

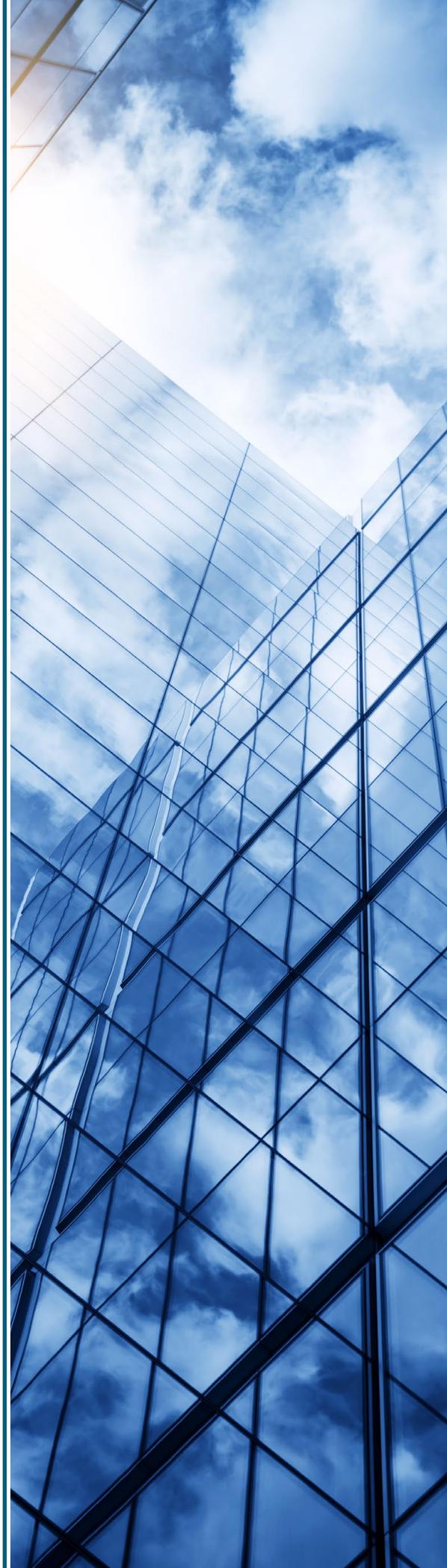
# Executive Order B-30-15 Resiliency Guidebook

## Vulnerable Populations

Executive Order B-30-15 directed State agencies to integrate climate change into all planning and investment, including accounting for current and future climate conditions in infrastructure investment. OPR was directed to convene a Technical Advisory Group to develop guidance to support implementation of the Executive Order.

The Technical Advisory Group (TAG) included members from nearly every State agency, local and regional governments, non-governmental and community-based organizations, and the private sector. The TAG produced a guidance document called "[Planning and Investing for a Resilient California: A Guidebook for State Agencies.](#)" This document provides high-level guidance on what future conditions to plan for and how State agencies should approach planning differently in light of a changing climate. The Executive Order also mandated that because "climate change will disproportionately affect the state's most vulnerable people", all "State agencies' planning and investments shall...protect the state's most vulnerable populations". This was the first mandate in the United States requiring all state agencies to plan for climate change and to protect vulnerable people while doing so.

The following document provides descriptions of how some populations are more vulnerable to the impacts climate change than others. While it is not an exhaustive list, the published evidence suggests that these groups of people face existing inequities, and tend to suffer worse outcomes associated with climate-related events. This resource can be used to help prioritize investments and resources to aid resilience for people more likely to suffer harm from the effects of climate change. These descriptions were developed by the Equity and Vulnerable Communities subcommittee of the Technical Advisory Group, facilitated by the Climate Change and Health Equity Program of the California Department of Public Health.<sup>1</sup>



## Children<sup>2</sup>

Injury, death, infectious diseases, malnutrition, and posttraumatic stress are more common in children than adults after extreme weather events.

Children are especially vulnerable to the impacts of climate change because of (1) their growing bodies; (2) their unique behaviors and interactions with the world around them; and (3) their dependency on caregivers.

Children's growth and development from infancy to adolescence makes them more sensitive to environmental hazards related to climate. For example, because children's lungs develop through adolescence, they are more sensitive to respiratory hazards. Climate change worsens air quality because warming temperatures make it easier for ground-level ozone to form. Changing weather patterns and more intense and frequent wildfires also raise the amount of pollution, dust, and smoke in the air. For children, this change in air quality may increase the number and worsen the severity of asthma episodes. During the 2003 wildfires in Southern California, respiratory hospital admissions related to wildfires increased 8.3% among children under 5 years old. Exposure to air pollution increases the risk for allergen sensitization in children under 5 years old and increases risk for hospitalization for bronchiolitis and death among infants. Increased levels of air pollution also can increase asthma related emergency department visits and hospitalizations. Climate change is also expected to lead to longer and more severe pollen seasons, triggering asthma and allergies in children.

In addition to developing physically, children are also developing emotionally. Climate change will lead to an increase in the frequency, severity and duration of some extreme weather events, increasing risks to children's mental health. When extreme weather causes injuries, death, or displacement, children may have difficulty controlling their emotions, may not perform as well in school, and may face depression, anxiety and

post-traumatic stress. While many children show resilience to traumatic events, mental health impacts may last into adulthood, especially if left untreated.

Children's behaviors and interactions with the world around them increase their exposure to certain health threats that are expected to increase due to climate change. Children, particularly those with disabilities or special health needs, must rely on parents or caregivers to provide for basic needs like nutrition, shelter, hygiene, and clothing. Children separated from their caregivers during weather events, such as during storms and floods, are at increased risk of health impacts. Small children play on the ground and place their hands and other objects in their mouths. This increases their exposure to allergens such as dust, mold spores, and pollen. Climate-related increases in droughts and dust storms can increase levels of dust. More frequent extreme weather events such as flooding can lead to indoor mold growth. Children and student athletes often play outside and may not recognize the signs of becoming dehydrated or overheated. Children have a higher risk of becoming ill or dying due to extreme heat. Children spend more time outdoors than adults, increasing their exposure to mosquito and tick bites. These bites can cause diseases that are diagnosed more often in children, such as La Crosse encephalitis or Lyme disease. Climate change and increased temperatures will lead to insects expanding their ranges and being present for longer seasons. Children swallow about twice as much water as adults while swimming, and are thus more likely than adults to develop serious stomach and diarrheal illnesses if they drink contaminated water. Climate change increases contamination risk in water bodies where children play. Storms and floods may compromise local sources of drinking water.

Climate change affects children differently depending on their age and stage of development. These stages begin in the womb and continue throughout

childhood and adolescence. Newborns are more likely to be born before their due date or at a low birth weight if their mother is exposed during pregnancy to extreme heat, air pollution, flood-related contaminants, or an extremely stressful event. Infants in particular have a greater risk for mortality and heat-related illnesses. Infants and toddlers breathe, eat, and drink more for their body size than adults. They are sensitive to pollutants or allergens in the air, which may trigger asthma episodes. Infants and toddlers are also sensitive to contaminants in water and food, which increases the risk of diarrhea. Heat-related illness is also a threat to very young children, as they are less able to regulate body temperature. School age and older children spend more time outdoors than adults, which increases their risk of being exposed to extreme heat and higher average temperatures, pollutants in air and water, and diseases carried by mosquitoes and ticks. High school athletes are particularly at risk for heat illnesses. About 9,000 children across the US are treated for heat illness (such as heat stroke and muscle cramps) related to athletic activity each year

Children most vulnerable to climate impacts include young children, infants, and pregnant women; children in low-income, rural, immigrant, or linguistically isolated households; children with pre-existing disease (especially cardiac and respiratory); and children who spend considerable time outdoors.

## Health Insurance

Excessive heat exposure, elevated levels of air pollutants, and extreme weather conditions are expected to cause direct and indirect health impacts, particularly for vulnerable populations with limited or no access to health services. Health insurance enables access to care by connecting people to health care providers and by protecting persons against the high and often unexpected costs of medical care. A lack of health insurance among vulnerable populations that are

exposed to the effects of climate changes may lead to greater health impacts.

Insurance coverage is a key determinant of timely access and utilization of health services, which is a fundamental pathway to improved health outcomes. A national study demonstrated an increased risk of mortality among the uninsured compared with the insured and estimated 44,789 annual deaths among Americans aged 18 to 54 associated with lack of health insurance. A systematic review of literature in 2008 found consistent evidence demonstrating that health insurance increases utilization of health care services and improves health. A national systematic review in 2010 found that patients who were uninsured were less likely to receive critical care services than those with insurance.

The most vulnerable among the uninsured include:

- » Low-income households
- » Women: A study in Los Angeles County revealed lack of access to health care services as a significant barrier to health promotion and wellness, particularly for women and especially for women of Black, Latino, or Asian/Pacific Islander ethnicity
- » Displaced populations: A study among populations displaced to shelters from Hurricane Katrina found lack of health insurance was a significant risk factor for lacking medications and arriving at the shelter needing immediate medical intervention
- » Undocumented immigrant populations, especially children

## Immigrants and Refugees<sup>3</sup>

Many immigrants and refugees have been displaced due to climate change impacts, and have already suffered trauma or disaster.<sup>4</sup> They are also more vulnerable to impacts of climate change because they tend to be overrepresented among the poor, but underrepresented in public benefits enrollment.<sup>5</sup> Most

immigrants lack the rights of citizenship so are often afraid to ask for help or call the police.<sup>6</sup> They also tend to be linguistically isolated.

Many immigrants work in occupations with higher risks of exposure to climate change impacts, such as farmworkers, construction workers or other outdoor occupations. People in certain occupations are at higher risk during times of extreme heat, particularly those required to work outdoors. Heat stress can be a major occupational hazard in the US agricultural industry. The agricultural workforce consists of people from diverse ethnic backgrounds, with the majority being from Latin America. There is also a significant proportion that are of African American and Native American descent, as well as Asian and Caribbean migrants.<sup>7</sup> An investigation of a 2006 Californian heat wave found significantly elevated rates of hospitalization and emergency department visits for cardiac-related illness in people from Latino backgrounds, and the authors postulated that this could be due to occupational heat exposures in crop workers.<sup>8</sup>

Many undocumented immigrants or refugees do not have adequate access to government and other services; and if there are other climate stresses, they may receive lower levels of service and supports due to their immigrant or refugee status.<sup>9</sup>

The most vulnerable immigrants and refugees include:

- » Mothers with babies (particularly single mothers) and young children
- » Immigrants and refugees with low socioeconomic status, or who are homeless
- » People with limited English, and those who are socially isolated within culturally and linguistically diverse communities.
- » New immigrants, political asylum seekers
- » Older first generation immigrants who revert to their first languages later in life due to aging. Also, recently

arrived people who are older may find it difficult to learn English and sometimes can only communicate with people their own age, if the younger generation does not speak the traditional dialects.

## Impervious Surfaces and Tree Canopy

Temperatures in most urban areas are significantly higher than less urbanized areas because pavement and building materials absorb sunlight and heat. This is known as the urban heat island effect (CalEPA developed Urban Heat Island Interactive Maps). The most intense effects are often in neighborhoods where impervious paved surfaces predominate, and trees, vegetation, and parks are less common. For example a study using national data found that African-Americans were 52% more likely, Asians 32% more likely, and Hispanics 21% more likely than Whites to live in areas where impervious surfaces covered more than half the ground, and more than half the population lacked tree canopy.<sup>10</sup>

Strategies that can reduce the urban heat island effect include increasing urban greening (such as trees, parks, gardens, and green roofs), and using lighter-colored materials that reflect heat (such as cool roofs).<sup>11</sup>

## Incarcerated & Formerly Incarcerated Populations

Climate change is responsible for increasing intensity of natural disasters. Climate-related natural disasters are not always predictable, so it is important to make emergency preparedness and evacuation plans ahead of time. In the development and preparation for evacuation plans in the face of climate-related natural disasters the incarcerated population is often left out.<sup>12</sup>

More than two million people are confined to federal or state correctional facilities, and in county jails in the United States. These people are completely

dependent on the county, state, and federal government to ensure their welfare, including for emergency and evacuation planning.<sup>13</sup> Disasters can inflict physical and mental health injuries on prisoners.<sup>14</sup> Incarcerated people are vulnerable because of their geographic isolation, lack of economic resources, cultural and ethnic characteristics, and age.<sup>15, 16</sup> The population of incarcerated individuals 55+ grew 282% from 1995-2010.<sup>17</sup> Older adults are less able to withstand extreme temperatures. Harm to prisoners linked to climate change can include communicable disease outbreaks, unsanitary living conditions, exposure to hazardous materials (in the event of floods that allow escape of hazardous materials into flood waters or potable water supplies, or damage water treatment facilities), violence from overwhelmed staff, and inmate-on-inmate violence.<sup>18</sup>

Hurricane Katrina in August 2005 illustrated the need to account for the incarcerated population in disaster plans. During the storm and for days after, thousands of men, women, and juveniles were abandoned at Orleans Parish Prison, the New Orleans city jail. Without emergency preparedness plans, there was chaos. Prison guards left their posts, and inmates were left without power, water, food, or proper ventilation.<sup>19</sup>

Beyond natural disasters, climate change can lead to increases in communicable diseases such as Valley Fever. Valley Fever, an incurable disease that infects about 150,000 people annually throughout the United States, is caused by an airborne fungal spore called *coccidioides* which infects the lungs when inhaled.<sup>20</sup> The Centers for Disease Control and Prevention conducted a screening process in 2015 and found that eight percent of California's incarcerated population had contracted Valley Fever.<sup>21</sup> In comparison, only about one percent of California's general population contracts the disease, which means that incarcerated populations are contracting Valley Fever eight times more frequently than other Californians.<sup>22</sup>

In addition to natural disasters and communicable disease, extreme temperatures caused by climate change are of concern for the incarcerated population as many correctional facilities do not provide adequate heating or air conditioning. Those most susceptible in the incarcerated population to heat-related deaths or illness are those with increased heat sensitivity due to taking certain medications (such as for some mental illnesses) and/or having pre-existing medical conditions such as obesity, diabetes, heart disease and hypertension.<sup>23</sup>

Once released, formerly incarcerated people are more likely to fall into additional groups that research shows are more vulnerable to climate change, such as low-income people, people with disabilities, people experiencing homelessness, people who are physically and/or socially isolated, and people with existing health conditions, including chronic diseases and mental health problems, due to their status as formerly incarcerated people.

## **LGBTQ (Lesbian, Gay, Bisexual, Transgender or Queer) Communities**

While no studies were found demonstrating a higher rate of death, injury or illness among LGBTQ people from direct climate change impacts, it is known that some LGBTQ people, and especially youth, are more likely to possess characteristics that have been linked to higher risk from climate change impacts. These risks include higher rates of poverty, homelessness, and mental illness.<sup>24</sup>

Research suggests that LGBTQ people face health disparities linked to societal stigma, discrimination, and denial of their civil and human rights. Discrimination against LGBTQ people has been associated with high rates of psychiatric disorders,<sup>25</sup> substance abuse,<sup>26, 27</sup> and suicide.<sup>28</sup> Experiences of violence and victimization are frequent for LGBTQ individuals, and

have long-lasting effects on the individual and the community.<sup>29</sup> Personal, family, and social acceptance of sexual orientation and gender identity affects the mental health and personal safety of LGBTQ people.<sup>30</sup>

Studies have reported that individuals in the LGBTQ population tend to have lower incomes and are less satisfied with their standard of living.<sup>31</sup> Families of gay and lesbian couples are significantly more likely to be poor than heterosexual, married couple families. Children in gay and lesbian households have poverty rates twice those of children in heterosexual married couple households.<sup>32</sup> People with low incomes are at higher risk of harm from climate change.<sup>33</sup> In addition, health and utilization of healthcare services among LGBTQ individuals are adversely affected by marginalization; and approximately 30% of LGBTQ adults do not seek healthcare services or lack a regular healthcare provider compared to 10% of heterosexual adults.<sup>34,35,36</sup> LGBTQ people can suffer from higher risks of developing chronic diseases such as obesity, heart disease, and certain cancers.<sup>37,38</sup> People with pre-existing or chronic medical conditions are at higher risk of harms from climate change impacts.<sup>39</sup>

The discrimination that LGBTQ people face can be particularly damaging to youth. On a single night in January 2014, California had 13,709 unaccompanied homeless children and youth.<sup>40</sup> An estimated 20 to 40 percent of unaccompanied homeless children and youth identify as LGBTQ.<sup>41,42</sup> This translates to between 2,742 and 5,484 LGBTQ unaccompanied homeless children and youth in California on any given night.

People experiencing homelessness are at higher risk of illness, injury and death from exposures related to climate change, such as high heat, storms and floods, and poor air quality. Homeless people are also more likely to have other conditions that put them at risk, such as physical or mental health conditions. On average, a homeless person's life is 36 percent shorter than a housed person's life.<sup>43</sup>

Research suggests that a high proportion of LGBTQ homeless youth are people of color. For example, the Williams Institute records 31 percent of LGBTQ homeless children and youth served in homeless service agencies as African American.<sup>44</sup>

Almost 18% of lesbian and gay youth participants met the criteria for major depression, and 11.3% for Post-Traumatic Stress Disorder (PTSD) in the previous 12 months. 31% of the LGBTQ sample reported suicidal behavior at some point in their life.<sup>45</sup> National rates for these diagnoses and behaviors among youth are 8.2%, 3.9%, and 4.1%, respectively.<sup>46,47</sup> People with mental illness, including depression, PTSD, or suicidal behavior, are documented to be at higher risk of harm from climate-related impacts.<sup>48</sup>

## Linguistically Isolated People<sup>49</sup>

A household is linguistically isolated when all persons 14 years of age or older speak a language other than English and no one speaks English very well. Climate change and resulting natural disasters and extreme temperatures pose a serious public health concern for people who are linguistically isolated. Many immigrants are linguistically isolated.

Linguistic isolation may hinder protective behaviors during extreme weather and disasters by limiting access to or understanding of emergency or health warnings. Failure to evacuate or take shelter in place during coastal storms or other extreme weather events increases vulnerability to injury or death. Low literacy in people who are linguistically isolated can pose additional barriers to accessing critical health and safety information. Additionally, natural disasters and extreme weather can disrupt management of chronic conditions for people who are socially or linguistically isolated. A study found that people who live in linguistically isolated households were at increased risk of extreme heat-related health problems and more heat distress calls to 911.

The most vulnerable linguistically isolated people include:

- » Mothers with babies (particularly single mothers), and young children
- » People with low socioeconomic status, people who are homeless
- » People who are socially isolated within culturally and linguistically diverse communities
- » New immigrants, political asylum seekers, and refugees

## Older Adults<sup>50</sup>

Older adults are vulnerable to climate change-related impacts for a number of reasons. One reason is that normal changes in the body associated with aging, such as loss of muscle and bone mass and agility, can limit mobility. Aging also impairs cognitive ability, immune system, and regulation of body temperature. Older adults are more likely to have a chronic health condition, such as diabetes, that requires medications for treatment. Some older adults, especially those with disabilities, may also need assistance with daily activities. In 2010, nearly half of people over age 65 were reported to have a disability, compared to about 17% of people aged 21–64. This includes disabilities in one or more areas related to communication (seeing, hearing, or speaking), mental functioning (such as Alzheimer’s disease, senility, or dementia), and physical functioning (limited or no ability to walk, climb stairs, or lift or grasp objects).

As the state’s population aged 65 and over increases in the coming years, the number of people living with the vulnerabilities mentioned above will grow.

Climate change will increase extreme heat events and lead to higher temperatures throughout the year. Extreme heat exposure can increase the risk of illness and death among older adults, especially people with congestive heart failure, diabetes, and other chronic

health conditions that increase sensitivity to heat. Growing evidence suggests that injury, disease, and death are greatest among the elderly during heat-waves. Acute kidney failure, electrolyte imbalance and inflammation were the most common heat related health effects among elderly in the 2006 California heat wave. Higher temperatures have also been linked to increased hospital admissions for older people with heart and lung conditions. Side effects of some medications intensified the heat-related conditions in elderly. Older adults with limited incomes who have air conditioning units may not use them during heat waves due to the high cost to operate them.

Climate change affects the frequency and intensity of some extreme weather events, such as flooding (related to heavy rains, hurricanes, and coastal storms), droughts, and wildfires. Older adults are more likely to suffer storm and flood-related fatalities. For example, almost half of deaths from Hurricane Katrina were people over age 75, while for Superstorm Sandy almost half were over age 65. If an extreme event requires evacuation, older adults have high risk of both physical and mental health impacts. Some of the most vulnerable are people with disabilities, with chronic medical conditions, or living in nursing homes or assisted-living facilities. Health impacts could be made worse by interruptions in medical care and challenges associated with transporting patients with their necessary medication, medical records, and any equipment like oxygen. Extreme events can also cause power outages that can affect electrically-powered medical equipment and elevators, leaving some people without treatment or the ability to evacuate.

Climate change worsens air quality because warming temperatures facilitate ground-level ozone formation and can lengthen the season of aeroallergens like ragweed pollen. Changing weather patterns and more intense and frequent wildfires also raise the amount of pollution, dust, and smoke in the air.

These changes will increase the number of emergency department visits and hospital admissions, even for healthy older adults. Poor air quality worsens respiratory conditions common in older adults such as asthma and chronic obstructive pulmonary disorder (COPD). Air pollution can also increase the risk of heart attack in older adults, especially those who are diabetic or obese. During the 2003 Southern California wildfires, respiratory hospital admissions related to wildfire smoke increased 10% among adults 65 years of age and older.

Climate change and increased temperatures will lead to ticks and mosquitoes expanding their ranges and being present for longer seasons. This means an increased risk of being bitten by disease-carrying ticks and mosquitoes. The West Nile and St. Louis encephalitis viruses, which are spread by mosquitoes, pose a greater health risk among older adults with already weakened immune systems. Several studies show that elderly people are at increased risk of West Nile virus infection with climate change predicted to increase the overall risk of transmission in California.

Climate change increases the contamination risk for sources of drinking water and recreational water. Older adults are at high risk of contracting gastrointestinal illnesses from contaminated water. Those already in poor health are more likely to suffer severe health consequences including death. In 2013, almost 28% of adults age 75 and older were described as in fair or poor health, compared to 6% for adults age 18 to 44.

Older adult populations with the following characteristics are at an increased risk of health impacts from climate change: age 65 years or older; living alone, with limited mobility, who are socially isolated, residents of institutions, or dependent of care; elderly women, low socioeconomic status, or of African American race; with multiple chronic conditions (e.g., cardiovascular diseases, respiratory illnesses, diabetes) or pre-existing health conditions.

## Outdoor workers<sup>51</sup>

Outdoor workers are often among the first to be exposed to the effects of climate change. A review of miners, construction workers, farm workers, first responders, and military personnel emphasized that heat-related illness may be the most common cause of nonfatal environmental emergency department admission in the United States. Climate change is likely to affect the health of outdoor workers through increases in temperature, poor air quality, extreme weather, diseases transmitted by ticks and mosquitoes, industrial exposures, and damage to infrastructure. Outdoor workers affected by climate change include: farmers, ranchers, and other agricultural workers; commercial fishery workers; foresters; construction workers; military personnel; miners; refinery workers; paramedics, firefighters, police, and other first responders; hazardous waste site workers, and transportation workers.

But it is not only outdoor workers who are affected by climate change. Individuals who are exposed to hot indoor work environments (such as steel mills, dry cleaners, manufacturing facilities, warehouses, and other areas that lack air conditioning) are also at risk for climate change impacts such as extreme heat exposure or indoor air pollutants.

Extreme heat may result in more cases of heat-related illnesses, like heat stroke, heat exhaustion, and fatigue among workers, especially among more physically demanding occupations. Heat stress and fatigue can reduce alertness and work capacity, leading to safety lapses that can increase the risk of injury. Higher temperatures can also worsen air pollution, raising the risk of respiratory illness for workers. Heat extremes in areas not previously affected by high temperatures can affect workers who are not used to working in high heat conditions or are unaware of heat-related hazards.

Extreme events, such as floods, storms, droughts, and wildfires are becoming more frequent and intense as a result of climate change. These events create risky conditions for workers involved in disaster response, rescue, and cleanup. For example, firefighters battling wildfires are exposed to hazards such as being overrun by fire, heat-related illnesses and injuries, smoke inhalation, and air pollutants. First responders and other emergency workers face greater health and safety risks when working in conditions with infrastructure disruptions, communication interruptions, and social unrest or violence following floods and storms.

Other health hazards for outdoor workers include increased exposure to waterborne and foodborne illness, allergens, and insects carrying diseases such as West Nile virus or Lyme disease. In addition, because of the increase in range and duration of pests and weeds, pesticide use is expected to increase, including in areas where pesticides were not previously used. This will increase the exposure of agricultural workers. For some groups, such as migrant workers and day laborers, the health effects of climate change can be cumulative, as they are affected both by work-related exposures and exposures associated with poorly-insulated housing and lack of air conditioning. California's agricultural and construction workers have experienced severe heat-related illness and death. During 1992-2006, the United States had a total of 68 farm workers die from heat stroke, representing a heat stroke rate of nearly 20 times greater than all civilian workers in the country.

The most vulnerable outdoor workers include:

- » Farm workers and day laborers: This population tends to have lower incomes and belong to communities of color, both of which are associated with adverse health effects due to climate change.
- » Immigrants who work outdoors: The socioeconomic status of immigrants in California who work

in the agricultural and construction sectors makes them particularly vulnerable because of long workdays under strenuous conditions, language barriers, limited capacity to protect their rights, and exposure to chemicals such as pesticides.

## People of Color

Some communities of color are more likely to reside in areas with greater flooding threats and more heat-absorbing surfaces. These populations also experience disproportionately high levels of vulnerabilities to climate change including lower income, less formal education, poorer physical health, multiple chronic conditions, language barriers, more elderly living alone, occupational exposures such as outdoor environments, and less access to air conditioning.<sup>52</sup> With clear causal pathways linking the experience of racism, socio-economic status, and poor health outcomes,<sup>53</sup> differences in vulnerability may be attributed to social and economic disparities rather than, or as well as, ethnicity.<sup>54,55</sup>

The combination of greater exposure to climate change environmental impacts, increased sensitivity, and reduced adaptive capacity compound the overall vulnerability to the health impacts of climate change. For example, in Hurricanes Katrina and Sandy, many residents in low-income communities and communities of color were killed, injured, or had difficulty evacuating and recovering from the storm.<sup>56</sup>

Due to historical and continuing discrimination, many people in communities of color are more likely to have low socio-economic status. They also are more likely to live in neighborhoods with more physical risks such as higher rates of pollution, violence, liquor stores, tobacco shops, fast food and convenience stores, and fewer health-promoting features such as parks, trails, grocery stores, and farmers' markets. Poorer people, the less educated, and people of color

are reportedly more likely to live in warmer neighborhoods,<sup>57, 58</sup> despite often lacking the social and material resources to cope with higher temperatures.<sup>59</sup>

Nationally, African Americans were 52% more likely, Asians 32% more likely, and Hispanics 21% more likely than Whites to live in high risk-related land cover where impervious surfaces covered more than half the ground and more than half the population lacked tree canopy. These conditions lead to greater heat island effect. A study in Fresno County found that African Americans were 8.6 times more likely and Latinos were 4.5 times more likely than Whites to reside in high risk areas that have greater climate change threats. These high risk areas typically have a greater proportion of elderly living alone and lower adaptive capacity (i.e., less social cohesion, less transportation options, and fewer air conditioners). Prevalence of central air conditioning among African American households was less than half that among White households in a national study examining four urban cities, and deaths among African Americans were more strongly associated with hot temperatures.

Heatwave studies in the United States have shown that African Americans are particularly vulnerable, with the mortality rate during a Los Angeles heatwave being nearly double that of the city's average.<sup>60</sup> Similar findings have emerged from heatwave studies in other US cities where the risk of mortality has been demonstrated to be higher for African American residents, but not necessarily for people of Hispanic backgrounds.<sup>61, 62, 63, 64, 65, 66</sup> During the 1995 heatwave in Chicago during which 739 excess deaths were recorded, African Americans were 1.5 times more likely to die than Whites, and almost 30 times more likely than Latinos.<sup>67, 68, 69</sup>

Heat-related emergency department visits increased for Asian/Pacific Islanders and African Americans, and for the latter there were also significant increases for conditions including acute renal failure, electrolyte imbalance and nephritis.<sup>70</sup>

Finally, communities of color may have decreased access to information about risk mitigation, as well as resources to prepare for, adapt to, and recover from climate related events, be they sudden or gradual.

## People with Existing Chronic Health Conditions

People with existing chronic health conditions (such as diabetes, cardiovascular diseases, and asthma) are especially vulnerable to the impacts of climate change through an array of intersections. This includes heat waves, extreme weather events, unreliable or unavailable access to medical care, tenuous interpersonal support networks, and simply having fewer resources to relocate, adapt, or otherwise manage climate change impacts.

People of color and people from low-income communities tend to have relatively high rates of some existing health conditions like heart disease, diabetes, asthma, and chronic obstructive pulmonary disease (COPD). A longitudinal study found that people living in areas of concentrated poverty had higher rates of obesity, diabetes, and depression than residents that moved out of those same areas.

Heart disease increases sensitivity to heat stress, as does diabetes. Extreme weather events can also be problematic for diabetics because these events may limit access to the medicine and food that diabetics need to stay healthy. Asthma can be exacerbated by changes in pollen season and exposure to air pollution caused by or made worse by changes in temperature, humidity, wind, or wildfires. People with COPD are more sensitive than the general population to changes in outdoor air quality made worse by climate change. Hospital admissions and emergency room visits increase during heat waves for people with diabetes, cardiovascular diseases, respiratory diseases, and psychiatric illnesses.<sup>71</sup>

People with chronic health conditions frequently have greater reliance on healthcare systems, and these systems may become disrupted during extreme weather events; and if climate change impacts individuals' financial situations or forces them to move, they may lose access to healthcare as well.<sup>72</sup> This can lead to worsening symptoms, compromised personal safety, new disease consequences, economic instability, and more.

### Who is most impacted?

There is a broad array of chronic health conditions including asthma, autoimmune disorders, diabetes, obesity, and heart disease or cardiovascular diseases. Among these, people with the following characteristics are at an increased risk of health impacts from climate change:

- » Elderly individuals of 65 years or older
- » Individuals without access to stable and reliable healthcare
- » Individuals with multiple health conditions or disabilities
- » Elderly women, low socioeconomic status, or of African-American race.

### People with Low Incomes

Economic factors including income, poverty, and wealth, are collectively one of the largest determinants of health. From the poorest to richest ends of the income spectrum, higher income is associated with greater longevity in the US.<sup>73,74,75</sup> In the year 2000, poverty and economic inequality led to nearly 300,000 deaths, or 12% of total deaths in the US that year.<sup>76</sup> Living below 200% of the poverty level reduced people's years of quality of life significantly more than even tobacco use.<sup>77</sup> The gap in life expectancy between the richest 1% and poorest 1% of Americans was almost 15 years for men in 2014, and about 10

years for women.<sup>78</sup> The ten-year difference in life span for rich versus poor women is equivalent to the difference between never-smokers and lifetime smokers.<sup>79</sup> Inequalities in longevity between rich and poor Americans increased between 2000 and 2014, as the wealthiest gained about three years of life and those with lowest incomes saw almost no increase in life span. Some geographic areas even saw declines in longevity for poor Americans.<sup>80</sup>

Early death among people living in poverty is only partially a result of those with higher incomes having better access to quality health care.<sup>81</sup> Only about 10-20% of a person's health status is accounted for by health care (and 20-30% attributed to genetics), while the remainder is attributed to the social determinants of health, which include environmental quality, social and economic circumstances, and the social, media, policy, economic, retail, and built environments, all of which in turn shape stress levels and behaviors, including smoking, diet, and exercise.<sup>82,83,84,85,86,87,88,89,90,91,92</sup>

The worse health status of most poor people compounds the risk of climate change impacts on people with low incomes.<sup>93</sup> Poverty increases vulnerability to climate change impacts, and communities in poverty have fewer resources to evacuate during natural disasters such as wildfires. Poverty reduces the capacity to adapt to rising food, water, or energy prices. It is harder for low-income communities to rebuild after a disaster, especially since fewer low-income people have insurance. Additionally, people with low to middle incomes have less access to health care and receive worse quality of care than people with high incomes. Those with low incomes are also more likely to reside in housing that sustains damage, due to lower-quality construction.

The impacts of climate change on higher food cost and food scarcity will magnify current inequalities in food access, food choices, and chronic diseases. The existing disparities in health status, living conditions, and

other inequities increase vulnerability of low-income communities to the health impacts of climate change.

Climate-related health burdens due to poverty disproportionately impact the following populations:

- » Populations who are unemployed, disabled, homeless, or have little formal education
- » Racial, ethnic, and linguistic groups, and migrants
- » Low-income children living in conditions that are harmful to their development and health
- » Children in low-income immigrant families with reduced access to services
- » People with psychiatric disorders, including neurotic disorders, functional psychoses and alcohol and drug dependence

## People with Mental Illness

Climate change is bringing a range of more frequent, long lasting and severe adverse environmental changes, which can affect the severity and incidence of mental disabilities and mental health problems.

Rates of depression, anxiety disorders, post-traumatic stress disorders, substance abuse, and suicides are all expected to rise as the effects of climate change worsen. Following disasters, mental health problems increase, among both people with no history of mental illness or disability, and those with pre-existing risk. Climate change may affect people with mental disabilities directly through exposure to trauma or by affecting their physical health. The impacts of climate change on mental health are likely associated with the stress, shock, loss of livelihood, housing, and displacement following storms, droughts, floods, heat, and environmental degradation. People with severe mental illness, such as schizophrenia, are at risk because their medications may interfere with self-regulation of body temperature. There are direct physiological effects of heat strain that can reduce the ability to work at full capacity and to carry out various daily activities, which can impact mental health as well

as livelihood. Additionally, the existential threat represented by climate change leads to anxiety and despair in some people.

The effects are felt most among children, the poor, the elderly, and those with existing mental health conditions. People with previous traumas or multiple losses may have longer recovery periods. Long-term mental health services are needed for low-income disaster survivors. Increasing heat exposure can also worsen the condition of people with pre-existing chronic diseases and mental health problems, as some medications affect thermoregulation, or a person's body's ability to regulate body temperature. Pre-existing dementia is a risk factor for hospitalization and death during heat waves.

Hospital admissions and emergency room visits increase during heat waves for people with psychiatric illnesses.<sup>94</sup>

In Australia, recent droughts substantially increased the incidence of suicide in rural populations, particularly among male farmers and their families.<sup>95</sup>

## People with Physical Disabilities

People with disabilities are a broad and diverse community, and their needs differ depending on individual circumstances like their age or ability to live independently within their communities. In general, however, climate change-related health impacts may affect people with disabilities more than others. Approximately 1 in 5 people in the United States has a disability. This includes about half of all American adults 65 and older and about 17% of Americans age 21-64. Many people with disabilities experience high rates of social risk factors that contribute to poor health, such as poverty, unemployment, and lower education. For example, people with disabilities are twice as likely to be unemployed than those without disabilities.<sup>96</sup>

Climate change is increasing the frequency or intensity of some extreme events, such as extreme heat events, flooding (related to heavy rains, hurricanes, and

coastal storms), droughts, and wildfires. During heat waves, certain risk factors can make some people with disabilities especially susceptible to heat-related illness and death. These include having dementia, depending on others for assistance in activities of daily living, having limited mobility (especially if confined to bed), or not having access to transportation.

These factors can also increase health risks during hurricanes and severe storms. People with disabilities have had high rates of illness, injuries, or death from these types of events. For example, almost half of deaths from Hurricane Katrina were people over age 75 (even though they only represented less than 6% of the population in the area), with over 10% of total deaths occurring in nursing homes. Most of those individuals had medical conditions and disabilities that made them vulnerable.

If an extreme event requires evacuation, people with disabilities have high risk of both physical and mental health impacts. People with disabilities may have reduced ability to receive or act upon emergency information or instructions, or to communicate their needs in an emergency or evacuation situation. Messages about extreme weather or other emergency information (such as a warning to boil contaminated water) are not always designed or delivered in a way that reaches individuals with disabilities, like those who have hearing loss or low vision.

People with disabilities are disadvantaged in their ability to adapt to physical displacement due to difficulty in mobility and access to resources. People with disabilities may also face additional physical challenges associated with evacuations, which can make health impacts worse, especially if local emergency response plans do not adequately anticipate and address the special needs of these populations. Examples from Hurricane Katrina include the inability to meet demand for wheelchair-accessible transportation, challenges associated with maintaining adequate supplies of

prescription medication or access to necessary medical equipment like oxygen, and a lack of evacuation shelters with appropriate facilities, equipment, and trained staff to meet the various needs of people with disabilities. Extreme events can also cause power outages that can affect electrically-powered medical equipment and elevators, leaving some people with disabilities without treatment or the ability to evacuate.

Factors that may impact quality of life and well-being of persons with a physical disability as a result of climate change exposures include the following: food insecurity and resulting malnutrition; decreased access to clean water, sanitation and hygiene; reduced access to shelter and basic services; and displacement or migration.

Populations with physical disabilities who experience increased vulnerability to the health impacts of climate change include the following: people with less education, less income, and living in an urban area; people who belong to marginalized groups based on gender, race, ethnicity, or language; elderly people and children with disabilities and their caregivers.

## **People Without Life-supporting Resources** *(People Who Lack Adequate Housing or Ways to Cool Living Space, are Tenants or Renters, or are Food-insecure)*

Life-supporting resources are essential to one's resilience in the face of climate change. There are many of these resources: secure housing, food and other sustenance, means to stay cool during extreme heat events, reliable transportation (for evacuating or navigating natural disasters), and access to necessary services including healthcare. Health, well-being and resilience during climate change-related events are closely related to the number and amount of these resources; individuals who lack one or multiple (i.e. those

who are food-insecure, the uninsured, people who lack adequate or quality housing or are tenants or renters, and the poor) are especially vulnerable.

Climate change resiliency is dependent on several factors: social status, location, race, gender, disability, and personal resources (tangible and intangible), among others. Each of these significantly impacts one's health and overall well-being during gradual or sudden climate-related events. Certain groups disproportionately lack life-supporting resources. For example, homeless individuals without access to reliable shelter may be especially vulnerable during extreme weather events including heat waves and heavy storms.<sup>97</sup> Renters without air-conditioning are vulnerable to heat illness, and are often unable to install air-conditioners because they do not own their home.<sup>98</sup>

One study found there were more heat distress calls made from neighborhoods with a higher proportion of low-income Hispanic residents who were often linguistically isolated and living in rental accommodation.<sup>99</sup>

Many people facing economic challenges choose not to use their air conditioning even if they have it due concern about paying energy bills.

Food-insecure individuals already experience hunger, which affects their immune systems and economic stability, but may experience excessive food insecurity during food shortages or price increases due to climate change-related food scarcity.<sup>100</sup> People who lack multiple life-supporting resources will be especially vulnerable to a wider array of climate impacts, and to a deeper extent. It is also important to note that there are different levels of many of these vulnerabilities (i.e. level of food insecurity or quality of housing) with related vulnerability.

Especially-impacted under-resourced groups and individuals are:

- » Those who are already vulnerable due to other factors (age, discrimination based on race, gender, disability, etc.)

- » Individuals who are unable to access compensating emergency resources (eg., a homeless person who is also refused from a storm shelter)
- » Individuals with a high severity of resource shortage (i.e. extreme hunger as opposed to undernourished)
- » Individuals who lack access to multiple resources

## Pregnant Women

Pregnant women are more vulnerable due to health impacts of pregnancy, and limitations on health interventions during pregnancy. Pregnant women are more susceptible to heat intolerance, and other disruptions. The U.S. Environmental Protection Agency, in its "Climate Change and the Health of Pregnant Women" publication,<sup>101</sup> lists the following among many climate change-related concerns for pregnant women:

- » Climate change impacts can make it more difficult for pregnant women to get the specialized health care they need.
- » Air pollutants can cause respiratory illness in pregnant women and also lead to low birth weight or pre-term birth. Climate change worsens air quality because warming temperatures make it easier for ground-level ozone to form.
- » Pregnant women and women who have recently given birth (postpartum) are at an increased risk for severe stress and other negative mental health outcomes due to weather-related disasters associated with climate change.
- » Severe maternal stress can increase risk of negative outcomes such as pre-term birth.

## People who are Physically or Socially Isolated

Resilience to climate change impacts decreases in isolated populations, due to decreased access to resources, and delayed or limited assistance in crises.

Climate change-related impacts are currently affecting rural communities. These impacts will progressively increase over this century and will shift the locations where rural economic activities (like agriculture, forestry, and recreation) can thrive.

Isolated and rural communities face particular geographic and demographic obstacles in responding to and preparing for climate change risks. In particular, physical isolation, limited economic resources, and higher poverty rates, combined with an aging population, increase the vulnerability of rural communities.

Systems of fundamental importance are already stressed by remoteness and limited access.<sup>102</sup>

In elderly populations, social isolation and income loss combine to form a too-frequent situation where individuals do not have access to information or resources.<sup>103</sup>

## People Experiencing Homelessness

Homelessness can be defined as individuals who use shelters to sleep as well as individuals who sleep outdoors or in other places not intended for human habitation. Homeless populations are more likely to live in poverty, lack access to health care services, and have multiple baseline conditions, including poor health and psychiatric conditions, which exacerbate the impacts of climate change.

This vulnerable population's high concentration of pre-existing conditions and lack of access to resources and basic needs increases the likelihood of experiencing the negative impacts of climate change exposures such as heat waves, air pollution, vector-borne disease and storms and floods. For example, the most

affected individuals from Hurricane Katrina were marginalized and poor individuals.<sup>104</sup>

According to the Centers for Disease Control and Prevention, vulnerable populations such as those experiencing homelessness, are at a higher risk of heat-related illness than other people living in a population.<sup>105</sup> Pre-existing psychiatric conditions are more common among people experiencing homelessness.<sup>106</sup> This triples the risk of death from extreme heat.<sup>107</sup> Heat illnesses are exacerbated because of difficulty finding refuge from the heat and hydrating,<sup>108</sup> and likely occupancy of areas where high concentrations of concrete increase risk of the heat island effect.<sup>109</sup>

Because people experiencing homelessness are more likely to have higher levels of exposure to outdoor air pollution, this population is more susceptible to illness and death from climate change exposure in conjunction with pre-existing cardiovascular and respiratory conditions.<sup>110</sup> Additionally, residing in cities, unhoused, puts them at higher risk of air pollutants from freeways.<sup>111</sup> Self-reported rates of lung diseases such as asthma, chronic bronchitis and emphysema in people experiencing homelessness are double that of the general population.<sup>112</sup>

Vector-borne diseases such as West Nile Virus have higher impacts on homeless populations, due to exposure from living outdoors, and baselines of poor health.<sup>113</sup> Because of the amount of time spent outside, people experiencing homelessness are more likely to be bitten by mosquitoes, exposing them to infectious diseases.<sup>114</sup> This population is more likely to live in immuno-compromising conditions that can exacerbate infectious diseases.<sup>115</sup>

People experiencing homelessness are more likely to occupy marginal areas of cities, along freeways, in creek beds and riverbeds, and other areas making them more vulnerable to environmental hazards, such as storms and floods.<sup>116</sup> The physical deficiency of shelter puts them at even greater risk from storms and floods from which

they cannot seek protection, except in the limited availability of a facility to house those experiencing homelessness. Even though people experiencing homelessness are particularly susceptible to natural disasters, they are often not included in disaster planning.<sup>117</sup>

## Indigenous People, Native Americans and Tribal Nations

There are more than 100 tribal nations in California alone. Certain tribal lands are already experiencing the impacts of climate change, and some coastal tribal communities in the U.S. have begun to relocate due to sea level rise.<sup>118</sup> Native American health and welfare statistics are startling. Tribes face disproportionate demographic issues (poverty, education, and employment), social issues (violence, trauma), health disparities and mental illness. The age-adjusted death rate for adults exceeds that of the general population by almost 40%, with deaths due to diabetes, chronic liver disease and cirrhosis, and accidents occurring at least three times the national rate, and deaths due to tuberculosis, pneumonia and influenza, suicide, homicide, and heart disease also exceeding those of the general population.<sup>119</sup>

Tribal governments manage health and welfare of tribal members, and tribal lands. Many tribes are already experiencing severe climate-related losses to cultural resources (e.g., certain traditional flora and fauna), wildlife and related ecosystems and habitat (e.g., impacts to fisheries), air and water quality reductions due to climate change impacts (e.g., non-point-source pollution and increasing temperatures).<sup>120</sup>

- » Tribal communities in the United States, particularly in coastal areas, are being forced to relocate due to accelerated rates of sea level rise, land erosion, and/or permafrost thaw brought on by climate change.

- » Forced relocation and inadequate governance mechanisms and budgets to address climate change and support adaptation strategies may cause loss of community and culture, health impacts, and economic decline, further exacerbating tribal impoverishment and injustice.<sup>121</sup>

## Vehicle Ownership

Vehicle ownership is a measure of mobility and access to transportation. Transportation is a critical resource for evacuation and survival during heat waves and other extreme weather events. For example, access to a vehicle is important during flooding which may require emergency evacuation of populations living in coastal and low-lying areas, and may also require adequate sheltering for displaced populations.

Vehicle ownership is important during extreme weather events because it improves access to evacuation or access to cooling centers or shelter from environmental exposures such as wildfire, air pollution, heat waves, or flooding. A survey among predominantly poor and African American Hurricane Katrina evacuees revealed that 34% reported lack of a car or other means of transportation as the main reason for not evacuating the storm's danger. In the Los Angeles-Long Beach Metropolitan Area, higher proportions of African Americans (20%), Latino (17%), and Asian (10%) households do not have access to a car compared to White households (8%).

Urban areas generally have lower rates of automobile ownership, particularly in inner city populations with low income.

Some communities of color are more likely to have limited or no car ownership, which increases their risk of being impacted during heat and other extreme weather events. Populations with higher numbers of people of color and higher rates of poverty are less likely to own cars.

## Notes

- 1 Members of the Equity and Vulnerable Communities subcommittee included Abe Doherty, Alex Leumer, Alex Ghenis, Aleecia Gutierrez, Angelica Ruiz, Arsenio Mataka, Ben Russak, Brian Beveridge, Carolyn Angius, Claire Jahns, Colin Bailey, Eve Mordaunt, Jamesine Rogers Gibson, Jana Ganion, Julia Ekstrom, Jose Lara, JR DeLaRosa, Kathleen Ave, Kathy Dervin, Kerri Timmer, Kirsten Andrews-Schwind, Linda Helland, Linda Rudolph, Lisa Bates, Margaret Gordon, Marianna Grossman, Megan Walton, Michael McCormick, Michelle Hasson, Monica Palmeira, Nuin-Tara Key, Paul McDougall, Sam Diaz, Solange Gould, Sonya Ziaja, Stacy Farfan, and Tracey Delaney
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