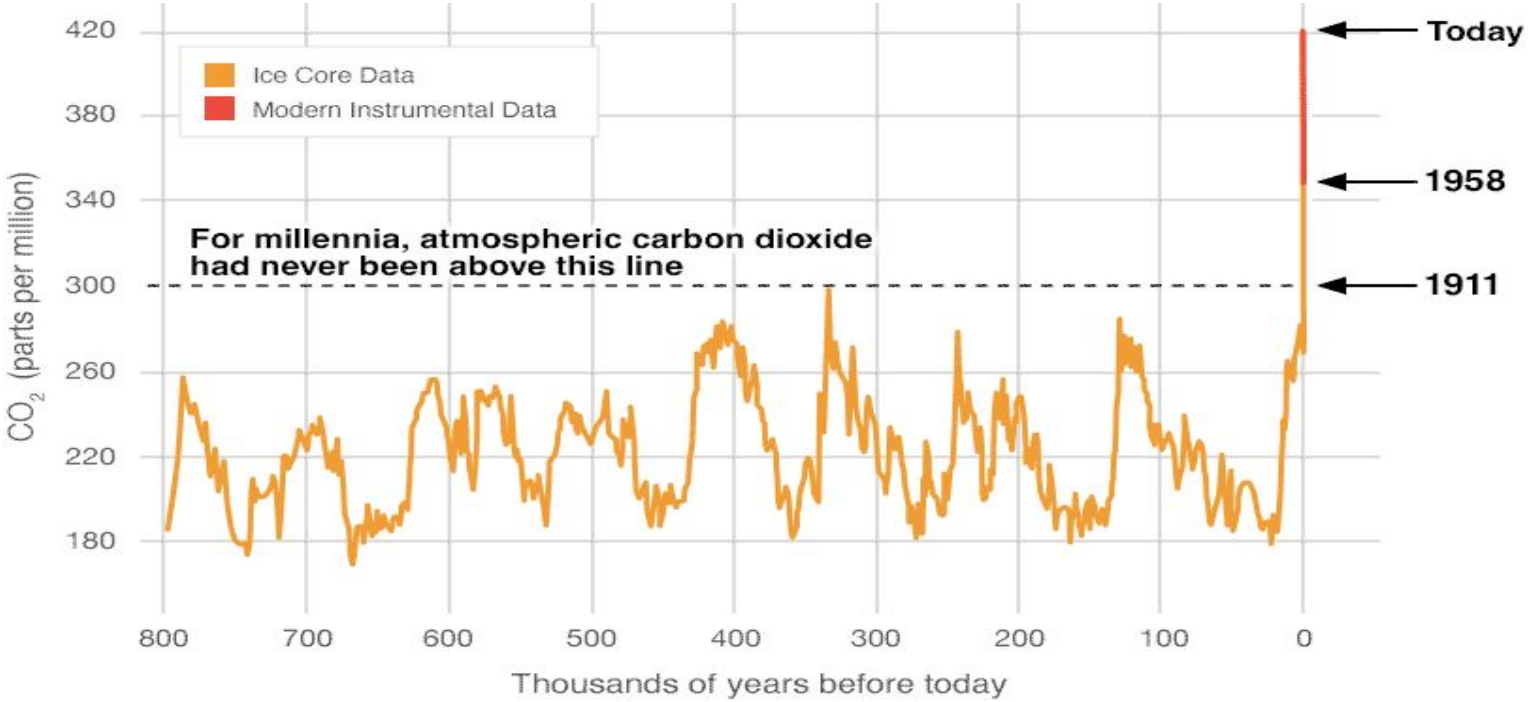
The Co-Benefits of reducing GHGs and Fossil Fuel Emissions

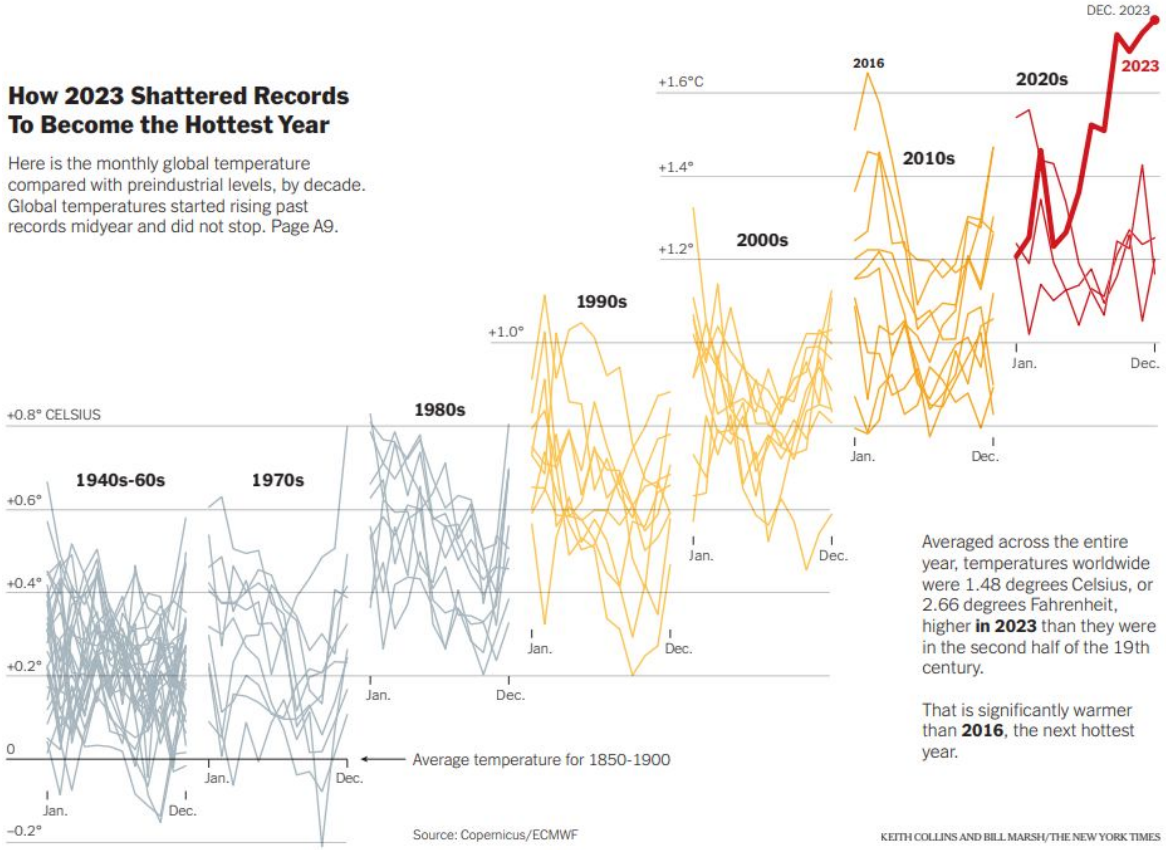
Bret Andrews DO, SF Bay Physicians for Social Responsibility Board Member
Co-Director of NICHe (Neurologists Interested in Climate and Health)
June 23, 2025

Is CO_2 Increasing?



https://climate.nasa.gov/vital-signs/carbon-dioxide/

Is warming accelerating?



NYT

Climate Change: Human and Global Stress

- **2024 had the highest average global temperatures. (Reached 1.5˚C IPCC milestone > Preindustrial); pattern continues in 2025.**
- **Atmospheric carbon is at ~425 ppm this year vs 280 ppm in pre industrial times(>50% rise)**
- **Extreme weather events - Wildfires, drought w decreased rain and snow, heatwaves, heavy rains and floods, and hurricanes.**
- **Not all from climate change, but the association is increasing, and frequency and severity are increasing**
- *****US cost climate change was averaging > $125 billion/yr.**
  - LA Wildfires could top $150 B
  - Global estimates by mid century $20-40 T

LA Fires, AP

- **Last Summary of the IPCC: Climate Change Report 2023**

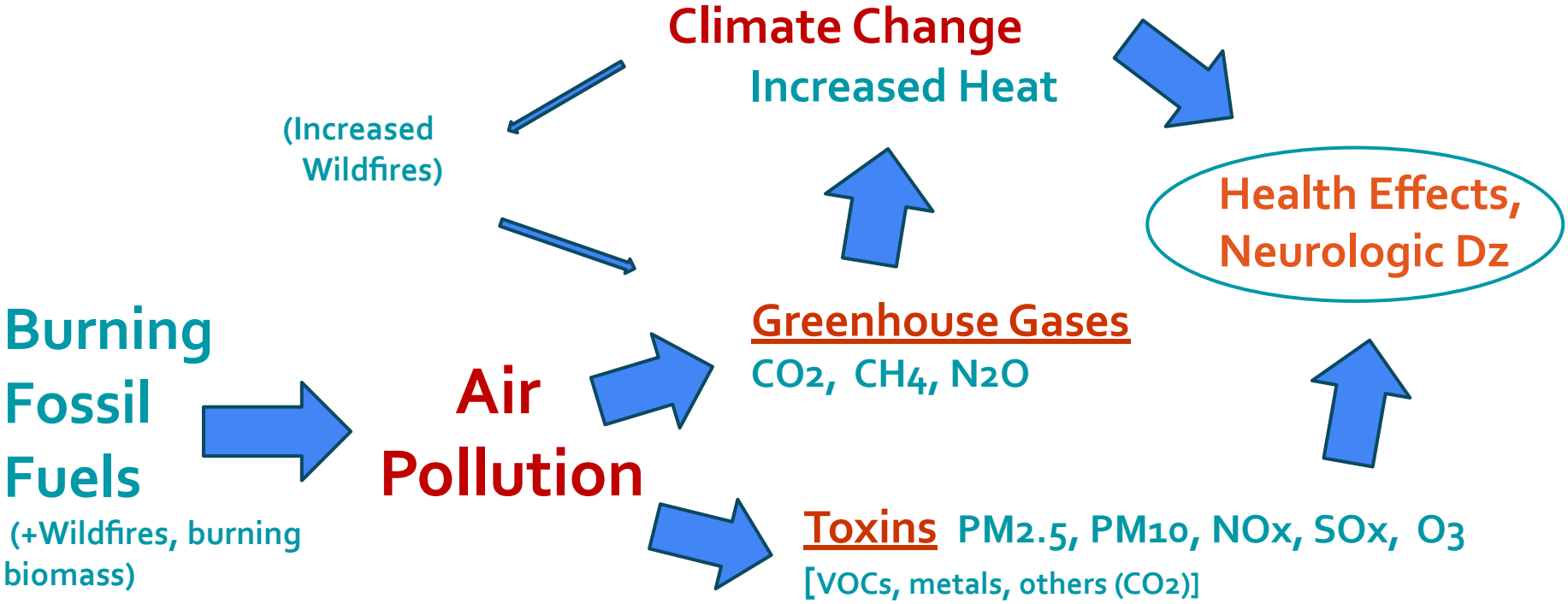
Climate Change, Unprecedented Heat

- **2024, record extreme heat events across the US**
- **Summer of 2022, >60,000 excess deaths due to European heat waves**
- **Vulnerable populations suffer more including those in urban heat islands (up to 10F warmer) and outdoor workers**
- **Probably a substantial underestimate, but recent report** 2023 extreme heat led to at least 2,325 heat-related deaths in the US. There has been a significant upswing since 2016.

AP

2023 Balester, Heat related Mortality in Europe, Nature Medicine[34]
2023 Vecellio. Greatly enhanced risk to humans…moist heat stress tolerance. PNAS[7]

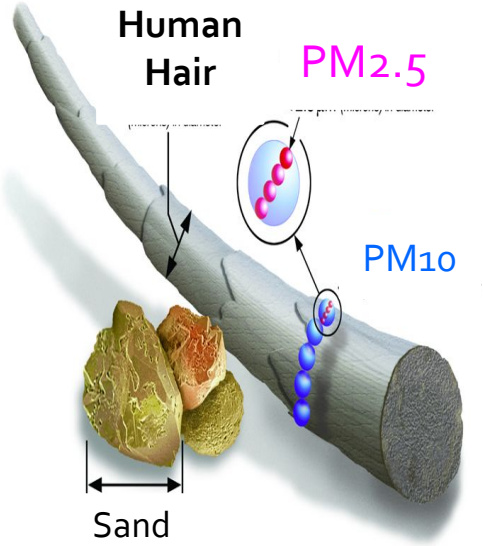
Climate Change and Air Pollution:

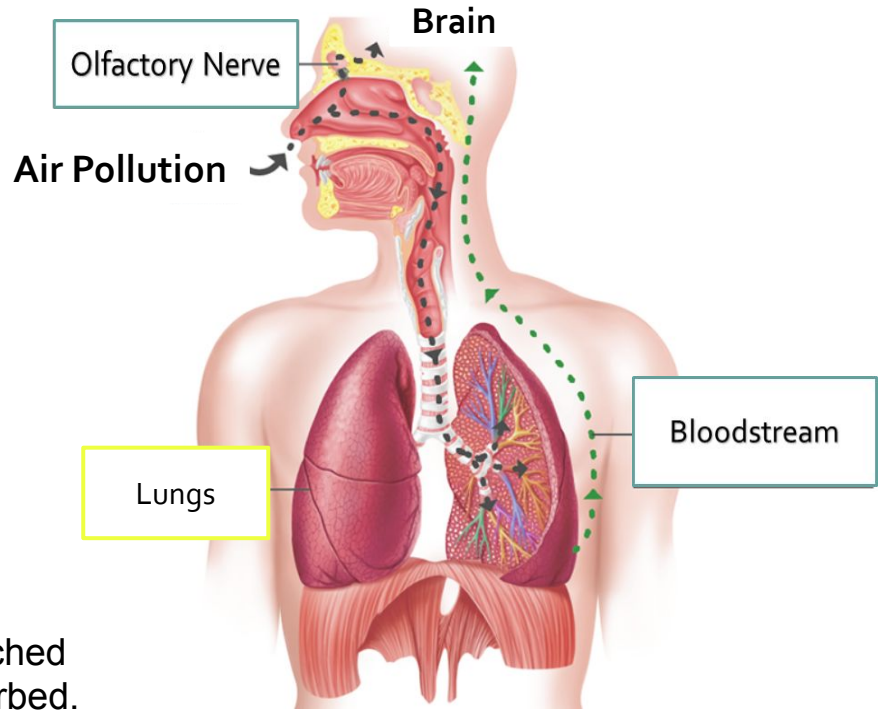


Air Pollution: contamination of the indoor or outdoor air by any agent that modifies the natural characteristics of the atmosphere **(any chemical, physical or biological agent): WHO**

*PAH= Polyaromatic Hydrocarbons, VOC= Volatile Organic Compounds

Air Pollution and Neurology





- PM2.5 (small **soot** < 2.5 μm) and NO2 most researched
- PM2.5 particles penetrate deep lungs, may be absorbed.
- Injury mechanism to brain and other organs likely involves inflammation and oxidative stress vs transit with direct organ toxicity

CA Air Resources Board[3]

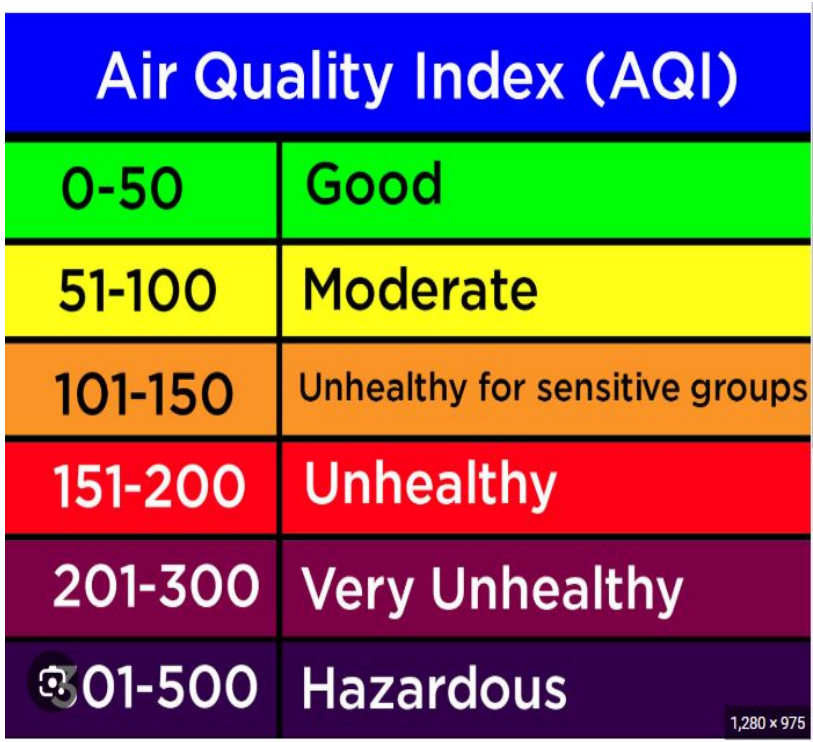
Air Pollution and the Air Quality Index (AQI)

24hr Air Quality Index is tied to the PM2.5 concentration:

50 AQI = 9 µg/m^3
100 AQI = 35 µg/m^3
150 AQI = 55 µg/m^3

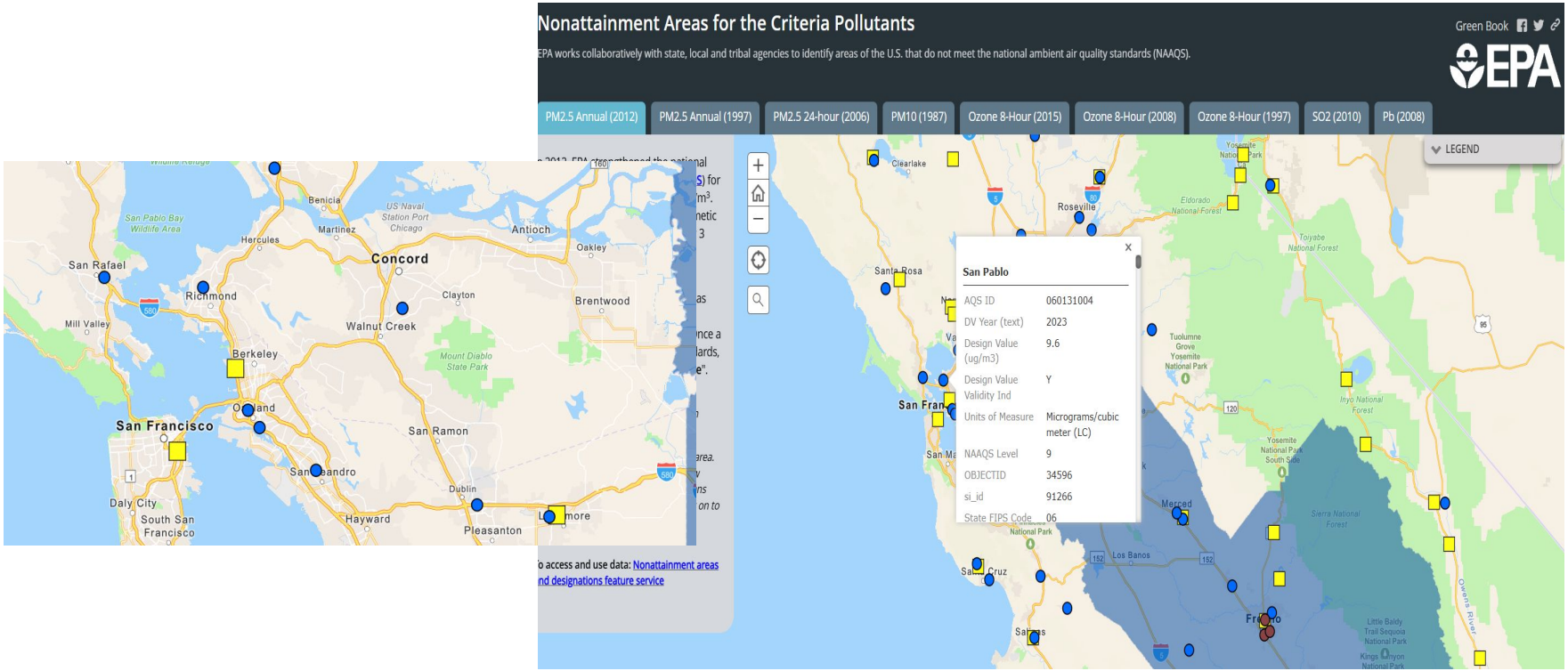
- **EPA guidelines are more lax than WHO for average annual upper limit of exposure (9 µg/m^3 vs 5 µg/m^3)**

- **No safe lower limits established**



Air Pollution *(like second-hand smoke)*

- While the Bay Area has the 6th worst annual PM2.5 averages in the country and often fails EPA air quality standards for pollutants, Contra Costa Co has been relatively spared.
- However, CCCo has a failing grades for annual PM2.5
- People of color live 3.7x more often in a county with 3 or more failing grades on air pollution
- Wildfire/heating smoke and ag/industrial dust add to pollution burden
- No established safe levels for air pollutants.



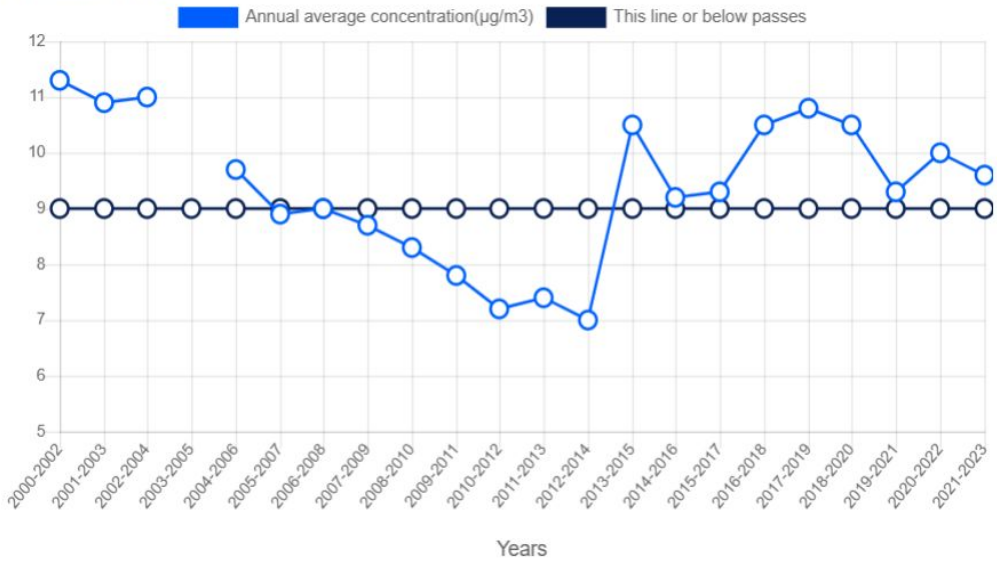
EPA Greenbook 2025

Particle Pollution - Annual

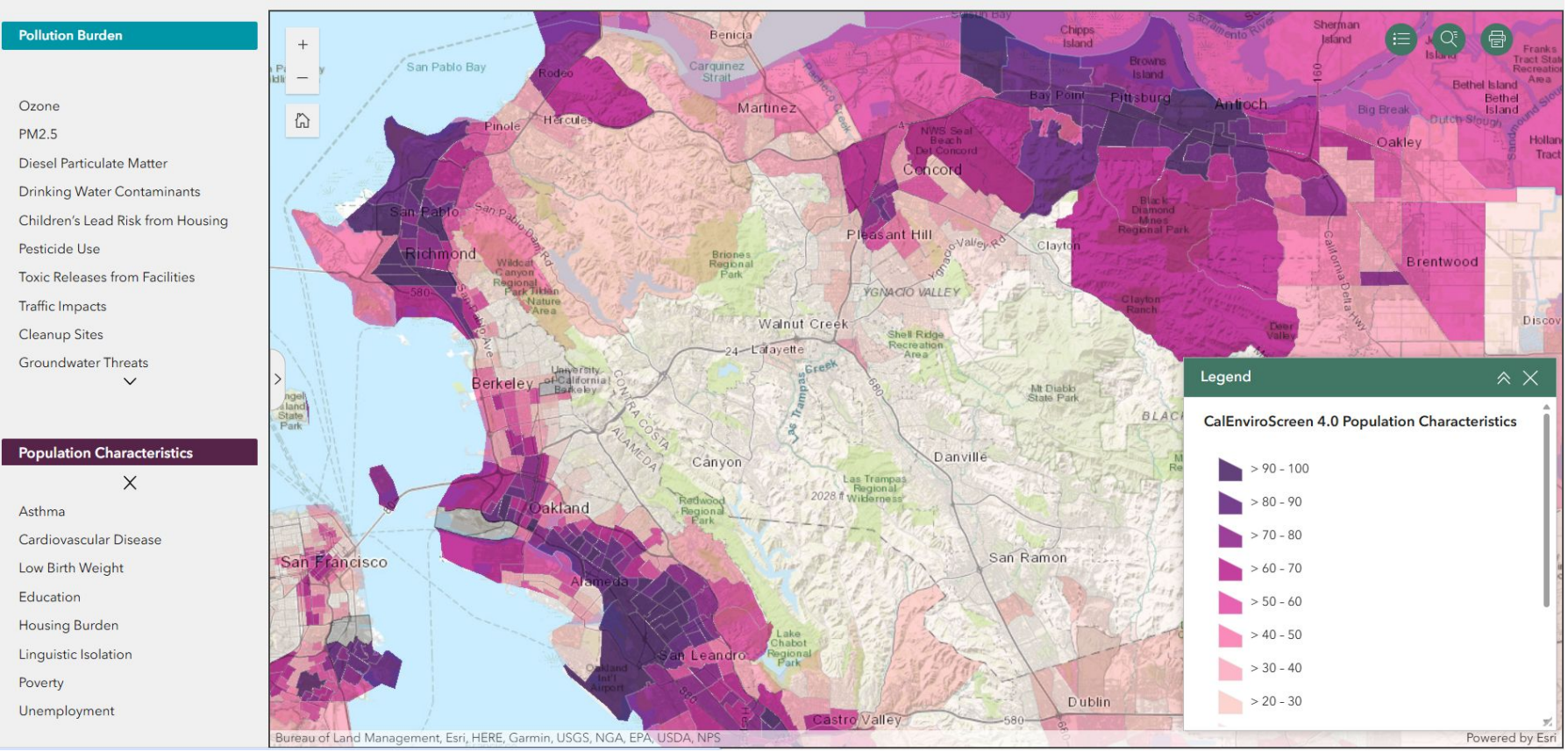
Learn More

Grade	Fail
Design Value	9.6

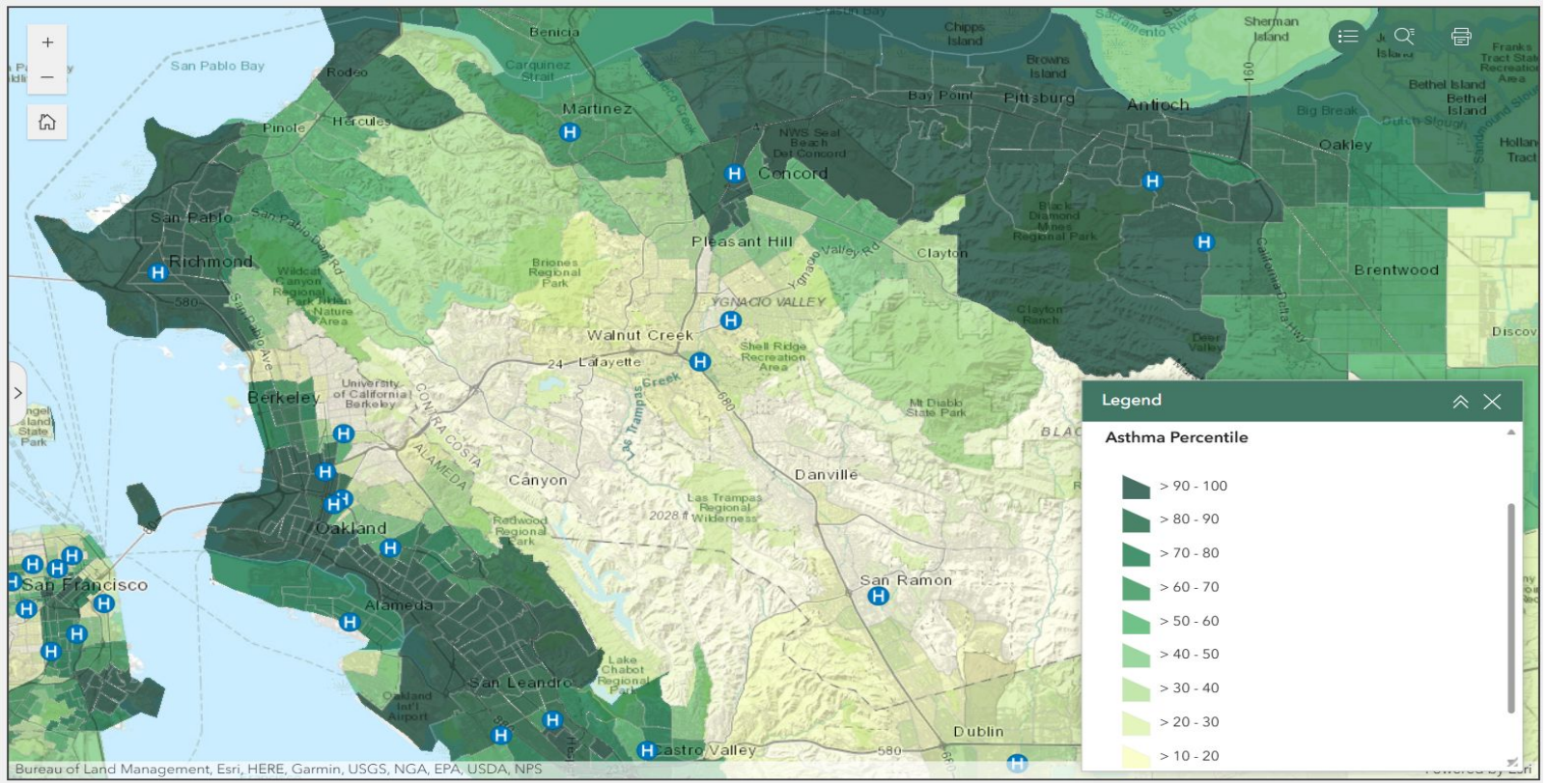
Contra Costa



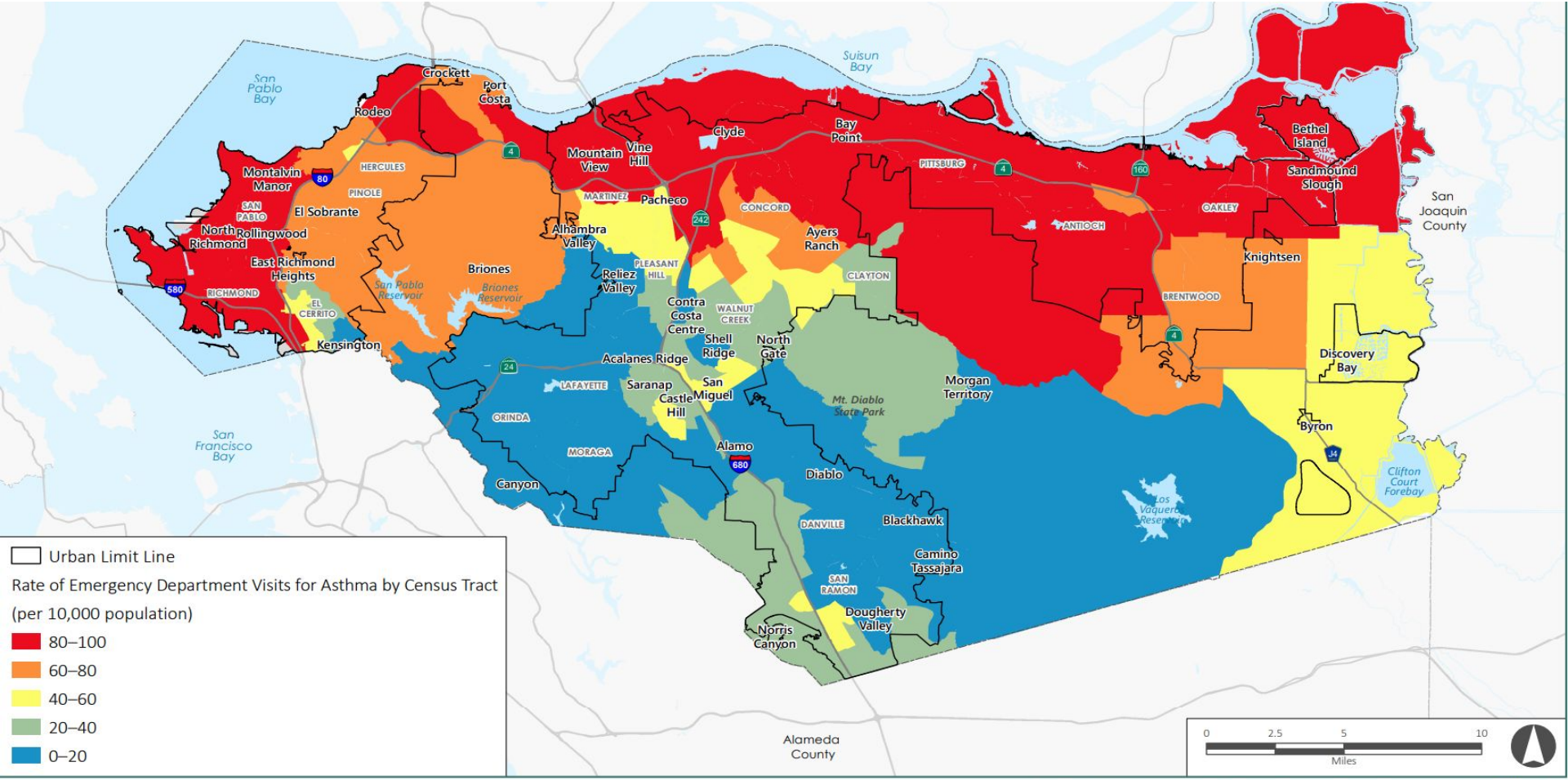
Population Characteristics Track with Population Burden



Asthma Percentile Disproportionate



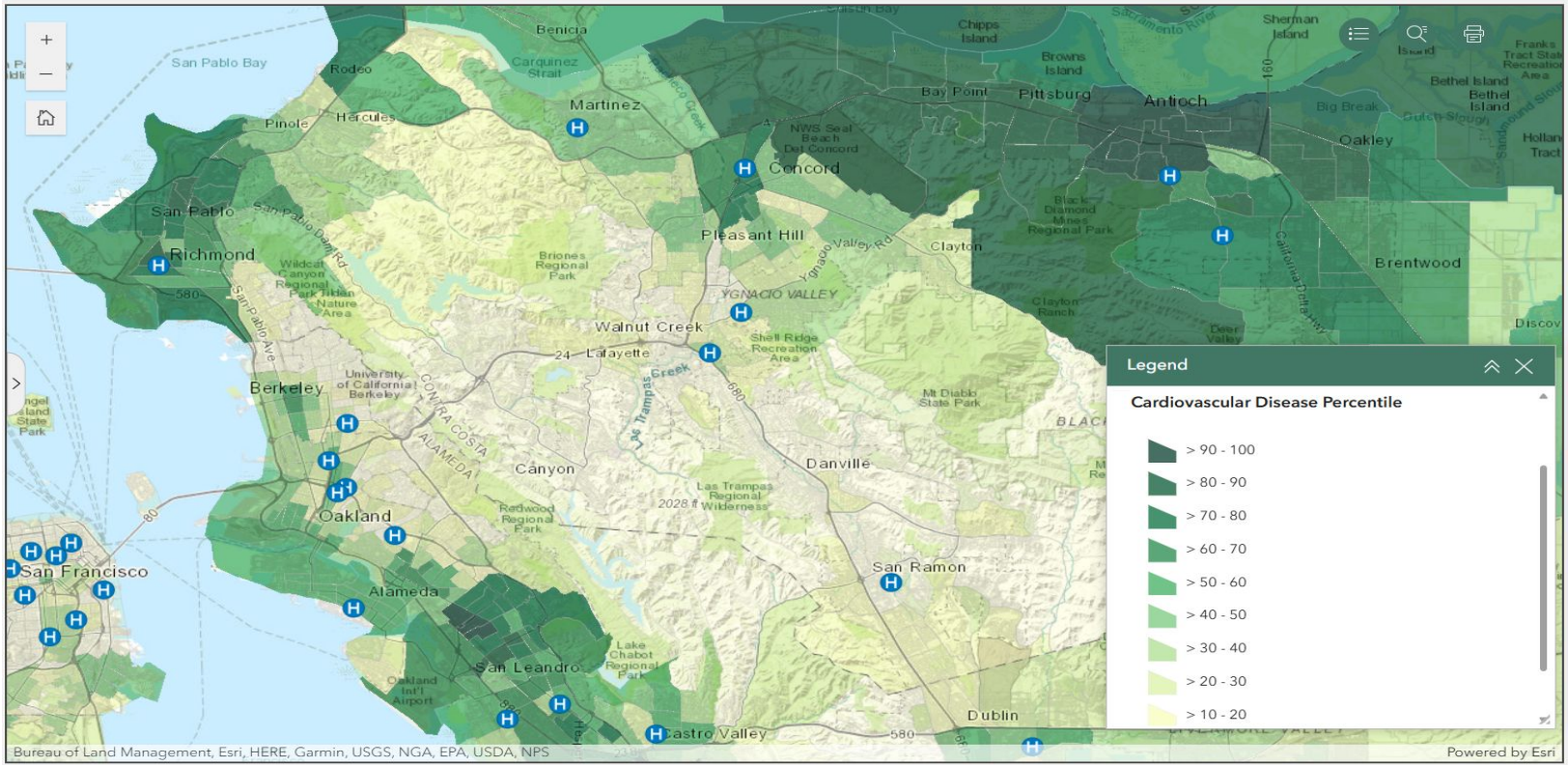
Estimate of the number of emergency department visits for asthma per 10,000 people from 2015 to 2017, Cal Enviro Screen 4.0



Source: California Office of Environmental Health Hazard Assessment, 2018; Contra Costa County, 2019; PlaceWorks, 2019.

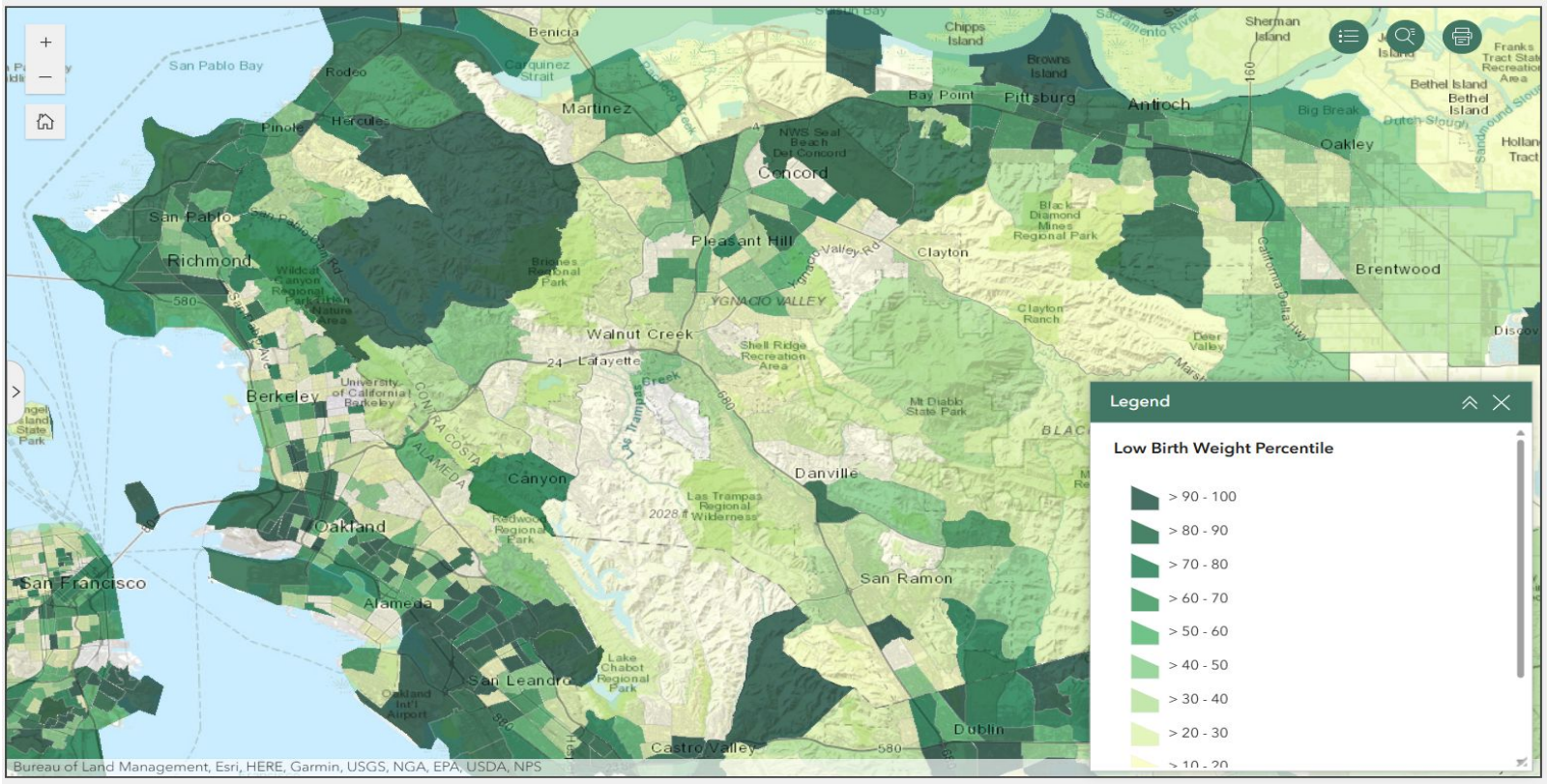
CA Office of Environmental Health Hazard Assessment 2018

Cardiovascular Disease Percentile Disproportionate



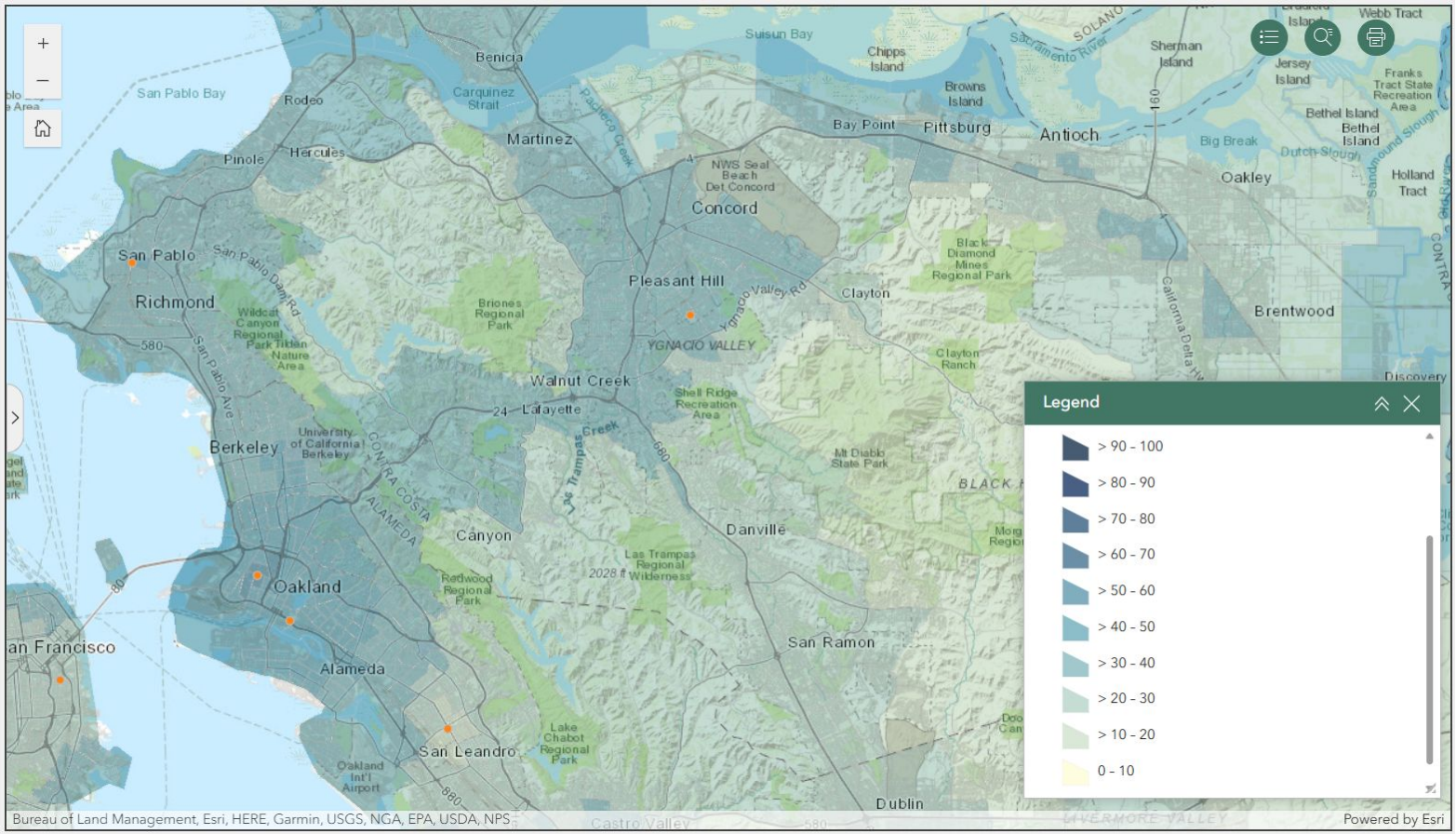
The number of heart attack emergency department visits per 10,000 people for the years 2015-2017, Cal Enviro Screen 4.0

Low Birth Weight Percentile Disproportionate

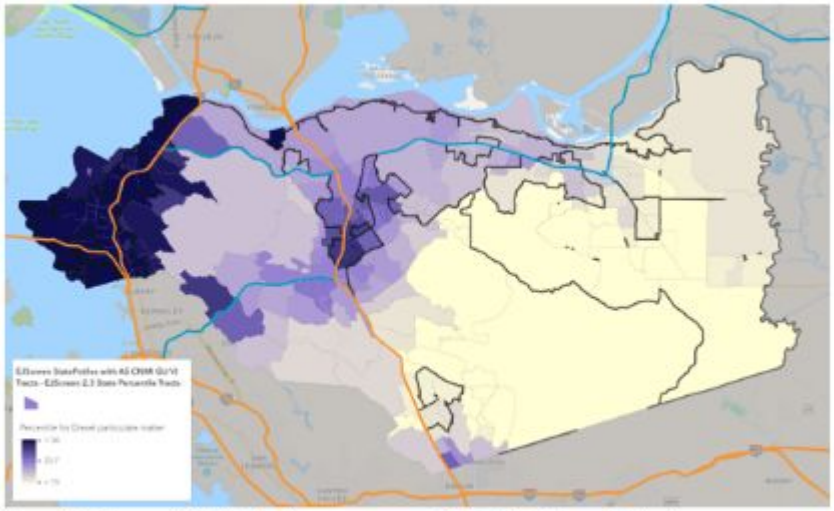


Babies weighing less than ~five and a half pounds (or 2500 grams) at birth are low birth weight. 2009-15, Cal Enviro Screen 4.0

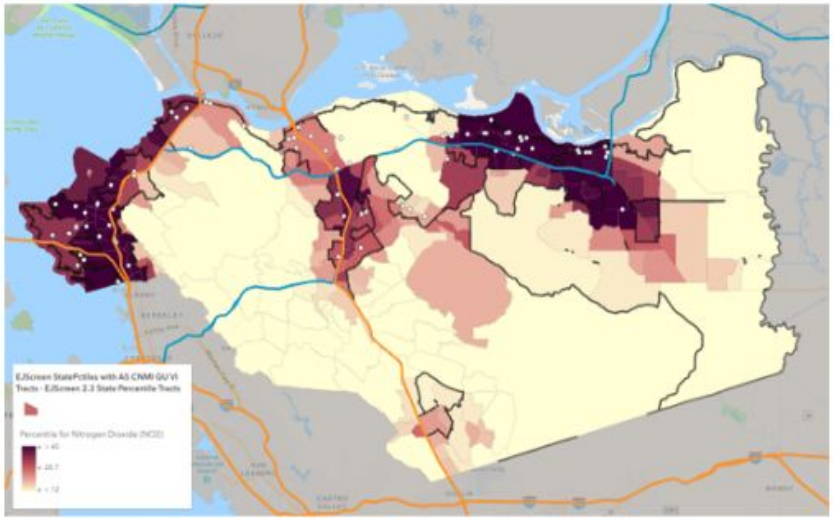
PM2.5 Disproportionate



Diesel Particulates (PM) and NO_2 also disproportionate



b. Diesel PM shown with Major Highways (colored lines)



c. NO2 shown with Industrial Facilities (white dots) & Highways (colored lines)

EPA EJScreen 2.3 State Percentile Tracts, 2024

Air Pollution Neurological Effects from PM2.5

- Meta-analyses of long term PM2.5 exposure: For each 10 µg/m^3 increase in average PM2.5 exposure: (equivalent to a rise in AQI 28 to 62)
  - Ischemic stroke up 13%
  - Ischemic heart disease mortality up 23%
  - Heart attacks up 8%

- Another meta-analysis for short term exposure:
  Less than 5 day exposure from multiple air pollutants including PM2.5 and NO_2 increased mortality of ischemic stroke onset.

JAHA

Alexeeff SE. 2021. Long-term PM2.5 exposure and risks of ischemic heart disease and stroke events:review and meta-analysis. J Am Heart Assoc[9]
(14 studies) [RR of an incident ischemic stroke in the random effects meta-analysis = 1.18 (95% CI, 1.14–1.22), with low heterogeneity among studies (I^2=11.8%)]
US/Canada/Europe/Asia

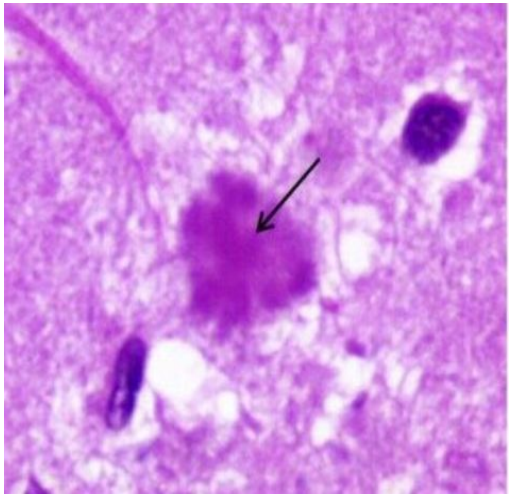
Toubasi A. 2023. Short-term Exposure to Ari Pollution and Ischemic Stroke: A Systematic Review and Meta-Analysis. Neurology [35]
110 studies, rest Europe and Americas) [short-term defined as exposure </= 5 days from onset of CVA] Asia predominant

Neurology®

Air Pollution Neurological Effects: Dementia

- Another meta-analysis:
  Showed a 3% increase in dementia for every 1 ug/m^3 increment in PM2.5
  (equivalent to a rise in AQI from 28 to 33.)

  - Another study found in the United Kingdom:
    Those living less than 1 km from a major traffic road had a 13% higher risk of dementia vs greater than 1 km.



Amyloid Plaque

Neurology®

Abolhasani E, et al. 2023. Air Pollution and Incidence of Dementia. Neurology[36] 20 cohort studies

Li C, et al. 2023. Relationships of Residential Distance to Major Traffic Roads and Dementia Incidence and Brain Structural Measures. *Health Data Science*[37]

Wildfire Smoke Neurological Effects: Dementia

10/25/24:

- Study of 1.2 million So Cal Kaiser members >65yo over 3 years,

- For a 1 μg/m^3 (AQI 28 to 33) increase in wildfire PM2.5 exposure, there was an 18% increase dementia vs the non-wildfire PM2.5 increase of 1%.

LA Fires, Sky News 2025

Elser H, et al. 2024 (11/25) Wildfire Exposure and Incident Dementia *JAMA Neurology*

18% (odds ratio [OR], 1.18; 95% CI, 1.03-1.34) vs 1% (OR, 1.01; 95% CI,1.01-1.02)

Neurocognitive Function and Air Pollution

-40 peer-reviewed studies link varied child brian adverse outcomes (structural and functional) to air pollution

Parenteau, AM, et al. 2024 Clearing the air: A systematic review of studies on air pollution and childhood brain outgomes to mobilize policy change. *Developmental Cognitive Neuroscience*

-Research has linked Autism to increased PM2.5

McGuinn LA, et al. 2020 Early Life Exposure to Air Pollution and Autism. *Epidemiology*

It’s not just burning, but FF production that is toxic

Adverse perinatal outcomes (LBW, Premature Births which increase risk of mortality and longterm developmental problems.)
Asthma exacerbations, asthma hospitalizations, and respiratory symptoms: *up to 1km or more from wells.*
California Oil and Gas Public Health Rulemaking Scientific Advisory Panel to Cal GEM Report (SB1137)

Higher concentrations of ambient air pollutants - PM2.5, CO, NO2, O3, and VOCs from wells *preproduction wells within 4 km(~2.5mi) and producing wells within 2km (~1.25mi)*
Gonzalez DJX, et al. 2022 Upstream oil and gas production and ambient air pollution. *Sci Tot Env*
(UCB/Stanford)

Air Pollution Associated Disease:

-**cardiovascular disease: stroke** and **heart attack**	**PM2.5**, NO_2
-**Alzheimer's Dz** and **Parkinson's Dz**.	**PM2.5**, NO_2
-**neurodevelopment**	Air pollution (AP)
-**lung disease: asthma** and chronics	Production, AP (PM2.5, **NO_2, Diesel PM**)
-**cancer:** lung, breast, leukemias, +	Production, AP (**VOCs:** Benzene/ Formaldehyde)
-**birth outcomes**	Production, AP (**PM2.5**, +)

Alexeeff SE, et al. 2023 Association of Long-term Exposure to Particulate Air Pollution With Cardiovascular Events in California. *JAMA Netw Open*

Wei Y, et al. 2024 Exposure-response associations between chronic exposure to fine particulate matter and risks of hospital admission for major cardiovascular diseases: population based cohort study. *BMJ*

Wei Y, et al. 2023. Additive effects of 10-year exposures to PM2.5 and NO2 and primary cancer incidence in American older adults. *Environ Epidemiol*

Cheng I, et al. 2019. Association between ambient air pollution and breast cancer risk: The multiethnic cohort study. *Int J Cancer*

Landrigan PJ, et al. 2017. Air pollution and the kidney—implications for control of non-communicable diseases. *Lancet*

Wu J, et al. 2024. Exposure to air pollution, genetic susceptibility, and psoriasis risk in the UK. *JAMA Netw Open*

Wang X, et al. 2024. Associations of prenatal exposure to PM2.5 and its components with offsprings' neurodevelopmental and behavioral problems: A prospective cohort study from China. *Ecotoxicology and Environmental Safety*

Heat also causes strokes and dementia hospitalization

A recent study found increased stroke and stroke mortality associated with extreme heat

Qu C, et al. Burden of Stroke Attributable to Nonoptimal Temperatures in 204 Countries and Territories [Neurology, 2024]

Alahmad B, et al. Extreme Temperatures and Stroke Mortality: Evidence From a Multi-Country Analysis. [Stroke 7/2024]

>49 countries, over 3.5 million AIS, 1979 to 2019: 2.2/1000 excess ischemic CVAs with extreme temps (2.5% of hottest days)

Dementia Hospitalizations increase

Delaney SW, et al. Extreme Heat and Hospitalization Among Older Persons With Alzheimer Disease and Related Dementias [JAMA Netw, 02/3/25]

Climate and Behavioral Health:

Extreme heat impacts include:

- Irritability/aggression/domestic violence
- Depression
- Increased suicide
- Memory, attention, reaction time
- Sleep changes additive

Climate Anxiety

Air Pollution and Climate Change Magnify Health Inequities

https://nca2023.globalchange.gov/chapter/15/https://nca2023.globalchange.gov/chapter/15/

Recommendations for Air Pollution and GHG Reduction Co-benefits:

-Supporting reductions in FF extraction, refining and ***usage*** have co-benefits of ***immediate health improvements*** along with longer term climate/GHG benefits.

-Encourage ***electrification*** with clean energy sources

-***Improved ventilation*** is also low hanging fruit for adapting to Air Quality that especially benefits POC and low income who already have increased health burden– Maximize education and access:

- N95 masks on yellow or greater AQI days
- Filtration, prioritizing low income/POC residents that are most vulnerable to incremental health consequences of AP

END

Science Advisory Panel to Cal GEM Report:

Adverse perinatal outcomes (Prenatal exposure): including preterm births, low birth weight, and small-for-gestational age births, increase the risk of mortality and long-term developmental problems in newborns (Liu et al., 2012; Vogel et al., 2018) as well as longer term morbidity through adulthood (Baer et al., 2016; Barker, 1995; Carmody & Charlton, 2013; Frey & Klebanoff, 2016). Asthma exacerbations, asthma hospitalizations, and respiratory symptoms

studies consistently demonstrate evidence of harm at distances less than 1 km, and some studies also show evidence of harm linked to OGD activity at distances greater than 1 km. In addition, exposure pathway studies have demonstrated through measurements and modelling techniques, the potential for human exposure to numerous environmental stressors (e.g., air pollutants, water contaminants, noise) at distances less than 1 km (e.g., Allshouse et al., 2019; Holder et al., 2019; McKenzie et al., 2018; DiGiulio et al., 2021; Soriano et al., 2020), and that the likelihood and magnitude of exposure decreases with increasing distance.

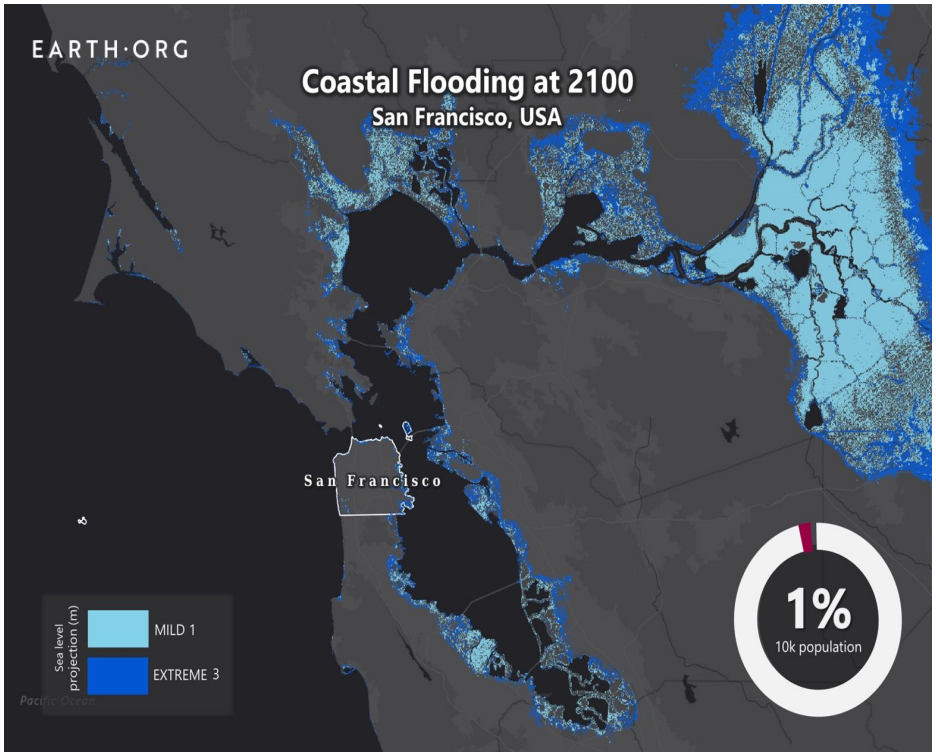
Stanford/UCB

Gonzalez DJX, et al. 2022 Upstream oil and gas production and ambient air pollution. *Sci Tot Env*

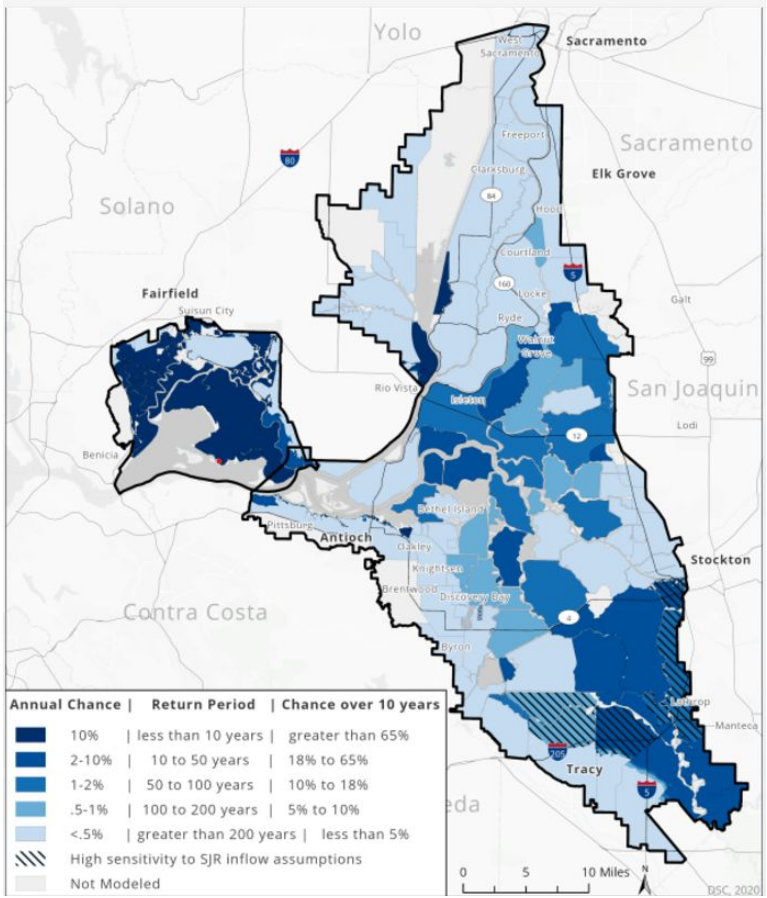
Findings: higher concentrations of ambient air pollutants at air quality monitors in proximity to preproduction wells within 4 km(~2.5mi) and producing wells within 2km (~1.25mi)

NO ESTB SAFE LIMITS

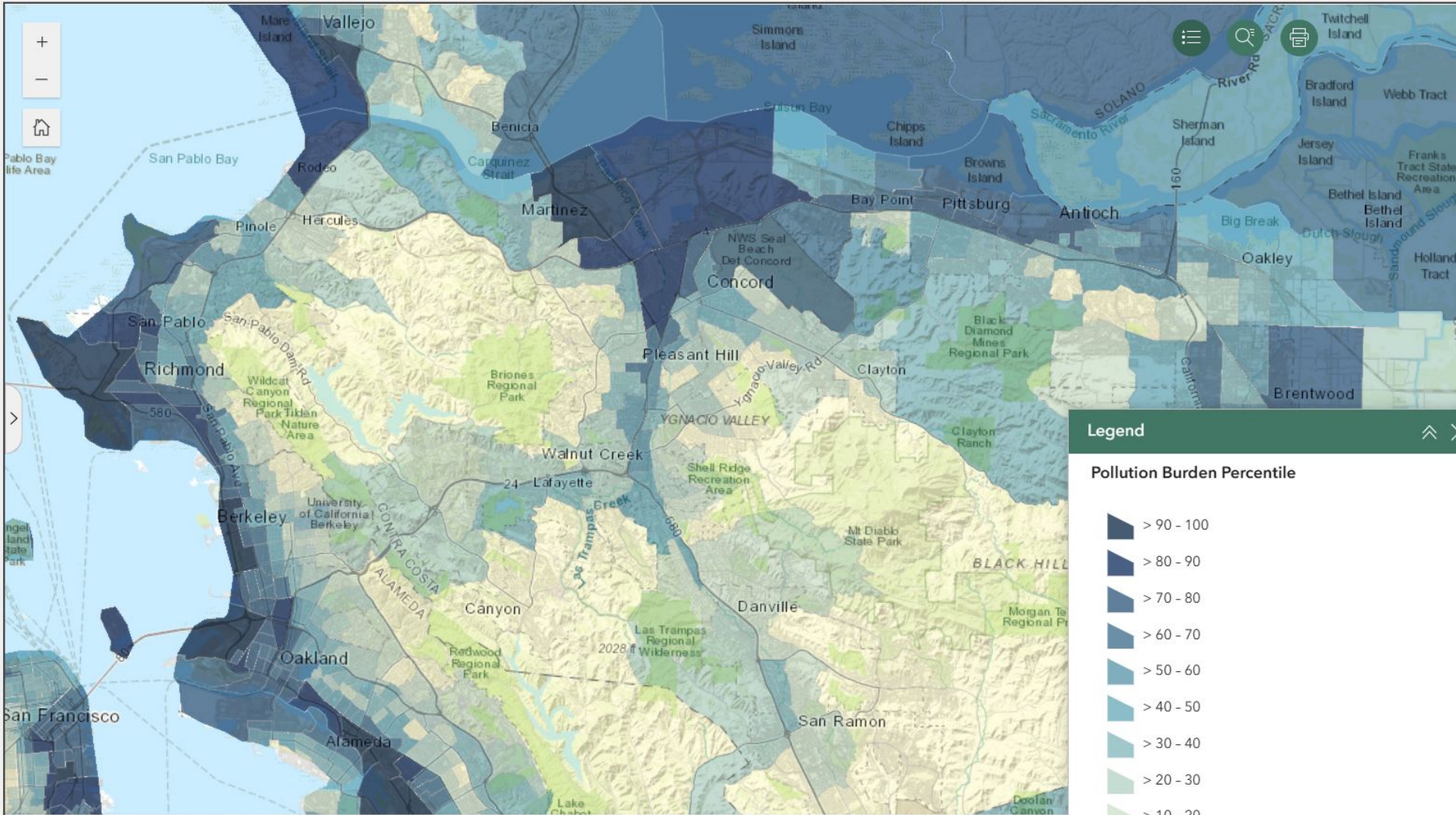
Flooding: California



Earth.org



Delta Stewardship Council


Legend
Pollution Burden Percentile
> 90 - 100
> 80 - 90
> 70 - 80
> 60 - 70
> 50 - 60
> 40 - 50
> 30 - 40
> 20 - 30
Vallejo
Benicia
Martinez
Pittsburg
Antioch
Concord
Pleasant Hill
Walnut Creek
Lafayette
Clayton
Oakley
Brentwood
Richmond
San Pablo
Berkeley
Oakland
Alameda
San Francisco
Canyon
Danville
San Ramon
San Pablo Bay
Carquinez Strait
Suisun Bay
Sacramento River
Mt Diablo State Park
Las Trampas Regional Wilderness
Briones Regional Park
Redwood Regional Park
Shell Ridge Recreation Area
Black Diamond Mines Regional Park
Clayton Ranch
Bethel Island
Jersey Island
Bradford Island
Webb Tract
Twitchell Island
Sherman Island
Chipps Island
Browns Island
Simmons Island
Pinole
Hercules
Rodeo
Mare Island
YGNACIO VALLEY
CONTRA COSTA
ALAMEDA
BLACK HILL