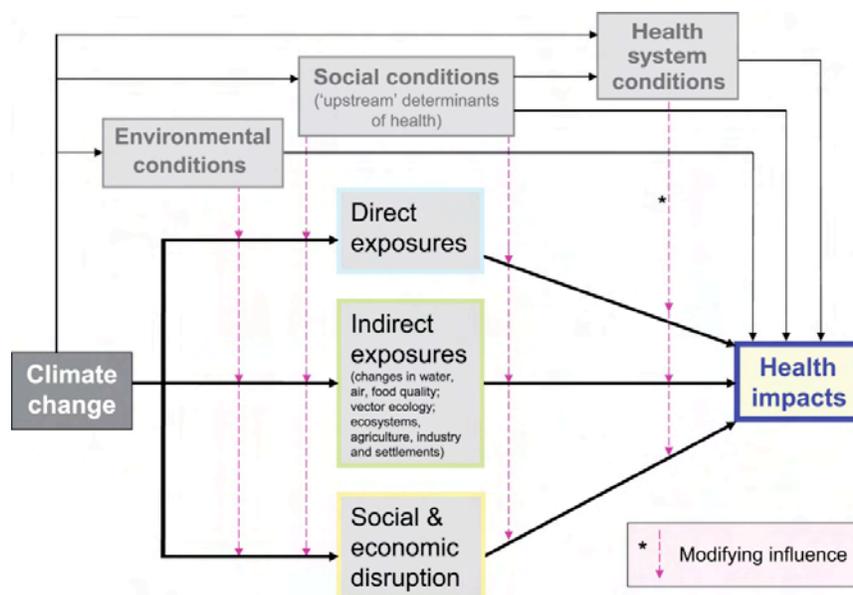


# IV. PUBLIC HEALTH

## Introduction

Climate change threatens the health and well-being of all Californians through a variety of environmental changes including more severe extreme heat and other weather events, a decline in air quality, increases in allergenic plant pollen, more frequent wildfires, and altered environmental conditions that foster the spread of communicable and vector-borne diseases. Climate change also threatens the basic life support systems on which humans depend – our water, food, shelter and security. Among the segments of the population that are at greatest risk include the elderly, infants, individuals suffering from chronic heart or lung disease, persons with mental disabilities, the socially and/or economically disadvantaged, and those who work outdoors.

**Figure 10:** Flow diagram showing inter-relationships of climate impacts to conditions affecting public health.  
Source: IPCC Fourth Assessment Report, 2007.



The effects of climate change are already becoming evident in California, and we will witness to more climate change in the coming decades due to the effects of greenhouse gases already in the atmosphere. Thus, implementation of a public health climate adaptation strategy is imperative. However, a strong public health voice for climate change mitigation is also imperative, because without strong mitigation actions, our adaptation efforts will likely be overwhelmed by more severe climate impacts. Many climate mitigation strategies offer significant public health co-benefits, and these should be prioritized. For example, reducing vehicle miles traveled reduces greenhouse gas emissions, increases physical activity, and leads to reduced rates of obesity and chronic illnesses such as cancer, diabetes, and cardiovascular disease that account for over 2/3 of deaths in the U.S.

Climate change introduces varying levels of vulnerability based on geographic location, community and individual characteristics, and the preparedness and response capacity of individuals and communities. It is important that adaptation planners assess the potential health co-benefits or adverse consequences of adaptation strategies, so that they do not increase vulnerability or adverse health impacts. Examples are increased use of pesticides to control agricultural and vector borne diseases, and increased use of air conditioning, which could increase emissions of GHG and criteria pollutants.

Criteria should be developed during the planning process to evaluate measures and determine the appropriate response in the development of an adaptation strategy. This will require collaboration across agencies.

## Future Climate Change Impacts to Public Health

### A. Increased Temperature and Extreme Weather Events

Climate change is expected to lead to an increase in ambient (i.e., outdoor) average air temperature, with greater increases expected in summer than in winter months. Larger temperature increases are anticipated in inland communities as compared to the California coast.

The potential health impacts from sustained and significantly higher than average temperatures include heat stroke, heat exhaustion, and the exacerbation of existing medical conditions such as cardiovascular and respiratory diseases, diabetes, nervous system disorders, emphysema, and epilepsy.<sup>1</sup> Numerous studies have indicated that there are generally more deaths during periods of sustained higher temperatures, and these are due to cardiovascular causes and other chronic diseases.<sup>2</sup> The elderly, infants, and socially-isolated people with pre-existing illnesses who lack access to air conditioning or cooling spaces are among the most at risk during heat waves.<sup>3</sup>

#### Extreme Heat Events

Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in California.<sup>4</sup> There is no universal definition of an extreme heat event (i.e., heat wave) since it depends on the locale, but in most parts of the U.S., three days over 90 degrees Fahrenheit is considered a heat wave. Extreme heat events can also be defined as temperatures that rise to the highest 10 percent of all temperatures that were recorded during the summer months from 1961-90 in a given locale.<sup>5</sup> Heat waves can be characterized by above-normal averages, or maximum daily temperatures, which may be accompanied by higher nighttime minimum temperatures.<sup>6</sup> There is evidence of a trend in heat waves in California toward higher nighttime (i.e., higher minimum) temperatures as compared with the historical record, with daytime maximum temperatures being more similar to past heat waves.<sup>7</sup> Higher nighttime temperatures mean there is less chance for people to physiologically recover and cool off, and for the built environment (indoors or outdoor) to cool; this contributes to continued heat stress overnight and compounds the effects of high temperatures the following day. In 2006, a ten-day heat wave set multiple records, including maximum

#### PUBLIC HEALTH AND ENVIRONMENTAL IMPACTS DUE TO WARMING

- Higher Rates of Mortality & Morbidity
- Increased Air Pollution
- Seasonal Changes & Increases in Allergens
- Changes in Prevalence & Spread of Disease Vectors
- Possible Decrease in Food Quality & Security
- Reduction in Water Availability
- Increased Pesticide Use

#### ADAPTATION - COUNTY OF SONOMA HEAT WAVE GUIDELINES:

- **Drink** - Drink plenty of cool fluids.
- **Dress** - Wear lightweight, light-colored, loose-fitting clothing. If outdoors, wear a wide-brimmed hat, sunglasses and sunscreen.
- **Decrease** - Limit physical activity and stay indoors in an air-conditioned space (home, library or shopping mall). In an **extreme heat event**, listen to the radio for the location of emergency cooling centers.
- **Defend** - If working outside, monitor your coworkers. Check on elderly friends and family at least twice a day. Check infants and children frequently. Check on those who are overweight or in poor health.
- **Demonstrate** - Avoid hot foods and heavy meals. Make sure animals and pets have plenty of fresh water and shade. Consider bringing pets inside and wet down outside animals.
- **Don't** - Do not leave children, adults or pets in a parked car for any length of time.

daily and minimum overnight temperatures, leading to 140 deaths from heat exposure according to county coroners.<sup>8</sup> A more accurate analysis estimated 655 excess deaths during the heat wave. More heat waves of similar length and intensity are expected to occur on an annual basis by the end of the century if the world follows a higher GHG emissions (A2) pathway.<sup>9</sup>

The anticipated increase in heat waves is expected to increase mortality in California, although further modeling is required to more accurately estimate the magnitude of likely increased deaths. Over the past 15 years, heat waves have claimed more lives in the state than all other declared disaster events combined.<sup>10</sup> This trend is likely to continue as the number of heat waves increase, and thereby lead to potentially hundreds of climate-related fatalities every year. Even though coastal areas will not see the greatest increases in average temperature, the largest increases in mortality rates are expected to occur in coastal cities such as Los Angeles and San Francisco, since these populations are relatively unaccustomed to extreme heat and thus less acclimatized when such events occur (e.g.,<sup>11</sup> less adequate access to air conditioning).

Increased heat waves can exacerbate higher occurrences of chronic disease or heat-related illness. Compared to baseline conditions, there were 16,166 excess emergency room visits and 1,182 extra hospitalizations linked to the July 2006 heat wave throughout California.<sup>12</sup> As record-breaking heat waves occur more frequently in California, excess morbidity will also increase during the summer months. This will require greater preparedness by health care providers and facilities, and will place a strain on California's health care system. Heat waves also necessitate an increase in energy use for cooling and air conditioning, which can lead to electricity shortages and blackouts. A reduction in energy availability can further impact public health by limiting access to air conditioning and refrigeration which can increase the risk of food-borne illnesses.

*Urban Heat Islands:* The "Urban Heat Island" is due to the greater heat retention of buildings and paved surfaces compared to vegetated surfaces. During heat waves, urban heat islands are especially dangerous because they are both hotter during the day and do not cool down at night, increasing the risk of heat-related illness.

### **Adaptation - County of Fresno**

#### **How to Reduce the Effects of Heat**

##### **Seasonal Readiness:**

- Educate the public on the greatest risks of heat
- Identify and prepare cooling centers
- Identify resources to transport citizens to cooling centers
- Coordinate community resources
- Encourage residents to check on family and friends at risk
- Initiate data collection on heat related deaths and illnesses by the Community Health Department Epidemiologist

##### **Heat Emergency Responses:**

- Open cooling centers
- Releasing heat response information to the media, local organizations and community groups
- Provide transportation resources for people unable to reach cooling centers
- Coordinate local heat-related resources, donations and volunteers
- Monitor the health of vulnerable populations by county agencies and community groups
- Monitor medical reports of heat-related illnesses and deaths; and
- Provide information to the public regarding available utility bill (air conditioning) assistance resources

*Health Inequities Issues:* Several factors could contribute to health inequities related to increased heat exposure:

- a. Chronic illness co-morbidities: Low income and minority communities have an increased prevalence of chronic illnesses that place individuals at greater risk of heat-related illness.
- b. Exposure to urban heat island effect: Low-income individuals and people of color are often concentrated in urban areas subject to the heat island effect.
- c. Access to air-conditioning: Low income individuals and people of color are less likely to have air conditioning.
- d. Occupation: Agricultural workers are especially at risk of heat illness due to the combination of outdoor work in hot climates (e.g. Central and Imperial valleys) and jobs demanding physical exertion.
- e. Fear of crime: Low income and minority communities may be reluctant to open doors and windows for ventilation during heat waves for fear of crime.

## **Fewer Freezing Spells**

Currently, freezing events occur on an annual basis in many areas of California. When temperatures drop below freezing, heat is lost from the body more rapidly and can lead to hypothermia. People without shelter, or who live in a poorly insulated home or lack a source of heat are at higher risk of cold-related health effects, as are children and the elderly.

Freezing spells are likely to become less frequent in California as climate temperatures increase; if emissions follow higher pathways, freezing events could occur only once per decade in a sizable portion of the state by the second half of the 21st century.<sup>13</sup> While fewer freezing spells would decrease cold-related health effects, too few freezes could lead to increased incidence of disease as vectors and pathogens do not die off.

## **Changes in Air Quality**

Many Californians living in or near urban areas currently experience the worst air quality in the nation, with associated economic costs reaching tens of billions every year.<sup>14</sup> Research indicates that climate change influences on atmospheric processes will promote formation of ground-level pollutants, such as ozone and secondary aerosols (particulate matter), and that these increases could offset much of the potential gains achieved through air pollution control measures, a phenomenon referred to as the “climate penalty”.<sup>15</sup>

Short-term effects of air pollution include irritation to the eyes, nose and throat, as well as increased incidence of upper respiratory inflammation. In addition, short-term air pollution tends to aggravate the medical conditions of individuals with asthma and emphysema. Similar to heat waves, public health impacts from particulate matter are highest among the elderly, followed by infants and young children.<sup>16</sup> Recent evidence shows that ozone and particulate matter exposures can initiate cardiovascular and lung disease resulting in increased overall mortality.<sup>17</sup>

An increase of ground-level (tropospheric) ozone can cause decreases in lung function and increase airway reactivity and inflammation. Particulate matter can aggravate existing respiratory and cardiovascular disease and damage the lungs, leading to premature death; it may also contribute to increased risk of cancer. According to the California Air Resources Board (CARB), current exposures to just two common air pollutants – ozone and particulate matter (PM) cause around 8,800 deaths, 9,500 hospitalizations, 200,000 cases of asthma and lower respiratory symptoms, and nearly 5 million school absences in California each year ([www.arb.ca.gov/research/health/qhe/qhe.htm](http://www.arb.ca.gov/research/health/qhe/qhe.htm)). Other air pollutants – such as sulfur and nitrogen oxides – also affect the respiratory and cardiovascular systems.

**Aero-allergens:** Both increased temperatures and increased carbon dioxide concentrations are expected to increase plant production of pollens, and may also increase fungal growth and spore release. Pollen and mold spores are allergens; they can induce and/or aggravate allergic rhinitis, asthma (already the

most common childhood chronic illness), and chronic obstructive pulmonary disease. Allergic diseases are the sixth leading cause of chronic disease in the U.S. and impose a substantial burden on the U.S. population. Some experts have suggested that the global rise in asthma is an early health effect of climate change. (<http://www.cdc.gov/climatechange/effects/allergens.htm>)

Changes in temperature affect atmospheric chemistry and the amount of some pollutants like ozone that are in the air. The relationship between temperature change, air quality and human health is complex and synergistic. Four specific dimensions of the relationship have been studied to different degrees: 1) direct effects of temperature on health; 2) direct effects of air pollution on health; 3) temperature and geographic factors that modify pollution effects on health; and 4) pollution factors that modify temperature effects on health.

Climate change can affect exposure to air pollution in several ways:<sup>18</sup>

1. Increasing air temperatures increase ozone levels, which are formed by reactions between nitrogen oxides and hydrocarbons released from motor vehicle combustion of fuel.
2. Increasing temperatures can change human behavior in ways that increase air pollution – for example, through increased fuel combustion to meet electricity demand for increased air conditioner use
3. Climate change can effect patterns of air mixing and air flow that transport pollutants
4. Increased temperatures can increase the emission of pollutants called volatile organic compounds from plants and vegetation.

Knowledge of air pollution direct health effects has resulted in regulations for criteria air pollutants and hazardous air pollutants. Changes in air pollutant levels due to temperature changes will result in more non-attainment days and greater risks of disease to the involved populations. Recent research suggests that changes in temperature and geographic location will further modify the effect of air pollutants on respiratory and cardiovascular health and mortality. Conversely, it has been demonstrated that changes in ozone or particulate matter levels modify the effect of heat on cardio-vascular mortality.<sup>19</sup> One recent study estimated that each one degree (Celsius) increase in temperature would cause about 1,000 additional deaths in the U.S. associated with air pollution.<sup>20</sup>

*Health Equity Issues:* Air pollution levels in poor urban neighborhoods are often substantially higher than those in other areas, due to closer proximity to freeways and other motor vehicle arterials, and industrial pollutant sources.<sup>21</sup> Asthma rates are higher in low income and minority children in California. Increases in air pollutants and/or aero-allergens may exacerbate these existing health inequities, unless special care is taken to reduce pollution sources; recent action by the CARB to reduce diesel truck pollution is a good example of a policy that could reduce these health inequities.

## B. Precipitation Changes and Extreme Events

Changes in precipitation patterns will affect public health primarily through extreme events such as floods, droughts and wildfires. In addition, higher temperatures combined with changes in precipitation patterns create conditions that are more conducive to the occurrence and spread of infectious diseases.

### Floods and Droughts

The impacts of flooding can be significant. Results may include population displacement, severe psychosocial stress with resulting mental health impacts, exacerbation of pre-existing chronic conditions, and infectious disease<sup>22</sup>. Additionally, impacts can include a loss of personal belongings, and the emotional ramifications from such loss, to direct injury and/or mortality. Preparation and emergency response plans are therefore needed to address anticipated flooding, especially in urban areas with high population densities which can potentially overwhelm emergency services and medical facilities.

Drinking water contamination outbreaks in the U.S. are associated with extreme precipitation events.<sup>23</sup> Runoff from rainfall is also associated with coastal contamination that can lead to contamination of shellfish and contribute to food-borne illness.<sup>24</sup> Flood waters may contain household, industrial and agricultural chemicals as well as sewage and animal waste. Flooding and heavy rainfall events can wash pathogens and chemicals from contaminated soils, farms, and streets into drinking water supplies. Flooding may also overload storm and wastewater systems, or flood septic systems, also leading to possible contamination of drinking water systems.

Drought impacts develop more slowly over time. Risks to public health that Californians may face from drought include impacts on water supply and quality, food production (both agricultural and commercial fisheries), and risks of waterborne illness. As the amount of surface water supplies are reduced as a result of drought conditions, the amount of groundwater pumping is expected to increase to make up for the water shortfall. The increase in groundwater pumping has the potential to lower the water tables and cause land subsidence. Communities that utilize well water will be adversely effected both by drops in water tables or through changes in water quality. Groundwater supplies have higher levels of total dissolved solids compared to surface waters. This introduces a set of effects for consumers, such as repair and maintenance costs associated with mineral deposits in water heaters and other plumbing fixtures, and on public water system infrastructure designed for lower salinity surface water supplies. Drought may also lead to increased concentration of contaminants in drinking water supplies.

**Figure 11: Increasing Wildfire Risk**



## Wildfires

Drought also results in increased frequency and duration of wildfires; another significant risk to public health. Wildfire frequency and intensity is expected to grow as temperatures increase and vegetation dries due to longer dry seasons.<sup>25</sup> In addition to the associated direct risk of fatalities, wildfires can lead to immediate and long-term adverse public health problems due to exposure to smoke. Smoke from wildfires is a mixture of carbon dioxide, water vapor, carbon monoxide, hydrocarbons and other organic chemicals, nitrogen oxides, trace metals, and fine particulate matter from burning trees, plants, and built structures. During wildfires, large populations can be exposed to a complex mixture of pollutant gases and particles, which can have both acute and chronic health impacts. Smoke can irritate the eyes, harm the respiratory system, and worsen chronic heart and lung diseases, including asthma.<sup>26</sup> People with existing cardiopulmonary diseases are generally at the greatest risk from smoke inhalation, with age being a complicating risk factor for the exposed population.

### PUBLIC HEALTH IMPACTS DUE TO SEA-LEVEL RISE

- Wastewater issues with flooding of septic systems near coastline
- Salt water intrusion – risks to drinking water
- Threats of injury and even death during coastal storms
- Emotional and mental health impacts related to more coastal flooding and erosion
- Emotional and mental health impacts related to internal displacement and migration of coastal residents

## C. Sea-level rise

As sea level rises, the flood risks will be exacerbated in coastal areas as higher storm surges cause greater tidal damage and flooding, and reach into inland areas that have been historically untouched by sea waters. Potential impacts include physical injury, loss of property and belongings, and emotional trauma from such events. In one study conducted for the 2008 Climate Change Impacts Assessment, researchers assessed the areas, population, and assets at risk from inundation during a coastal storm after sea level had risen by ~5 feet (1.4 m). In the face of the encroaching ocean, up to 480,000 people and their residential assets (homes and property) were found to be at risk (70 percent of all at-risk assets) by the end of the century from such flooding events.<sup>27</sup> In short, much of California's prime real estate will be affected in coming decades by accelerating sea-level rise.

Sea-level rise also increases the likelihood of saline intrusion into drinking water sources and agricultural water supplies. Such events have already occurred along the Los Angeles and Orange county coastal areas since the 1950's. In response, sea water intrusion barriers were built and operated to protect these aquifers. As sea levels rise, more effort will be needed to protect these and other coastal communities from salt water intrusion into the water supply.

## Infectious Diseases

Climate change could affect the range, incidence and spread of infectious diseases, including vector-borne diseases, zoonotic diseases, (i.e., animal diseases that are transmissible to humans), water-and food-borne diseases, and diseases with environmental reservoirs (e.g., endemic fungal diseases).<sup>28</sup> In California, predictions for more frequent wildfires, droughts and heat waves are associated with possibilities for forced migration of communities which could enhance transmission of disease due to crowding, homelessness, poverty and scarce resources – here at home and abroad. Large scale migrations have been associated with surges in communicable disease and emergence of not previously noted novel infections throughout recorded history. These new demands will occur in an environment of global travel, emerging novel viruses such as H1N1, multiple drug resistance, and immune disorders (including HIV/AIDS) with their associated increased risk of tuberculosis and other infections.

## **Vector-Borne Diseases**

Changes in temperature and precipitation are likely to cause changes both in the geographic distribution and the quantity of vectors (such as ticks and mosquitoes) that carry human disease. In California, three vector-borne diseases are of particular concern: human hantavirus cardiopulmonary syndrome, Lyme disease, and West Nile virus. These diseases vary in their response to climate-related factors such as temperature, humidity, and rainfall.<sup>29</sup> The distribution of vectors may change as humid areas become drier and less suitable habitats, while other areas may become wetter, allowing for the vectors to exist where they previously did not. Abundance of small mammal reservoirs may similarly be affected.

In California, the adult or sub-adult (nymph) western black-legged tick can transmit a Lyme disease agent to humans. Lyme disease-carrying ticks are found in patchy distribution patterns in moist, humid environments such as coastal redwood or hardwood forests, and the risk of Lyme disease is highly correlated with exposure to habitats where these ticks live.<sup>30</sup> Exposure to the western black-legged tick in California is most often through recreation or occupation where ticks are prevalent, although exposure also occurs with increased development in previously wild areas.

Though increased rainfall may temporarily provide increased mosquito breeding sites, in fact, rainfall has little effect on West Nile Virus (WNV) transmission since urban mosquitoes breeding in municipal water systems may benefit from below-normal rainfall. However, an increase in summer rainfall could make California more at risk for the introduction and establishment of exotic vectors such as the principle mosquito vectors of dengue and yellow fever. Each of these climate-related variables – along with unrelated changes in land use and land cover – can modify the geographic range of vectors, thereby raising the possibility that some of these vector-borne diseases may become more common in California. According to the CDC the first West Nile virus infection was detected in 2003 in California and the transmission appeared to increase and spread soon after.<sup>31</sup>

Climate change may affect rodent populations through the availability or increase in food supplies.<sup>32</sup> Prolonged rainfall and/or flood can increase the food supply for rodents, thereby increasing the risk that human populations will become infected by diseases carried by rodents. Wild rodents can also act as hosts to ticks and fleas that can transmit diseases such as Lyme disease, plague, tularemia, and rickettsial infections. Humans can also contract hantavirus cardiopulmonary syndrome when they come into contact with infected rodents or their urine and droppings.

## **Water- and Food-Borne Diseases**

The risk of water- and food-borne diseases such as mild gastrointestinal illnesses could increase as California's drinking, irrigation, and recreational waters are impacted by climate change. Such infections and illnesses can become chronic and even fatal in infants, the elderly, pregnant women, and people with weakened immune systems.

Historically, outbreaks of water-borne diseases have been linked to heavy rainfall and subsequent runoff, which results in a decline in the quality of surface water arriving at water treatment plants.<sup>33</sup> In California, the expected increase in the intensity of rainfall could result in periodic deterioration of the quality of drinking water, and require not only more careful monitoring, but also additional water treatment to maintain adequate water quality. People can contract water- and food-borne diseases by drinking contaminated water, eating seafood from contaminated water, and eating produce irrigated with contaminated water. They can also be exposed to water-borne infectious illnesses while fishing or swimming in affected waters. Higher water temperatures, as a result of warming, can accelerate the spread of water-borne diseases.

Harmful algae blooms, which produce nerve and liver toxins, have been noted to be of longer duration and larger intensity, and are suspected to be tied both to increased temperatures due to climate change and nutrient runoff. Exposure to marine life has resulted in death and poisonings of California sea lions. Human exposure is of concern both through drinking water contamination and recreational exposure. Human exposure to these blooms can cause eye and skin irritation, vomiting and stomach cramps,

diarrhea, fever, headache, pains in muscles and joints, and weakness. Chronic exposure in drinking water supplies is suspected to have links with liver damage and cancer.<sup>34</sup>

## **The Food Supply**

*Marine Biotoxins:* Warming oceans and rising sea level may have a dramatic impact on both commercial and recreational shellfish harvesting. Increased water temperatures could lead to an increase in the frequency and distribution of naturally-occurring pathogens such as *Vibrio parahaemolyticus*, which has caused hundreds of illnesses linked to shellfish consumption. Likewise, increased temperatures, combined with decreased salinity from greater rainfall, could result in increases of the deadly *V. vulnificus* bacterium currently found predominantly in the Gulf of Mexico.

Exceptionally clean water is necessary to ensure that filter feeding shellfish are safe for consumption. Rising sea level will inundate coastal structures, flooding septic systems and other low-lying sewage collection systems. As a result, coastal waters, particularly in bays and estuaries, will be too polluted for shellfish culture, harvesting and consumption.

Marine biotoxins are naturally occurring neurotoxins produced by a small number of single-celled marine algae called phytoplankton. Phytoplankton populations are affected by a variety of physical processes (e.g., sea surface temperature, upwelling, nutrient flux, salinity) that could dramatically change due to global warming. Marine toxins are bioconcentrated by filter-feeding organisms such as bivalve shellfish (e.g., mussels, clams, oysters, scallops), omnivorous crustaceans (e.g., Dungeness crab, lobster), and small finfish (e.g., anchovy, sardines). The occurrence of these toxins in seafood presents serious health risks to human consumers as well as marine life such as sea lions and sea otters. California has had illnesses and deaths associated with the paralytic shellfish poisoning (PSP) toxins documented in coastal tribes predating written history. Domoic acid, a new toxin which produced four deaths and hundreds of illnesses in 1987 in Canada, was identified just four years later in California, where it caused hundreds of deaths in marine birds in Monterey Bay.

*Crop yields:* Climate change could present serious negative impacts to the crop yields of California's agricultural system, including both annual and perennial crops. Crop yield is likely to be impacted by climate change effects on water supply, as well as by reduced freezes required for many crops such as stone-fruits. Not only is the food produced in California necessary to feed Californians, especially fresh fruits and vegetables that are a critical part of a healthy diet, but many of the crops are produced for export outside of the state and to other countries, and result in significant tourism (e.g., wine grapes). Any significant decrease in crop yields endangers food availability to Californians, the multibillion agricultural system, and also the employment of many low-paid migrant farm workers.

*Fisheries:* Changes in ocean conditions will also substantially change the distribution and abundance of major fish stocks. Diminished stream flows, warming ocean water temperatures, and ocean acidification could all contribute to fisheries declines. Impacts to fisheries related to El Niño/Southern Oscillation illustrate how climate directly impacts marine fisheries on short term scales. Higher sea surface temperatures in 1997-1998 during the El Niño had a great impact on market squid, California's largest fishery by volume. The California Regional Assessment reports that landings fell to less than 1,000 metric tons in that season, down from 110,000 tons in the 1996-1997 season. Other unusual events also occurred such as poor salmon returns, a series of plankton blooms, and seabird die-offs. As with agricultural crop yields, significant declines in fisheries will adversely affect the availability and price of fish (an important component of a healthy diet) and employment of workers in this industry. Additionally, food systems may be under stress due to disruptions in transportation systems (e.g. extreme weather conditions, heat buckling of roads or railways).

*Health inequities:* Declines in crop yields and fisheries may contribute to substantial increases in food prices, which would disproportionately impact low income communities who already spend a higher percentage of their income on food. Reduced agricultural employment will impact low income farm workers and their families.

## **D. Risks to Public Health**

In summary, climate change brings significant public health risks. Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in California, which is likely to increase the risk of mortality and morbidity due to heat-related illness and exacerbation of existing chronic health conditions. Those most at risk and vulnerable to climate-related illness are the elderly, individuals with chronic conditions such as heart and lung disease, diabetes, and mental illnesses, infants, the socially or economically disadvantaged, and those who work outdoors.

The expected increase in extremely high temperatures and increased ultraviolet radiation due to climate change is likely to exacerbate existing air quality problems unless measures are taken to reduce GHG as well as air pollutants and their precursors. Climate change can lead to an increase in the occurrence and severity of respiratory illnesses as a result of declining air quality combined with higher temperatures. It can also alter the timing and/or duration of seasonal allergies.

Changes in precipitation patterns affect public health primarily through potential for altered water supplies, and extreme events such as floods, droughts, and wildfires. These extreme events are likely to increase, thereby exposing the population to the risk of direct injury and/or mortality, respiratory illness associated with wildfires, property loss, displacement, and associated emotional distress. Adequate preparation is needed to provide sufficient emergency services and access to medical facilities. The direct risk of injury and fatalities from a combination of wildfires, higher temperatures, and longer dry seasons will contribute to an increase in poor air quality and related respiratory illnesses.

Wide ranging and unpredictable communicable disease impacts that are likely to result from climate change highlight the need to strengthen public health infrastructure related to electronic disease surveillance, food and water safety, control of insect vectors, control of animal reservoirs of diseases, and increasing the capacity of infectious disease outbreak response.<sup>35</sup>

## **Public Health Adaptation Strategies**

### **Introduction**

The goal of these Public Health Adaptation Strategies is to minimize the negative health impacts of climate change. This will require an increased awareness of potential climate change-related public health impacts, improved surveillance and monitoring of climate risks and related outcomes, maintenance of a robust public health infrastructure, expanded research, and most importantly, healthy, equitable, and resilient communities that are able to mitigate and respond to climate change and protect vulnerable populations. Failure to control greenhouse gas emissions will result in more extreme and possibly catastrophic climate change that will likely overwhelm our capacity to adapt; the Public Health climate change adaptation work group has thus incorporated climate mitigation strategies with health co-benefits in its strategy to increase community resilience to climate change. Implementation of a credible public health climate change adaptation strategy will require dedicated and sustained resources.

## Adaptation Strategies and Actions

The Public Health Climate Change Adaptation Work Group, in concert with the Department of Public Health, has identified the following priorities for public health adaptation for climate change. The near-term actions referenced below are those identified actions which can be initiated by 2010 (contingent on available and sustained funding). The long-term actions include those recommended actions that will require support from the state and collaboration with multiple state agencies and are identified as cross-sector strategies.

### ***Strategy 1: Promote Community Resilience to Reduce Vulnerability to Climate Change.***

#### **Near-Term Actions:**

- a. **Promote Healthy Built Environments** – CDPH should continue working in collaboration with local health departments, community based organizations (CBOs), and other state and local planning and transportation agencies to improve community planning and design to promote healthy living, and to balance integration of social, economic and environmental concerns. CDPH should identify mechanisms to institutionalize the consideration of health in local and regional land use and transportation decision-making in, for example, local general plans, regional transportation plans, or CEQA guidelines, and through the use of Health Impact. CDPH should develop guidelines for health impact assessment, for use by local health departments and other agencies.
- b. **Identify and Reduce Health Vulnerabilities** -- CDPH should provide tools for use by local health departments, other agencies, and CBOs to identify and reduce climate-related health vulnerabilities. For example, community wide assessments could identify the homes occupied by disabled persons and seniors, assess the safety, energy and water use efficiency of these homes, and modify or retrofit homes, for example weatherproofing, energy efficient appliances, and shade cover. Identification of urban heat islands could lead to targeted efforts to increase shading and reduce heat-reflecting pavement through,<sup>36</sup> for example, expansion of parks and community gardens. Increased efforts to reduce air pollution in “toxic hot spots” would also decrease vulnerability to the health effects of increased air pollution with rising temperatures.
- c. **Food Security and Quality**– CDPH should work in partnership with USDA, CDFA, and CDSS to maintain commitment to healthy foods and nutrition programs that improve access to healthy foods in low-income communities. CDPH should partner with Local Health Departments and CBOs to promote healthy sustainable local food systems through working for consideration of healthy food access in agricultural, land use, and other policies (e.g., zoning to allow farmers markets, incentives for farm to school/business/consumer, community and school gardens, and strong state support for programs such as Women, Infants and Children (WIC), SNAP-Ed, etc). CDPH should partner with CDFA and local health and environmental agencies to enhance capacity for surveillance and response for food-borne illness outbreaks.

#### **Long -Term Actions:**

- d. **Food Sustainability** – CDPH should promote sustainable local food systems to reduce reliance on food that requires a high amount of “vehicle miles traveled”. This could be done through supporting projects with mutual partners and/or through media/outreach campaigns, such as school and community gardens, peri-urban “ring” agriculture, farmland preservation, etc. CDPH should consider working in conjunction with the Natural Resources Agency and the CDFA to discuss/to develop a work group on food and climate change to assure the implementation of sustainable food practices, and policies including promoting a wider range of organic and local foods to California residents and California programs

- e. **Reduce Heat Islands** – CDPH should partner with academia, local, state and federal agencies, and other climate change experts to identify urban heat islands, and work with state and federal agencies such as CAL FIRE, USFS Urban Forestry Program and DPR (Department of Parks and Recreation), and community partners to increase ground cover and shading by expanding urban forests, community gardens, parks, and native vegetation-covered, as well as open spaces.
- f. **Support Social and Community Engagement** – The experience of Hurricane Katrina suggests how important neighbors and local support networks can be in response to climate emergencies and in rebuilding after disasters. Community-based approaches will be more likely to result in meeting the needs of all communities, rather than top down approaches administered at the state level. CDPH should incorporate concepts of social and community engagement into its work with local health departments and CBOs, and develop climate change communication tools and messages that promote active community engagement, to build resilient communities, identify vulnerable populations, and promote social support networks.
- g. **Health Access** – State departments and agencies that have a direct role in health access (e.g., Department of Health Care Services, MRMIB, Department of Managed Health Care, and CDPH) should promote increased access to health care, in order to ensure that at-risk populations are prepared for gradual and extreme climate change events. .

***Strategy 2: Educate, Empower and Engage California Citizens, Organizations and Businesses to Take Actions to Reduce Individual and Community Vulnerability to Climate Changes through Mitigation and Adaptation.***

**Near -Term Actions:**

- a. **Educational Outreach Campaign** – Incorporate climate change and public health messages into existing education and media outreach efforts. Develop diverse educational materials for diverse populations (e.g., vulnerable communities, school-age children, business, and labor) that focus on the health impacts of climate change. Conduct focused outreach to clinicians and the health sector about the health impacts of climate change, actions the health sector can take to mitigate and adapt to climate change, and prevention and management of climate-related illnesses (e.g., heat illness). Utilize existing resources to disseminate climate-related health information (e.g., [bepreparedcalifornia.ca.gov](http://bepreparedcalifornia.ca.gov)., public health advisories).
- b. **Specific Outreach to Vulnerable Populations** – Identify dissemination networks (e.g., CBOs, local government, philanthropic organizations) that can reach vulnerable populations (e.g., outdoor workers and their employers, residents in urban heat islands, asthmatics, immigrants with literacy/language needs) and provide them with information on what they need to know about the risks of climate change, and what they can do to address them, both individually and at the community and state levels.

**Long-Term Actions:**

- c. **Proactive Social Marketing Campaign** – CDPH should encourage and participate in partnerships with local, state and federal agencies, business, and NGOs to develop coordinated social marketing campaigns to reduce greenhouse gas emissions and implement climate adaptation strategies; these campaigns should support local efforts and empower communities to act on their own behalf to minimize the health impacts of climate change.

### ***Strategy 3: Identify and Promote Mitigation and Adaptation Strategies with Public Health Co-benefits.***

#### **Near -Term Actions:**

- a. **Identify and Prioritize Strategies with Co-benefits** – CDPH should identify public health and climate change mitigation and adaptation strategies that offer health and climate co-benefits; strategies with co-benefits should be prioritized. For example, community design (“smart growth”) that promotes walking and bicycling to increase physical activity and decrease motor vehicle greenhouse gas and toxic pollutants. When possible, adaptation strategies that increase health risks and/or greenhouse gas emissions should be avoided. (e.g. promoting air conditioner use without changes in electricity production reliance on fossil fuel combustion). Strive to institutionalize the inclusion of public health considerations in all applicable climate change policies.

### ***Strategy 4: Establish, Improve and Maintain Mechanisms for Robust Rapid Surveillance of Environmental Conditions, Climate-related Illness, Vulnerabilities, Protective factors and Adaptive Capacities.***

#### **Near -Term Actions:**

- a. **Monitor Outcomes at State and Local Level** – CDPH should work with local health departments and the health care services sector to increase capacity to monitor the climate related deaths and illnesses associated with heat-related and other events, as well as other climate related illnesses, environmental risks, vulnerabilities, protective factors, and adaptive capacities. Maintain operation of the California Environmental Health Tracking Program, and incorporate the climate health indicators recommended by the Council of State and Territorial Epidemiologists.
- b. **Environmental Contaminant Biomonitoring** – CDPH and Cal/EPA (California Environmental Protection Agency) should encourage the development of the existing California Environmental Contaminant Biomonitoring Program to determine the level of contaminants in California residents to help reduce baseline illness and increase community resiliency.
- c. **Water Accessibility Information** – Maintain and upgrade the existing Safe Drinking Water Information System, which provides information about public water systems and their violations of EPA's drinking water regulations regarding maximum contaminant levels, treatment techniques, and monitoring and reporting requirements, in order to ensure safe and reliable public water resources.
- d. **Heat Warning Systems** – Work with the CDPH Emergency Preparedness Office EPO, CalEMA, and local health and emergency response agencies to develop heat warning systems for regions of the State that have not yet adopted them. These systems should be coupled with existing heat emergency response plans.

#### **Long -Term Actions:**

- e. **Electronic Surveillance Systems** – The CDPH should continue actions to improve disease reporting, management and surveillance by replacing the current paper based system with a secure electronic system, (CDC is exploring ways to develop rapid surveillance by coordinating with larger entities such as the Regional Health Information Organizations (RHIOs) and Health Information Exchanges (HIE).
- f. **Expand the Electronic Death Reporting System** for the continuous monitoring of abnormal death patterns, asthma, and heat deaths. Actions should be taken to consider mandatory reporting of climate-sensitive morbidity and mortality.

- g. **Emergency (Event) Monitoring** – Build a real-time data collection system for the daily monitoring of emergencies based on daily hospitalizations data, emergency department care, and diagnostic, laboratory, and prescription information.

### ***Strategy 5: Improve Public Health Preparedness and Emergency Response***

#### **Near -Term Actions:**

- a. **Preparedness Response** – CDPH and local health departments should refine existing emergency preparedness plans and conduct exercises to augment preparedness for events likely to increase with climate change (e.g., heat waves, wildfires, floods), and should develop plans for anticipated impacts such as sea level rise, saline intrusion into drinking water, etc. Public health agencies should also be prepared for the more frequent occurrence of severe heat events in geographic areas where they have previously been very rare (e.g., coastal areas). Formally request the Centers for Disease Control and Prevention to incorporate climate change response and preparedness as an acceptable use of federal funds for public health preparedness.

### ***Strategy 6: Work in Partnership with Multiple Agencies (e.g., Environmental, Agricultural, Transportation, and Education at Local, State and Federal levels, as well as Business, Labor, Schools and Community-based Organizations).***

#### **Near -Term Actions:**

- a. **Institutional Capacity** – CDPH should work with appropriate state and local agencies to expand training and education to build capacity to respond appropriately to the public health risks of climate change. Institutional capacity needs should be addressed in local health departments, health and social services providers, and mental health agencies (e.g. for post-disaster recovery).

### ***Strategy 7: Conduct Research to Enable Enhanced Promotion and Protection of Human Health in Light of Climate Change.***

#### **Near -Term Actions:**

- a. **Vulnerability Assessments** – CDPH should conduct detailed vulnerability assessments for all the leading climate-change health outcomes (e.g., heat morbidity, valley fever, flooding, wild fires) utilizing locally scaled-down emergency and environmental shift scenarios, including assessments of impacts on vulnerable populations and cumulative impacts, and risk and resilience factors.
- b. **Research Collaboration:** – CDPH should encourage the California Energy Commission PIER program to devote more substantial attention to a public health research agenda. CDPH should develop a closer working relationship with the University of California and other universities and NGO's involved with climate change analysis and impacts, and provide greater input to federal agencies conducting climate change research to increase funding and focus on public health impacts.

**Long -Term Actions:**

- c. **Assess Local Impacts of Climate Change on Health** – Apply downscaled climate change predictions and modeling to provide analysis of anticipated local impacts on health.

***Strategy 8: Implement Policy Changes at Local, Regional and National Levels.***

**Near -Term Actions:**

- a. **Policy Collaboration:** Work with stakeholders to develop federal and state policies to implement adaptation strategies that reduce public health risks related to climate change.
- b. **Occupational Safety Standards** – Advise and revise occupational health and safety standards to identify occupations at risk due to climate change.

**Long -Term Actions:**

- c. **Model Policies & Training** – Identify model adaptation policies for local communities, and provide supportive training and technical assistance to facilitate implementation.
- d. **Public Engagement** – Initiate the engagement of all sectors of government, thereby including public health issues in all climate change policies they that offer possible co-benefits for climate change adaptation.

***Strategy 9: Identify, Develop and Maintain Adequate Funding for Implementation of Public Health Climate Adaptation Strategy.***

**Near -Term Actions:**

- a. **Funding Mechanisms** – Develop a comprehensive funding strategy for public health adaptation strategies that utilize a broad range of funding strategies including fees, taxes and grants. Funds should be allocated to both statewide and local efforts, and specifically to local health departments.

**Long -Term Actions:**

- b. **Funding Mechanisms/AB32** – Develop proportional funding proposals for public health research, adaptation and climate resiliency education that addresses Environmental Justice, and is based upon market mechanisms such as carbon auctions and carbon trading.