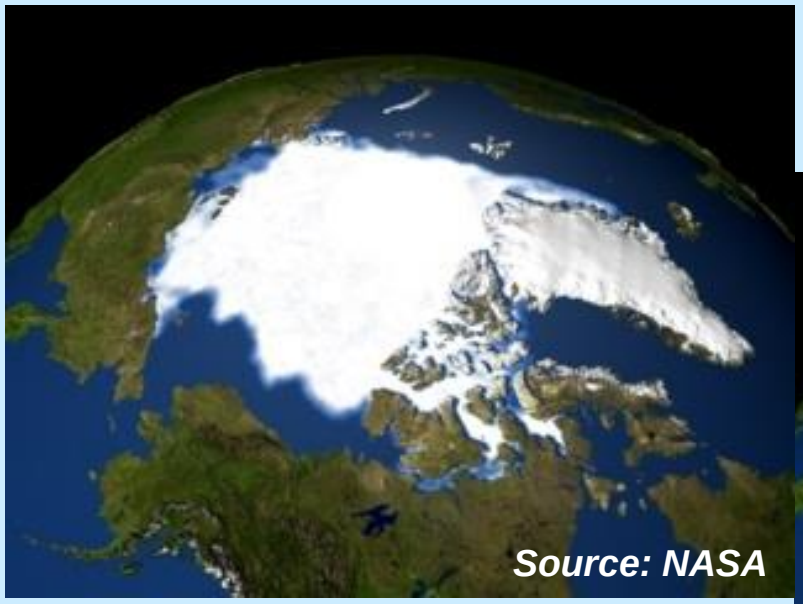
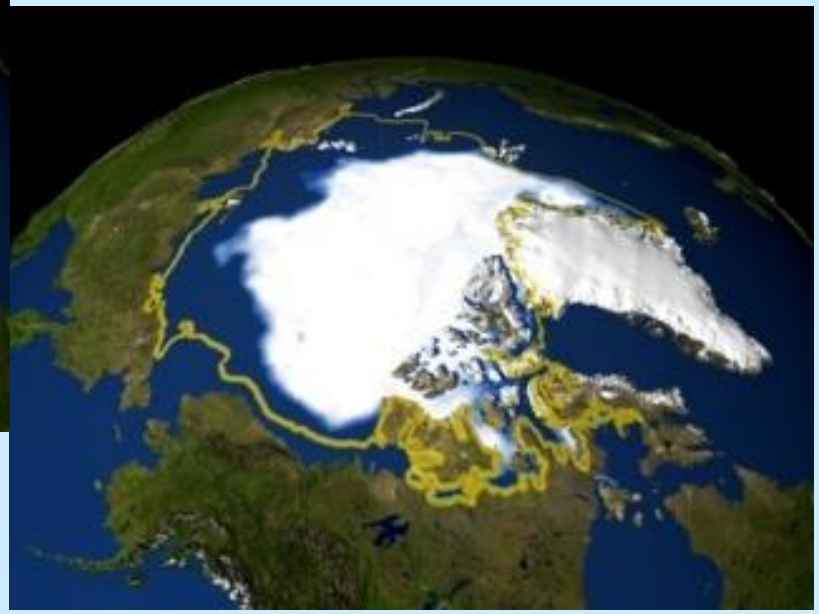
Climate Change Threats and Solutions

California's 4th Climate Change Assessment: Sacramento Valley



Helene G. Margolis, M.A., Ph.D.



Sacramento Environmental Commission

January 24, 2022

Virtual Meeting

Sacramento, California

UCDAVIS HEALTH | SCHOOL OF MEDICINE

CHPR Center for Healthcare Policy and Research UCDAVIS

UCDAVIS John Muir Institute of the Environment

CALIFORNIA'S FOURTH
CLIMATE CHANGE ASSESSMENT

Sacramento Valley Region

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

Sacramento Valley Region Authors

COORDINATING LEAD AUTHORS[1]

Benjamin Z. Houlton, ***UC Davis***

Jay Lund ***UC Davis***

LEAD AUTHORS

Steven Greco, *UC Davis*

Jonathan London, *UC Davis*

Helene Margolis, *UC Davis*

Debbie Niemeier, *UC Davis*

Joan Ogden, *UC Davis*

Steven Ostoja, *USDA Climate Hub*

Paul Ullrich, *UC Davis*

Stephen Wheeler, *UC Davis*

CONTRIBUTING AUTHORS

Maya Almaraz *UC Davis*

Susan Harrison *UC Davis*

Beth-Rose Middleton *UC Davis*

Peter Moyle *UC Davis*

Sara Nichols *UC Davis*

Travis O'Brien *Lawrence Berkeley National Lab and UC Davis*

Kent Pinkerton *UC Davis*

Chad Roberts *Independent Conservation Ecologist*

STAKEHOLDER ADVISORY COMMITTEE

Kathleen Ave *Sacramento Municipal Utilities District*

Thad Bettner *Glen Colusa Irrigation District*

Allan Fulton *UC Cooperative Extension*

Bonnie Holmes-Gen *American Lung Association of California*

Campbell Ingram *Sacramento-San Joaquin Delta Conservancy*

Ben Pennock *Glen Colusa Irrigation District*

Liz Ponce *Shasta County Farm Bureau and Lassen Canyon Nursery*

Glennah Trochet *Health Effects Task Force of California*

Ernie Washington *Butte County*

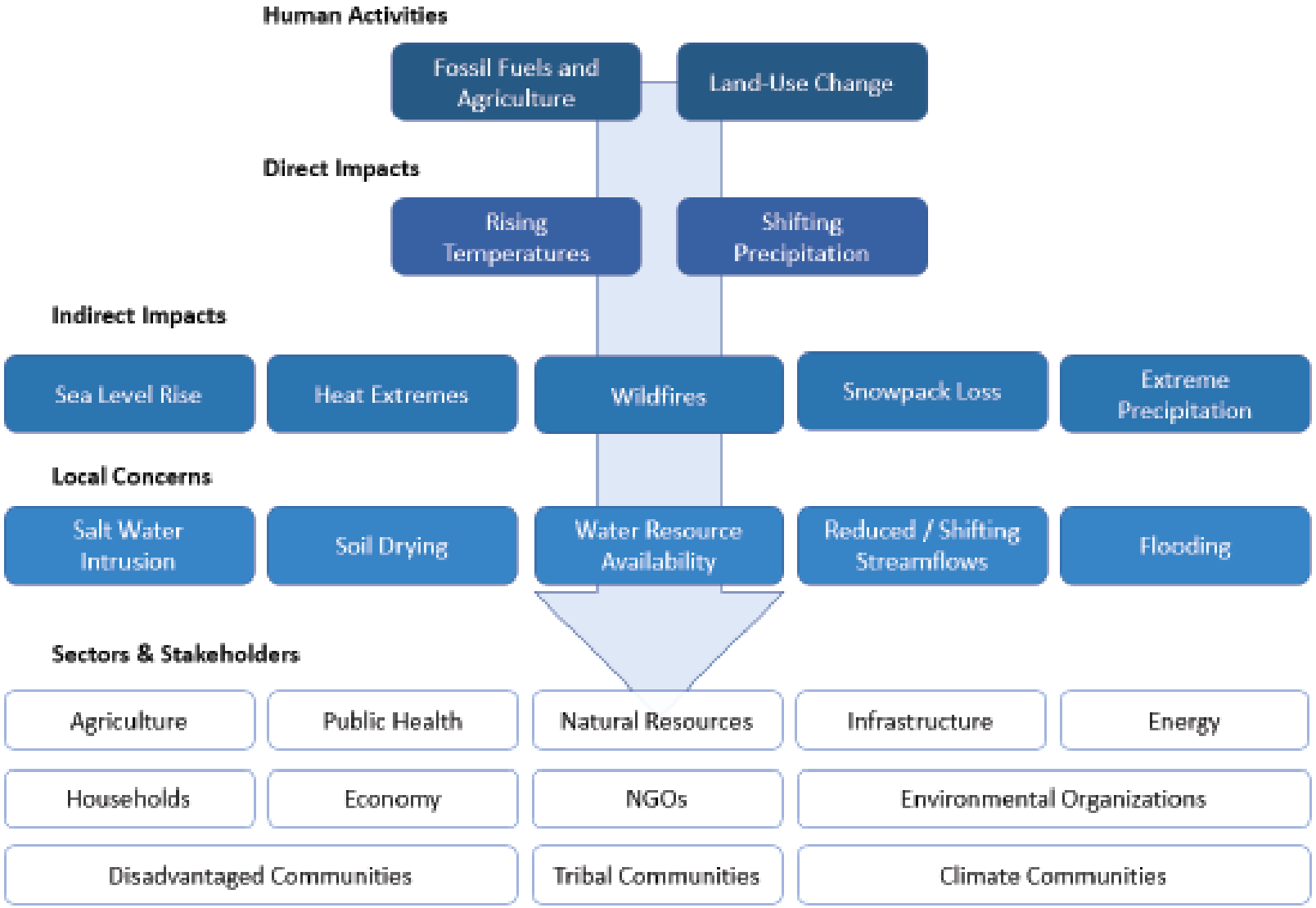
[1] Contact information: bzhoulton@ucdavis.edu and jrlund@ucdavis.edu

CITATION: Houlton, Benjamin, Jay Lund. (University of California, Davis). 2018. Sacramento Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-002.

https://www.climateassessment.ca.gov/regions/

https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-002_SacramentoValley_ADA.pdf

FIGURE 3



Human greenhouse gas emissions and land-use affect energy flows in the atmosphere that raise temperatures and shifts precipitation, with many direct and indirect effects in the Sacramento Valley.

It is likely that climate change will have significant impacts in the following areas:

Public health: More frequent and extreme heat waves;
greater heat stress risk especially for outdoor occupations and recreation;
greater air pollution exposures from wildfires.

Energy: Reduced snowpack resulting in reduced hydropower production;
increased risk to generation and transmission infrastructure from wildfires;
greater use of low-carbon fuels and generation;
greater air conditioning energy loads, less demand for heating.

Agriculture: Longer growing seasons;
insufficient cold for some tree crops;
low elevation flooding;
changes in productivity of current crop varietals;
conversion of agricultural land to other land uses.

Floods: More extreme floods;
greater floodplain vulnerability;
pressure to expand flood bypasses, levees, and flood storage in reservoirs;
higher Delta water levels.

It is likely that climate change will have significant impacts in the following areas:

Water supply: More extreme droughts;
pressure to reduce water supply storage due to larger floods;
possibly greater water demands from higher crop and landscape water use.

Delta: Higher sea levels, levee subsidence, and greater floods threaten Delta levees;
higher temperatures threaten Delta native species;
saltwater intrusion into areas from which water is pumped for agricultural and municipal uses.

Aquatic ecosystems: Higher temperatures threaten native species and make reservoirs less effective for sustaining salmon populations;
higher Delta water levels.

Forests: Higher temperatures, variable overall precipitation with less snow and earlier snow melt;
lower soil moisture and changes in water storage and runoff;
increased wildfire activity in terms of the number of fires, overall area burned, and more area burned at high severity promoting changes.

Wildfires: More frequent and larger wildfires in both forests and shrubland ecosystems;
thinning and fuel reduction can reduce risk in forests but less so in shrublands.

….& at wildland-urban interface ('WUI')

Systems Perspective: A Vulnerability Conceptual Framework*

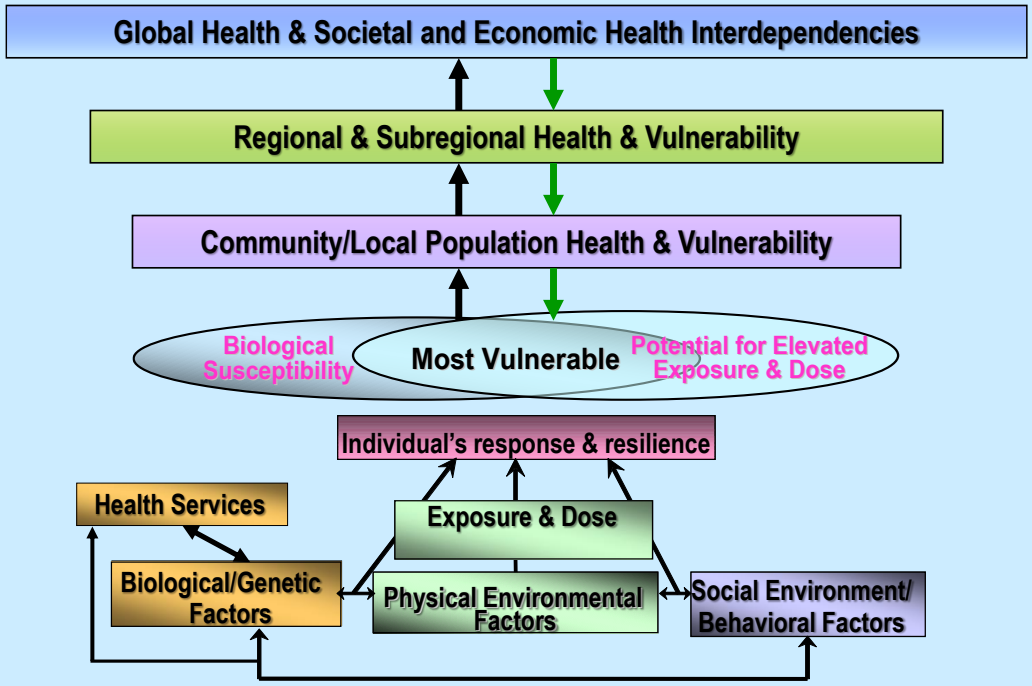
Multiple Determinants of Health/Health Disparities

As for most public health issues, there are disparities in how climate change will impact different populations and sub-groups.

The relative impacts are a function of individual & population ***Vulnerability***

Vulnerability factors may differ at different geographic scales & change over time.

The impact of environmental factors on populations… begins with impacts on individuals.



In a lifetime everyone passes through stages of vulnerability.

Population and individual vulnerability for experiencing the impacts of climate change is a function of complex interrelationships among (a) **biologic factors**, including those that confer innate biologic sensitivity and/or resilience to an environmental insult (e.g., genetics, sex, nutritional status, co-morbidities and related treatments), (b) **physical environment and exposure characteristics** (e.g., chemical/physical/infectious nature of the exposure, duration and dose), and (c) the **social, behavioral, and economic factors** that may influence both biologic response and exposure (e.g., disparate neighborhood exposure levels, access to health care). Many of these **factors are interrelated, including key environmental exposures & population vulnerability factors.**

* **Margolis H.G. Chapter 7. Heat Waves and Rising Temperatures: Human Health Impacts and the Determinants of Vulnerability** in *Global Climate Change and Public Health,* Respiratory Medicine K.E. Pinkerton and W.N. Rom (eds.), 7, https://doi.org/10.1007/978-3-030-54746-2_7 © Springer Nature Switzerland AG 2021

Climate Change Challenge: Compound Risks

Understanding risk factors helps identify interventions to reduce risk

Susceptibility :
Biological/Physiological/Clinical Factors:
Age (< 5 years, teens, ≥ 60 years)
Sex/Gender
Race/Ethnicity
Genetics/Epigenetics
★ Health Status
- Dehydration/hypohydration
- Nutrition
- Physical Fitness
- Obesity/Overweight
- Oxidative Stress & Inflammation

Communicable Diseases:
- Water- & food borne diseases (Diarrheal)
- Influenza & other acute viral infections

★ Chronic Diseases:
- CVD, respiratory (asthma, COPD), diabetes, renal insufficiency, immunologic disorders, neurologic disorders, mental illness

Medications & Pharmacologic Agents

★ Clinical management of chronic disease
Access, adequacy, quality of care

Physical Environmental Factors
Temperature, Humidity
↑ Long-term Average Temperature
↑ Freq. Hot Days/Nights
↑ Freq. Heat Waves/Extreme Heat Events (EHE)
↑ Intensity, duration, geographic extent EHE
↓ Freq. Cold Days/Nights
Sub-regional/local scale influences on meteorology
- Topography
- Coastal (e.g., cloud cover) & sea surface temp.
- Land surface characteristics (e.g., soil moisture, irrigation, vegetation)
- Built environment (e.g., impervious surfaces)

Coincident Challenges
- Air Pollution (additive, synergistic): ozone, MVE
- Water Quantity/Quality
  - ↑ Heavy Rainfall Events *(without ↑ in total annual precipitation)*
  - ↓ Snowfall & Snow pack
  - ↓ Mountain Glaciers
  - ↑ Drought *(Areas, Freq. & Duration)*
  - ↓ Soil Moisture *(Met. Feedbacks)*
  - ↑ Extreme High Sea Level (Storm surges)

Social/Cultural/Behavioral/Economic Factors
Demographic
Age
Gender/Sex
Race/Ethnicity
Education
Economic
Built Environment
Location-Time-Activity Patterns ★
Building Age, type, condition, heating/ cooling systems (presence/usage)
Time-outdoors (work, leisure activities) ★
Community-level factors (e.g., design, assets such as parks)
Disparities (and consequences of disparities) in quality of indoor ★ environments: residences, schools, work
Social/cultural influences (clothing, climate-influenced behaviors)
Lifestyle Factors
Physical activity (daily-living activities; ★ exercise (recreational))
Water/diet/nutrition: quality, quantity, subsistence cultures' food sources
Psychosocial support
Living conditions (e.g., alone & isolated, crowding)
Psychosocial stress
Community infrastructure ★

★
Factors that Modify Exposures
Location-Time-Activity Patterns
- Age-related differences: Children, older adults
- Time(s) outdoors & indoors

Physical or cognitive development or impairment
Built Environment – Outdoor & Indoor Factors
- Impervious surfaces
- Community Design (Trees/vegetation, land-use)
- Building Age, type, condition, heating/ cooling systems (presence/usage), indoor air quality & ventilation

Think about lessons learned from COVID-19 pandemic….
who was most at risk of being infected & of dying and why!

Margolis H.G. Chapter 7. Heat Waves and Rising Temperatures: Human Health Impacts and the Determinants of Vulnerability in *Global Climate Change and Public Health,* Respiratory Medicine K.E. Pinkerton and W.N. Rom (eds.), 7, https://doi.org/10.1007/978-3-030-54746-2_7

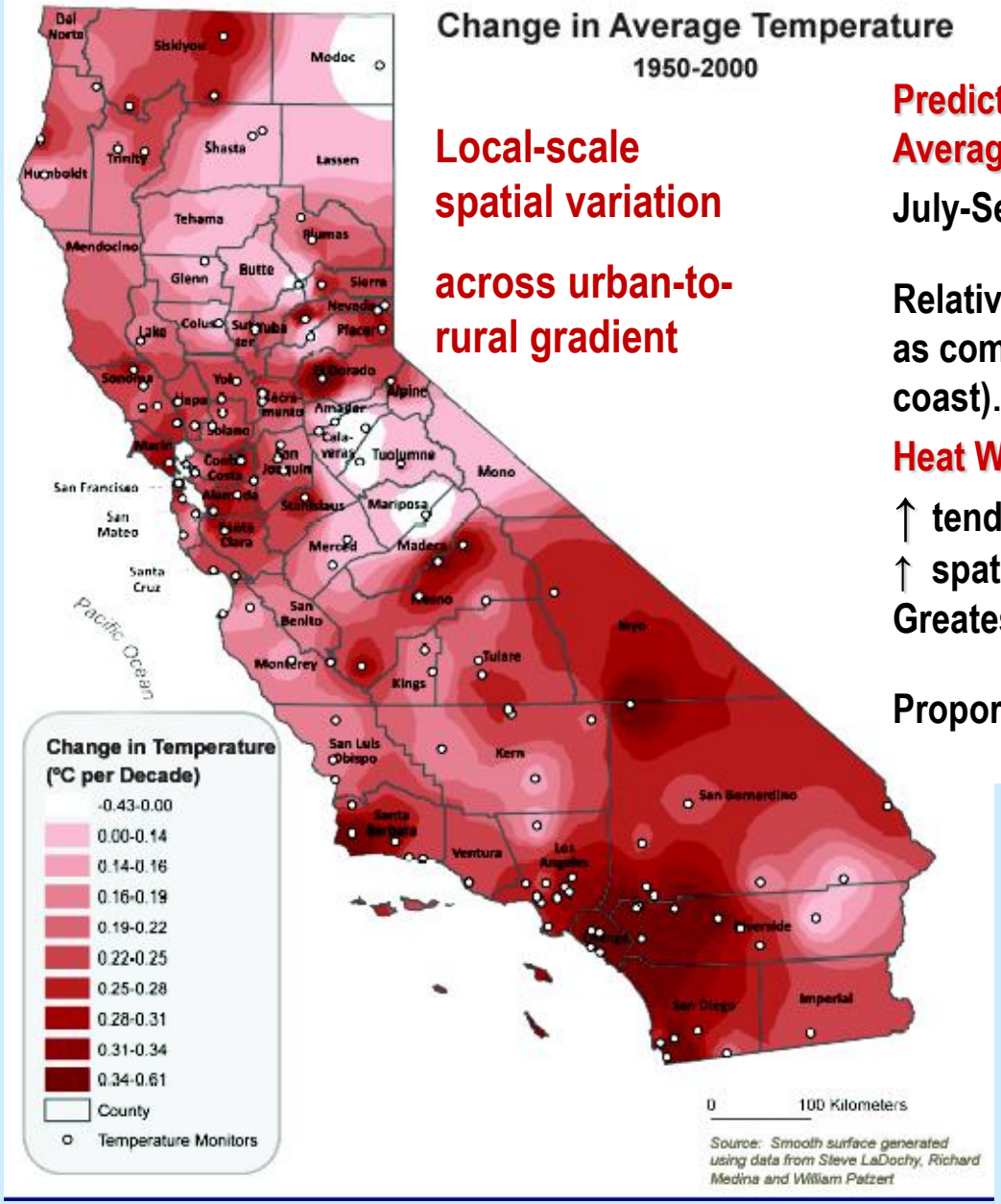
Consequences of Climate Change on Health: High Temperatures

Key points about heat stress and heat-associated outcomes:

- Heat stress can develop in anyone engaged in 'intense' physical activity and/or exposed to environmental heat (and humidity).
  (Intensity is relative to individual…)
- Beyond 'Heat-Related Illness,' which is a clinically defined spectrum of conditions, there are many adverse health outcomes associated with excessive heat exposure.
- Risk of heat associated morbidity/mortality -- not just during heat waves.
- Heat associated illnesses & deaths are preventable.

  https://www.cdc.gov/disasters/extremeheat/index.html

Climate Change: Past, Present, Future Heat Exposure Potential



California Climate Change Scenarios Project

Dan Cayan et al., 2008, A. Gershunov et al., 2009

Predicted change over 21st Century:

Average temperatures: > increase in summer *vs.* winter

July-September ↑ in range of: 1.5°C–6°C (2.7°F–10.8°F)

(Depends on the GCM and GHG emissions scenarios.)

Relative to historical average temps… > warming inland as compared with coastal regions (within ~50 km of coast)…. "…as much as 4°C (7.2°F) higher…"

Heat Waves: ↑ in frequency: Individual events --

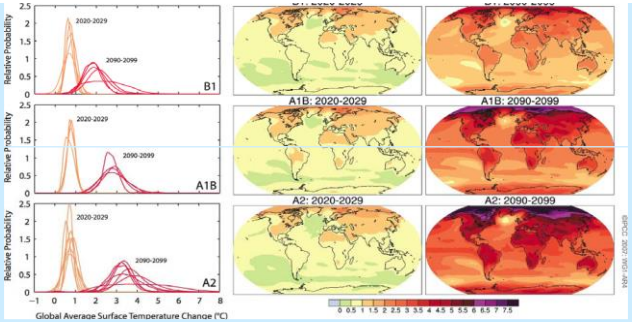
↑ tendency for longer duration

↑ spatial footprints *(multiple population centers affected)*

Greatest magnitude events:

more humid ⟶ less nighttime cooling.

Proportionately more extreme temperatures inland.



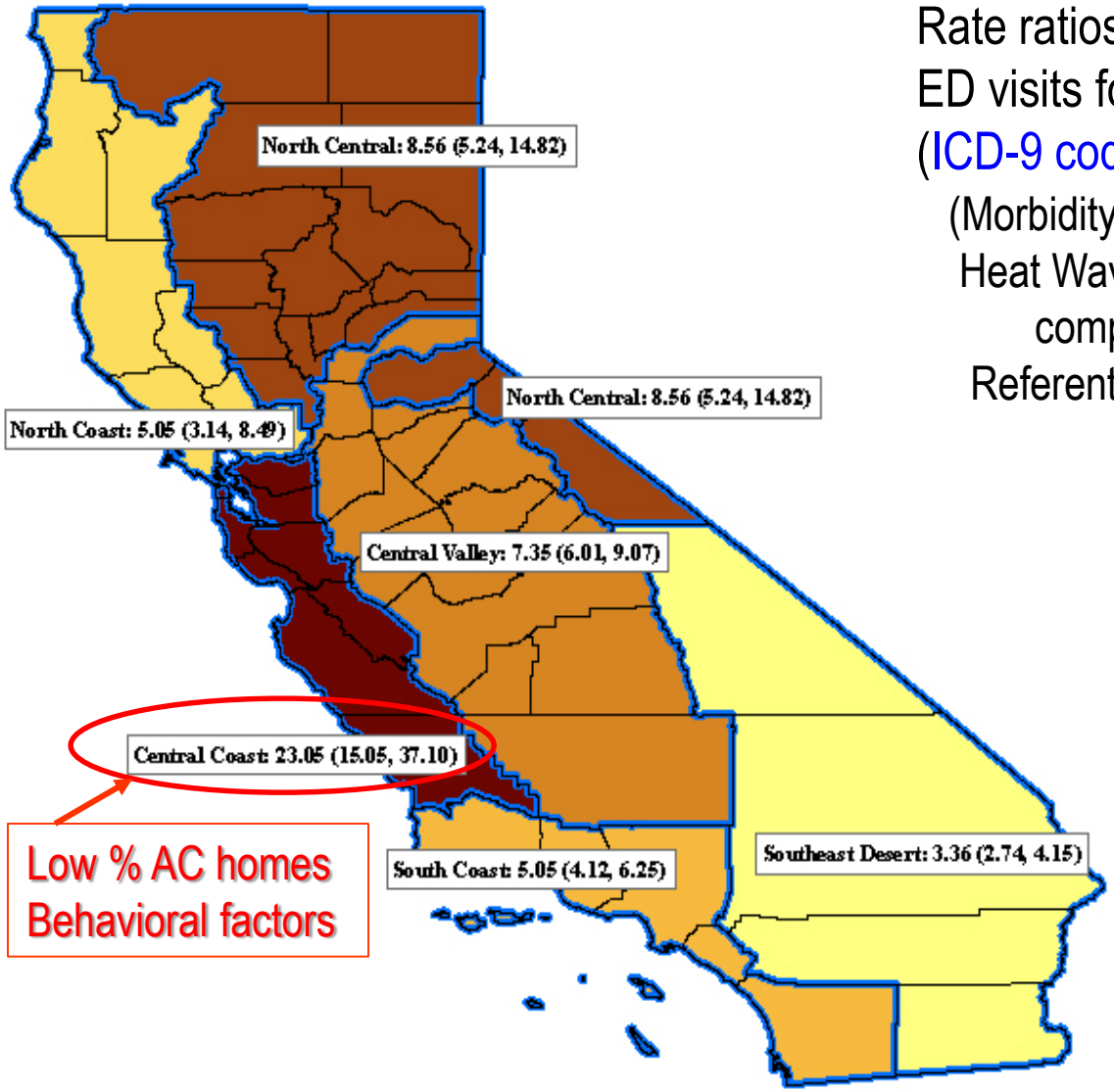
Source: IPCC Climate Change 2007: The Physical Science Basis

Historic California temperature data courtesy of: Richard Medina, University of Utah, Dept. of Geography, Salt Lake City, Steven LaDochy, California State University, Los Angeles, & William Patzert, Jet Propulsion Lab, NASA, Pasadena, CA.

Consequences of Climate Change on Health: High Temperatures

2006 California Heat Wave: Emergency Department Visits & Hospitalizations*

Results: During heat wave: 16,166 excess ED visits, 1,182 excess hospitalizations



Rate ratios (95% confidence limits) for ED visits for Heat-related Illnesses (ICD-9 code 992) among all ages.

(Morbidity rates for Heat Wave: July 15-August 1 compared to rates for Referent Period: July 8-14 & August 12-22)

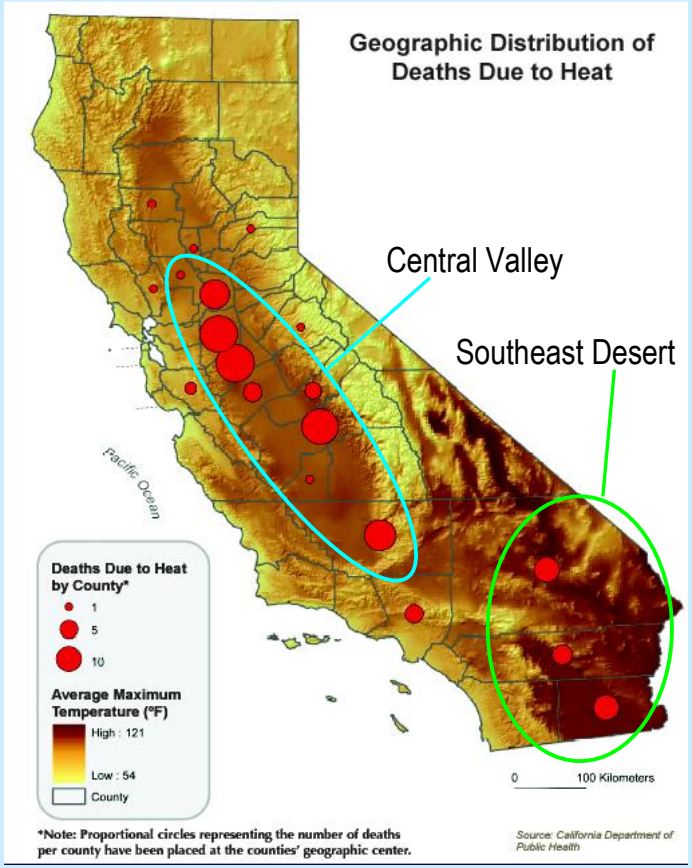
Low % AC homes
Behavioral factors

The risk for an Emergency Department visit due to a heat-related illness was greatest in Central Coast region…includes San Francisco Bay area….

*** CA Office of Statewide Health Planning & Development administrative data**

Knowlton, K et al. Environmental Health Perspectives. 2009. 117(1): 61–67.

Geographic Variation in Environmental & Population Risk Factors



Majority of cases lived in zip codes where > 50% of residents live below Poverty Guide Line

Hispanic cases -- younger

2006 California Heat Wave: excess deaths ~660

140 Coroner's Reports: Case Series

"Classic Heat Stroke" 126 cases
(vs. "Exertional Heat Stroke")

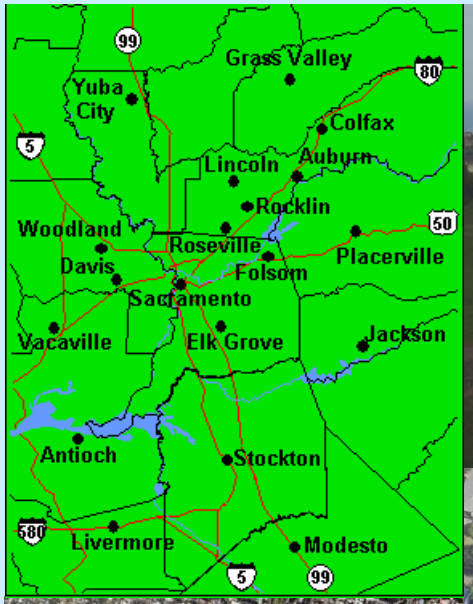
- Mostly older adults
- Chronic Disease Conditions

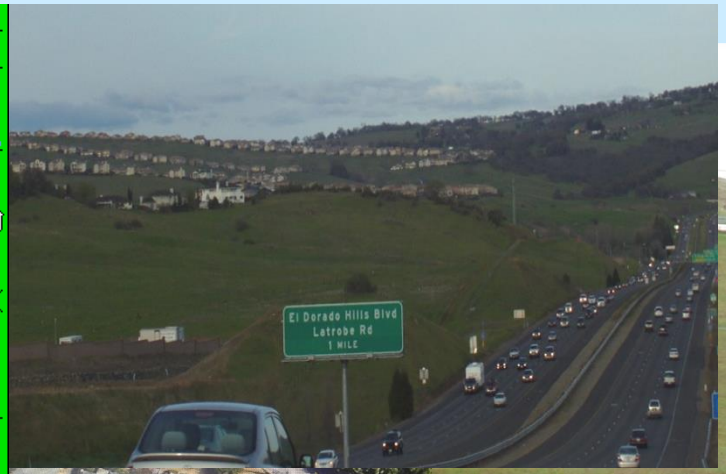
Cardiovascular	**47%**
Psychiatric	23%
Alcohol abuse/dependence	17%
Pulmonary	7%
Confined to bed	2%

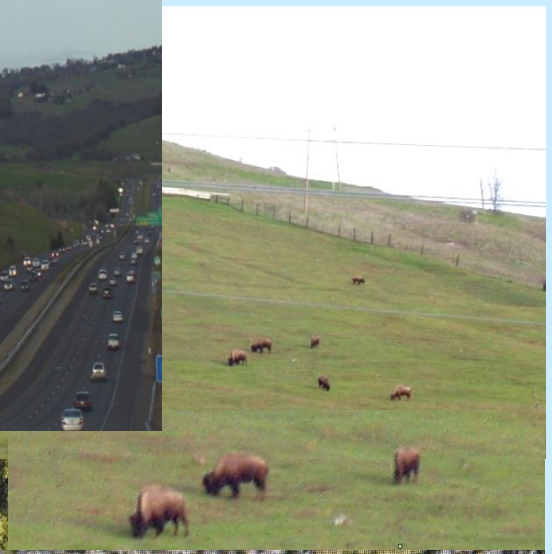
- Heat exposure occurred indoors in most cases.
- Air Conditioning
  - 1 person reported to be using air conditioning prior to death.
  - No AC, or not reported 74%
  - Not functional 13%
  - **Functional but not used** **13%**

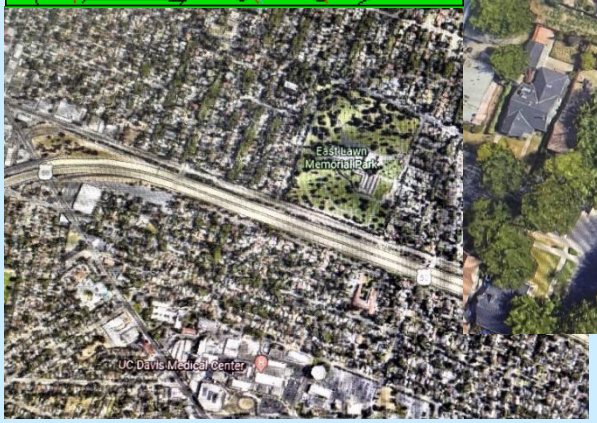
Trent, R.B., et al., Review of July 2006 Heat Wave Related Fatalities in California, available at: http://s3.amazonaws.com/zanran_storage/www.cdph.ca.gov/ContentPages/33125149.pdf

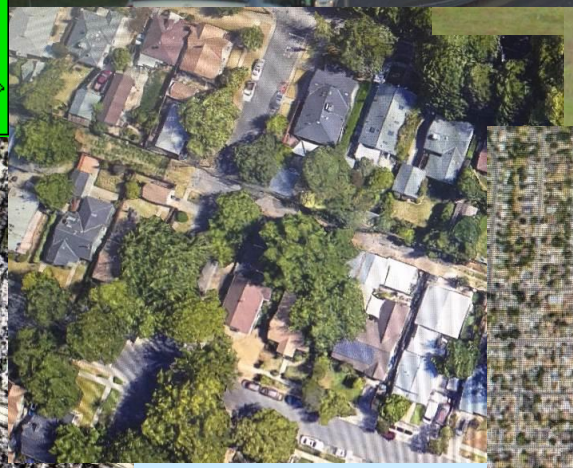
Variation & Inequity in Exposure & Risk: Built Environment

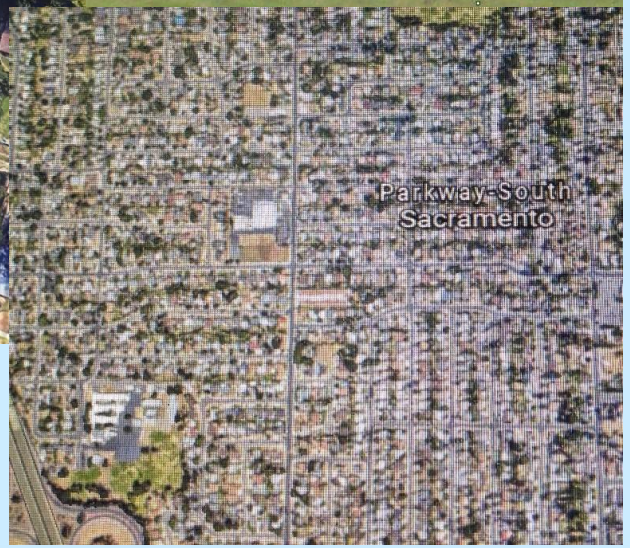












Built environment heat gain:

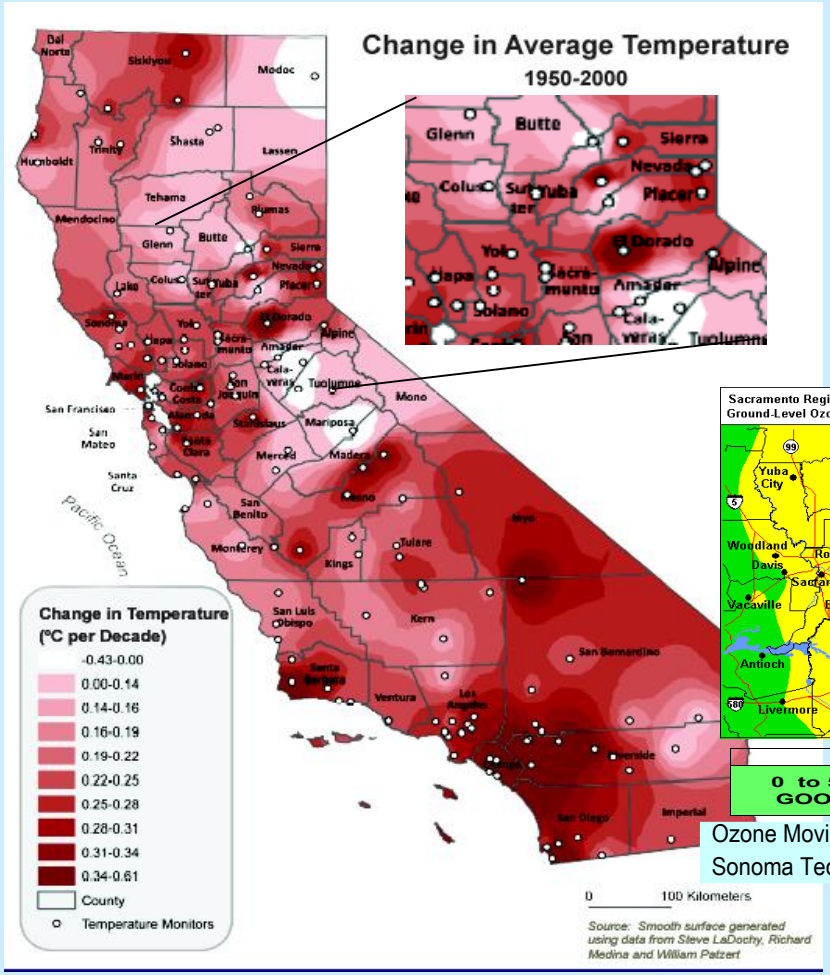
increased by **Impervious Surfaces**

reduced by **Tree canopy**

Consequences of Climate Change on Health: Vulnerability: Exposures

Built Environment & Co-Exposures: Heat Islands, Topography & Ozone

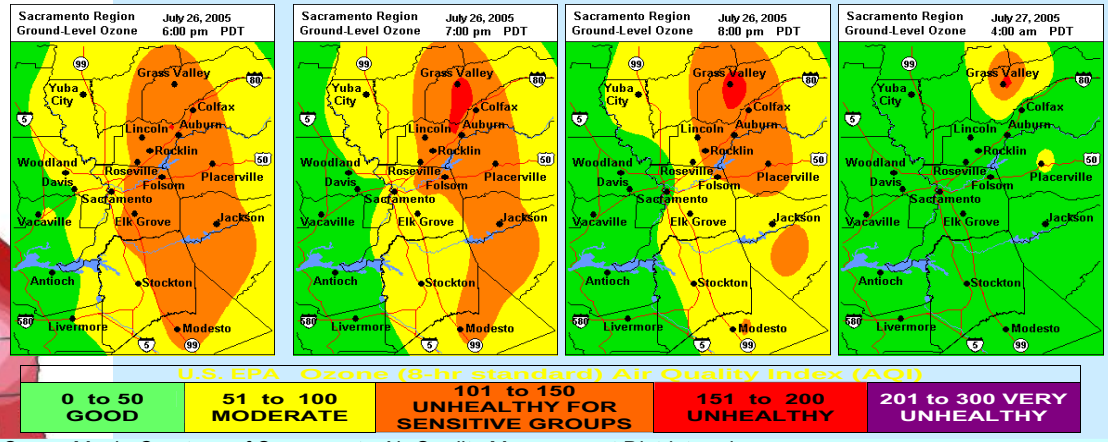
Local-scale spatial variation across urban-to-rural gradient



[Urban] Heat Island Effect: A phenomenon whereby urban (or suburban) areas tend to be warmer than their rural surroundings. Results from vegetation loss and more land surfaces being paved or covered with buildings. The change in ground cover results in less shade and moisture to keep urban areas cool. Built-up areas also evaporate less water, which contributes to elevated surface and air temperatures.

Air pollution not just an urban problem…

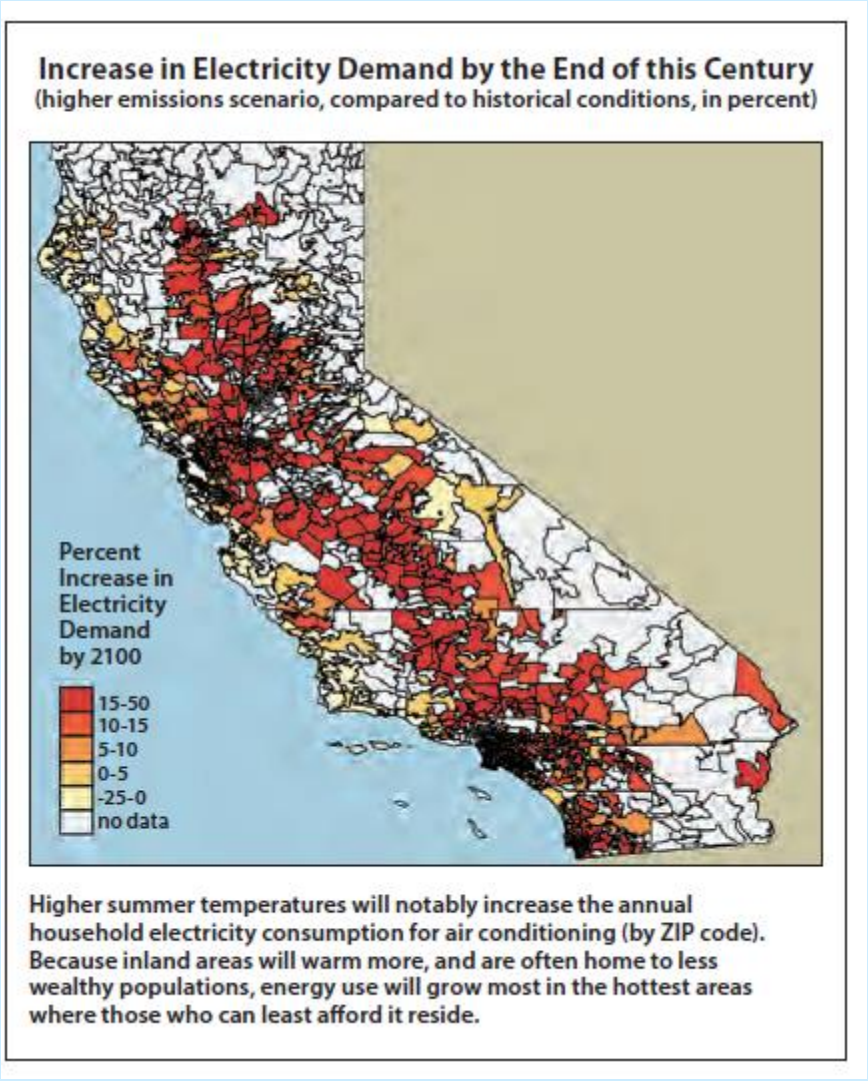
…rural communities can also be seriously impacted by ozone and other pollutants

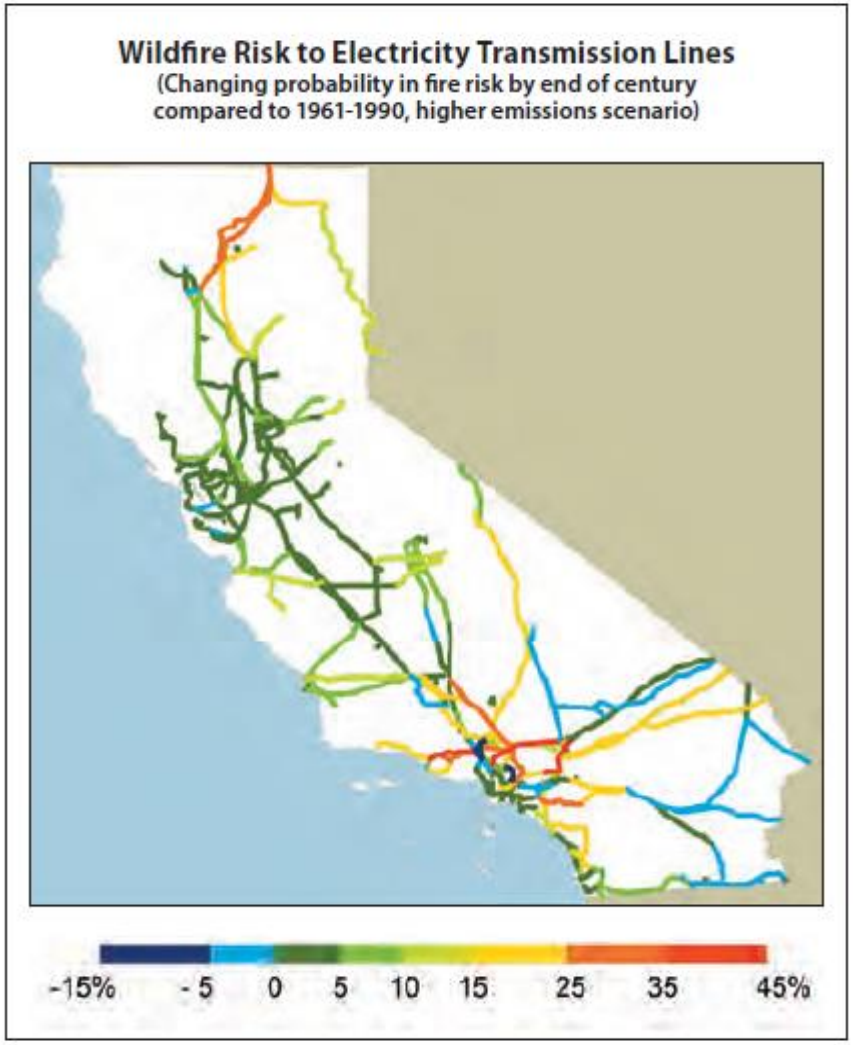


Ozone Movie Courtesy of Sacramento Air Quality Management District and Sonoma Technology, Inc., Petaluma, CA. Visit: www. sparetheair.com to see more.

Vulnerability: Exposures: Infrastructure Demands & Failures

Electricity Demand & Supply: Adaptation Strategies Essential





Consequences of Climate Change on Health: Drivers of Risk

Underlying population health, essential infrastructure

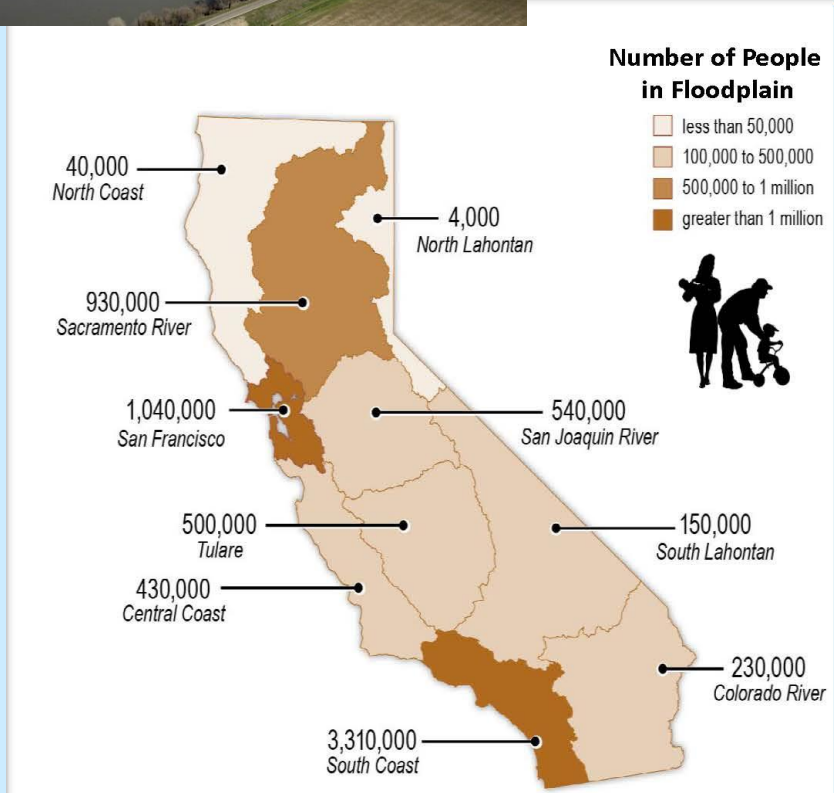
Water access…. Real problem that needs to be fixed!

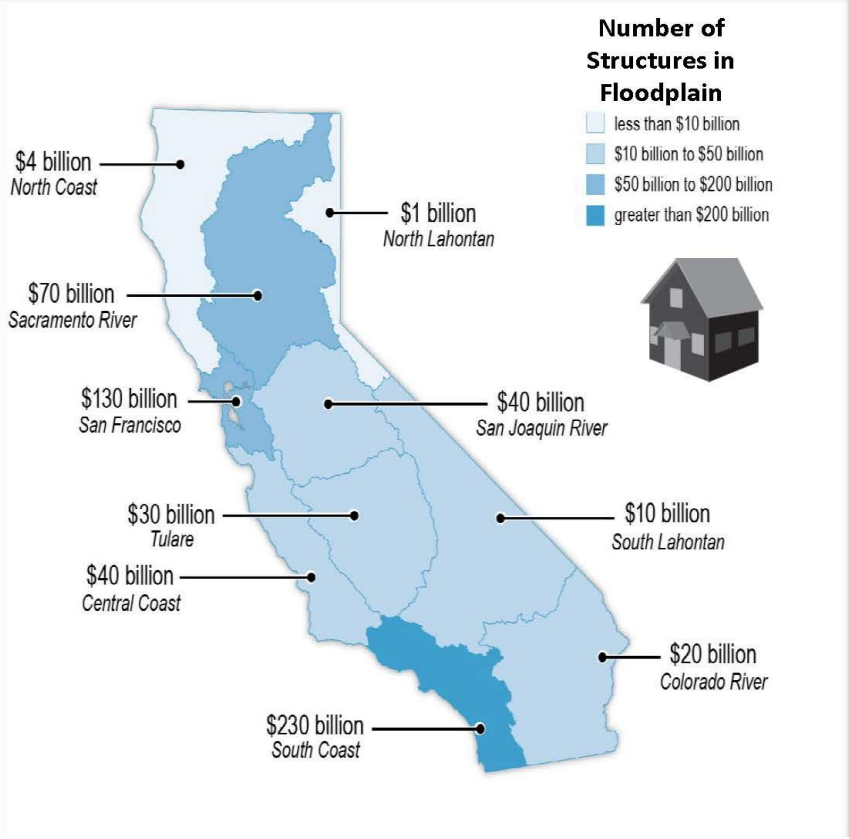
San Joaquin Valley, California in 2016
after the 4-year drought was officially declared over!

https://www.newsdeeply.com/water/articles/2016/06/16/is-drought-causing-a-health-crisis-in-california

Vulnerability: Exposures: Infrastructure Demands & Failures

Flood Exposure





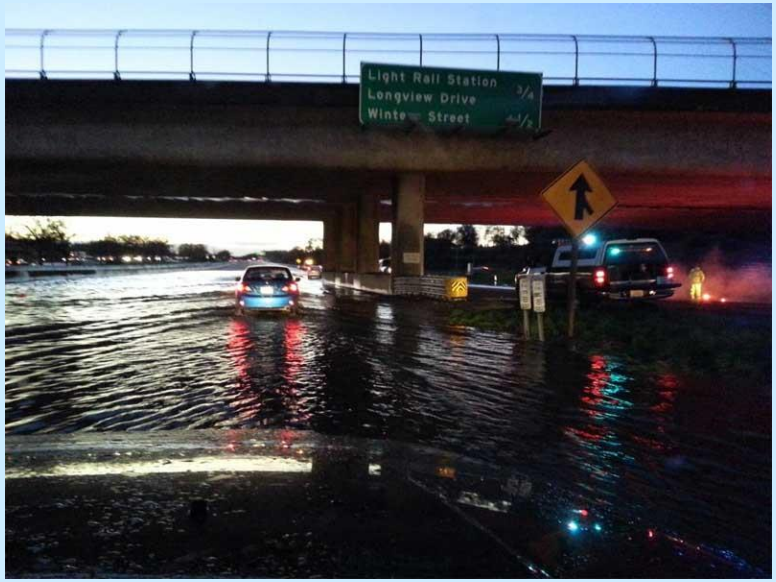
FloodSAFE CALIFORNIA DEPARTMENT OF WATER RESOURCES

PUBLIC SAFETY ENVIRONMENTAL STEWARDSHIP ECONOMIC STABILITY

US Army Corps of Engineers ®

Vulnerability: Exposures: Infrastructure Demands & Failures

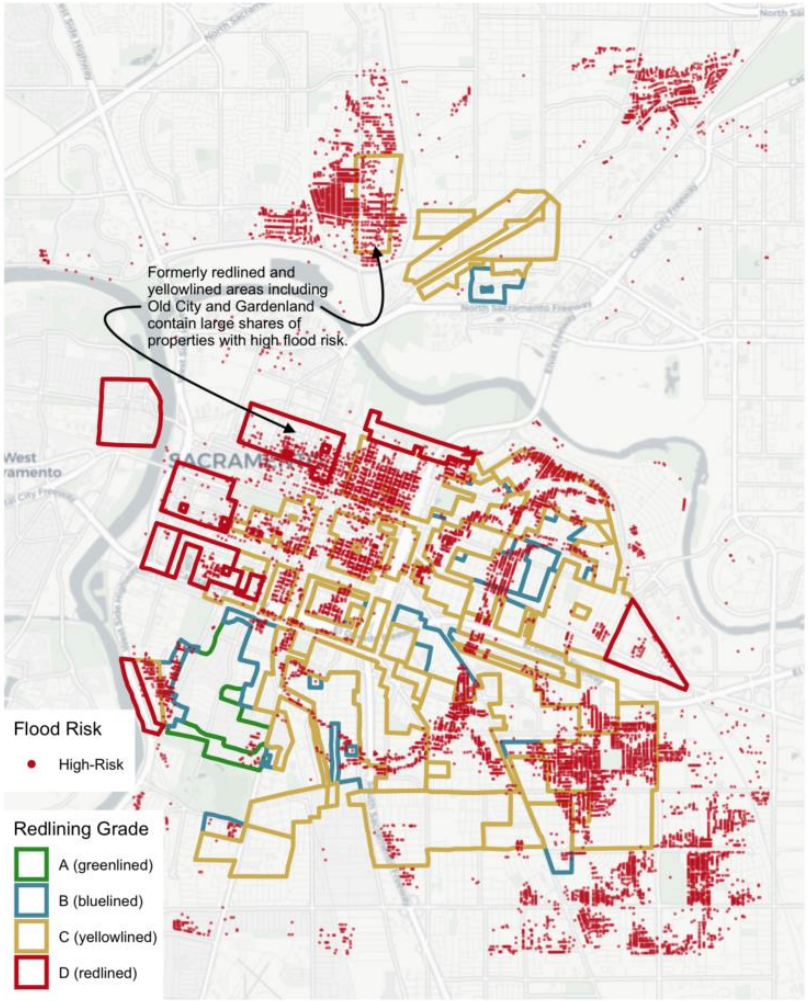
Impaired Escape Routes & Commerce Corridors



‘Consider Sacramento. The California capital region, with a population of more than 2 million, had the highest racial flood-risk disparity in Redfin’s analysis.’

Sacramento's Formerly Redlined and Yellowlined Neighborhoods Face High Flood Risk

Flood risk in Sacramento, CA



Source: Redfin analysis of First Street Foundation flood risk data and HOLC redlining maps. Background map copyright OpenStreetMap contributors.

https://www.bloomberg.com/graphics/2021-flood-risk-redlining/

Maps of historic housing discrimination show how neighborhoods that suffered redlining in the 1930s face a far higher risk of flooding today.
By Kriston Capps and Christopher Cannon
March 15, 2021

Flooding is a rising threat across the U.S., with homeowners facing as much as $19 billion in damages every year. What puts a neighborhood at high risk for flooding? Geography is key, but new data reveal another factor that can be determinative, too: race.

Contemporary maps for flood risk overlap in striking ways with New Deal–era maps used by the federal government to assess risk for mortgage lending. When appraisers mapped cities for the federal Homeowners’ Loan Corporation in the 1930s, they assigned grades to neighborhoods based on several factors, race high among them. Black and immigrant neighborhoods were deemed undesirable, marked by yellow or red lines designating these areas “declining” or “hazardous”—a racist practice known as redlining.

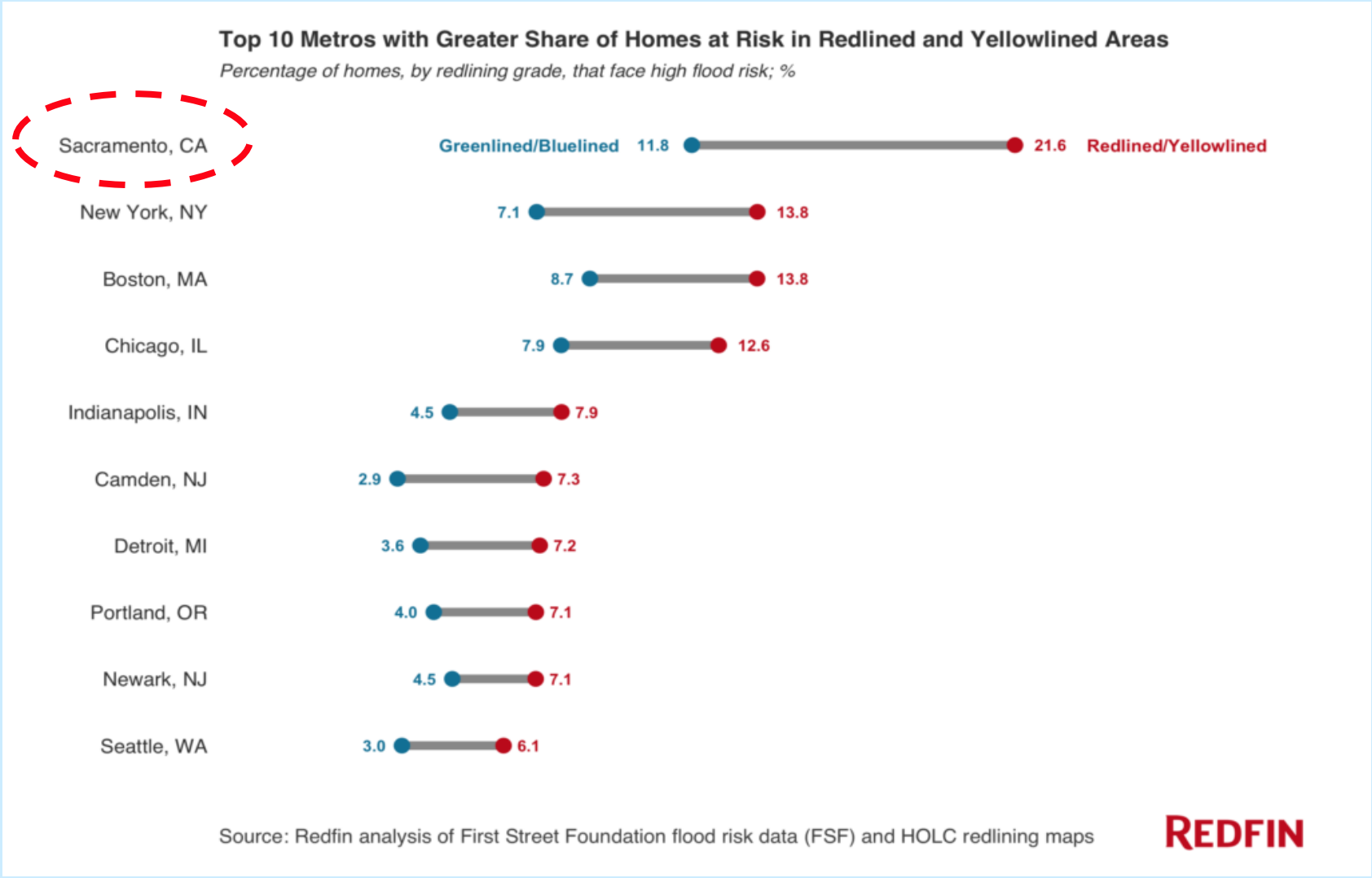
These historically redlined neighborhoods suffer a far higher risk of flooding today, according to new research from Redfin, the Seattle-based real-estate brokerage.

Using flood risk data from the nonprofit First Street Foundation and redlining maps from the University of Richmond’s Mapping Inequality project, Redfin assessed racial disparities in flood risk across dozens of major metro areas.

ORIGINAL Redfin Article: https://www.redfin.com/news/redlining-flood-risk/

Climate Change Risks Amplified for People Subjected to Legacy and Extant Structural Racism & Discrimination

Investments in solutions must prioritize addressing risks in disenfranchised neighborhoods & communities



Vulnerability: Exposures: Infrastructure Demands & Failures: Floods
Health Risks – Immediate and Over Lifetime

Hurricane Katrina – 2005 (> $108 Billion)

~2000 Deaths – most from flooding

Acute Morbidity/Mortality

Injury & complications of injuries
(e.g., wound infections)
Chronic disease acute events
Toxin-related illnesses
Water/Food-borne Diseases
Heat-related illness *(less likely w/SV flood)*

Katrina: ~1000 cases of diarrheal diseases (Norovirus) evacuees in Texas & Mississippi.

Milwaukee 1993: Cryptosporidiosis: 400,000 cases; $96 million ($32M direct medical; $65M lost productivity) Due to drinking water contamination; coincided with Mississippi flooding

Psychosocial Distress/ Mental Health – Acute & Chronic

Toxic Stress
Childhood Trauma

Linda, CA – Vulnerable Community – Flooded 1986

7/9/2018, 5:13:24 PM

CalEnviroScreen 3.0 Results (June 2018 Update)

- 11 - 20%
- 21 - 30%
- 31 - 40%
- 41 - 50%
- 51 - 60%
- 61 - 70%
- 71 - 80%
- 81 - 90%

1:144,448

0 1.25 2.5 5 mi

0 2.25 4.5 9 km

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

Web AppBuilder for ArcGIS

Bureau of Land Management, Esri, HERE, Garmin, USGS, NGA, EPA, USDA, NPS | OEHHA |

Consequences of Climate Change on Health: Heat, Water Vulnerability: Agriculture, and Food & Water Security

- Economic impacts of 2006 heat wave on dairy industry ~ $1 Billion.
  Heat wave kills 16,500 dairy cows statewide.
  (Other estimates – 25,000 in Central Valley or 1% of State's Dairy Herd succumbed plus 70,000 poultry *(Source: http://news.bbc.co.uk/1/hi/world/americas/5223172.stm)*
  Central Valley saw disruption of animal breeding and >10% reduction in milk-production. *Source: Fresno Bee: Mark Crosse*
- Wide array of potential "downstream" public health & clinical risks e.g., water quality, communicable disease, psychosocial stress

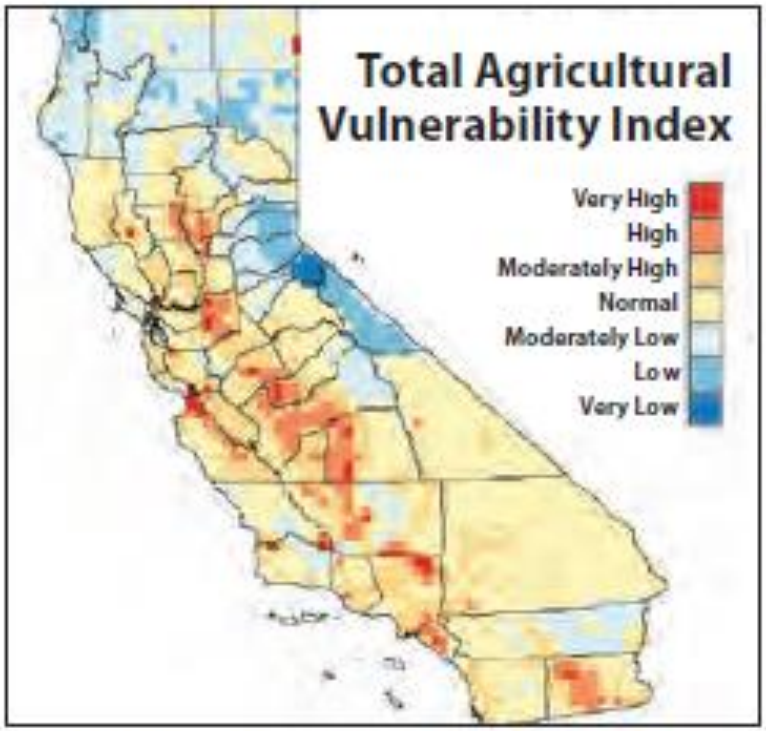
Misters give cows some relief at Pacheco Dairy in Kerman, Fresno County.

Source: Fresno Bee/Mark Crosse

Source: Modesto Bee/Marty Bicek

Vulnerability: Exposures: Infrastructure Demands & Failures

Agricultural Vulnerability & Impacts



Agriculture varies in its vulnerability to climate change. The map shows a composite index of vulnerability revealing the Sacramento-San Joaquin Delta, Salinas Valley, Imperial Valley, and the corridor between Merced and Fresno as particularly vulnerable. Underlying factors vary among regions, including differences in climate, crops, land use and socioeconomic factors.

Source: *Our Changing Climate 2012 Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. Publication # CEC-500-2012-007. Posted: July 31, 2012. http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf*

Consequences of Climate Change on Health: Air Quality

Ecological & Phenological Changes and Health Consequences

★ Increases in Aeroallergens & Plant Biomass

- CO_2 is essential to photosynthetic processes & promotes plant growth

  ↑ CO_2 = ↑ Invasive plant species

- ↑ Temperatures + ↑ CO_2 = ↑ Ragweed in urban locations

  (grew faster, flowered earlier, greater above-ground biomass & pollen)

  Ziska LH et al. J Allergy Clin Immunol 2003;111(2):290-5.

- ? Increase in asthma & allergy in urban communities?

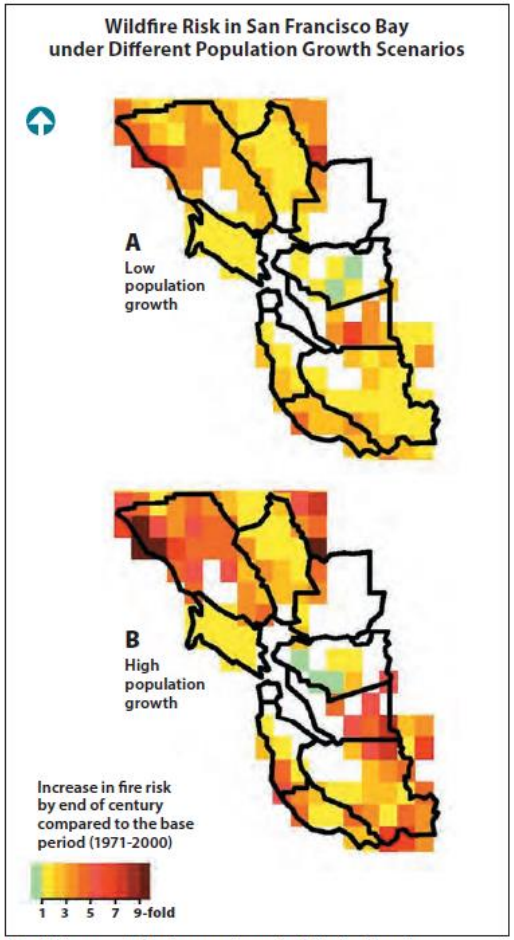
  (↑ exposures to allergens or allergen+ diesel emissions)

  Diaz-Sanchez, D. et al. Current Allergy and Asthma Reports 2003;3(2):146-52.

- ↑ Biomass + more arid conditions = ↑ risk of wildfires

  (↑ air pollution & ↑ risk of injury)

Climate Change Health Risks: Drought, Heat, Air Quality: Wildfires



Fire risk is expected to increase in much of the San Francisco Bay Area. Population growth will be a major factor, even if little changes at the wildland–urban interface. Yellow hues indicate smaller increases in fire risk, and darker reds and browns indicate greater increases compared to the risk during the base period (1971-2000). Green represents reductions in risk, white indicates areas that were not modeled.

Source: *Our Changing Climate 2012 Vulnerability & Adaptation to the Increasing Risks from Climate Change in California. Publication # CEC-500-2012-007. July 31, 2012. http://www.energy.ca.gov/2012publications/CEC-500-2012-007/CEC-500-2012-007.pdf*

Not just a rural problem & not just during a Wildfire

Acute Morbidity/Mortality

Death & Injury

Chronic disease acute events

Loss of access to healthcare, medications, infrastructure, etc.

Toxin-related illnesses

Water/Food-borne Diseases

Psychosocial Distress/ Mental Health – Acute & Chronic

Toxic Stress

Childhood Trauma

Population displacement & loss of social cohesion, leads to adverse health outcomes in near- and long-term

Fire Prevention strategies potential health risks, e.g. 'Power Safety Shut-Offs'

life-sustaining power-dependent medical devices (e.g., home dialysis, oxygen), medications

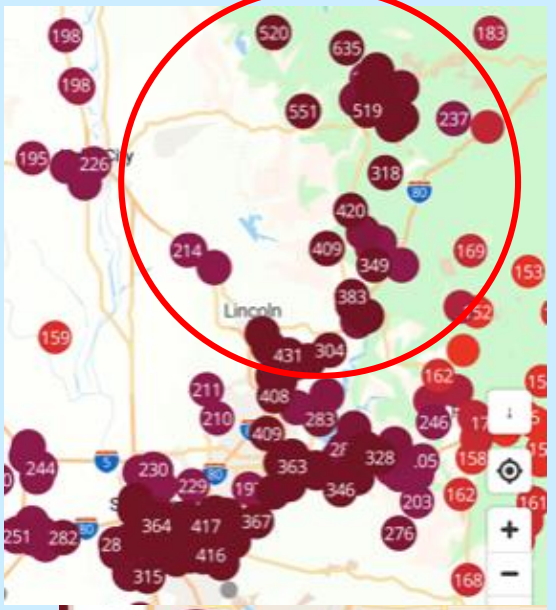
Climate Change Challenge: Wildfire Smoke: Exposure & Health Risk Reduction

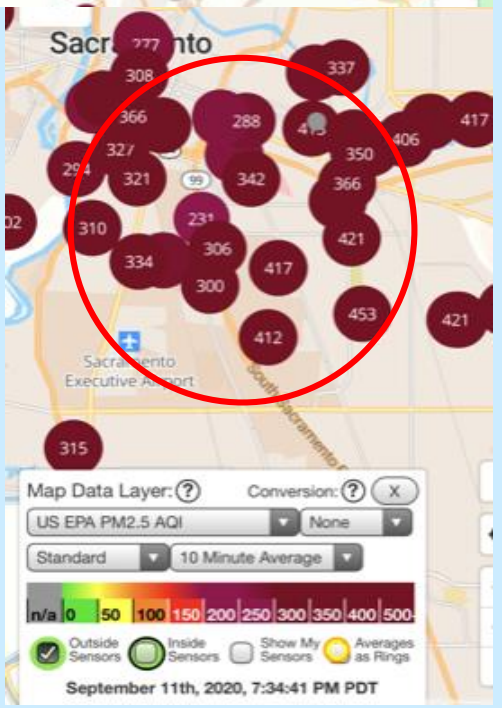
Some days are too hazardous to exercise outdoors…
but many people do not have access to safe indoor spaces
Becomes more of a problem during multi-week smoke events

Air Quality Index serves as a public health messaging tool

Air Quality Index for $PM_{2.5}$

Air Quality Index	Who Needs to be Concerned?	What Should I Do?
Good 0-50	It's a great day to be active outside.	
Moderate 51-100	Some people who may be unusually sensitive to particle pollution.	**Unusually sensitive people:** *Consider reducing* prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. **Everyone else:** It's a good day to be active outside.
Unhealthy for Sensitive Groups 101-150	Sensitive groups include **people with heart or lung disease, older adults, children and teenagers.**	**Sensitive groups:** *Reduce* prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath. **People with asthma** should follow their asthma action plans and keep quick relief medicine handy. **If you have heart disease:** Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.
Unhealthy 151 to 200	**Everyone**	**Sensitive groups:** *Avoid* prolonged or heavy exertion. Move activities indoors or reschedule to a time when the air quality is better. **Everyone else:** *Reduce* prolonged or heavy exertion. Take more breaks during all outdoor activities.
Very Unhealthy 201-300	**Everyone**	**Sensitive groups:** *Avoid all* physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better. **Everyone else:** *Avoid* prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.
Hazardous 301-500	**Everyone**	**Everyone**: *Avoid all* physical activity outdoors. **Sensitive groups:** Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.





For more information see: EPA 454/B-18-007 September 2018 Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI)
https://www3.epa.gov/airnow/aqi-technical-assistance-document-sept2018.pdf

Consequences of Climate Change on Health: In California

Environmental Changes & **Altered Communicable Disease Occurrence**

Vector-Borne: West-Nile, Lyme Disease, viral encephalitides, malaria, dengue, hantavirus, Rift Valley fever
Water-Borne: Cholera, cryptosporidiosis, campylobacter, leptospirosis

Hot dry conditions increase incidence of **Valley Fever**
Fungi: *Coccidioides immitis* and *Coccidioides posadasii*
in certain types of soil found mainly in desert regions from northern Mexico, Texas, Arizona, New Mexico and Southern California….and California's Central Valley

Interannual cycles of drought and extreme precipitation can promote conditions that enhance vector-borne disease pathogen transmission

Lyme Disease
Borrelia burgdorferi and *Borrelia mayonii* bacteria, in California carried primarily by western blacklegged tick, *Ixodes pacificus*.
Increase also related to Land use, wildlife corridors, predators-host populations dynamic relations
(e.g., Deer, predators, and the emergence of Lyme disease. 2012 T. Levia, A. M. Kilpatrick, M. Mangel, and C.C. Wilmers. PNAS: V109 (27):10942–10947 www.pnas.org/cgi/doi/10.1073/pnas.1204536109)

Consequences of Climate Change on Mental Health
Emergent health outcome & research

'Climate change may weigh heavily on mental health in the general population and those already struggling with mental health disorders. *468,469,470,471,472*

One impact of rising temperatures, especially in combination with environmental and socioeconomic stresses, is violence towards others and towards self. *473,474,475*

*Slow-moving disasters, such as drought, may affect mental health over many years.*470

*Studies of chronic stress indicate a potentially diminished ability to cope with subsequent exposures to stress.*476,477,478 '

Gonzalez, P., G.M. Garfin, D.D. Breshears, K.M. Brooks, H.E. Brown, E.H. Elias, A. Gunasekara, N. Huntly, J.K. Maldonado, N.J. Mantua, H.G. Margolis, S. McAfee, B.R. Middleton, and B.H. Udall, 2018: Southwest. In Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, pp. 1092–1175. doi: 10.7930/NCA4.2018.CH25

Climate Change Science & Policy: Concepts & Definitions

Strategies to address Climate Change and its Consequences

Climate Change ***Adaptation Strategies***

Actions to lessen the adverse impacts by preparing for inevitable changes in climate and climate variability.

Climate Change ***Mitigation Strategies***

Actions to limit further climate change by reducing the production of greenhouse gases.

Vulnerability Reduction Solutions: General Principles

Need to consider simultaneous risks changing over space & time
Geographic variation & population variation

Capitalize on and enhance existing programs and projects
(Local-to-federal government, NGOS, faith-based organizations, etc.)

In developing/applying solutions think **multi-dimensionally…**
and think about **adverse unintended consequences**
and opportunities to realize **co-benefits** across sectors & populations

Mitigation and **Adaptation** strategies need to be integrated, complementary...
For example – Community actions to increase air conditioning in residences, need to be accompanied by actions that promote 'cooler built environment' and more (non-polluting) green-energy production strategies.

Ensure **equitable distribution** of costs-benefits of mitigation and adaptation strategies.
Example – do not shift production of [polluting] 'green-energy technology' to less-empowered neighborhoods or to nations with weak worker health and environmental laws and policies.

Critical **all nations accept social responsibility** for fostering international business practices that promote global health and resource sustainability.

We need to plan for and make the ethical choices now…not in crisis.

Vulnerability Reduction Solutions: Health & Healthcare Services

To reduce vulnerability at individual, population, community, regional, country, and global levels:

Promote good health (reduces risk, increases resilience)

Ensure access to health care, medical management

Improve standard of care for all groups…

…Increase physician awareness

Build resilient & sustainable healthcare services infrastructure

Strive for health equity and reducing health & social disparities

Examples:

Community Health Clinics (e.g., UCD medical student run)

Breathe California Sacramento Region – Mobil Health Clinic & Health Fairs

Investment in research and clinical infrastructure to optimize primary health care & chronic disease management and personal* health management saves lives (and $$)

* *need to increase health literacy*

Investment in Emergency Response Capacity saves lives (and $$)

Vulnerability Reduction Solutions & Investments: Infrastructure & Built Environment

Reduce potential exposure (individual, neighborhood, community)

Prevention & Response

Ensure response is adequate & does no harm

(e.g., cooling centers & transportation;
not fans* unless clear guidance/oversight for use)

**Fans may contribute to heat stress & illness when high humidity (> ~33%) and high temperatures (≥ 90°F (32.2°C)) or temperatures ≥ 100°F (37.8°C).*

Enhance/support programs to build resilient infrastructure

Redesign/design neighborhoods and communities to adapt to changing climate and increase the resiliency of people and places…

Prioritize designs that promote physical and mental health, e.g., active transportation, tree canopy and greenspaces, community centers & gardens (social cohesion, food security, etc.)

Disparities (and consequences of disparities) **in individual and community assets** will be amplified by climate change.

Vulnerability Reduction Solutions

Public health messaging is powerful tool….
but the messages need to be correct/complete
and do not assume messages are being heeded…

"Older adults & persons with 'medical conditions' should avoid the heat"

Many older adults do not perceive themselves as old or at risk.

Persons who believe limitations in their lives are related to aging are less likely to adopt preventive or adaptive behaviors.

(L. Richard et al. Health Educ Res. 2011: 26(1):77-88)

FOCUS AREA	RISKS	ADAPTATION STRATEGIES AND SOLUTIONS
4.1 PUBLIC HEALTH	• More frequent heat-related stress, illness, and human mortality due to increases in number of extremely hot days (i.e., prolonged heatwaves) • More disease-causing pathogens including West Nile virus, Valley Fever, harmful algal blooms, etc.	• Reducing/managing potential exposure(s) (individual, community) to heat and other hazards • Reducing heat pollution and eliminating urban heat islands
	• More exposure to ground-level ozone, particulate air pollution and respiratory allergens	• Promoting good health and access to quality healthcare (reduces risk and increases resiliency)
	• Negative impacts on mental health from chronic social and economic stressors	• Improving Emergency Preparedness and Response Action Plans and resources

FOCUS AREA	RISKS	ADAPTATION STRATEGIES AND SOLUTIONS
4.2 COMMUNITY PLANNING	• Potential disruptions to the housing market in response to un-mitigated flooding and concomitant economic impacts that disproportionately affect particular sociodemographic groups	• Implement zoning, building codes, and design guidelines that emphasize residential and neighborhood greening, cool roofs, climate adaptive building shells, and other techniques to reduce climate impacts on urban environments and public health
	• More frequent severe storms and floods • Increased stress on levee systems	• Regional levee and watershed planning to retain storm water, reduce flooding, and sequester carbon
	• Increased wildfire risks and impacts, especially for rural communities in hilly and forested terrain	• Supporting climate-conscious planning that restricts housing in high fire risk areas • Requiring flame-resistant materials for structures and fuel reduction in residential yards
	• Increased susceptibility to illness from high temperatures	• Tree-planting to shade parking and other surfaces
	• More risks from poor air quality, especially in areas with air pollution from transportation and other industrial sources	• Engaging stakeholders in adaptation planning (e.g., Sacramento Area Council of Government's Rural-Urban Connections Strategy) • Sharing climate adaptation information among regional institutions (e.g., Capitol Region Climate Readiness Collaborative)
	• Please refer to the Tribal and Indigenous Communities report for further information on how California's Tribal communities face unique threats from climate change and how these communities are spearheading adaptation and mitigation efforts (Tribal and Indigenous Communities Summary Report 2018)	• Climate adaptation strategies by tribal communities (e.g., Yocha Dehe Wintun, Karuk Tribe, Yurok Tribe) • Tribal engagement in carbon sequestration to provide local employment and ecological and disaster mitigation benefits for rural communities

FOCUS AREA	RISKS	ADAPTATION STRATEGIES AND SOLUTIONS
4.3 **ENERGY, WATER, UTILITIES AND TRANSPORTATION**	• Reduced thermo-electric power plant operating efficiency and generation capacity due to increasing air and water temperatures • Reduced or disrupted hydropower generation from greater evaporative losses, altered runoff timing, decreased snow pack and increased storms intensity • Uncertain impacts on solar and wind power outputs (i.e., from variable wind patterns) • Decreased efficiency of electric transmission and distribution systems from higher temperatures	• Principles and best practices for adaptation (e.g., Council on Environmental Quality) • Continuing development of comprehensive statewide strategies to adapt to climate change (e.g., California Natural Resources Agency, California Energy Commission, electric utilities, US Department of Energy, others) • Cross-sectoral approaches to better facilitate adaptation at the local level (refer to the Cross-sector Interactions Section) • Rapid decarbonization of buildings and transportation • Planning to deploy distributed generation and energy storage for more local control of the energy supply
	• Accelerated roadway deformation and track buckling resulting from extreme heat • Increased expansion and contraction at critical bridge joints resulting from temperature fluctuations • Traffic and signal disruptions from extreme weather • Decreased driving visibility and health hazards due to wildfire	• State policies to integrate alternative fuel aspirations and driving trends (e.g., autonomous vehicles) into transportation plans and policies, and implementation of long-term maintenance plans • Integration of energy-transport long-term planning at the local level upward • Developing new finance tools for ensuring long-term maintenance and adaptation funds • Incentivizing climate-smart infrastructure planning to prioritize mode shift to low carbon alternatives and active transportation
	• Reductions in groundwater in response to drought and increased water demands	• Implement water conservation strategies • Assessment of additional water storage solutions • Increased stormwater capture
	• Economic impacts that disproportionately affect particular sociodemographic groups depending on location	• Understanding broader social issues of climate change, especially for low-income and disadvantaged communities

FOCUS AREA	RISKS	ADAPTATION STRATEGIES AND SOLUTIONS
4.4 LAND USE, NATURAL HABITATS AND WORKING LANDS	• More threats from flooding, drought and fire	• Expanding flood channels for 200+-year protection (levee setbacks); water conservation; fire and fuel management near wildland-urban interface • Prescribed burn treatments in forests and shrublands under the right context, settings, and conditions
	• Species composition changes and reduction, and loss of iconic species	• Connecting habitats and refugia
	• Increased extinction risk for most native fish species • Increased threats, displacement, and/or local extinction due to invasive species, pests, disease, etc.	• Naturalizing the hydrograph of regulated rivers and assist hatchery fish migration • Controlling invasive and non-native species
	• Changes in productivity of current crop varietals and conversion of agricultural land to other land uses • Loss of agricultural/semi-natural habitats	• Ecosystem agricultural practices (e.g., hedgerows, tail water ponds, enhancing riparian areas, and vegetated road verges and canal edges)

Closing Thoughts

Investment of resources to mitigate global warming, and to prevent or adapt to the impacts of our changing climate can also contribute significantly to improvement of overall health and well-being of ***all*** inhabitants of this planet's global community.

Contact Information:

Helene G. Margolis, M.A., Ph.D.

hgmargolis@ucdavis.edu

Department of Internal Medicine

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Thank You!