

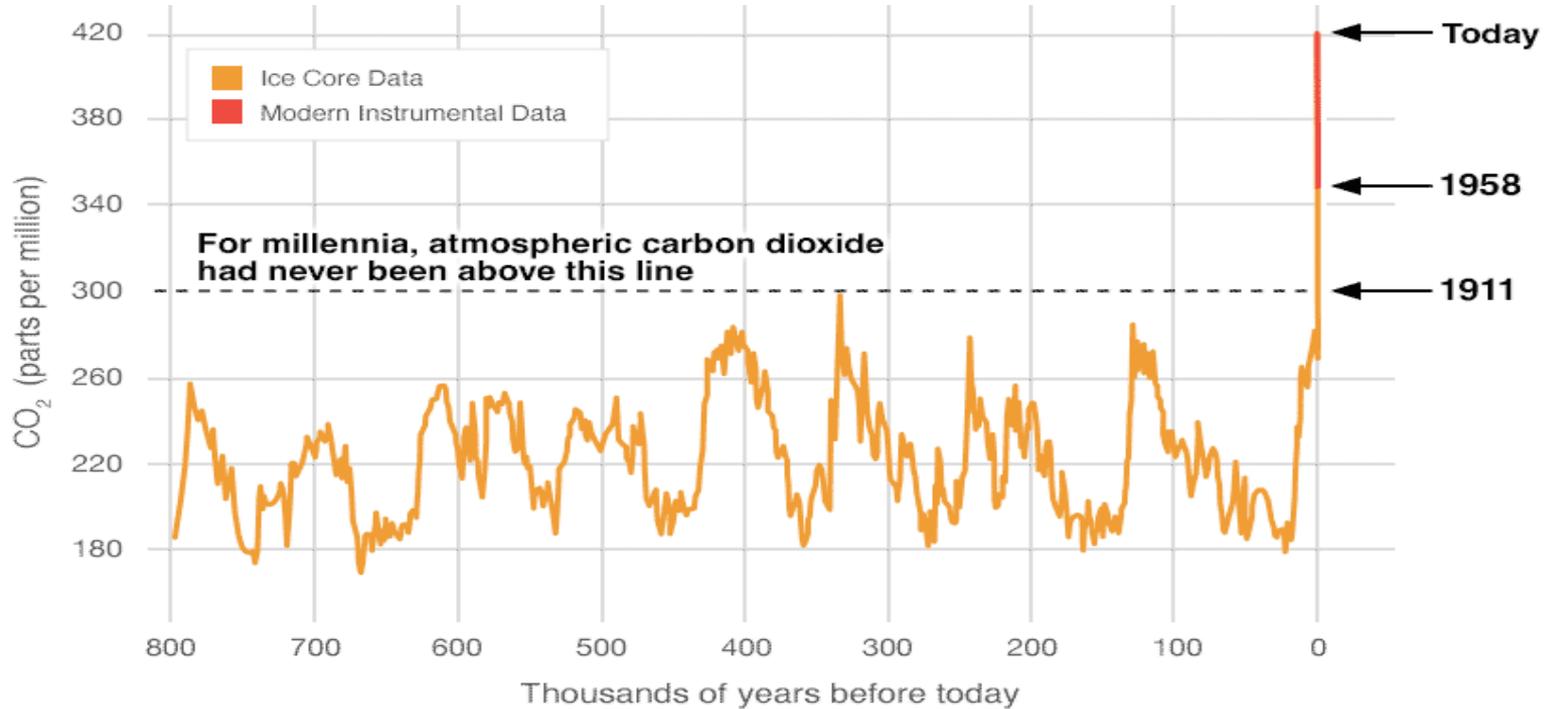
The Co-Benefits of reducing

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)
July 28, 2025

Is CO₂ Increasing?

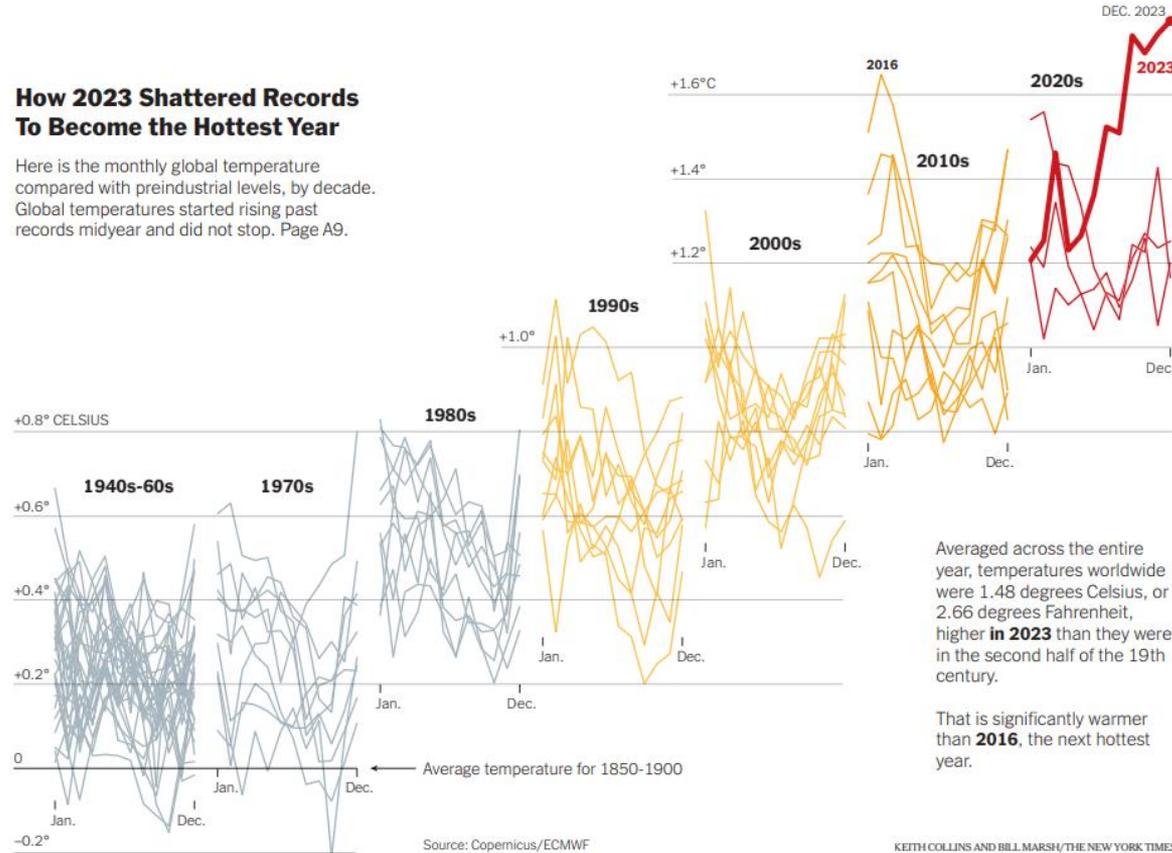


<https://climate.nasa.gov/vital-signs/carbon-dioxide/>

Is warming accelerating?

How 2023 Shattered Records To Become the Hottest Year

Here is the monthly global temperature compared with preindustrial levels, by decade. Global temperatures started rising past records midyear and did not stop. Page A9.



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.

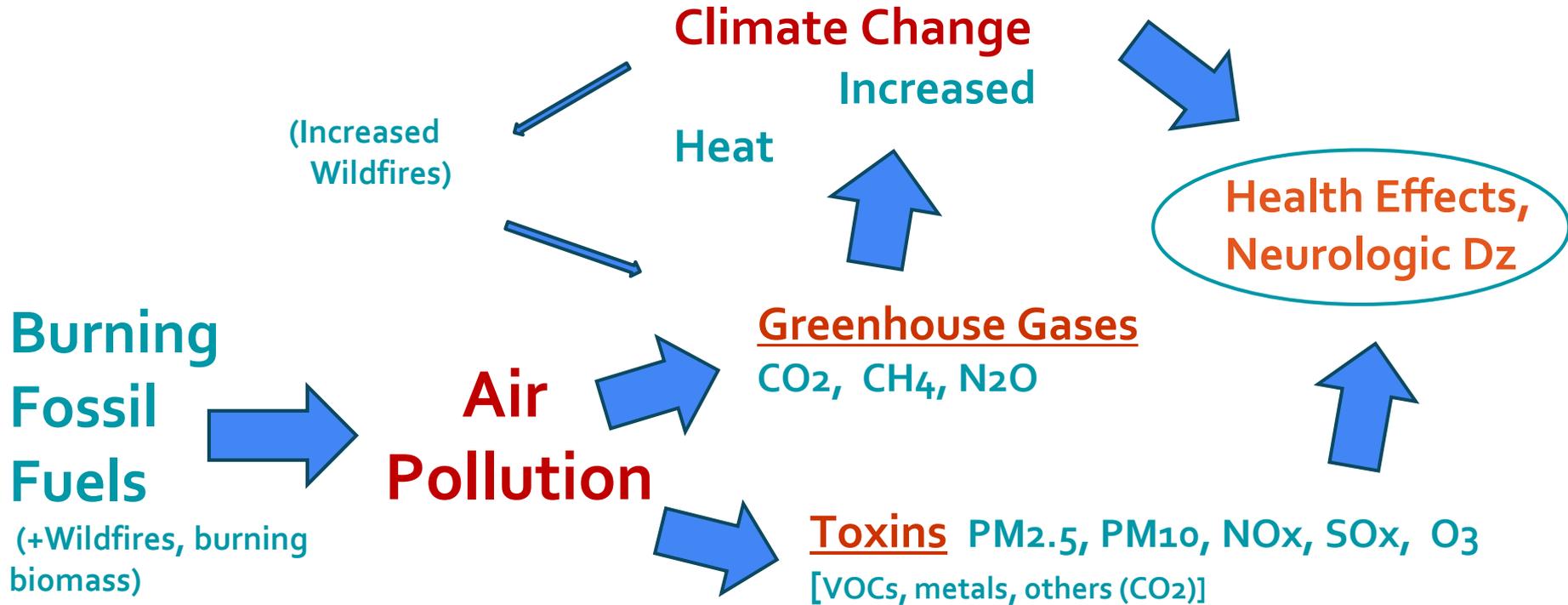
[2023 Balester, Heat related Mortality in Europe, Nature Medicine](#)³⁴

[2023 Vecellio, Greatly enhanced risk to humans...moist heat stress tolerance. PNAS](#)⁷



AP

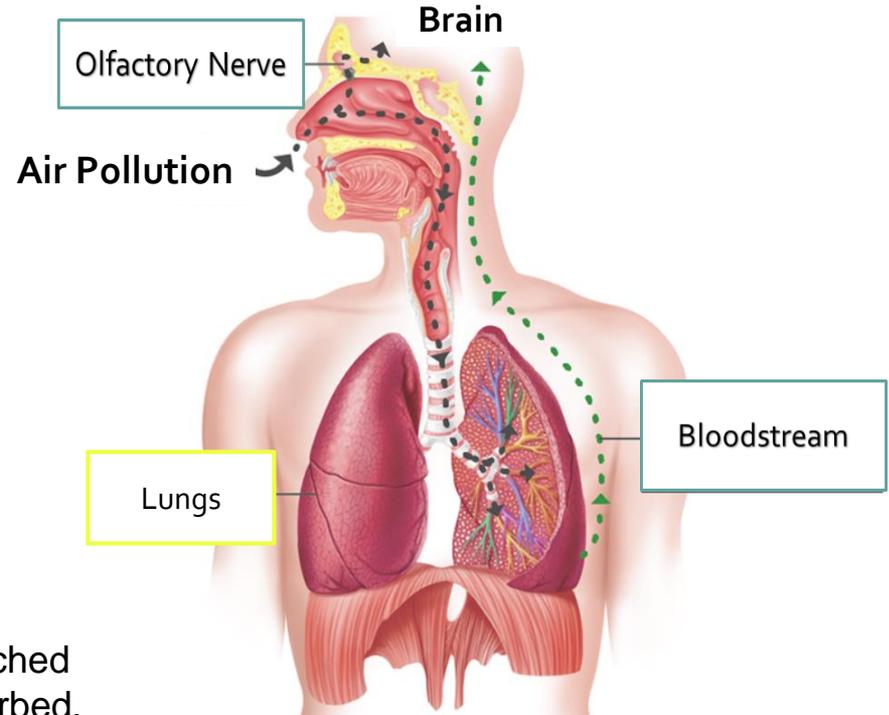
Climate Change and Air Pollution:



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

Air Pollution and the Air Quality Index (AQI)

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

50 AQI = 9 $\mu\text{g}/\text{m}^3$

100 AQI = 35 $\mu\text{g}/\text{m}^3$

150 AQI = 55 $\mu\text{g}/\text{m}^3$

- EPA guidelines are more lax than WHO for average annual upper limit of exposure (9 $\mu\text{g}/\text{m}^3$ vs 5 $\mu\text{g}/\text{m}^3$)
- No safe lower limits established

Air Quality Index (AQI)	
0-50	Good
51-100	Moderate
101-150	Unhealthy for sensitive groups
151-200	Unhealthy
201-300	Very Unhealthy
301-500	Hazardous

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 (American Lung Association 2025 Report)
- 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.

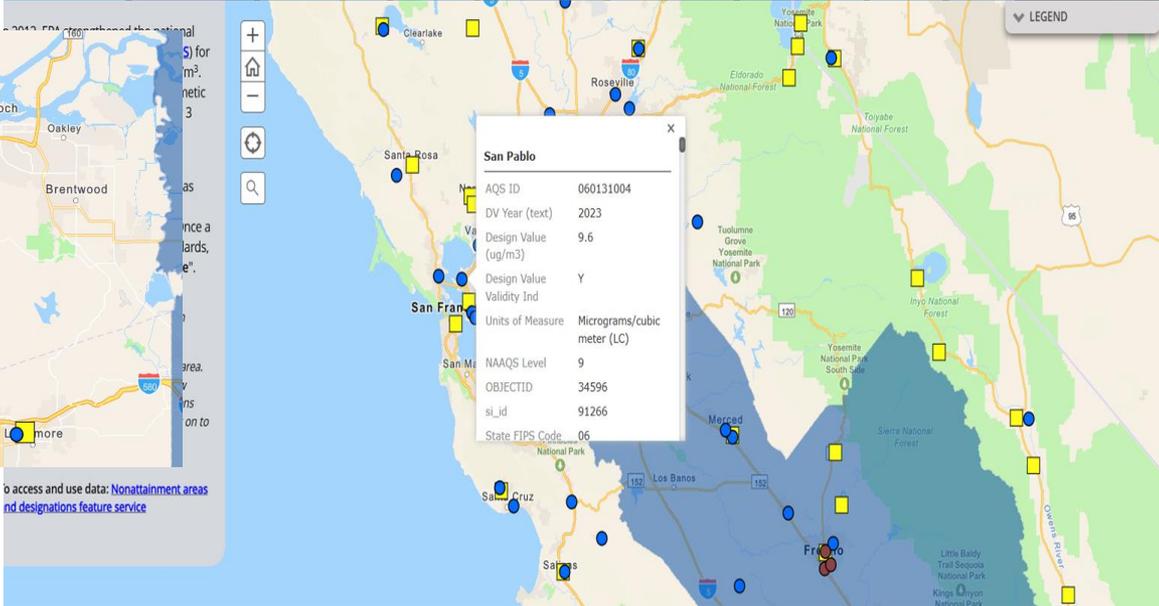
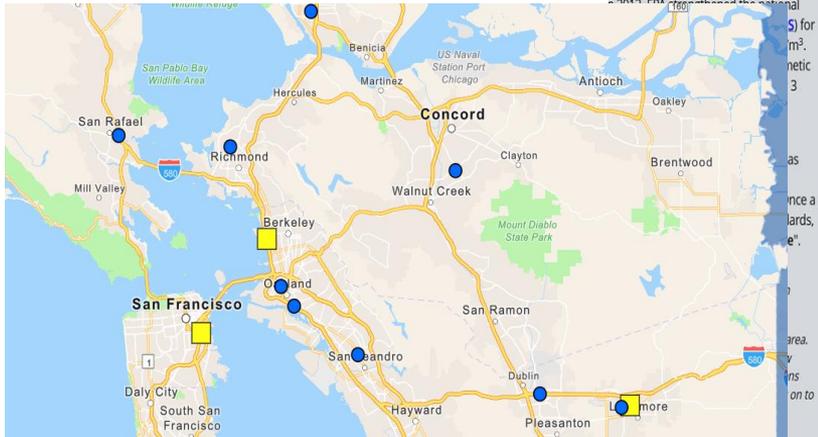


Nonattainment Areas for the Criteria Pollutants

EPA works collaboratively with state, local and tribal agencies to identify areas of the U.S. that do not meet the national ambient air quality standards (NAAQS).



- PM2.5 Annual (2012)
- PM2.5 Annual (1997)
- PM2.5 24-hour (2006)
- PM10 (1987)
- Ozone 8-Hour (2015)
- Ozone 8-Hour (2008)
- Ozone 8-Hour (1997)
- SO2 (2010)
- Pb (2008)



San Pablo	
AQS ID	060131004
DV Year (text)	2023
Design Value (ug/m3)	9.6
Design Value Validity Ind	Y
Units of Measure	Micrograms/cubic meter (LC)
NAAQS Level	9
OBJECTID	34596
sl_id	91266
State FIPS Code	06

to access and use data: [Nonattainment areas and designations feature service](#)



Particle Pollution - Annual

[Learn More](#)

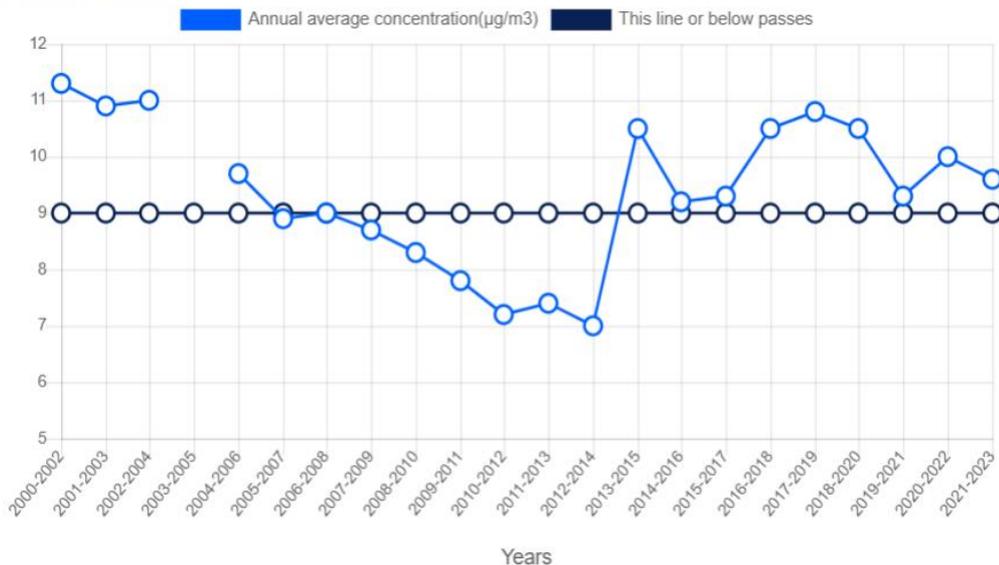
Grade

Fail

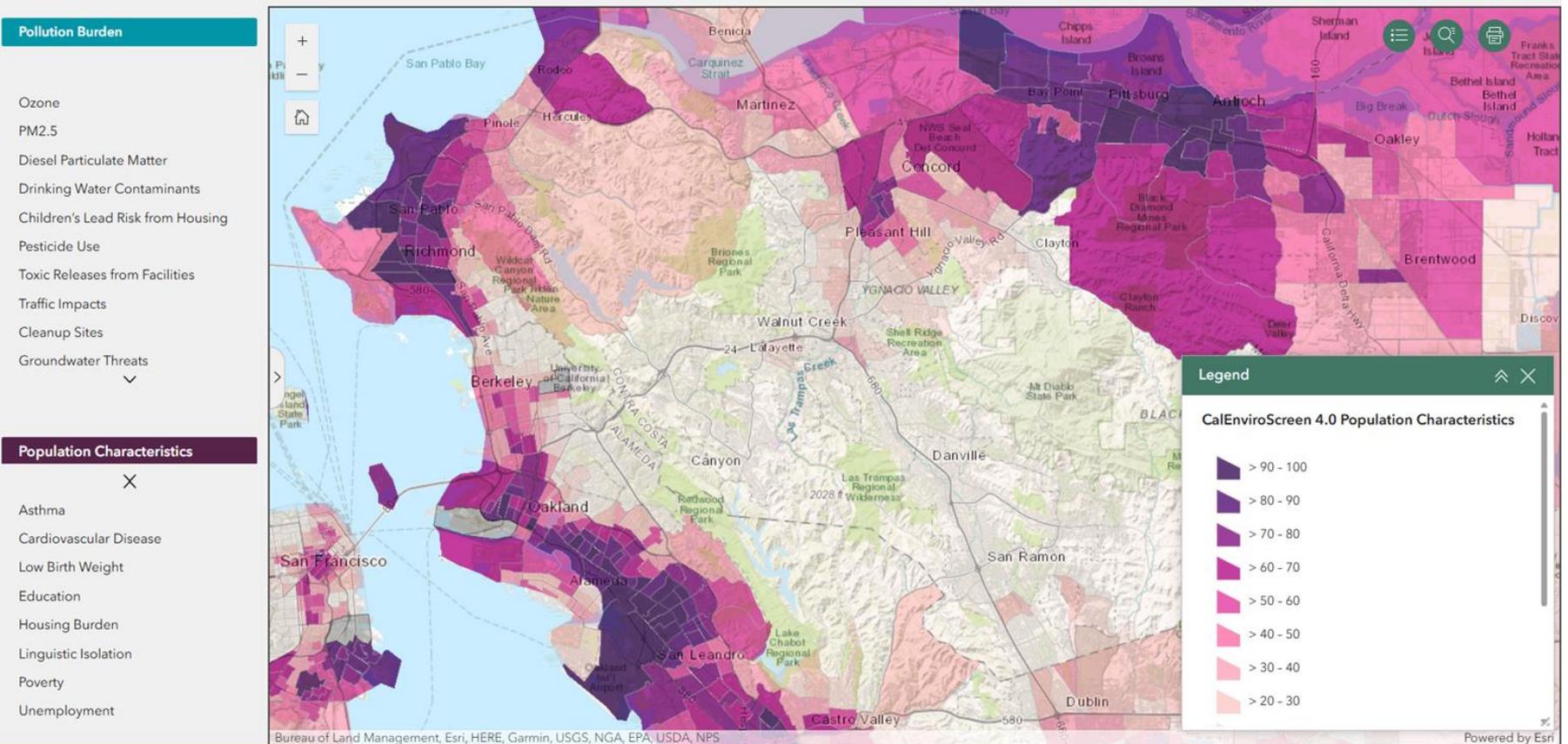
Design Value

9.6

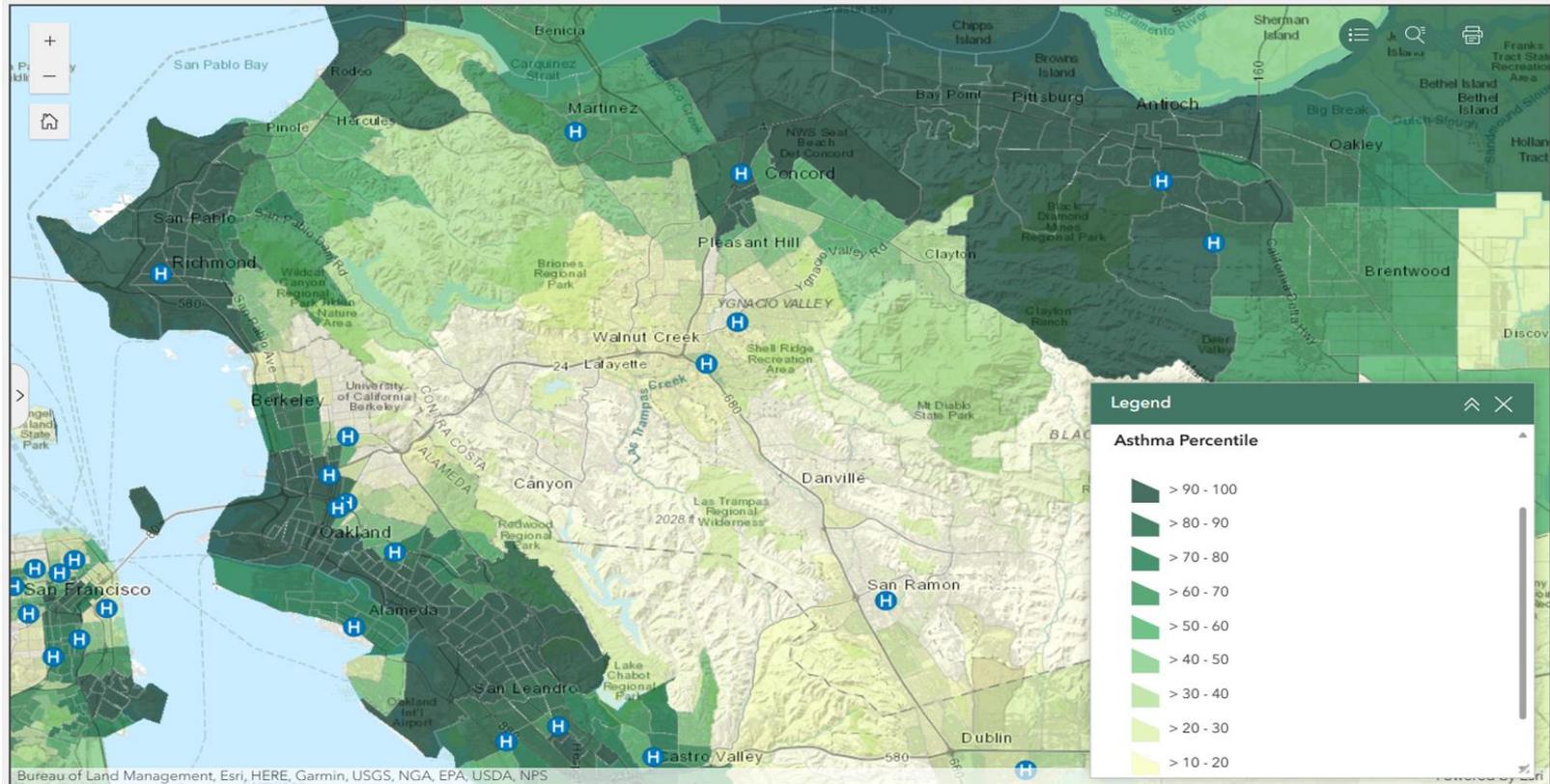
Contra Costa



Population Characteristics Track with Population Burden

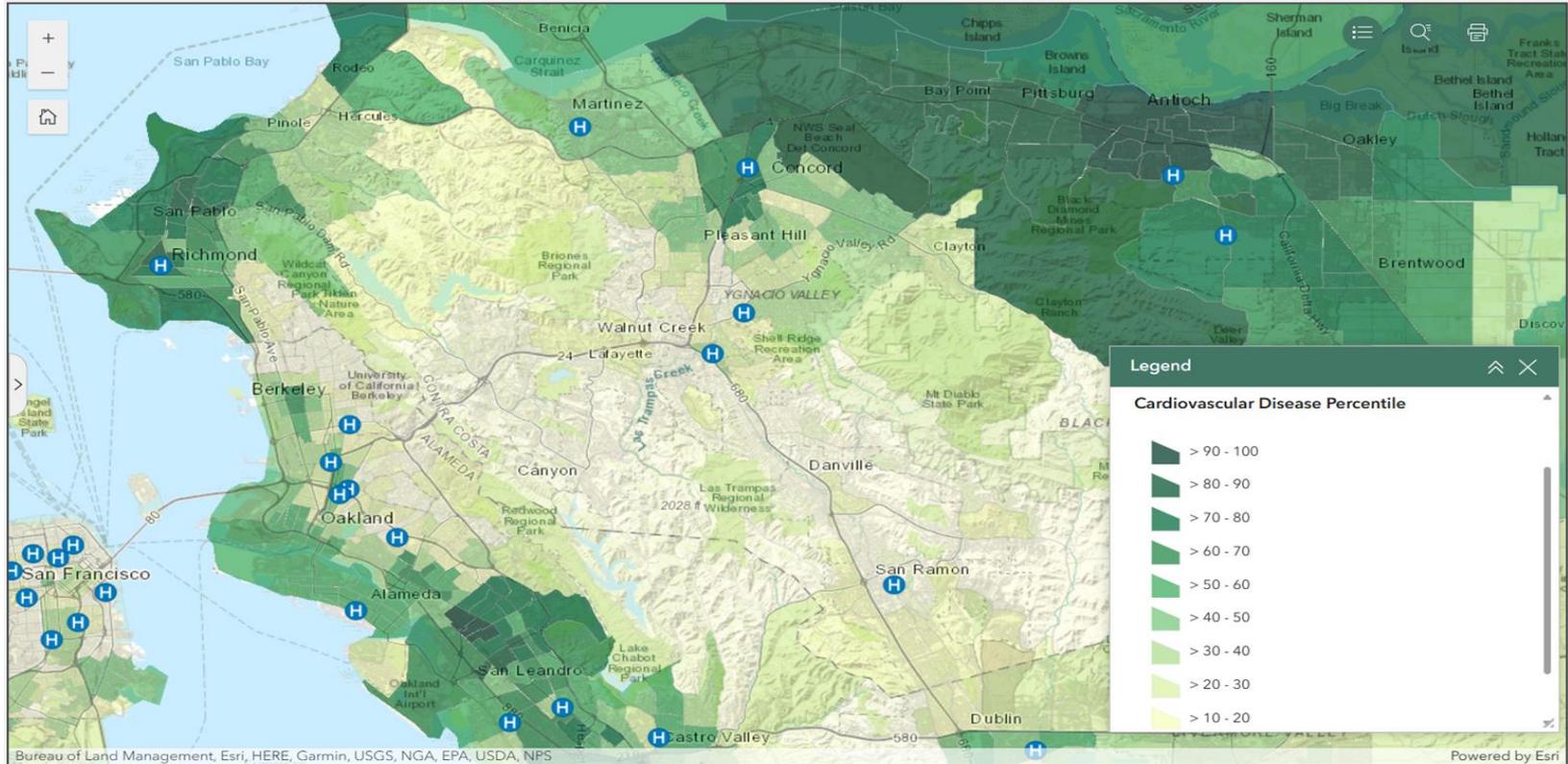


Asthma Percentile Disproportionate



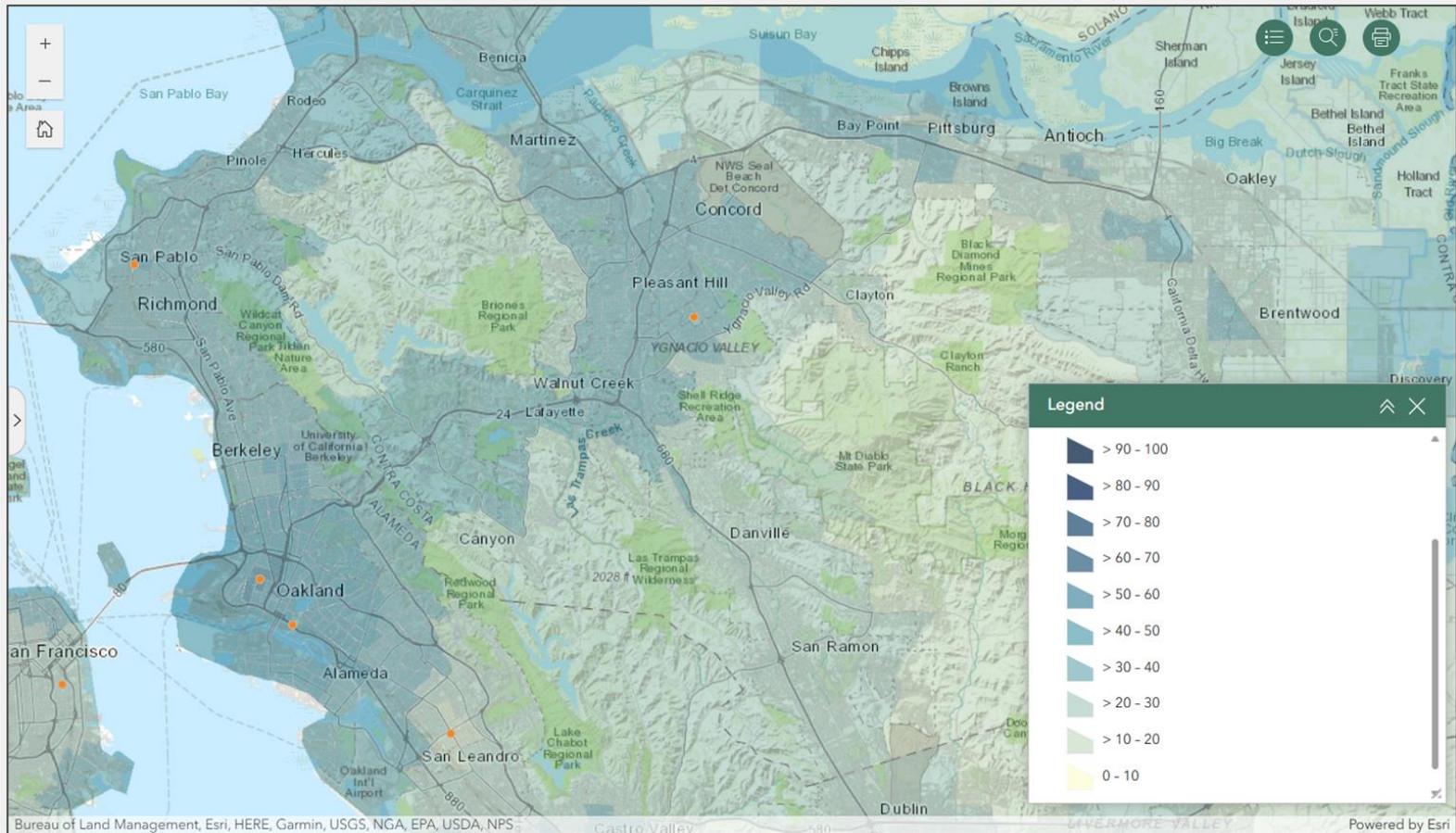
Estimate of the number of emergency department visits for asthma per 10,000 people from 2015 to 2017, Cal Enviro Screen 4.0

Cardiovascular Disease Percentile Disproportionate

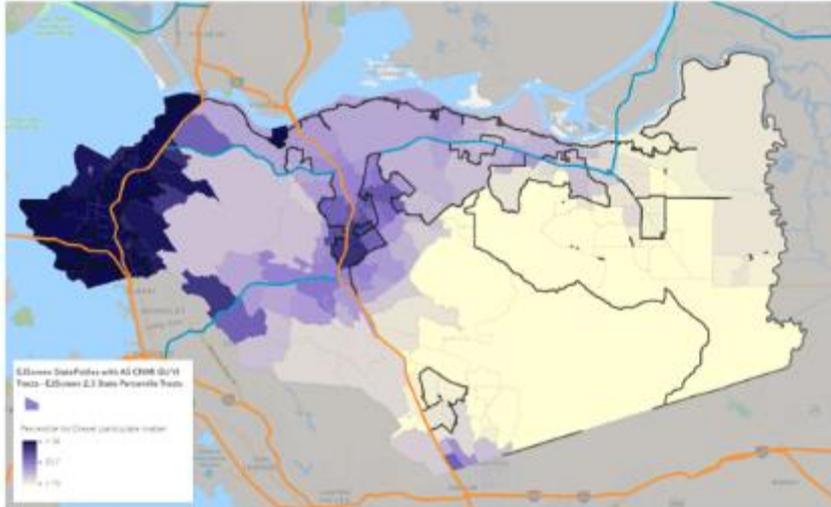


The number of [heart attack emergency department visits](#) per 10,000 people for the years 2015-2017, Cal Enviro Screen 4.0

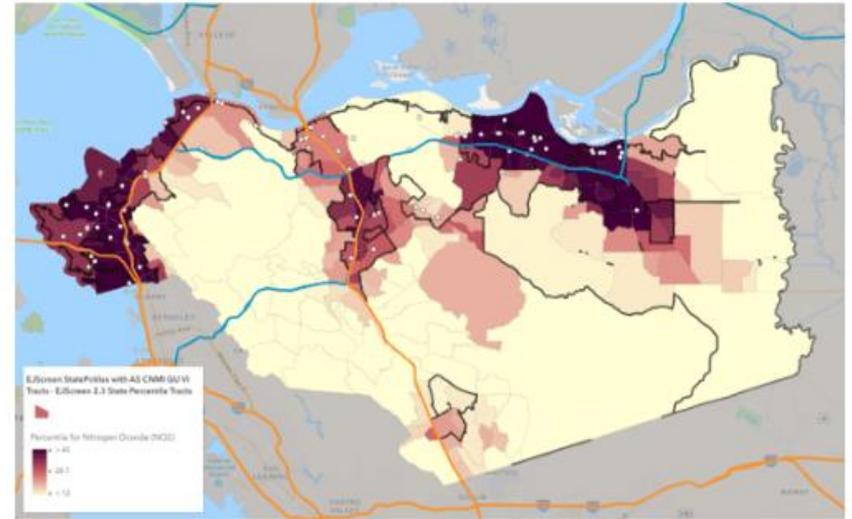
PM2.5 Disproportionate



Diesel Particulates (PM) and NO₂ also disproportionate



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



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

Air Pollution Neurological Effects from PM2.5

- Meta-analyses of long term PM2.5 exposure: For each 10 $\mu\text{g}/\text{m}^3$ 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

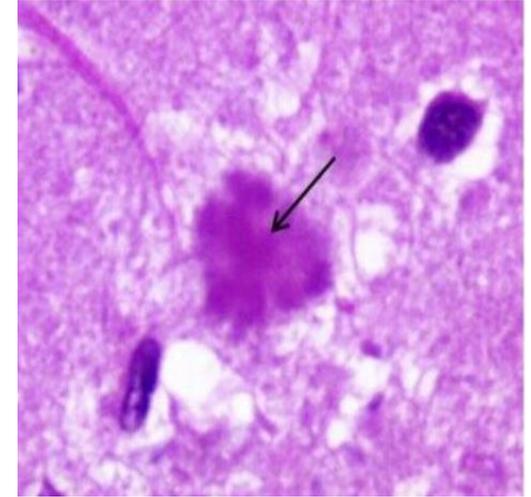
[Alexeeff SE. 2021. Long-term PM2.5 exposure and risks of ischemic heart disease and stroke events: review and meta-analysis. J Am Heart Assoc⁹](#)
(14 studies) [RR of an incident ischemic stroke in the random effects meta-analysis = 1.18 (95% CI, 1.14–1.22), with low heterogeneity among studies ($I^2=11.8\%$)
US/Canada/Europe/Asia

[Toubasi A. 2023. Short-term Exposure to Air Pollution and Ischemic Stroke: A Systematic Review and Meta-Analysis. Neurology³⁵](#)
Asia>50% 110 studies, rest Europe and Americas) [short-term defined as exposure \leq 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 $\mu\text{g}/\text{m}^3$ 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

Neurocognitive Function and Air Pollution

-40 peer-reviewed studies link varied child brain 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 outcomes 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, NO₂

-Alzheimer's Dz and Parkinson's Dz.

PM2.5,

NO₂

-neurodevelopment

Air pollution (AP)

-lung disease: asthma and chronics

Production, AP (PM2.5, NO₂, Diesel

PM)

cancer: [Alexeeff S, 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*](#)

-birth outcomes

Production, AP

[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: Environmental Justice & Health Equity

Vulnerable (Environmental Justice) communities have compounded health risk due to increased air pollution and multiple other factors:

- Often near heavy air pollution sources due to environmental racism by redlining and economic policies.
- Other determinants of health – racism; lower income, safety, and food choices; increased noise; and lack of green spaces and tree cover
- Also, their homes smaller, with older appliances, lacking ventilation hoods to the outside and filtration from bad outdoor air quality.



Outdoor Pollution Health Harm



- Typical gas stove/oven use can produce unsafe levels of NO_2 and benzene that can linger even in distant bedrooms for hours.
- People living in small homes have 4x more long-term NO_2 exposure than people in larger homes – typical in lower-income, EJ communities.
- American Indian/Alaska Native homes have 60% and Black/Hispanic homes 20% more NO_2 exposure than the national average.
- In the Bay Area, people of color are exposed to 55% more NO_2 pollution than mostly white neighborhoods. (Indoor plus outdoor)

Health Harms of Gas Stoves: Protect Our Families

1. When cooking: open 1-2 windows!
2. Turn on the fan (if available.)
3. Cook on back burners.
4. Use electric appliances like microwaves, tea kettles, air fryers, instant pots, etc whenever possible.
5. Get a portable induction unit, see photo, or full electric or induction stove if possible.



Air Pollution and Climate Change

Related Extreme

Heat Magnify Health Inequities



- Historically redlined communities (BIPOC and low-wealth communities) are often hotter than other neighborhoods.
- Access to cooling centers is more limited in some areas.

Location



- Certain populations are more vulnerable to extreme heat and have less access to healthcare.
- Socially isolated individuals may have less access to cooling centers.



Social and Racial Factors



- Energy costs and the costs of repairs limit the ability to afford air-conditioning.
- Low-wealth residents often live in homes that provide less protection against extreme heat.

Economics



Compound Risks



- COVID-19 protocols reduced the accessibility and effectiveness of cooling centers.
- Disadvantaged populations are more at risk for heat-related illnesses during power outages.

Health Benefits of Electrification

If we ***stopped*** using **gas for cooking** in California, there would be up to **20% less childhood asthma**.

Completely moving to **heat pumps for water and space heating** in the Bay Area would prevent:

- (37) up to 85 premature deaths, and
- about 110 new cases of asthma annually
- Save ~ \$900 million in health impacts
- Countless emergency room visits, lost days of work and school, and other health harms would also be prevented



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.

The outline of your path is in the CCC Climate Action and Adaptation Plan

-Encourage **electrification** with clean energy sources and prioritize your

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

- KN95 masks on yellow or greater AQI days
- Low cost Air 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.

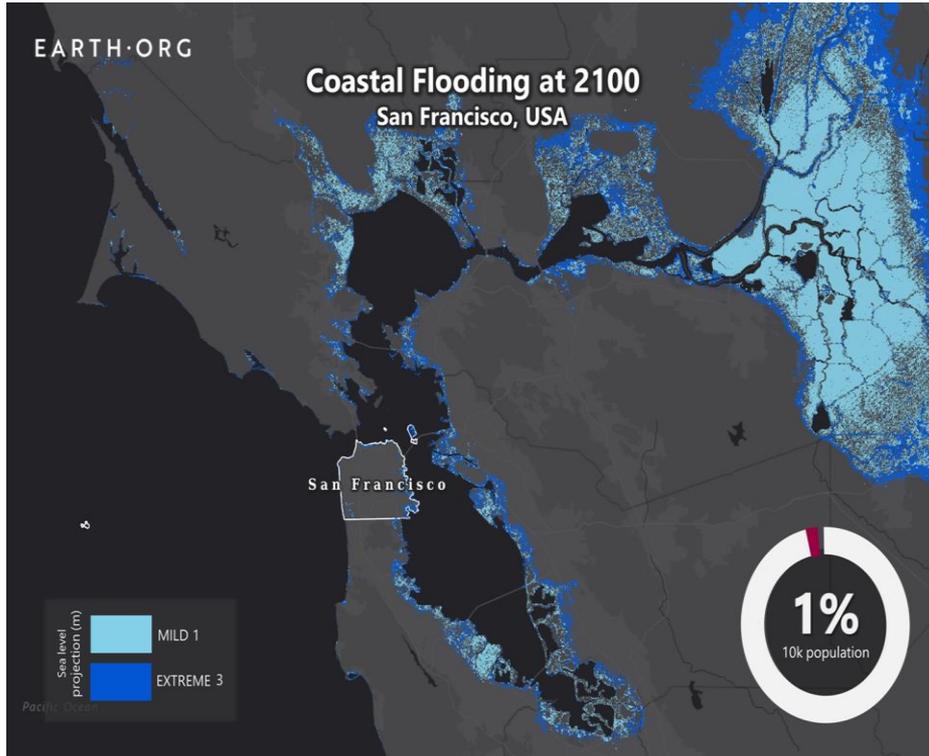
Stanford/UCB

[Gonzalez DJX, et al. 2022 Upstream oil and gas production and ambient air pollution. *Sci Tot Env*](#)

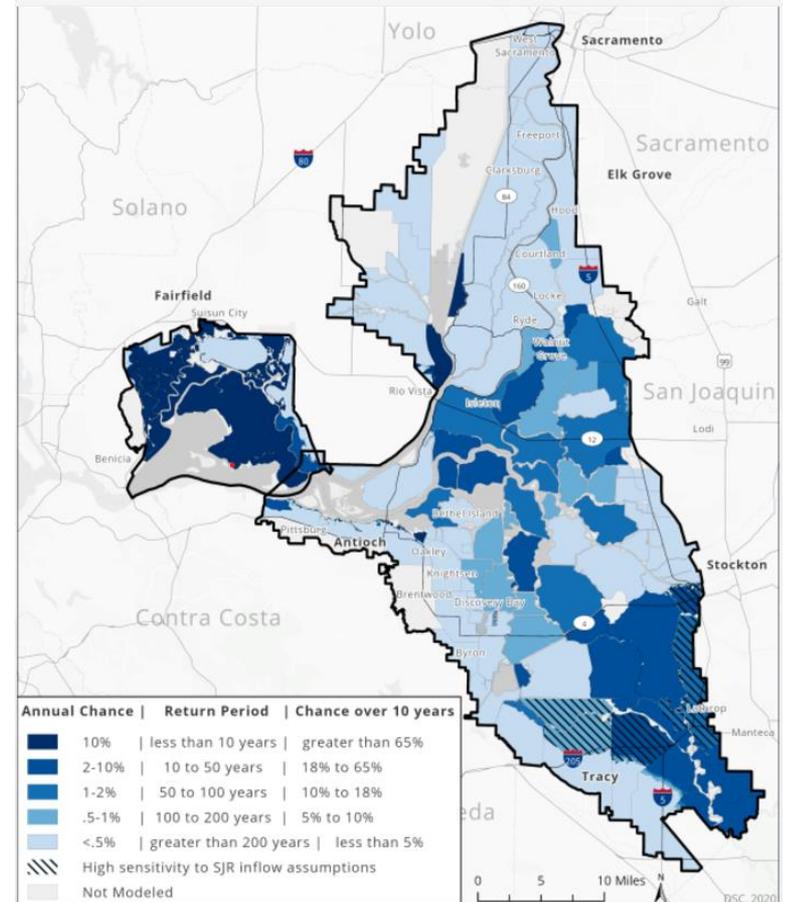
Findings: higher concentrations of ambient air pollutants at air quality monitors in proximity to preproduction wells within 4 km (~2.5mi) and producing wells within 2km (~1.25mi)

NO ESTB SAFE LIMITS

Flooding: California



Earth.org



Delta Stewardship Council

