LOCAL POLICY SCAN ON CLIMATE CHANGE ADAPTATION

ChangeLab Solutions
Law & policy innovation for the common good.

ACKNOWLEDGMENTS

Prepared for ChangeLab Solutions by Adrienne I. Greve & Michael R. Boswell.

ChangeLab Solutions is a nonprofit organization that provides legal information on matters relating to public health. The legal information in this document does not constitute legal advice or legal representation. For legal advice, readers should consult a lawyer in their state.

Support for this document was provided by The California Endowment and the Resources Legacy Fund.

CONTENTS

4 Executive Summary

6 Glossary

8 Introduction

9 Climate Change and Public Health

13 Strategies for Responding to Climate Change

21 Background Research

30 Case Studies

50 Expert Interviews

54 Research Method

56 Bibliography

EXECUTIVE SUMMARY

The Climate Change Adaptation Policy Scan provides a snapshot of the current state of community-level activities in the United States and Canada for addressing climate change impacts on public health. The report was developed using a combination of literature review, expert interviews, and case studies to identify best practices, common challenges, and keys to success.

This report is intended to be useful to public health officials and community organizations; city and county public agencies, especially those involved in city planning and sustainability; and scholars in these fields. The information provided for the emerging area of climate adaptation policy development is organized into four areas. The first two topic areas, **Climate Change** and **Public Health and Strategies for Responding to Climate Change**, summarize the information gathered from literature, expert interviews, and case studies. The third area, **Background Research**, details the three data sources used to develop the report, and the fourth area, **Research Method**, describes the data collection process.

CLIMATE CHANGE, PUBLIC HEALTH, AND STRATEGIES FOR RESPONDING TO CLIMATE CHANGE

Climate change adaptation refers to strategies that position communities to be resilient in the face of the unavoidable impacts of climate change. Climate change impacts include sea level rise, extreme heat, changed precipitation patterns, reduced snowpack, and more severe storms. These impacts can affect many aspects of community function, including public safety, public health, economic continuity, and ecological health. This report focuses specifically on potential public health impacts. The process for adaptation strategy development is broken into three phases.

Getting Started. Adaptation strategy development can be supported by a growing number of guidance documents available to local governments and community organizations. To complement the listing of guidance documents, the report summarizes research findings that identify best practices for communicating adaptation concerns to the public, building local capacity, and establishing beneficial collaborations.

Vulnerability Assessment. Climate change impacts on public health vary based on factors such as geographic location, condition of the built environment, the availability of resources, pre-existing level of physical health, access to basic lifelines, and occupation. These factors allow communities to identify the most pressing climate adaptation needs, including specific locations and local populations.

Strategy Development. Climate adaptation measures are broken into four categories: surveillance, educational, organizational, and issue-specific strategies. Surveillance, or monitoring, is critical to adaptation as climate change has the potential to affect each community differently. This requires that data be collected to both assess potential impacts and track strategy effectiveness. Education and collaboration refer to the need to build relationships and shared understanding between departments in a city government, among other entities in a region, and with members of the community. The final section identifies best practices that have been utilized by communities already taking adaptive action.

BACKGROUND RESEARCH

The research conducted to develop the summary of climate adaptation needs, policy development process, and best practices included a literature review, case studies, and expert interviews. This section details these findings.

LITERATURE REVIEW OF PRIOR RESEARCH

Existing research on climate change adaptation, with particular focus on studies that evaluate local public health efforts, is described. Included in this section is a discussion of the manner in which climate change may affect public health. Based on these potential impacts, the actions being taken by public health agencies, the services that should be offered, and the guidance available for creating policies are identified.

CASE STUDIES

Eight communities currently implementing climate adaptation policy are presented. Each community represents different circumstances and adaptation needs. The lessons learned from the policy development process are presented and key strategies identified.

The Case Studies include these eight cities:

- City of Chula Vista, CA
- City of Coachella, CA
- Cook County, IL
- City of Minneapolis, MN
- Orange County, FL
- City of Point Hope, AK
- San Luis Obispo County, CA
- City of Windsor, Ontario

EXPERT INTERVIEWS

Experts in climate adaptation policy development were identified and interviewed. The interviews sought to understand the current state of practice, existing challenges, and best practices. Six themes emerged from these interviews: **motivation** for initiating an adaptation strategy development process; the most effective **scale** for addressing climate impacts; **constraints** that can hold back an adaptation process; **getting started** on an effective adaptation planning process; **emerging areas** of focus for adaptation policy development with a focus on public health; and **example strategies** for addressing climate impacts to public health.

GLOSSARY

ADAPTATION

In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.

ADAPTIVE CAPACITY

The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities.

CLIMATE CHANGE

A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.

CO-BENEFITS

The benefits of policies implemented for various reasons at the same time, acknowledging that most policies designed to address greenhouse gas mitigation have other, often at least equally important, rationales (e.g., related to objectives of development, sustainability, and equity). The term *co-impact* is also used in a more generic sense to cover both positive and negative side of the benefits.

DISASTER

Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery.

DISEASE VECTORS

Agents such as insects or animals that transmit diseases to humans.

EXPOSURE

The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected.

GREENHOUSE GAS

Those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, by the atmosphere itself, and by clouds. This property causes the greenhouse effect. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane

(CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere. Moreover, there are a number of entirely human-made greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances.

MONITORING

Procedures for gathering and evaluating data on the performance and effectiveness of programs, strategies, and actions that have been implemented.

PUBLIC HEALTH

All organized measures (whether public or private) to prevent disease, promote health, and prolong life among the population as a whole. Its activities aim to provide conditions in which people can be healthy and focus on entire populations, not on individual patients or diseases. Thus, public health is concerned with the total system and not only the eradication of a particular disease.

SURVEILLANCE

The continuous, systematic collection, analysis, and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice. Such surveillance can:

- serve as an early warning system for impending public health emergencies;
- document the impact of an intervention or track progress toward specified goals; and
- monitor and clarify the epidemiology of health problems, to allow priorities to be set and to inform public health policy and strategies.

URBAN HEAT ISLAND

The relative warmth of a city compared with surrounding rural areas, associated with changes in runoff, the concrete jungle effects on heat retention, changes in surface albedo, changes in pollution and aerosols, and so on.

VULNERABILITY ASSESSMENT

The process of identifying and evaluating the potential consequences of climate change for a community.

The glossary was derived from definitions from the World Health Organization (WHO) and the Intergovernmental Panel on Climate Change (IPCC). For additional definitions see:

www.who.int/trade/glossary/story076/en/

www.ipcc.ch/pdf/special-reports/srex/SREX-Annex_Glossary.pdf

ChangeLab Solutions is a nongovernmental organization that supports community-based efforts to ensure that all neighborhoods have nourishing food; safe places to live and play; plenty of opportunities to bike, walk, or take transit; and fresh water and clean air indoors and out. Meeting those needs requires good laws and policies that link housing, education, jobs, and the environment to healthy outcomes. It means efficient government working with strong and diverse leadership toward common goals.

INTRODUCTION

This report provides a snapshot of the current state of community-level activities in the United States and Canada for addressing the impacts of climate change on public health. Based on a combination of literature review, expert interviews, and case studies, it provides a set of best practices and example cases that can serve as a starting point for communities that want to integrate public health with climate change policy. This report should be useful to public health officials and community organizations; city and county public agencies, especially those involved in city planning and sustainability; and scholars in these fields. Currently this is an emerging field with few examples of progress or success; this report should be viewed in this context and be seen as a starting point for policy entrepreneurship by communities.

Climate change emerged as a focus for local, state, and federal policy making about 20 years ago (UN 1997). Initial efforts focused primarily on the reduction of greenhouse gas emissions through energy efficiency, renewable energy, and reduced reliance on gasoline-powered motor vehicles. More recently, new approaches have emerged that position communities to be resilient in the face of the unavoidable impacts of climate change. This is often referred to as climate change adaptation. Adaptation measures are developed based on a vulnerability assessment that considers how climate change will affect community function. Climate change impacts include sea level rise, extreme heat, changed precipitation patterns, reduced snowpack, and more severe storms (CNRA 2009). These changes can produce a wide variety of consequences that affect many aspects of community function—including public safety, public health, ecosystem health, economic continuity, and food security.

HOW IS THE REPORT ORGANIZED?

In this report, findings were developed using a combination of literature review, expert interviews, and case studies that sought to identify best practices, common challenges, and keys to success (more detail is available in the "Research Methods" section). Included are a series of example strategies that communities might use to address their own adaptation needs. The report is organized into the following sections:

Climate Change and Public Health summarizes the ways in which climate change is projected to affect the public health of communities.

Strategies for Responding to Climate Change offers a set of examples drawn from literature, expert interviews, and case studies. These examples include best practices for all parts of strategy development, from getting started and building local capacity to implementation.

Background Research details the findings of climate adaptation and public health research, presents details of eight case studies, and summarizes the findings resulting from expert interviews.

Research Method details the process used to develop this report.

CLIMATE CHANGE AND PUBLIC HEALTH

Climate change impacts vary widely based on a community's geographical (e.g., topography, climate, ecosystems) and community (e.g., social, political, economic) characteristics. Assessment of a community's vulnerability to climate change is based on a combination of projected direct changes such as increased temperature and a variety of potential secondary impacts such as reduced agricultural productivity. Climate change directly alters the seasonal patterns of temperature and precipitation—including annual averages and seasonal timing, as well as shorter duration events such as heat wave, drought, and intense rainfall (IPCC 2007). Sea level rise, ocean acidification, and wind are also direct climate impacts. *Sea level rise* (SLR) refers to the average ocean levels but is experienced locally as higher high tides, greater coastal erosion, and, in combination with wind, more severe coastal storms. *Ocean acidification* refers to the absorption of additional carbon dioxide by oceans. This causes ocean water to be slightly more acidic, which detrimentally impacts marine ecosystems and associated industries, particularly shellfish harvest.

Direct climate change impacts result in a wide range of consequences and cannot be considered in isolation. In any one location, climate change impacts result from a combination of direct climate impacts, the existing structures (homes, business, and infrastructure), and socioeconomic factors. For example, reduced rainfall and increased temperature can lead to higher wildfire risk. The extent to which this threatens a community depends on such factors as the local emergency response capacity, surrounding vegetative habitat, the distribution of structures, community evacuation procedures, and the location and integrity of transportation and water infrastructure.

Because of this, most adaptation guidance suggests viewing climate change through the lens of impact sectors, which is simply a way of organizing a planning effort. Sectors should not be viewed as absolute, and communities should categorize impacts in a manner that best matches local needs and organization. Sectors also overlap and interact; for example, most natural hazards have the potential to affect human health. Common sectors include the following (Snover et al. 2007; CNRA 2009; Cal EMA 2012):

Public health and equity. Climate impacts can result in extreme temperatures, reduced air quality, altered disease vectors, and access to basic needs such as water and food. For example, in the United States more than 3,400 deaths between 1999 and 2003 resulted from exposure to extreme heat. These impacts do not affect all locations and populations equally. Groups can be disproportionately sensitive to these impacts due to factors such as age, financial resources, knowledge, occupation, etc. (Parry et al. 2007; U.S. Global Change Research Program 2009; Portier et al. 2010; CalEMA and CNRA 2012).

Natural hazards and disasters. Climate change is expected to exacerbate many natural hazards and increase the frequency and severity of natural disasters. Potential impacts related to climate change include increased extreme heat, increased heavy precipitation, more frequent tropical cyclones, intensified droughts, and greater coastal flooding (IPCC 2012). Disasters can affect human health and safety and result in damage to human developments such as housing, transportation systems, and infrastructure. For example,

in 2012 Hurricane Sandy killed more than 40 people, left many homeless, and resulted in billions of dollars of damage.

Ocean and coastal resources. Ocean and coastal resources may be impacted by changes such as sea level rise, intensification of coastal storms, and ocean acidification. These changes can result in a wide range of consequences from coastal flooding and erosion that threatens built structures and ecosystems, to saltwater intrusion into groundwater supply, to the disruption of marine ecosystems and associated industries such as shellfish (Snover et al. 2007; Parry et al. 2007; Cal EMA and CNRA 2012). Communities in California have begun to relocate coastal structures and infrastructure in the face of sea level rise, for example.

Water resources. Climate changes such as altered timing and amount of precipitation and increased temperatures influence the availability of water supply. Water availability is a combination of reduced supply due to lower precipitation levels or reduced snowpack and increased demand. For example, most of the United States is forecasted to see diminishing amounts of snow cover. In addition, freshwater ecosystems may be detrimentally impacted by altered runoff and temperature regimes (U.S. Global Change Research Program 2009).

Biodiversity, habitat, and terrestrial ecosystems. Climate change alters the seasonal patterns of temperature and precipitation and, as a result, disturbance regimes such as wildfire. These impacts together can result in habitat alteration, species loss, increased invasive species range including pests, and altered growing ranges for vegetation. The United States has already observed large-scale shifts in the ranges of species and the timing of the seasons and animal migration (U.S. Global Change Research Program 2009). Together, these can affect both ecosystem health and agricultural productivity, including livestock health and forestry operations (Parry et al. 2007; Backlund et al. 2008; CalEMA and CNRA 2012).

EXAMINING PUBLIC HEALTH AND EQUITY IMPACTS

The 2009 *National Climate Assessment* (prepared the U.S. Global Change Research Program) identified human health as an important sector for assessing the impacts of climate change. In the report they summarized the key findings:

- Increases in risk of illness and death related to extreme heat and heat waves are very likely. Some reduction in the risk of death related to extreme cold is expected.
- Warming is likely to make it more challenging to meet air quality standards necessary to protect public health.
- Extreme weather events cause physical and mental health problems. Some of these events are projected to increase.
- Some diseases transmitted by food, water, and insects are likely to increase.

- Rising temperature and carbon dioxide concentration increase pollen production and prolong the pollen season in a number of plants with highly allergenic pollen, presenting a health risk.
- Certain groups, including children, the elderly, and the poor, are most vulnerable to a range of climate-related health effects.

Climate change affects public health both directly and indirectly. Samet (2010) separates public health impacts into three categories: direct exposure, indirect exposure, and social and economic disruption. Direct exposures result from things like extreme heat, sea level rise, or episodic weather events such as floods, wildfire, storms, or hurricanes. In contrast, indirect exposure results from the interaction between climate change and personal and environmental factors and produces a wide variety of public health concerns: altered patterns of infectious disease; reduced air quality that exacerbates asthma or other respiratory ailments; cancer; cardiovascular disease; nutrition; mental health and stress-related disorders; and drought and water scarcity. Social and economic disruption describes interruptions in local economic continuity, such as reduced agricultural yields, population or business place displacement, or interruption of food and water.

ASSESSMENT

The impacts of climate change on public health are not expected to be uniform and instead will affect different populations differently. The *National Climate Assessmen*t states: "Infants and children, pregnant women, the elderly, people with chronic medical conditions, outdoor workers, and people living in poverty are especially at risk from a variety of climate related health effects" (U.S. Global Change Research Program, 2009, p. 97).

Assessment of the potential health impacts of climate change must focus on the individuals or groups that may be impacted. This leads to consideration of equity—the assertion that climate change impacts disproportionately affect some populations. Populations can be sensitive to climate change due to a variety of factors such as geographic location, financial resources, knowledge, physical condition, lifeline access, and occupation (Cal EMA, 2012).

Geographic Location or Condition of the Built Environment. This affects individuals who live in, work in, or visit areas subject to climate impacts. In addition, specific local characteristics may further contribute to the extent an individual is affected. For example, a neighborhood with large amounts of pavement and few trees tends to be warmer than surrounding areas. Similarly, a poorly insulated structure offers its inhabitants less protection from high temperatures.

Lacking Material Resources. Preparing for, responding to, or recovering from climate impacts requires resources such as insurance. Low-income, homeless, or other populations may be less prepared and slower to recover from climate change–exacerbated natural hazard events. The aftermath of Hurricane Katrina in New Orleans demonstrated how some residents were ill prepared for a major disaster.

Lacking Knowledge. Individuals in this category lack the knowledge needed to prepare for, respond to, or recover from climate impacts. This can be as simple as someone who

has recently moved to an area and is unfamiliar with the threat posed by climate change. Non-English speakers, those without a formal education, or individuals disconnected from traditional communication networks may also be poorly informed about preparation and recovery from climate impacts.

Physical Condition. Some individuals are physically unable to prepare for, respond to, or recover from climate impacts. This can include the elderly, children, people with disabilities, or those who are institutionalized. Not only are some of these populations less able to physically adapt, they may also be more susceptible to climate impacts such as heat or reduced air quality. For example, children are particularly vulnerable to high ozone levels.

Lacking Basic Lifelines. Lifelines such as transit, cars, or telephones are critical in the event of a climate-induced event. Populations that are not connected to these vital lifelines are more likely to be affected.

Occupation/Activities. Two groups fall into this category: people who work in impacted industries and people who are personally at risk due to their job. The latter includes construction or farm workers who, while working outside, will be exposed to heat events or other outdoor pollutants.

The sectors listed at the beginning of the section and the assessment categories reviewed above provide a snapshot of the breadth of potential climate impacts. The following section will outline the strategies and process for addressing climate change health impacts based on a review of literature, expert interviews, and a series of case studies.

STRATEGIES FOR RESPONDING TO CLIMATE CHANGE

We identified best practices for responding to climate change through a literature review, interviews with national experts, and case studies of communities that have pursued climate change adaptation efforts that target public health impacts (see "Research Methods" section for more detail). This section summarizes the best practices; the background (and more detailed) data used to create this section of the report is detailed later in the "Research Summaries." The best practices described here are organized into five themes derived from several comprehensive guidance documents (see "Guidance" section below). While there is some variation in these guidance documents, they overlap more than they diverge. Particular points of overlap or shared emphasis serve as a good basis for organizing the information. The summary of collected data includes both best practices and commonly identified constraints. The organizational themes are described below.

Getting Started. This section describes the critical steps and common stumbling blocks for communities interested in initiating an adaptation strategy.

Vulnerability Assessment. The first step in developing an adaptation strategy is clear identification of potential climate impacts and community adaptation needs. This section reviews guidance, best practice, and key examples for this process.

Strategy Development. Translating points of vulnerability into actionable policy requires strategic thinking and collaboration. This reviews the process of strategy development and identifies exemplary adaptation strategies.

Implementation, Monitoring, and Evaluation. Strategies are only effective if implemented. This section first reviews ways to ensure long-term effectiveness of adaptation strategies. Climate science is uncertain and dynamic, and the identification of potential impacts is often inexact. Monitoring allows for local projections of both science and impact to be evaluated, and it also tracks the effectiveness of developed strategies. Based on this data strategies can be updated and tailored.

GETTING STARTED

Each source we examined had a slightly different point of emphasis for getting started for a community interested in initiating a climate adaptation strategy development process. Communities begin planning processes for a variety of reasons, including periodic, required plan updates for plans such as a comprehensive plan or local hazard mitigation plan. Climate change can be integrated into many existing plans. In addition to plan updates, communities that observe emerging issues such as climate change or health-related challenges may decide to develop a local plan to address the issue. Taking the collected data together, a multifaceted approach is revealed that covers many of the challenges that can be faced when beginning a new project.

GUIDANCE

Several of the expert interviewees indicated that communities with whom they had worked felt that there was little guidance relevant to their particular needs. Some of the case studies also lamented the lack of peer examples, which communities were hoping to use to provide insight into the adaptation process. In contrast, the literature review revealed several "best practice" guidance documents that may be able to fit the identified need, suggesting that communities are unaware of the resources. These guidance documents are summarized below for interested communities.

- The Centers for Disease Control and Prevention (CDC) Building Resilience Against Climate Effects (BRACE) program broadly outlines a public health climate adaptation process and may have funding available for supporting local governments. For more information, contact: *www.cdc.gov/cdc-info/requestform.html*
- Two guidance documents out of Oregon provide step-by-step instructions and numerous examples for integrating climate change into public health strategy development. Both are available at The Resource Innovation Group website: *www.theresourceinnovationgroup.org/climate-preparedness-pubs/*
    - Public Health and Climate Change: A Guide for Increasing the Capacity of Local Public Health Departments
    - Ready for Change: Preparing Public Health Agencies of the Impacts of Climate Change
- ICLEI—Local Governments for Sustainability provides training and technical assistance for local governments on sustainability and climate change. Full access to ICLEI resources requires membership. Their Five Milestones for Climate Adaptation overview can be accessed here: *www.icleiusa.org/climate_and_energy/Climate_Adaptation_Guidance*
- The guidebook Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments, developed by ICLEI with the Center for Science in the Earth System (The Climate Impacts Group), Joint Institute for the Study of the Atmosphere and Ocean at the University of Washington can be accessed here: *http://cses.washington.edu/cig/fpt/guidebook.shtml*
    - Full access to ICLEI resources requires membership. See: *www.icleiusa.org/join/*
- The California Climate Adaptation Planning Guide (APG) (2012), developed by the California Emergency Management Agency and California Natural Resources Agency, with assistance from California Polytechnic State University, San Luis Obispo, describes a systematic process for assessing climate vulnerability and developing strategies. See: *http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html*

While guidance can be a wonderful starting point, there are several steps that must be pursued that can be difficult to communicate in any guidance document aimed at a wide audience. Based on information from all of our data sources, two steps emerged as key elements to initiating an adaptation strategy development process: (1) communicating climate change and capacity building, and (2) establishing collaborative partnerships. For each step, examples of community successes are provided. Unless noted, these examples are from the case studies developed as part of this report. Additional details can be found in the "Research Summaries: Case Studies" section.

COMMUNICATION AND CAPACITY BUILDING

Communication and capacity building are necessary first steps, but these tactics should persist throughout the process from initiation to strategy development and implementation. Communication refers to the need for communicating the technical and policy aspects of climate adaptation to the public and to decision makers. Capacity building is the act of educating and organizing those who will be involved in planning and implementing public health strategies for climate change adaptation. This may include government agency staff, nonprofit advocates, scientists, and community members. In the beginning, building capacity relies on establishing a shared understanding of climate impacts and collective mission. Gaining this shared view depends on effective communication of climate change science and projected risk. There is no single right way to build capacity and shared understanding. It must be tailored to a community's characteristics.

- Orange County (FL) found success by focusing on an agency's core mission and framing climate risks in a manner that makes the issue recognizable to the public, jurisdiction staff, and decision makers. They also engaged in significant staff training on the linkage between climate change and public health.
- The City of Chula Vista (CA) formed a working group and began its planning process by holding a series of public workshops with expert speakers such as regional public health experts and climate scientists.
- The City of Coachella (CA) created a Wellness Advisory Committee made up of local public health advocates and professionals to make sure that climate and health information reached as broad an audience as possible. This group was then relied on throughout the general plan and climate action plan process.
- The Alaska Native Tribal Health Consortium (a nonprofit health services provider), in collaboration with the community of Point Hope, made an effort to keep all activities transparent. Large amounts of data were used to assess potential impacts from food and water security, disease vectors, and economic consequences. These findings were made widely available, and used as a basis for community discussion.

COLLABORATION

One of the most commonly cited constraints for adaptation strategy development was insufficient resources (funding, staff, or time). A common solution to this challenge was collaboration with regional entities or neighboring communities. These collaborations can fill a variety of needs critical to an adaptation effort, from relevant climate science related to local impacts, to funding, to implementation. The science and funding aspects of these benefits are critical to the initiation phase of the process because they directly address the most prevalent constraint. Similar to the variation found above, these collaborations can take many forms.

- The City of Chula Vista's (CA) plan gained its initial momentum as a result of a San Diego Foundation report that summarized the projected climate impacts in the San Diego region, where Chula Vista is located. In addition, ICLEI provided in-kind support for scientific interpretation and assessment.
- The City of Coachella's (CA) efforts began when they were selected as a focus city for the California Endowment, which provided both funding and direction for their efforts.

- Cook County (IL) planning was a collaborative effort among the county, the cities of Chicago and Evanston, a local nonprofit, and a local university (faculty and students did the bulk of the work).
- The City of Minneapolis (MN) worked closely with the Minnesota Department of Health, which made available several resources and tools. This state–local collaboration helped overcome local resource and fiscal limitations.
- The Alaska Native Tribal Health Consortium (ANTHC) collaborated with communities like Point Hope to obtain funding, collect and interpret data, and offer methodological guidance.
- San Luis Obispo County (CA) participated in a series of workshops organized and facilitated by a nonprofit organization.
- The City of Windsor (Ontario) joined the Climate Change Adaptation Initiative (a technical assistance program by the nonprofit ICLEI—Local Governments for Sustainability) and was selected as a Health Canada extreme heat vulnerability assessment pilot community. These two collaborations provided scientific and methodological guidance and support.

VULNERABILITY ASSESSMENT

A vulnerability assessment is the process of identifying and evaluating the potential consequences of climate change for a community. Such an evaluation must be informed by local knowledge, which can be gathered from a team of city staff or a larger collaborative group that includes local stakeholders. It can be helpful to begin with a listing of potential impacts, and then identify those that are specifically relevant for a given community. As previously discussed, public health impacts from climate change can be organized using three categories: direct exposures, indirect exposures, and social and economic disruption (see Table 1).

As described in the State of California's Adaptation Planning Guide (2012), vulnerability assessment involves answering five questions:

1. Exposure: What climate change effects will a community experience?
2. Sensitivity: What aspects of a community (people, structures, and functions) will be affected?
3. Potential Impacts: How will climate change affect the points of sensitivity?
4. Adaptive Capacity: What is currently being done to address the impacts?
5. Risk and Onset: How likely are the impacts and how quickly will they occur?

Additionally, the *Guide* directs that "Climate change vulnerability assessment can require data collection and analysis. The level of detail required will depend on the depth desired by a community. Some of the data may be well documented for the community and some may exist only in the collective knowledge of community experts. The analysts conducting the vulnerability assessment will need to identify data needs and consider consulting a group of experts…to create a robust assessment" (p. 16).

TABLE 1. PUBLIC HEALTH IMPACTS FROM CLIMATE CHANGE

DIRECT EXPOSURES	INDIRECT EXPOSURES	SOCIAL AND ECONOMIC DISRUPTION
• Exposure to extreme heat and heat waves • Extreme weather events such as thunderstorms, floods, tornadoes, hurricanes, and wildfire • Sea level rise and associated erosion • Drought and water scarcity • Altered water quality	• Altered patterns of infectious disease (animal-, water-, and food-borne vectors) • Increased air pollution and exacerbation of asthma, allergic diseases, and airway diseases • Cancer • Cardiovascular disease and stroke • Nutrition and human developmental effects • Mental health and stress related disorders • Neurological diseases and disorders	• Changing agriculture, fishery, and/or game yields • Population displacement • Failure of governments to assure environmental quality

Assessing whether these potential points of vulnerability pose a threat to a particular community can be done in many ways, but vulnerability assessment will always play a critical role in strategy development. Successful adaptation measures should be linked to expected local impacts and community conditions so that they are tailored to be the most effective

- A team of city staff members from the City of Chula Vista, CA, conducted a vulnerability assessment. Each projected impact and point of vulnerability was qualitatively rated (ranked on a low, medium, high scale) based on the likelihood of an impact occurring and the severity of potential consequences. The rating process produced a prioritized list that was used as a basis for strategy development.
- In Alaska, the ANTHC collaborates with communities such as Point Hope to conduct a comprehensive vulnerability assessment focused specifically on public health factors such as safety, food and water security, disease vectors, service interruption, and mental health.
- In Minnesota the state Department of Health prepared vulnerability maps for several communities.
- In San Luis Obispo County, CA, a nonprofit organization conducted a full climate vulnerability assessment with funding from the Kresge Foundation. The assessment has been used by a variety of county organizations, including the public health services agency.

- The City of Windsor conducted a thorough and effective vulnerability assessment that also served to educate departmental staff and build local capacity. Building on their partnership with ICLEI, city staff identified two climate exposures as most concerning for the city. The projected climate exposures were presented to each department, and staff was asked to identify and qualitatively rate the severity of consequences for their department. Departmental staff was also asked to estimate the potential cost of the impact. The potential impacts, severity ratings, and costs were then combined to identify largest points of vulnerability.

The conclusion of the vulnerability assessment should be a list of potential impacts that have been ranked or rated by a team of community members and/or staff for level of importance.

The City of Windsor (Ontario) experienced flooding and extreme heat as a result of climate change. Several years prior to developing an adaptation plan, they had developed adaptive measures such as heat alert and urban forestry programs. Once the formal adaptation planning process was under way, these existing measures served as the foundation of the strategy development phases due to their demonstrated success and public support.

STRATEGY DEVELOPMENT

The vulnerability assessment is then used to develop actionable strategies. Strategies must be locally relevant, meaning they directly address an identified point of vulnerability and use a method that is most likely to be locally effective. Both the interviewed experts and case study communities emphasized that a first priority in strategy development is identifying existing measures that already serve to bolster community resilience, as they are most likely to have a funding source, public and political support, and demonstrated effectiveness.

Strategies can be loosely categorized by type: surveillance, education, organization, and issue-specific. Because of the dynamic nature of climate change science and associated consequences, some categories do not address specific impact areas. Monitoring to track the progression of climate impacts (i.e., surveillance), ongoing outreach to bolster capacity, and organizational changes to be institutionally positioned to address climate change can be as important as issue-specific strategies. A series of strategy types are described in the following sections.

SURVEILLANCE

Climate change is most often modeled at larger scales, which can be less relevant for local policy development. Communities are well served by establishing their own programs to track the pace of impact onset and assess severity. This can be particularly important for indirect impacts such as disease vectors or vegetative shift that alters seasonal allergens and fire frequency. Both interviewed experts and case study communities stressed the importance of improved data tracking. These data can also serve to evaluate the effectiveness of issue-specific strategies. Suggested strategies include:

- Communities might want to enhance existing monitoring systems or develop new ones to track health impacts and outcomes.
    - Point Hope and ANTHC have identified several data collection opportunities as part of their Community Health Plan from disease in wild-caught game, to air and water quality, to coastal erosion.
- Similarly, communities might also investigate infectious water-, food-, and vector-borne disease outbreaks, including "signature" diseases such as dengue fever in Florida, which may be leading indicators of climate change.

EDUCATIONAL

Data is only as powerful as those who are aware of and use it. Educational strategies seek to assure that decision makers, staff, and the public are aware of not only the threats but also potential adaptation strategies. The need for informational transparency and data sharing was emphasized in literature and by experts, and demonstrated by the case studies. Suggested strategies include:

- Develop an ongoing program to inform the public and policymakers about health impacts of climate change. This can include information such as the air quality, pollen, and allergen conditions that may occur in the future and the risks posed by these changes.
- In the City of Windsor, there is an effort to educate and train asset management staff to use regional climate change information as part of implementing risk management tools.
- Alert medical practitioners and their patients to the potential for changes in patterns of exposure to aeroallergens that exacerbate allergic diseases like asthma and allergic rhinitis ("hay fever").

ORGANIZATIONAL

Climate change adaptation crosses many traditional jurisdictional boundaries. Effective strategies often require establishment of new organizational relationships or altered training and procedural steps. These changes can better position a community for long-term resilience in the face of projected climate impacts. Strategies that emerged for the research include the following:

- Establish public health partnerships with industry, professional groups, faith communities, and others to craft and implement solutions. This is an approach being pursued in the City of Coachella.
- Explicitly include and plan for health care service provision following disasters.
- Update local plans to include health impacts such as the local hazard mitigation plan, general plan, or water management plan. The City of Chula Vista has plans to integrate climate adaptation into its hazard plan, and the City of Coachella has integrated public health into both its general plan and its forthcoming climate action plan.
- The City of Windsor is developing maps that visualize direct and indirect health effects. These were developed using risk management tools and sought to involve climate-vulnerable populations in developing service responses.
- Ensure public health agency representation on committees and work groups addressing the issue of climate change, especially climate action planning efforts.

ISSUE-SPECIFIC STRATEGIES

Heat wave and urban heat island. Addressing heat events can have crosscutting benefits in a community. There is broad overlap with greenhouse gas reduction goals and several key public health co-benefits. Heat events have direct public health consequences, particularly for vulnerable populations such as the elderly, children, outdoor workers, or individuals with substandard housing. The Cities of Chula Vista and Windsor and San Luis Obispo County have all enacted warning systems and urban heat island measures. Suggested strategies include:

- Develop municipal heat-wave preparedness plans and warning systems.
- Enact urban heat island measures, including cool paving, green building standards, urban forestry programs, and urban park development.

Flooding and stormwater. Increased standing water can alter disease vectors such as West Nile virus, and flooding events can alter the quality of drinking water, which then poses health consequences. Suggested strategies include:

- The community of Point Hope and the City of Windsor are taking action to address the impacts of flooding and altered precipitation patterns This includes improved monitoring for long-term trend documentation, water quality assessment, and design guidelines for flood hazard mitigation.
- Windsor has adopted a plan with a broad range of measures to address stormwater, from downspout disconnection, to green roofs, to mandatory backwater valves that prevent basement flooding.

IMPLEMENTATION, MONITORING, AND EVALUATION

The long-term effectiveness of climate adaptation strategies relies on effective implementation and subsequent monitoring and evaluation of success. Unlike the strategy development process, which occurs over a period of time and is then complete, implementation is an ongoing process that must be sustained for decades.

Because climate adaptation is a fairly new area of strategy development, few case studies exist. However, some communities are putting themselves in a position to achieve effective implementation, and expert interviews and literature offer several suggestions. The City of Chula Vista has demonstrated short-term success in implementation, and the City of Minneapolis has tasked a staff person to oversee implementation.

Keys to successful implementation, monitoring, and evaluation include the following:

- Prioritize strategies by considering the scale/magnitude of the impact, the certainty of the impact, how quickly they can be instated, and how much lead time is required for full implementation.
- Develop strategies that identify a lead department, staff member, or entity; a phasing program; a potential funding source; and a monitoring program.
- Periodically review the basic assumptions of the vulnerability assessment and the prioritization of adaptation strategies.
- Share the results of implementation, monitoring, and evaluation with other communities and organizations to build collective knowledge based on best practices.

BACKGROUND RESEARCH

This section provides details of all the research conducted for this study that was used to develop the prior sections. It is divided into three subsections:

- Literature Review of Prior Research
- Case Studies
- Expert Interviews

LITERATURE REVIEW OF PRIOR RESEARCH

This section is a summary of the relevant literature on climate adaptation and public health. The information has been organized into a series of questions based on themes from the literature and to assist the reader in interpreting the prior research. Additional details on the methods are available in the "Research Methods" section.

WHY IS CLIMATE CHANGE RELEVANT TO PUBLIC HEALTH?

The World Health Organization and other experts assert that climate change is more than an environmental issue; it's an issue affecting human health and well-being that requires specific adaptation strategies. In mobilizing public health organizations to address climate change, WHO (2008, p.3) takes the tack of emphasizing the international health community's experience in responding to "climate-sensitive hazards" and its toolkit of tested strategies for successful health interventions, whereas Huang et al. (2011, p.184) caution that because the pace and unpredictability of climate change may outpace current public health practices, specific climate change adaptation strategies are required. Maibach, Nisbet, and Weathers (2011) believe that because Americans value good health and well-being, public health professionals in the United States have an important role in communicating the scope of the problem and the potential for action.

HOW WILL CLIMATE CHANGE AFFECT PUBLIC HEALTH?

The potential impacts to public health due to climate change are numerous and challenging to organize. The impacts are both direct and indirect. For example, increased extreme heat will directly result in increased mortality and morbidity due to heat stress. It may also exacerbate air pollution such as ground level ozone, which in turn may result in exacerbation of airway diseases. As mentioned previously, Samet (2010, p.2) offers three broad pathways linking climate change to public health impacts: direct exposure, indirect exposure, and social and economic disruption. We use these three categories to organize public health impacts identified in the literature.

Direct Exposures

Effects resulting directly from climate change include:

- Exposure to extreme heat and heat waves (Samet 2010; Binder 2010; The Interagency Working Group on Climate Change and Health 2010; World Health Organization 2008; IPCC II 2007; Gamble et al. 2008)
- Extreme weather events such as thunderstorms, floods, tornadoes, hurricanes, and wildfire (Binder 2010; The Interagency Working Group on Climate Change and Health 2010; IPCC II 2007; Gamble et al. 2008)
- Sea level rise (Binder 2010; World Health Organization 2008)

Indirect Exposures

Effects resulting indirectly from climate change include:

- Altered patterns of infectious disease (animal-, water-, and food-borne vectors) (Samet 2010; Binder 2010; The Interagency Working Group on Climate Change and Health 2010; World Health Organization 2008; IPCC II 2007)
- Increased air pollution and exacerbation of asthma, allergic diseases, and airway diseases (The Interagency Working Group on Climate Change and Health 2010; IPCC II 2007; World Health Organization 2008; Gamble et al. 2008)
- Cancer (The Interagency Working Group on Climate Change and Health 2010)
- Cardiovascular disease and stroke (The Interagency Working Group on Climate Change and Health 2010; Gamble et al. 2008)
- Nutrition and human developmental effects (The Interagency Working Group on Climate Change and Health 2010; IPCC II 2007; World Health Organization 2008)
- Mental health and stress-related disorders (The Interagency Working Group on Climate Change and Health 2010)
- Neurological diseases and disorders (The Interagency Working Group on Climate Change and Health 2010)
- Drought and water scarcity (Samet 2010; Gamble et al. 2008)

Social and Economic Disruption

Social and economic disruption includes:

- Changing agriculture yields (Samet 2010; World Health Organization 2008)
- Social and economic disruption and population displacement (Samet 2010; Gamble et al. 2008)
- Interruption of safe food and water supplies (Samet 2010; Gamble et al. 2008)
- Failure of governments to assure environmental quality (Samet 2010)

HOW DO PUBLIC HEALTH PROFESSIONALS VIEW THE ISSUE OF CLIMATE CHANGE AND PUBLIC HEALTH?

Several studies in the United States and Canada of local public health officials look at their level of awareness of climate change and public health (Maibach et al. 2008; Syal et al. 2011; Paterson et al. 2012; Bedsworth 2012; Vynne and Doppelt 2009; Minnesota Department of Health 2012). From these studies it is possible to conclude that about half of local public health officials acknowledge the threat of climate change to local public health. Two of the studies, though, showed higher rates in Oregon (Vynne and Doppelt 2009) and Minnesota (Minnesota Department of Health 2012), suggesting that individual states will vary.

WHAT DO PUBLIC HEALTH PROFESSIONALS VIEW AS THE MOST IMPORTANT PUBLIC HEALTH THREATS DUE TO CLIMATE CHANGE?

Based on the surveys identified in the previous question, respondents identified extreme heat, storms and floods, poor air quality, vector-borne infectious diseases, and water- and food-borne diseases as the most urgent threats.

WHAT ARE PUBLIC HEALTH AGENCIES DOING TO ADDRESS THE PUBLIC HEALTH IMPACTS OF CLIMATE CHANGE—AND WHAT ARE THE BARRIERS TO ACTION?

In general, local public health agencies are not directly addressing climate change and public health, and many assert that they are not prepared to do so. This issue was assessed in a wide variety of ways in the different studies, but a consistent message emerged. Climate adaption is a lower priority than other, more immediate health concerns, for local decision makers (Vynne and Doppelt, 2009; Bedsworth, 2012; Minnesota Department of Health, 2012).

The most commonly cited constraints included lack of funding, staffing, staff training, technical support, and uncertainty of impacts (Bedsworth 2012; Huang et al. 2011; Maibach et al. 2008; Vynne and Doppelt 2009). These constraints are potentially part of a larger problem, which is lack of political or institutional recognition of the importance of the problem (Huang et al. 2011).

WHAT SERVICES FOR CLIMATE CHANGE ADAPTATION SHOULD PUBLIC HEALTH ORGANIZATIONS OFFER?

Frumkin et al. (2008, p.438) suggest using the American Public Health Association's "10 Essential Services of Public Health" as a framework for climate change services. They provide examples of services and activities that could be offered by a local public health organization (see Table 2).

TABLE 2. THE 10 ESSENTIAL SERVICES OF PUBLIC HEALTH WITH CLIMATE CHANGE EXAMPLES

SERVICE	CLIMATE CHANGE EXAMPLE
Monitor health status to identify and solve community health problems	Track diseases and trends related to climate change
Diagnose and investigate health problems and health hazards in the community	Investigate infectious water-, food-, and vector-borne disease outbreaks
Inform, educate, and empower people about health issues	Inform the public and policymakers about health impacts of climate change
Mobilize community partnerships and action to identify and solve health problems	Forge partnerships with industry, other professional groups, faith community, and others to craft and implement solutions
Develop policies and plans that support individual and community health efforts	Establish municipal heat-wave preparedness plans
Enforce laws and regulations that protect health and ensure safety	(Little role for public health)*
Link people to needed personal health services and ensure the provision of health care when otherwise unavailable	Create plan for health care service provision following disasters
Ensure competent public and personal health care workforce	Train health care providers on health aspects of climate change
Evaluate effectiveness, accessibility, and quality of personal and population-based health services	Assess preparedness efforts such as heat-wave plans
Research for new insights and innovative solutions to health problems	Research health effects of climate change, including innovative techniques such as modeling, and research on optimal adaptation strategies

Source: Frumkin et al. 2008, Table 2. For the "service" areas they cite: Public Health Functions Steering Committee, *www.health.gov/phfunctions/public.htm*

* Frumkin defines this so narrowly that public health agencies have little role in enforcing policies to directly address climate change. Public health agencies do have a role in enforcing public health–related laws and regulations. As public health law expert Lawrence Gostin notes, "[p]ublic health agencies are part of the executive branch of government [and] wield considerable authority to make rules to control private behavior, interpret statutes and regulations, and adjudicate disputes about whether an individual or a company has conformed with health and safety standards."

Bell (2011, p.806) proposes a "whole-of-systems" approach "that involve[s] a wide range of health and community services that could feasibly be part of whole-of-government or even whole-of-community responses to climate change. This approach includes strategic, political, and economic responses, not just narrow health interventions" (Table 3).

TABLE 3. "WHOLE-OF-SYSTEMS" APPROACH TO CLIMATE CHANGE THAT COMPRISES FIVE AREAS OF HEALTH SERVICES

AREA OF HEALTH SERVICES	DEFINITION	STRATEGIES FOR DEVELOPMENT
Governance and culture	The mechanisms through which health services are managed, including for risk, both explicitly and implicitly	Plan for use of different mechanisms for adaptation—legislative, technical, educational and advisory, cultural, and behavioral
Service delivery	The form (programs and interventions) that service delivery takes to achieve specific population health outcomes	Map direct and indirect health effects using risk management tools; involve climate-vulnerable populations in developing service responses
Workforce development	The use of education and training approaches to increase the capacity of the health workforce	Develop undergraduate, postgraduate, and professional development systems, including those oriented toward health agency leadership
Material infrastructure	The management and development of the physical assets of health care services	Educate and train asset management staff to use generic and regional information as part of implementing risk management tools
Finance	The processes and tools through which the economic aspects of health care services are expressed	Adapt economic decision-support approaches and develop business plans and models for mitigation and adaptation

Source: Modified from Bell (2011).

WHAT GUIDANCE IS AVAILABLE FOR PUBLIC HEALTH AGENCIES TO CREATE CLIMATE ADAPTATION STRATEGIES?

There are several guides and programs aimed specifically at public health and climate change:

Public Health and Climate Change: A Guide for Increasing the Capacity of Local Public Health Departments (2012)

This guide, prepared by The Resource Innovation Group (TRIG) and Biositu, LLC, is designed for use by local public health agency staff, ideally with support from local climate change experts. It contains step-by-step instructions, examples, sample forms, and references for additional resources. It includes:

- An overview of the impacts of climate change on public health
- Opportunities and strategies for integrating climate planning across programs
- How to identify and build unique external collaborations to meet goals in a resource-efficient way
- Recommendations for communicating with different stakeholders

Building Resilience Against Climate Effects (BRACE)

The CDC developed the BRACE framework so that "a jurisdiction can develop strategies and programs to confront the health implications of climate change." There are five sequential steps (*www.cdc.gov/climateandhealth/BRACE.htm*):

Step 1: Forecasting Climate Impacts and Assessing Vulnerabilities – where a health department identifies the scope of the most likely climate impacts, the potential health outcomes associated with them, and the populations and locations vulnerable to these health impacts within a jurisdiction.

Step 2: Projecting the Disease Burden – where a health department estimates or quantifies the additional burden of health outcomes due to climate change to support prioritization and decision making.

Step 3: Assessing Public Health Interventions – where a health department seeks to identify the most suitable health interventions for the health impacts of greatest concern..

Step 4: Developing and Implementing a Climate and Health Adaptation Plan – where a health department develops and implements a plan that addresses health impacts, gaps in critical public health functions/services, and a plan for enhancing adaptive capacity in the jurisdiction.

Step 5: Evaluating Impact and Improving Quality of Activities – whereby a health department can evaluate the processes it has used, determine the value of utilizing the framework, and the value of climate and health activities undertaken. This step is also important for quality improvement and to incorporate refined inputs such as updated data or new information.

Ready for Change: Preparing Public Health Agencies of the Impacts of Climate Change
The Oregon Climate Leadership Initiative created this manual to help public health departments "prioritize and implement the operational changes that allow public agencies to prepare their employees and communities for climate change" (p.5). It also addresses climate communication, low-cost actions, and budgeting. Several climate preparedness categories are addressed, including extreme heat, disease patterns, water, food, air quality, and mental health.

Additionally, there are a number of resources for addressing climate change adaptation more broadly:

Five Milestones for Climate Adaptation
ICLEI is a nonprofit membership organization that provides training and technical assistance to member local governments. They developed these milestones, which mirror their widely adopted and referenced milestones aimed at greenhouse gas emissions reduction, to assist local governments:

- Milestone One: Conduct a Climate Resiliency Study (vulnerability assessment)
- Milestone Two: Set Preparedness Goals
- Milestone Three: Develop a Climate Preparedness Plan
- Milestone Four: Publish and Implement Preparedness Plan
- Milestone Five: Monitor and Reevaluate Resiliency

Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments
In cooperation with ICLEI, the Center for Science in the Earth System (The Climate Impacts Group), Joint Institute for the Study of the Atmosphere and Ocean at the University of Washington, created this easy-to-use guidebook. It is based on the ICLEI's five milestones and addresses the science of climate change, building community support, creating a team, conducting a vulnerability assessment, and developing, implementing, and monitoring the plan.

California Climate Adaptation Planning Guide
The *APG*, developed by the California Emergency Management Agency and California Natural Resources Agency, introduces the basis for climate change adaptation planning and details a step-by-step process for local and regional climate vulnerability assessment and adaptation strategy development. Although it is not focused specifically on public health, the basic process of vulnerability assessment and policy development is applicable. The *APG* outlines a process of developing climate change adaptation strategies:

Vulnerability Assessment

1. Exposure: Identify the climate change effects a community will experience.
2. Sensitivity: Identify the key community structures, functions, and populations that are potentially susceptible to each climate change exposure.
3. Potential impacts: Analyze how the climate change exposure will affect the community structures, functions, and populations.
4. Adaptive capacity: Evaluate the community's current ability to address the projected impacts.
5. Risk and onset: Adjust the impact assessment to account for uncertainty, timing, and adaptive capacity.

Adaptation Strategy Development

6. Prioritize adaptive needs: Based on the vulnerability assessment, prioritize the adaptive needs.
7. Identify strategies: Identify strategies to address the highest priority adaptation needs.
8. Evaluate and prioritize: Prioritize strategies based on the projected onset of the impact, projected cost, co-benefits, and other feasibility factors.
9. Phase and implement: Develop an implementation plan that includes phasing of strategies and a monitoring system to assess effectiveness.

Conveying the Human Implications of Climate Change: A Climate Change Communication Primer for Public Health Professionals

Maibach, Nisbet, and Weathers prepared this document to assist public health officials in communicating about the implications of climate change for public health and the ways that public health agencies can help address the problem. The focus is on "getting the right message" and then "getting the message out." Specific tools and examples are included.

WHAT ACTIONS CAN A PUBLIC HEALTH AGENCY TAKE TO ADDRESS CLIMATE ADAPTATION?

Public health agencies must be key collaborators in the development and implementation of climate adaptation measures. Measures can include improved communication and awareness among staff and with community members; surveillance systems; and issue-specific programs and policies. Samet (2010) recommends the following short-term policy actions:

- Make certain that existing public health surveillance systems are sufficiently comprehensive and sensitive to detect potential effects of climate change on health.
- Ensure that infectious disease surveillance systems can detect potential "signature" diseases that may affect the United States consequent to climate change.
- Establish and implement heat warning systems and take steps to increase public awareness of consequences of heat exposure.
- Enhance awareness of climate change and health among public health and medical practitioners.
- Alert practitioners and their patients to the potential for changes in patterns of exposure to aeroallergens that exacerbate allergic diseases like asthma and allergic rhinitis ("hay fever").

Ready for Change: Preparing Public Health Agencies of the Impacts of Climate Change (May 2010) provides lists of specific actions to take for the following threat areas (p.iii):

- Extreme heat: Heat waves and heat-related illnesses
- Disease patterns: Communicable and vector-borne diseases
- Water: Clean water access and water-borne diseases following floods and droughts
- Food: Agricultural impacts on food security, poisonings from seafood toxicity
- Air quality: Allergies and respiratory diseases from pollution and wildfires
- Mental health: Psychiatric risks in response to climate change impacts

ARE THERE ACTIONS AIMED SPECIFICALLY AT REDUCING GREENHOUSE GAS EMISSIONS THAT ALSO HAVE PUBLIC HEALTH BENEFITS?

Some greenhouse gas emissions reduction strategies will have public health co-benefits. For example, tree planting and creating urban green spaces (e.g., parks) provide carbon sinks that reduce net greenhouse gas emissions. They can also help reduce the urban heat island effect, thus reducing public health impacts associated with extreme heat, and they may entice people to walk more, which could improve overall cardiovascular health. A study by Leadership for Health Communities (2010, p.2) discusses the benefits of green spaces on childhood obesity: "Research shows that green spaces—such as parks, nature centers and community gardens—also increase the likelihood that young people will be physically active, reducing their risk for obesity. One study found that young people with access to a variety of built and natural open spaces and recreation areas were 43 percent more likely to exercise for at least 30 minutes on most days."

Another example is the emphasis on alternative transportation, especially biking and walking, to reduce greenhouse gas emissions. These activities can improve the cardiovascular health of individuals. This makes them less susceptible to disease and other impacts of climate change such as extreme heat.

CASE STUDIES

This section includes case studies of eight communities, listed below. Communities selected for case studies have done more than simply acknowledge or study the issue; they have taken concrete climate adaptation actions explicitly to address potential public health impacts. This yielded very few communities. In fact, one of the important findings of the study is that few communities had undertaken climate adaptation activities explicitly for public health. Data for the case studies was gathered from interviews with key informants and document analysis.

Additional details on the methods are available in the "Research Methods" section.

CASE COMMUNITIES

- City of Chula Vista, CA
- City of Coachella, CA
- Cook County, IL
- City of Minneapolis, MN
- Orange County, FL
- City of Point Hope, AK, and ANTHC
- San Luis Obispo County, CA
- City of Windsor, Ontario

CITY OF CHULA VISTA (CA)

Emerging Practices: Comprehensive land use planning; community engagement and public health participation; implementable actions; reporting

In early 2009, the San Diego Foundation released a report that summarized the potential climate impacts to the San Diego region, which included public health. This report motivated the City of Chula Vista (pop. 247,535) to direct a Climate Change Working Group (CCWG) to identify recommendations to prepare Chula Vista for the projected impacts. City staff from all departments then developed implementation actions for each of the recommendations. The implementation strategies were approved by the City Council in May 2011.

What stands out about Chula Vista's plan is its comprehensive nature that covers many aspects of city function, the collaboration with the community (including the county public health agency) for plan development, and the detailed implementable action items produced.

CHULA VISTA ADAPTATION STRATEGY FOCUS AREAS

1. Cool paving
2. Shade trees
3. Cool roofs
4. Local water supply & reuse
5. Stormwater pollution prevention & reuse
6. Education & wildfires
7. Extreme heat plans
8. Open space management
9. Wetlands preservation
10. Sea level rise & land development codes
11. Green economy

THE PLANNING PROCESS

The process relied on close collaboration between city staff, residents, regional entities, and local nonprofits. It began with an evaluation of the climate impacts projected for the city. This vulnerability assessment was a qualitative process where city staff, aided by support from ICLEI—Local Governments for Sustainability and the San Diego Foundation, rated each projected impact and point of vulnerability based on the likelihood of an impact occurring and the severity of potential consequences. The rating process produced a prioritized list that was used as a basis for the work of the CCWG.

The CCWG was made up of Chula Vista residents, business owners, and community organization representatives and included a public health professional. Representatives of each city department also participated in the meetings. The 11 CCWG meetings and two workshops were open to the public, which allowed for even wider participation. In the beginning, experts on climate change topics such as public health impacts and sea level rise were invited to present to the CCWG.

Over the course of the meetings, the CCWG identified more than 180 initial recommendations. This initial list was then evaluated based on three criteria: (1) it was in the city's purview; (2) it did not duplicate or conflict with a greenhouse gas reduction strategy; and (3) it was fiscally feasible. The larger CCWG split into smaller groups focused on narrowing the number of recommendations, and the final list was consolidated into 11 focus areas.

City staff then developed implementation actions for each of the 11 recommendations. This resulted in 30 individual, implementable actions, some of which piggyback on existing programs and activities to achieve cost-effectiveness and coordinated action. Each action has a phasing plan, budget, responsible department, and performance metric to monitor progress. Progress updates are presented to city council every six months.

PUBLIC HEALTH

The City of Chula Vista does not have a public health department, but it invited representative from the County of San Diego Public Health Services to present to the CCWG and had a public health professional as a member of the CCWG. While only one specific strategy identifies public health as its main focus (extreme heat), public health was a primary co-benefit of several other adaptation actions.

In the case of extreme heat, there were two implementable action items: (1) improved noticing of air quality and extreme heat events; and (2) the inclusion of extreme heat in the next update of the city's local hazard mitigation plan.

Health-related co-benefits resulted from actions to address the urban heat island effect: cool paving, cool roofs, and shade trees. Each of these strategies moderates outdoor temperatures, which improves air quality by limiting the production of ground-level ozone and makes pedestrian areas such as sidewalks more hospitable. Shade trees not only offer shade to pedestrians but also often improve pedestrian safety.

LEARNING FROM CHULA VISTA

- **Community involvement:** Involving the community from the beginning ensures that community needs are prioritized and builds public support critical for long-term effectiveness.
- **Piggyback:** Build on strategies and plans already effective in a community. These strategies are often cost-effective and more easily implemented. This can include actions such as adding extreme heat to the local hazard mitigation plan at the next scheduled update, or tying local noticing to the regional air quality warning systems to improve awareness.
- **Create specific, actionable strategies:** Too often plans lack specific, implementable actions. Chula Vista identified not only specific actions but also phasing, funding sources, and a responsible department for each action. In addition, every six months staff must present a progress update to the city council.
- **Institutionalize:** Strategies should include actions such as updating or adjusting local plans and ordinances (e.g. grading ordinance, local hazard mitigation plan, etc.) so their effectiveness is more likely to last beyond the tenure of the staff and stakeholders that developed the recommendations.

PUBLIC HEALTH CO-BENEFITS

Cool paving, Shade trees, Cool roofs } Cooler temperature can lead to reduced heat stress

Stormwater pollution
Disease vector control

Education & wildfires
Air quality awareness

LEARN MORE

City of Chula Vista Climate Change Working Group: *www.chulavistaca.gov/clean/conservation/Climate/ccwg1.asp*

City of Chula Vista. (2011). *Climate Adaptation Strategies: Implementation Plans.* Retrieved on April 4, 2013 from: *www.chulavistaca.gov/clean/conservation/Climate/documents/ClimateAdaptationStrategiesPlans_FINAL_000.pdf*

CITY OF COACHELLA (CA)

Emerging Practices: Community outreach and plan integration

Five years ago, the City of Coachella (pop. 40,704; 96.4% Hispanic or Latino origin) embarked on an ambitious effort to envision the city's future. What is unique about the planning efforts in Coachella is that the focus of the plan development was public health. Consistent with a long-held community commitment to public health, the city applied for and was awarded a California Endowment grant to develop a comprehensive healthy community plan, with a general plan update and a climate action plan.

The integrated nature of this effort sets Coachella apart. By conducting a planning process that considers public health, climate change, and a community's general plan or comprehensive plan simultaneously, Coachella has taken steps to ensure that climate and health considerations are integrated throughout city operations.

COMMUNITY OUTREACH

City of Coachella community workshop activity

Photo: City of Coachella

Two parallel efforts were used to engage the community. The process began with the establishment of a Wellness Advisory Committee made up of local representatives of public, private, and nonprofit organizations including public health. Committee members were chosen in part for their level of community connection and activity. The Wellness Advisory Committee members were asked to be ambassadors for the planning process to their network of local connections; their activities included efforts such as community surveys and information sharing.

In tandem with the Wellness Advisory Committee's work, a series of workshops was held to scope and vet the goals and policies for the general plan update. The committee aided in publicizing these events. The workshops, which were designed to bring together as broad a cross-section of the Coachella community as possible, included food, music, informational booths for health organizations, raffles, high school performances, childcare, and bilingual presentations. Each of the three workshops attracted more than 200 attendees.

PLANS

The public review draft of the General Plan Update City Of Coachella, California is now available. Not only are public health and adaptation-related measures integrated throughout the plan, but two optional general plan elements are included: Community Health and Wellness, and Sustainability and Natural Environment. In addition, to enhance understanding and navigation of the document, a series of graphic icons were used to highlight policies in other elements that have public health co-benefits.

The Community Health and Wellness element includes many goals and policies that reach beyond simply adaptation, but adaptation concerns are integrated through the goals and policies.

DRAFT CITY OF COACHELLA GENERAL PLAN – COMMUNITY HEALTH AND WELLNESS ELEMENT GOALS

(climate adaptive goals in bold)

1. **Healthy Community. A physical, social and civic environment that supports residents' health, well-being and equity.**
2. **Healthy Housing. Safe, affordable and healthy housing for every stage of life.**
3. Smoke-Free Environments. Reduced negative public health impacts of tobacco smoke.
4. Public Safety and Social Support. Close-knit and safe communities.
5. **Local Food System. Strong local food production and ample opportunities to eat locally grown food.**
6. **Healthy Food Access. Safe and convenient access to healthy, affordable and culturally diverse foods with low concentrations of unhealthy food providers.**
7. Jobs, Prosperity and Economic Development. Improved economic prosperity and vibrancy of households and businesses.
8. Educational and Community Facilities. Community facilities and school facilities that support physical activity, civic life and social connections for residents of all ages and interests.
9. **Healthcare and Social Services. Affordable, accessible and high-quality health care and social services for all residents.**

The Sustainability and Natural Environment Element specifically identifies climate change and adaptation as goals.

DRAFT CITY OF COACHELLA GENERAL PLAN – SELECTED SUSTAINABILITY AND NATURAL ENVIRONMENT ELEMENT GOALS

1. Climate Change. A resilient community that is prepared for the health and safety impacts of and minimizes the risks of climate change.
2. Water Resources. Protected and readily available water resources for community and environmental use.
3. Green Building. Community building stock (both new construction and renovations) that demonstrates high environmental performance through green design
4. Agricultural Preservation. Viable, productive local agricultural lands and industry.
5. Waterways. Waterways and desert washes that serve a natural, environmental function and provide aesthetically pleasing open space for the community.
6. Passive Open Space. Preserved open space areas that represent significant aesthetic, cultural, environmental, economic and recreational resources for the community.
7. Air Quality. Healthy indoor and outdoor air quality through reduced, locally generated pollutant emissions.
8. Parks and Open Space. Increased access to parks, recreation, and natural open spaces to support and increase physical activity.

The draft general plan is currently available for public comment and is planned for adoption later in the year. Currently, the climate action plan is in development with a public review draft expected at the end of the summer.

LEARNING FROM COACHELLA

- **Community outreach.** Establishing a Wellness Advisory Committee made up of local leaders and stakeholders engaged a larger cross-section of the community. The workshops were rich in information but were held as community celebrations with the intention of attracting and engaging everyone who attended.
- **Plan integration**. The integration of health and climate change into not only optional elements of the general plan but also throughout the required elements ensures that health and climate change will be reflected in all aspects of community operations.

LEARN MORE

City of Coachella. (2013). General Plan Update City Of Coachella, California Draft. Retrieved June 25, 2013 from: *http://cityofcoachellageneralplanupdate.weebly.com/uploads/1/2/1/2/12129446/general_plan_update_for_website.pdf*

COOK COUNTY (IL)

Emerging Practices: Strategic planning; leveraging community expertise

Chicago Physicians for Social Responsibility, nonprofit organization, worked with two students from the Environmental Engineering and Science program at Northwestern University to prepare the *Cook County Climate Change and Public Health Action Plan.* Staff members from the public health departments of Cook County, the City of Chicago, and the City of Evanston assisting in preparation of the plan.

Rather than attempt to be comprehensive the plan focuses on five key areas for action:

- Extreme weather
- Foodborne illnesses
- Vector-borne diseases
- Water quality, quantity, and waterborne illnesses
- Air pollution and allergens

For each area, the plan describes the current and potential impacts to public health in the region. For example, the plan shows the increasing trend in Lyme disease incidences and the potential for this to continue as temperature increases.

The current status of the plan is unknown and interviews could not be obtained, but the plan stands as one of the few examples of this type of work in the United States.

LEARNING FROM COOK COUNTY

- **Strategic focus:** Addressing climate change and public health has the potential to be a significant effort that many communities may not be able or willing to undertake. Focus on a few issues that may have the biggest impacts or the most local salience.
- **Leverage community expertise:** Chicago Physicians for Social Responsibility engaged faculty and students at local university to provide technical assistance and support.

COOK COUNTY GOALS:

Goal 1: To inform public health professionals, state agency personnel, policy-makers, healthcare providers, vulnerable populations and the general public on human health risks associated with climate change

Goal 2: To identify vulnerable populations who are especially at risk for negative health outcomes as a result of climate change

Goal 3: To move the focus from mitigation to adaptation and recommend potential adaptation strategies to address climate change effects on public health

Goal 4: To encourage planning and preparation for emergency response to protect the public's health against possible health outcomes resulting from climate change

Goal 5: To expand the scope of this plan to a statewide preparedness plan in the future

LEARN MORE

Chicago Physicians for Social Responsibility. (n.d.). *Cook County Climate Change and Public Health Action Plan.* Retrieved from: *http://chicagopsr.org/PDFs/climatechangepublichealthplancookcounty.pdf*

CITY OF MINNEAPOLIS (MN)

Emerging Practices: Coordination with state public health agency; active engagement by local public health officials; planning for vulnerable populations

In 2012, the Minnesota Department of Health (MDH) published *Assessment of Health and Climate Preparedness*, a report from the State Community Health Services Advisory Committee (SCHSAC), Climate Change Adaptation Workgroup (funded by a grant from the U.S. Centers for Disease Control). The report included a vision and goals (see box), a summary of impacts and how they affect public health, and a set of recommendations for the state and for local public health agencies. There are three recommendations for local public health agencies:

1. Assess and plan for the potential effects of extreme weather events and climate change on the health of the public and health infrastructure;
2. Encourage staff to get trained on health issues associated with climate changes and share MDH climate change adaptation products with the community and policy makers when available; and,
3. Begin or continue to work with community partners to prepare for the effects of extreme weather events and climate change.

The City of Minneapolis (pop. 392,880), especially the Health Department, has worked closely with MDH in all of these activities. They have representatives on numerous committees and workgroups, they have used MDH tools and resources, and they are currently implementing a heat response plan consistent with state guidance.

STATE ASSISTANCE AND COORDINATION

MDH has prepared a variety of resources and tools to assist local agencies in addressing public health and climate change, including:

- A series of training modules on public health and climate change covering four topics:
    - Climate Change 101
    - Extreme Heat
    - Water Quality and Quantity
    - Air Quality

The modules are appropriate for public health professionals, decision makers, and the public. They can be found at: *www.health.state.mn.us/divs/climatechange/communication.html*

An Extreme Heat Toolkit that provides information to local governments and public health professionals about preparing for and responding to extreme heat events. The toolkit can be found at: *www.health.state.mn.us/divs/climatechange/extremeheat.html*

A guide called *Incorporating Health and Climate Change into the Minnesota Environmental Assessment Worksheet*, which can be found at: *www.health.state.mn.us/topics/places/review.html*

A series of reports, training materials, and guides on incorporating public health and climate change into local comprehensive plans. They can be found at: *www.health.state.mn.us/topics/places/plans.html*

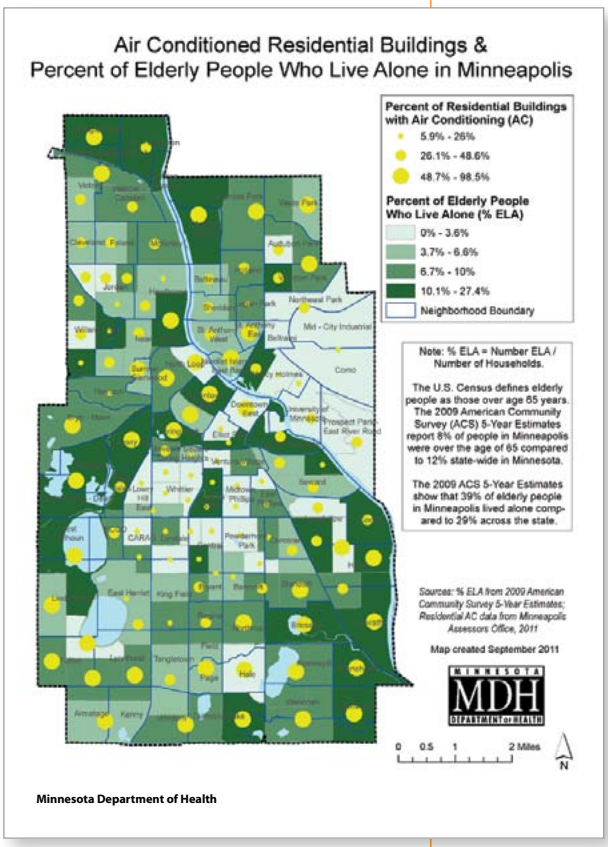
VISION AND GOALS FROM THE ASSESSMENT OF HEALTH AND CLIMATE PREPAREDNESS REPORT

Vision:

To prevent injuries, illnesses, and deaths related to extreme weather events and climate change.

Goals:

1. Advocate for partnerships and collaboration (across jurisdictions, departments, levels of government, and between sectors) for planning and responding to extreme weather events and climate changes that affect the health of the public.
2. Raise awareness of the potential effects of extreme weather events and climate changes on the health of the public.
3. Focus on practical, local responses to events that have occurred and may continue to occur from extreme weather events and climate changes that impact the health of the public



Minnesota Department of Health

ACTIVE ENGAGEMENT BY LOCAL PUBLIC HEALTH OFFICIALS

The City of Minneapolis Health Department has a preparedness manager position with responsibilities that include ensuring that climate change issues are incorporated into health department policies and programs. The manger represents the department in various statewide committees and participates in training activities related to public health and climate change. The state health department has reported that working with local health department representatives has been key in catalyzing action; in particular, they have been successful in increasing the number of local heat response plans.

PLANNING FOR VULNERABLE POPULATIONS

The City of Minneapolis has taken several steps to ensure that vulnerable populations are considered when planning for climate impacts to public health. For instance, they coordinate heat response with community organizations that deal with vulnerable populations. They use extreme heat vulnerability maps prepared by MDH for response and planning purposes. These maps show that, for example, youth, elderly, and low-income areas have limited access to air-conditioned spaces. The city is also working with university researchers to develop a refined set of maps that will show the locations most vulnerable to the impacts of climate change. In the recent update of the Minneapolis Climate Action Plan, the city created an environmental justice subcommittee for the planning process.

LEARNING FROM MINNEAPOLIS

- **Coordinate with the state health agency:** Many state public health agencies have started addressing climate change and may have resources, tools, and expertise available to communities.
- **Assign responsibility:** The city is making progress on climate adaptation because they have assigned the responsibility to a key position in the organization.
- **Attend to the most vulnerable populations:** Some climate change impacts will affect vulnerable populations first and with greater magnitude. Identify populations most vulnerable and least able to adapt to climate change impacts and ensure this information is incorporated into the development and implementation of public health strategies. Establish a committee to address social justice issues.

LEARN MORE

Minnesota Department of Health (MDH) Climate and Health *www.health.state.mn.us/divs/climatechange/index.html*

City of Minneapolis Climate Action Plan *www.minneapolismn.gov/sustainability/climate/index.htm*

ORANGE COUNTY (FL)

Emerging Practices: Staff education and training; focusing on tangible problems and building on existing programs; building partnerships.

Orange County (pop. 1,202,234), which includes Orlando, began addressing public health and climate change in 2006—making them one of the early pioneers. Their initial efforts were focused on greenhouse gas emissions reduction programs such as green, healthy buildings and alternative transportation. The shift to climate adaptation came when the county was selected by the National Association of County and City Health Officials (NACCHO) as a climate change demonstration site. NACCHO provided funding and technical assistance for the Orange County Public Health Effects of Climate Change Project. Outcomes of the project included:

- Training 75 percent of Orange County Health Department staff on the health effects of climate change and verifying the effectiveness of the training
- Producing and distributing a video, "Health Effects of Global Climate Change in Central Florida"
- A spatial analysis (using geographic information analysis tools) to identify populations vulnerable to climate change

The NACCHO project served as a catalyst for additional action and helped overcome some resistance from public officials to engaging in climate adaptation. The Orange County Health Department has continued to expand or enhance existing programs that are related to climate change impacts such as heat shelters, monitoring of illness vectors, mosquito control, and interagency coordination, especially with the Environmental Health and Planning & Development departments.

The Orange County case is exemplary for three reasons: (1) they linked climate change impacts to existing areas of capacity and action within the department; (2) they focused outreach on tangible problems to avoid the politics of climate change; and (3) they educated their staff and brought in new expertise as needed.

ORANGE COUNTY HEALTH DEPARTMENT CLIMATE ADAPTATION ACTIVITIES

1. Staff training on the public health effects of climate change
2. Public information campaigns
3. Monitoring for illness vectors
4. Robust mosquito control
5. Publication of heat and air quality indexes as well as other public advisories
6. Coordination with community and inter-agency partners

TABLE 4. SHOWS HOW ORANGE COUNTY LINKED POTENTIAL HEALTH RISKS FROM CLIMATE CHANGE WITH THE PUBLIC HEALTH RESPONSE.

POTENTIAL HEALTH RISK FROM CLIMATE CHANGE	PUBLIC HEALTH RESPONSE
• **Increased heat waves are expected to increase human and livestock mortality** • **Expected increase in cardiorespiratory morbidity and mortality associated with ground-level ozone and extreme heat**	• Heat index monitored, press releases given to multiple sources to inform public of dangers and to offer suggestions to avoid heat related illness • Air Quality Index on website with press releases given when ozone levels exceed health threshold to inform public to take precautions • Community ERs and schools advised of conditions
• **Warmer climate predicted to increase proliferation of pollen-producing plants**	• Pollen and other allergen information posted on website daily
• **Algae blooms much more active in warmer water**	• Investigation of all potential algae blooms in Orange County with lake posting and resident notification when necessary
• **Warmer ocean temperatures make severe weather much more likely**	• Participation in county preparedness efforts as well as training staff to be deployed where needed
• **Increased storms and water intrusion expected to result in more indoor air quality and mold issues, resulting in increased childhood asthma**	• Comprehe nsive county indoor air quality program that serves clients in two neighboring counties
• **Higher food prices and declining yields due to climate change and erratic weather patterns may lead to increased hunger and worse nutrition**	• Women, Infants and Children (WIC) nutrition program being expanded with longer hours, more staff, and more sites • Community garden created in at-risk neighborhood to improve access to nutritious food and inspire dietary changes

TABLE 4
(Continued from previous page)

POTENTIAL HEALTH RISK FROM CLIMATE CHANGE	PUBLIC HEALTH RESPONSE
• **Poor will not be able to adapt to changes as readily** • **Impacts of climate change may cause social disruption, economic decline, and displacement of populations**	• Community issues being addressed through Protocol for Assessing Community Excellence in Environmental Health (PACE EH) efforts, community health initiatives, and increases in numbers served by the health department • Partnerships and collaborations with various community and faith-based organizations
• **Droughts can cause waterborne illnesses by depleting drinking water and concentrating contaminants**	• All suspected waterborne illnesses investigated, in addition to well-testing and well-decontamination information for homeowners
• **Forest fires expected to increase in frequency due to shifting patterns of heat and drought**	• Air quality and outdoor activity risk communicated to public and schools
• **Vector-borne diseases linked seasonally to rainfall and ambient temperature** • **Tropical diseases located outside the United States may emerge here as the temperature changes**	• Monitoring infectious disease cases and outbreaks through surveillance • Participate in syndromic surveillance being set up in local hospitals as well as research being done within the Department of Health and Mosquito Control
• **Extreme precipitation linked to waterborne disease outbreaks: cryptosporidiosis, typhoid fever, dengue fever, cholera, and other diarrheal illnesses**	• Used part of NACCHO funding to train staff about the health effects of climate change • Educating the public about the risk of infectious diseases and prevention methods

FOCUSING ON TANGIBLE PROBLEMS

Orange County Public Health took the approach of focusing on immediate tangible problems that were or would be exacerbated by climate change, such as mosquito control, heat emergencies, and vector-borne diseases. In each case the public and officials were aware of the problems and the department already had programs in place to address them. The climate adaptation response could then be used to augment understanding and implementation of these existing conditions. In doing so they were able to reduce the politicization of the climate change issue and were able to leverage existing resources and build on prior successes.

TRAINING AND HIRING STAFF

The Orange County Health Department trained 571 of the 689 (75%) part- and full-time staff members on the health effects of climate change. Staff members were taught to recognize how climate change could be exacerbating current risks (and monitor for trends) and to cross-train in response areas that could see increased demand (for example, heat emergencies). They verified the effectiveness of the training program by conducting pre- and post-training evaluations; this also helped identify knowledge gaps. In addition to the training program, they hired an urban and regional planner to assist with integrating sustainability and the built environment with public health issues such as obesity, chronic disease, and community wellness.

LEARNING FROM ORANGE COUNTY

- **Build a knowledgeable staff:** Establish a training program for all staff members so that they are knowledgeable about how climate change will impact public health, what they should watch for, and how they can best prepare. Hire nontraditional employees to diversify the agencies' knowledge base and capacity.
- **Tailor the approach to discussing the science and politics of climate change to the knowledge and values of local officials and the public:** Focus on the agencies' core mission, frame problems in a way that is recognizable and meaningful to the public and decision makers, and build on existing programs and successes.
- **Build partnerships:** Partner with national organizations such as NACCHO and the CDC, other local departments and agencies such as Environmental Health and Planning and Building, and local nonprofits and universities.

LEARN MORE

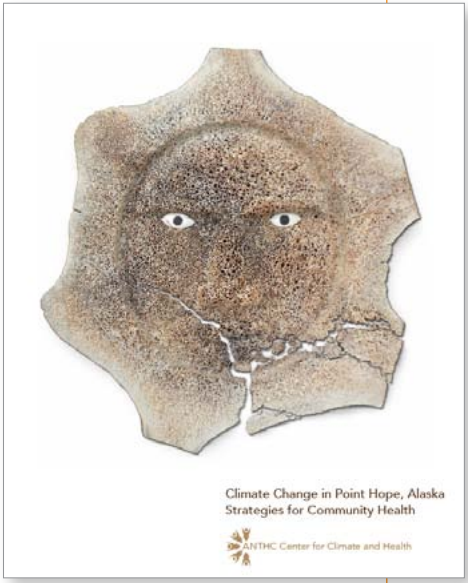
Orange County Health Department: *www.orchd.com*

National Association of County and City Health Officials (NACCHO) Climate Change Demonstration Sites: *www.naccho.org/topics/environmental/climatechange/ccdemosites.cfm*

CITY OF POINT HOPE (AK) AND THE ALASKA NATIVE TRIBAL HEALTH CONSORTIUM

Emerging Practice: Comprehensive community health assessment and regional collaboration

In rural northern Alaska, rapid climate change has been impacting the daily lives of community members for decades. The Alaska Native Tribal Health Consortium (ANTHC) is a nonprofit health organization, formed in 1998, that works with tribal communities interested in and willing to engage in an adaptive process to assess the threats posed by climate change to the health of their community. This comprehensive process includes several steps described below. With support from the Alaska Department of Health, the ANTHC is implementing several critical adaptation measures to position themselves to be resilient in the face of projected changes.



GETTING STARTED

Collaboration between a community and the ANTHC begins with a regional assessment. Based on available data collected by the State of Alaska, ANTHC conducts a regional assessment, which qualitatively ranks communities based on available data such as erosion vulnerability (critical for infrastructure integrity such as water), state flood records, and water supply rating. This allows the most vulnerable communities to be identified.

ANTHC does not work with a community unless invited by its tribal council. The first step for the collaboration is obtaining funds from such organizations as the U.S. EPA, U.S. Indian Health Service, or landscape conservation cooperatives. In the community, the first step is to conduct informal interviews with departments such as public works, health, public safety; local experts in harvest and environment; and anyone with professional health knowledge.

ASSESSING VULNERABILITY

Health working groups are formed to assess potential health and safety impacts, including the following factors:

- **Safety:** Rural communities can be isolated, making it more difficult to communicate risk and other needs.
- **Water security:** Climate change alters the quality of source water, making the treatment needs dynamic.
- **Disease vectors**: The emergence of new disease vectors influences the treatment needs of water and broader threats to public health.
- **Service interruption:** The availability of backup systems for water, power, and other critical needs is assessed.
- **Food:** Up to 80 percent of some community members' diet is made up of wild food. Climate change has resulted in an observed increase in frequency of harvest failure (caribou, salmon, berries, halibut, etc.). The nutritional and economic impacts are assessed.
- **Mental health:** Through conversations with local experts in behavioral health, the climate influence on stress, fear, or anxiety is assessed. The outcomes can result from climate-forced changes in lifestyle, food, loss of property, infestation, or increased costs.

Children playing near sagging waterline in Selawik, Alaska.

Photo: Mike Brubaker

STRATEGIES

Strategies for community health are generated through collaboration between an individual community such a Point Hope and ANTHC. Some of the particularly important strategies being implemented in Point Hope and other nearby communities include the following:

- **Wildlife blood testing for disease:** A blood-test strip is distributed to hunters that they can then send to a state wildlife lab so climate-altered health conditions to be tracked.
- **Proposed air quality and algal boom monitoring:** Similar to the self-administered wildlife monitoring, an effort is currently under way to expand it to other potential climate impacts.
- **Regional collaboration and information sharing:** The managers for the tribal network of local environmental observers (LEO) have formed a network to post, map, and share anything unusual that is observed.
- **Improved data:** Adapting to rapidly changing conditions requires data. The Point Hope strategies include plans for a weather station, improved shoreline assessment to track erosion, food security, and more.
- **Improved food storage:** Permafrost thaw means that cellars and other methods for keeping food (especially meat) cool are less effective. The community has proposed three options for cooling: "1) improve the environment (ventilation, drainage, temperature) at the current location; 2) establish new *sigl-uaqs* [ice cellars] at a location with a better subsurface environment; and 3) develop an alternative method for food storage, such as community cold storage facilities" (ANTHC 2010, p.18).
- **Local and regional climate advisory groups:** Future success requires both local and regional collaboration and integration. These groups can coordinate data and share resources.

LEARNING FROM ANTHC AND POINT HOPE

- **Comprehensive health assessment:** Community health was treated comprehensively from infrastructure reliance to food to mental health.
- **Collaboration:** Point Hope is small (population <1,000) with limited resources and expertise, so taking action to address climate change requires collaboration with nearby communities and state and regional entities. Point Hope is collaborating with ANTHC for their plan and with several other groups for data collection and ongoing strategy implementation.

LEARN MORE

Alaska Native Tribal Health Consortium: *www.anthc.org*

ANTHC. (2010). *Climate Change in Point Hope, Alaska: Strategies for Community Health.* Retrieved on May 15, 2013 from: *www.anthctoday.org/community/reports.html*

SAN LUIS OBISPO COUNTY (CA)

Emerging Practices: Leadership from nonprofit organizations; broad stakeholder engagement including public health agencies; strategic efforts at implementation

In 2009 and 2010, a diverse group of local leaders and experts in San Luis Obispo County (pop. 45,878) used a collaborative process to develop a suite of local climate adaptation strategies. This included a staff representative from San Luis Obispo County Public Health Services. The stakeholders met in a series of workshops and identified the following potential public health impacts of climate change:

1. Increased heat-related mortality and hospitalizations
2. Increased respiratory and cardiovascular disease
3. Declining food security for low-income populations
4. Higher demand for emergency and social services if natural disasters become more frequent or severe

Based on these impacts and the county's vulnerabilities and capacities, participants then developed recommended strategies (see box).

The San Luis Obispo example is exemplary for four reasons: (1) the active role played by a nonprofit organization in preparing technical information and convening a broad group of stakeholders; (2) the active participation by a public health expert; (3) the strategic efforts by public health agency staff members to implement strategies without direct funding; and (4) integration with a local climate action plan.

NONPROFIT LEADERSHIP

The impetus for the climate adaptation workshops came from the GEOS Institute and the Local Government Commission (LGC) with funding from the Kresge Foundation. GEOS and LGC chose San Luis Obispo and Fresno Counties as pilot communities for this collaborative effort. San Luis Obispo County was chosen "based on a number of factors, including high biological diversity, agricultural and wine industry importance, federal land ownership, coastal resources, Climate Action Plan progress, support from County officials, and others" (LGC 2010). The nonprofit organizations organized and led the collaborative planning process and provided technical information on potential climate change impacts. This gave stakeholders the freedom to focus on developing solutions.

ACTIVE PARTICIPATION BY PUBLIC HEALTH EXPERTS

In the county, the issue of climate change had focused on greenhouse gas emissions reduction and mostly included community development and energy experts and stakeholders. This was the first major effort to address the impacts of climate change and it prominently featured public health impacts. Moreover, public health experts worked collaboratively with a wide variety of community stakeholders (for example, government officials and staff members, business owners, nonprofit advocates) to ensure that public health issues and strategies were included in the discussion and final products. It was important for these professionals to be at the table, or else issues of community planning and hazard mitigation may have trumped public health concerns. Instead, all of these issues were addressed in an integrative fashion and represented a new level of collaboration among these different interests.

PUBLIC HEALTH ADAPTATION STRATEGIES FOR SAN LUIS OBISPO COUNTY

- Expand outreach and education on emergency preparedness
- Identify and target vulnerable populations for outreach
- Increase local food production and security
- Promote healthy lifestyle practices

STRATEGIC EFFORTS BY PUBLIC HEALTH AGENCY STAFF MEMBERS

The completed plan was not the product of a government agency and was not formally adopted as county policy. Instead, the plan served as a resource and as guidance for future activities. These types of plans can easily be dismissed or forgotten, and usually will only have an impact if individuals or organizations champion their principles. The San Luis Obispo County Public Health Agency has been one of these champions. Despite not having a formal mandate to address climate change or a budget for new programs, agency staff have ensured that strategies are incorporated into regular ongoing programs to the extent feasible. For example, they partnered with other stakeholders on a "buy local" food program that has both public health and climate adaptation benefits.

INTEGRATION WITH LOCAL CLIMATE ACTION PLAN

Shortly after the workshops, the county began the process of preparing a local climate action plan—called the EnergyWise plan—that addressed greenhouse gas emissions reduction and climate adaptation. The following actions from the EnergyWise plan address public health and were partly driven by the collaborative workshops:

- Mitigate the urban heat island effect by planting urban forests and using light-colored building and pavement materials.
- Encourage businesses and local and regional agencies to participate in the utility provider's Demand Response Program, to reduce energy use during peak demand.
- Establish formal partnerships with health agencies and organizations, local parks and recreation departments, and the YMCA to identify health risks and conditions that may compromise the population's ability to withstand health-related stressors.
- Identify specific populations with limited capacity to adapt to health-related stressors such as heat waves, disease outbreaks, or poor air quality events.
- Identify potential costs and funding sources for protecting the population from increased public health risks.
- Update the county emergency operations plan to incorporate public health–related events or outbreaks as well as procedures to protect the population.
- Contact and advise vulnerable populations during public health–related events.
- Identify locations for public cooling centers during extreme heat events.

LEARNING FROM SAN LUIS OBISPO COUNTY

- **Partner with nonprofits:** Identify nonprofit and university partners that can assist in conducting vulnerability assessments, organizing education and training, and facilitating strategy development workshops and programs.
- **Get a seat at the table:** Many communities have processes under way for dealing with climate change. Ensure that public health has representation on committees and that climate action plans address public health. Look to city and county planning and environmental agencies for information.
- **Leverage existing resources and programs**: Many of the actions needed to address climate change are consistent or complementary with existing public health programs and activities. Look for opportunities to include climate adaptive actions with these rather than creating new programs, especially when resources are limited.

LEARN MORE

Local Government Commission for San Luis Obispo County Climate Adaptation (includes report): *www.lgc.org/adaptation/slo*

San Luis Obispo County EnergyWise Plan: *www.slocounty.ca.gov/planning/CAP*

CITY OF WINDSOR (ONTARIO, CANADA)

Emerging Practice: Vulnerability assessment; building on existing action; implementable strategies and mapped vulnerability

The City of Windsor (pop. 216,473) was already experiencing climate impacts, particularly in the form of flooding and heat. In 2010, the Windsor City Council approved participation in the ICLEI—Local Governments for Sustainability Climate Change Adaptation Initiative. Shortly after making this commitment, Health Canada selected Windsor as a pilot community for conducting an extreme heat vulnerability assessment. The result was that the community developed two plans in parallel: *The Urban Heat Island Effect in Windsor, ON: An Assessment of Vulnerability and Mitigation Strategies* (adopted August 2012) and the *City of Windsor Climate Change Adaptation Plan* (adopted September 2012).

ADAPTATION PLANNING PROCESS & VULNERABILITY ASSESSMENT

Using the method outlined by ICLEI, complemented by data from Health Canada, two potential climate impacts emerged as most pressing for Windsor: increased precipitation and increased temperature. Windsor's adaptation plan was based on a detailed vulnerability assessment that also served to engage relevant departments throughout city government. Staff from each department were presented with the projected climate changes for the city with a focus on precipitation and temperature. Each department was then asked to do three things:

- Identify the potential impact of the shifts in precipitation and temperature for their department.
- Qualitatively rank the severity of each impact.
- Estimate the cost associated with each identified impact.

This process resulted in more than 250 potential impacts. Using the ICLEI adaptation framework, the data was used to give each impact a designated risk level. In January 2012, the ranked impacts were presented to the city council, which passed a motion approving the development of adaptation strategies with a focus on impacts with a medium-high to extreme-risk rating.

The next step was to inventory existing strategies that already address the identified climate impacts in order to provide a foundation for formulating new measures. The table below lists new strategies that address heat, which has direct public health consequences.

ADAPTATION STRATEGIES IN WINDSOR (from two plans)

- Cool roofs
- Green roofs
- Cool pavement
- Porous pavement
- Urban greening & tree planting
- Rain gardens
- Shade structures
- Heat education

TABLE 5. STRATEGIES ADDRESSING INCREASED TEMPERATURES FROM THE CITY OF WINDSOR CLIMATE CHANGE ADAPTATION PLAN

ADAPTATION ACTION	CO-BENEFITS
REDUCING RISKS ASSOCIATED WITH INCREASING PRECIPITATION AND TEMPERATURES	
• **Develop a green roof policy**	• Mitigation of the urban heat island effect and reduction of summer air-conditioning demand
• **Develop pilot projects for the use of porous pavement on city properties and develop guidelines for development**	• Improved stormwater quality
• **Install rain gardens as a pilot project to determine effectiveness**	• Improved stormwater quality
• **Improve and enhance green space to improve rainwater retention**	• Mitigation of the urban heat island effect, improvements to air quality, improved quality of life for city residents
• **Increase tree planting**	• Reduce stormwater runoff, improved quality of life for city residents
REDUCING RISKS ASSOCIATED WITH INCREASING TEMPERATURES	
• **Increase capital for shade structures**	
• **Increase in heat education at community centers and pools**	

Source: City of Windsor. (2012). *City of Windsor Climate Change Adaptation Plan.*

URBAN HEAT ISLAND MITIGATION STRATEGIES

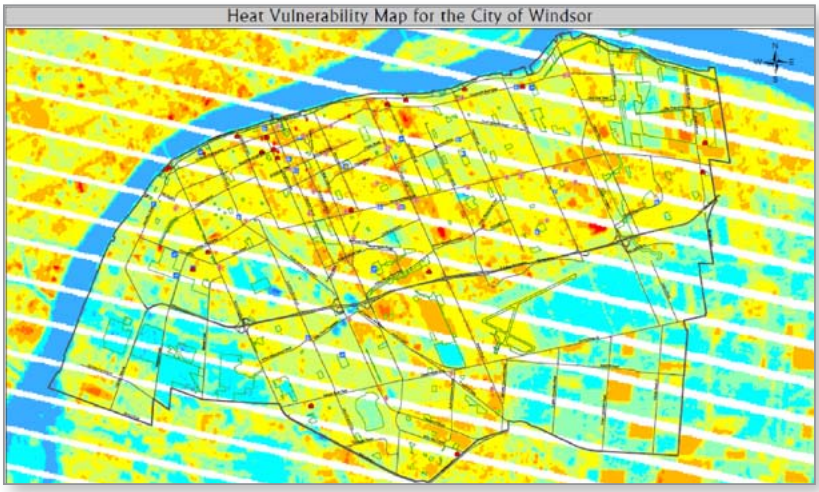
Parallel to the development of the adaptation plan, a set of strategies that specifically address the heat island effect were developed and presented in *The Urban Heat Island Effect in Windsor, ON: An Assessment of Vulnerability and Mitigation Strategies.* While consistent with the adaptation plan, this Health Canada–sponsored effort was more detailed. The heat island plan includes a detailed vulnerability assessment that specifically identifies vulnerable populations. The strategies included in the plan are consistent with the adaptation plan: cool roofs, green roofs, cool pavement, and urban greening. The heat island plan takes these strategies a step further by using a vulnerability mapping exercise to prioritize locations for implementation. The urban heat vulnerability map analysis used the following data:

- Age characteristics—infants (age 0–4)
- Age characteristics—children (age 5–9)
- Age characteristics—seniors (Age ≥ 65)
- Age characteristics—seniors (Age ≥ 85)
- Total number of immigrants arriving between 2001–2006

- Total number of people over the age of 15 without a certificate, degree, or diploma
- Total number of families by prevalence of low income

Using the mapping data, a series of recommendations were issued, ranging from heat emergency response plans to shade structures at park facilities.

Source: City of Windsor (2012)



Heat vulnerability map for the City of Windsor.

LEARNING FROM WINDSOR

- **Vulnerability assessment:** The qualitative assessment of potential impacts by all city departments ensured that staff were aware of climate impacts and that all aspects of community function were considered.
- **Build on existing action:** The climate impacts that occurred in Windsor prior to the beginning of the planning process in 2010 resulted in a series of measures being developed. Many of these existing measures served as the basis for new policies.
- **Implementable strategies and mapped vulnerability:** Strategies were specifically defined to be cost-effective and build on existing measures. This increased the feasibility of implementation; the mapping exercise added increased spatial refinement.

LEARN MORE

City of Windsor. (2012). *Windsor Climate Change Adaptation Plan.* Retrieved on June 25, 2012 from: *www.citywindsor.ca/residents/environment/environmental-master-plan/documents/windsor climate change adaptation plan.pdf*

City of Windsor. (2012). *The Urban Heat Island Effect in Windsor, ON: An Assessment of Vulnerability and Mitigation Strategies.* Retrieved on June 25, 2012 from: *www.citywindsor.ca/residents/environment/environmental-master-plan/documents/urban heat island report (2012).pdf*

EXPERT INTERVIEWS

Experts from state and federal agencies, nongovernmental entities, and academia were interviewed to complement the literature review and case studies. These ten professionals were identified as leaders in the field of climate change adaptation and/or public health. The interviews focused on the current state of practice, areas of opportunity, barriers to adaptation efforts, and suggestions for communities initiating climate adaptation efforts with a focus on public health.

One emerging theme was that as an area of public policy development, adaptation to climate change is in its infancy. Several commented that adaptation is lagging behind efforts that address climate change by reducing greenhouse gas emissions. Also, when asked for good examples of local implementation of public health-related climate adaptation, there were only a few suggestions. More optimistically, awareness of potential climate impacts was seen as improving, and adaptation planning efforts were viewed as quickly gaining momentum.

The expert interviews revealed several themes that could be helpful for communities initiating a climate adaptation planning effort. This summary is organized into the following categories:

- **Motivation** for initiating an adaptation strategy development process
- The most effective **scale** for addressing climate impacts
- **Constraints** that can hold back an adaptation process
- **Getting started** on an effective adaptation planning process
- **Emerging areas** of focus for adaptation policy development with a focus on public health
- **Example strategies** for addressing climate impacts to public health

MOTIVATION

The most consistently cited factor for development and implementation of adaptation strategies was the presence of a local champion. A champion can take many forms depending on the community—such as a city staff member, city council member, or stakeholder. A champion helps build the political and social capital necessary to sustain an adaptation effort. Trigging events—the local experience of climate impacts such as heat, flooding, fire, or others—were cited almost as frequently as a motivating factor. Some experts indicated that triggering events provided a basis for conversation, but the events themselves did not result in political action. A champion, individual, agency, or organization could establish a link between climate change and local climate events to motivate strategy development.

Another frequently cited motivation was funding availability. Most of the experts felt that awareness of the risks posed by climate change was rising, and, for some communities, experts observed that the availability of external funds (e.g., state or federal grants) resulted in initiation of an adaptation strategy development process.

Two other themes were cited by several of the experts: the emergence of public health as an adaptation leader and an increase in collaborative regional efforts.

CLIMATE ADAPTATION EXPERTS

Michael Brubaker, Director of Community Environment and Safety, Alaska Native Tribal Health Consortium

Jacques Colon, former NACCHO Program Analyst

Kathy Dervin, California Department of Public Health

Bob Doppelt, Director, Resource Innovation Group

George Luber, Associate Director for Climate Change, Centers for Disease Control and Prevention

Ed Maibach, Director, Center for Climate Change Communication, George Mason University

Susanne Moser, Director and Principle Researcher Susanne Moser Research and Consulting; Research Fellow at the Woods Institute, Stanford University

David Overfield, Environmental Health Director, Orange County (Florida) Health Department

Laura Tam, Sustainable Development Policy Director, SPUR

Stacy Vynne, formerly the Adaptation Manager, Resource Innovation Group; now Ecosystem Recovery Coordinator, Puget Sound Partnership

SCALE

There was consensus among the experts with respect to the best scale for adaptation: there isn't one. Scale can be issue dependent based on who has the jurisdiction to effect change or the spatial extent of the impact being addressed. For example, public health is most often managed at a regional or county scale, making this a common, and often effective, scale at which to assess and address public health climate impacts.

CONSTRAINTS

The most frequently cited constraint on adaptation efforts was a lack of resources. This could be funding, staff, or time. In particular, the staff challenge was defined not simply as having staff, but having staff whose time was specifically dedicated to adaptation, as opposed to a staff member who simply had adaptation added to her existing responsibilities.

Lack of support for adaptation efforts was another frequently cited limitation. There were several types of support cited that were not related to the resource deficiency mentioned above. The first, and most important, is a lack of support from local decision makers. Without political leadership it is difficult for staff to feel empowered to pursue adaptation goals or able to seek training necessary to address climate impacts. Similar to a lack of political support on a local level, a lack of willing regional collaborators can inhibit adaptation planning efforts. Some adaptation challenges are regional in nature, such as agricultural disruption or pest outbreaks. These are most effectively pursued at larger spatial scales that require collaboration between neighboring communities. Without willing partners, it can delay or inhibit adaptation measures. A third challenge was a lack of supportive existing regulation that either does not include adaptation concerns or directly conflicts with adaptation goals. This type of institutional barrier requires that a community reorient its policy direction. This can be time-consuming and politically difficult.

The final constraint was communication of climate adaptation as an area of strategy development. This is related to political support and local community capacity. Some of the observed challenges to adaptation efforts were attributed to a lack of understanding in both staff and community members. Another often-cited challenge was communicating the need for action in the short term when the benefits will only be experienced in the long term. This was seen as a communication challenge.

GETTING STARTED

Two broad themes emerged when the experts were asked what they saw as the critical first steps. The first regards **local capacity**. A critical first step for any community is to build capacity. The first target should be staff from all potentially affected departments, with a goal of building a shared understanding of what climate change will mean locally and developing a foundation for interdepartmental collaboration. Next, decision makers and community members should be engaged, including public health departments. Several of the experts pointed to public health departments not only as key collaborators but also as models for engaging a community and taking action.

The second theme was to **build on existing local success.** The most successful communities have begun their adaptation plans by bolstering existing actions. In both financial and political terms, this is one of the simplest and most effective solutions.

EMERGING AREAS OF NEED

Experts were asked to identify underaddressed climate adaptation needs. These included changing disease vectors and the emergence of new diseases; food and water security; and mental health and social resiliency.

Disease vectors and emerging new diseases: Climate change may result in shifts in the range for both human and wildlife/plant diseases. The effects on wildlife or plant life, including crops, are not well understood and may require much greater attention in the future.

Food and water security: The shift in seasonal patterns for precipitation and temperature may detrimentally alter the food system. This may require shifts in agricultural practice and in the manner in which food and water are delivered and obtained.

Mental health: Climate impacts cannot be projected with high levels of precision. This inherent uncertainty combined with increased volatility in climate patterns can result in anxiety, fear, and stress for community members concerned about issues such as maintaining their current lifestyle, unexpected costs, safety, property loss, and pest infestation.

STRATEGIES

The experts identified a wide range of effective and innovative strategies, which are grouped into categories and briefly summarized here.

Monitoring: Early detection is critical for addressing impacts that may progress slowly. Ongoing monitoring allows a community to prepare for and be aware of oncoming impacts. This should be tailored to local context and can include data such as allergies, pests, wildfire, agricultural impacts, or illness. In addition, this data should be posted publicly and communicated to decision makers and community members.

Coordination: There often multiple jurisdictions, or even just multiple departments, that have some authority or role in managing climate impacts. Coordination can greatly enhance a community's resilience to climate impacts. This can be as simple as linking warning systems between county and city noticing for emergencies such as fire or poor air quality. Coordination can also ensure that public transportation networks mesh well for community members that do not have access to a personal vehicle. A critical third area for coordination is between emergency services and public health to ensure that hospitals, cooling centers, and other critical facilities have the capacity for projected changes.

Social resiliency and behavior change: The uncertainty and imprecision in climate change at the local level can be handled through a focus on social resiliency, which means working with communities to better prepare socially for the unexpected. Behavior change is about the changes community members can make in their own lives to be more resilient from food choices, water use, landscaping vegetation choices, and more.

Natural adaptation: Natural adaptation refers to a wide variety of strategies that use natural elements as opposed to structural solutions. This includes heat island mitigation using street trees and parks or stormwater management with low-impact development.

RESEARCH METHOD

The preparation of this report followed a research method that included goals, research questions, and data gathering and synthesis.

GOALS

Goals for the report were established to ensure that the research would culminate in the development of a relevant, usable, and effective guide for climate change adaptation and public health. The goals for the report are to:

1. Prepare a report on established and emerging practices in climate change adaptation and public health that includes examples of "best practice" cases and strategies at the local level.
2. Ensure the report is relevant and useful to public health professionals, community-based organizations, advocates, local planners, and policymakers.
3. Ensure the report has accessible language, summaries, straightforward examples, and illustrative and navigational graphics.

RESEARCH QUESTIONS

Research questions were established to focus the literature review and data gathering. The research questions are:

1. How are local, regional, and state-level agencies adapting to the impacts of climate change (including extreme weather events and air pollution) both within and outside of California?
2. Why do communities choose to engage in climate adaptation planning and policy development?
3. How do the relationships between local, regional, and state government impact individual communities' perceived ability to respond to the challenges of a changing climate?
4. What are the most critical needs and barriers, and what policies at the regional/state level could be added or amended to better support local communities' ability to adapt?
5. What are the co-benefits of climate adaptation strategies?
6. To what extent do climate adaptation policies (or could these policies) address impacts on vulnerable populations?
7. What are the factors that best predict a successful adaptation planning process and effective implementation?
8. What are the most frequently identified barriers to a successful adaptation planning process and effective implementation?
9. What is the role of other organizations (e.g., NGOs, churches, community groups) in supporting and/or participating in adaptation efforts?

DATA GATHERING AND SYNTHESIS

Data for the report was gathered from three sources:

1. A review of the literature addressing climate change and public health impacts and adaptation strategies.
2. Interviews with experts in climate change adaptation and public health.
3. Case studies of communities that had begun implementing climate adaptation strategies that directly addressed public health.

The literature review was conducted by searching online databases for scholarly articles, Internet searches for agencies and organizations addressing climate change and public health, and reviewing citations of the previous sources. Some additional literature was identified from interviews and case study informants. The literature was thematically summarized.

Interviews were conducted with ten climate change and public health experts, each lasting 45 minutes to an hour. Experts from government and nonprofit organizations who had community-level knowledge or experience were first identified using the literature review. Then as interviews were conducted, interviewees were asked to identify additional experts; this "snowball" sampling strategy identified additional experts. Ultimately more than 20 experts were identified, and the choice of ten interviews was based on availability and willingness to participate. The interviews were thematically summarized and participant names are reported but not attributed to specific information.

Case studies were conducted for eight communities. These communities were identified through the literature review and the expert interviews. Communities selected for case studies had to have done more than simply acknowledge or study the issue; they had to have taken concrete climate adaptation actions explicitly to address potential public health impacts. This yielded very few communities. In fact, one of the important findings of the study is that few communities had undertaken climate adaptation activities explicitly for public health. Although there was an initial desire to ensure a diversity of cases based on location/region, size, socioeconomic status, and climate change risk, a more practical "take what you can find" approach prevailed. Data for the case studies was gathered from interviews with key informants and document analysis.

BIBLIOGRAPHY

American Public Health Association. (2011). *Climate Change: Mastering the Public Health Role.* Washington, D.C.

Bedsworth, L. (2011). California's local health agencies and the state's climate adaptation strategy. *Climatic Change, 111*(1), 119–133. doi:10.1007/s10584-011-0245-z

Bell, E. (2011). Readying health services for climate change: A policy framework for regional development. *American Journal of Public Health, 101*(5), 804–813. doi:10.2105/AJPH.2010.202820

Binder, B. (2011). Impact of climate change on public health. *The Public Manager, Spring,* 32–36.

Binder, L. C. W., Barcelos, J. K., Booth, D. B., Darzen, M., Elsner, M. M., Fenske, R., Graham, T. F., et al. (2010). Preparing for climate change in Washington State. Climatic Change, 102(1–2), 351–376. doi:10.1007/s10584-010-9850-5

Birkenholtz, T. (2011). Network political ecology : Method and theory in climate change vulnerability and adaptation research. *Progress in Human Geography, 36*(3), 295–315.

Boswell, M. R., Greve, A. I., & Seale, T. L. (2012). *Local Climate Action Planning.* Washington, D.C.: Island Press.

California Emergency Management Agency & California Natural Resources Agency. (2012). California Adaptation Planning Guide (four documents). Sacramento, CA. Retrieved from *http://resources.ca.gov/climate_adaptation/local_government/adaptation_policy_guide.html.*

California Emergency Management Agency. (2010). *State of California Multi-Hazard Mitigation Plan.* Sacramento, CA. Retrieved from *http://hazardmitigation.calema.ca.gov/plan/state_multi-hazard_mitigation_plan_shmp.*

California National Resources Agency. (2009). *2009 California Adaptation Strategy.* Sacramento, CA. Retrieved from *http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf.*

Cooney, C. M. (2010). Preparing a people: Climate change and public health. *Environmental Health Perspectives, 119*(4), A166–A171.

Curtis, S. E., & Oven, K. J. (2012). Geographies of health and climate change. *Progress in Human Geography, 36*(5), 654–666.

Forsberg, B., Bråbäck, L., Keune, H., Kobernus, M., Krayer von Krauss, M., Yang, A., & Bartonova, A. (2012). An expert assessment on climate change and health—with a European focus on lungs and allergies. *Environmental Health, 11* (Suppl 1), S4. doi:10.1186/1476-069X-11-S1-S4

Frumkin, H., Hess, J., Luber, G., Malilay, J., & McGeehin, M. (2008). Climate change: The public health response. *American Journal of Public Health, 98*(3), 435–445. doi:10.2105/AJPH.2007.119362

Glick, P., Stein, B. A., & Edelson, N. A. (2011). *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment*. Washington, D.C.: National Wildlife Federation.

Gostin, .LO. (2000). *Public Health Law: Power, Duty, Restraint*. Berkeley: University of California Press, 248.

Hess, J. J., McDowell, J. Z., & Luber, G. (2012). Integrating climate change adaptation into public health practice: Using adaptive management to increase adaptive capacity and build resilience. *Environmental Health Perspectives, 120*(2), 171–180.

Hosking, J., & Campbell-Lindrum, D. (2012). How well does climate change and human health research match the demands of policymakers? A scoping review. *Environmental Health Perspectives, 120*(8), 1076–1083.

Huang, C., Vaneckova, P., Wang, X., Fitzgerald, G., Guo, Y., & Tong, S. (2011). Constraints and barriers to public health adaptation to climate change: A review of the literature. *American Journal of Preventive Medicine, 40*(2), 183–190. doi:10.1016/j.amepre.2010.10.025

Interagency Working Group on Climate Change and Health. (2010). *A Human Health Perspective On Climate Change: A Report Outlining the Research Needs on the Human Health Effects of Climate Change.* Cary, NC: Environmental Health Perspectives and the National Institute of Environmental Health Sciences.

Intergovernmental Panel on Climate Change. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* A Special Report of Working Groups I and II of the IPCC [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge and New York: Cambridge University Press.

Leadership for Healthy Communities. (2011, February). Making the Connection: Linking Policies to Prevent Climate Change and Childhood Obesity. Retrieved from *www.leadershipforhealthycommunities.org/index.php?option=com_content&task=view&id=552.*

Maibach, E. W., Chadwick, A., McBride, D., Chuk, M., Ebi, K. L., & Balbus, J. (2008). Climate change and local public health in the United States: Preparedness, programs and perceptions of local public health department directors. *PloS One,* 3(7), 8. doi:10.1371/journal.pone.0002838

Maibach, E. W., Nisbet, M., Baldwin, P., Akerlof, K., & Diao, G. (2010). Reframing climate change as a public health issue: An exploratory study of public reactions. *BMC Public Health, 10,* 299. doi:10.1186/1471-2458-10-299

Maibach, E., Nisbet, M., & Weathers, M. (2011) Conveying the Human Implications of Climate Change: A Climate Change Communication Primer for Public Health Professionals. Fairfax, VA: George Mason University Center for Climate Change Communication.

McMichael, A. J. (2001). Health consequences of global climate change. *Journal of the Royal Society of Medicine, 94,* 111–114.

McNeeley, S. M. (2011). Examining barriers and opportunities for sustainable adaptation to climate change in Interior Alaska. *Climatic Change, 111*(3-4), 835–857. doi:10.1007/s10584-011-0158-x

Metz, B., Davidson, O. R., Bosch, P. R., Dave, R., & Meyer, L. A. (eds.). (2007). Climate Change 2007: Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge and New York: Cambridge University Press.

Minnesota Department of Health. (2012, May). Assessment of Health and Climate Preparedness Final Report of the SCHSAC Climate Change Adaptation Workgroup. St. Paul, MN.

Myers, T. A., Nisbet, M. C., Maibach, E. W., & Leiserowitz, A. A. (2012). A public health frame arouses hopeful emotions about climate change. *Climatic Change, 113*(3-4), 1105–1112. doi:10.1007/s10584-012-0513-6

Park, A. (2009). *Everybody's Movement: Environmental Justice and Climate Change.* Washington, D.C.

Paterson, J. A., Ford, J. D., Ford, L. B., Lesnikowski, A., Berry, P., Henderson, J., & Heymann, J. (2012). Adaptation to climate change in the Ontario public health sector. *BMC Public Health, 12,* 452. doi:10.1186/1471-2458-12-452

Samet, J. (2010). *Public Health: Adapting to Climate Change.* Issue Brief 10-06. Washington, D.C.: Resources for the Future.

Sheffield, P. E., & Galvez, M. P. (2009). U.S. childhood obesity and climate change: Moving toward shared environmental health solutions. *Environmental Justice, 2*(4), 207–214. doi:10.1089/env.2009.0027

Shonkoff, S. B., Morello-Frosch, R., Pastor, M., & Sadd, J. (2011). The climate gap: Environmental health and equity implications of climate change and mitigation policies in California—a review of the literature. *Climatic Change, 109*(S1), S485–S503. doi:10.1007/s10584-011-0310-7

Smith, J. B. (1997). Setting priorities for adapting to climate change. *Global Environmental Change, 7*(1), 251–264.

Snover, A. K., Whitely Binder, L., Lopez, J., Willmott, E., Kay, J., Howell, D., & Simmonds, J. (2007). *Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.* In association with and published by ICLEI - Local Governments for Sustainability, Oakland, CA.

Syal, S. S., Wilson, R. S., Crawford, J. M., & Lutz, J. (2011). Climate change and human health—what influences the adoption of adaptation programming in the United States public health system? *Mitigation and Adaptation Strategies for Global Change, 16*(8), 911–924. doi:10.1007/s11027-011-9302-1

The Climate Leadership Initiative. (2010). *Leading by Example: Emission Reduction in Public Health Agencies.* Eugene, OR: The Resource Innovation Group.

The Resource Innovations Group. (n.d.). *Public Health and Climate Change: A Guide for Increasing the Capacity of Local Public Health Departments.* Eugene, OR.

Urwin, K., & Jordan, A. (2008). Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change, 18*(1), 180–191. doi:10.1016/j.gloenvcha.2007.08.002

U.S. Climate Change Science Program. (2008). *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. [Gamble, J. L. (ed.), K. L. Ebi, F. G. Sussman, T. J. Wilbanks (Authors)]. U.S. Environmental Protection Agency, Washington, D.C.

U.S. Global Change Research Program. 2009 *National Climate Assessment* (prepared the. Retrieved from: *http://nca2009.globalchange.gov.*

U.S. Environmental Protection Agency & California Department of Water Resources. (2011). *Climate Change Handbook for Regional Water Planning.* Sacramento, CA. Retrieved from *www.water.ca.gov/climatechange/CCHandbook.cfm.*

Vynne, S., & Doppelt, B. (2009). *Climate Change Health Preparedness in Oregon.* Eugene, OR.: Climate Leadership Initiative, Institute for a Sustainable Environment, University of Oregon.

Watkiss, P., & Hunt, A. (2012). Projection of economic impacts of climate change in sectors of Europe based on bottom-up analysis : Human health. *Climatic Change, 112,* 101–126. doi:10.1007/s10584-011-0342-z

World Health Organization. (2008). *Protecting Health from Climate Change. Geneva,* Switzerland.

Ziska, L. H., Epstein, P. R., & Rogers, C. A. (2008). Climate change, aerobiology, and public health in the Northeast United States. *Mitigation and Adaptation Strategies for Global Change, 13,* 607–613.

ChangeLab Solutions

Law & policy innovation for the common good.

changelabsolutions.org