mental health and social well-being (Ebi et al., 2018; Maizlish et al., 2013a; Smith et al., 2014). Many key strategies for reducing GHG emissions are some of the same strategies used by the public health community to improve community health and health equity (CDPH, 2018a; Gould & Dervin, 2012).

In **Chapter 4,** I present findings from a systematic document analysis of select CCI program documents to identify the programs that offer the most alignment with current LHD activities and practice. CCI programs that invested at least 50 percent of funds in disadvantaged communities were included in this analysis. The findings showed that even though health departments are currently not engaged and partnerships with LHDs are not required for a majority of the programs, there is synergy between the objectives of the CCI programs and LHDs. The chapter also provides insight on potential opportunities for partnerships between LHDs and applicants to the CCI programs. Findings also that LHDs are eligible applicants as county or city entities. **Chapter 4** also provides an overview of the CCI programs for LHDs with the objective of putting these climate mitigation and adaptation programs within the context of established LHD practices and services provided to the community.

Opportunities for LHD Engagement in the California Climate Investments: A Closer Look at the Urban Greening and Community Forestry Programs

Due to the critical role of the public health sector in climate change adaptation planning, there have been national and statewide surveys examining how health departments or the public

health sector has been engaging in climate action efforts (Bedsworth, 2009, 2012; Clarke & Berry, 2012; Eidson, Clancy, & Birkhead, 2016; Gould, 2016). These studies have also considered the barriers to health departments in integrating climate change into their public health practice. The study by Gould et al. elaborated on the individual and institutional barriers that limit public health sector engagement in the climate change arena, and also identified key opportunities to advance public health activity on climate change. Opportunities include "integrating climate change into current public health practice, providing intersectoral support for climate solution with health co-benefits, and using a health frame to engage and mobilize communities (Gould & Rudolph, 2015)." The study concluded that efforts to "increase public health sector engagement should focus on education and communications, building leadership and funding, and increasing work on the shared root causes of climate change and health inequities (Gould & Rudolph, 2015)."

In effort to identify the opportunities for LHD involvement within the context of the CCI, I focus on two of the CCI programs that are most aligned with LHD activities, which are the Urban Greening Program and the Urban and Community Forestry Program. Through semi-structured interviews with selected health department personnel and other key stakeholders, I explore the various ways some local health departments are engaging in community greening and forestry activities. **Chapter 5** presents the findings from these interviews, identifying the barriers to local health department engagement in these programs, best practices and current activities of LHDs as applicants or active partners in the UG and UCF programs or community greening in general, and offer key recommendations on how to ensure increased LHD engagement in these programs.

Overarching Conclusions and Future Direction

The objective of this thesis is not to provide an exhaustive policy analysis of the CCI or provide a cross-sectional look at community greening activities within all LHDs in California. Instead, it is meant to highlight the synergy between CCI and LHDs activities, offer key examples of the resources and expertise LHDs have to offer to those implementing a CCI-funded project, and highlight the best practices of LHDs engagement in the CCI. California's approach to tackling climate change is a model for the rest of the nation and other countries, and therefore it is crucial that the public health sector play a larger role to ensure that public health consideration is well integrated in to climate action policies. In **Chapter 6**, I present overarching conclusions and recommendations associated with the findings from my research.

FIGURES AND TABLES FOR CHAPTER 1

Table 1. 1 – List of CCI Programs and Administering Agencies. Adapted from the California Climate Investments webpage (California Air Resources Board, 2019).

Category	Administering Agency	CCI Program
Transportation and Sustainable Communities	California Air Resources Board (CARB)	Community Air Protection Program
		Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program
		Low Carbon Transportation
	California Department of Transportation (Caltrans)	Active Transportation Program (ATP)
		Low Carbon Transit Operations Program (LCTOP)
	California High-Speed Rail Authority (HSRA)	High-Speed Rail Project (HSR)
	California State Transportation Agency (CalSTA)	Transit and Intercity Rail Capital Program (TIRCP)
	Strategic Growth Council (SGC)	Affordable Housing and Sustainable Communities (AHSC)
		Climate Change Research Program
		Sustainable Agricultural Lands Conservation (SALC)
		Technical Assistance (for DACs)
		Transformative Climate Communities

Clean Energy and Energy Efficiency	California Air Resources Board (CARB)	Woodsmoke Reduction Program
	California Department of Community Services and Development (CSD)	Low-Income Weatherization Program (LIWP)
	California Department of Food and Agriculture (CDFA)	Alternative and Renewable Fuels Program
		State Water Efficiency and Enhancement Program
	California Department of Water Resources (DWR)	State Water Project Turbines
		Water and Energy Use Efficiency Program
	California Energy Commission (CEC)	Food Production Investment Program
		Renewable Energy for Agriculture Program
		Low Carbon Fuel Production Program
Natural Resources and Waste Diversion	California Air Resources Board (CARB)	Prescribed Fire Smoke Monitoring
	California Coastal Commission	Local Coastal Program
	California Conservation Corps (CCC)	Training and Workforce Development Program
	California Department of Fish and Wildlife (CDFW)	Wetlands and Watershed Restoration
	California Department of Food and Agriculture (CDFA)	Dairy Digesters and Manure Management • Dairy Digesters and Research Development Program (DDRDP) • Alternative Manure Management Program (AMMP)
		Healthy Soils Program
	California Department of Forestry and Fire Protection (CAL FIRE)	Forest Health Program and Urban Community Forestry Program
		Prescribed Fire
		Fire Prevention

Natural Resources and Waste Diversion (Cont.)	California Department of Resources Recycling and Recovery (CalRecycle)	Waste Diversion • Organics Grant Program • Recycled Fiber, Plastic, and Glass Grants • Greenhouse Gas Reduction Loan Program • Food Waste Prevention and Rescue Grant Program
	California Natural Resources Agency (CNRA)	Urban Greening Program
		Regional Forest Health
	California State Coastal Conservancy	Climate Ready Program and Adaptation
	California Wildlife Conservation Board (WCB)	Climate Adaptation and Resiliency Program
	Governor's Office of Emergency Services (Cal OES)	Wildfire Response and Readiness
	San Francisco Bay Conservation and Development Commission (BCDC)	Climate Adaptation and Planning

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CHAPTER 2: REVIEW OF EXISTING FRAMEWORKS FOR CLIMATE CHANGE VULNERABILITY ASSESSMENT

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(This chapter is based on research that was conducted through a UCLA Luskin Center for Innovation project funded by the United States Forest Service, an agency of the U.S. Department of Agriculture. The chapter was submitted to the U.S. Forest Service Pacific Southwest Research Station in July 2015 to be published in a larger report; however, the report was not published. The chapter was conceptualized by Colleen Callahan and Dr. JR DeShazo, and Tamanna Rahman conducted the review and drafted the chapter with guidance from Colleen Callahan. Other than reformatting the chapter to comply with UCLA's thesis and dissertation preparation guidelines, including footnotes on the CalEnviroScreen 3.0 Update, and other minor edits, this chapter has not been updated to reflect vulnerability assessment frameworks that have been reported since 2015.)

INTRODUCTION

As information on the effects of climate change increased, actions to respond to climate change becomes even more important for the public health sector and sectors that may impact human health. Vulnerability assessment is a vital component in the design and planning process related to climate adaptation planning that aims to prepare communities for the climate change that is already underway. According to the Intergovernmental Panel on Climate Change (IPCC), the international body within the United Nations responsible for assessing the science related to climate change, vulnerability assessments are designed to "identify the degree of future risk due to climate change, identify the key vulnerable sectors or geographic areas, and provide the evidence base for designing and implementing informed mitigation and adaptation strategies (McCarthy, Canziani, Leary, Dokken, & White, 2001). Assessing how particular individuals, populations, communities or regions are vulnerable, and in what ways, allows for the development of better and effective climate adaptation responses.

There are various types of vulnerability assessments. Vulnerability assessments have been used widely in other contexts outside of climate change, for example food security, natural disasters and risk management. Vulnerability assessments may also be more qualitative or quantitative in style depending on the resources available and the overall objective of the assessment. Assessments may vary by level (e.g., ecosystem, habitat, or species) or by scale (e.g., geographic or temporal) (Füssel & Klein, 2006).

Foundational research in the field of vulnerability assessments considered the impacts of climate change in a linear pattern stemming from the direct impacts of climate change. However, a system-wide view is needed to capture the full complexity of climate change as it impacts the environment and human well-being in a more non-linear and dynamic way. The

complex geographical, temporal, spatial and social dimensions of climate change vulnerability have resulted in a research shift that incorporates this multi-dimensionality into more integrative conceptual frameworks. The degree of human vulnerability to climate change depends on the nature of the climate impacts as well on characteristics of the affected human communities. There are a number of definitions for the concept of vulnerability (Hinkel, 2011). Based on the IPCC definition of vulnerability within the context of climate change, it is most commonly described as a function of exposure to climate impacts, sensitivity of systems to these climate impacts, and the adaptive capacity of the system to adapt to climate change (Hinkel, 2011).

In this chapter, we present a literature review of selected frameworks to structure a discussion around climate change vulnerability. The objective is to identify a relevant conceptual framework to later examine how climate change can manifest in the Los Angeles region and impact local communities. The main role of a conceptual framework is to organize the salient concepts of a subject meaningfully and to provide a structure to the relationships and drivers of various factors (Ash et al., 2010). This chapter does not provide a comprehensive literature review of all climate change vulnerability assessment frameworks and methodologies. Instead, the authors provide an illustrative overview of common types of frameworks to identify a more integrative, systems-level conceptual framework, which is needed to conduct a climate change vulnerability assessment in the Los Angeles region through an environmental justice lens.

Here, we attempted to select frameworks based on their conceptual clarity, scope, flexibility, and influence. In general, frameworks that considered the complexities of addressing climate change were selected. Consideration of conceptual clarity and scope ensures that the framework addresses key concepts and includes logical and relevant evidence-based linkages. Flexibility allows for the consideration of the issue at any stage or component of the framework

(Hambling, Weinstein, & Slaney, 2011). Influence is determined by how the vulnerability assessment frameworks were applied in the field and we try to include examples of how the frameworks have been applied or assessment tools that were developed in relation to the frameworks.

We attempt to categorize the frameworks by their focus on specific dimension and scale of climate change impacts and we also consider the more integrative frameworks. We organize the pertinent vulnerability assessments according to the following dimensions: 1) ecological; 2) institutional; 3) social & community; and (4) human health. These categories are aligned per the ecosystem pyramid as demonstrated in **Table 2.1**. We also highlight frameworks that are particularly cross-sectoral, multi-level, and dynamic through their systems-level approach to considering climate change vulnerability in effort to identify relevant policies to address the impacts. While we have organized the selected frameworks into the aforementioned categories, it does not mean that they are limited to those categories. The selected frameworks are grouped in a way that highlights their strengths in conceptualizing individual linkages and interactions. We also examine the key concept of social vulnerability which helps to integrate a socio-economic and environmental justice lens into the climate vulnerability assessment framework.

FRAMEWORKS AT THE ECOLOGICAL LEVEL

Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MEA) conceptual framework has emerged as a dominant framework for ecosystem-level assessment. Initiated by the United Nations Secretary General in 2001 to help achieve the Millennium Development Goals, the MEA is used to assess

the how changes in the ecosystem may impact human well-being, analyze the options available to support ecosystems to meet human needs, and integrates the scientific foundation that is required for action for sustainability and ensuring human health (Ash et al., 2010). Taking into account local, regional, global scales as well as temporal dimensions, the MEA conceptual framework considers multi-directional impact of direct and indirect drivers of change on a variety of ecosystems services. The four categories of ecosystem services include: provisioning (e.g., food, timber, water), regulating (e.g., climate regulation), cultural (e.g., recreation or spiritual) and supporting (e.g., soil formation). The MEA is a global assessment but is meant to facilitate informed decision making at different scales (Ash et al., 2010). This approach can be used to integrate actors who only operate in certain spatial domains (e.g. official agencies).

The MEA conceptual framework assumes that a dynamic interaction exists between people and other parts of ecosystems, with the changing human condition serving to both directly and indirectly drive change in ecosystems and with changes in ecosystems causing changes in human well-being (Ash et al., 2010). The framework highlights a direct driver influencing ecosystem processes, while indirect drivers that underlying root causes can alter one or more direct drivers. The indirect drivers are formed by a complex of social, economic, political, demographic, technological and cultural variables (Ash et al., 2010). The structure and elements of the MA conceptual framework and related examples may be useful starting points in developing a new holistic framework that considers the relationship between forests and climate change. However, there is also the concern that the MEA framework cannot be applied to assessments examining climate change impacts on health since the framework does not easily allow the integration of human health vulnerability (Hambling et al., 2011).

Climate Change Response Framework

Climate Change Response Framework (CCRF) is another important framework that considers climate change impacts on ecosystems but advances the concept by also considering adaptation and mitigation strategies to respond to climate change. The CCRF was developed by the Northern Institute of Applied Climate Science (NIACS), a collaborative effort among the Forest Service, universities, and forest industry to incorporate climate change considerations into natural resources management processes (Northern Institute of Applied Climate Science (NIACS), 2014). Similar to the adaptive management framework that will be discussed later in the chapter, the CCRF is adaptive, works on multiple scales, and incorporates new information into the planning process. The key components that comprise this framework include partnerships, vulnerability assessments, forest adaptation resources, and demonstration projects.

Urban forests are also a focus of this framework. Projects focusing on urban forests aims to: engage with communities that are interested in adapting their urban forest management to climate change, working with these communities to assess the vulnerability of their urban forests to climate change, identifying and/or developing tools to aid adaptation of urban forests to climate change, and developing real-world examples of climate-informed management of urban forests (Northern Institute of Applied Climate Science (NIACS), 2014). NIACS developed the six-step framework to help land managers understand the potential impacts of climate change on forest ecosystems and incorporate climate change considerations into land management planning and activities.

FRAMEWORKS AT THE INSTITUTIONAL OR COMMUNITY LEVEL

Municipalities across the U.S. and world are beginning to consider their ability to cope, prepare and respond to climate change. The following frameworks inform national, regional and local governments' adaptation measures, plans and policies to decrease community-level climate vulnerability and increase resiliency.

UNDP Adaptation Policy Framework (APF)

The United Nations Development Programme (UNDP) Adaptation Policy Framework (APF) is intended for use by stakeholders in developing countries to facilitate the process of adaptation to climate change, but it may be adapted by developed nations to integrate national policy making efforts with a bottom-up approach. The framework focuses on the participation of stakeholders at all stages of the process. The framework is designed to help policy makers define programmatic efforts to reduce vulnerability and facilitate adaptation that should be made, and in identifying what types of development paths may lead to greater vulnerability in the future. The APF outlines four general approaches: a climate hazards approach, a vulnerability-based approach, a policy analysis approach and an adaptive capacity approach. The APF is a flexible method in which the following five steps may be used in different combinations according to the amount of available information and the point of entry to the project: defining project scope and design; assessing vulnerability under current climate; characterizing future climate related risks; developing an adaptation strategy; and continuing the adaptation process. The main premise of the APF is that improving adaptive capacity is necessary for mitigating vulnerability. And the APF is particularly applicable where the integration of adaptation measures into broader sector

specific policies, economic development, poverty reduction objectives, or other policy domains is necessary (Lim & Spanger-Siegfried, 2004).

Modified Adaptive Management Framework

Another key framework that has the potential to explore issues related to climate change adaptation is the Adaptive Management Framework (AMF). Ecosystem managers have long used the AMF to manage natural resource systems in a way that allows for iterative processes that considers uncertainties and complexities. The AMF closely parallels the aforementioned APF because it focuses on institutional stakeholder engagement and adaptation. The AMF has been used to address issues related to ecosystem management, watersheds, emissions trading, and air quality monitoring. Hess et al. (2012) The tradition AMF has been modified to show how government agencies can use it to inform climate change adaptation planning and demonstrate how the adaptive management process can be used by public health agencies to better prepare for and respond to extreme heat events (Hess et al., 2012). The modified AMF is the precursor to the following framework guiding how health departments consider climate change vulnerability in practice.

Building Resilience Against Climate Effects (BRACE) Framework

The Climate and Health Program at the Centers for Disease Control & Prevention (CDC) developed a framework guiding health departments to incorporate advanced models into otherwise routine planning and response activities related to climate change. The Building Resilience Against Climate Effects (BRACE) framework, as seen in **Table 2.2**, is a five-step process that enables health departments to prepare for and respond to climate change (Marinucci

et al., 2014). The BRACE framework "incorporates an assessment of climate change impacts, a vulnerability assessment, the modeling of projected health impacts, an evidence-based evaluation of intervention options, a strategy for implementing interventions, and systematic evaluation of all activities in an iterative framework" (Manangan et al., 2014). Using the BRACE framework, a jurisdiction can develop strategies and programs to confront the health implications of climate change. Coupling atmospheric data and projections with epidemiologic analysis enables a jurisdiction to more effectively anticipate, prepare for and respond to a range of climate sensitive health impacts. A health department's approach to planning for, rehearsing and responding to climate and weather-related health impacts can be greatly enhanced by incorporating emerging integrated models that incorporate atmospheric science, considers local and regional climate conditions and needs, and thus relating environmental research to public health practice. The BRACE framework for conducting vulnerability assessment and using that data in decision-making has been widely used. The CDC has awarded a number of states funding (through the Climate-Ready States and Cities Initiative) to implement the BRACE Framework in its efforts to reduce health risks associated with climate change through preparedness and resilience planning by local health departments (Centers for Disease Control and Prevention, 2014).

Health Impact Assessment (HIA) Framework

Health Impact Assessment (HIA) is a systematic process to determine the potential health effects of a policy, program or project on a population, especially on vulnerable or disadvantaged groups. The HIA process aims to systematically identify and quantify the various pathways through which human health can be affected and provides recommendations to decision-makers

and other institutional stakeholders with the goal of maximizing positive health effects and minimizing the adverse health impacts (Council, 2011).

The principles of HIA are well suited for considering the implications of any range of policy options that could affect health in association with climate change. This framework also enables decision-makers to weigh the pros and cons of adaptation strategies. A comprehensive health impact assessment (HIA) approach has been applied to examine the various pathways through which climate change can potentially affect health in order to better inform decision making and policy interventions (Council, 2011; Patz et al., 2008). The HIA framework has been tested in various locations and has been used to assess projects, plans and programs from a number of sectors and systems that may be impacted by climate change (Brown et al., 2014; Cole & Fielding, 2007; Pew Charitable Trusts, 2015). Because the guidance HIAs provide is not prescriptive, the HIA process can be amended to suit the scope and available resources of each project, thus providing flexibility and ability to factor in uncertainty.

FRAMEWORKS AT THE SOCIO-ECONOMIC OR POPULATION LEVEL

The literature pertaining to climate change primarily focused on physical impacts, however, there increasing discourse on the social equity and health implications surrounding climate change vulnerability. The frameworks presented in this section integrate consideration of social vulnerability and environmental justice in the process of conducting vulnerability assessments.

Social Vulnerability Index

Social vulnerability to climate change is defined as 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, Emrich, Webb, & Morath, 2009). While climate vulnerability encompasses risk factors based on geography, social vulnerability to climate change is focused on the population level and recognizes that some populations are more sensitive to climate impacts and related stresses due to characteristics including income, age, health status, language skills, and existing environmental hazards (Gamble et al., 2008). For instance, the elderly, people living alone, people in poor health, and people already impacted by environmental hazards may be particularly at risk as climate change exacerbates current environmental hazards and results in other impacts (Gamble et al., 2008; Karl et al., 2009; Lynn & Donoghue, 2012; Morello-Frosch et al., 2009). Social vulnerability helps to explain why some communities experience environmental hazards differently, even though they experience the same intensity of an extreme weather event (Lynn et al., 2012). To understand such different outcomes, social vulnerability may be considered an inherent property or a pre-existing condition of these communities, regardless of the natural hazard (Cutter et al., 2009). Social vulnerability indicators are shaped by other conditions that are not linked to a specific hazard, but instead is an inherent characteristic of the community that greatly determines the impact of the extreme event. Understanding vulnerability factors and the populations that exhibit these characteristics is critical for crafting effective climate change adaptation policies and response strategies.

The Social Vulnerability Index (SoVI) developed by Cutter et al. (2003), has served as an influential method to assess social vulnerability to environmental hazards, and it has provided a foundation for which important social vulnerability frameworks are based (Cutter et al., 2003).

SoVI is multidimensional, scale dependent, and spatially reliant quantitative method that integrates the socio-economic and demographic quality of a place as a means to understanding vulnerability (Cutter et al., 2003). It uses a factor analysis approach to reduce 42 vulnerability variables to 11 statistically independent factors. These factors are then aggregated to compute a summary SoVI score, which is useful for assessing overall vulnerability and comparing areas within a region or state. Using such an index may assist in determining the projected climate impacts in a given area as well as identifying the social groups who experience heightened vulnerability in those areas, thus highlighting the locations where efforts may be especially needed to build community resilience. Most commonly used proxies or variables to represent social vulnerability include: socioeconomic status (wealth or poverty), age, special needs population, gender, race and ethnicity (Cooley et al., 2012; Cutter et al., 2003).

While SoVI was not developed specifically to assess social vulnerability to climate change, various climate studies have adapted the SoVI methodology to examine the social vulnerability of specific climate variability hazards with respect to their specific region. The following assessments have applied the SoVI methodology or another such methodology to their respective regions in order to explore the vulnerability of different populations in their region.

Applications of the SoVI Framework

Researchers with Oxfam America developed a framework for assessing social and climate change-related hazard vulnerability in the Southeastern United States (Oxfam America, 2009). The researchers considered social vulnerability to four climate change-related hazards: drought, flooding, hurricane force winds, and sea-level rise. This study used a modified SoVI to identify hot spots at particularly high risk to climate impacts using 32 variables to define the

multiple dimensions of vulnerability (components). In considering the relationship among society, climate and vulnerability, eight components were analyzed: wealth, age, race, gender, ethnicity, rural population, special needs populations, and employment status (Oxfam America, 2009). The study highlights the importance of considering social context and the differentiation of vulnerability across the population because not all had the same capacity to prepare for, respond to, or adapt to those hazards linked to climate variability in the region (Oxfam America, 2009).

The Pacific Institute, for the California Energy Commission, created a framework and tool to assess social vulnerability to climate change in California (Cooley et al., 2012). The study integrated potential climate impacts using downscaled climate model outputs and spatially identified their distribution across California. To understand how population exposed to the identified impacts would be affected, Cooley et al. created a vulnerability index that combined 19 vulnerability factors into one composite score (Cooley et al., 2012). The methodology for this vulnerability index was based on the SoVI but differs from the SoVI in that it only includes indicators specific to climate change impacts (Cooley et al., 2012; Cutter et al., 2009). In addition to extreme heat days, the analysis also considered mean sea level, likelihood of wildfires, and levels of particulate matter. Some impacts (e.g. ozone concentrations, frequency and intensity of droughts, and frequency and intensity of flooding) were not evaluated because of the inability to assess these impacts on a geographic scale.

The Texas Health Institute, commissioned by the Joint Center for Political and Economic Studies and with support from the Forest Service of the U.S. Department of Agriculture, developed an analytical framework that supported regional case studies of status and progress in addressing climate change issues for diverse populations across the U.S. to conduct analysis

which highlighted the lack of attention to vulnerable communities among state legislative actions in addition to local and community level initiatives (Andrulis et al., 2012). The main objective of the framework was to assess national research and programs on climate change and environmental priorities for vulnerable populations. The research group applied a climate change-related vulnerability framework around four dimensions: hazard, temporal reference, system, and attribute of concern. This framework draws from SoVI and integrates the concept of "place" with the Hazard-of-Place model (Cutter, 1996). Within this model, vulnerability is a combination of biophysical risk and a social response, but within a geographic context. According to a later assessment by Cutter, the HOP framework is appropriate for assessing a population's vulnerability to climate-related hazards because it incorporates both demographic and information related to physical and environmental hazards (Cutter et al., 2009).

Non-Climate-Specific Tools for Assessing Environmental Justice

Here, we include two important tools for the assessment of vulnerability to cumulative impacts of existing environmental hazards. These tools are relevant to the development of any climate vulnerability framework that incorporates environmental justice dimensions.

Environmental Justice Screening (EJSM) Tool

The Environmental Justice Screening Method (EJSM) is an approach to examine the patterns of cumulative impacts from environmental and social stressors across neighborhoods within regions (Sadd et al., 2011). EJSM identifies areas that are relatively vulnerable using a set of defined indicators organized along three categories: 1) hazard proximity and land use; 2) air pollution exposure and estimated health risk; and 3) social and health vulnerability. According to

Sadd et al., there has been work on a fourth category of metrics, climate change vulnerability, for which the indicators include tree canopy cover and the amount of impervious surface (2011). The EJSM method does not assign weights to specific metrics but can be adapted to allow weighting if a specific decision-making context warrants such an approach (Sadd et al., 2011). The EJSM is the most tested and validated method that has been applied in key vulnerability regions in California. The EJSM was developed for urban areas and has been used to screen most of Southern California and the Bay Area (Jerrett et al., 2012). It was developed with continuous feedback from community members and used by community and environmental justice organizations. The EJSM has been a model for other climate vulnerability assessment tools, including the California Department of Public Health's Community Vulnerability to Climate Change Index and the California Communities Environmental Health Screening Tool (CalEnviroScreen).

California Communities Environmental Health Screening Tool (CalEnviroScreen)

Building upon the EJSM, the California Communities Environmental Health Screening Tool (CalEnviroScreen) was developed by the Office of Environmental Health Hazard Assessment (OEHHA) on behalf of the California Environmental Protection Agency (CalEPA) to identify California communities that are disproportionately burdened by multiple sources of pollution. A comparison of the two methods can be seen in **Table 2.4**. CalEnviroScreen 2.0 uses existing environmental, health, demographic and socioeconomic data, as presented in **Table 2.3**, to develop a screening score for communities at the census tract level across the state. An area with a high score would be expected to be more vulnerable to environmental health hazards than an area with a lower score (Alexeeff et al., 2012).

CalEnvironScreen 2.0[2] is being extensively used across the state. CalEPA is using the tool to designate California communities as disadvantaged in order to inform the investment of State's Cap-and-Trade Program revenue specially prioritized for disadvantaged communities (OEHHA, n.d.). CalEPA also plans to use CES to administer its Environmental Justice Small Grant Program and to help prioritize resources for various projects and outreach efforts. Due to the nature of the methodology and the purpose it serves, there is opportunity to refine and strengthen the methodology as additional data sets become available and as research advances in this area.

FRAMEWORKS AT THE HUMAN HEALTH AND INDIVIDUAL LEVEL

In this section we look at frameworks that explore links between climate change and human health. We start with a simplified bio-medical framework and progress to complex frameworks that begin to bridge and incorporate aspects of social vulnerability. We aim to explore some critical approaches to understanding the impact of climate change on human health

[2] Since completing this chapter, OEHHA has released an update to the CalEnviroScreen 2.0 presented here. In January 2017, OEHHA released Version 3.0 of the California Communities Environmental Health Screening Tool (CalEnviroScreen). CalEnviroScreen 3.0 includes more recent data for all indicators, has improvements in how some indicators are calculated to better reflect population vulnerability to environmental pollution, removal of the "children and elderly" age indicator and replacing with an analysis of age. CalEnviroScreen 3.0 also includes two new indicators, Cardiovascular Disease and Housing-burdened Low Income Households, to better reflect a subpopulation's and community's vulnerability to pollution. This tool identifies communities, at the census tract level, disproportionately burdened by and vulnerable to multiple sources of pollution resulting in cumulative impacts. In June 2018, there was a minor update to CalEnviroScreen 3.0 to address an issue with the algorithm in the software program that is used to calculate the overall census tract scores. Due to this change, there was a shift in the rankings of the census tracts, however, no census tracts moved in or out of the top 5 percent scoring category (Rodriquez & Zeise, 2017). Further details can be found on the CalEnviroScreen at the link here: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

in order to both mitigate and adapt to the environmental effects of climate change in the healthiest and most effective way.

Simplified Bio-Medical Frameworks

Patz et al., (2000) proposed a framework to identify anticipated human health impacts of global climate change. This framework focused on the physical consequences of climate change, such as temperature rise, sea level rise and extremes in the hydrologic cycle. Health outcomes are grouped by: 1) direct physical consequences (heat mortality or drowning), 2) physical/chemical sequelae (atmospheric transport and formation of air pollutants), 3) physical/biological consequences (vector or waterborne disease), and 4) socio-demographic impacts (climate or environmentally induced migration or dislocation). One of the seminal studies looking at the health impacts associated with climate change, this study concluded that better understanding the linkages between climate variability as a determinant of disease will be important, among other key factors, in constructing predictive models to guide public health prevention (Patz et al., 2000).

Haines and Patz (2004) built upon this framework to assess climate change impacts based on health outcomes from various climatic shifts. Their framework adds three important elements: 1) mitigation policies for greenhouse gas emissions, 2) moderating influences, and 3) and adaptation measures (Haines & Patz, 2004). Although Haines and Patz take into account population exposures and adaptation measures that could limit health effects, Jerrett et al., suggests that this framework lacks an assessment of either individual-level or community-level vulnerabilities, without which it is difficult to quantify risk (2012).

Intergovernmental Panel on Climate Change (IPCC) Pathways Framework

Modifying the framework put forth by Haines and Patz, the Intergovernmental Panel on Climate Change (IPCC's) Fourth Assessment Report (AR4)[3] developed a framework that captures a more dynamic system between physical climate changes and human health outcomes (Confalonieri et al., 2007). The IPCC AR4 framework shows that climate change leads to health consequences through pathways of direct exposures (e.g., extreme heat), indirect exposures (e.g. changes in water, air, and food quality), and social and economic disruptions. However, in contrast to previous IPCC reports, the AR4 assesses the linkages between climate change drivers, impacts and responses multi-directionally, thus evaluating possible development pathways and global emissions reductions that would reduce the risk of future impacts that society may wish to avoid (i.e., societal options for adaptation responses and mitigation strategies). The AR4 attempts to incorporate some complexities associated with climate change producing a system where one condition exerts influence in multiple pathways with feedback loops and associated health consequences. While an advancement, the AR4 IPCC framework still provides only a general overview of the linkages between climate change and human health. The IPCC report does address adaptation and vulnerability and shows how modifying influences can affect the direct and indirect links between exposures related to climate change, however, the framework itself does not specify how adaptation measure could intervene between climate change and exposure, or between exposures and health outcomes.

[3] Since the completion of this chapter, the IPCC released the Fifth Assessment Report (AR5) later in 2015 (IPCC, 2015) .

Intrinsic-Extrinsic Framework

Shonkoff et al. advances the Haines and Patz framework and considers the impacts of climate change on public health through an equity lens (Shonkoff et al., 2009). Through this study, researchers highlight the disproportionate impacts of climate change on low socioeconomic groups in California and discusses the ability of different groups to adapt. Shonkoff et al. developed a categorization mechanism and framework to assess vulnerability to heat-associated morbidity and mortality outcomes. Risk factors associated with heat-related morbidity and mortality can be categorized as intrinsic (i.e., age, disability) or extrinsic (e.g., housing, access to cooling centers, transportation). This intrinsic-extrinsic framework helps highlight some important factors that are taken into account for other public health vulnerability mapping analysis (2009). The study also considers how vulnerable populations will be disparately impacted by indirect effects such as economic shift associated with increasing costs of basic necessities and by threats of job loss. Beyond just recognizing that certain groups will be disproportionately impacted by climate change and examining the differences in the capacity of various groups to adapt to direct and indirect effects of climate change, Shonkoff et al. also consider how mitigation strategies in response to climate change could impose adverse consequences on vulnerable groups by potentially reinforcing and amplifying current as well as future socioeconomic and racial disparities (Shonkoff et al., 2009).

Climate Change and Health: A Framework for Action

The Public Health Institute's "Climate Change and Health: A Framework for Action" aims to highlight the intersection between the social determinants of health, health inequities, climate change and its health impacts (Rudolph et al., 2015). While not a traditional vulnerability

assessment framework, this framework is conceptualized on the understanding that systems, social inequities, powerful institutions, health processes and climate processes interact in complex ways to impact health, health inequities and the environment. These impacts are also dependent upon individual and community vulnerability and resilience. This framework integrates various other frameworks to highlight key concepts that require the consideration of health and equity impacts of various climate change interventions that is needed to optimize the co-benefits and minimize harms to health, especially to vulnerable populations. According to the framework, one of the key concepts that frame this need is that the root causes of poor health outcomes and inequities (the social determinants of health), climate change, and other adverse environmental impacts are largely the same. Therefore, interventions that address the social determinants of health and population health and aims to reduce health inequities can also reduce vulnerability and increase resilience to climate change (Rudolph et al., 2015).

CROSS-SECTORAL OR OVERARCHING FRAMEWORKS

Many of the aforementioned frameworks recognize that climate change is not only an environmental issue, it is also a public health, social equity and policy issue. The complexity of this issue calls for a systems-level approach that extends research beyond just one sector and aims to address complex interactions and feedback between natural and human systems from multi-disciplinary fronts (Frumkin & McMichael, 2008). While many of the previously discussed frameworks cross disciplines and dimensions, the following frameworks are selected because they are particularly complex, multi-level, and dynamic through their systems level approach to addressing environmental issues through a vulnerability context.

Vulnerability Assessment in Sustainability Science

The Research and Assessment Systems for Sustainability Science Program (SUST) framework presents an approach for assessing the coupled human-health environment, rather just considering vulnerability within the sole frame of a particular sector, ecosystem, population or economic activity (Turner et al., 2003). This framework aims to present the concept of vulnerability with greater emphasis on identifying and measuring multiple factors and scales occurring within a system, along with considering sustainability and global climate change. This model conveys vulnerability as a product of the simultaneous interaction of multiple biophysical and human processes, stresses, and shocks acting on the coupled system, which may respond nonlinearly and dynamically with multiple feedbacks across scales. However, the model fails to clearly differentiate between exposure and sensitivity and also does not include a temporal dimension that shows where vulnerability begins and ends. The final outcome of the analysis is not necessarily the identification of present or future impacts, or the identification of particularly vulnerable populations, but rather the illumination of the processes and interactions that are generating vulnerable conditions. The SUST framework is designed to guide decision makers and practitioners through the key processes and feedbacks that create vulnerable conditions. However, in practice this goal is challenged by the complexity of the framework. While it may be important to consider the local to global interactions of both social and environmental processes within vulnerability research, it is very difficult to conduct methodologically; therefore, this complete framework has not been applied in practice (Turner et al., 2003).

Geographies of Environmental Health Risk

Jerrett and colleagues proposed an operational framework (**Figure 2.1**) which includes three underlying geographies: exposure, susceptibility and adaptation, plus the interaction between these three (Jerrett et al., 2012). Their points of interaction are called the "geography of risk" (Jerrett et al., 2012). Many health geographers only explore one or two of these domains at a time. Yet for climate change studies in particular, it is necessary to take into account how these three domains intersect. Each concept encompasses multiple factors, such as temporal-spatial human activity patterns, the dispersion of pollutants, dispersion patterns, behavioral changes associated with the perception of danger, and the distribution of vulnerable (susceptible) populations and individuals in time and space. Due to these elements, this framework for identifying vulnerable communities integrates various domains and therefore is a key example of cross-sectoral approaches to assessing climate change impacts on vulnerable populations.

There are other frameworks in the literature similar to the geography of risk framework developed by Jerrett and co-workers (Jerrett et al., 2012). As mentioned earlier in the chapter, the Working Group II for the Fourth Assessment Report for the IPCC also defines vulnerability to climate change as a function of a system's exposure, sensitivity, and adaptive capacity (Confalonieri et al., 2007). The domains of geography and climate change impacts and adaptation arrived at essentially the same framework for identifying vulnerable communities (Jerrett et al., 2012). These conceptual frameworks of risk/vulnerability justifiably include three critical components and their interrelations and feedbacks that influence health risk as part of a dynamic system. With this type of framework, it now becomes possible to assess and begin to address climate-health-vulnerability pathways within an environmental justice context. However,

this simple conceptual model does not visually capture some of the nuances contained with each component (Jerrett et al., 2012).

CONCLUSION

This literature review provided key examples of existing frameworks that highlight the complex links between climate change and its impacts. The concept of vulnerability framed our selection and review of the frameworks. These frameworks recognize that climate change will have impacts in many different dimensions operating at different scales and timeframes but that these dimensions and scales will interact in complex and non-linear ways. It is beyond the scope of this document to review all available frameworks related to climate vulnerability. Since the completion of this chapter, there are been reviews of vulnerability assessment frameworks published in the literature.

This chapter sets the stage to further explore the different dimensions and scales of the ecosystem pyramid: ecological at the ecosystem level; institutional at the community level; socio-economic and environmental justice at the population level; and human health at the individual/organism level. While such a categorization has its limitations, it is meant to be just one way of organizing these frameworks for understanding. Understanding the complex interactions within and across these dimensions and scales is what is critical for the development of any new or modified framework to guide the process of analyzing and responding to the impacts of climate change, particularly in a place as diverse and complex as Southern California. In an upcoming chapter on health, we will adapt some of the above reviewed frameworks to propose a health-vulnerability model for Los Angeles that incorporates non-linear pathways as

part of a complex, dynamic system where climate exposures, susceptibility, and adaptation interact to determine vulnerability.

FIGURES AND TABLES FOR CHAPTER 2

Figure 2. 1 – Geographies of Risk Conceptual Model. Reprinted with permission from Jerrett et al., 2012.

Table 2.1 – Organizational structure of frameworks literature review

Dimension	Scale
Ecological (e.g. urban forest, tree canopy and density)	Ecosystem
Institutional (e.g. provision of parks and other governmental services)	Community (from national to regional to local levels)
Social-economic & environmental health hazards (e.g. environmental justice indicators, social vulnerability)	Population
Human health	Individual

Table 2.2 – Building Resilience Against Climate Effects (BRACE) – a Framework for Public Health Agencies. Adapted from (CDC, 2012).

Building Resilience Against Climate Effects (BRACE)	
Step 1	Forecast climate impacts and conduct vulnerability assessment based on projected climate impacts for local jurisdiction.
Step 2	Conduct health risk assessment to estimate the added burden of climate change related health outcomes to inform decision-making.
Step 3	Based on health risk assessment, identify the most suitable public health intervention to address health impacts.
Step 4	Develop and implement an adaptation plan for climate change that addresses the health impacts and aims to enhance adaptive capacity for the jurisdiction.
Step 5	Evaluate the interventions implemented and the processes used in the framework. This will feed into the framework and will refine future activities based on availability o data.

Table 2.3 – Indicators and formula for calculating CalEnviroScreen Score (OEHHA 2014).

Pollution Burden		**Population Characteristics**		
Exposure: Ozone concentrations PM2.5 concentrations Diesel PM emissions Pesticide use Toxic releases from facilities Traffic density *Environmental Effects:* Cleanup sites Groundwater threats Hazardous waste Impaired water bodies Solid waste sites and facilities	**X**	*Sensitive populations:*[4] Children and elderly Low birth-weight births Asthma emergency department visits *Socioeconomic Factors*[5] Educational attainment Linguistic isolation Poverty Unemployment	=	**CalEnviroScreen 2.0 Score**

[4] This table is based on CalEnvironScreen 2.0 and does not include updates from CalEnviroScreen 3.0 which was released in 2017. In CalEnviroScreen 3.0, Sensitive Population indicators include Asthma, Cardiovascular Disease, and Low Birth Weight Infants (Rodriquez & Zeise, 2017).

[5] This table is based on CalEnvironScreen 2.0 and does not include updates from CalEnviroScreen 3.0 which was released in 2017. In CalEnviroScreen 3.0, Socioeconomic Factor indicators include: Educational Attainment, Housing Burdened Low Income Households, Linguistic Isolation, Poverty, and Unemployment ((Rodriquez & Zeise, 2017).

Table 2.4 – Comparison of two main cumulative impact screening methods in California: Environmental Justice Screening Method (EJSM) & CalEnviroScreen.

	EJSM	**CalEnviroScreen 2.0**
Geographic Units	Custom neighborhood-sized cumulative impact (CI) polygons (environmental indicators); census tracts (public health and SES indicators)	Census tracts
Geographic Area	Regional (within CA)	Statewide (within CA)
Environmental Indicators	Air quality hazards: California Community Health Air Pollution Information System (CHAPIS) facilities, chrome-platers, hazardous waste sites hazardous land uses: railroad facilities, ports, airports, refineries, intermodal distribution sensitive land uses: childcare facilities, healthcare facilities, schools, urban playgrounds	Exposures: ozone and $PM_{2.5}$ concentrations, traffic density, toxic releases from facilities, pesticide use environmental effects: cleanup sites, impaired water bodies, leaking underground storage sites and cleanups, solid waste and hazardous waste sites and facilities
Public Health Indicators	Health risk and exposure: Risk Screening Environmental Indicators (RSEI) toxic concentration hazard score, National Air Toxics Assessment (NATA), cancer risk from air toxics, ozone, $PM_{2.5}$	Public health effects: low birth-weight infants, asthma, cancer, heart disease
Sensitive Population and Socioeconomic (SES) Indicators	Social and health vulnerability: people of color, poverty, home ownership, housing value, educational attainment, children, elderly, linguistic isolation, voter turnout, birth outcomes	SES factors: educational attainment, income level, poverty, race and ethnicity sensitive populations: children, elderly
Scoring/Ranking	Quintile (1-5) score assigned for each of the three categories; categories summed into a Total Cumulative Impacts (CI) Score ranging from 3-15	Averaged percentiles within each category assigned a score: exposures 1-10, environmental effects 1-5, public health effects 1-5, SES factors 1-3, sensitive populations 1-3; summed and multiplied to yield a Cumulative Impact Score ranging from 6-120

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CHAPTER 3: CLIMATE CHANGE, HUMAN HEALTH, AND ENVIRONMENTAL JUSTICE: THE APPLICATION OF A VULNERABILITY ASSESSMENT CONCEPTUAL FRAMEWORK

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(This chapter is based on research that was conducted through a UCLA Luskin Center for Innovation project funded by the United States Forest Service, an agency of the U.S. Department of Agriculture. The chapter was submitted to the U.S. Forest Service Pacific Southwest Research Station in July 2015 with the original intent that it would be published in a larger report; however, the longer report was not published. The chapter was conceptualized by Colleen Callahan and Dr. JR DeShazo, Dr. Gary Evans drafted the sections pertaining to mental health and behavioral responses; Tamanna Rahman conducted the review and drafted the chapter with guidance from Colleen Callahan. Other than reformatting the chapter to comply with UCLA's thesis and dissertation preparation guidelines, including references to the 2016 USGCRP report on the health impacts of climate change and the 2017 State of the Air Report from the American Lung Association, and some minor edits, this chapter has not been fully updated to reflect advances in recent modeling studies on the projected impacts in the Los Angeles region that have been reported since 2015.)

INTRODUCTION

Climate change poses the greatest global health threat of the 21st century, affecting the very systems in which people depend for survival and well-being, such as clean air, safe drinking water, nutritious food, shelter, and security (Costello et al., 2009; CSDH, 2008; Luber et al., 2014; Rudolph et al., 2015). Everyone is directly or indirectly affected by climate change, but certain groups of people across the United States and in our local communities are disproportionately affected by climate change. In general, this vulnerable groups include children, older adults, low-income communities, people of color, those with pre-existing chronic health conditions, immigrants, and people who do not speak English fluently. These groups are less able than others to adapt to or recover from the impacts of climate change, and due to the decreased ability to prepare for, cope with and respond to the effects of climate change, their health is more likely to be impacted (USGCRP, 2016). Health of individuals and populations is the manifestation of complex systems in which biology interacts with environments and individuals interact with each other and other environments over time (Diez Roux, 2011). Therefore, understanding the factors that influence the disparate impacts of climate change on populations can help communities better address the risk and prepare for the impacts to better protect health. If efforts are targeted to those communities most in need of the resources, benefits, and reduction of risks resulting from climate change, then health inequities may also be addressed (Rudolph & Harrison, 2016).

Chapter 2 provides a literature review of conceptual frameworks to examine and better understand the complex relationship between the geographical, temporal, spatial, biophysical and social dimensions of vulnerability, especially as it related to climate change. This chapter (**Chapter 3**) presents some key concepts related to climate change vulnerability and builds upon

the conceptual framework developed by Jerrett and co-workers (Jerrett et al., 2012) to examine what vulnerabilities may exist in the context of Los Angeles County communities.

Conceptual Framework

Based on the Geography of Risk framework presented Jerrett and co-workers (Jerrett et al., 2012), this chapter presents a modified framework that integrates the complex relationships between climate change-related exposures, susceptibility, adaptation, and the interaction of which determines health risk and vulnerability (**Figure 3.1**). Similar to the geography of risk framework adapted by Jerrett et al., the IPCC's climate assessment report also defines vulnerability as a function of exposure, sensitivity and adaptive capacity (Confalonieri et al., 2007). Comparable to Jerrett's framework, the modified conceptual framework presented in **Figure 3.1** demonstrates the recognition that adverse health effects due to climate change are not only associated with exposure (whether primary or secondary), but also dependent on susceptibility conditions and adaptation (Jerrett et al., 2012).

As shown in **Figure 3.1**, susceptibility is divided into two broad categories: compositional and contextual. Compositional refers to the individual characteristics that may determine vulnerability such as age, health status, level of linguistic isolation, whereas contextual factors of susceptibility may include housing conditions, level of access to health services and transportation, or being in an urban community that lacks tree cover (Jerrett & Finkelstein, 2005). An extensive literature in "health inequalities" has evolved around these concepts (Jerrett & Finkelstein, 2005; Macintyre & Ellaway, 2000).

Another key component of this framework is the concept of adaptation, which refers to the actions needed at various levels (e.g. individual, community, or government) to reduce or

eliminate the vulnerability of the system to climate change. It is important to note that human activity patterns and adaptive behavioral changes in relation to perceived or real danger of these climate impacts may influence the extent of health vulnerability and the distribution of vulnerable populations and individuals over time and space, which again underscores the overlap between the three main components.

All components—climate impact exposures, susceptibility conditions, and adaptation– offer lever points where interventions can occur to reduce health vulnerability/risk and improve health outcomes. This feature aligns with the framework developed by Rudolph et al., (2015) that demonstrates the key points of intervention by the public health sector. The authors acknowledge that the initial conceptual model presented in **Figure 3.1** simplifies many complex issues, however, the objective was to guide the proceeding discussion on health effects and vulnerability.

Purpose

The purpose of this chapter is to identify the salient impacts and pathways through which changes in climate may pose health and environmental justice concerns. This exercise aims to identify the key factors that should inform a more comprehensive vulnerability assessment of the Los Angeles region to be conducted by the USDA Forest Service. Using the modified conceptual framework presented in **Figure 3.1**, we examine the likely climate impacts and the related public health effects for the Los Angeles region. Due to the region's geography, topographical features, diverse population, and land use and transportation characteristics, examining the Los Angeles region offers a unique look at how climate impacts can vary within one region. Based on the projected climate impacts, we conducted a literature review to understand what non-climatic

stressors, cumulative impacts, and adaptations may influence vulnerability in order to inform targeted adaptations measures. We organize the discussion of the health effects by their associated climate impacts. We recognize that this organization fails to capture the complex and dynamic interconnections and that other organizational schemes could be more appropriate. The chapter concludes with a summary of potential health trends under a business-as-usual scenario which underscores points of leverage that could inform adaptation measures to decrease climate-health risk vulnerabilities.

PROJECTED CLIMATE IMPACTS IN LOS ANGELES

This section summarizes specific climate impacts projected for the Los Angeles area that are most pertinent to health outcomes. This includes direct and indirect impacts related to increases in temperature, changes in precipitation patterns (rainfall and snowpack), sea-level rise, worsened air quality, wildfires, and issues related to vectors and infectious diseases. To provide context within the greater Los Angeles area when feasible, we focus on the communities of Brentwood and Sun Valley due to the hypothesized variation in potential local climate impacts and differences in topography and population characteristics. These communities were selected by the US Forest Service as potential sites for a future vulnerability assessment. Localized comparisons are possible due to a series of studies conducted at the University of California, Los Angeles that provide localized climate projections for the Los Angeles region in high resolution, offering a range of temperatures down to the 2 km resolution level (compared to the 100-200 km scale typical of other climate models) (Hall et al., 2012). Data was requested for downscaled temperature projections for Brentwood and Sun Valley from researchers. Downscaled modeling data was not included for impacts where localized downscaled data was not available or was not

relevant, however, for those impacts areas we present applicable research at the most relevant geographic scale.

Temperature and Extreme Heat Events

The Los Angeles region is expected to face warmer conditions as a result of climate change. Hall et al. compared baseline levels (1981-2000) to mid-century (2041-2060) and end-of-century (2081-2100) estimates and projected that the region will likely warm by 3-4°F by mid-century with hotter than normal temperatures occurring mainly in the late summer and early fall. By end-of-century, the region is likely to get warmer by 7 -10°F under a business-as-usual scenario which does not include implementation of any GHG reduction measures (mitigation). While all areas of the region are projected to get warmer by mid-century, inland, mountain and desert areas will get hotter at a faster rate than the coastal regions. Mountain peaks are expected to have more extreme warming due to loss of snow cover, which induces a positive feedback leading to more warming (Hall et al., 2012). The number of extreme hot days, or days when the temperature exceeds 95°F, is also expected to increase significantly, but the magnitude will vary by area. Areas that currently experience the most extreme heat days will experience even more in the next 30 years. Regions where temperatures reach below freezing (e.g., mountains and high elevation areas) are projected to have fewer days when the temperature decreases to below freezing. **Table 3.1** summarizes projections for the communities of Brentwood and Sun Valley using modeled future mid-century (2041-2060) surface air temperature warming compared to the baseline period (1981-2000). The annual-mean and seasonal-mean of each four seasons are also presented. Hall et al. projects that Brentwood, an affluent community located in west LA, will experience an annual mean temperature increase of 3.81°F (+/-2.56) by mid-century, whereas

Sun Valley, a low-income community of color located more inland, is projected to experience higher temperatures (4.10ºF +/-2.67 ºF) (Sun & Hall, 2012).

Precipitation and Snowpack

The common precipitation-related impacts for the region include excessive rainfall, flooding, drought, and level of snow fall. Model projections for precipitation show that California will continue to experience the Mediterranean pattern of wet winters and dry summers with seasonal, year-to-year and decadal variability, but overall the same amount of precipitation with continued variation that occurs yearly. Hall et al. determined that extremely dry and extremely wet events will become more common over the century (Hall et al., 2012; Swain et al., 2018). While the overall amount of precipitation is expected to stay the same, more will fall as rain than snow (Berg et al., 2014).

Stream flow from local storms and mountain snow and groundwater are critical resources for California and snowpack is an important natural reservoir for water supply management and planning. While precipitation stored as snow on the mountains typically melts in the spring, rainfall runs off the mountain immediately. Increased rainfall not only increases the risk of flooding, but also decreases the opportunity to capture local water from the seasonal melting of snow. This can pose additional challenges to the water supply in the Los Angeles region which imports more than two-thirds of the water it consumes.

If greenhouse gas emissions continue to increase, the Los Angeles area mountains may see a reduction in snowfall of up to 42% of their annual averages by the year (Sun, Walton, & Hall, 2015). If immediate efforts are made to substantively reduce emissions through mitigation, mid-century loss of snow could stabilize and be limited to 31%. However, if emissions are not

curbed, projections show that the mountains will lose 66% of their snowfall by the end of the century, compared with present day. Rising temperatures are also very likely to accelerate melting of snowpack accumulated on the ground. By 2050, it is predicted that seasonal snowpack is likely to melt completely an average of 16 days earlier than usual by spring (Sun et al., 2015). Less snowfall during the winter combined with earlier snowmelt during the spring, is likely to alter critical hydrological and ecosystem processes that make the Los Angeles region especially vulnerable.

Sea Level Rise

Climate change affects sea level through two main processes: thermal expansion (increase in water volume) as a result of increasing temperatures, and through transfer of freshwater from land to ocean (e.g. snowmelts). Increasing average sea level is expected to increase the frequency and intensity of extreme weather events. Flooding and erosion due to storm surges threaten California coastal communities. Areas that are not vulnerable to flooding may be susceptible to erosion, which is expected to accelerate with increasing sea-level. Although sea-level rise will happen gradually, the destructive effects will be powerful and will be felt first when storms hit vulnerable low-lying areas.

The communities of Brentwood and Sun Valley are not expected to be directly impacted by sea-level rise due to their location, but sea-level rise is a concern for other coastal Los Angeles communities, especially the Channel Islands and Catalina. Sea-level is projected to increase an estimated 0.1 to 0.6 m (5-24 inches) from 2000 to 2050 and 0.4 to 1.7m (17-66 inches) from 2000 to 2100 in the Los Angeles region over the next century (Grifman et al., 2013). Low-lying coastal communities such as Wilmington and San Pedro may be more

impacted by sea-level rise due to having a predominately lower-income and minority populations, with higher percentage of renters, and generally having an older housing stock. The city of LA's wastewater management and potable water systems are highly vulnerable to sea level rise and any flooding and erosion damage to roads could impede emergency services and also impact the local economy (Grifman et al., 2013).

Secondary/Intermediate Impacts

Increasing temperatures and greater variability in precipitation have impacts on local weather patterns which pose secondary or intermediate impacts that may significantly affect the health of people in Los Angeles.

Wildfires

Earlier snowmelt, higher temperatures, moisture availability, and longer dry periods over a long fire season will likely increase the severity, frequency, duration, and geographic extent of wildfires. Wet conditions during the growing season promote fuel (e.g., grasses) production via the growth of vegetation, while dry conditions during and before the fire season can increase the flammability of vegetation that fuels wildfires (Westerling & Bryant, 2008; Westerling, Hidalgo, Cayan, & Swetnam, 2006). In the Los Angeles region, wildfire models show that there is variation in fire risk, largely driven by differences in precipitation between the different scenarios. Drier conditions in various model scenarios led to reduced fire risk in most areas (Westerling et al., 2006). Dry summers followed by hot and dry wind conditions contribute to the region's autumn fire season. With projections for increased temperatures and decreased precipitation, the risk of large wildfires is also likely to increase (Westerling & Bryant, 2008;

Westerling et al., 2006). Another key factor in wildfire risk in the Los Angeles area is driven by variation in land use and development. Modeled simulations estimate that property damage from wildfire risk could be as much as 35% lower if smart growth policies were adopted and followed than if there is no change in growth policies and patterns (California Energy Commission (CEC), 2012).

Air Pollution

While great strides have been taken to reduce local air pollution levels, the Los Angeles air basin still exceeds both state and federal standards for ozone and particulate matter (American Lung Association, 2017). Climate change will likely exacerbate air pollution levels through direct pathways (e.g., wildfire emissions) or indirectly via higher temperatures accelerating chemical processes that increases concentrations of ozone and particulate matter precursors in the air we breathe. (Ebi et al., 2006; Frumkin & McMichael, 2008; Kinney, 2008; Kleeman & Chen, 2010; Steiner, Tonse, Cohen, Goldstein, & Harley, 2006). A CARB analysis of ground-level ozone and particulate matter concentrations under various climate scenarios showed that by the year 2050, California would experience an additional 22-30 days per year (under business-as-usual) versus 6-13 days per year (under GHG mitigation scenario) that exceed ozone standards. Both levels violate current public health standards (Kleeman & Chen, 2010). Dynamic downscaling modeling techniques indicate that extreme PM2.5 mass concentrations are also predicted to increase (Kleeman & Chen, 2010). Meteorological factors – such as cloud cover, wind patterns, humidity, mixing height and wind speed–can also influence air pollutant levels in response to climate change and interact with the temperature effects (Drechsler et al., 2005).

UCLA researchers are currently modeling these climate factors with expected Los Angeles-specific projections to be released in the future.

Aeroallergens

Increased temperatures and increased carbon dioxide concentrations are expected to increase production of pollens and increase fungal growth and spore release, which are allergens (Wan et al., 2002). Changes in timing and length of pollen season can lead to changes in human exposure, which can impact sensitization as well as exacerbate allergic illnesses (Reid et al., 2009; Ziska, Epstein, & Schlesinger, 2009). Ragweed is a type of aeroallergen of concern in the Los Angeles region and it is projected to grow faster in urban areas (Ziska et al., 2003). Although the authors are not aware of modeled projections of ragweed and other aeroallergens for Los Angeles, studies of ragweed in controlled environments and field studies show that pollen production increases with increased temperature and CO_2 levels (Wan et al., 2002). Other experimental studies demonstrate that a doubling of CO_2 levels would result in a 30-90% increase in ragweed pollen production (Gilmour et al., 2006; Ziska & Caulfield, 2000). Differences between rural and urban growth patterns also highlighted that ragweed flowers earlier and produces greater amounts of pollen at urban locations where there is higher CO_2 concentrations and temperatures compared to rural locations (Ziska et al., 2003).

Changes in Vector Habitat and the Spread of Infectious Disease

Climatic variability, heat waves, severe storms, floods, and droughts could affect the transmission of vector borne diseases which is influenced by the range, incidence, and spread of vector or organisms (Gage et al., 2008; Patz et al., 2000). One important vector in the context of

climate change in Los Angeles County is the mosquito. West Nile Virus cases are increasing in Los Angeles County, and is expected to increase with higher temperatures (Hahn et al., 2015). Additionally, drought conditions and limited water sources has been linked to higher number of West Nile virus cases among birds, as more birds and disease-carrying mosquitos came into contact in urban areas (CDPH, 2015). Most research on the impacts of climate change on infectious diseases has focused on short-term changes in weather patterns (primarily temperature and rainfall), as opposed to long-term variations due to climate change. Because the interactions between host and infectious organisms are complex, the impact of climate on the ecology of infectious disease is complex, and therefore it is difficult to predict changes in infectious disease patterns with climate change. However, factors such as rising temperatures, heavy rainfall, extreme storm events, increased urban runoff, and presence of stagnant water, exposure to contaminated water, toxic algal blooms or El Niño-Southern Oscillation events have been associated with more cases of infectious disease (Luber et al., 2014).

UNDERSTANDING THE LINKAGE BETWEEN CLIMATE IMPACTS AND HEALTH RISK THROUGH A VULNERABILITY LENS

Climate change will likely reinforce, exacerbate and further amplify existing socioeconomic and health disparities, thereby increasing the environmental health burden on vulnerable communities. In this section we discuss the relevant compositional and contextual susceptibility factors that align with the salient climate impacts discussed in the previous section. As shown in the conceptual framework presented in **Figure 3.1**, compositional refers to the demographic characteristics or intrinsic factors relevant at an individual level (e.g., medical status, age, gender, or socio-economic status), whereas contextual refers to the characteristics of

a location or the extrinsic factors that define a community (e.g., impervious areas, housing condition, access to transportation and other services) (Shonkoff et al., 2009). In this section, we provide an aggregate discussion of susceptibility since many of the same factors increase vulnerability under various climate impact conditions. In the context of Los Angeles County, especially considering the communities of Brentwood and Sun Valley, exposure to heat and increased air pollution poses the greatest concern for vulnerable communities, therefore those exposures will be used for key examples in the proceeding discussion.

Compositional Susceptibility

In general, the compositional conditions that greatly influence the sensitivity of communities and individuals to climate change stressors include age, health status and life stage (USGCRP, 2016). For instance, populations most vulnerable to heat-related illnesses include children, older adults (Gamble et al., 2008; Kovats et al., 2004; Kovats et al., 2006), low-income populations, communities of color, pregnant women, outdoor workers (e.g., firefighters, construction workers, farmworkers) and those with preexisting chronic conditions (Shonkoff et al., 2009). Workers at greater risk include those are 65 years of age and older, are overweight, have heart disease or high blood pressure, or take medications that may be affected by extreme heat (CDC, 2012). African-Americans and non-white racial groups were found to be particularly vulnerable during extreme heat events (Basu, Feng, & Ostro, 2008; Reid et al., 2009).

Preexisting medical conditions and use of medications also increases vulnerability to extreme heat and poor air pollution. For instance, people with asthma or COPD are especially sensitive to exposures to wildfire smoke or other respiratory irritants. Those taking prescription medications that impair the body's ability to regulate temperature are at greater risk for heat-

related illness and death (Luber & McGeehin, 2008; McGeehin & Mirabelli, 2001), particularly medications for diabetes (Basu et al., 2008; Reid et al., 2009; Schwartz, 2005), psychiatric illness (Naughton et al., 2002; Poumadere et al., 2006), and cardiovascular disease (Poumadere et al., 2006). Because economically disadvantaged groups are disproportionately affected by medical conditions partially due to their lack of access to technological, informational, and social resources to cope with these conditions (Phelan et al., 2004), they tend to be most adversely affected by extreme heat events or other natural disasters (Jerrett et al., 2012).

Contextual Susceptibility

Factors related to neighborhood conditions, level of access to transportation or health services, or amount of impervious surfaces or tree cover can impact the contextual susceptibility of a system to climate impact exposures. For example, Harlan and co-workers (Harlan et al., 2006) identified living in a neighborhood with high settlement density, sparse vegetation, and lack of open space as factors contributing to heat stress. Shonkoff and co-workers. (Shonkoff et al., 2011; Shonkoff et al., 2009) found a positive correlation between poverty and high amounts of impervious surfaces in a community, and a negative correlation between poverty and tree cover in four urban areas in California. This suggests that low-income populations are disproportionately exposed to the urban heat island effect. The urban heat island is a major factor in impacting local climate. The combined effect of mostly concrete and blacktop roads, the lack of tree cover, the low ventilation ability of the "urban canyons" created by the tall buildings, and emissions from vehicles serve to extend the temperature increases and worsen local air pollution (Stone et al., 2010). Relative to the surrounding rural areas, urban heat islands can add 7-12 degrees Fahrenheit to the urban heat load. The urban heat island serves to absorb heat during the

daytime and radiate it out at night, raising nighttime minimum temperatures, which have been epidemiologically linked with excess mortality (Stone et al., 2010). Communities of color also tend to be in higher concentrations in urban inner cities.

Living conditions are also associated with increased vulnerability to extreme heat. Those most commonly identified as vulnerable are those that live on higher floors of multistory buildings (Semenza et al., 1996), limited access to air conditioning at home (Reid et al., 2009) or do not turn on air conditioning or fans to avoid high electricity bills. Additionally, those without access to reliable public transit or who do not own vehicles may be at increased risk during extreme heat events (Shonkoff et al., 2009) or other extreme weather events. For example, during the 1995 heat wave in Chicago, being confined to bed was found to be the strongest risk factor for heat-related death (Semenza et al., 1996). Additionally, those living in high-crime areas may be afraid to open their windows for ventilation when it is hot (Blum et al., 1998; Hajat et al., 2010). Other key contextual conditions that influence susceptibility to climate impact exposures include level of community social cohesion, lack of access to media, lack of strong community networks or social ties with neighbors, limited English language skills, living alone, and not leaving home every day have all been associated with increased vulnerability (Harlan et al., 2006; Naughton et al., 2002; Semenza et al., 1996).

ASSOCIATED HEALTH RISKS AND VULNERABILITIES'

In this section, we present the findings from the literature review on the health risks associated with the projected climate impacts salient to Los Angeles County. This is not meant to be an exhaustive list of health impacts but is meant to highlight some key linkages.

Health Impacts Associated with Higher Temperatures and Extreme Heat Events

Heat-related Mortality and Morbidity

Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, cardiovascular health-related hospital visits and even death if heat-related medical emergencies are left untreated (CDPH, 2007; Lugo-Amador & Rothenhaus, 2004; Schwartz, 2005). Studies have shown that a 10 degree Fahrenheit increase in mean temperature was associated with increases in ischemic stroke and several other disease-specific outcomes including all respiratory diseases, pneumonia, dehydration, and acute renal failure (Green et al., 2010). Even relatively moderate heat can cause heat-related illness or death for those who are not acclimated to heat. During the 2006 heat waves in California, those living in the relatively cooler Northeast part of the state and in the Central Coast had the highest rate of emergency room visits, suggesting that people in these areas may have higher vulnerability due to lack of adaptation to heat (Knowlton et al., 2009). Emergency medical service needs related to heat exposure increases during the times of maximum temperature, elevated heat indices and when there was the most sunshine (Golden et al., 2008).

High ambient heat also affects human health through its effect on air pollution. While we will be addressing air pollution as a secondary impact in a following sub-section, it should be highlighted that heat wave mortality is greatest in days with poor air quality (Luber et al., 2014).

Although heat exposure alone is implicated in increased morbidity and mortality, physiological, social, and economic factors are also fundamental to understanding the uneven distribution of these adverse heat-specific health outcomes across diverse populations (Cutter et al., 2003).

Heat-related Impacts to Mental Health and Behavior

The impact of extreme heat on mental health is associated with increased mortality and morbidity, aggression, violence, suicide, increases in hospital and emergency room admissions for those with mental health or psychiatric conditions (Luber et al., 2014). People with mental health issues are especially susceptible to adverse health effects during heat waves and extreme heat conditions. Studies examining heat-wave related deaths found that preexisting mental health issues was related to a tripling of the risk of death due to exposure to heat waves (Dodgen et al., 2016). People facing greater isolation and lacking ability to take care of themselves – common characteristics of those with mental illness or the elderly – are at greater risk for heat-related illness and death. These same populations are also at greater risk of declined mental health and, often increase in aggression and violence (Dodgen et al., 2016; Luber et al., 2014).

The most research on heat and human behavior has addressed aggression, but the relationship between heat and aggression are complex. Laboratory studies consistently show that as temperature rises, aggression goes up until about 85-90° Fahrenheit. At that point further elevations in temperature depress aggressive behaviors (Bell, 1992). Research from field studies such as rioting or various crime indices and temperature are more mixed. At very high levels of negative affect, aggression is muted. This makes sense since when one is feeling very bad, it is unlikely they would aggress towards another person. Rather the primary motivation will be to escape from or diminish the high level of negative affect.

There is increasing evidence to indicate that high ambient temperatures may play a role in an increase in suicidal behavior (Berry et al., 2010; Eastwood & Peacocke, 1976; Helama et al., 2013; Lim et al., 2012). Given the complexity of suicide as a multifaceted psychiatric syndrome and the difficulty in isolating temperature (or for that matter any other single ‘causal’ variable) in

the etiology of a disorder like suicide, the strongest evidence of elevated temperature and suicide comes from an 11-year period time series analysis by Page and colleagues on all deaths in the UK, which shows that when temperatures exceeded 18°Celsius, there was a 3.8% increase in the relative risk of suicide for each degree increment in ambient temperature (Page et al., 2007).

There are also studies looking at the relationship between temperature and quality of life. A multi-county comparison shows that the warmer the coldest month of the year, the happier the country, and the warmer the hottest month of the year, the less happy the country (Rehdanz & Maddison, 2005). Of additional interest, this effect was stronger the farther south within the country. Major Italian cities where average temperatures are higher, manifested more marked drops in happiness when temperatures went up. Hansen and colleagues examined the association between heat waves and hospital admissions for mental health disorders in Adelaide, Australia (Hansen et al., 2008). When temperatures exceeded 34°Celsius for three or more consecutive days, mental health admissions increased 7.3% compared to non-heat-wave periods. They analyzed data over a 13-year period.

Studies of behavioral responses to elevated temperatures include assessments of thermal comfort. Several studies suggest that when outside temperatures become uncomfortably hot, use of outdoor space and outdoor physical activity are curtailed (Baranowski et al., 1993; Lin, 2001; Zacharias et al., 2001)

Precipitation and Extreme Weather Event Effects on Health Vulnerability

The literature also reveals the following key pathways in which water affects health and vulnerability: 1) water and food-borne diseases, 2) drought-related health outcomes, and 3) behavioral and psychological effects.

Water and Food-borne Diseases

A larger number of severe precipitation events will likely lead to an increased number of instances where water and sewage treatment facilities fail, causing exposure of the public to contaminated water (Rose et al., 2001). Periods of heavy rainfall, flooding and sewage overflow are associated with outbreaks of water-borne disease (Curriero et al., 2001; Curriero et al., 2002; Thomas et al., 2006) Outbreaks related to surface water contamination showed the strongest association with extreme precipitation during the month of the outbreak, while there was a lag for groundwater contamination (Curriero et al., 2001). Polluted runoff is increasingly an issue of concern in coastal waters of California where urban growth and land use decisions impact the quality of runoff water that flows through creeks and rivers to coastal beaches. In coastal zones, toxic algal blooms will likely be more frequent as a result of water temperature rising, thus increasing the risk of illness originating from water-related recreation (e.g. swimming, surfing) and from contaminated seafood (Rose et al., 2001). Food supplies may also become contaminated through use of contaminated irrigation water and lack of field sanitation (Rose et al., 2001). The most common water-borne diseases in the U.S. are *cryptosporidiosis* and *giardiasis*. Infection with these organisms typically cause gastrointestinal illness that are acquired through direct ingestion, absorption through the skin, water contamination of food, and contamination of seafood due to toxic algal blooms (Rose et al., 2001).

Drought-related Health Effects

Recent drought conditions have prompted emergency restriction on outdoor water use by residents in a number of cities in the southwest, including Los Angeles. Drought conditions pose a number of far-reaching health implications including those related to air quality, food safety,

and infectious diseases. Conditions associated with drought may negatively impact people who have certain chronic health conditions such as asthma and some immune disorders. Drought-related changes in air quality, such as increased concentrations of air particulates and airborne toxins resulting from freshwater algal blooms, can irritate the eyes, lungs, and respiratory systems of persons with chronic respiratory conditions (CDC, 2017). There is also evidence that increases in infectious diseases can be a direct consequence of drought. *E. coli* and *Salmonella* are examples of bacteria that during drought can more readily contaminate food and cause gastrointestinal illness. Food can serve as a vehicle for disease transmission during a drought because water shortages can cause farmers to use recycled water to irrigate their fields and process the food they grow. When used to grow crops, improperly treated water can cause a host of infectious diseases (such as those caused by toxin-producing *E. coli* and *Salmonella*), which can be life-threatening for people in high-risk groups (CDC, 2017).

Hydrological Cycle Change Effects on Human Behavior and Mental Health

There is little information on human behavioral responses to more extreme weather conditions such as drought or periods of heavy rains. Yet both life satisfaction (Carroll et al., 2009), as well as psychological wellbeing (Coêlho et al., 2004), appear to suffer with prolonged drought conditions. At least among adolescents, there is evidence that the longer the drought, the more severe the impacts on psychological health (Dean & Stain, 2010). There is also evidence that social networks help individuals cope with drought but over time the strain of continued psychological distress takes a toll, eventually undermining these social resources (Caldwell & Boyd, 2009).

Not surprisingly outdoor recreational behaviors are curtailed when it rains (Brandenburg et al., 2007; Connolly, 2008; de Montigny et al., 2011). About 10% of American, middle aged women in a nationally representative sample remarked that bad weather was a barrier to physical activity (King et al., 2000; Wilcox et al., 2000). Some studies, however, find no significant relations between physical activity and bad weather (King et al., 2000).

Another potential link between climate change and mental health is more indirect. Common psychological reactions to extreme weather events such as floods and hurricanes include post-traumatic stress disorder including symptoms such as sleep disorders and high anxiety, overall declines in general psychological wellbeing, and heightened family conflict and turmoil (Fritze et al., 2008; Gittelman, 2003; Norris et al., 2002). The Intergovernmental Panel on Climate Change (IPCC) estimates that global warming will lead to ~150 million people being displaced worldwide in the next 50 years due to coastal flooding, shoreline erosion, and severe agricultural degradation from disturbed hydrological cycles, particularly drought and heavily eroded croplands (Confalonieri et al., 2007). Moreover, displacements will occur disproportionately more often among the poor (UN, 2006). Children and the elderly appear to be especially vulnerable to the ill effects of involuntary relocation.

Sea- Level Rise Effects on Health Vulnerability

Populations most at risk from extreme events are growing, particularly as a result of increased coastal development (Cayan et al., 2009; McCarthy et al., 2001). Over the next 100 years, California coastlines will be altered due to natural forces. Elevated sea-level will likely affect beaches through permanent inundation (the loss of beach due to flooding) and increasingly intense erosion when higher tides interact with severe storms (Cayan et al., 2009). Many

residents living in the coastal regions of Los Angeles will likely experience some health effects. Sea level rise associated with climate change will amplify the threat from storm surges associated with extreme weather events in coastal areas. Sea-level rise and increased coastal flooding will lead to disruption due to evacuations, displacement from destruction of homes and property, and possibly the loss of lives. Weather disasters such as major floods reliably elevate stress and increase psychological distress, particularly among those who are displaced. In combination with higher temperatures in many coastal areas, sea-level rise will contribute to the expected reemergence of certain mosquito-borne diseases such as Dengue and malaria in the US. Sea-level rise and inundation can create warm, stagnant bodies of brackish water that are perfect breeding groups for disease-bearing mosquitos (Ramasamy & Surendran, 2011).

Air Pollution and Wildfire Effects on Health Vulnerability

The literature provides evidence that air pollution threatens human health in four main ways: 1) increasing risk of mortality, 2) impaired respiratory health and cardiovascular function and 3) increasing risk of cancer and other health effects and 4) diminished mental health.

Mortality

In a number of time-series studies, daily fluctuations in particulate matter (and other pollutants) were correlated with daily changes in mortality. One of the largest of these studies following daily fluctuations in particulate matter (PM) over a five-year period in a number of European cities found a clear association between PM exposure and death rates; when PM levels increased, mortality also increased for about a day. The impact of the PM exposure was higher among vulnerable populations such as children, and in cities where the NOx was also high and

where climate was warm and dry (Künzli et al., 2006). Similar relationship between PM exposure and mortality was also found in the US (Zeger et al., 2001). Another analysis in California revealed associations of PM2.5 concentrations with mortality related to various causes (i.e., respiratory, cardiovascular, ischemic heart disease and diabetes) (Basu et al., 2008; Ostro et al., 2006). In addition to PM, exposure to ozone also results in adverse health effects. Results from meta-analysis and time-series studies in the US provide evidence of short-term associations between ozone and mortality as well (Bell & Dominici, 2005).

Respiratory and Cardiovascular-related Health Effects

While air pollution can cause death, a far more common outcome is chronic disease. Elevated exposures to ozone and particulate matter can have a number of adverse respiratory- and cardiovascular-related health effects.

It has been firmly established that breathing ground-level ozone (a secondary pollutant) can cause inflammation of the deep lung as well as short-term, reversible decreases in lung function. Epidemiologic studies of people living in urban areas have suggested that ozone can increase the risk of asthma-related hospital visits, and premature mortality (Kinney, 2008; Levy et al., 2005; Peel et al., 2007). Vulnerability to ozone effects on the lungs is greater for people who spend time outdoors during ozone periods, especially those who physically exert themselves, which results in a higher cumulative dose to the lungs. Thus, children, outdoor laborers and athletes all may be at greater risk than people who spend more time indoors and who are less active. Those with asthma are also considered a vulnerable subgroup.

Fine particulate matter (PM2.5) is a complex mixture of particles typically emitted during the combustion of fuels by motor vehicles, power plants and wildfires, and also windblown dust.

Research has demonstrated associations between short-term and long-term average ambient PM2.5 concentrations and a variety of adverse health outcomes, such as premature death, hospitalizations and emergency room visits for heart- and lung-related causes, as well as reduction in lung function, asthma exacerbation, and possible changes in lung development.

Additionally, smoke from wildfires has been associated with lung inflammation, increased hospital visits for respiratory problems, and other serious health effects in affected communities (Hoyt & Gerhart, 2004; Johnston et al., 2002; Wegesser et al., 2009). Wildfire smoke can contain many gaseous pollutants such as carbon monoxide (CO), nitrogen oxides (NOx), ozone (O_3), and volatile organic compounds (VOCs), but particulate matter is the compound of greatest concern for human health from this source (Ostro et al., 2006). The respiratory irritation from exposure to chemicals in smoke can be particularly serious for those with pre-existing lung disease (e.g. asthma) (Wu et al., 2006). Groups sensitive to wildfire smoke are similar to those identified as sensitive to particulate matter (i.e., elderly, children, those with cardiovascular disease). Other groups identified as sensitive to wildfire smoke are also those with asthma and other respiratory diseases, pregnant women, smokers (Lipsett et al., 2008).

Cancer and Other Health Effects

Several components of air pollutions are considered probable human carcinogens and a number of epidemiologic studies have linked exposure to air pollution with cancer, showing association with breast cancer and even lung cancer among nonsmokers (Turner et al., 2011). Air pollution may also play a role in adverse birth outcomes, such as low birth weight and preterm births (Ritz et al., 2007; Ritz et al., 2002; Wilhelm et al., 2012; Wilhelm & Ritz, 2005). A number of other studies have examined the association between low birth weight and traffic-

related air pollution and found that there is indeed an association (Bell & Dominici, 2005; Ponce et al., 2005; Wilhelm et al., 2012); especially among women of lower socioeconomic status (Ponce et al., 2005). There is also evidence that maternal exposure to wildfire events may also result in modestly lower infant birth weight (Holstius et al., 2012). Although the effects are much smaller than for other exposures (e.g., smoking), the extent and increasing frequency of wildfire events suggest potentially important implications for infant health and development.

Air Pollution, Behavioral Responses, and Mental Health

Behavioral responses to air pollution have received scant attention in the research literature. Research pertinent to the potential impacts of global warming impacts on human behavioral responses to elevated pollutants can be divided into impact on 1) recreational behavior, and 2) mental health.

Recreational Activities

One of the potential public health concerns of chronic exposure to air pollution is reductions in outdoor activities. A study found that 51% of Los Angeles metropolitan area residents curbed outdoor activity during smog alerts (Evans & Jacobs, 1981). Evans et al. also found evidence that persons with a history of exposure to ambient pollutants had habituated to some extent and were not only less likely to be aware of smog in their community but were also less inclined to curb outdoor physical activity when levels of ozone were high (Evans et al., 1988). Persons who believe that it is possible to do something about air pollution in their communities are more likely to alter the behaviors in response to ambient air quality levels.

Mental Health

Studies have also examined the association between air pollution and various indicators of mental health and psychiatric distress. Among the elderly, higher level of ambient air pollution was associated with an increase in depressive symptoms (Lim et al., 2012). More specifically to Los Angeles, studies examining the relationship between exposure to higher levels of ambient air pollutants and mental health show slightly higher symptoms of psychological distress (Evans & Jacobs, 1981). A larger study of the Los Angeles air basin found that Los Angeles citizens had higher levels of anxiety as a function of ozone exposure. Hostility and depression were elevated as well but not to a significant degree (Evans et al., 1988). Both sets of the studies by Evans and colleagues in Los Angeles statistically accounted for covariation with SES and temperature. While there are fewer studies examining the effect of air pollution on mental health, there is evidence to suggest that there is link between air pollution and mental health and psychological health. There is evidence to support that people already under stress from other circumstances appear to be a vulnerable subgroup for the psychological costs of heightened pollution levels.

Aeroallergen Production Effects on Health Vulnerability

Airborne allergens (aeroallergens) are substances present in the air that, once inhaled, can stimulate an allergic response in sensitized individuals. Aeroallergens can be broadly categorized as pollen, mold and a variety of indoor proteins linked to dust mites, animal dander and cockroaches. Changes in climate patterns can affect aeroallergen production, which, in turn, impacts the prevalence or severity of allergic illness.

Allergic diseases include allergic asthma, hay fever (allergic rhinitis) and eczema (atopic dermatitis) that individually and collectively impose substantial health consequences and large economic burdens (Reid et al., 2009). Over the last three to four decades, the prevalence of allergic diseases has markedly increased. Asthma is the major childhood chronic disease, with almost 4.8 million US residents affected. It is also the principle cause for school absenteeism and hospitalizations among children (O'Connell, 2004). Mold and pollen exposures and home dampness have been associated with exacerbations of allergy and asthma, as has air pollution (Gilmour et al., 2006; IOM, 2000, 2004; Jaakkola & Jaakkola, 2004). Important indirect effects of elevated allergic diseases include elevated school absenteeism among children, worker absenteeism, and fatigue (Schmier & Ebi, 2009).

Infectious Disease/Vector-borne Zoonotic Disease

Changes in weather patterns can also influence human disease through both direct and indirect effects on vectors, microorganisms, reservoirs and hosts (Greer et al., 2008; Mills et al., 2010). While many infectious diseases were once all but eliminated from the US, there is evidence to suggest that climate change patterns can lead to the spread of many of these diseases. As temperatures increase, summers become longer and rainfall patterns change, insects can remain active for longer seasons and in wider areas, greatly increasing the risk for people who live there. Vector-borne diseases are infectious diseases that are caused by a variety of viruses, bacteria, protozoa that spend a part of their life cycle in a host species (e.g., mosquitos, fleas, and ticks) and are spread to humans and animals during insect feeding. Because insects are cold-blooded, their life cycles are affected by changes in climate, suggesting that climate can affect the life cycles of these infectious agents. Thus changes in climate can affect the range, incidence,

and spread of infectious agents (Drechsler et al., 2005). These diseases include malaria, dengue fever, and yellow fever (all mosquito-borne), various types of viral encephalitis, schistosomiasis, leishmanisis, Lyme disease and West Nile virus. West Nile virus, which first entered the U.S. in 1999, expanded rapidly westward across the country. By 2005, over 16,000 cases had been reported and warmer temperatures, heavy rainfall and high humidity reportedly increased the rate of human infection (Soverow et al., 2009).

People who tend to be outdoors may be also exposed to many of these infectious diseases, especially tick-borne diseases, the most common being Lyme disease, which is caused by a bacteria transmitted by a tick (*Ixodes pacificus*). The people most at risk for experiencing serious effects from these diseases are the very young, older adults, those with pre-existing health conditions, and people with compromised immune systems. Most healthy people are at little risk of serious disease from infection with these infectious organisms (Luber et al., 2014). Exposure to these organisms leads to antibody formation that persists for at least several years, however the degree and duration of protection provided by antibodies from initial infection is unknown due to the rareness of these diseases.

SUMMARY AND CONCLUSION

As evident through the research, Californians, but more specifically, vulnerable populations in Los Angeles, face a number of adverse health effects due to changes in climate patterns. **Table 3.2** summarizes the major trends that were previously discussed in this chapter, specifically what the climate models predict as general trends and what the health literature describes as linkages between climate conditions and adverse health effects. It should be acknowledged that while we have highlighted the major climate impacts, there is a great deal of

uncertainty that can cause variations in trends depending on a number of other climate factors that were not discussed in this report (e.g., wind patterns, humidity, cloud cover, etc.).

While presented as a summary, **Table 3.2** oversimplifies complex issues and does not fully capture the important interactions with susceptibility conditions, adaption, and continuous behavior change over time and place that overlap to influence vulnerability. The conceptual model proposed in **Figure 3.1** attempts to capture more of the dynamic complexity inherently involved. This conceptual model could be used to create a framework for assessing vulnerability. Once a full framework is developed, this could guide next steps to better model predicted vulnerability in communities such as Brentwood and Sun Valley, and to prioritize interventions.

FIGURES AND TABLES FOR CHAPTER 3

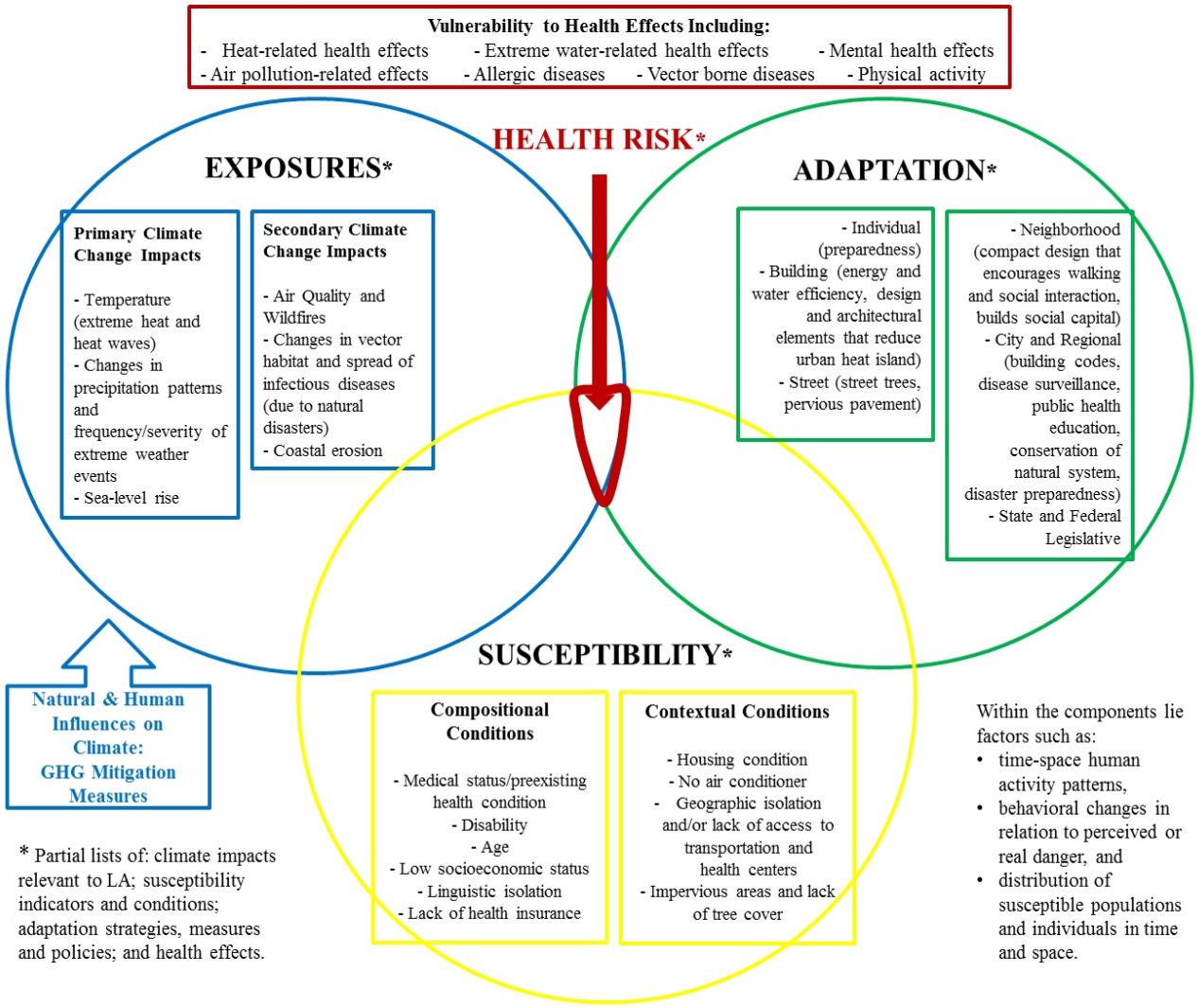

Figure 3.1 – Conceptual Model for Understanding Non-Linear Climate-Health Vulnerability Pathways

Table 3. 1 – Projected Mid-Century Temperature Changes in Brentwood and Sun Valley

	Brentwood	Sun Valley
Annual mean temperature increase (°F)	3.81 (+/-2.56)	4.10 (+/-2.67)
Seasonal mean temperature increase (°F)		
Fall	4.46 (+/-2.81)	4.70 (+/-2.91)
Winter	3.66 (+/-2.78)	3.82 (+/-2.91)
Spring	3.46 (+/-2.43)	3.76 (+/-2.61)
Summer	3.64 (+/-2.55)	4.10 (+/-2.68)

Source: (Sun & Hall, 2012).

Table 3. 2 – Summary Trends of Climate Change Impacts on Health in Los Angeles

Regional/Local Change due to Climate Variability	Direct Impacts	Indirect Impacts	Adverse Public Health-related Effects
↑Temperature	↑Heat waves/extreme heat events	↑ Urban heat island effect ↑ Air pollution (ozone and VOCs)	Heat-related morbidity & mortality Air pollution-related health outcomes (respiratory, CVD, cancer, and other)
Variable precipitation patterns	Changes in seasonal/spatial distribution of plants and other vegetation	↑ Risk of wildfires ↓ Recreational activity ↑ Aeroallergens (e.g. pollen, ragweed, mold)	Allergic diseases Infectious diseases (vector-borne, waterborne, food-borne, and rodent-borne)
Changes in frequency/severity of extreme weather events	Flooding/ heavy storms ↑Drought conditions	Changes in vector habitat ↓water quality and freshwater quantity	
↑Sea level rise	Flooding and coastal erosion	↑Economic damage (e.g. house damaged by flooding or fire)	Storm surge- or fire-related injuries/deaths
		Socioeconomic and demographic disruption	Psychosocial and mental health effects

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CHAPTER 4: THE INTERSECTION BETWEEN CALIFORNIA CLIMATE INVESTMENTS AND LOCAL HEALTH DEPARTMENT ACTIVITIES: A CONTENT ANALYSIS

ABSTRACT

Background: The California Climate Investments (CCI) is a statewide initiative that reinvests auction funds from the Cap-and-Trade program into projects that reduce greenhouse gas emissions and provide environmental, public health, and economic co-benefits. A portion of these investments are made in disadvantaged communities and low-income communities and households. While climate change mitigation and adaptation strategies are linked to public health impacts and benefits, there has been limited engagement by local health departments (LHDs) in activities funded through the CCI at the local level.

Method: A qualitative document analysis was conducted to identify CCI programs that offer the most opportunity for LHDs to actively engage. CCI programs selected for analysis was based on the inclusion criteria of providing at least 50 percent of funds to benefiting disadvantaged communities, have publicly available documents, and program must have linkage to public health impacts. Based on selection process, thirteen CCI programs from the three priority areas were included in the analysis. For each program, documents were selected for analysis. Documents included program guidelines, request/call for proposals, grant application forms, and awardee lists. Relevant excerpts from the selected documents were deductively coded using a coding template developed using public health frameworks and key document analysis questions. Coding and analysis helped to identify CCI programs that offer the most opportunity for local health departments (LHDs) to actively engage based on program eligibility criteria, partnerships

requirements, alignment with foundational public health services, and core upstream and public health interventions related to climate change activities.

Results: Based on the analysis of the selected CCI programs, there are varying levels of engagement available for LHDs. The Active Transportation Program and Urban Greening Program provide language in the program guidelines or awardee list to indicate that LHDs are eligible applicants. Other programs (i.e., Transformative Climate Communities, Affordable Housing and Sustainable Communities, and Urban Greening) either require or list LHDs as potential partners. All selected CCI programs have programmatic overlap with LHDs. CCI program objectives also align with the activities of LHDs based on alignment with core upstream and public health interventions. Requirements for applicants to discuss public health co-benefits varied by program based on the grant application.

Conclusion: Analysis of the selected CCI programs demonstrated that even though the CCI grant programs were not designed with the involvement of LHDs in mind, there is opportunity for LHD to engage. However, the LHD role may be currently limited due to lack of clarity on whether LHDs are eligible to apply for funding, limited requirements for eligible applicants to partners with their LHDs, and lack of consideration of health benefits in the grant proposal evaluation process. Administering agencies should consider actions, such as updating the guidelines to better reflect opportunities for LHD engagement and integrating health benefits in the grant proposal evaluation criteria, to better support increased LHD involvement in the CCI. California is a model for other jurisdictions for innovations in addressing climate change, and therefore increasing LHD engagement in the CCI programs can demonstrate to other jurisdictions how the public health sector can be integrated in the implementation of statewide climate change mitigation initiatives across sectors.

INTRODUCTION

Climate change poses a serious threat to public health, however, climate action strategies that aim to protect the health and well-being of those most vulnerable to climate change can provide the opportunity for win-win solutions that reduce greenhouse gas (GHG) emissions but also help to build climate resilient communities. California's approach to tackling climate change offers such an opportunity. One of the strategies the state is using to meet AB 32 (i.e., California's main legislation that establishes the state's program to reduce GHG emissions from major sources and sectors throughout the state) goals is through the implementation of a cap-and-trade auction process. Since 2012, the state has reinvested billions of dollars in auction proceeds generated from the Cap-and-Trade Program into projects, collectively termed the "California Climate Investments" (CCI), to reduce greenhouse gas emissions; provide health, environmental and economic co-benefits; and also maximize benefits to disadvantaged communities (California Air Resources Board, 2018). Communities where investments have occurred are realizing a wide range of benefits including increased access to affordable housing opportunities; improved mobility options through transit, walking, and biking; cleaner air through zero-emission vehicles; job creation, energy and water savings; and greener, more vibrant communities (California Air Resources Board, 2019a).

The implementation of CCI provides a model for the rest of the nation by demonstrating how climate action strategies can be integrated across sectors to reduce greenhouse gas emissions and deliver environmental, economic, and public health benefits for Californians, including meaningful benefits to the most disadvantaged communities (DACs). California Environmental Protection Agency (CalEPA) defines disadvantaged communities as the top 25 percent of communities experiencing disproportionate amounts of pollution, environmental

degradation, and socioeconomic and public health conditions according to OEHHA's CalEnviroScreen tool. Under Senate Bill 535 and then Assembly Bill 1550, agencies administering the CCI programs are required to invest:

- at least 25 percent of funds for "projects located in and benefiting people living in disadvantaged communities;
- at least 5 percent of funds for "projects located in and benefiting low-income households or low-income communities anywhere in the State;" and
- at least 5 percent of funds for "projects located in and benefiting low-income households or low-income communities that are within ½ mile of a disadvantaged community" (State of California, 2012c, 2016).

Based on these criteria, at least 35 percent of funds are required to benefit priority populations, which include disadvantaged communities (DACs), low-income communities, and low-income households throughout California. To date, investments have exceeded these minimum standards and some programs even allocate 100 percent of their CCI funding to projects that benefit DACs or are located within DACs (California Air Resources Board, 2019a). Projects include components to implement enhanced outreach efforts to disadvantaged and low-income communities to build community capacity, strengthen partnerships, ensure access to program information, and promote effective community engagement and participation (California Air Resources Board, 2018).

Despite these innovative strategies to integrate benefits to disadvantaged communities and take a multi-sector approach to climate action, there are some key limitations. For instance, equity issues are raised by how pollution credits are allocated to facilities and how revenues generated are redistributed to communities (Shonkoff et al., 2011). A preliminary assessment of

the Cap-and-Trade program implementation found that communities adjacent to heavy polluting facilities are not seeing reinvestments in their community and are being exposed to increased pollution (Cushing et al., 2016).

The public health sector has a key role to play in the CCI process. Health departments and public health professionals can engage in multi-sector efforts to ensure that climate mitigation and adaptation strategies also reduces the health and equity impacts on the most vulnerable populations and that these communities have the resources to face the unavoidable impacts of climate change. Public health agencies can be a valuable resource for engaging communities in climate change planning and promoting health co-benefits, however, the health department role is not defined in the CCI framework. Local health departments' long-standing relationships within low-income and ethnically diverse communities, existing programs serving those with chronic conditions and vulnerable populations, and expertise in community engagement and education can be leveraged to achieve both health and climate change mitigation goals. Public health departments throughout California and the nation have demonstrated the expertise to work across sectors to ensure that the result of climate action efforts produce beneficial health outcomes for all residents and do not exacerbate health inequities and disparities. Given the complex and multifaceted connections between climate change, health and public health practice, there is potential value in identifying the areas of overlap between CCI program activities and public health interventions.

Although there are key opportunities for the public health community to engage in the CCI process, the various CCI programs funded by the Greenhouse Gas Reduction Fund (GGRF) have not been analyzed through a public health lens to determine opportunities for local public health department involvement. In this chapter, I use established public health frameworks to

systematically determine which California Climate Investment programs offer the greatest opportunity for local health departments to be active partners in supporting health-based climate investment projects benefiting vulnerable communities.

Conceptual Frameworks Guiding Local Health Department Activity

Governmental public health agencies work to ensure conditions to protect and promote the health and well-being of individuals and communities spanning a wide range of health issues. These issues have defined public health practice which traditionally focused on only infectious disease, maternal and child health, environmental health, and more recently, chronic diseases such as diabetes, heart disease, stroke and cancer (Berglas et al., 2018). With the changing public health arena in this newer phase of Public Health 3.0, the focus of public health departments is reaching further upstream to consider the social and environmental determinants of health (Desalvo et al., 2017). Health departments have engaged in issues outside the traditional public health scope, but activities have been guided by a common public health framework – the 10 Essential Public Health Services.

The Essential Public Health Services describe the public health activities that should be undertaken in all communities. The three core functions of public health and the 10 Essential Public Health Services (EPHS) provide a working definition of public health and a guiding foundation for local public health system activities (IOM, 1988). Developed in 1994 by the American Public Health Association and a group of federal, state and local agencies and partners, these ten essential services been accepted by health departments at all levels of government and it forms the foundation of the National Public Health Performance Standards Program, which provides the structure and measures used for national public health accreditation

(CDC, 2018c). It has also been a useful tool for both public health practitioners and public health scholars for delineating how health departments should engage with emerging public health topics such as abortion and climate change. In the case of climate change, Frumkin et al. proposes a public health approach to climate change by demonstrating how the 10 Essential Services of Public Health aligns with key activities relevant to climate action (Frumkin et al., 2008). This seminal article shows how these essential services of public health are critical to planning and implementing an integrated public health response to prevent injuries and illnesses, reduce risk, enhance public health preparedness, increase public awareness, and build individual and community resilience.

The 10 Essential Public Health Services forms the basis of another key framework for public health practice, the Foundational Public Health Services (FPHS) model. The FPHS model was developed in 2013 following recommendations from the Institute of Medicine report "For the Public's Health: Investing in a Healthier Future" to create a core package of services that public health departments should offer (IOM, 2012). This resulted in a conceptual framework describing a basic set of public health services that must be made available by health departments in all jurisdictions. The FPHS model is a conceptual framework outlining the essential capabilities and areas (i.e., programs) that no health department should be without (PHNCI, 2016). Foundational areas are key "areas of expertise or program-specific activities in all state and local health departments that are also essential to protect the community's health." Foundational capabilities are "cross-cutting skills and capacities needed to support the foundational areas, and other programs and activities that are key to protecting the community's health and achieving equitable health outcome" (PHNCI, 2016). Any health department that uses this framework can modify it and ensure that foundational programs are designed to apply to

their own community needs. This FPHS model provides the framework for the 2017 Policy Platform used by the California Conference of Local Health Officers (CCLHO), which advises and "makes recommendations to the California Department of Public Health (CDPH), other departments, boards, commissions and officials of federal, state, and local government, the Legislature, and any other organization or association on matters affecting health," (CHHS, 2017).

The CCLHO Policy Platform adapted the FSPH model to include the goal of Achieving Health Equity as a foundational capability to better integrate a health equity framework to ensure that health in advanced in non-health sectors. Public health departments and their partners need to consider how conditions in the places where people live, work, learn and play affect a wide range of health risks and outcomes. These social determinants of health – which includes neighborhood and built environment, health and health care, social and community context, education, and economic stability – and any actions to address the resulting health inequities, need to align with all aspects of public health work.

A framework that considers the social determinants of health and integrates the core public health strategies to define key actions for public health practitioners in the climate change arena is the Climate Change and Health: A Framework for Action. Developed by the Public Health Institute with input from public health professionals and peer-reviewed literature, this framework highlights critical intersections between social determinants of health, climate change, and its health effects (Rudolph et al., 2015). The strategies delineated in the Climate Change and Health: A Framework for Action aligns with the 10 Essential Public Health Services and the FPHS model through core intervention strategies such as "community capacity building, community engagement, partnerships and collaborations, advocacy, communications, and

surveillance, evaluation, and research" (Rudolph et al., 2015). These upstream core strategies, embodying key aspects of the Public Health 3.0 initiatives also aims to increase the effectiveness of other public health intervention strategies such as "policy and systems change, healthy communities and environmental change, health education, risk reduction, safety net services, medical care, and public health/all hazards preparedness" (Rudolph et al., 2015). **Table 4.1** shows how the Climate Change Health Framework for Action aligns with the FPHS model. In this chapter, I use this established public health framework to systematically determine which California Climate Investment programs offer the greatest opportunity for local health departments to be active partners in supporting health-based climate investment projects benefiting vulnerable communities.

METHODOLOGY

Qualitative document analysis was conducted to identify which CCI programs offer the greatest opportunity for local health departments to be active partners in supporting investments that maximize public health-co-benefits. Document analysis is a systematic procedure for reviewing or evaluating documents, which requires that the content of the selected documents be examined and interpreted "to elicit meaning, gain understanding, and develop empirical knowledge (Bowen, 2009; Pinto et al., 2012). Documents (e.g., written, visual, digital, or physical artifacts) are key sources of data in qualitative research. Some examples of common types of documents include official records, government documents, letters, memos, diaries, songs, poems, survey data, photos, organizational or institutional report, historical accounts, press releases, and other relevant media. In relevance to this study, this approach has been used to previously analyze content of municipal policy documents (Merriam & Tisdell, 2015), local

government health policy health planning priorities (Browne et al., 2016), and evaluate local climate action plans for public health and environmental justice content (Mendez, 2015).

CCI Program Selection and Document Identification

CCI programs that offer benefits to disadvantaged communities and most likely to provide public health co-benefits were selected for this study. Publicly available records were reviewed to determine which CCI programs awarded fifty-percent or more of their funds to projects categorized as benefiting disadvantaged communities or were located within CalEnviroScreen designated disadvantaged communities. The 2016 and 2017 Annual Reports to the Legislature provided program expenditure data from 2015 to mid-2017 (California Air Resources Board, 2016; California Air Resources Board 2017). This analysis did not include new programs that were first appropriated funding in September 2017.

The CCI programs selected for further analysis are listed in **Table 4.2**. The CCI programs are grouped into three priority areas (i.e., Transportation and Sustainable Communities, Clean Energy and Energy Efficiency, and Natural Resources and Waste Diversion) and are administered by state agencies with the authority and/or jurisdiction to implement the programs. Some CCI programs have funds that are primarily awarded to projects benefiting low-income communities. For example, all funds from the TCC and Urban and Community Forestry programs were awarded to projects that benefited disadvantaged communities. Another example includes the Low-Income Weatherization Program (LIWP) which installs solar panels and energy-efficient home improvements in single- and multi-family low-income housing units within disadvantaged communities at no cost to residents. Some CCI programs did not have reporting data on investments to DACs publicly available at the time the study was conducted,

and therefore those programs were not included. For a complete list of programs funded through the CCI, a current list can be found on the California Climate Investment website.

For the selected CCI programs shown in **Table 4.2**, relevant publicly available documents were downloaded from the California Climate Investments website (http://www.caclimateinvestments.ca.gov/) or the California Air Resources Board CCI webpage (California Air Resources Board, 2019b). and saved in their original format (PDF or MS Word). Publicly available documents include program guidelines, request/call for proposals, application forms, and awardee list (if applicable). These program documents were selected because they describe the purpose and goals of the program, delineate the eligible program activities, and reflect the intent of the agency (Merriam & Tisdell, 2015). The program guidelines have gone through revisions based on new legislative requirements and include a drafting process that involves expert review and public input. For the purpose of this analysis, the most updated versions of the guidelines have been collected. Some of the program guidelines were going through revisions at the time of this study, so the most recent final adopted version was analyzed, which spanned late 2017 to early 2018. For a complete list of documents collected for this analysis, see **Table A.1**.

Document Coding & Analysis

Based on the review of the CCI guidelines and LHD activity literature, I developed a list of criteria that influence the level of engagement LHDs can have in various CCI programs. The criteria listed in **Table 4.3** provided the framework for the questions guiding the document analysis (See **Table 4.4**). The document analysis questions were used to guide the development of a coding framework (See **Figure 4.1**) which was used to tag or code the excerpts from the

selected documents. Developing the coding framework was the first step in the coding process. The coding framework was then inputted into Dedoose (Dedoose, 2019), which is a software used in qualitative research to code documents and organize memos.

Deductive and inductive coding of selected documents was used to determine which CCI programs offer the most opportunity for LHD or public health sector engagement. The selected documents were analyzed and categorized based on potential for direct LHD involvement as applicant or required partner (deductive), overlap with LHD program areas corresponding to the Foundation Public Health Services model (deductive), alignment of CCI program objectives with public health interventions according to the Climate Change and Health Framework for Action (deductive), identification of activities that emerged within the various categories (inductive),and created codes for additional activities or areas of priority that emerged from the data but did not fit in the existing categories (inductive).

The selected program guidelines were initially reviewed to determine local health department's eligibility to apply directly for funding **(**See Question 1 in **Table 4.4**) or be a partner (See Question 2 in **Table 4.4**). A key term search was conducted, "health department," "public health agency," "local health department," and "health." Each instance of the relevant terms was reviewed for context. This process was used to determine whether the role of a local health department was integrated into the program guidelines since having such a directive provides the incentive for local health departments to be actively involved. Categories to determine the alignment of CCI program activities with health department program areas (See Question 3 in **Table 4.4**) and public health interventions (See Question 4 in **Table 4.4**) were based on review of literature on the respective frameworks, Foundational Public Health Services Model and the Climate Change and Health Framework for Action. Preliminary questions

generated secondary questions which focused on the subsequent reading and coding of the document. In addition to the selected program guidelines, proposal application forms and reporting requirements were reviewed to determine whether applicants are required to provide descriptions or quantification of the public health or environmental health impacts of the project to obtain funding. This component was explored since this may require eligible applicants to reach out to their local health department for assistance. All content was coded as complete statements and where a CCI program objective or activity aligned with two or more categories, it was coded as such, creating multiple codes for that program requirement. Analytic memos were written to capture ideas and questions about LHD involvement as understandings emerged and changed.

RESULTS & DISCUSSION

The programs funded under the California Climate Investments were not specifically designed with the involvement of local health departments in mind. Analysis of the selected program guidelines documents shows that even though LHD involvement was not fully integrated, there is alignment between LHD goals and objectives and CCI program activities. For example, some programs offer LHDs the opportunity to apply for funding (e.g., Active Transportation and Urban Greening) and others require applicants to demonstrate their partnership with their local health departments (i.e., TCC and AHSC). While it is difficult to link to clear health impacts resulting from these partnerships, findings from previous studies have shown that such partnerships enhance collaboration and alignment across sectors, leverage limited funds, ensure that projects take local health and equity impacts into consideration, develop a project that addresses community need, and establishes partnerships for future work.

Table 4.5 shows the CCI programs that offer the most opportunity for LHDs to be actively involved. This selection was based on the presence/absence of codes used to deductively analyze the program documents (See **Table A.2**). Aside from the programs for which LHDs can apply for funding, the more codes applied to the document being analyzed, the more overlap between the specific CCI program and LHD activities and goals. The programs with the most codes applied were TCC (23 out of the 24 main code categories or 96% of the codes), AHSC (21 out of the 24 main code categories or 88% of the codes), and Urban Greening (21 out of the 24 main code categories or 88% of the codes). The Active Transportation and Urban and Community Forestry programs both had 13 out of the 24 codes (54%) applied during document analysis. Programs related to increasing transit options and accessibility (i.e., LCT, LCTOP, and TIRCP) also had potential for LHD and public health sector involvement (11 out of the 24 or 46% of codes were applied). Wetland Restoration and Dairy Methane programs offered the least opportunity for LHD involvement even though these programs invested in projects that provided benefits to DACs, had program activities that highlighted the need for partnerships, and aligned with public health interventions focused on healthy community and environmental change.

The following sections will further discuss the CCI programs that offer the most opportunity for local health departments to actively engage in climate action efforts in the communities they serve based on (1) eligibility to apply for CCI funding, (2) partnership requirements integrated within the program guidelines, and (3) overlap between CCI program objectives and LHD areas of focus and public health interventions. A brief overview of the programs will also be provided for context, however, more information about the programs can be found on the CCI website (State of California, 2019).

Opportunities for Local Health Departments as Eligible Applicants & Active Partners

The main factor that determines which CCI programs offer the most opportunity for LHDs to directly participate is the eligibility of LHDs to apply for funding. Categories of eligible applicants varied by program, but generally included: local, regional and state agencies; city and county entities; non-profits; tribal governments; or other entities with jurisdiction related to the program area (e.g. affordable housing developers, transit agencies, or other special districts or entities). Eligibility is limited to implementing agencies or organizations. Across the 13 selected programs, only the Active Transportation program explicitly listed public health departments as an "Implementing Agency" and therefore an eligible applicant (California Transportation Commission, 2016, 2018; Caltrans, 2014, 2018). While not listed in the program guidelines, the Urban Greening grant program awarded funds to a local health department. This specific project will be discussed in further detail in the next chapter, but the Madera County Health Department was eligible to apply as a county entity to build a trail around their health services facility (Madera County, 2018).

To see if other programs awarded funds to LHDs, funding award releases and notifications from the other CCI programs were examined. Analysis was expanded to all CCI programs for this component to account for not including documents from programs that awarded less than 50% of their funds to benefit disadvantage communities, but those that may have awarded funds to LHDs. After expanding the pool of programs for this question, I did not find other CCI-funded programs where LHDs were awarded funding or were eligible to apply funds. The following subsections offer more information about the CCI programs for which LHDs are eligible to apply for funding and be active partners.

Active Transportation Program

Administered by the California Department of Transportation (Caltrans), the Active Transportation Program (ATP) is a competitive grant program supports the construction of new bicycle paths or lanes, new pedestrian facilities, and new or expanded bike share programs. Increased use of active modes of transportation such as biking and walking reduces vehicles miles traveled, which decreases GHG and air pollutant emissions, resulting in better air quality. Having access to better active transportation options and air quality improve public health in communities where projects are located. Infrastructure (small, medium or large) or non-infrastructure projects like education, encouragement and enforcement activities, and planning grants (for bicycle, pedestrian, safe routes to school (SRTS) programs, or active transportation plans) are eligible for ATP funding, however, only projects that have quantifiable greenhouse gas reduction are eligible for cap-and-trade funds.

The ATP offers the most opportunity for LHDs to seek funding and to actively engage in projects that align with public health objectives. Among CCI funded programs, the ATP is the only one that explicitly listed "public health departments" as an "Implementing Agency" and therefore an eligible applicant (Caltrans, 2018, p. 5). The Implementing Agency must be able to enter into a Master Agreement with Caltrans and be responsible for the use and expenditure of the program funds, ensuring that project abides by funding requirements, and ensuring future operational and maintenance needs. One of the key requirements for an eligible applicants is familiarity with "the requirements to administer a Federal-Aid Highway Program project" and if they are not, interested parties are encourage to partner with an eligible applicant that can implement the project (Caltrans, 2018, p. 6). Other entities eligible for funding include: city, county, MPO, Regional Transportation Planning Agency, transit agencies, Caltrans, natural

resources or public land agencies, public schools or school districts, tribal governments, non-profits, and other entities responsible for oversight of eligible transportation or recreational trails (California Transportation Commission, 2018).

While partnerships with health departments are not required by the ATP and no points are allocated for identifying a partnering agency, there are opportunities for LHDs to engage in the projects funded by the ATP. The ATP guidelines included program objectives, goals, and eligible project activities that aligned with all Public Health Interventions and Core Strategies (**Table 4.5**). Some examples of eligible project goals from the Active Transportation program guidelines that align with LHD activities include the following:

- "Increase the proportion of biking and walking trips
- Increase mobility and safety for non-motorized users
- Advance active transportation efforts of regional agencies to achieve GHG reduction goals
- Enhance public health, include reduction of childhood obesity through the use of programs including, but not limited to, projects eligible for Safe Routes to School Program funding.
- Ensure disadvantaged communities fully share in the benefits of the program
- Provide a broad spectrum of projects to benefit many types of active transportation user." (Caltrans, 2018)

Health departments have key program activities in the area of active transportation due to established linkage to public health benefits (Stevenson et al., 2016). Promoting safe active transportation as a public health intervention or informing the development of local and regional plans has created a key opportunity for public health practitioners to leverage limited resources to produce multiple health benefits (CDC, 2015). In addition to reducing VMTs, active transportation is a primary strategy for incorporating physical activity into people's daily routines, and thus reducing the risk of heart disease, overweight and obesity, improving mental health, and lowering blood pressure (Maibach et al., 2009). Additionally, replacing short car trips

with bicycling, has been shown to improve air quality in urban areas and in downwind rural settings (Maibach et al., 2009). While LHDs are not responsible for constructing bicycle paths or lanes, pedestrian facilities, or expanded bike share programs, many have partnerships with entities that are eligible to implement the funds (APHA and Safe Routes to School, 2012). LHDs can also be key partner in developing plans and ensuring that community needs and concerns are addressed through meaningful engagement. Public health departments can be a key resource to outreach to the community and education about active transportation projects, build community capacity, establish partnerships and collaborations and also be a resource for data and best practices (Green & Klein, 2011). Some examples of health departments that are involved in Safe Routes to School Program planning or have a program they lead, include Santa Clara County Department of Public Health, Minnesota Department of Public Health (Henderson et al., 2013; Minnesota Department of Health, 2018; Santa Clara County Public Health, 2018).

Urban Greening Program

Administered by the California Natural Resources Agency (CNRA), the Urban Greening (UG) Program competitively awards grant funding to projects that reduce GHG emissions by transforming the existing built environment by incorporating natural and green infrastructure to create more sustainable and livable communities. Eligible projects must reduce GHG emissions by either: (1) sequestering and storing carbon by planting trees; (2) reducing building energy use by strategically planting shade trees; and/or (3) reducing VMT by constructing bicycle paths, lanes or pedestrian facilities. Examples of projects eligible for UG program funding include enhancing and expanding neighborhood parks and community spaces; greening of public lands and structures; establishing green streets and alleyways; developing nonmotorized urban trails

that provide safe routes for travel between residences, workplaces, commercial centers, and schools; mitigating urban heat islands and energy conservation efforts.

The UG grant program is the only other CCI program, aside from ATP, under which a LHD has been awarded funding. The Madera County Public Health Department was awarded Urban Greening funds for a health trail around the perimeter of a new Health and Social Services office complex, with exercise stations and landscaping to help mitigate GHG emissions and provide outdoor space for public use (Madera County, 2018). This health department was eligible to apply as a county entity. Further details about this project will be discussed in **Chapter 5** of this thesis.

In addition to accepting applications for funding, the UG grant program offers various opportunities for local health departments to be actively engaged. Proposals submitted to the UG program are evaluated based on statutory priorities for which points can be awarded for a project's use of "interagency cooperation," which includes partnerships with local public health authorities (CNRA, 2017, 2018). Applicants are required to describe the partnership and the corresponding responsibilities in the project. Additionally, the city or county Environmental Health Department a potential entity from which eligible applicants must obtain relevant permits or approvals pertaining to the proposed project. Another key role for health departments is as a resource for community health data. LHDs can provide expertise on the health co-benefits of the proposed project since the application guidelines lists the potential co-benefits to public health that can be included in the project. Aside from these requirements, key public health intervention strategies align with the program objectives and activities. Based on the analysis, the codes that were most applied were: *Building Healthy Communities and Environmental Change, Risk Reduction, Community Engagement, Partnerships and Collaborations, and Community Capacity*

Building. According to the program guidelines, priority consideration is given to applicants that address a critical need of disadvantaged communities to provide benefits, incorporate meaningful community engagement, and consider how the project will build climate resilience and support the adaptation of urban areas to reduce vulnerability to climate impacts. Health departments have been key partners in such projects and the LHD program areas most aligned with the objectives and activities of the UG program were *Chronic Disease & Injury Prevention and Environmental Health*.

Opportunities for Local Health Departments to Actively Engage

Despite the limited opportunity to directly apply for funding, there are key opportunities for LHDs to be active partners in projects that are implemented with CCI funds. There are programs that require or recommend eligible applicants to partner with a local health department or public health organization. There are also CCI programs for which eligible activities align with a basic set of public health services and programs that are key to protecting the health of the community and achieve equitable health outcomes. While all the CCI programs have goals and activities that align with some public health intervention or core strategies, the programs that have the most alignment and opportunity for LHD engagement are the previously mentioned Active Transportation and Urban Greening programs, and include Transformative Climate Communities, Affordable Housing and Sustainable Communities, and the Urban and Community Forestry programs. The selected documents for these programs include language requiring or recommending local health department partnerships, includes consideration of public health impacts, and has substantial alignment with local health department programs and public health interventions. In the following sections, I provide an overview of the CCI programs that offer the

opportunity for LHDs to be active partners and discuss how LHDs can be involved based on the program guidelines.

Transformative Climate Communities Program

The Strategic Growth Council's (SGC's) Transformative Climate Communities (TCC) program is designed to fund the development and implementation of neighborhood-level transformative climate community plans that include multiple, coordinated GHG emissions reduction projects that provide local economic, environmental, and health benefits to disadvantaged communities most impacted by pollution (SGC, 2018c). The goal of the TCC program is to provide 100% of available funding to projects that provide a direct, meaningful, and assured benefit to DAC, consistent with the objectives of SB 535 and AB 1550. This program includes grant or loan funds for implementation and planning. The Implementation Grant Program provides grants and loans to projects that reduce GHG emissions and provide benefits to DACs, and some examples include:

- "Increasing accessibility of affordable housing, employment centers and other key destinations;
- Improving transit access and mobility by prioritizing biking, walking and public transit use
- Increasing recycling and food waste rescue programs that provide improved access to health food;
- Increasing access to health-promoting systems and environmental, such as open space and parks, and other types of greening; and
- Ensuring workforce development, education, and opportunities for high quality jobs" (SGC, 2018c).

Eligible applicants for the implementation grants include CBOs, local governments, nonprofits organizations or coalitions, philanthropic organizations, faith-based organization, community development corporations or finance institutions, joint powers authorities, and/or tribal

governments. For the first year of the TCC program, the SGC approved $140 million in competitive grant funds to transform three cities. In January 2018, SGC announced the allocation of $70 million to the City of Fresno, $35 million to the Watts neighborhood in the City of Los Angeles, and $35 million to the City of Ontario (SGC, 2018b). In addition, a limited number of planning grants can be awarded to help communities prepare to submit a future TCC implementation grant. Eligible applicants include cities, counties, MPOs, joint powers authorities, regional transportation planning agencies, councils of governments, combinations of these entities (SGC, 2018c). The TCC program aims to address equity, climate change, and environmental health using a place-based framework that also emphasizes a community-led approach. And because of this approach, the is strong alignment with public health and therefore offers key opportunities for public health departments to be actively engaged.

The TCC program was developed in consultation with the California Department of Public Health (CDPH) and other state agencies engaged in the Strategic Growth Council. Due to this involvement, the TCC program offers the greatest opportunity for local health departments to be active partners and integrate public health outcomes in several areas. Those applying for funding through the TCC program are required to "establish a minimum of three Goals to improve public health outcomes for community residents and achieve environmental benefits for the Project Area (SGC, 2018c, p. 18). The TCC program guidelines further state that goals addressing public health outcomes should be based on either:

> *…consultation with the jurisdiction's local health department or other local health organization (e.g., local health non-profit, hospital, community health clinic, school-based health provider, etc.), or accessing health data through county CHA and CHIP, CHNA done by hospitals serving the area, indicators in the California Health Disadvantage Index, the Healthy Communities data and indicators project, or the climate change and health vulnerability indicators or other relevant local health studies.* (SGC, 2018c, p. 18).

Applicants are encouraged to utilize one or more of these options. While consultation with LHDs is not the only option, health departments are a key asset to accessing and translating health data in this program that emphasizes the importance of data-driven and measurable outcomes. Public health professionals can also ensure that the needs of the vulnerable populations are addressed.

Aside from requiring eligible applicants to directly consult with health departments in the proposal development process, there is substantial alignment between TCC program objectives and LHD program areas and activities. As mentioned previously, TCC proposals are required to have a minimum of three goals that improve public health and provide environmental benefits. According to the guidelines, goals specific to addressing the community's public health needs should, at a minimum, consider the disproportionate health, environmental and socioeconomic burdens identified by CalEnviroScreen 3.0. Goals are also required to reduce emissions from local sources of air pollution, improve public health outcomes, and increase equity and economic opportunity for low-income residents (SGC, 2018c, p. 18). As shown in **Table 4.5**, there is alignment between TCC eligible activities and LHD program areas such as, Access and Linkage to Clinical Care, Communicable Disease Control, and Maternal, Child and Family Health, but the most overlap is with departments of Chronic Disease and Injury Prevention and Environmental Health. Public health professionals in all program areas can be key resources for TCC applicants since LHDs work closely with vulnerable populations and are key partners in community initiatives (**Table 4.5**).

To be eligible for TCC funding, proposals are required to have "transformative" components which include:

> *…track and monitor GHG emission reduction, community benefits, and other indicators; avoid displacement of existing households and small businesses; ensure community engagement; leverage additional funding that align with TCC goals; and incorporate climate adaptation and resiliency* (SGC, 2018c).

As a result, there is significant alignment between TCC eligible project activities and public health interventions and overarching (upstream) core strategies. The most common upstream core strategies were Community Engagement and Partnerships/Collaboration, and the most common public health intervention was related to Healthy Communities and Environmental Change. In addition to actively engaging community stakeholders, building partnerships and providing data to anticipate impacts on health and vulnerable populations, LHDs can inform the design of projects to alleviate the impact of climate change risks and exposures on the community. For example, eligible applicants can partner with their LHD to leverage efforts in priority communities to address urban heat island impacts through increasing access to parks, gardens and shade trees in disadvantaged communities. TCC applicants must also integrate strategies[6] that reduce GHG emissions and achieve public health, environmental and economic co-benefits. For example, partnering with a LHD can provide the opportunity to combine weatherization and healthy home interventions with asthma education to significantly improve childhood asthma control while also addressing energy usage (Breysse et al., 2014). Additionally, prioritizing strategies that increase transit access between equitable housing and job opportunities can reduce vehicle miles traveled, increase household income, and increase physical activity through active transportation which can provide large health gains through reduced prevalence of heart disease, stroke, and depression (Maizlish et al., 2013b).

[6] These strategies include equitable housing and neighborhood development; transit access and mobility; decarbonized energy and energy efficiency; water efficiency; materials management; urban greening and green infrastructure; land conservation and restoration; health and well-being; workforce development and education; high-quality job creation and local economic development) (SGC, 2018a).

Affordable Housing and Sustainable Communities Program

The Affordable Housing and Sustainable Communities (AHSC) program is designed to further the purpose of AB 32 and the Sustainable Communities and Climate Protection Act of 2008, known as SB 375, by investing in projects that reduce vehicle miles traveled (VMT). The program funds support multi-faced projects that preserves and develops affordable housing options for lower income households while improving connectivity and accessibility to jobs, housing and other services and increasing options for mobility through active transportation and other transit options. This program also seeks to protect agricultural lands to encourage infill develop rather than urban sprawl and may include green infrastructure components and community programs. Through these funded projects, AHSC seeks to lower GHG emissions from driving, improve air quality, provide living conditions in DACs, and ultimately improve public health. The Strategic Growth Council (SGC) administers the AHSC in coordination with CARB and the state Department of Housing and Community Development, which implements the program. The AHSC funding is designed to help local jurisdictions, transportation/transit agencies, developers, federally recognized Indian tribes, and facilities such as schools, colleges and university districts, create communities where affordable housing, jobs, and key destinations are accessible by walking, biking and transit, and thus reduce vehicle miles traveled (SGC, 2018a).

Local health departments are not eligible applicants through this program, however, the goal of improving public health is very prominent in the eligibility of getting AHSC funding. The AHSC Grant Application includes scoring categories that align with key public health priorities and provide the opportunity for LHDs to actively engage in the grant application development process. For example, projects can earn points in the quantitative scoring category

by integrating active transportation improvements that support walkable communities, ensure pedestrian and bicyclist safety, implement anti-displacement strategies to support low-income households, and provide access to key services (e.g., grocery stores, medical facilities that accept Medi-Cal payments, public schools, and licenses child-care facilities). LHDs can also have a prominent role in developing the components of the project that is scored in the narrative-based policy section of the application, which is scored based on the following categories. First, the collaboration and planning component lists local health departments as one of the agencies with which the eligible applicant can potentially partner when integrating components derived from local planning efforts. Second, the community benefits and engagement category are assessed based on how community-based organizations and local residents were meaningfully involved in developing the project and what community needs were addressed. Third, the community climate resiliency component requires applicants to consider local climate impacts (such as drought, sea level rise, flooding, wildfires, heat waves and severe weather) and community experiencing any specific climate vulnerability and describe how projects aims to address these concerns through climate adaptation and resiliency strategies. However, this narrative-based policy section of the application is scored only for projects that obtain over 50% of the quantitative and GHG points.

There is also significant alignment between AHSC goals and LHD program areas and activities, as shown in **Table 4.5**. For example, AHSC focus on building healthy communities by aligns with public health sector's support for healthy neighborhood design that incorporates mixed-use, mixed-income neighborhoods with access to transit, jobs, affordable housing, and key amenities. Health departments can be a valuable partner in integrating strategies to reduce the health, social, environmental, and economic harms due to sprawl, displacement/gentrification, traffic, noise, and air pollution. Partnering with local health

departments can help to ensure effective community engagement and capacity building among at-risk populations and others that are marginalized communities that may have limited representation in current planning efforts. Risk reduction strategies are also integrated in this program because projects need to consider pedestrian and bicycle safety issues, which is a component of complete streets. This program also considers access to clinical care since projects are given additional points for considering access to medical care facilities for Medi-Cal recipients. Additionally, through the various LHD program areas, health departments can provide relevant health and community impact data, as well as ensure that projects address current and future community need.

Urban & Community Forestry Program

Administered by the Department of Forestry and Fire Protection (CAL FIRE), the Urban and Community Forestry (UCF) Grant Program focuses on use of trees and vegetation to support the goals of AB 32 and to provide multiple benefits (environmental, economic and social) to those living in urban areas. There are three project areas that are eligible for funding through the Urban and Community Forestry Program: Urban Forest Expansion and Improvement, Urban Forest Management Activities, and Urban Wood and Biomass Utilization. Aside from the biomass utilization subprogram, all projects must contain a tree planting component. Eligible applicants for this program include cities, counties, districts, and nonprofits.

Public health departments are not listed as eligible applicants nor is LHD partnership defined in the reviewed guideline documents, however, there is opportunity for LHD involvement in this program because there is alignment between UCF goals and eligible activities and LHD expertise and services. First of all, program activities detailed in the reviewed

documents align with the core intervention strategies required to address the social determinants of health and health inequities. For example, the UCF program guidelines include activities that align with the following core intervention strategies: advocacy, communication, community capacity building, community engagement, partnership and collaboration, and surveillance and evaluation. One of the eligibility criteria for funding under this program is that proposals must demonstrate that applicants have *authentically* engaged the local community to develop the project (CAL FIRE, 2017, p. 4). The project applications are also evaluated based on how the project engages community residents in the planting and/or maintenance of the trees to establish a sense of stewardship over these community assets (CAL FIRE, 2017, p. 24). The program guidelines also align with the public health intervention objective of building healthy community and environmental change, and risk reduction when it comes to issue of heat mitigation with trees. To be eligible for funding under this program, "the project area must be located in an urban area or immediately adjacent to an urban area." Consideration of urban heat island mitigation is also included in the program guidelines since project co-benefits are scored in the application evaluation process. According to the scoring criteria, evaluators will consider the degree to which "the project uses trees to…improve air quality, and/or reduce urban heat island effects…and will contribute to improved public health" (CAL FIRE, 2017). LHDs can also help to convene partners in applying for funding and ensuring that projects benefit the at-risk communities they serve by providing health data related to vulnerable communities.

Barriers for Local Health Departments

Although there are ways for LHDs to be involved in the selected CCI programs, the opportunities for involvement is fairly limited considering the many ways in which public health

and quality of life will be impacted by climate change, especially for vulnerable populations. The most significant and obvious barrier is the limited eligibility of local public health agencies to apply for funding. Aside from the ATP, public health departments are not explicitly listed as eligible applicants in CCI programs. Without the explicit language listing or clarifying that local public health agencies may be eligible to apply, LHDs may not pursue this funding source. CCI program funding is awarded to implementing entities, but these entities are typically not qualified to assess the health impacts or to ensure the public health co-benefits of the project. Eligibility to apply for funding is limited to those responsible for project implementation, and such entities for some of the programs include city/county departments, transportation agencies, tribal governments, joint powers, metropolitan planning organization, and non-profits. However, LHDs and public health advocates accomplish their work in close partnership with these entities in their local community to implement programs and improve the health of the most vulnerable and underserved populations. For example, the Los Angeles Department of Public Health (LACDPH) in partnership with other agencies in a county-wide Healthy Design working group, collaboratively develops and implements climate preparedness and mitigation initiatives with the aim of bringing a public health awareness in the climate decision-making process and to improve the built environment (LACDPH, 2018).

The ineligibility of LHDs to apply to the CCI programs is compounded by the more general difficulties that LHDs have in obtaining funding for climate-related activities. For most of the CCI programs that I analyzed, there is a lack of funding available for the planning and design phase of a project and this is an area in which LHDs have been widely involved. For example, health departments provide data and expertise on the development of a General Plan's Health Element or integrate safety concerns on local active transportation plans. Public health

already has limited funding stream to work on climate change and therefore funding needs to be available to provide the fiscal resources needed to support LHDs and the public health community to engage in both mitigation and adaptation efforts.

The lack of requirement for eligible applicants to establish meaningful partnerships with their local public health agencies has also limited the level of engagement by LHDs in the local CCI process. Aside from the TCC program, eligible applicants are not required to consult with their LHD or public health experts in the project development process. There was also no language in most of the program guidelines recommending consultation with an LHD or public health organization. Having such a recommendation that is tied to the application evaluation will ensure that those submitting applications engage with their LHD for input on the project.

Increasing the Public Health Role in California Climate Investments

The process by which the California Climate Investments are updated provides the opportunity to improve the programs based on public input, within legislative limitations. The programs funded through the CCI have undergone various revisions when program guidelines are updated based on new statutory requirements or updated Funding Guidelines for Administering Agencies and Investment Plan. It is because of this that there is opportunity to integrate solutions to address LHD's barriers to engagement. Based on the analysis, the following include recommended actions to administering agencies, eligible applicants and to public health officials at the local level.

First, I recommend that more administering agencies offer funding for LHDs and/or make it clear in their documents that LHDs are eligible for funding. Funding can vary by program based on how LHDs can be involved. For example, for certain programs, LHDs can

help in the planning process before projects go to the implementation phase. Additionally, LHDs can be eligible applicants for programs that are closely aligned with the work they already do. Another key recommendation that agencies can integrate into the evaluation process of the application is to require eligible applicants to partner with their LHD in the project design and implementation phase. Agencies can also include language that integrates local and regional planning efforts that consider health. For example, the AHSC scores grant applications based on how projects will integrate components derived from local plans. Some examples of plans include: General Plans, Climate Action Plans, Bicycle Master Plan, Pedestrian Master Plan, Redevelopment Plan. However, the grant application does not include plans that on the public health sector such as community health improvement plans, healthy communities' plans, or health elements of CAPs. Another key area of agency activity should be on educating and actively engaging LHDs. Administering agencies and regional entities can educate LHD on the various CCI programs and work with their LHD to highlight key areas of involvement and align resources. Agencies and regional entities can also engage with LHD to attend local program workshops. Administering agencies can also include public health representatives in the application review process.

Second, I recommend that eligible applicants be encouraged to increase LHD involvement in their projects. Applicants can reach out to their LHD during the project planning process to establish meaningful partnerships and make sure that community needs are being addressed. Have strong public health consideration and integrating a multi-sectoral collaboration makes more competitive applications and projects that help to build healthy communities. In addition to having an official partnership with a LHD, there are other key opportunities for public health involvement based on alignment between CCI program activities and public health

services. All CCI programs are statutorily required to ensure benefits to disadvantaged communities and a method for doing that is to incorporate meaningful community engagement throughout the process and building community capacity. An effective community engagement process provides avenues to work collaboratively with and through groups of people to address key community concerns and needs, with the goal of increasing community involvement in the decision-making process. Through community capacity building, public health partners can provide information, technical assistance, and support for assessing the health and climate vulnerabilities most prominent in the community. LHDs works with local CBOs and have interactions with at-risk populations in the community. Because of LHD's engagement in the community and as a community resource, LHDs can also play a key role as convener, collaboration builder and an important partner. LHDs can also develop communication and provide information to educate on the linkage between climate change impacts, mitigations/adaptations and public health and other vulnerabilities. Collaborating with public health agencies on the various CCI program can help to better leverage these limited funds to have more lasting impacts. Integrating public health expertise in designing and implementing the project can also help to avoid potential unintended adverse health consequences. Local agencies implementing CCI funding will find it beneficial to partner with their local health departments because many health departments work in disadvantaged and impacted communities most vulnerable to climate change and they also work with diverse partners. Having a robust public health role in the CCI programs provides a method to leverage funds to build healthy communities and enhance community resilience while also reducing GHG emissions.

Third, I recommend that local health can also actively pursue greater involvement in the CCI programs. From a public health perspective, the SB 535 and AB 1550 requirements to

maximize benefits to priority populations and disadvantaged communities through meaningful engagement aligns with key public health objectives and activities. According to the 2018 Funding Guidelines, administering agencies are required to "design programs and select projects that avoid or minimize substantial burdens to residents of disadvantaged communities and low-income communities…" and are required to "…implement outreach efforts that seek to directly engage and involve local community residents and community-based organizations in disadvantaged and low-income communities (California Air Resources Board, 2018). These communities are more likely to be disproportionately burdened by the impacts of climate change, exposed to multiple sources of pollution, and especially vulnerable to environmental pollutants. These are the communities where public health agencies are already engaged or have established partnerships. It is important to note that climate change confronts public health departments with a variety of new and increasing threats within the context of limited funding, limited expertise, and uncertainty about the likelihood and magnitude of specific threats. Yet the public health community has a "toolbox" of evidence-based methods suited to addressing these threats and build community resiliency (Roser-Renouf et al., 2016). Within the context of the CCI, LHDs can educate themselves on the CCI programs and find who in their region has been funded. LHDs can also inform partners on funding opportunities. LHDs can also develop partnerships with local agencies and "be at the table." LHDs can also educate internal staff on the linkage between climate change mitigation and adaptation and public health. However, these strategies go up against one of the key challenges for LHDs to engage in climate change policy, which is limited capacity and resources. This is why funding is important to support LHD involvement.

Limitations

While the use of document analysis as a qualitative research method has its advantages (**Table A.3**), there are key limitations of this approach with respect to this study that are worth noting. First, analysis was limited to what was presented in the program guidelines to determine the potential for local health department involvement in the respective CCI programs. Without further corroborating with program administrators and funding awardees, it is difficult to fully identify the different ways LHDs can be engaged. Interviews with grant administrators and applicants could provide a more complete picture of how LHDs can be involved. Future research could focus on each of the programs to determine additional potential for LHD activity. Additionally, document analysis was limited to programs that provided a minimum of 50% of funds to benefiting disadvantaged communities, however, a preliminary assessment of all programs was conducted to determine if LHDs were eligible to apply or if a LHD was awarded funding through the program. This preliminary assessment was conducted with programs newly funded under the CCI. The findings provided here are limited to researcher interpretation of the document analysis, however, to provide validity, an established public health framework was used to ground the analysis. Another key limitation of this study is that it provides a snapshot of the CCI program guidelines at the time the study was conducted. The California Climate Investment (CCI) initiative is complex with multiple components that are governed by different legislations and are continually being updated. Programs under the CCI umbrella will annually release revised guidelines to satisfy regulatory requirements. This study does not provide findings based on the 2019 program guidelines. However, through the span of updates, administering agencies have not drastically changed the program objects, eligibility criteria, or the scoring criteria during this early phase of the CCI.

CONCLUSION: IMPLICATIONS FOR POLICY AND PRACTICE

The public health sector has an important role in helping California reduce GHG emissions and adapt to the impacts of climate change. This analysis helps to identify which CCI programs offers the most opportunity for local public health departments in California to actively partner with other local agencies and stakeholders implementing the funds, and also to directly apply for funding. Based on the analysis of the selected CCI programs, I recommend that public health be more prominently at the table and seek opportunities to apply for CCI funding directly or in partnerships. Eligible applicants to the CCI programs can also seek to collaborate with their LHD and identify opportunities to maximize health benefits in their grant proposals. Administering agencies may support increasing opportunities for LHD engagement by clarifying LHD eligibility to apply for funding, require eligible applicants to partner with their LHDs, integrate health consideration in the grant application, and include the evaluation of health benefits into the grant proposal scoring criteria.

Although the various CCI grant programs were not designed with the involvement of local health departments in mind, this analysis of the selected program guidelines shows that there are varying levels of involvement available for LHDs. Some programs offer LHDs the opportunity to apply for funding (e.g., Active Transportation and Urban Greening) and others (i.e., TCC and AHSC) require applicants to demonstrate their partnership with their local health departments. While it is difficult to link to clear health impacts resulting from these partnerships, findings from previous studies have shown that these partnerships enhance collaboration and alignment across sectors, leverage limited funds, ensure that projects take local health and equity impacts into consideration, develop a project that addresses community need, and establishes partnerships for future work. The primary reason for LHD involvement is to ensure that public

health co-benefits are realized in the CCI funded projects, since projects are required to provide public health, environmental and economic co-benefits. Demonstrating partnership with local health departments also adds to the competitiveness of the application since the evaluation and scoring criteria for the proposals allots points for such collaborations or for designed projects that provide public health co-benefits.

Despite its limitations, the statewide implementation of the California Climate Investments provides a unique model for how cap-and-trade funds can be reinvested into communities. How public health is integrated into the Funding Guidelines is a baseline and there is opportunity for further integration or highlighting health considerations. Health impact consideration is integrated within the CCI programs that require or have investments in DACs or benefiting DACs because DAC designation is based on the CES, which has a pollution burden component and a population characteristic component.

Climate change is transforming the field of public health by altering the severity, frequency and types of challenges faced by local public health professionals and their partners. Because the health impacts of climate change are experienced locally, the involvement of local communities and jurisdictions in monitoring, developing, and implementing climate change mitigation and adaptation strategies is crucial. As demonstrated in this study, the California Climate Investment Programs can potentially offer such an opportunity. Local health departments work closely with governmental agencies and community partners to address health impacts of environmental change by developing and implementing solutions that keep people healthy and safe. Since the public health sector is at the front lines addressing health impacts, it has a critical role to play in advancing and mobilizing support for health-based climate change strategies that protect health and reduce greenhouse gas emissions. In this new phase of public

health practice and multi-sectoral collaborations, integrating and prioritizing health and health equity in climate action planning is a crucial strategy to ensuring that the challenges of climate change, health, and inequities are address in concert to better optimize the health of our communities throughout the state.

FIGURES AND TABLES FOR CHAPTER 4

Figure 4. 1 – Coding Framework used in Chapter 4

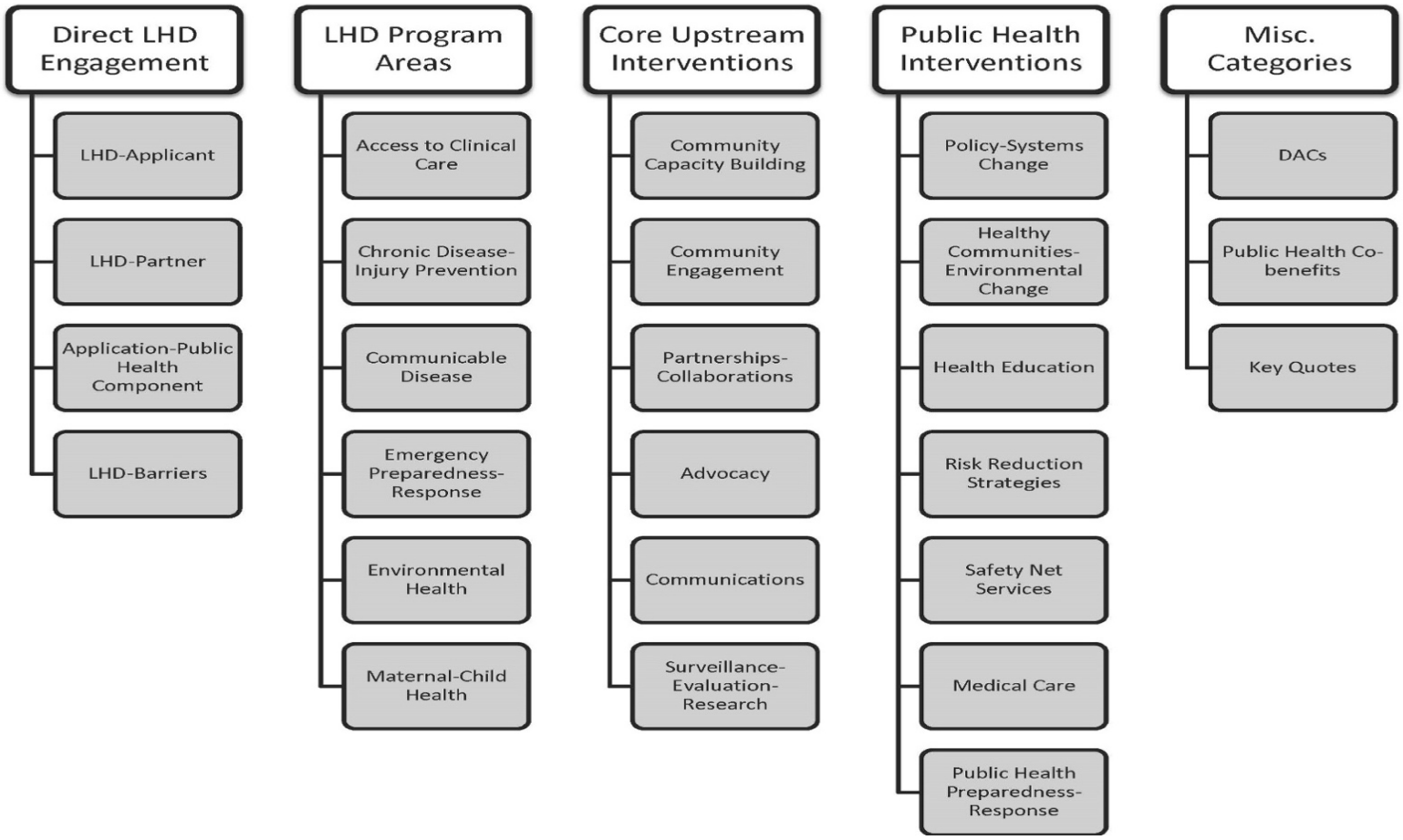

Table 4. 1 – Alignment Between the Foundation Public Health Services Framework and the Climate Change and Health: A Framework for Action

	Public Health Actions to Address Climate Change (Climate Change and Health A Framework for Action) *											
CCLHO Foundational Capabilities	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Achieving Health Equity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Assessment					✓	✓						
All Hazards Preparedness and Response	✓		✓		✓	✓	✓	✓		✓	✓	✓
Policy Development/Support			✓	✓		✓	✓	✓	✓			✓
Communications			✓		✓							✓
Community Partnership Development		✓	✓	✓		✓			✓			
Organizational Competencies	✓		✓			✓	✓				✓	

*Legend:
1: Community Capacity Building
2: Community Engagement
3: Partnerships and Collaborations
4: Advocacy
5: Communication
6: Surveillance, Research, and Evaluations
7: Policy and Systems Change
8: Healthy Communities and Environmental Change
9: Community Health Education
10: Risk Reduction/Safety Net Services
11: Medical Care
12: Public Health Preparedness and Response

Table 4. 2 – Selected California Climate Investment Programs for Analysis

Priority Areas	Selected California Climate Investment Programs
Transportation & Sustainable Communities	Affordable Housing and Sustainable Communities (AHSC)
	Transformative Climate Communities (TCC)
	Transit and Intercity Rail Capital Program (TIRCP)
	Low Carbon Transit Operations Program (LCTOP)
	Active Transportation Program (ATP)
	Low Carbon Transportation (LCT)*
Clean Energy & Energy Efficiency	Low Income Weatherization Program (LIWP)*
	Dairy Methane Program (DMP)*
	Water Energy Efficiency Program
Natural Resources & Waste Diversion	Urban Greening (UG)
	Wetlands and Watershed Restoration
	Urban and Community Forestry Program (UCF)
	Waste Diversion*
*Indicates sub-programs were included in analysis.	

Table 4. 3 – Criteria Used to Determine Potential for LHD Engagement in CCI Programs

Criteria for LHD Engagement in CCI Programs		Source
I	Eligibility of local health departments to apply for funding	CCI Documents
II	If not eligible to apply, requirement of eligible applicants to partner and/or collaborate with their local health department	CCI Documents
III	Overlap between CCI program objectives and LHD program areas and services	FPHS
IV	Alignment of CCI program objectives with LHD activities and public health interventions.	Climate Change & Health: A Framework for Action

Table 4. 4 – Questions used to examine the selected California Climate Investment documents

Questions Guiding the Document Analysis		Criteria
Preliminary Questions	Are LHDs eligible to apply for funding through the CCI program?	I
	If LHDs are not eligible to apply themselves, do program guidelines require eligible applicants to partner or collaborate with LHDs or other public health agencies?	II
	How do the CCI program activities align with LHD programs areas?	III
	How do the CCI program goals and activities align with public health intervention strategies?	IV
Secondary Questions	Are applicants required to describe the public health impacts/benefits of the proposed project/program?	IV
	Are public health impacts considered in the application scoring criteria and evaluations process?	IV
	Are there any emerging public health topics addressed in the CCI program?	IV

Table 4. 5 – California Climate Investment Programs with the Most Opportunity for Local Health Department Engagement

Administering Agency	CCI Programs				Foundational Areas					Public Health Intervention							Core Strategies					
		LHD Eligible Applicants	LHD required or listed as partner	Benefits to DACs	Access and Linkage to Clinical Care	Chronic Disease & Injury Prevention	Environmental Health	Communicable Disease Control	Maternal, Child, & Family Health	Policy & Systems Change	Healthy Communities & Environmental Change	Health Education	Risk Reduction Strategies	Safety Net Services	PH Emergency Preparedness & Response	Access to Medical Care	Advocacy	Communication	Community Capacity Building	Community Engagement	Partnerships & Collaborations	Surveillance, Evaluation & Research
CNRA	Urban Greening	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Caltrans	Active Transportation	✓		✓		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SGC	Transformative Climate Communities		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Affordable Housing & Sustainable Communities		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CalFIRE	Urban & Community Forestry			✓		✓	✓				✓		✓				✓	✓	✓	✓	✓	✓

APPENDIX A: SUPPORTING INFORMATION FOR CHAPTER 4

Table A.1 – Documents Analyzed

Program	Documents Analyzed
Active Transportation	California Transportation Commission. (2016). *2017 Active Transportation Program Guidelines*.
Affordable Housing and Sustainable Communities	California Strategic Growth Council. (2017). *Affordable Housing and Sustainable Communities Program: FY 2016-2017 Program Guidelines*.
Transit and Intercity Rail Capital Program	California State Transportation Agency. (2017). *2018 Transit and Intercity Rail Capital Program Guidelines*.
Low-Income Weatherization Program	Department of Community Services and Development. (2017). *Low-Income Weatherization Program Guidelines FY 2015-16 Appropriation Procurements: Single-Family Energy Efficiency, Single-Family Solar Photovoltaics*. Department of Community Services and Development. (2017*). Low-Income Weatherization Program Guidelines: Multi-Family (MF) Energy Efficiency and Renewables*.
Food Waste Prevention and Rescue Grant Program (Waste Diversion)	Department of Resources, Recycling and Recovery. (2017). *Food Waste Prevention and Rescue Grant Program: Application Guidelines and Instructions 1st Cycle-FY 2016-17*. Department of Resources, Recycling and Recovery. (2017). *Food Waste Program Scoring Criteria – FY 2017-18*. California Department of Food and Agriculture. (2017). *2017 Alternative Manure Management Program: Request for Grant Applications*. California Department of Food and Agriculture. (2017). *2018 Dairy Digester Research and Development Program: Request for Grant Applications*.
Urban Greening	California Natural Resources Agency. (2017). *Urban Greening Program Final Guidelines*.
Low Carbon Transportation	California Air Resources Board. (2017). *Proposed Fiscal Year 2017-18 Funding Plan for Clean Transportation Incentives*.
Transformative Climate Communities	California Strategic Growth Council. (2017). *Transformative Climate Communities Program: FY 2016-17 Final Program Guidelines*.
Urban and Community Forestry	California Department of Forestry and Fire Protection. (2017). *2017-18 California Climate Investments Urban and Community Forestry Program Grant Guidelines*.
Low Carbon Transit Operations Program	California Department of Transportation. (2017). *Low Carbon Transit Operations Program FY 2017-18 Final Draft Guidelines. Division of Rail and Mass Transportation. Office of State Transit Programs and Plans*.
Wetlands Restoration	California Department of Fish and Wildlife. (2014). *Wetlands Restoration for Greenhouse Gas Reduction Grant Program: FY 2014-15 Proposal Solicitation Notice*.

Table A.2 – Presence/Absence Code Analysis Results for the Selected CCI Programs

							Foundational Areas					Upstream Core Strategies						Public Health Interventions								
CCI Programs	Public Health Co-Benefits	Grant Application	Health Metric	LHD Applicant	LHD Partner	CCI Program/DACs	Communicable Disease	Chronic Dz-Injury Prevention	Access to Clinical Care	Environmental Health	Maternal, Child Health	Community Engagement	Communications	Community Capacity Building	Advocacy	Partnerships-Collaboration	Surveillance-Eval-Research	Policy & Systems Change	Hlthy Comm-Env Chg	Medical Care	Health Education	Preparedness & Response	Risk Reduction	Safety Net		
ATP	1	1		1	1	1		1		1		1		1		1	1		1		1				13	54%
DMP						1				1		1				1			1				1		6	25%
UCF	1	1				1		1		1		1	1	1	1	1	1		1				1		13	54%
Waste						1		1		1		1	1	1		1			1					1	9	38%
UG	1	1	1		1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	21	88%
LCT	1		1			1		1		1		1	1			1	1		1					1	11	46%
LCTOP	1					1		1		1		1	1			1	1		1				1	1	11	46%
LIWP	1					1				1		1	1	1		1	1		1					1	10	42%
AHSC	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	21	88%
TCC	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	23	96%
TIRCP	1					1		1		1	1	1	1			1	1		1				1		11	46%
WETLAND	1					1				1									1				1		5	21%

Table A.3 – Advantages and Disadvantages of Document Analysis

Advantages and limitations of using documents as an approach for collecting data. Excerpted from Creswell, 4th edition, p 191-192.	
Advantages	Enables researchers to obtain language and words of participants.
	Can be accessed at a time convenient to researcher.
	An unobtrusive source of information.
	Represents data to which participants have given attention.
	As written evidence, it saves a researcher the time and expense of transcribing.
Limitations	Not all people are equally articulate and perceptive
	Requires the researcher to search out the information in hard-to-find places.
	Requires transcribing or optically scanning for computer entry.
	Materials may be incomplete.
	The documents may not be authentic or accurate.

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CHAPTER 5: THE CALIFORNIA CLIMATE INVESTMENTS AND LOCAL HEALTH DEPARTMENT ENGAGEMENT – A CLOSER LOOK AT THE URBAN GREENING AND COMMUNITY FORESTRY PROGRAMS

ABSTRACT

Background: Climate change is a defining public health issue and offers the opportunity for transformational change across systems and sectors. Climate change already affects the health of many communities and will continue to exacerbate health disparities that disproportionately burden already marginalized communities. As a result, local health departments (LHDs) have a critical role to play in implementing climate action strategies and leveraging these efforts to build healthy, equitable, and climate-resilient communities. The California Climate Investments (CCI), which is a statewide initiative to reinvest cap-and-trade funds into strategies to reduce greenhouse emissions, offers the opportunity for LHDs to integrate health consideration into this statewide effort to mitigate climate change. However, there has been limited LHD engagement in the CCI. This study focuses on current and potential LHD engagement in the CCI program areas related to urban greening (e.g., Urban Greening (UG) and Urban & Community Forestry (UCF) programs). This study also highlights opportunities to increase LHD engagement and provides recommendations on addressing the key barriers to LHD engagement in the UG/UCF programs that can also inform other CCI programs.

Methods: Semi-structured interviews were conducted with local health department personnel and key stakeholders (n = 13) to assesses how local health department personnel have been engaged in urban greening activities either with or without CCI funding to determine their level of knowledge of the UG and/or UCF programs, and the CCI in general, to identify exemplary

activities related to the selected grant programs or related to urban greening in general. Interviews were recorded and transcribed. Dedoose, a qualitative data analysis software, was used for coding and analysis to identify key opportunities for active engagement by LHDs, factors limiting LHD activity, best practices, and recommendations.

Results: The UG program has awarded grant funding to one local health department. LHDs have been involved in the UCF as an active partner in the application development process to include health consideration and inform the community engagement and outreach process. Among LHD respondents, only those who had previously applied to either the UG or UCF programs had any familiarity with the programs. Those who had not previously applied typically did not know about the UG/UCF programs or even about the CCI more broadly. Despite not knowing about the UG/UCF grants, these LHD respondents were still engaged in urban greening activities outside of CCI funding. The major factors limited LHD engagement in these programs was lack of awareness about the programs and limited funding capacity.

Conclusions: There is opportunity to conduct more outreach to LHDs to inform them of this funding opportunities related to the UG and UCF programs. LHDs can help convene and coordinate collaborations between public health, urban forestry/greening, and other community partners. State level agencies can also organize a convening to bring together awardees, interested applications and other community partners to support increased LHD engagement.

INTRODUCTION

According to the Fifth Assessment Report of the International Panel on Climate Change (IPCC), climate change is expected to exacerbate existing health problems by 2050, and populations that are already affected by climate-related health impacts will likely face greater risk in the coming decades (IPCC, 2015). Climate change can directly and indirectly impact human health – physiologically, psychologically, and socially – through environmental consequences such as extreme heat events, rising sea-levels, increased risk of floods, droughts, and wildfires, worsening air quality, and other extreme weather events (USGCRP, 2016). Climate change is also expected to exacerbate already existing health disparities experienced by vulnerable populations such as older adults and children, those preexisting health conditions and disabilities, the lower income, some communities of color, certain immigrant groups, those with limited English proficiency, indigenous peoples, pregnant women, and certain occupational groups (Gamble et al., 2016). The vulnerability of these populations, and any populations for that matter, is a function of their sensitivity to the health risks associated with climate change, their exposure to those risks, and their capacity and the capacity of the systems on which they depend on to respond to, cope with, and recover from the environmental consequences associated with climate variability. With the frequent occurrence of public health emergencies, worsening environmental conditions that contribute to poor health, and more environmental health disparities, there is a need for climate change policies that provide greater opportunity for public health sector engagement.

Local health departments in particular should be at the front lines of addressing the climate change impacts faced by communities. While surveys of LHD officials have highlighted a number of constraints and barriers to LHD involvement in climate change adaptation

(Bedsworth, 2012; S. Gould & Rudolph, 2015; Huang et al., 2011), the public health sector has a host of tools and methods to address threats and build community resilience. Whether by issuing heat wave alerts, monitoring vector-borne disease, planning for emergencies, or building awareness in the community and with key partners on the health impacts of climate change, the public health sector is essential to addressing health impacts to climate change (Cheng & Berry, 2013b). In a 2008 national survey of LHD directors, nearly 70 percent believed that their jurisdiction had already been impacted by climate change and about 78 percent believed that their jurisdiction will be impacted by climate change in the next 20 years (Maibach et al., 2008). LHDs are also well engaged in the communities already impacted by health disparities and those who will be more impacted by climate change. These strategies which have been used to address various other emergent threats to public health include: conducting risk assessments, developing response strategies, initiating and implementing public education campaigns, modeling climate impacts and disease burdens, assessing vulnerabilities, developing climate action plans, and evaluating interventions (Roser-Renouf et al., 2016). Additionally, LHDs can help to identify and address the unintended negative health and consequences that may be associated with climate action strategies, especially mitigation or adaptations that may disproportionately burden vulnerable populations. While the core function of LHDs has been to provide foundational public health services to support individuals and community, there has been a broadening of LHD activities to also support policy and systems change across multiple sectors (e.g.,, transportation and land use, local agriculture, and food systems) that influence the social and environmental determinants of health (CHHS, 2017). For example, a select number of LHDs have further expanded their scope to prepare for the local impacts of climate change in their jurisdictions by

working more upstream on the spectrum of interventions (CDPH, 2018b; Rudolph et al., 2018; Rudolph et al., 2015).

As the urgency increases for local public health agencies to integrate climate change consideration into public health practice and for to engage with further with partners (Watts et al., 2015), the climate policy environment in California provides LHDs the opportunity to show that the climate change threat to public health can also be an opportunity to build healthy, equitable, and climate-resilience communities. This chapter will present how LHDs have engaged in these CCI-funded urban greening programs to date in order to identify best practices and recommendations for supporting LHD engagement in green infrastructure activities that improve public health and help to build climate-resilience communities.

California's Climate Policy: An Overview of the California Climate Investments

The California Climate Investments (CCI) is a statewide initiative to reinvest auction proceeds from the state's Cap-and-Trade program to support climate mitigation and adaptation strategies, reduce pollution, and benefit vulnerable communities throughout the state. The CCI and Cap-and-Trade program are strategies under the larger umbrella of California's primary climate legislation, the Global Warming Solutions Act of 2006 (Assembly Bill 32). AB 32 and the subsequent update requires economy-wide reductions in GHG emissions to 40% below 1990 levels by 2030 (California Air Resources Board, 2014; State of California, 2006). The regulation also requires the consideration of how the implementation of mitigation strategies will impact communities that are already adversely affected by air pollution. Since 2012, a portion of the funds raised through the Cap-and-Trade program's quarterly auctioning of tradeable emission allowances or permits has been legislated to be deposited in the Greenhouse Gas Reduction Fund

(GGRF) (State of California, 2012b). Through the GGRF, billions of dollars in auctions proceeds have been reinvested into initiatives to reduce greenhouse gas emissions, support innovative ways to reduce pollution, and maximize public health, environmental, and economic co-benefits to communities throughout California. Communities where these investments, collectively termed "California Climate Investments" or CCI, have occurred, are realizing a wide range of benefits including: increased access to affordable housing; improved mobility options through transit, walking, and biking; more access to zero-emission vehicles; employment opportunities; energy and water savings; and greener, more vibrant communities (California Air Resources Board, 2019a). State agencies that are appropriated funds, administer, develop, and implement a suite of programs in three priority areas: transportation and sustainable communities; clean energy and energy efficiency; and natural resources and waste diversion. Programs housed under these priority areas are required to advance AB 32 goals and provide benefits to priority populations who are economically disadvantaged, exposed to multiple sources of pollution, or are especially vulnerable to the effects of pollution and a changing climate.

The CCI integrates a unique model to ensure that the implementation of climate mitigation and adaptation strategies target co-benefits to marginalized communities already burdened by the cumulative impacts of pollution. Through Senate Bill 535 (SB 535, De Leon. Global Warming Solutions Act of 2006: Greenhouse Gas Reduction Fund) and Assembly Bill 1550 (AB 1550, Gomez. Greenhouse Gases: Investment Plan: Disadvantaged Communities), the State requires that a portion of the auction proceeds from the Cap-and-Trade Program be reinvested in GHG mitigation strategies within or benefitting "priority populations," which includes disadvantaged communities, low-income communities, and low-income households

(California Air Resources Board, 2018; State of California, 2012c, 2016).[7] To identify disadvantaged communities the State uses the CalEnviroScreen tool which ranks communities based on indicators for cumulative burden of various environmental hazards and chronic public health conditions, overlaid with poor social determinants of health indicators (OEHHA, 2018). Communities that rank in the top 25 percent of census tracts based on CalEnviroScreen are identified as disadvantaged communities (DACs).

Despite the intention to target investments to marginalized communities, key gaps exist, however there are also opportunities for increased LHD engagement. An assessment of the cap-and-trade reinvestments found that the most impacted populations were not seeing reinvestments in their neighborhoods (Cushing et al., 2016).[8] There is also a need for better targeted effort to address the health disparities that can further be exacerbated by climate change. Additionally, there has been limited engagement by LHDs in the CCI programs at the local level. However, there is opportunity to increase LHD engagement in the CCI. An analysis of CCI programs that have invested over 50 percent of funds to benefits DACs showed that there is alignment between CCI program activities and LHD activities (based on the core foundational public health services, public health interventions, and upstream interventions) and core program areas. (See **Chapter 4**).

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[7] At least 35 percent of auction proceeds must benefit priority populations (25 percent to DACs and 10 percent to low income communities or households), and the remaining 65 percent of funds can be spent anywhere in the state, including in DACs and low-income communities and households (State of California, 2016).

[8] This assessment was conducted prior to the implementation of AB 1550 that incorporated additional investments to low-income households or communities statewide, and low-income households or communities within a ½ mile of a DAC.

What California's Climate Policy Means for Urban Forests and Green Space

One of the program areas that align with public health sector activities related to climate adaptation and building climate-resilient communities and provide the opportunity for LHDs to apply for funding or be active partners are the program areas related to urban greening and community forestry, both of which center around increasing green infrastructure. Grant programs focused solely on urban greening and community forestry include the Urban and Community Forestry Program (UCF) and the Urban Greening Program (UG). Four other grant programs (i.e., Active Transportation Program, Affordable Housing and Sustainable Communities, Transformative Climate Communities, and the Climate Ready Program) have urban greening components but do not require applicants to implement those measures to be eligible for funding. The following section provides a brief overview of the above-mentioned programs and greening activities that are eligible for funding through the CCI. **Table 5.1** provides an overview of the discussion below.

Urban and Community Forestry Program

Administered by the Department of Forestry and Fire Protection (CAL FIRE), the Urban and Community Forestry (UCF) Grant Program focuses on the use of trees and vegetation to support the goals of AB 32 and to provide multiple benefits (environmental, economic and social) to those living in urban areas. To be eligible for funding under this program, the project area must be located in an urban area or adjacent to an urban area (California Air Resources Board, 2018). There are three project areas that are eligible for funding through the UCF program which includes: Urban Forest Expansion and Improvement, Urban Forest Management Activities, and Urban Wood and Biomass Utilization. Aside from the biomass utilization

subprogram, all projects must contain a tree planting component. Eligible applicants for this program include cities, counties, districts, and nonprofits. Seventy-five percent (75%) of appropriated funds to this program must be expended on projects meeting the criteria for being located within AB 1550 communities, which includes priority populations such as low-income communities, low income households, and disadvantaged communities (CAL FIRE, 2017, 2018).

Urban Greening Program

Administered by the California Natural Resources Agency (CNRA), the Urban Greening Program competitively awards grant funding to projects that reduce GHG emissions by transforming the existing built environment by incorporating natural and green infrastructure to create more sustainable and livable communities. Eligible projects must reduce GHG emissions by: (1) sequestering and storing carbon by planting trees; (2) reducing building energy use by strategically planting shade trees; and/or (3) reducing VMT by constructing bicycle paths, lanes or pedestrian facilities. Some examples of urban greening projects include enhancing and expanding neighborhood parks and community spaces; greening of public lands and structures; establishing green streets and alleyways; developing nonmotorized urban trails that provide safe routes for travel between residences, workplaces, commercial centers, and schools; mitigating urban heat islands and energy conservation efforts. While there are some overlapping components between the Urban and Community Forestry and the Urban Greening grant programs, most projects will generally be more compatible with one program over another. The key distinguishing factor between the two grant programs is that Urban Greening projects result in the conversion of existing built environment into green spaces that implement green

infrastructure approaches. Eligible applicants for this program include cities, counties, nonprofits, joint power of authorities, and special districts (CNRA, 2019).

Other CCI Programs with Urban Greening Components

Urban greening and tree planting are eligible cost components within four other CCI programs: Active Transportation Program (ATP), Affordable Communities and Sustainable Communities (AHSC), Climate Ready Program and Climate Adaptation, and Transformative Climate Communities (TCC). Within the Active Transportation Program, applicants can integrate tree planting, landscaping, and recreational trails within a larger project that supports safe and accessible transport by walking, biking, or other active transportation options that support all users (CTC, 2018; Caltrans, 2018). For both the AHSC and TCC, urban greening components are integrated within a larger effort to build climate resilient communities. The AHSC program includes urban greening projects such as tree planting, providing greenscaped active trails, green roofing, community gardens, and drought tolerate landscaping and restoration (SGC, 2018a). The TCC program includes similar urban greening elements as the AHSC program, but also includes funding for urban forestry and tree canopy planning activities and urban heat island mitigation efforts. The TCC also requires partnership with LHDs for develop public health goals for evaluation purposes (SGC, 2018c). A Climate Ready Program is a newer program that integrates mitigation and adaptation and one of the components is related to urban greening. The Climate Ready Program eligible projects within the urban greening area includes creating demonstration parks, community gardens, and other multi-benefit green spaces, it also funds research related to “Living Streets” projects, and also highlights the need for community engagement in these efforts (Coastal Conservancy, 2019). An overview of the above-mentioned

programs and how each program touches on urban greening components is included in **Table 5.1**. While all the programs listed above include urban greening components, this study focused on the Urban Greening Program and the Urban and Community Forestry Program, but still considered greening activities that LHDs engaged in outside of CCI funding.

A Key Opportunity for Local Health Department Engagement

The public health sector has a critical role to play in promoting, informing, and implementing urban greening initiatives that are currently a component of the California Climate Investments. As discussed previously, the LHD role in climate action initiatives have been widely promoted due to the various areas of expertise and credibility that health departments bring to these efforts (CDPH, 2018b; Cheng & Berry, 2013b). There is reemerging interest in the potential of green space to support healthy community initiatives due to the connection between greening, access to nature, and health outcomes. Even though urban greening and community forestry activities are not within the traditional purview of local health department activities, there has been more public health engagement in greening initiatives as the field of public health has shifted to include more upstream interventions that consider the social and environmental determinants of health and well-being. Urban greening strategies are key public health interventions because they not only help to sequester carbon, mitigate the urban heat island effect, and improve local air quality, but these strategies, when implemented with consideration of the needs of local communities, can also promote physical activity, provide access to locally grown produce, improve social cohesion, support mental health, and also increase opportunities for community engagement (Harlan & Ruddell, 2011). Jennings et al. (2016) provides a summary of publications that examine the linkage between health and green space. It is also

important to consider the nuances of urban greening measures and the potential unintended negative consequences to ensure equitable access to green space (Cole et al., 2017). Having a health and equity lens may help to ensure that mitigation and adaptation measures, such as urban greening, effectively addresses the disproportionate burden of climate risk faced by already vulnerable populations without exacerbating inequities and health disparities.

Within the context of urban greening and creating healthy communities, a potential unintended consequence that is of concern is the issue of green gentrification and displacement. Green gentrification is related to the gentrification process that is often associated with improving access to urban green spaces (Maantay et al., 2018; Wolch et al., 2014). Inequities has been shown to arise in marginalized neighborhoods after the implementation of urban greening interventions such as increasing and improving access to parks, greenways, community gardens, and other green infrastructure measures. Green interventions, while well-intentioned, are associated with a shift in the community demographic, increase in property values, and increase in the cost of living, which may influence the displacement of long-time residents, especially vulnerable urban households with limited incomes (Cole et al., 2017; Wolch et al., 2014). Typically, those who move in to these neighborhoods are white, affluent, and have higher levels of educational attainment (indicators of gentrification) than those who are displaced. However, with access to affordable housing, effective community engagement, multi-sector partnerships, education, and integrating a health equity lens, displacement and gentrification do not have to be a default when implementing greening interventions to create healthy communities and build climate resilience (Aboelata et al., 2017).

Local health departments can also help ensure that under-served communities have improved access to green spaces and similar amenities. Studies have also shown that lower-

income and more minority neighborhoods have less access to open or green space, and those amenities are often smaller or of inferior quality than open spaces in more affluent neighborhoods (Maantay et al., 2018, p. 3). Therefore, LHDs and community partners have an critical role to play in the UG and UCF programs to ensure that poorer, under-served communities have access to quality green spaces, and is important to building healthy and climate-resilient communities that also advance health equity and environmental justice goals. Environmental justice is the concept that all people have the right to live, work, and play in healthy and safe environments without the disproportionate exposure to environmental hazards and equitable access to environments that help them thrive (Maantay et al., 2018).

Despite the importance and opportunity for public health sector engagement in urban greening measures to provide health co-benefits and build community resilience, there has been limited LHD engagement in the UG and UCF programs. LHDs are eligible to apply to the UG and UCF grant programs since local government agencies are eligible applicants, however, there has only been one health department that has been awarded funds through the Urban Greening program. Therefore, the goal of this study is to identify the opportunities for LHD engagement in the UG and UCF programs through interviews with LHD personnel engaged in urban greening activities. Interviews will help inform recommendations to address barriers to LHD engagement in the UG/UCF programs and also to support more LHD involvement in UG/UCF programs and other CCI programs in general.

METHODOLOGY

Data Collection

Semi-structured interviews were conducted with key experts and stakeholders in governmental and non-governmental organizations who would be able to provide key insights in to how LHDs could actively engage in community greening initiatives under the CCI or in general. Participants were initially selected based on the non-probability sampling method of purposeful sampling. This initial pool of interviewees were health department personnel who were identified based on prior professional connections. Other Southern California LHD personnel were identified by contacting chronic disease divisions and requesting referrals to personnel working on healthy communities, tree planting, or climate action initiatives. Sampling of LHD personnel was based on convenience and expert referral. Through snowball sampling, additional participants were identified. This snowball strategy involved identifying a few key participants who met the established criteria for participation in the study. The initial participants were asked for referrals to other potential participants to interview. Referrals were excluded if they did not meet at least one of the following criteria:

1. Worked previously on CCI-funding projects in the Urban Greening or Urban & Community Forestry programs; or
2. Engaged previously in the CCI process; or
3. Worked in a LHD in an area that is relevant to urban greening, tree planting, community or edible gardens, or healthy communities.

Eligibility was determined prior to the formal interview based on information provided during the screening process that was conducted in-person or over the phone. Individuals who

met the criteria and agreed to join the study were invited to participate in the full in-person interview process. Attempts were made to recruit participants from all Southern California LHDs, but contacts were unable to participate due to time constraints, limited activity in areas of greening, or just a lack of follow-up. A total of 13 individuals were interviewed for this study. Two participants requested that the interview not be audio-recorded. Due to the lack of audio-recording, these interviews were mainly informational. Majority of those interviewed were health department personnel (9 out of 13). See **Table 5.2** for more information on interviewees. Interviews were conducted between November 2017 – July 2018.

A semi-structured interview guide was developed (See **Appendix B** for the interview guide and all supplemental materials). Questions were modified for each category of participant (i.e., individuals working in LHDs vs. those not working in health departments). Participants were mainly from Southern California, with a smaller sample from other parts of California (i.e., Sacramento and Madera counties). Interviewees were first asked about their knowledge of the CCI, activities related to urban greening, community forestry, and community gardens. Interviewees were also asked about the strategies they used to engage in these efforts, the partners they engaged with, key challenges to and opportunities for further engagement in CCI efforts and the community greening area. Interviewees also provided insights which helped to define the key recommendations to increase LHD engagement in these efforts.

Data Analysis

Interviews were audio-recorded with permission from the participants. However, one individual who agreed to participate in the study, requested that their interview not be recorded. Recorded interviews were later transcribed and uploaded to Dedoose for analysis. Dedoose is a

web-based analysis software designed to maintain rigorous security of datasets and can be used to analyze qualitative data (Dedoose, 2019). Descriptors were assigned to the interview participants (**Table B.1**) and inputted into Dedoose. The transcripts were initially coded based on preliminary code topics such as barriers, opportunities/public health role, and recommendations, and also from derived from *Climate and Health Framework for Action* (Rudolph et al., 2015). To develop the codebook, half of the transcripts were coded. Codes were then revised and used to recode the transcripts and code the remaining transcripts. Code topics include barriers to LHD engagement in UG and/or UCF programs, opportunities for LHD engagement in UG and/or UCF programs, recommendations, and important quotes and insights. Examples of sub-codes include funding, insufficient awareness, limited PH role, partnerships and collaborations, community engagement and outreach, provide health data, urban greening/forestry activities. A full list of codes can be found in **Figure B.1**.

RESULTS AND DISCUSSION

The responses gathered during the interview process highlight how local health departments can actively engage in the UG and UCF programs by identifying how select LHDs are currently engaged in these programs or in community greening activities outside of this grant funding. Key public health roles and factors that limit LHD engagement are identified. This chapter also focuses on the Madera County Public Health Department, which was the only LHD to receive CCI funding through the UG Program. Based on the interviews, recommendations are provided for how to increase LHD and public health sector involvement in the UG and UCF grant programs, and the CCI in general. Recommendations are categorized by target audience:

LHDs, partner organizations, and state agencies to address identified barriers and increase LHD engagement and public health consideration.

Study Participants

Regional grant managers for the UG and UCF programs were interviewees with the most familiarity with the CCI and the UG/UCF grant programs. LHD personnel familiar with the CCI and the programs were those who had previously participated in grant application process for either the UG or UCF grant programs. LHD personnel who engaged in other CCI-funded grant programs as an active partner, a proposal reviewer, or were engaged in greening activities not funded through the CCI, had knowledge of the CCI programs in general but not the UG and/or UCF programs specifically. Interviewees from LHDs were primarily those not familiar with the CCI or the grant programs. Despite the lack of awareness about the CCI or these particular grant programs, LDH interview respondents and the programs they led were engaged in urban greening activities such as funding school-based community garden supporting the integration of parks and open space related language for general plan updates (County of Riverside, 2011), and promoting increased access to parks and open spaces to build healthy communities (Riverside University Health System - Public Health, 2017). Those currently not engaged in CCI-related activities shared their interest in learning more about the UG and UCF programs and the other programs under the CCI umbrella.

Opportunities for LHD Engagement in the CCI

Despite limited direct involvement within the Urban Greening and Urban & Community Forestry programs, interviews revealed that the sampled LHDs engaged in various community

greening activities. Some examples of projects included: prioritizing tree planting in lower-income neighborhoods, integrating community gardens with nutrition classes for lower-income families and schools, school-based edible gardens, community engagement using pop-up parks, and partnering with other local agencies and community organizations to promote parks and trails for recreation and establishing community greenbelts. While the majority of these activities were implemented through programs not supported by CCI funding, these projects have the potential to be eligible for funding through the UG and UCF grant programs. Analysis of the interviews helped to determine key categories within which LHDs engage in urban greening activities. The emergent categories include Supporting Partnerships & Collaboration; Educating & Informing; Conducting Community Engagement and Outreach; Providing Health Data and Evaluation; and Administering Funds.

Support Partnerships & Collaborations

One of the primary ways in which local health departments have been engaged in urban greening initiatives is through multi-sectoral partnerships and collaborations. These partnerships include community organizations, both private and public entities, health care providers and other non-health care partners. These collaborations allow health departments to engage in collective action that helps to leverage limited resources (e.g., funding or workforce capacity) and address the root causes and social determinants of health. Partnerships and collective action are important components of "Public Health 3.0" (CHHS, 2017, p. 11). One LHD respondent who was engaged in urban greening efforts but was not familiar with the UG/UCF grant programs said:

> *"…everything we do is a partnership because that's the only way you're going to have the kind of meaningful impact in a community that you really want and that's sustainable while also leveraging resources, filling gaps, and not duplicating efforts…"*

The major roles that LHD representatives described playing within a partnership were as conveners, coordinators, and facilitators. LHD respondents shared that they have a lot of experience with bringing together key partners around issues impacting their community by facilitating and supporting these partnerships. The public health department is seen as a "*neutral party*." A non-HD respondent said that they continue to collaborate with their LHD because there is a level of trust that has been built from past partnerships. One LHD respondent leading a multi-sector committee engaged in developing a county-level Urban Heat Island Plan that integrates green infrastructure (e.g., trees, green space, cool roofs, permeable pavements) said this about the LHD's role in facilitating and coordinating:

> *…I realized that people are happy to have someone step-up in a leadership role. Facilitation and leading a workgroup is a lot of work. It has actually been really well-received having Public Health lead these efforts because they (*representatives from other departments or organizations*) think we have demonstrated and done a good job.*

Public health accomplishes their work in collaboration with both traditional and non-traditional partners. Within the scope of urban greening projects, the primary partners that were commonly mentioned include: local government departments of parks and recreation, public works, regional planning, and transportation, and also schools and school districts, faith-based organizations, and other local community organizations.

A formal partnership that was referenced by all health department respondents and the Urban and Community Forestry Program representative from CAL FIRE as a best practice was Los Angeles County's Healthy Design Workgroup. The Healthy Design Workgroup (HDW) is a

partnership between various county-level departments to collaboratively develop policies and practices around building healthy communities and improving interdepartmental coordination (LACDPH, 2018). The HDW brings together high-level representatives from various County departments including: Public Health, Public Works, Regional Planning, Parks and Recreation, Sheriff, Beaches and Harbors, Fire, Community Development Commission, Arts Commission, Chief Executive Office, Chief Information Office, Agricultural Commissioner/Weights and Measures, and Internal Services Department, and Office of Sustainability (LACDPH, 2018).

The Los Angeles County Department of Public Health (LACDPH) leads and coordinates the activities of the HDW. HDW subcommittees most directly engaged in urban greening initiatives are the Trees Committee and the Climate Committee. The Trees Committee, led by the Department of Public Health, involves interdepartmental coordination between various county-level local government agencies. The committee, in collaboration with community partners and youth leadership groups, primarily focus on developing strategies for preserving, managing, and growing LA County's urban forest in low income, tree-poor neighborhoods (CDPH, 2018c). This committee has been engaged in piloting tree giveaways at Smart Gardening Workshops, piloting new tree irrigation technology that supports water conservation, improving and streamlining process for resident tree requests, and connecting partners to provide low-cost trees for tree planting in unincorporated county areas.

The Trees Committee provides a key example of the important roles that LHDs can play in the grant proposal development process for the UCF grant program. The Department of Public Health collaborated with the Department of Public Works on a CAL FIRE grant application through the UCF program which resulted in a $1 million award for a countywide street trees inventory and a tree planting/community education project in South Los Angeles County

(CDPH, 2018c). This grant helped to address a key barrier that was identified within the committee, which was the issue watering and who has the responsibility to care for newly planted trees. While LACDPH was not the primary applicant, the health department jointly wrote the proposal with the Public Works department to develop a tree inventory to support long-term urban forestry planning. The LHD respondent said that, "*we played a very unique role within this joint effort since our part was to do the GHG calculations*," (i.e., to determine how many metric tons of GHG will be sequestered as a result of the proposed project). The LHD was uniquely positioned to engage in this effort through a partnership with a local academic institution's graduate student fellowship program. Another key role the public health department played in this partnership was to design the community outreach component of the grant application, which will be further discussed in the next section.

There are also other ways LHDs can support these efforts within a partnership. Public health can also support grant applicant by being "*thought partners*" as stated by an LHD respondent, *"Part of what we do is be thought partners for those working on a grant application and thinking through how they would frame it."* Another LHD respondent engaged in non-CCI funded urban greening efforts said that health departments can also "*bring to the attention of other departments applicable grant opportunities, support those departments in the application process, and also write letters of support."*

SHAPE Riverside County is another example of how LHDs have collaboratively engaged in greening activities. SHAPE (Strategic Health Alliance Pursuing Equity) Riverside County "*is a community-wide effort to coordinate resources of public health system partners to improve health for all communities in Riverside County*" (Riverside University Health System - Public Health, 2019). This initiative is coordinated by the Riverside County Health Coalition which is a

public-private partnership working collaboratively to identify and support comprehensive solutions to tackling obesity, poor nutrition and physical inactivity "*to improve the overall health of Riverside County residents and enhance the community's capacity to address these risk factors."* (Riverside University Health System - Public Health, 2018). According to a LHD respondent, SHAPE Riverside County has integrated community gardens as a strategy to promote healthy eating and access to meet the goal of "*creating safe physical and social environments that promote health*."

Respondents also revealed that it is beneficial for non-HD entities to establish a collaborative relationship with their LHD. According to one LHD respondent:

> *Our interest is that if we can't go for it, how do we bring players and partners together to be the most competitive and steer them towards applying, support them in applying, and also help to make it the most competitive and most impactful (proposal) that they can."*

A non-HD personnel who is engaged in urban greening efforts in partnership with their LHD provided the following insight, *"I think our overall collaboration with the health department helps us to focus on our highest need communities first*." Partnerships with LHDs also help to make applications more competitive. A non-LHD respondent familiar with the CCI programs shared that:

> *"The TCC (Transformative Climate Communities) program has an urban greening component as well and that's where we (CAL FIRE) really see public health departments come in since it requires that partnership…a grant won't be competitive without partners…and so we see them (LHDs) as partners a lot…being involved in outreach and public education."*

Educate & Inform to Integrate Health Perspective

LHD respondents engaged in urban greening activities identified that another role for health departments have been to encourage public health consideration, provide a health frame,

and incorporate a health education component highlighting the health benefits of green infrastructure such as community gardens and increasing park space. Activities discussed in this section and following sections present other ways in which LHDs have engaged in urban greening efforts, but it is important to note that these activities are conducted in partnerships with other traditional and non-traditional entities.

Interviews revealed that within an LHD, urban greening efforts related to community gardens, parks, open spaces, and urban trails are typically initiated by or related to priorities of the nutrition education, obesity prevention and physical activity programs. These programs are centered around health promotion and education. Analysis of the interviews showed that education and integration of public health ranged from a localized intervention/projects to policy level interventions. At a more localized level, LHDs have partnered with other organizations and schools to implement school-based edible garden programs. An LHD respondent engaged in these community garden projects not funded by the CCI, but serving low-income communities shared that, "*the intent of the school gardens, a farm-to-fork model, was to help students gain a deeper connection about where their food comes from because in a lot of low-income communities, food comes in a wrapper.*" Then these programs were linked to nutrition education events for students and their families where they participated in food demonstrations to learn how to prepare the produce they grow and also had the opportunity to take the produce home. LHD personnel shared that these school-based edible garden programs provided "*an interactive learning opportunity for the students that also incorporated science standards, language arts, nutrition, and other multi-disciplinary topics."*

Within the context of the Trees Committee, in addition to coordinating the committee, bringing together resources, and helping to write the grant applications, the health department

was integral to providing the justification for how the greening project will provide health co-benefits. A LHD respondent engaged in a collaboration to develop a urban forestry curriculum development said that:

> *"We were the background players in moving people, convening people, developing the scope and making sure that the community was involved. I think that's what public health does well. Even though there wasn't so much of a health focus, what was great was that there was health integrated."*

Providing education and training is also a key role that LHDs can play in collaboration with other experts. An LHD respondent engaged in non-CCI funded community garden initiatives discussed how partners were enlisted to train subcontractors:

> *"One of the things we do is partner with the UC Cooperative Extension. They have a wonderful Master Gardener Program and an Urban Greening Program. We partnered with them to provide trainings to our external partners on how to build a garden, how to use a raised bed, what to plant and when, how to deal with pests, essentially the basics of building and maintaining gardens, but also integrate the environmental health perspective to teach how to conduct soil testing to make sure there are not toxic chemicals on a site that would be harmful and prohibit consumption of produce grown in those lots. So training is one of the areas in which public health expertise is provided."*

Health integration with respect to greening initiatives has also taken a "Health in All Policies" approach. To build healthy and livable communities, Riverside County has integrated health into land use and transportation planning in an effort led by the LHD (County of Riverside, 2011). The health benefits of open spaces, parks, trails, street trees, and community gardens are integrated in the following documents: the County's Healthy Communities Element which is part of the County's General Plan (County of Riverside, 2011), the Healthy Riverside County Resolution that encourages cities to incorporate health into their land use and transportation policies (Riverside University Health System - Public Health, 2014), and also the Healthy Development Checklist which is a tool to support healthy and equitable development

practices (Riverside University Health System - Public Health, 2017). The Healthy Development Checklist provide healthy development criteria organized into six categories: active design, connectivity, public safety, environmental health, community cohesion, and access to food, services and jobs. According to an LHD respondent, this tool allows other departments "*to be aware of the kinds of things that are important from the public health lens.*" This approach also addresses a gap that may be present in city ordinances or design guidelines. As clarified by the LHD personnel:

> *"...with community gardens for example, there may not be a formal policy or ordinance requiring developers to provide that amenity…but the healthy development checklist allows different cities with different requirements to learn what are the basic elements to consider when reviewing plans from a public health lens."*

Another LHD respondent engaged in non-CCI funded community parks and gardening activities shared their perspective on the public health role:

> *"I think we are often the one to shift the focus. If the focus isn't there on ensuring that equity is considered or that health impacts are considered…. I think that is definitely the role of the health department at the table."*

Conduct Community Engagement and Outreach

In addition to coordinating, convening, and providing a health framing, local health departments have been involved in supporting partner organizations to develop effective community engagement and outreach strategies. A non-HD respondent involved in the CAL FIRE grants at state level shared:

> *"One of the key things that I have been hearing…a major benefit to having the public health partnership is to get connected to local nonprofits and other community organization but also making sure that effective community engagement is a component of the different projects."*

Health department personnel also agree that what public health departments can bring to the table is a connection to the community. An LHD respondent involved in the UCF grant said this about the HD role:

> *"Public Health was integral in designing the community outreach component for the grant proposal. CAL FIRE is really big on making sure that the communities bought into the tree planting and that they are part of the tree planting itself. They actually wrote it into the grant guidelines. For this particular grant, we developed the model based on another project…where we have a community-based organization within the area we are do tree planting to be the lead of the community outreach campaign and education."*

Health departments have expertise in developing culturally- and audience- appropriate messaging that is a key component of effective outreach. An LHD respondent engaged in community garden projects not funded by the CCI said:

> *For schools it has been more about garden-based nutrition education. That messaging and framing really work with teachers and students because it was an interactive learning opportunity for the students that also incorporated science standards, language arts, nutrition, and other multi-disciplinary topics. That framing was good for schools. For faith-based organizations, we framed the benefits of community gardens with messaging around healthy body, health soul. Then for the larger community setting, it's about how growing food can help households save money while eating good nutritious food."*

A non-CCI engaged LHD respondent shared that health departments can provide the connection to communities or populations that may be more challenging to engage with because "*it is about relationship building with the community and the health department is connected in a way that has established trust*." Non-LHD respondent also echoed this sentiment:

> *There is also the important piece of having the trust and more direct connection with the community that our health department does very well where we here in our department have 19 planners for half a million people so we have extremely limited staff whereas the health department has 400 or so and they are in many community locations and have that sort of direct community knowledge.*

Health departments can also help identify and connect to "*the voices not heard from*." A respondent from a non-HD governmental agency shared this about their interaction with their local health department on their outreach plan which was a component of their CAP development process:

> *The health department knows our community partners a lot better than we do so it was about learning which groups to talk to and how we should engage….We have a diverse set of communities with various needs and different ways that makes sense to engage. We got some great suggestions on how to better partner or just learning that our health department partners will be out doing these community events and so can help collect surveys and do some of the work on the ground.*

The Long Beach Health Department integrates community engagement into their parks planning by having events such as pop-up parks in park-poor areas. The LHD personnel explained, *"…it's kind of like an idea of a demonstration project showing the possibilities and it's a great way to do meaningful community engagement*." Another event was to inform the design of a greenbelt that is meant to expand park space in a park-poor neighborhood facing some issues with crime. At such events, "*the community comes out, ranks ideas, and shares ideas for what they would like to see and what they see their families utilizing. We also have kids draw pictures of what they want to see in the space and also have other fun games and activities*." Engaging communities in this way helps to connect to residents who otherwise "*don't come to community meetings and often feel like their voices are not heard*." The LHD participant added that, "*It's a great way to engage youth and neighborhoods that have high populations of residents for who English is not their first language…it doesn't require people to come out or drive out to the other side of the city or to City Hall.*"

An LHD respondent clarified that a well-designed community engagement strategy is linked to efforts to support healthy and livable communities:

> *"...engaging the residents and letting them design based on each neighborhood, what makes sense and what meets the uniqueness of those neighborhoods when it comes to providing more green space and better use of open space, well that really ties in the larger livability goal of the city."*

Community health assessments can also help inform community engagement efforts. An LHD personnel shared the following about their experience in integrating community outreach plan into their UG grant proposal.

> *"one of the components was that you had to reach out to the community. You have to do community outreach and so because we were in the middle of doing our community health assessment, we were able to use the findings from our community health assessment to address this."*

LHD respondents also shared examples of community and stakeholder outreach activities during the process of develop urban heat island reduction plans. These outreach efforts to local CBOs, nonprofits, academics, and other private sector entities to get feedback.

Administer Funds

Those eligible for CCI funds are entities with the authority to implement projects within the respective program areas. While local health departments are not explicitly listed as a potential applicant, they are eligible to apply as a county or city entity. Later in this chapter, I will further discuss Madera County Public Health Department which is currently the only health department that has been awarded CCI funding to support greening activities through the Urban Greening Program.

Three respondents provided examples of LHDs administering funds in projects or programs that align with CCI-eligible projects but are not funded through the CCI. Through SNAP-Ed funding, local health departments have supported community gardens on school

campuses and in low-income neighborhoods to serve the local community. Partners have included elementary schools, school districts, faith-based organizations, and other non-profits and community-based organizations. For example, an LHD had funded community garden projects that did not charge a fee for the plot, and they also integrated nutrition classes, produce giveaways, and easy, low-cost recipe demonstrations. Another LHD respondent shared their activities related to their SNAP-Ed funded projects,

> *"...we have been awarded $3,000,000 for about year three years with the overall goal increasing fruit and vegetable consumption and levels of physical activity among lower-income populations…and a strategy we use is edible gardens."*

LHDs have also funded projects related to the expansion and redesign of an existing park to have better connectivity with the community and funded the establishment of two new parks to increase access to open spaces.

> *"Under one of our earlier CDC grants, we passed through a large pool of money through SANDAG* [San Diego Association of Governments] *in 2012 to fund master park planning…we called it the Healthy Communities Campaign. We funded a number of projects, but parks were definitely a popular proposal.*

The LHD responded further added, "…we *funded a Tribal Nation which rarely receive funding from us let alone SANDAG.*" Unfortunately, limited funding streams prevent LHDs for engaging in these efforts even though there is interest and expressed need from the communities they serve. Another LHD respondent shared information about funding received to do tree planting and community outreach around trees in four unincorporated communities.

Factors Limiting LHD Engagement/Barriers

Even though the interviews demonstrated key opportunities for LHDs within the UG and UCF programs based on current activities of LHDs, the respondents also highlighted some key

barriers that limit LHD participation in the area of urban greening or within CCI funded programs. The key factors that limited LHD participation include funding and workforce capacity, grant application process and the public health role, and insufficient awareness and understanding.

Funding & Workforce Capacity

Respondents from health departments engaged in CCI-funded urban greening initiatives and those dependent on other funding sources both shared that lack of funding and limited workforce capacity are key factors that limit engagement in areas related to urban greening. In fact, one LHD respondent engaged in funding community garden programs and parks related activities shared that, *"…funding and staff capacity…are the number one and two issues side by side."*

When first discussing the CCI and the UG/UCF grant programs, all LHD respondents unfamiliar with the programs were interested in the potential funding opportunities for which public health departments can apply. Dedicated grant funding is needed because LHD programs engaged in greening strategies are dependent on on-going grant funding to continue their work in this area. For example, respondents from HDs engaged in developing community gardens to serve low-income communities shared that their respective programs rely on funding received from the United States Department of Agriculture (USDA) through CDPH to implement the Supplemental Nutrition Assistance Program Education (SNAP-Ed) project, formerly known as Nutrition Education and Obesity Prevention (NEOP) program, to support strategies that promote healthy eating, active living, and healthy and safe environments. However, there is shared concern about the longevity of this funding source. There was shared interest about learning

more about the CCI grant opportunities, stating that, "*it is unfortunate that our NEOP funds are going down in 2019 and beyond and it is also unfortunate that one of the things that may get cut first is support for the gardens…"*

The respondent iterated that concern by saying that:

> *"…our ability to support gardens is based on continued funding through NEOP... and we are talking about federal dollars that are tied to SNAP-Ed and the Farm Bill and it's anyone's guess given political climate…whether funding will be available. But I will tell you that funding levels increase and decrease and that is just the nature of what we do here at the health department. We do everything for the most part because we partner with the community, whether it involves community-based organizations funded partnerships within my division alone or what we do in partnership with the community…"*

Another way in which funding is a barrier for LHD engagement in these efforts is that it is tied to what health departments can work on. One health department personnel who was the director of a division in a health department said, *"…in public health we just operate on whatever grant we are funded to do and we kind of just end up in these silos…*"

Health department interviewees stated the concern over their priority activities shifting based on the funding they receive. One LHD respondent involved in active living efforts and parks master planning in their county said:

> *"…even for a public health department to want to support those efforts even if funding goes away. For the last 10 years I have been working here I know we have been grant-driven. We have been lucky enough that every grant opportunity that we have had, active living has been woven into it, but that might go away…If there isn't a funding opportunity for me and a couple of colleagues, we are going to be shipped to another grant … and so my work is unstable which is disappointing, but very well could happen. So we like to leverage and be creative. Our USDA grant is funding some work around active living. We have little pots but the pot somehow gets a little bit smaller and that's okay because it's a test for public health departments. Are you ready to really back this kind of work up or is it just going to be dependent on funding?*

A HD personnel actively engaged in CCI-funded urban greening project shared that limited funding is a barrier to conducting robust evaluations, hiring more staff to work on these projects, and implementing a tree giveaway program for unincorporated areas of the county not serviced by cities. When discussing funding limitations and its linkage to staff capacity, a few HD respondents compared their department as not being at the level of Los Angeles County Department of Public Health due to their lack of funding and capacity. For example, an LHD respondent shared:

> *"...we have been involved in active transportation and land use for a long time and indirectly working on climate issues and urban greening. We don't have a concerted effort. We just don't have staff time unfortunately like Los Angeles does. I know that they have the PLACE Program which has like 10 staff. Here it's me working on active transportation and a couple of grants. Other than that, there is a sliver of me working on climate, there's a sliver of another person working on admin, and that is literally it."*

Another health department respondent shared a key barrier to the funding limitation is related to institutional barriers:

> *"...we are great partners, but we can only go so far in a lot of cases. We would love to be a formal partner and receive funding and have a role, but we are not a nimble department. Unfortunately, we can't just go after any grant that we know would make a difference. The contracting process is so laborious and cumbersome that it's just easier if we don't receive funding, but that also has the effect that if our time is not accounted for, then that reduces capacity as well so it's kind of a catch-22 unfortunately."*

Grant Application & Public Health Role

Local health department personnel who were familiar with the UG/UCF programs stated that the grant application and program requirements were barriers to more LHD engagement, since there was (1) limited space for public health consideration and (2) partnerships or engagement with LHDs were not required. A health department personnel who was familiar with

the UCF grant application process shared that, "*…one section of the application was just checking of boxes for co-benefits and one of them was public health. We also had to briefly discuss it."* Even though a typical role for public health department is providing health data, it is in fact a core public health function, there was not much opportunity to integrate health data or health justification in the grant applications. Others agreed that the limited space available for public health consideration did not allow for a major public health role. One LHD respondent who was involved in applying for the UCF grant through CAL FIRE shared this about the opportunity to integrate public health data:

> *"I haven't for this in particular, but usually for public health technical assistance, it is about providing health data and our data resources, but for the CAL FIRE grant, we didn't reference a lot of health data for it because we were very limited in space, and they also didn't ask for it."*

They further expanded that for the health justification:

> *"We did pretty much your boiler plate health benefits of trees kind of thing, but health wasn't the focal point since greenhouse gas emissions where the primary outcomes of interest…I think we mentioned one of the obvious ones which was cleaning the air for those with respiratory issues or increasing the likelihood of physical activity, but that was a small section and they only allowed for so many and there were so many other co-benefits listed besides just public health."*

Another LHD personnel engaged in non-CCI funded community greening efforts shared: "*…integrating health in the application ensures consideration of public health because then that gets applicants thinking about it."* However, even when there are some health-oriented questions in a grant application, there are often no public health representation on the review committees for the submitted application. A health department personnel who was engaged with the CCI-funded Active Transportation Program, shared that, *"There were some health-oriented questions,*

but I have found out that there was no health perspective on the review panel locally, so I thought how were they going to know if there was a need or not."

While UG and UCF does not require partnerships with a local public health agency, the UG grant guidelines do require the applicant to describe partnerships with "other entities" with one of them being a local public health agency. Respondents who were from LHDs and some of those who were not from LHDs were familiar with the CCI cited the Transformative Climate Communities Program as an example of how public health considerations and partnerships should be included in the UG and/or UCF programs or other CCI programs in general. However, grants requiring applicants to partner with their LHD without a formal role or funding can exacerbate the limited workforce capacity issues faced by many LHDs which may already have limited capacity. One LHD respondent shared the concern about requiring LHD partnerships without financial backing, *"The question about how other health departments could move more into urban greening is such a tough question for health departments that don't have as much capacity as we do…."*

Insufficient Awareness and Information

Lack of adequate awareness and information about the CCI also emerged as a key factor limited LHD engagement as active partners in the UG/UCF programs and the CCI in general. LHD respondents engaged in non-CCI funded urban greening activities said that they did not know about this funding opportunity and "*wouldn't even know where to look*." These LHD respondents shared interest in the eligibility criteria, and even if they are not eligible for funding, they would want to inform their community partners about this resource, as exemplified by the following statements from two LHD respondents:

> *"I think it would be useful for us to know, especially if they are not required to include us, it would be great if there was a resource for us to see who has been funded or who is applying for funding in our jurisdiction. So as a health department, it would be good to know which local department, whether it is Park, Public Works, or Planning, is going after this funding."*

> *"What I genuinely don't know is how a community or how a city is (1) eligible for the funds, (2) how those funds are allocated. Is it a preset formula? And (3) who those funds go directly to or are they applied for at the local level? So as a health department, for example, is there a mechanism for us to apply for funding to do any of this? Or does it go to the city itself and then the city somehow uses these funds for various things?"*

Both LHD and non-LHD respondents who had engaged in CCI-funded programs stated that the CCI was very complex and it was difficult to know about the various funding opportunities.

Barriers related to the field-specific language and also limited knowledge about LHD activities also exist. Some LHD respondents also said that language and terminology were barriers. An LHD respondent who was engaged in non-CCI funded community garden projects in low-income communities stated:

> *"…those are not the words I use to frame and talk about our work and you know just saying that I come to realization that it's mitigation…that makes sense, but I would not have thought about our work framed in that way at all if I had not talked to you. That's not the lingo that we use."*

Another LHD personnel who applied and was awarded funds through the UG program also shared that the terminology related to climate change impacts and linkage to the environment was a key challenge that had to be addressed. The respondent who was a grant writer for that application shared that:

> *"Google was my very best friend. I didn't have a clue about what GHG meant or what 'CCI' stood for… or even how trees help to benefit ozone and mitigate climate change...I had to look up and find out that the stomata of the leaves help to trap ozone and such. It was just me working in this, but I was lucky because I had the time…and some other avenues of help."*

One LHD respondent shared that they are not engaged in urban greening efforts because urban greening is seen as a design element:

> *"...we know that is important for a healthy community, but we have not dived into seeing that as an opportunity in the way that we are looking at the food environment or the design of our communities. Urban greening is part of designing a community, but we are not at that point in which we are…focusing on the street environment. Instead we focus more on sidewalks and urban greening could be a part of sidewalks, but we haven't really stopped to look at any one feature besides the feature that is most important to prevent injuries.*

Non-LHD respondents who were not engaged with their local public health agency in the UG/UCF efforts had limited awareness of what LHDs can provide outside of public health data. One non-LHD respondent shared that they did not understand why LHD would want to go after the UG and/or UCF grant funding, but later clarified that they were not aware that some LHD programs were grant funded.

Madera County Public Health Department – An Urban Greening Grantee

To understand how LHDs might further engage in CCI program, it is helpful to look in more detail at the one LHD (Madera County Department of Public Health) that has been awarded CCI funding through the UG program as a primary applicant as of May 2019. In 2017, the Madera County Public Health Department (MCPHD) applied for grant funds through the UG program. MCPHD was awarded the funds to build a health trail around the perimeter of the new Madera County Public Health Department and Department of Social Services campus. According to a LHD respondent, the objective of the project is to provide the local SB 535 designated disadvantaged community "*a safe place to exercise, shade in the summer, and serve as a place to enjoy being outdoors*." Along the health trail, there will be nine exercise stations, and three of them will be designed for wheelchair-dependent trail users. There will also be trees

planted to provide shade and other plants and will also include sustainable mulching and irrigation.

In this project, urban greening is integrated into a larger project that serves the needs of the community and thus providing a "*human scale*." According to one LHD personnel involved in this effort:

> *"We are located in a disadvantaged community but we also have low-income people and other at-risk groups coming from across the county really just to this one hub to where the Social Service and Public Health campuses currently are…so while they are here, they can take advantage of the park course…we also have a farmers market that goes on. Within the new campus, the director even earmarked a piece of property that we will develop into a community farm."*

Another LHD respondent shared:

> *"…we are part of that community. The new campus will be across the street from a school. We are in an area where they are building up a little bit. There is not a lot of parks around here and so it definitely is a benefit to the neighborhood. People coming in for social services and things are often lower income and so it would be an opportunity for them to be to be able to use it too. You know, build it and they will come."*

The respondent also added, "*we are looking to use the services of the local jail inmates to maintain the community farm."* Through this partnership, the inmates will help keep the costs down for maintenance and in turn for their service, they will be getting job training. The LHD respondent added, "…*it is a super low-income area where residents don't have a community gathering space and they don't have any community parks at all. This Urban Greening grant is going to introduce the pseudo park space into this area."*

There were a number of factors that helped to make this project possible. According to respondents, Madera County Public Health had an already established partnership through the LiveWell Madera County which is a collaboration between a number of county departments,

other local agencies, local businesses, CBOs, faith-based organizations. Health department staff attended a local UG workshop and had a director that saw the connection to their current activities and upcoming projects. In addition to having a dedicated grant writer, leadership support was provided, both by the health department and through the Board of Supervisors. A LHD personnel shared:

> *For Madera County...they are practicing and have been practicing Health in All Policies in that decision-makers are thinking about health and wanting to incorporate health in a collaborative way, so when the opportunity of the Urban Greening Grant came around, I'm really not surprised that it had the support of the Board…of the CEO."*

The public health department also led the effort where staff were able to provide input on the design and on what they would like included to cater to a broad spectrum of people. Public health practitioners were given the opportunity to create a list of amenities they would like to see in this new complex to cater to the various populations that utilize this health complex since it is a hub for the surrounding community. The dedicated grant writer also had to learn the language of urban greening and climate change. Key recommendations and insights that emerged from this project will be further discussed in the next section.

In summary, interviews presented evidence to show that: (1) local health departments are engaged in urban greening activities that align with requirements of the UG and UCF grant programs; (2) LHD respondents conveyed interest in learning more about the selected grant programs and the CCI as a potential source of funding, however there are factors that limit LHD activity in urban greening and the CCI; and (3) even though LHDs are eligible to apply to the UG and UCF grant programs, only one LHD has been an awardee.

Recommendations

Based on assessment of the interviews with LHD personnel and key informants familiar with the UG and UCF programs, discussed below are some recommendations that have emerged. These recommendations are presented according to potential actions by target audience which includes local health department personnel, non-LHD entities applying to the UG/UCF grant programs, state-level agencies with authority to administer or inform how the grant programs are implemented, and also other jurisdictions looking to implement their own cap-and-trade program. It should be noted that even though the recommendations presented here focus on the UG and UCF grant programs, these recommendations can be applied to other CCI programs that have overlap with LHD program activities. Even if there is no direct program overlap, opportunities should be available for engagement by LHDs to bring a health equity lens to these mitigation and adaptation measures.

Recommendations for Local Health Departments

Local health department personnel should examine CCI Programs as a potential funding source to support urban greening activities or activities that are eligible for CCI funding. A key factor that limits public health department engagement in the UG/UCF grant programs was related to not knowing about this potential funding stream. County and city public health departments can explore the UG and UCF grants as potential funding sources to support greening activities that align with the CCI requirements and complement their work. With respect to the UG and UCF grant programs, eligible applicants include cities, counties, qualifying districts (e.g., schools, parks, recreation, water, and others), and qualifying 501(c)(3) nonprofit organizations (CAL FIRE, 2018). LHDs can leverage this funding opportunity to engage with

local partners, such as local community organizations, schools, faith-based organizations, and local government agencies.

Local health departments should continue to engage with traditional and non-traditional partners and seek out local urban forest councils or urban heat island mitigation planning efforts. LHDs respondents engaged in the UG/UCF grants and other greening initiatives also highlighted the importance of "being at the table" and attending workshops and meetings with traditional and non-traditional partners. An LHD respondent engaged in CCI-funding urban greening activities shared that:

> *"It's about working in partnerships but not just within government. It is important to work with other community partners because they are those who have been doing it for years. This experience is especially important if a health department is new to this work, then they are going to need some guidance and direction. What I have learned is that there are some big voices, strong voices, that have a vision of where this work should be going…."*

Attending meetings and workshops also helped LHD personnel to learn about the UG/UCF grant programs and potential grant opportunities. Attending meeting and "being at the table" were commonly suggested solution to integrate public health and to support a "Health in All Policies" approach. As suggested by a non-LHD respondent, health department personnel engaged in community tree planting efforts or improving access to parks and community gardens, can become involved in their local tree boards, urban forestry councils, or partner with local CBOs engaged in similar work. Another non-LHD respondent suggested:

> *From the urban greening side, it's about approaching us with an idea, I trust the health department…to be better connected with what's happening in the community. If they identify a community need and want to work with planning to create an urban greening project…it's about initiating the conversation and needing to communicate it to us."*

Respondents shared that integrating health consideration with multi-sectoral partnerships made proposals more competitive for funding. Local health departments engaged in CCI-funded greening projects were initiatives within multi-sectoral partnerships, i.e., Livewell Madera and the Tree Committee of the Healthy Design Workgroup. These partnerships are more common due to current LHD accreditation and the recognition that multi-sector collaborations enhance program activities. However, LHD respondents did discuss the challenges of actively engaging in partnerships with limited staff time and capacity. Therefore, based on the interviews, it is has been a key practice of the formal partnerships to not put additional work for members, but rather provide a forum where members can enhance their program activities.

In addition to interdepartmental partnerships within the jurisdiction, LHDs should collaborate with other LHDs in the region and beyond. This would provide a key opportunity to identify best practices related to urban greening and forestry activities and identify how other departments are addressing the challenges they face related to urban greening projects.

Local health departments should consider building internal capacity related to the CCI programs and how programs may align with LHD activities, and also int related to the CCI and also incorporate staff education on how LHDs activities align with climate change mitigation and adaptation strategies. Interviews revealed a need for health departments to build internal capacity to educate staff on the linkage between current urban greening/community gardening efforts to climate mitigation and adaptation efforts and also on the CCI initiatives. Such a staff education initiative may be modeled on the Climate and Health Workshop Series, which was a coordinated effort between UCLA School of Public Health Faculty and doctoral students and LACDPH staff (Godwin & Heymann, 2015). This 16-week workshop series for LACDPH staff provided an overview of climate change and health, provided participating staff the opportunity to discuss

how their work and the communities they serve will be impacted locally by climate change, and also brainstorm how LACDPH can expand their work associated with climate change and health. This workshop series and internal engagement process helped to establish LACDPH's "Five-Point Plan to Reduce the Health Impacts of Climate Change" (LACDPH, 2014). In the context of urban greening efforts, staff education effort can highlight the health co-benefits and the climate adaptation capability of urban greening activities and help LHD personnel frame their work in the climate mitigation and adaptation lens. This can inform LHD efforts to potentially seek CCI funding because it may help LHD staff to reframe relevant program activities to align with CCI program requirements. It is about learning the language. Additionally, informed staff can integrate urban greening components and health benefits into projects and plans to reduce urban heat islands, expand and enhance access to nature in park-poor communities, and advocate for dedicated funding stream for public health to work on these initiatives that also serve climate change mitigation and adaptation efforts. Health department personnel are well-trained to integrate the public health frame and communicate health impacts since an essential public health role is to "inform, educate, and empower people about health issues" (PHNCI, 2016).

Other LHD personnel provided recommendations related to internal department activities. One LHD personnel shared:

> *"I think part of the capacity building needs to be around having a dedicated grant writing staff. Some departments have a unit that pursues grants pretty aggressively and that's their full-time job and as a result that department gets a lot of grants. Health departments would be wise to invest in something like that because it pays for itself. In my department, we get a lot of requests to support others grant writing effort but I don't have the capacity and time to do a lot of grant writing myself. So I think having a grant writing unit with full-time staff would be very helpful."*

Another LHD personnel recommended modifying the LHD's contracting process to support future formal partnerships that are linked to funding.

Recommendations for Partner Organizations

Non-LHD entities that are eligible applicants to the UG and/or UCF grant programs, or other CCI programs in general, should establish formal partnerships with their LHD to integrate public health consideration and develop robust community engagement and outreach strategies. Through the analysis of interview responses, key recommendations emerged for potential partner organizations and other eligible applicants for the UG/UCF grant programs. It should be noted that these recommendations may also apply to eligible applicants in other CCI-funded grant programs with limited LHD engagement. LHD respondents suggested that partner organizations applying for grants to fund urban greening projects are encouraged to contact their LHD during the proposal development process. As demonstrated by how LHDs have been currently engaged in urban greening activities, local public health departments can be a key partner in helping to demonstrate the need for the proposed project, integrate public health data, develop an inclusive community engagement and outreach strategy, and design an appropriate evaluation process that may set the groundwork to pursuing future funding. It is important to note that partner organizations should integrate LHD involvement throughout the process from proposal development to project implementation. Health department and non-health department respondents shared that integrating health and partnering with their local health department on grant applications has helped to make grant proposals more competitive for funding. Partner organizations are recommended to establish formal partnerships with their LHD that may be linked to funding to support the work of the LHD.

Another key recommendation that emerged is related to cross-disciplinary professional development. As stated by a non-LHD respondent engaged in urban forestry activities:

> *"...having them involved in our professional development and having us involved in their professional development can help the public health community understand the ins-and-outs of tree care and establishment and so they can also see it through their lens. So once LHD representatives understand what we do in urban forestry and vice versa, then we will have a better understanding of how we can get involved there."*

This can be an organized workshop, a panel at a conference, or presentations at on-going meetings. Partner organizations can contact their LHD's chronic disease division and invite personnel engaged in active transportation, community-based nutrition and local food programs, and other programs engaged in place-based built environment initiatives. This will provide the opportunity to learn about what local health departments do and start the conversation in building partnerships.

Recommendations for State Agencies

State agencies administering CCI programs should include language in the program guidelines clarifying LHD's eligibility to apply for funding. One of the primary factors limiting LHD engagement in urban greening activities has been related to lack of funding streams. In terms of the UG/UCF grant programs, LHD respondents who applied to the programs stated that the eligibility of LHDs to apply for funding was not very clear from the grant guidelines. Administering agencies responsible for providing the program guidelines can clarify that LHDs are eligible to apply since the program guidelines do not explicitly state whether LHDs are eligible for funding. An LHD respondent familiar with the CCI and the UG/UCF programs said the following:

> *"I hope that at some point there will be a dedicated funding stream for health departments because I think there is a huge gap. There is really no major funding stream for health departments, aside from CDC BRACE funding which is only going to departments that got the first round of funding. The capacity to engage in these activities and the legitimacy would definitely be increased if there was dedicated funding."*

The respondent further elaborated that integrating planning activities and integrating "*public health type adaptation interventions is going to be an important way to have public health more involved and directly pursue funding*."

State agencies can also require or encourage eligible applicants to partner with their LHD during the grant application development process and throughout the implementation of the project and link this with funding. Not all LHD programs engaged in urban greening activities will have the internal staff capacity to pursue grant funding themselves but may have the capacity to inform project development to integrate public health. Interviews demonstrated that LHDs have been involved in the application process by providing relevant community health data, informing the project evaluation process, designing the community outreach plan, and making sure projects consider health equity concerns. However, interview respondents shared that they are not able to engage as much as they would like to in these efforts due to limited resources. This ties to the idea that various programs are grant-funding and if there is a mandate to partner with the LHD, but there is no funding associated, this puts a strain on already limited LHD resources. An LHD respondent engaged in urban greening and active transportation activities shared that, "…*when we get unfunded mandates to be at the table, it is difficult because my division is grant-funded for the most part*." LHD respondent further elaborated that funding entities may be quick to require applicants to partner without their LHD without providing the funds to support the work. Another LHD respondent who has been involved in CCI grant

programs shared that having funding allows for, "*more robust evaluations and capacity of a couple of Staff within the program to work on these projects that align with our overall goals*." Respondents familiar with the Transformative Climate Communities program provided it as an example of how the UG and UCF program may integrate LHD partnerships. Written into the RFP that proposal had to identify at least two public health goals with consultation with their local health department.

Administering agencies can support information-sharing and improving outreach to LHDs. Another key barrier that can be addressed by state-level intervention is related to information-sharing and improving outreach to local public health agencies. LHD respondents engaged and not engaged in CCI-funded greening-related activities shared that having resources that summarized the CCI programs and the intersection with public health interventions would be helpful. Another LHD respondent engaged in administering funds to non-CCI- funded urban greening projects suggested a recommendation to have liaisons or consultants that can help LHDs make the connection between their urban greening activities and climate adaptation or mitigation efforts of the state. It is about reframing. Due to the diverse geography and development patterns in Riverside County, urban forestry and greening is reframed as providing greater access to nature LHDs respondents also suggested having a convening to share best practices and include LHDs to participate. An LHD respondent also shared this insight:

> *I don't know where I would go to look. I think it would be useful for us to know... especially if we are not required to... especially if they are not required to include us... it would be great if there was a resource for us to see who has been funded, who is applying for funding in your jurisdiction... so Health Department... so If I knew that Parks was going after this... or Public Works is going after this... or the planning department…"*

Recommendations for Other Jurisdictions

Findings from this study can also inform other jurisdictions outside of California looking to develop and implement their own cap-and-trade program to address climate change. California's cap-and-trade program is a model for other jurisdictions outside of the state since no other jurisdiction in North America has implemented a multi-sector cap-and-trade program. Additionally, California's cap-and-trade program is the only statewide program that has a reinvestment component that integrates consideration of economically disadvantaged populations and communities burdened by multiple sources of pollution. Other states that are starting to implement their own cap-and-trade program are looking to California. For example, Oregon is currently in the process of approving a cap-and-trade program that is also directing investments to vulnerable populations. Other jurisdictions should consider involving the public health sector in the initial phases of the cap-and-trade program development and implementation. These other jurisdictions should also incorporate a cap-and-trade auction proceeds reinvestment component like the California Climate Investments, which target benefits to priority populations. Priority populations, as identified using CalEnviroScreen and household income census data, should also consider climate change and health vulnerability factors. Additionally, jurisdictions could integrate the public health sector in the development and implementation of other policies and strategies to mitigate and adapt to climate change, and also to build equitable and sustainable communities.

CONCLUSIONS & FUTURE RESEARCH

The results of the first-person semi-structured interviews provide insights of how selected sample of local health departments have been actively engaged in the CCI-funded Urban Greening Program and the Urban and Community Forestry Program, as active partners and also as a grantee. Findings demonstrate that most LHDs have limited awareness about the UG/UCF Programs and the CCI as a potential funding resource even though limited funding was a major barrier to LHDs further implementing urban greening projects. The results suggest that there is a need to increase outreach to local health departments as an eligible applicant and as a key resource for partner organizations applying for funding to support inter-agency and multi-sectoral partnerships, incorporate effective community engagement, and integrate health throughout the project development process. Local health departments are key partners in the community and have played a key also to ensure that UG/UCF funded projects effectively engage vulnerable communities who will face the disproportionately impact of increased heat events and worsened air quality.

While this chapter has highlighted opportunities for LHD engagement, factors limiting LHD activity, and also provided recommendations for LHDs, eligible applicants to the UG/UCF programs, and state-level entities with authority to inform program guidelines on how to support increased participation by LHDs in the UG and UCF programs, this study has limitations that need to be noted. First, this study does not provide a comprehensive examination of all LHDs in California. Findings from this assessment can be used to develop a survey that can be administered to all LHDs in California to get a comprehensive baseline assessment of current urban greening activities relevant to various CCI-funded programs. Secondly, this study limited scope to local health department even though there is urban greening activity to promote health

co-benefits and build climate change resiliency in other sectors. Opportunities for furthering the research include analyzing submitted proposals to the UG and UCF programs to determine how health was integrated, which proposed projects included partnerships with LHDs, and what metrics were included in successful applications. Strategic evaluation of the UG and UCF programs and other programs that have urban greening components may be further informed through a convening of past and current awardees, potential applicants, those in the urban greening and forestry community, local health departments, nonprofits, and other traditional and non-traditional partners of the public health sector. This convening can help to inform future funding and grant guidelines. Urban greening strategies provide a key opportunity to implement climate mitigation and adaptation strategies at the community level where health benefits can be realized on a shorter timeframe. Additionally, LHDs engaged in the CCI programs can leverage resources, which includes funding and partnerships, to advance environmental health equity and support efforts to build climate-resilient communities.

FIGURES AND TABLES FOR CHAPTER 5

Table 5. 1 – List of California Climate Investment Programs That Include Urban and Community Greening Components and Examples of Eligible Projects

	CCI Programs	Examples of Eligible Projects
Greening Required	**Urban & Community Forestry** CAL FIRE	Urban tree planting and planting of urban vegetation, or adjacent to urban areas. Tree site improvements, bioswales, vacant parcel improvements that are consistent with the California Urban Forestry Act. Urban wood and biomass utilization and replacement (CAL FIRE, 2018).
	Urban Greening CNRA	Conversion of existing built environment into green space; establish, enhance or expand community parks; greening public land and structures and schools; green streets and alleyways; urban trails that provide safe routes for travel between residences, workplaces, commercial centers, and schools; urban heat island mitigation and energy conservation efforts (CNRA, 2019).
Greening Not Required	**Active Transportation** Caltrans	Integrate tree planting, landscaping, or trails within larger project that support safe and accessible transport via biking or walking for all users while also enhancing public health (California Transportation Commission, 2018).
	Affordable Housing & Sustainable Communities Strategic Growth Council	Urban greening components that can be integrated: urban street tree planting, greenscaped pedestrian and bike trails, green roofing, community gardens, green alleys, drought tolerant and native species landscaping and restoration, natural infrastructure and stormwater features in public open spaces (SGC, 2018a).
	Climate Ready Program and Climate Adaptation State Coastal Conservancy	Create demonstration parks or gardens, or multi-benefit green infrastructure; conduct research to quantify benefits of "Living Streets" program and design living streets demonstration projects; tree planting/urban trail project with community engagement that sequesters carbon and mitigations urban heat island effect (Coastal Conservancy, 2019).
	Transformative Climate Communities Strategic Growth Council	Implement urban forestry and tree canopy plans; enhance or expand community parks and open space; improve access to parks, greenbelts, trails, or natural areas; construct, develop or expand community gardens install green roofs and landscaping to mitigate effects of urban heat islands; construct or expand non-motorized urban trails; implement green streets and alleyways; use of natural or green infrastructure to capture, store, and infiltrate stormwater onsite for groundwater recharge and use; install drought tolerant landscaping; bioswales to reduce stormwater runoff and increase infiltration (SGC, 2018c).

Table 5. 2 – Overview of Study Participants

Characteristics of Participants (N = 13)	Number
Location (county)	
Los Angeles	5
Madera	2
Riverside	2
Sacramento	2
San Diego	2
Organization Type	
LHD	9
Non-HD	4

Table 5. 3 – Local Health Department Activities that Align with Urban Greening and Urban & Community Forestry Grant Program Requirements

	LHD Activities/Projects that can potentially be eligible
Urban Greening Program	Developing park space around public health building/health facility to be a community hub in DAC. Park planning Greenbelts Pocket/pop-up parks Expanding tree canopy in DAC Urban Heat Island Mitigation Funding community-based park expansion projects to improve access Converting vacant lots to urban agriculture zones
Urban & Community Forestry Program	Expanding tree canopy in DACs Tree plantings/Community engagement events School-based edible garden programs Faith-based community garden programs Community gardens with nutrition classes and produce giveaways

Table 5. 4 – Summary of Recommendations Based on Interviews

Recommended Actions			
Barriers/Limiting Factors for LHDs	*Local Health Departments*	*Partner Agencies/Organizations*	*State Agencies*
Funding & Workforce Capacity	• Research UG/UCF as potential funding sources • Establish partnerships to leverage resources (funding, staff capacity and expertise)	• Establish formal partnership with LHD • Integrate LHD role in grant application and budget in LHD time or to support increased	• Provide dedicated funding stream for LHDs • Require formal partnerships with LHDs (linked to funding to support LHD activities)
Insufficient Awareness and limited information	• Attend local grant program workshops • Invite urban greening and forestry sector personnel to relevant professional development trainings. • Conduct trainings on the health benefits of trees or	• Invite LHD representative to professional development trainings • Approach LHD to learn about public health activities and identify opportunities to collaborate.	• Have Liaisons do targeted outreach to LHDs • Partner with CDPH to disseminate program information to LHDs. • Invite LHD representative to workshops in each region
Grant Applications & Limited Public Health Role	• Work with partner organization to develop community engagement and outreach plan. • Inform the evaluation component • Develop messaging and communicate the health benefits of urban greening and forestry activities. * • Work with partners to integrate health and equity. * • Approach partner organization with urban greening project ideas to address community need.	• Reach out to LHD for health data and to design community engagement efforts • Collaborate with LHD representative in the proposal development process and project implementation. • Integrate health equity-based evaluation metrics based on LHD input	• Expand the public health co-benefits section in grant applications • Require LHD partnerships be integrated through project (project design to implementation) • Clarify that LHDs are eligible applicants

*Aligned with Foundational Public Health Services (CHHS, 2017).

APPENDIX B: SUPPORTING INFORMATION FOR CHAPTER 5

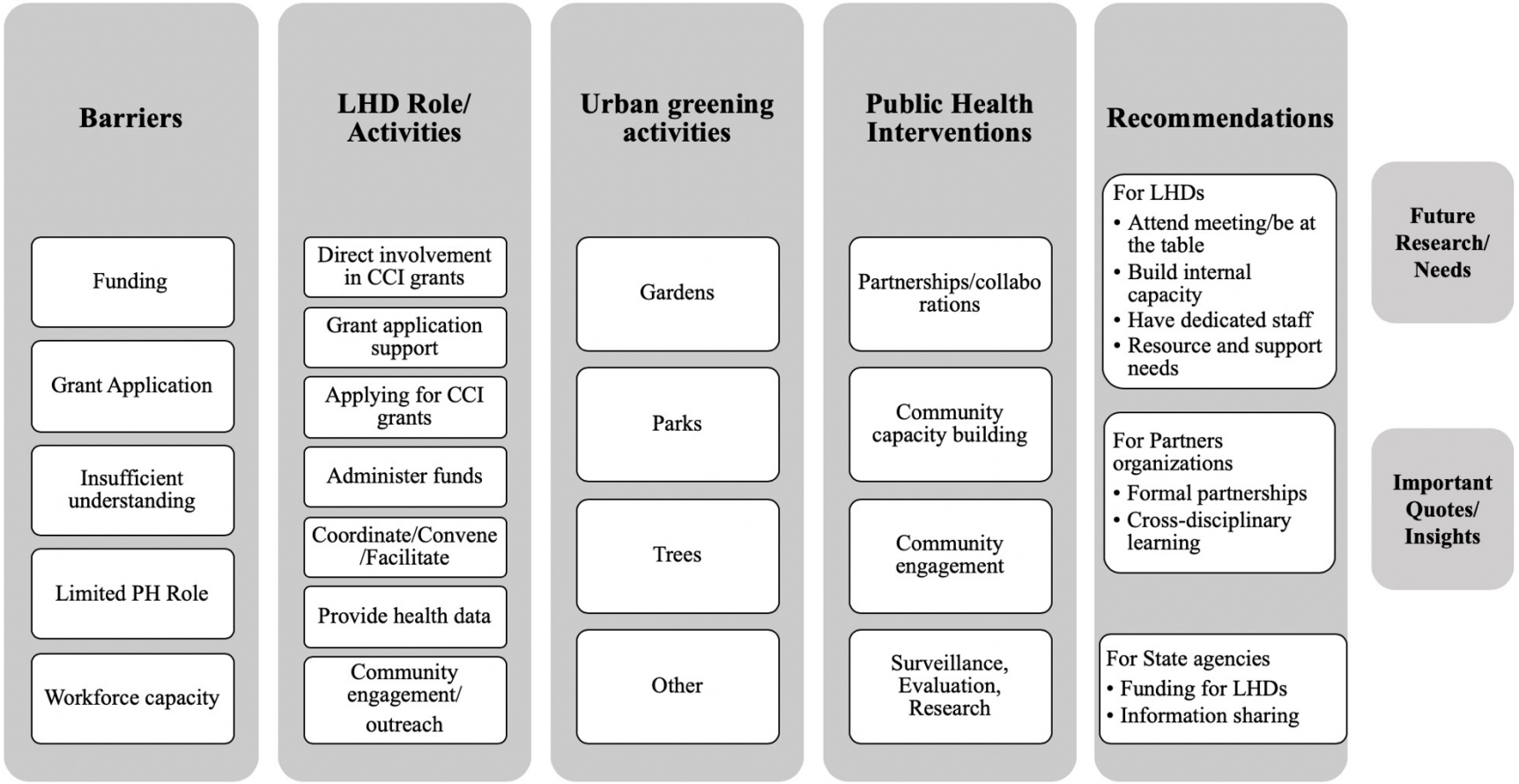

Figure B. 1 – Coding Framework used in Chapter 5

Table B. 1 – Definition of Descriptors Used in Data Analysis

Descriptor	Definition
Name	This is the first name of the interview participant.
Organization Type	This indicates the type of organization the participant is affiliated with.
	LHD – Local Health Department
	Non-LHD Government Agency – Government personnel but does not work at a local health department
	Other – Participant is not affiliated with a health department or government agency (ex. Non-profit, or university)
Location	Indicates the jurisdiction/region of the participant.
Knowledge of CCI	Expert
	Familiar
	Limited
	Not Familiar
CCI Awardee Status	Yes
	No
	N/A
CCI Engagement	LHD – CCI
	LHD – Non CCI
	Non LHD – CCI
	Non LHD – Non CCI
Greening Engagement	CCI – UG
	Non CCI – UG
	CCI – Other
	Non CCI – Other

PROJECT INFORMATION SHEET

Project Title: Local Health Departments as Active Partners in the California Climate Investments: A Closer Look at the Urban and Community Forestry Program
Researcher: Tamanna Rahman, MPH, [redacted]
Primary Investigator [redacted]
IRB Contact: Office of the Human Research Protection Program, ([redacted],
http://ohrpp.research.ucla.edu/

Overview

I am a Doctoral Student at the UCLA Fielding School of Public Health working on my dissertation. The overall purpose of my dissertation is to better understand how local health departments (LHD) can be active partners in supporting the California Climate Investment (CCI) Programs to ensure that investments help to reduce climate vulnerability and address the health-related needs of California's most vulnerable communities. The focus of this study will be on urban greening projects as it relates to the California Climate Investments.

My goals in conducting these interviews are to: (1) Identify how LHDs can actively support partner agencies and stakeholders during application development for CCI program related to urban greening and community forestry; (2) Identify how LHDs can be active partners in the implementation of urban greening and community forestry projects funded through the CCI program; (3) Identify best practices that highlight exemplary cross-sectoral collaboration, creative and effective community engagement approaches, and effective LHD partnerships related to these programs; and (4) Identify future opportunities and roles for LHDs in the CCI program context to ensure that funded projects address climate and health equity issues.

Who am I interviewing?

I am conducting approximately 10 interviews with local health department personnel and key stakeholders affiliated with urban greening projects or related CCI-funded projects. You were identified as an individual who may be interested in participating in this study, based on your expertise in this field and area of focus.

Interview Details

These interviews should last no more than 1 hour, with potential for follow-up emails or short phone calls for clarification. As the interviewee, you have the right to refuse to answer any question or to stop the interview at any time. These interviews will be recorded and transcribed for use in my research. The interviewee will also have access to the interview transcripts post-interview to make corrections or additions.

Confidentiality

Any information that is obtained in connection with this study and that can identify you will remain confidential. Published research will not identify you by name, and all transcription files will be stored on a password-protected computer. Digital recordings of these interviews will be transcribed by Tamanna Rahman, who will be the only researcher with access to this data.

Questions to be asked
This study will examine how local health departments are currently being active partners in supporting sister agencies and other CCI applicants in projects related to Urban Greening and Community Forestry. I am aiming to identify the successful strategies and future opportunities available for local health departments to actively support partner agencies and stakeholders applying for, designing and implementing CCI-funded projects in the Urban and Community Forestry Program that reduce climate vulnerability and address the health needs of the community. The key output of this study will be to define a set of skill-sets LHDs can offer to CCI applicant agencies that will help them develop competitive applications and projects that address the needs of vulnerable population to create healthy, equitable and resilient communities.

For follow-up
If you have any questions regarding the ethics behind this research or interview process, feel free to contact the UCLA Office of Human Research Protection [redacted] http://ohrpp.research.ucla.edu/) or my advisor, Dr. Hilary Godwin [redacted] A copy of this interview will be available by request by contacting Tamanna Rahman ([redacted], [redacted]

RECRUITMENT INFORMATION SHEET

Project Title: Local Health Departments as Active Partners in the California Climate Investments: A Closer Look at Urban Greening and Community Forestry Projects ([redacted])
Researcher: Tamanna Rahman, MPH, [redacted]
Advisors: Hilary Godwin, PhD, [redacted]
IRB Contact: Office of the Human Research Protection Program, [redacted],
http://ohrpp.research.ucla.edu/

Overview
I am a Doctoral Candidate at the UCLA Fielding School of Public Health working on my dissertation. I am in the process of recruiting participants for my study. The goal of this study is to identify successful strategies and future opportunities for greater partnership between local health departments (LHDs) and partner agencies in urban greening and community forestry projects or projects funded by the California Climate Investments (CCI). Interviews conducted for this dissertation will help inform the research and provide a resource of best practices related to the California Climate Investments. The overall purpose of my dissertation is to better understand how local health departments (LHD) can be active partners in supporting the California Climate Investment (CCI) Programs to ensure that investments help to reduce climate vulnerability and address the health-related needs of California's most vulnerable communities.

Who am I interviewing?
I am conducting approximately 10 interviews with local health department personnel and key stakeholders affiliated with urban and community greening projects or related CCI-funded projects. You were identified as an individual who may be interested in participating in this study based on your expertise in this field and area of focus.

Interview Details
These interviews should last no more than 1 hour, with potential for follow-up emails or short phone calls for clarification. As the interviewee, you have the right to refuse to answer any question or to stop the interview at any time. These interviews will be recorded and transcribed for use in my research. The interviewee will also have access to the interview transcripts post-interview to make corrections or additions.

Confidentiality
Any information that is obtained in connection with this study and that can identify you will remain confidential. All data from the screening and the interview and any publications resulting from this interview will not refer to you by name, but rather the agency/department you represent. Digital recordings of these interviews will be transcribed by Tamanna Rahman, who will be the only researcher with access to this data. The recordings will be deleted at the end of the study.

Questions to be asked
I am aiming to identify the successful strategies and future opportunities available for LHDs to actively support partner agencies and stakeholders working on urban greening and community forestry projects or applying for and implementing CCI-funded projects related to urban greening that reduce climate vulnerability and address the health needs of the community. Some of the key outputs of this study will include (1) identifying best practices of how local health departments have been involved in the area of focus, and (2) defining a set of strategies LHDs can offer to partner agencies to develop competitive CCI grant applications and effective projects that address the needs of vulnerable population to create healthy, equitable and resilient communities.

For follow-up
If you have any questions regarding the ethics behind this research or interview process, feel free to contact the UCLA Office of Human Research Protection [redacted] http://ohrpp.research.ucla.edu/) or my advisor, Dr. Hilary Godwin [redacted] A copy of this research will be available by request by contacting Tamanna Rahman ([redacted]

UCLA Office of the Human Research Protection Program (OHRPP):
If you have questions about your rights while taking part in this study, or you have concerns or suggestions and you want to talk to someone other than the researchers about the study, please call OHRPP at [redacted]

INITIAL IDENTIFICATION/RECRUITMENT EMAIL SCRIPT

Dear Mr./Ms./Dr._____,

My name is Tamanna Rahman and I am a Doctoral Candidate at the UCLA Fielding School of Public Health conducting research for my dissertation. I am contacting you because I would like to invite you to participate in a study that examines how local health departments and the public health community are engaging with local agencies and community partners on urban greening and community forestry projects aimed at moderating the effects of urban heat islands, reducing air pollution, increasing access to parks, and other green infrastructure to mitigate the local impacts of climate change and promote healthy, equitable and climate resilient communities. This study also examines how the public health sector has engaged in urban greening projects funded by the California Climate Investments (CCI). The objective is to highlight effective cross-sectoral collaborations, community engagement approaches and LHD partnerships that can be a model for other jurisdictions interested in engaging in the CCI or urban greening projects to provide health co-benefits and address health inequities in their local communities. I have attached a project information sheet that provides more details about the study.

To this aim, I would like to conduct a in-person interview with you at your convenience. The interview is planned to last around an hour and will be voice recorded for the purpose of analysis by me. Everything you tell me will be strictly confidential and any publications related to the study will not refer to you by name. Your participation in this study is fully voluntary, and you are welcome to ask questions or stop the interview at any time.

Please let us know if you would like to participate. The insights you provide through this conversation will be greatly appreciated since you have been selected based on your expertise in this area of study. If you have any further questions regarding the study, please refer to the attached information sheet or contact me directly at any time.

Sincerely,
Tamanna

Tamanna Rahman, MPH
PhD Candidate
UCLA Fielding School of Public Health
Department of Environmental Health Sciences
Email: [redacted]
Phone: ([redacted]

SCREENING CONSENT SCRIPT

Participant ID: _____ **Date:** _____

Interview: Thank you for calling regarding the "Local Health Departments as Active Partners in the California Climate Investments" study. I would like to ask you a few questions to determine whether you may be eligible to participate in the study. Before I begin the screening I would like to tell you a little bit about the study.

This study is part of my dissertation research. My faculty advisor and the Co-Principal Investigator is Dr. Hilary Godwin. The overall purpose is to better understand how local health departments can actively engage with partner agencies to ensure that the California Climate Investment Programs help to reduce climate vulnerability and address the health-related needs of California's most vulnerable communities. I will be focusing activities related to urban greening and community forestry projects or initiatives.

Would you like to continue with the screening? The screening process should take no more than fifteen minutes to complete (and probably much less). I will ask you about how long you have worked in your department/agency, if you have worked on projects related to urban greening or increasing access to parks and open spaces, and also if you have worked on projects related to the California Climate Investments. Are you familiar with the California Climate Investments or the Greenhouse Gas Reduction Fund?

You do not have to answer any questions you do not wish to answer or are uncomfortable answering, and you may stop at any time. Your participation in the screening is voluntary. Your answers will be confidential. No one will know about your answers except for the research team.

The information gathered from this screening process will only be used to determine eligibility. If you are not eligible to participate in the study, your information will not be kept. All data from the screening and the interview will be kept strictly confidential and any publications resulting from this study will not refer to you by name, but rather the agency/department type you represent. The actual interview will occur at a later date and will take approximately one hour. No compensation will be provided for participating. Would you like to continue with the screening?

Participant: ☐ Yes ☐ No

Interviewer:
(If no) You indicated that you do not wish to continue with the screening process. Thank you for being a part of my research to this point, and I appreciate your participation.

(If yes) Thank you. You indicated that you wish to continue with the screening process. At any time during this process, you may opt out of this interview by saying, “stop.” Also, please feel free to ask me any questions throughout the process. At the end of today’s screening process, there will also be time for you to ask me any questions you have about the research project.

SCREENING QUESTIONNAIRE

Participant ID: _____ **Date:** _____

Interview Format: Non-scheduled standardized narrative questions

A. Please provide your position and responsibilities within your department.

Prompts given participant response	1. How long have you been working in your local health department or agency? 2. Are you familiar with the work done within your department or agency related to any of the following topics? a. Air quality and health b. Green roofs and landscaping to mitigate effects of urban heat islands c. Urban forestry and increasing tree canopy d. Parks and open spaces e. Community gardens, farms f. Urban trails for physical activity g. Increase access to parks, greenbelts, walkways, bicycle paths, natural areas, etc. h. Green streets and alleyways i. Natural or green infrastructure to capture, store, infiltrate stormwater onsite for groundwater recharge and use 3. In what capacity have you participated in your department's work related to these topics (or urban greening and community forestry)? 4. Are you familiar with the California Climate Investments or the Greenhouse Gas Reduction Fund? a. [if NO] Are you familiar with the projects funded by the cap-and-trade auction money? b. [If yes] In what capacity have you participated in the CCI activity efforts? 5. Are you familiar with the Urban Greening and Community Forestry programs funded by the California Climate Investments? a. [If YES] Have you worked on California Climate Investment-funded projects in the Urban Greening and Community Forestry Programs?

Thank you for answering the screening questions.

[To determine eligibility, participants will be excluded if they do not meet at least one of the following criteria:

1. *Worked previously on CCI-funded projects in the Urban and Community Forestry Program, or*
2. *Engaged previously or currently engages in the CCI process, or*
3. *Works in a local health department in an area that is relevant to the Urban Greening and Community Forestry Program within the CCI]*

[**If participant is NOT eligible**] Based on your information provided, you are not eligible [*and explain why using checklist above*].

[**If participant is eligible**] Based on your information provided, you are eligible to participate in this study [*explain why using checklist above]*. Please provide a date and time during which I can conduct the full interview with you.

Do you have any questions about the screening or the research? I am going to give you a couple of telephone numbers to call if you have any questions later. Do you have a pen? If you have questions about the research screening, you may call me, Tamanna Rahman, at [redacted] or Dr. Hilary Godwin [redacted], and we will be happy to answer any of your questions.

If you have questions about your rights as a research subject or if you wish to voice any problems or concerns you may have about the study to someone other than the researchers, please call the UCLA Office of the Human Research Protection Program at [redacted]

Thank you again for your willingness to answer our questions.

ORAL CONSENT SCRIPT

Participant ID: _____ **Date:** _____

Interviewer:
Thank you for agreeing to meet with me today. This interview is part of my dissertation research at the UCLA Fielding School of Public Health. Your participation in this research is voluntary.

The purpose of this study is to better understand how local health departments have been collaborating with partner agencies in the California Climate Investment process and to identify successful strategies and future opportunities for greater partnership between health departments and partner agencies. The public health community has a key role to play in ensuring that projects funded by the auction proceeds from the cap-and-trade program provides health co-benefits to California's most vulnerable populations.

You have been selected for this interview based on your position and expertise in working with the California Climate Investment projects and/or your work related to urban and community greening in your local health department/agency.

If you agree to participate in this study, I will ask you questions about your work related to urban and community greening projects, whether and how you and your department has been involved in the California Climate Investment process, and how you and your department collaborated with partner agencies or organizations for these projects. Please don't worry about whether or not your answers are "right" –for many of the questions there are no "right" answers. I am asking them so that I can have a better understanding about the strategies that worked when later I sort through the interviews to identify best practices for how the public health community can engage in this specific type of policy based on the insights and recommendations you provide. The aim of this study is to identify best practices that can be a model for other jurisdictions looking to integrate public health sector involvement in activities related to climate mitigation and adaptation initiatives.

If at any time during our interview you feel even slightly uncomfortable in answering questions, you have the option of skipping these questions, or completely ending the interview. This interview should take no more than one hour to complete. No compensation will be provided for participating.

Everything you tell me will be kept strictly confidential, unless I specifically ask for your permission to quote you. I will be taking notes and will have a voice recording of this interview. I am the only person who will have direct access to these recordings and they will be stored under password protection. All personal identifiers relating back to you will be removed. Privacy and confidentiality is my utmost priority. All data will be kept strictly confidential and any publications resulting from this interview will not refer to you by name.

Should you have any questions about the research, please contact Tamanna Rahman [redacted] or Dr. Hilary Godwin, the Co-Principal Investigator [redacted]

Should you have any questions about your right as a participant, please contact:
UCLA Office of the Human Research Protection Program (OHRPP) at [redacted] or write to:
UCLA Office of the Human Research Protection Program
[redacted]

Do you consent to be interviewed for this research?

Participant: Yes or No. (Circle one)

Interviewer: (No) You indicated that you do not wish to continue with this process. Thank you for being a part of my research to this point, and I appreciate your participation.

Interviewer: (Yes) You indicated that you wish to continue with this interview, and it is now being recorded. At any time during this interview, you may opt out of this interview by saying, "stop," and refusing or discontinuing participation involves no penalty. Also, please feel free to ask me any questions throughout our conversation. Okay, let's get started.

[Proceed to Interview Tool.]

INTERVIEW TOOL

Participant ID: _____ **Date:** _____

Format: one-on-one interview, in-person or Zoom (web-cast) meeting

Introduction
Before we begin, I want to make sure you are familiar with some of the terms we will be using.

Later in our conversation, I will be referring to the California Climate Investments (or the CCI). How familiar are you with the California Climate Investment program and the Greenhouse Gas Reduction Fund? [*Provide the following information based on level of knowledge*]

- In 2012, the State of California started a program to help the state meet its goals in reducing green house gas emissions by capping the amount of green house gases that California industries can release and providing a mechanism for companies to trade their emission credits in a market-based system that involves auctioning emission credits. This is the Cap-and-Trade Program.
- A portion of the auction proceeds from California's cap-and-trade program is deposited in the Greenhouse Gas Reduction Fund (GGRF) which is used by the State of California to invest in projects that reduce greenhouse gas emissions, improve air quality, and provide economic, environmental and public health co-benefits.
- As a result of Senate Bill 535 and Assembly Bill 1550, a percentage of the funds in the GGRF are required to also provide benefits to disadvantaged communities throughout the state.
- GHG reduction projects focus on 3 key priority areas related to: transportation and sustainable communities, clean energy and energy efficiency, and natural resources and waste diversion. These programs are collectively known as the California Climate Investments.
- A number of state agencies such as the California Air Resources Board, CA Department of Transportation and the Strategic Growth Council administer competitive grant programs funded by the CCI. Approximately $3.4 billion have been appropriated by the State Legislature to the agencies to implement various CCI-funded programs and projects aimed at reducing greenhouse gas emissions.
- Some of these projects funded through the CCI include: installing energy efficiency measures in homes, rebates for zero-emission and plug-in hybrid vehicles, planting trees in urban areas, land conservation and restoration, expanding transit options, increasing the number of affordable housing units, and integrating job creating and benefits to disadvantaged communities throughout the various programs. In each case, the applicants are required to demonstrate that the projects not only will result in reduction of green house gas emissions, but will also benefit disadvantaged communities in the State of California.

Because I am interested in how these projects can also be used to improve the health of disadvantaged communities in California, I am particularly focusing on projects that are funded

through the CCI program that are related to urban greening and community forestry. Green infrastructure and trees provide a number of benefits that indirectly and directly impact human health by influencing local temperature, air quality, and building energy use. Urban trees also help to reduce stormwater runoff, improve water quality, and decrease the urban heat island effect. Research has shown that trees and greenspace also provide mental health and social benefits. Examples of projects that are relevant to urban greening and community forestry include the following [*provide some examples from below*]:

- Green roofs and landscaping to mitigate effects of urban heat islands
- Increasing tree canopy
- Parks and open spaces, or urban trails for physical activity
- Creating and increasing access to community gardens and local farms
- Green streets and alleyways
- Natural or green infrastructure to capture, store, infiltrate stormwater onsite for groundwater recharge and use
- Other activities related to increasing access to parks, greenbelts, walkways, bicycle paths, natural areas, etc.

My goals in conducting these interviews are to:

1. Identify how LHDs can actively support partner agencies and stakeholders during application development for CCI program related to urban greening and community forestry;
2. Identify how LHDs can be active partners in the implementation of urban greening and community forestry projects funded through the CCI program;
3. Identify **best practices** that highlight exemplary cross-sectoral collaboration, creative and effective community engagement approaches, and effective LHD partnerships related to urban greening projects;
4. Identify future opportunities and roles for LHDs in the CCI program context to ensure that funded projects address climate and health equity issues.

Do you have any questions?

Okay, let's get started.

General Information

1. First, can you tell me a little bit about the work you do?

Probes:	a. What is your role at your health department/agency? b. How long have you been working with your health department/agency? c. What program areas are you involved in within the health department/agency?

California Climate Investments Program

2. How familiar are you with the California Climate Investments Program or the Greenhouse Gas Reduction Fund?

Probes:	a. Are you familiar with California's cap-and-trade program?

3. Can you tell me whether you and your [health department] [agency] have been involved in the California Climate Investment process?

Probes if YES:	a. How did you and your department/agency first become involved in the CCI? b. How have you or your department/agency been previously involved in the CCI process? c. What programs were you and your department/agency engaged in? • Why? d. What types of activities were you engaged in related to the programs? • Some examples: technical assistance; capacity building, community engagement, partnerships and collaborations across sectors, education and advocacy, communication, and surveillance and research? e. How were you or the health department involved in the proposal/application development process? f. How were you or the health department involved in project design or implementation process? g. How were you or the department/agency involved in the CCI process in any other way?

Urban Greening and Local Health Department Activities

4. Can you tell me whether you been involved in any activities or programs related to urban and community greening?

Probes:	a. Some example include: • Tree planting to improve local air quality • Green roofs and landscaping to mitigate effects of urban heat islands • Urban forestry and increasing tree canopy • Parks and open spaces • Community gardens, farms • Urban trails for physical activity • Increase access to parks, greenbelts, walkways, bicycle paths, natural areas, etc. • Green streets and alleyways • Natural or green infrastructure to capture, store, infiltrate storm-water onsite for groundwater recharge and use

5. Describe how you and your department were involved in urban greening projects and the type of public health expertise that was provided.

Probes	a. What type of activities or strategies were used to ensure that this project provided health benefits and addressed health inequities? b. Please describe any activities related to proposal development, project design, implementation, and/or evaluation. *c.* How did you or the health department provide: technical assistance; capacity building, community engagement, partnerships and collaborations across sectors, education and advocacy, communication, and surveillance and research?

6. Are you familiar with the Urban Greening or Urban and Community Forestry Programs?

Probes	a. Have you or your agency worked previously on projects related to the Urban Greening or Urban and Community Forestry Programs?
Probe if YES	a. Describe any activities you and your department/agency were involved in, especially as it related to: the grant process, proposal development, project design, implementation, and/or evaluation. b. Describe your role. c. What type of activities or strategies were used to ensure that this project provided health benefits and addressed health inequities? b. How did you or the health department provide: technical assistance; capacity building, community engagement, partnerships and collaborations across sectors, education and advocacy, communication, and surveillance and research?

7. What recommendations would you provide to other LHDs and the public health sector that want to engage in the CCI effort or the Urban Greening and Community Forestry Program?

Partnerships and Collaborations

8. Do you currently (or did you previously) work with other organizations – either government agencies like Parks and Rec and Public Works, or other organizations that work on projects related to the urban greening (or climate mitigation, and adaptation?

*Probes if **YES***	a. Which of these organizations have you worked with? b. What type of expertise or support did you or your department/agency provide to ensure that this project provided health benefits and addressed health disparities? c. What role did the LHD play in this partnership? i. *Probes:* technical assistance; capacity building, community engagement, partnerships and collaborations across sectors, education and advocacy, communication, and surveillance and research [Climate Change and Health – Framework for action – core strategies]. ii. Policy and systems change, healthy communities and environmental change, health education, risk-reduction, etc. d. What was successful about the partnership? e. What key factors helped to lead to these success? f. What key factors helped to make this partnership a success? g. What were some key challenges and how were they addressed? h. Were there any health messages or framing that had been particularly effective to ensuring that the project provided health benefits and addressed health inequities, especially for vulnerable communities? i. Has the partnership changed anything in your work or how your health department operates? How about your partner agencies? How? j. What do you think you and others got out of having this collaboration? k. What would you do differently?
*Probes if **NO***	l. Would you like to be working with other non-local health department more? m. What groups/organizations/stakeholders do you envision building partnerships with? n. What role could LHDs play in that partnership? o. What could support building that relationship/partnership?

9. What types of activities are you and your department continuing to do related to the CCI and the Urban Greening and Community Forestry Program?

Probes	a. What are some key strategies or activities? i. *Probes:* technical assistance; capacity building, community engagement, partnerships and collaborations across sectors, education and advocacy, communication, and surveillance and research [Climate Change and Health – Framework for action – core strategies]. ii. Policy and systems change, healthy communities and environmental change, health education, risk-reduction, etc. b. Who will you be reaching out to? c. What groups/stakeholders? What are the other groups that are not currently involved but should be? d. Do you see any gaps or areas that need more attention? Please explain.

10. Do you have any thoughts about what might help or support greater partnerships or collaboration on activities related to the CCI between local health departments and partner agencies or other stakeholders?

Probes	a. What do think are some best practices that your HD or other LHDs can implement to develop effective partnerships? b. What recommendations would you offer? c. What resources are needed?

LHD Involvement and Role

11. How do you see LHDs develop their role in the CCI process to ensure that funded projects address climate and health inequity issues?

Probes	a. What set of skills and technical assistance can LHDs offer to partner agencies and other CCI applicants to develop strong proposals and projects? b. Do you think that LHDs should be striving to engage in the CCI process and even have a role? c. How can Local Health Departments increase their engagement in the CCI process? d. What resources or support is needed?

12. Is there anything else you would like to share?

Probes	a. Are there any other insights or information you would like to share? b. What other recommendations do you have related to LHD involvement in climate mitigation and adaptation strategies? c. Do you have any questions for me?

Additional Participants & Helpful Documents

13. Do you have any suggestions for other people I can potentially interview for this project? I am looking for people with some awareness about the California Climate Investments or those who are working on areas related to urban greening or forestry, and who may be able to increase public health consideration in that area of work.
    - If there are any individuals that you feel should be included in this study, we have created a project information sheet that you may provide to them.
14. Are there people or publications that you especially trust to give you good information that is relevant to your work?
15. Do you have any suggestions for publications/documents that would be helpful for this work?

Closing

That is all for the questions I have now. You have been so helpful. I really appreciate the time you have taken to talk to me today. Do you mind if I contact you in the future with any follow-up questions that may emerge?

I will be putting together a final white paper reporting the results of the study, which I will share with the study participants. Would you want me to report back to you with the results? Also, would you like to be listed in the acknowledgement section of the whitepaper?

Thank you very much.

INTERVIEW QUESTIONS/DISCUSSION TOPICS FOR NON-HEALTH DEPARTMENT STAKEHOLDERS

[*Similar introduction to health department personnel, then continue to the questions below.]*

1. Brief description of your role in the organization/agency.

2. What is your agency's role in supporting urban greening and community forestry projects?

3. In projects related to urban greening and community forestry, were there any health messages or framing that highlighted the health benefits and/or help to address inequities faced by vulnerable communities?

4. What type of expertise or support did you or your department/agency provide to ensure that projects provide health benefits and addressed health disparities?
    a. Some examples include:
        i. Increasing tree canopy to mitigate urban heat islands, provide shade, & improve local air quality
        ii. Increasing access to parks, greenbelts, walkways, urban trails, bicycle trails, and other open spaces to provide safe opportunities to be physically active.
        iii. Support development of local community gardens in DACs
        iv. Ensure increased tree canopy and locally relevant green infrastructure as part of complete streets policies
        v. Access to green infrastructure and mental health benefits
        vi. Natural or green infrastructure to capture, store, infiltrate storm-water onsite for groundwater recharge and use
        vii. Any other examples I am missing…?

5. Describe any examples of public health expertise that was needed or any examples of partnerships with a public health department or public health stakeholders.
    a. If yes:
        i. What role did the health department play in this partnership?
        ii. What were the successes and challenges of this partnership? What were the barriers and how were they addressed?
        iii. Has the partnership with the LHD changed anything in your work or how your department operates? How about your other partner agencies?
        iv. What do you think you and others got out of having this collaboration?
        v. What would you do differently?
    b. If no partnership with HDs:
        i. Why not? What opportunities are there? What would help to build that partnership?
        ii. Other local partners like local non-profits, CBOs, schools, local parks and rec depts?

6. Are you familiar with the California Climate Investments or the Greenhouse Gas Reduction Fund?
    a. If familiar, then how have you and your organization/agency been involved in the CCI? (*Prompt*: grant programs, reviewer, capacity, funder, applicant, etc.)
    b. Thoughts on local public health department or public health sector role in greening and forestry programs? Is there opportunity for LHDs to be involved? If so, then in what capacity?
    c. What might help or support greater partnerships or collaboration on activities related to the CCI or greening initiatives between local health departments and partner agencies or other stakeholders?

<u>Additional Participants & Helpful Documents</u>

7. Do you have any suggestions for other people I can talk to for my research? I am looking for people with some awareness about the California Climate Investments **or** those who are working on areas related to urban & community greening or forestry, and who may be able to increase public health consideration in that area of work.
    - If there are any individuals that you feel should be included in this study, we have created a project information sheet that you may provide to them.
8. Do you have any suggestions for publications/documents that would be helpful for this work?

California Climate Investments Program Handout
Auction Proceeds Funded Programs

Adapted from https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceeds.htm

Category	State Agency	CCI Program Name	Project Types Funded
Transportation and Sustainable Communities	High Speed Rail Authority	High Speed Rail	• Planning, design, and right-of-way acquisition of the initial operating segment • Construction of the initial operating segment
	California State Transportation Agency (CalSTA)	Transit and Intercity Rail Capital Program (TIRCP)	• Connectivity to existing/future rail systems by adding new rail cars/engines • Increased service and reliability, and decreased travel times of intercity and commuter rail systems • Rail integration (e.g. integrated ticketing and scheduling)
	Department of Transportation (Caltrans)	Low Carbon Transit Operations Program (LCTOP)	• New/expanded bus, rail services, or expanded intermodal transit facilities • Service or facility improvements, e.g. equipment, fueling, and maintenance
		Active Transportation Program (ATP)	• Bike facilities • Pedestrian facilities
	Strategic Growth Council	Affordable Housing and Sustainable Communities (AHSC)	• Transit-oriented development • Intermodal affordable housing • Transit capital projects • Active transportation/complete streets • Local planning and implementation
		Sustainable Agricultural Lands Conservation (SALC)	• Agricultural land preservation
		Transformative Climate Communities	• Combined climate investments from multiple programs within a local area to achieve transformational improvements
	Air Resources Board (ARB)	Low Carbon Transportation	• Zero and near-zero emission passenger vehicle rebates • Heavy duty hybrid/ZEV trucks and buses • Freight demonstration projects • Pilot programs (car sharing, financing, etc.) in disadvantaged communities
Clean Energy and Energy Efficiency	Community Services and Development (CSD)	Low-Income Weatherization Program (LIWP)	• Single and multi-family low-income energy efficiency and renewable energy projects
	Department of Food and Agriculture (CDFA)	Dairy Methane Program	• Dairy digesters and research development • Alternative manure management practices
		State Water Efficiency and Enhancement Program	• Water and energy use efficiency
		Healthy Soils	• Soil management practices

	Department of Water Resources (DWR)	Water-Energy Grant Program	• Water conservation and efficiency grants
	Air Resources Board (ARB)	Woodsmoke Reduction Program	• Consumer incentives program for wood burning device replacement and alternatives to green waste burning
Natural Resources and Waste Diversion	California Natural Resources Agency (CNRA)	Urban Greening Program	• Capture, infiltrate, and store storm water • Greening of public lands and structures • Urban heat island mitigation • Non-motorized urban trails • County parks and open space
	Department of Fish and Wildlife	Wetlands and Watershed Restoration	• Delta coastal wetlands • Mountain meadows • Water use efficiency in wetlands
	Department of Forestry and Fire Protection (CalFIRE)	Forest Health	• Forest health • Reforestation • Fire risk reduction
		Urban and Community Forestry	• Planting and maintaining trees in disadvantaged communities
	Department of Resources Recycling and Recovery (Cal Recycle)	Waste Diversion	• Organics • Recycled fiber, plastic, and glass • Greenhouse gas reduction loan program • Food waste prevention and rescue

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CHAPTER 6: OVERARCHING CONCLUSIONS AND FUTURE DIRECTION

INTRODUCTION

Climate change is transforming the field of public health by altering the severity, frequency and types of challenges faced by local public health professionals and their partners (L. Brown, 2016). Because the health impacts of climate change are experienced at the local level, the involvement of local communities and jurisdictions in designing, implementing, evaluating climate change mitigation and adaptation strategies is crucial. Local health departments (LHDs) already work closely with governmental agencies and community partners to address environmental health disparities and inequities through the core public health services. Since the public health sector is at the front lines addressing health impacts, it has a critical role to play in advancing and mobilizing support for health-based climate change strategies that protect health and reduce greenhouse gas emissions (Bedsworth & Hanak, 2013; Brown, 2016; Carr, Sheffield, & Kinney, 2012; Cheng & Berry, 2013b; Paterson et al., 2012). LHDs are already engaging in efforts to address increases in heat-related illnesses and vector-borne diseases, responding to extreme weather events, integrating climate change consideration into agency planning efforts, and preparing for the impacts that will adversely affect the health of the communities they serve (Carr et al., 2012; CDPH, 2018b; Plough et al., 2013). Climate action strategies can also be leveraged to build healthy and resilience communities. In this new phase of public health practice and multi-sectoral collaborations, integrating and prioritizing health and health equity in climate action planning is a crucial strategy to ensuring that the challenges of climate change, health, and other environmental health inequities are addressed in concert to better optimize the health of our communities throughout the state.

OVERVIEW OF THESIS CHAPTERS

Chapter 2 of this thesis presented a literature review of existing conceptual frameworks to structure a discussion around climate change vulnerability. The objective was to identify a relevant conceptual framework to later examine how projected climate change impacts in the Los Angeles region will differentially affect communities through a climate change vulnerability lens. **Chapter 2** does not provide a comprehensive literature review of all climate change vulnerability assessment frameworks and methodologies. Instead, we provide an illustrative overview of common types of frameworks to identify a more integrative, systems-level conceptual framework, which is needed to conduct a climate change vulnerability assessment in the Los Angeles region through an environmental justice lens as of 2015. **Chapter 2** presented the climate change vulnerability assessment frameworks based on the dimensions and scales of the ecosystem pyramid: ecological, institutional, population, and individual/organism level. This categorization was meant to organize the frameworks to inform a future vulnerability assessment that was to be conducted by the US Forest Service. However, there are limitations to this categorization. Since the submission of this report to the US Forest Service (2015), there have been other reviews of vulnerability assessment frameworks published in the literature that categorize vulnerability assessment concepts and methodologies that better align with advancements in the field of study.

In **Chapter 3**, I presented the projected climate change impacts and associated health impacts using a climate change vulnerability conceptual framework reviewed in **Chapter 2**. The Geographies of Risk framework conceptualized the interaction between exposure, susceptibility, adaptation, and health risk to determine climate change vulnerability (Jerrett et al., 2012). The selected framework was used to guide the discussion on the projected climate change related

public health impacts for Los Angeles County based on projected modeling data. Adapting the geographies of risk framework, the report presented the potential environmental exposures, the health risks associated with those exposures and the factors that make vulnerable populations more susceptible to the adverse health consequences.

Chapter 4 presents findings from the qualitative document analysis of the selected grant programs with funding from California Climate Investments (CCI). The objective of the study was to identify which CCI funded programs offered the most opportunity for local health departments (LHD) to actively partner with other local agencies and stakeholders implementing the funded projects. The opportunity to actively engage was based on alignment between CCI project eligibility requirements and LHD programs areas (Foundational Public Health Services) and public health interventions (Climate Change, Health, and Equity: A Framework for Action) (CHHS, 2017; Rudolph & Gould, 2015). Although the various CCI grant programs were not designed with the involvement of local health departments in mind, this analysis of the selected program guidelines showed that there are varying levels of involvement available for LHDs. Based on the analysis of the guiding documents some programs clearly defined LHDs as eligible applicants and provided the opportunity to apply for funding (e.g., Active Transportation and Urban Greening) and others (i.e., TCC and AHSC) explicitly require applicants to demonstrate their partnership with their local health. Demonstrating partnership with local health departments adds to the competitiveness of the application since the evaluation and scoring criteria for the proposals allots points for such collaborations or for designed projects that provide public health co-benefits.

Chapter 5 presented findings from in-depth interviews with selected LHD and non-LHD participants regarding their level of engagement in the CCI-funded Urban Greening (UG)

Program, the Urban and Community Forestry (UCF) Program, and other green infrastructure projects not funded through the CCI. The objective of this study was to identify opportunities for active participation by LHDs in the local CCI process, and the Urban Greening and Urban and Community Forestry Programs were used to contextualize the analysis and discussion. Interviews demonstrated that all selected LHDs engaged in urban greening activities that were eligible for funding through the CCI. The sample of participants included representation from the only LHD that was awarded funding through the Urban Greening Program, i.e. Madera County Department of Public Health. Study participants also included representation from a LHD that played an active role in supporting a partner agency to apply and get awarded funds through the Urban and Community Forestry program. Case studies were presented in **Chapter 5.**

In addition to current activities, interviews also revealed factors limiting LHD activity in the UG/UCF programs, which were representative of potential barriers to LHD engagement in other CCI programs. Besides limited funding and workforce capacity, another key barrier limiting LHD engagement in the CCI process was insufficient awareness or information about the CCI. These results suggest that there is a need to increase outreach to local health departments as an eligible applicant and as a key resource for partner organizations applying for funding to support inter-agency and multi-sectoral partnerships. Based on analysis of interviews, key recommendations emerged for LHDs, eligible applicants to the UG/UCF programs, and state-level entities with authority to inform program guidelines, on how to support increased participation by LHDs in the UG and UCF programs and also the local CCI process in general. In addition to the outreach strategies listed above, efforts to incorporate effective community engagement and integrate health throughout the project development process can also support increased LHD engagement in the local CCI process.

IMPLICATIONS OF STUDY & FUTURE DIRECTIONS

The analysis of the CCI program documents and subsequent interviews demonstrate that there are key opportunities for LHDs to actively engage in the local CCI process. Depending on the program and projects eligible for funding, LHDs may qualify as eligible applicants. Analysis of the Urban Greening and Urban and Community Forestry grant programs and interviews with LHD personnel demonstrated that health departments are engaged in activities that would qualify for CCI funding if the project was framed as a climate change mitigation strategy. However, climate change mitigation is not a focus for the public health sector and therefore this requirement of the CCI programs may limit LHD activity. While climate change mitigation is the primary objective of the California Climate Investments, there is opportunity to integrate climate change adaptation consideration. Whether by adding climate change adaptation consideration in the proposal evaluation criteria and integrating climate change adaptation strategies across the CCI funded programs, these strategies will help to support community resiliency and provide greater opportunity for LHD engagement due to greater alignment with public health sector activities.

In addition to the recommendations provided above, there are other opportunities to support increased LHD engagement in the local CCI process and to also examine how health can be integrated in project design and implementation. To identify baseline activities and best practices thus far, submitted proposals may be analyzed to determine how health was integrated, which proposed projects included partnerships with LHDs, and what metrics were included in successful applications. There is also a need to create resources that will help applicants better integrate and evaluate health co-benefits. Additionally, state agencies with authority to implement the funds can partner with the California Department of Public Health to organize a

convening of past and current awardees, potential applicants, those in the urban greening and forestry community, local health departments, nonprofits, and other traditional and non-traditional partners of the public health sector. This convening can inform measures to address the factors limiting LHD engagement, provide an opportunity to exchange ideas and best practices, and establish partnerships that can inform future urban greening activities in the communities that effectively integrate public health consideration and benefit vulnerable communities. This convening can be expanded to other CCI programs areas to better inform future activities under the CCI.

California's cap-and-trade program is a model for other jurisdictions since no other jurisdiction in North America has implemented a multi-sector cap-and-trade. Other states that are starting to implement their own cap-and-trade program are looking to California. For example, Oregon is currently in the process of approving a cap-and-trade program that is also directing investments to vulnerable populations (Zimmerman, 2019). The State of Washington is currently in the preliminary stages of designing their energy sector-focused cap-and-trade program, and this preliminary planning process is largely informed by what California has done. These examples highlight the need and opportunity for California to demonstrate how the public health sector can be integrated in the development and implementation of projects funded through the Cap-and-Trade program, while also integrating health and climate change adaptation.

In summary, local health departments can play a key role in integrating an environmental health equity frame and consideration of vulnerable communities into how California implements its climate policy. Recent reports have provided guidelines on how local health departments can integrate climate change consideration in their planning efforts (Rudolph et al., 2018), but non-public health sector should also look to integrating public health consideration in

climate action planning efforts. Entities outside of the health department infrastructure can build partnerships with their local health departments to inform planning process related to climate change mitigation and adaptation. Such engagement can help to prioritize health and health equity in climate action planning to ensure that the challenges of climate change, health, and other environmental health inequities are addressed in concert to better optimize the health of our communities throughout the state. As other states look to cap-and-trade, it is critical that California pushes innovation and sets the example of how to effectively integrate public health sector engagement in all levels of climate action to reduce greenhouse gas emissions, help communities adapt to climate change, and advance environmental health equity so that communities can thrive and become climate-resilient.

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