



Old Wisdom New Climate

Lori Byron, MD, MS, FAAP

Robert Byron, MD, MPH, FACP

JoRee Lafrance

Acknowledgment & Appreciation

- We acknowledge that we inhabit the unsundered lands of the Absaalooka (Crow) people who have been stewards of their land for 1000s of years;
- We are indebted to the Crow and Northern Cheyenne peoples for their openness and the trust they placed in us.



<https://www.publicdomainpictures.net/pictures/260000/velka/teepees-15265766570Ai.jpg>

Learning Objectives

- Identify effects of climate and heat on fetuses, cardiovascular health, and mental health.
- Describe some traditional knowledge to improve climate-causes problems
- Apply skills to communicate both concern and prevention strategies to patients at risk for worsening health due to climate and heat

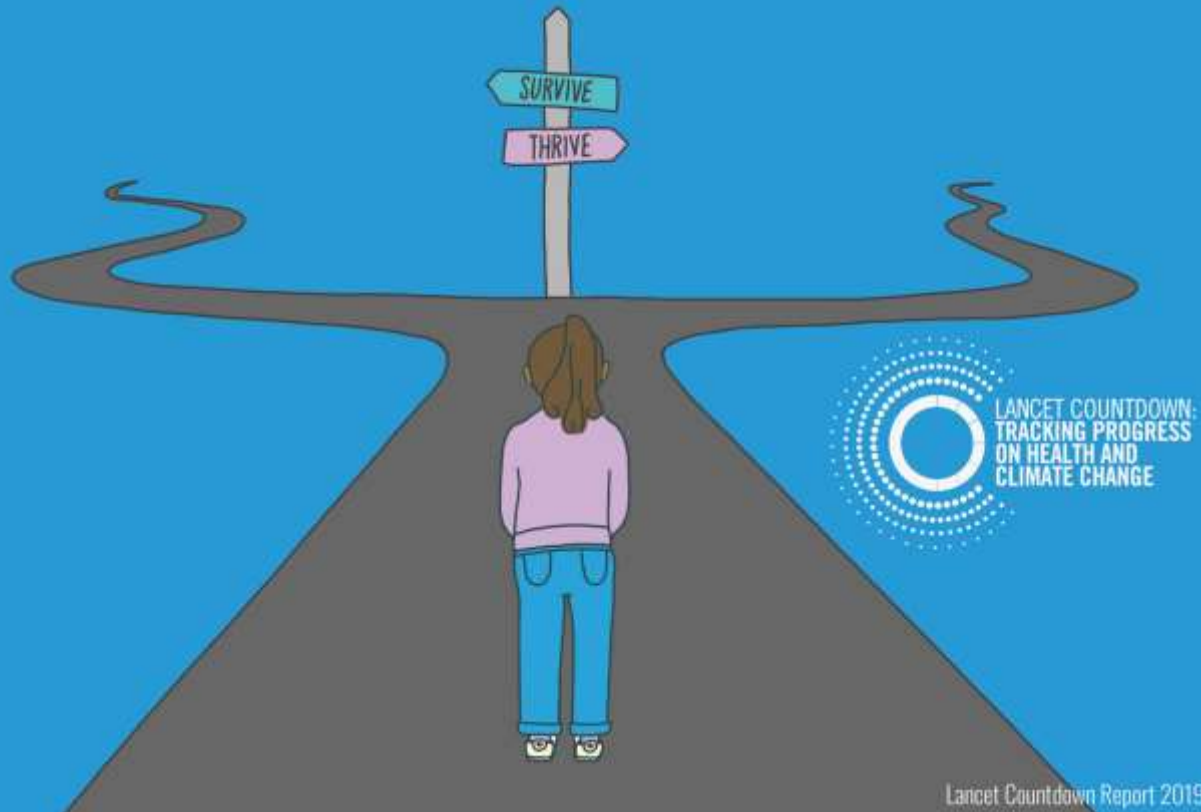
In the past 24 months, JoRee LaFrance and Rob and Lori Byron have no relevant financial relationships with the manufacturer(s) of commercial services discussed in this CME activity.

We do not intend to discuss an unapproved/investigative use of a commercial product/device in my presentation.

200 major medical journals, including the New England Journal of Medicine, BMJ, and the Lancet, published the same editorial on the same day: **the greatest threat to public health in the 21st century.**



Every child born today will be affected by **climate change**. How we respond will determine the world we live in tomorrow and will shape the health of children across the globe, at every stage of their lives.



Climate
change is
here

It is **now**

It is **us**



Global Climate Change and Children's Health

COUNCIL ON ENVIRONMENTAL HEALTH

INTRODUCTION

Rising global temperatures are causing major physical, chemical, and ecological changes in the planet. There is wide consensus among scientific organizations and climatologists that these broad effects, known as "climate change," are the result of contemporary human activity. Climate change poses threats to human health, safety, and security, and children are uniquely vulnerable to these threats. The effects of climate change on child health include: physical and psychological sequelae of weather disasters; increased heat stress; decreased air quality; altered disease patterns of some climate-sensitive infections; and food, water, and nutrient insecurity in vulnerable regions. The social foundations of children's mental and physical health are threatened by the specter of far-reaching effects of unchecked climate change, including community and global instability, mass migrations, and increased conflict. Given this knowledge, failure to take prompt, substantive action would be an act of injustice to all children. A paradigm shift in production and consumption of energy is both a necessity and an opportunity for major innovation, job creation, and significant, immediate associated health benefits. Pediatricians have a uniquely valuable role to play in the societal response to this global challenge.

INTRODUCTION

It is clear from observations across a range of indicators that many fundamental measures of climate are changing. These broad changes, known as "climate change," threaten the biological systems on which the life, health, and prosperity of all children depend. On the basis of well-established evidence from the past 20 years, there is now wide consensus among scientific organizations and approximately 97% of climatologists that human-generated greenhouse gas emissions are the cause of climate change.¹⁻⁴ Although the effects of climate change are already being felt across the world, the magnitude of the effects of future changes depends on our ability to substantially reduce greenhouse gas emissions and implement adaptation strategies within the ensuing decades.⁵ Thus, it remains possible to protect children, families, and communities from the worst potential effects of climate change.



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Policy statements from the American Academy of Pediatrics benefit the countless physicians and children and address national issues of importance to the American Academy of Pediatrics and all reflect the views of the Academy or its organization or government agencies that they represent.

The guidelines in this document are not intended to restrict clinical practice or to dictate any management or treatment. They are intended to guide clinical practice.

All policy statements from the American Academy of Pediatrics have been reviewed by a panel of experts and approved by the Council on Environmental Health.

www.aap.org/policystatements

DOI: 10.1542/ps.2019-0302

ISSN: 1099-0959 (print); 1099-0967 (online); 1099-0959 (print)

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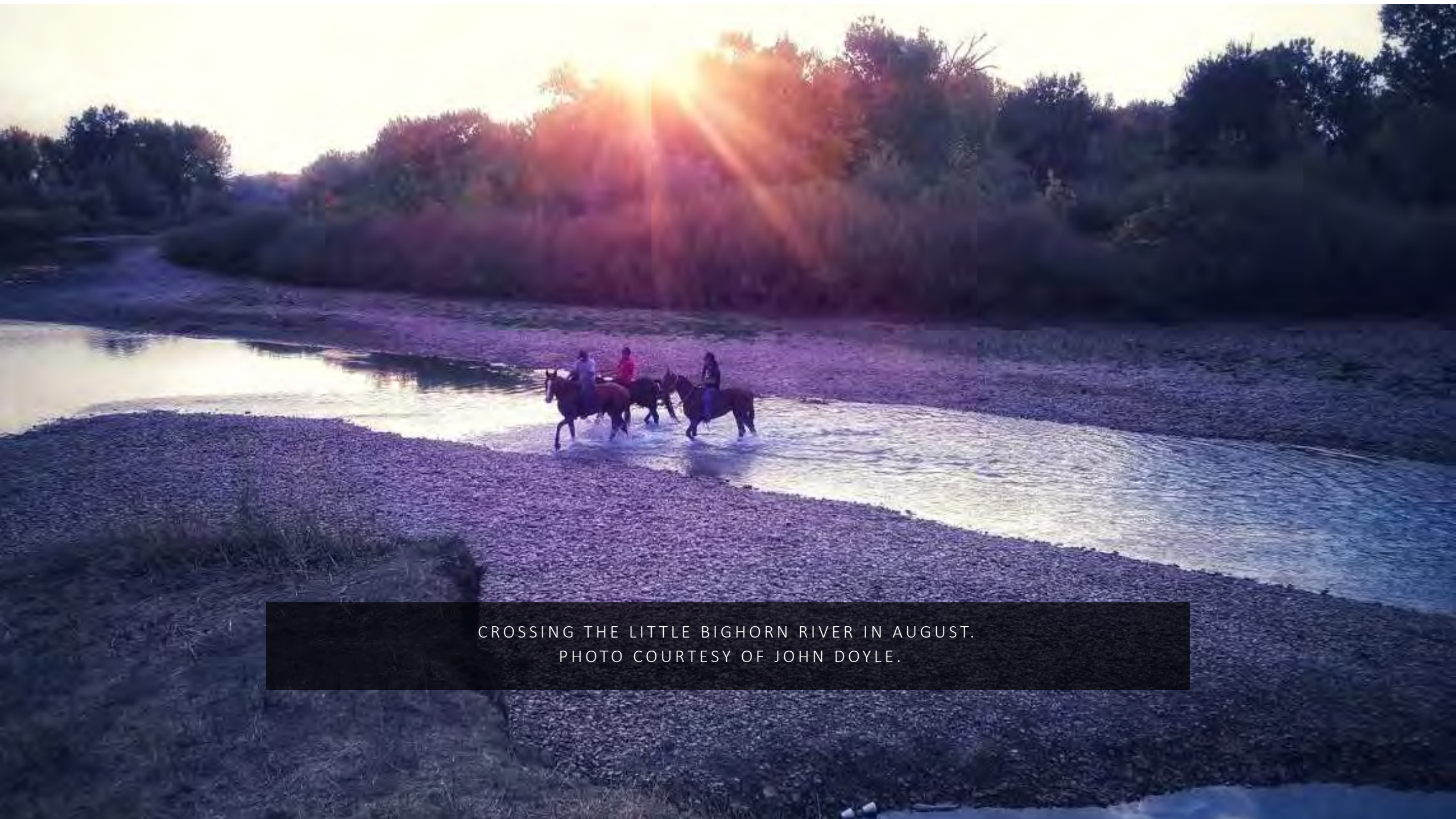


Climate Change and Women's Health

Position Statement

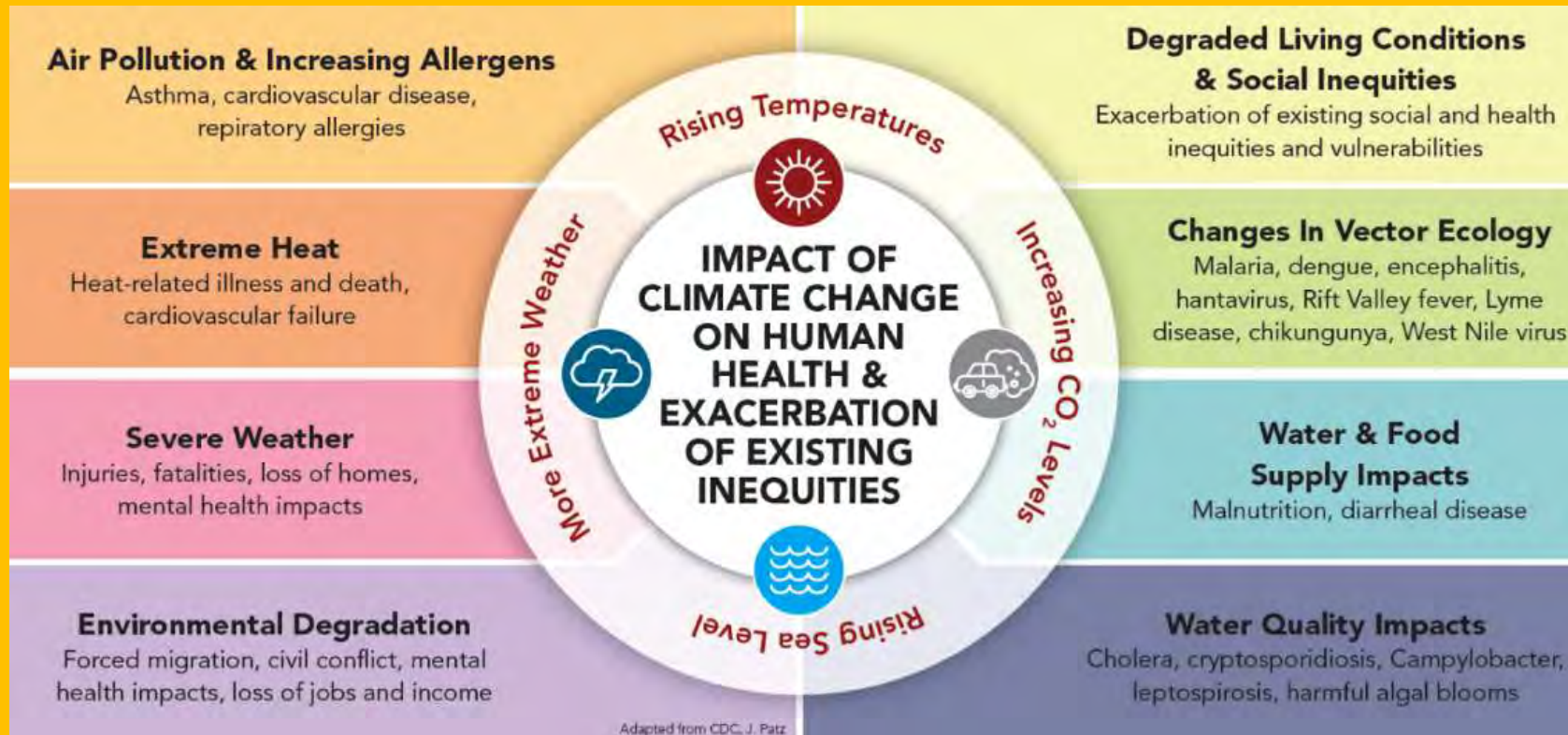
Conclusive evidence has demonstrated that that climate change is having a dramatic impact on the lives of people around the world. Representing physicians dedicated to the whole well-being of women—including their safety, security, and access to quality care—the American College of Obstetricians and Gynecologists recognizes that climate change is an urgent women's health concern as well as a major public health challenge. We call on our national and international leaders to act to curb greenhouse gas emissions and limit further climate destabilization.

Without question, climate change has a disproportionate effect on global women's health¹, as it broadens existing gender-based health disparities. The effects of climate change—such as food and water insecurity, civil conflicts, extreme weather events, spread of disease, and more—put women in affected regions at elevated risk of disease, malnutrition, sexual violence, poor mental health, lack of reproductive control, negative obstetric outcomes, and death. This also has an impact on future generations, with the rate of low-birth weight infants increasing in regions impacted by the effects of climate change, and with the erosion of the health care infrastructure needed to support healthy women and healthy families.



CROSSING THE LITTLE BIGHORN RIVER IN AUGUST.
PHOTO COURTESY OF JOHN DOYLE.

Climate change and health



INCREASED ANTHROPOGENIC GREENHOUSE GAS EMISSIONS

CLIMATE PRESSURES



Increasing temperatures



More extreme weather



Rising sea levels



Extremes of precipitation

EXPOSURE PATHWAYS



Extreme heat & heatwaves



Air pollution (PM2.5 & O₃)



Water contamination



Changes in vector ecology



Increasing allergens



Food supply and quality



Population displacement

HEALTH OUTCOMES



Heat stress & heat stroke



Respiratory disease



Cardiovascular disease



Gastrointestinal illness



Vector-borne diseases (Lyme, West Nile, Zika)



Mental health illness/worsening mental health



Adverse birth outcomes



Physical trauma and death

- Salas RN, Knappenberger P, Hess J. 2018. 2018 Lancet countdown on health and climate change brief for the United States of America [report]. London UK: Lancet Countdown. 32 p. Available online <https://storage.googleapis.com/lancet-countdown/2019/10/2018-lancet-countdown-policy-brief-usa.pdf>. Accessed 2021.01.21

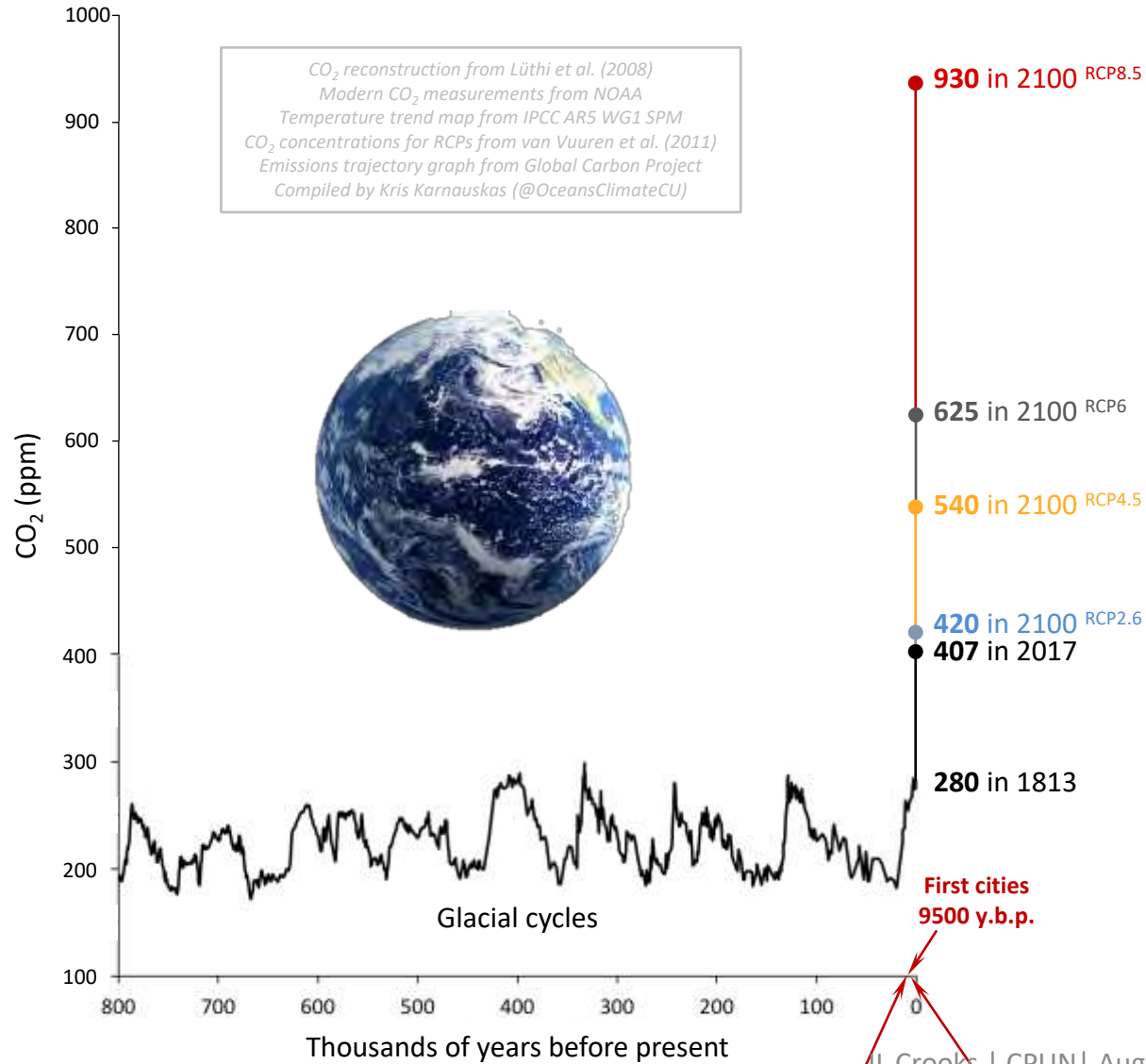
Figure created for Brief by M. Lee (Climate Nexus).

Populations especially vulnerable are children, older adults, pregnant women, those with chronic medical conditions, those with lower socioeconomic status, outdoor workers, and racial minorities.

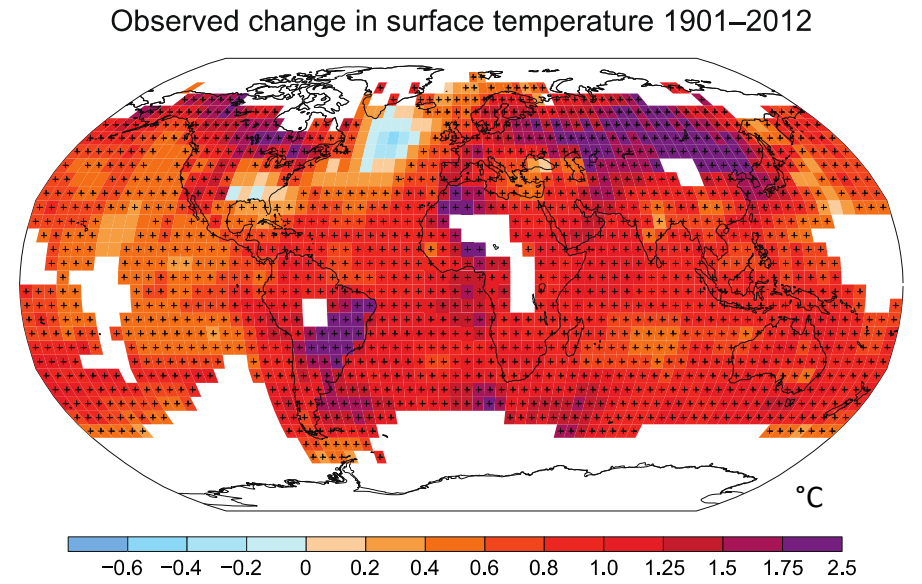


Air Quality





CO₂ reconstruction from Lüthi et al. (2008)
 Modern CO₂ measurements from NOAA
 Temperature trend map from IPCC AR5 WG1 SPM
 CO₂ concentrations for RCPs from van Vuuren et al. (2011)
 Emissions trajectory graph from Global Carbon Project
 Compiled by Kris Karnauskas (@OceansClimateCU)



Agriculture emerges 11500 y.b.p.

First cities 9500 y.b.p.

Writing Invented 5500 y.b.p.

JL Crooks | CPUN | August 9, 2022

Slide source: Kris Karnauskas, CU Boulder

Climate Change and Air Pollution Relationships

Climate Change = GHG's

- Carbon dioxide (CO₂)
- Methane (CH₄)
- Nitrous oxide (N₂O)
- Fluorinated gases

Air Pollution Health Impacts

- Particulate matter (PM_{2.5})
- (Ground level) Ozone
- Allergens

Air Pollution Damages Our Health



-Overall air quality in the US is better than it was 2-3 decades ago.

-68,000-250,000 deaths/year in the US^{1,2}

1. Lancet Countdown, 2020: 2020 Lancet Countdown on Health and Climate Change Policy Brief for the United States of America. Salas RN, Lester PK, Hess JJ. Lancet Countdown U.S. Policy Brief, London, United Kingdom.)<https://www.lancetcountdownus.org/wp-content/uploads/2021/01/2020-lancet-brief.pdf>

2.Shindell, Drew. Testimony to the House Committee on Oversight and Reform Hearing on “The Devastating Impacts of Climate Change on Health” on August 5, 2020. <https://oversight.house.gov/legislation/hearings/the-devastating-health-impacts-of-climate-change>

STATE OF GLOBAL AIR /2020

A SPECIAL REPORT ON GLOBAL EXPOSURE TO AIR POLLUTION AND ITS HEALTH IMPACTS



FIGURE 11 Global ranking of risk factors by total number of deaths from all causes in 2019.

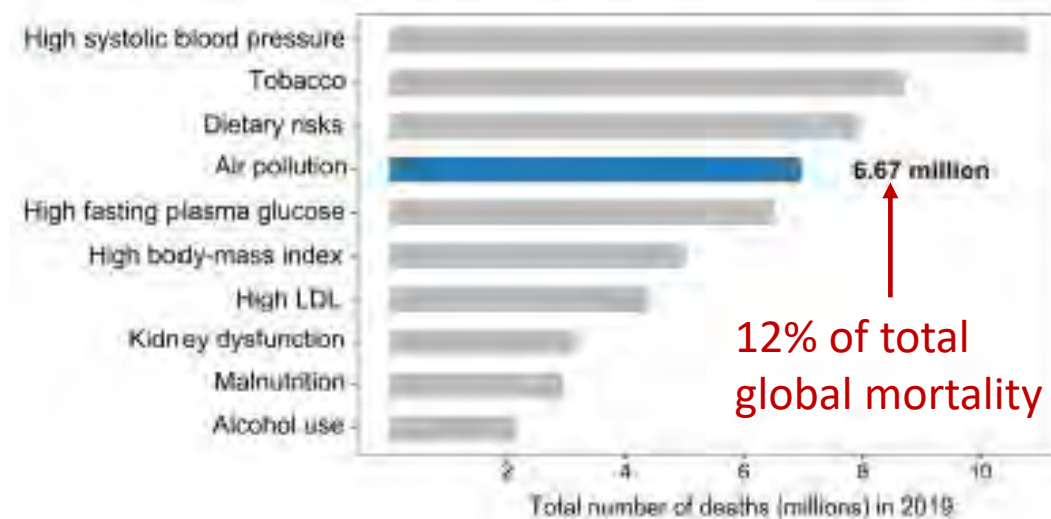
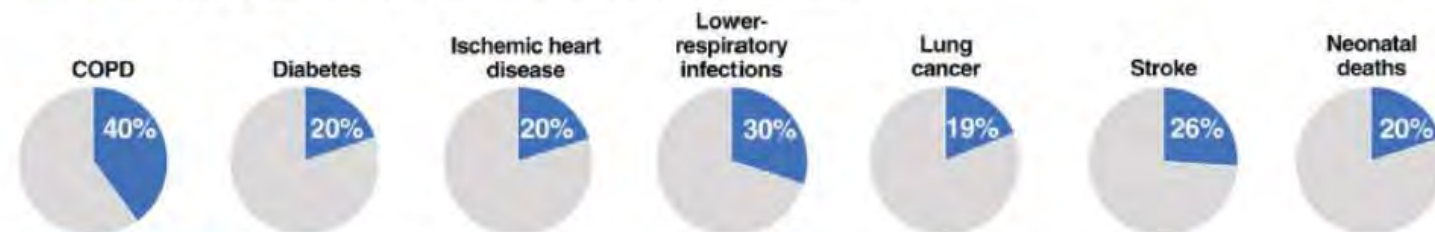


FIGURE 13 Percentage of global deaths from specific causes attributable to total air pollution.



Visit stateofglobalair.org to explore data for your country.

PM_{2.5} pollutants disproportionately and systemically affect people of color in the United States

CHRISTOPHER W. TESSUM, DAVID A. PAOLELLA, SARAH E. CHAMBLISS, JOSHUA S. AFTI, JASON D. HILL, AND JULIAN D. MARSHALL. [Authors Info &](#)

[Affiliations](#)

SCIENCE ADVANCES • 28 Apr 2021 • Vol 7, Issue 16 • DOI:10.1126/sciadv.abe4491

“Nationally, racial-ethnic exposure disparities are not caused by a small number of emission sources; instead, most source types and sectors result in higher-than-average exposures for POC and lower-than-average exposures for Whites (Fig. 1).”

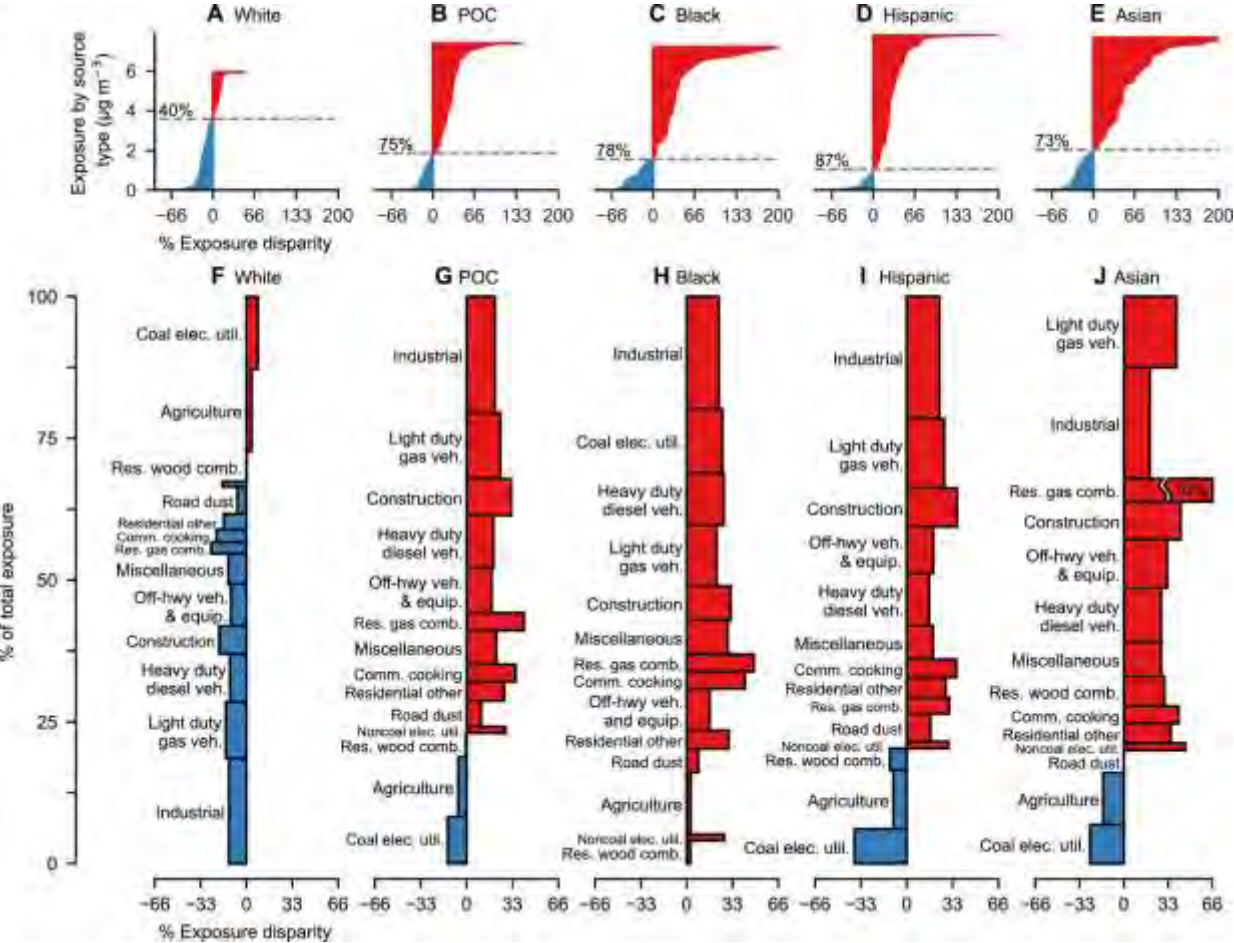


Fig. 1 Source contributions to racial-ethnic disparity in PM_{2.5} exposure.



- Air pollution *from fossil fuel burning alone* was responsible for 10.2 million deaths worldwide in 2012, or 20% of global mortality.
- In the U.S., fossil fuel burning was responsible for 355 thousand deaths in 2012, or 12% of total mortality.
- Our country experiences 2/3 of a pandemic worth of deaths *every year* just due to air pollution from fossil fuel burning.
- If this isn't a crisis then the word has no meaning.



Environmental Research
Volume 195, April 2021, 110754



Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem

Karn Vohra ^a  , Alina Vodonos ^b, Joel Schwartz ^b, Eloise A. Marais ^{c,1}, Melissa P. Sulprizio ^d, Loretta J. Mickley ^d

SARS-CoV2 & Air Pollution

- Increase of only 1 $\mu\text{g}/\text{m}^3$ in PM_{2.5} is associated with an 8% increase in the COVID-19 death rate (95% confidence interval [CI]: 2%, 15%).

Wu, X., Nethery, R. C., Sabath, B. M., Braun, D., & Dominici, F. (2020). Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study. *MedRxiv*, 2020.04.05.20054502. doi: 10.1101/2020.04.05.20054502

Particulate Matter (PM): Sources

Primary sources:

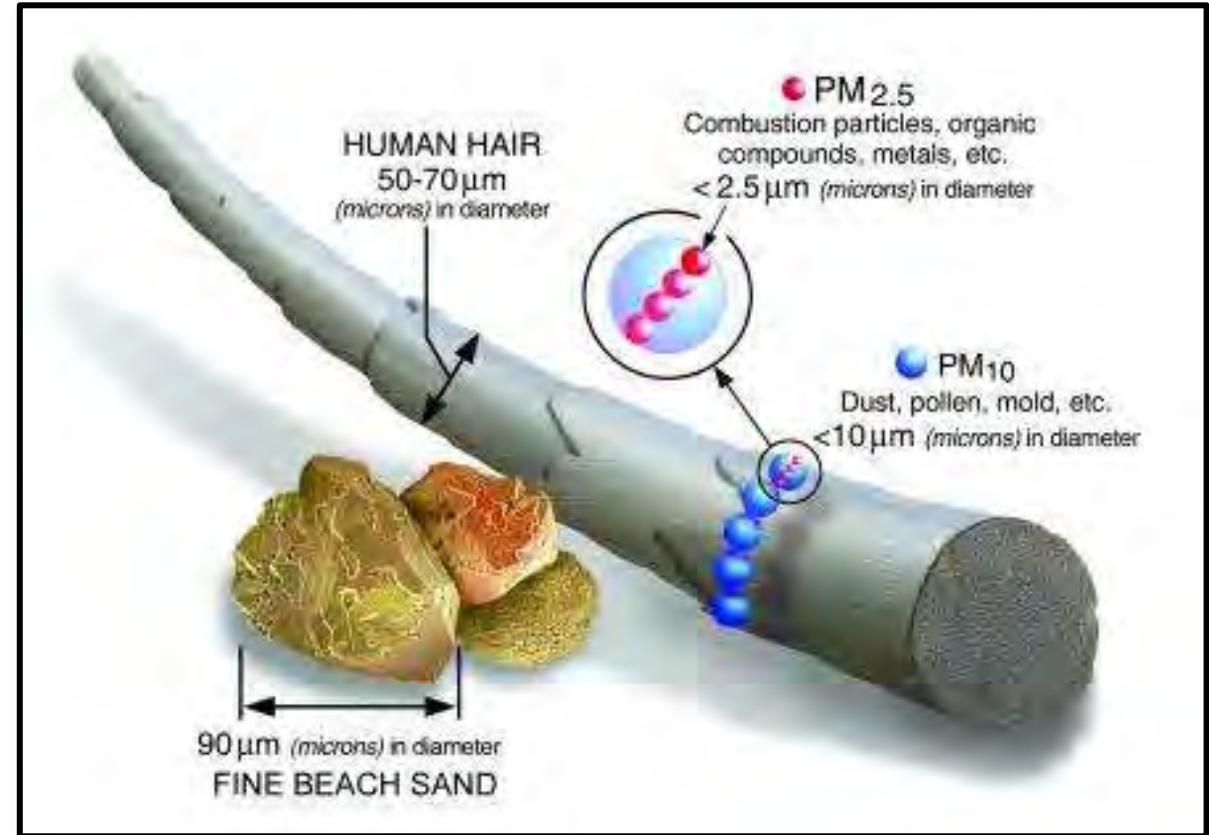
- Coal and oil burning
- Vehicle brake and tire wear
- Diesel exhaust
- Wildfires
- Dust storms
- Sea salt

Secondary sources:

- Fertilizer fumes
- Vehicle and power plant exhaust
- Leaks from oil & gas development

Particulate Matter (PM): Size Categories

- PM_{10} = PM less than $10\mu\text{m}$ across
- $PM_{2.5}$ = PM less than $2.5\mu\text{m}$ across (AKA “fine particles”)
- $PM_{10-2.5}$ = PM between 2.5 and $10\mu\text{m}$ across (AKA “coarse particles”)
- Ultrafines = particles less than $\sim 0.1\mu\text{m}$ across

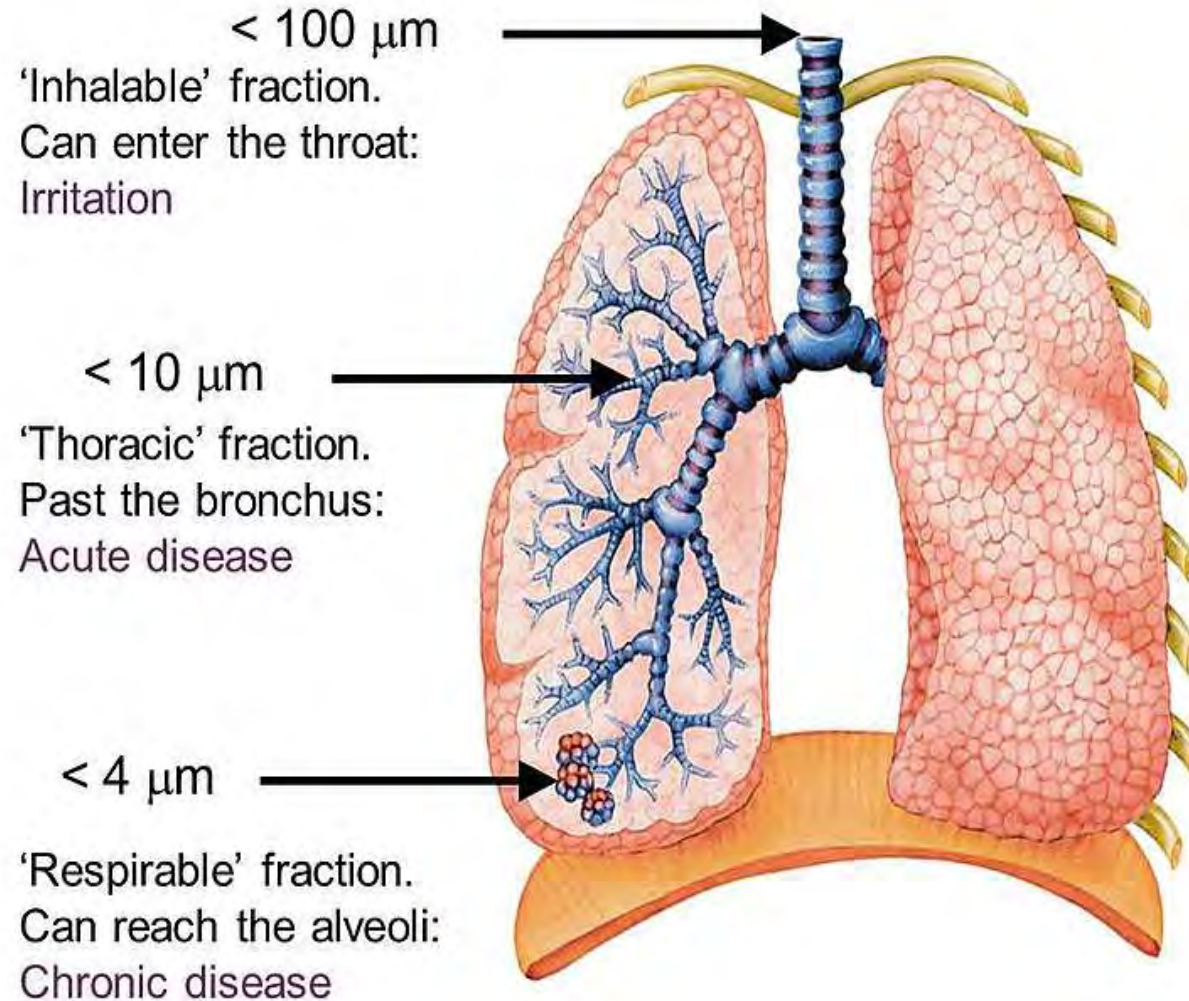


<https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM>

Health effects of airborne particles

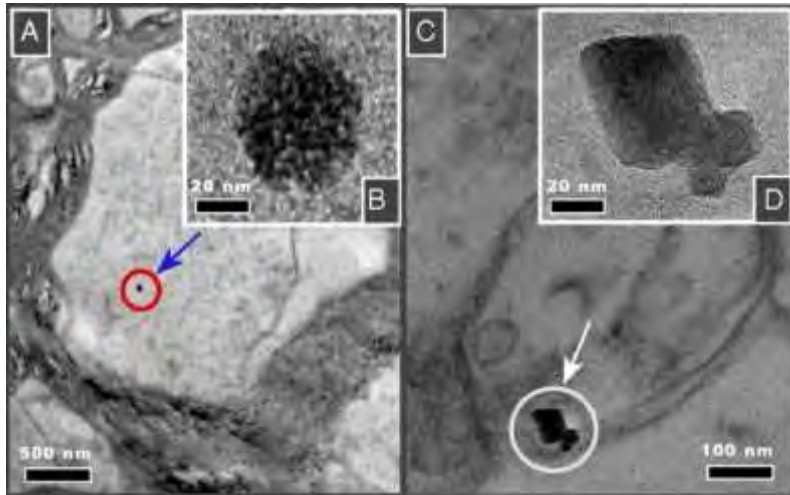
- 1940s-1980s – Particulate matter $<10\mu\text{m}$ affects respiratory disease!
 - COPD, asthma, emphysema
 - lung cancer
- 1990s – Fine particulate matter ($<2.5\mu\text{m}$) affects cardiovascular disease!
 - stroke
 - heart attack
 - congestive heart failure

Penetration of PM into the Lungs



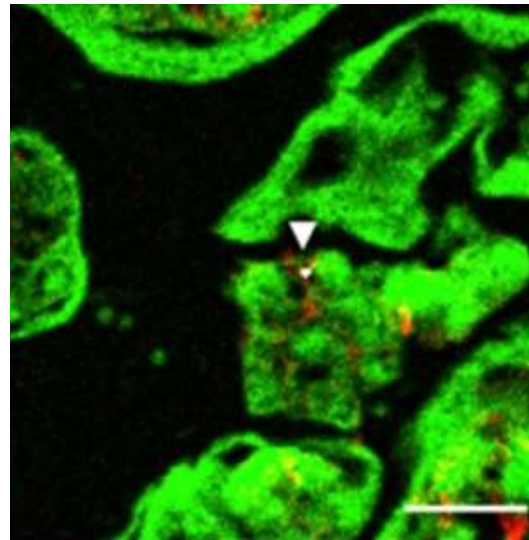
Health effects of airborne particles

Human Brain Cells



<https://www.pnas.org/doi/full/10.1073/pnas.1605941113>

Human Placenta

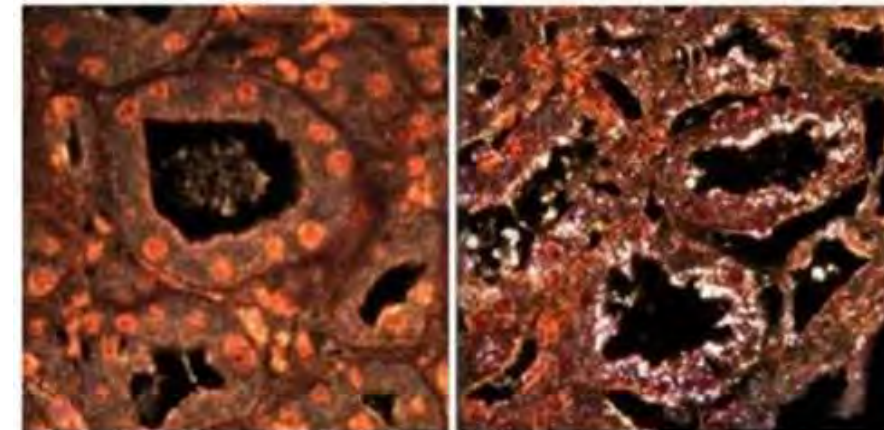


<https://www.nature.com/articles/s41467-019-11654-3>

Human Kidney Cells

Control Patient

CKDu Patient



Enhanced darkfield hyperspectral imaging demonstrating the presence of nanoparticles within kidney biopsy sections for a control patient and an individual with CKDu.

<https://pharmacy.cuanschutz.edu/research/research-labs/immunotoxicology-lab>

Ozone and PM 2.5

Systemic Inflammation

Accelerated atherosclerosis

Vascular disease

Increase risk of heart attack



Negative impacts on fetal and maternal health

Pre-term delivery, low birth weight



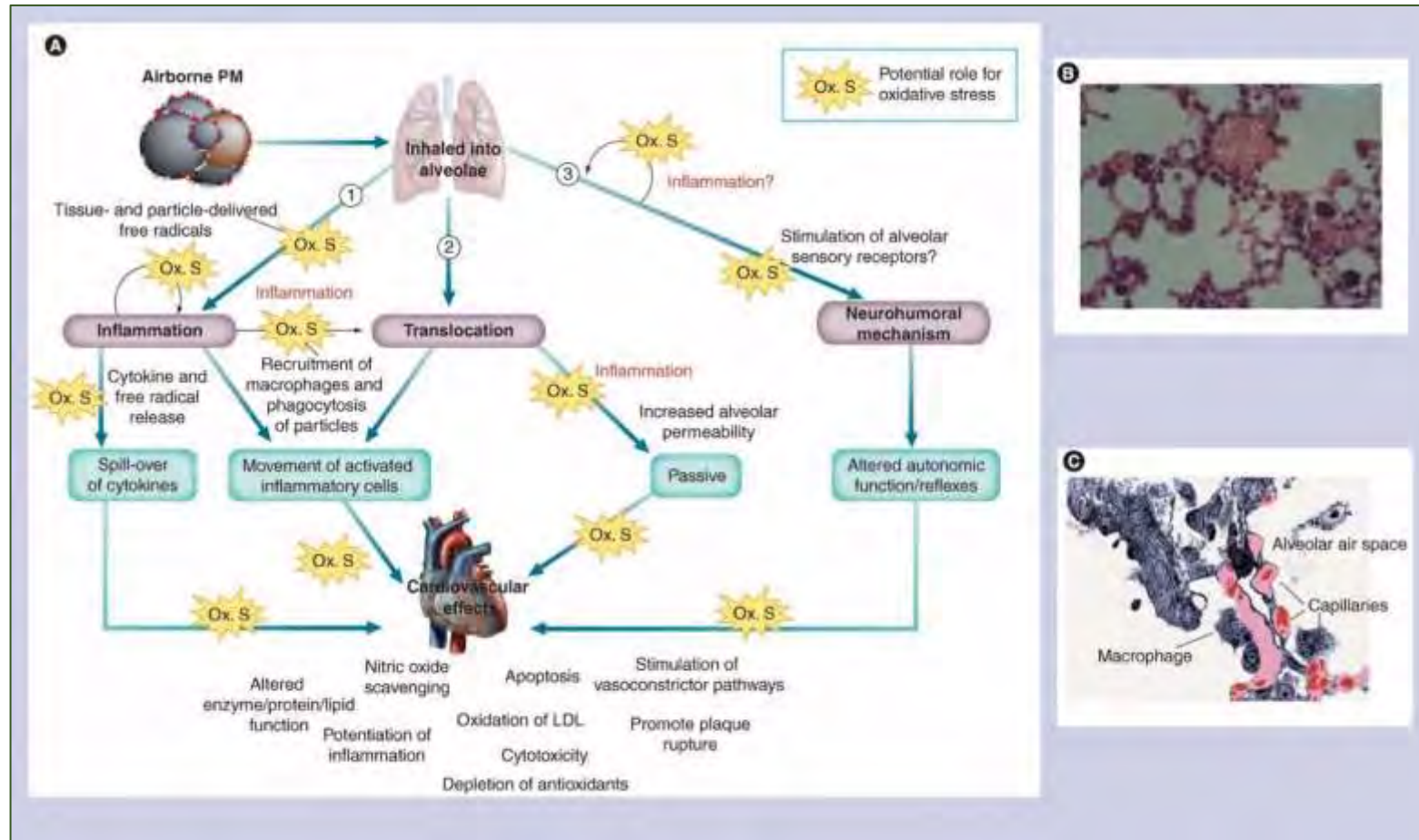
Pulmonary Inflammation

Long term impacts on lung tissue and increase risk of developing asthma

Short term impacts on exacerbations of respiratory diseases (COPD and Asthma)



Health effects of airborne particles



Health effects of airborne particles

- 1940s-1980s – Particulate matter $<10\mu\text{m}$ affects respiratory disease!
 - COPD, asthma, emphysema
 - lung cancer
- 1990s – Fine particulate matter ($<2.5\mu\text{m}$) affects cardiovascular disease!
 - stroke
 - heart attack
 - congestive heart failure
- 2000s-2020s – Fine particulate matter affects more or less any disease process involving inflammation or oxidative stress!
 - congenital birth defects
 - low birth weight and pre-term birth
 - Developmental delays and behavioral problems in childhood
 - Autism
 - Dementia, Alzheimer's disease, and Parkinson's disease
 - cognitive declines
 - metabolic syndrome, diabetes, and obesity...
 - ...

Health effects across organ systems

Short term exposure to fine particulate matter and hospital admission risks and costs in the Medicare population: time stratified, case crossover study

Yaguang Wei,¹ Yan Wang,^{1,2} Qian Di,³ Christine Choirat,⁴ Yun Wang,² Petros Koutrakis,¹ Antonella Zanobetti,¹ Francesca Dominici,² Joel D Schwartz¹

Cite this as: *BMJ* 2019;367:l6258
<http://dx.doi.org/10.1136/bmj.l6258>

Accepted: 16 October 2019

RESULTS

Positive associations between short term exposure to PM_{2.5} and risk of hospital admission were found for several prevalent but rarely studied diseases, such as septicemia, fluid and electrolyte disorders,

and acute and unspecified renal failure. Positive associations were also found between risk of hospital admission and cardiovascular and respiratory diseases, Parkinson's disease, diabetes, phlebitis, thrombophlebitis, and thromboembolism, confirming previously published results. These associations

Health effects at low concentrations

Results

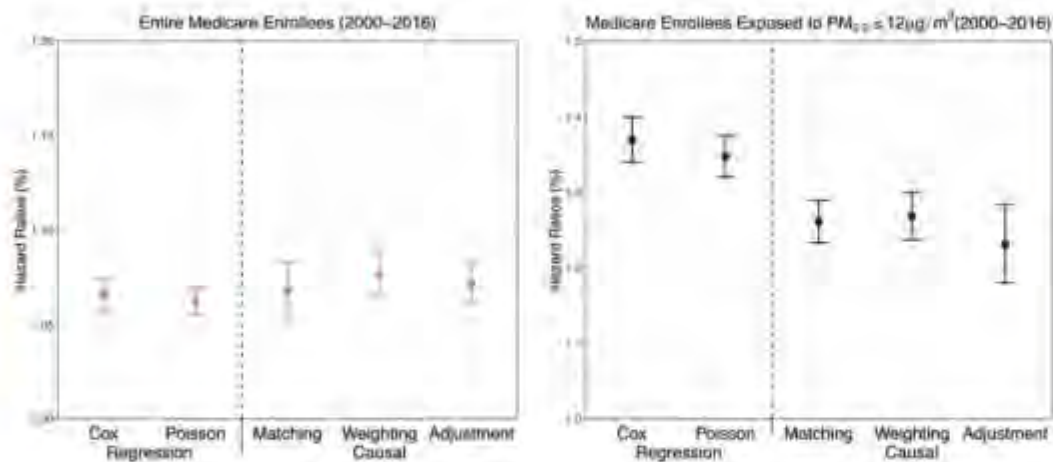


Fig. 3. Hazard Ratios (HR) and 95% Confidence Intervals (CIs). The estimated HRs were obtained under five different statistical approaches (two traditional approaches and three causal inference approaches). HRs were adjusted by 10 potential confounders, four meteorological variables, geographic region, and year.

Using five distinct statistical approaches, we found that a decrease of $10 \mu g/m^3$ $PM_{2.5}$ leads to a statistically significant 6%–7% decrease in mortality risk.

Based on these models, lowering the air quality standard to $10 \mu g/m^3$ would save 143,257 lives (95% confidence interval 115,581–170,645) in one decade

Wu X, et al. Evaluating the impact of long-term exposure to fine particulate matter on mortality among the elderly. *Science advances*. 2020 Jul 17;6(29):eaba5692.

Table. Summary of Evidence Key Questions 1 Through 6

Exposure and outcome	Studies finding an association, No./total No.	Births/study, mean (SD)	Total births in millions	Increased risk, median (range), % ^a	Studies finding racial disparity, No./total No.	Notable findings ^b
Air pollution						
Preterm birth	19/24	318 960 (393 272)	7.3	11.5 (2.0-19.0) ^c	10/19	Preterm birth risk increased 52% for asthmatic mothers
Low birth weight	25/29	661 205 (878 074)	18.5	10.8 (2.0-36.0) ^c	13/25	Low birth weight risk increased 3% for each 5-km proximity to a solid waste plant
Stillbirth	4/5	1 020 975 (1 176 174)	5.1	14.5 (6.0-23.0) ^c	1/4	Stillbirth risk increased 42% with high third-trimester exposure
Heat						
Preterm birth	4/5	192 625 (207 995)	0.8	15.8 (9.0-22.0) ^d	2/4	Preterm birth risk increased 11.6% per 5.6 °C increase
Low birth weight	3/3	902 277 (985 803)	2.7	31.0 (13.0-49.0) ^d	1/3	Term birth weight decreased 16 g per IQR temperature increase
Stillbirth	2/2	115 943 (115 933)	0.2	NA ^e	2/2	Stillbirth risk increased 6% per 1 °C increase the week before delivery during the warm season

Abbreviations: IQR, interquartile range; NA, not applicable.

^a Risk presented as range from significant studies. The median is calculated from the range; a pooled analysis was not performed. For consistency, the whole pregnancy exposure was presented where possible.

^b Single study unless specified.

^c For whole pregnancy PM_{2.5} exposure.

^d For whole pregnancy heat exposure.

^e The only 2 studies on heat and stillbirth did not provide comparable data; they could not be combined into a range with a median.

Air Pollution and Preterm Birth

- Globally, in 2010, the number of PM_{2.5}-associated preterm births was estimated as **2.7 million, 18% of total preterm births globally**



Environment International

Available online 10 February 2017

In Press, Corrected Proof — Note to users



Preterm birth associated with maternal fine particulate matter exposure: A global, regional and national assessment

Christopher S. Malley^a, Johan C.I. Kuylenstierna^a, Harry W. Vallack^a, Daven K. Henze^b, Hannah Blencowe^c, Mike R. Ashmore^a

[Show more](#)

<http://dx.doi.org/10.1016/j.envint.2017.01.023>

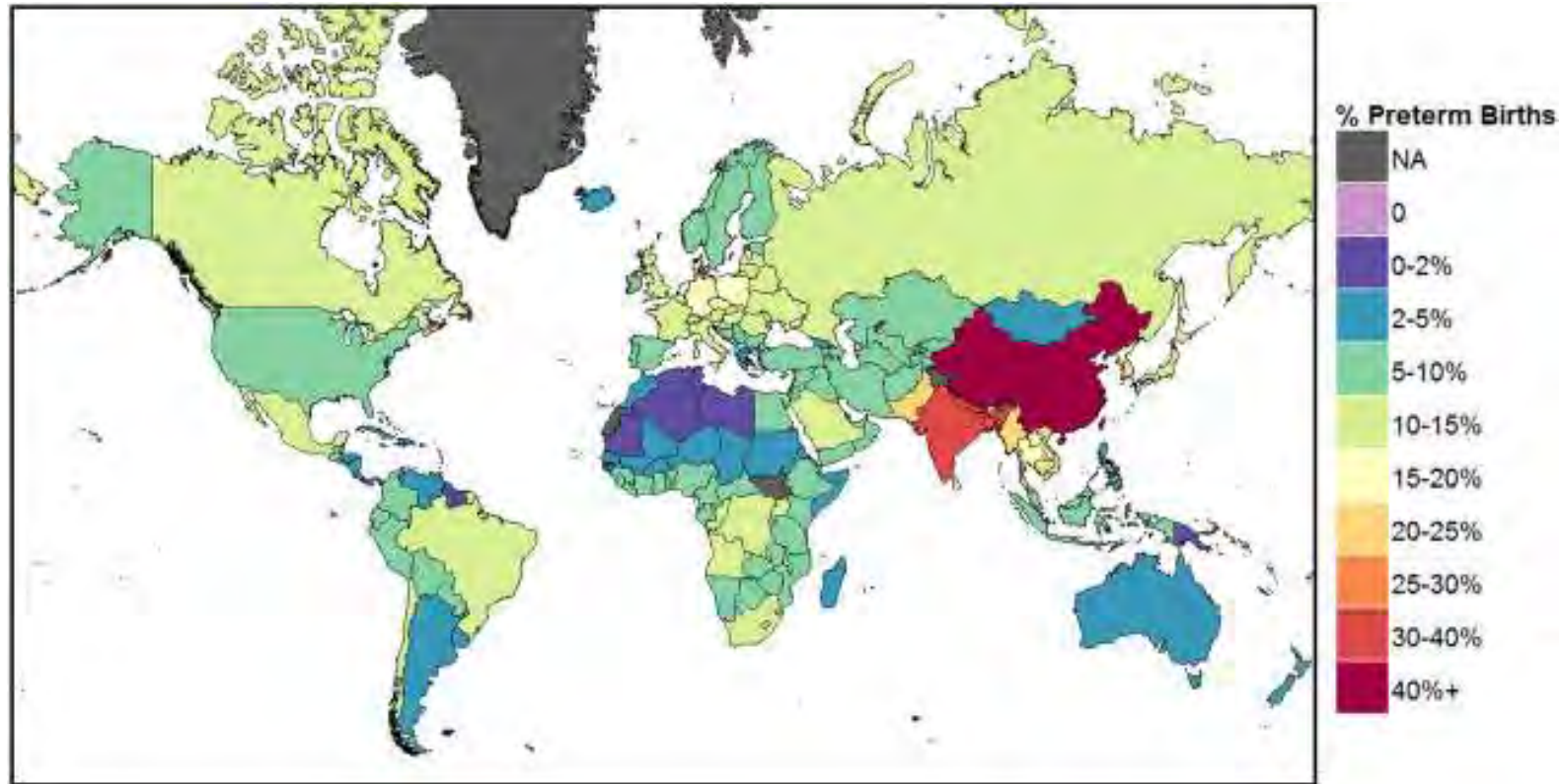
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Highlights

- Ambient fine particulate matter (PM_{2.5}) exposure is a possible risk factor for preterm birth.
- We estimate 2.7–3.4 million preterm births may be associated with PM_{2.5} exposure in 2010 globally.
- South/East Asia, North Africa/Middle East and West sub-Saharan Africa had largest burdens.
- Maternal PM_{2.5} exposure should be considered alongside other preterm birth risk factors.



Air Pollution and Preterm Birth

- Percentage of total preterm births which were associated with anthropogenic ambient PM_{2.5} only in 2010.

Air Pollution and Preterm Birth: 3.32% of PTBs nationally attributed to PM_{2.5} 5.09 billion in cost of which \$760 million are medical care

RESEARCH ARTICLES

DECEMBER 2016 | VOLUME 124 | ISSUE 12



CHILDREN'S HEALTH



Environ Health Perspect. DOI:10.1289/ehp.1510810

Particulate Matter Exposure and Preterm Birth: Estimates of U.S. Attributable Burden and Economic Costs

Leonardo Trasande,^{1,2,3,4,5} Patricia Malecha,¹ and Teresa M. Attina¹

Author Affiliations [open](#)

PDF Version (395 KB)

Abstract | [About This Article](#)

Background: Preterm birth (PTB) rates (11.4% in 2013) in the United States remain high and are a substantial cause of morbidity. Studies of prenatal exposure have associated particulate matter ≤ 2.5 μm in diameter (PM_{2.5}) and other ambient air pollutants with adverse birth outcomes; yet, to our knowledge, burden and costs of PM_{2.5}-attributable PTB have not been estimated in the United States.

Objectives: We aimed to estimate burden of PTB in the United States and economic costs attributable to PM_{2.5} exposure in 2010.

Methods: Annual deciles of PM_{2.5} were obtained from the U.S. Environmental Protection Agency. We converted PTB odds ratio (OR), identified in a previous meta-analysis (1.15 per 10 $\mu\text{g}/\text{m}^3$ for our base case, 1.07–1.16 for low- and high-end scenarios) to relative risk (RRs), to obtain an estimate that better represents the true relative risk. A reference level (RL) of 8.8 $\mu\text{g}/\text{m}^3$ was applied. We then used the RR estimates and county-level PTB prevalence to quantify PM_{2.5}-attributable PTB. Direct medical costs were obtained from the 2007 Institute of Medicine report, and lost economic productivity (LEP) was estimated using a meta-analysis of PTB-associated IQ loss, and well-established relationships of IQ loss with LEP. All costs were calculated using 2010 dollars.

> [Am J Epidemiol](#). 2018 Aug 1;187(8):1586-1594. doi: 10.1093/aje/kwy110.

Retirements of Coal and Oil Power Plants in California: Association With Reduced Preterm Birth Among Populations Nearby

Joan A Casey ¹, Deborah Karasek ², Elizabeth L Ogburn ³, Dana E Goin ⁴, Kristina Dang ⁵, Paula A Braveman ⁶, Rachel Morello-Frosch ^{1 7}

Affiliations + expand

PMID: 29796613 PMID: [PMC6070091](#) DOI: [10.1093/aje/kwy110](#)

[Free PMC article](#)

27% reduction in preterm birth from 7.0→5.2% after power plant closure.

Mechanisms: Air Pollution and Preterm Birth

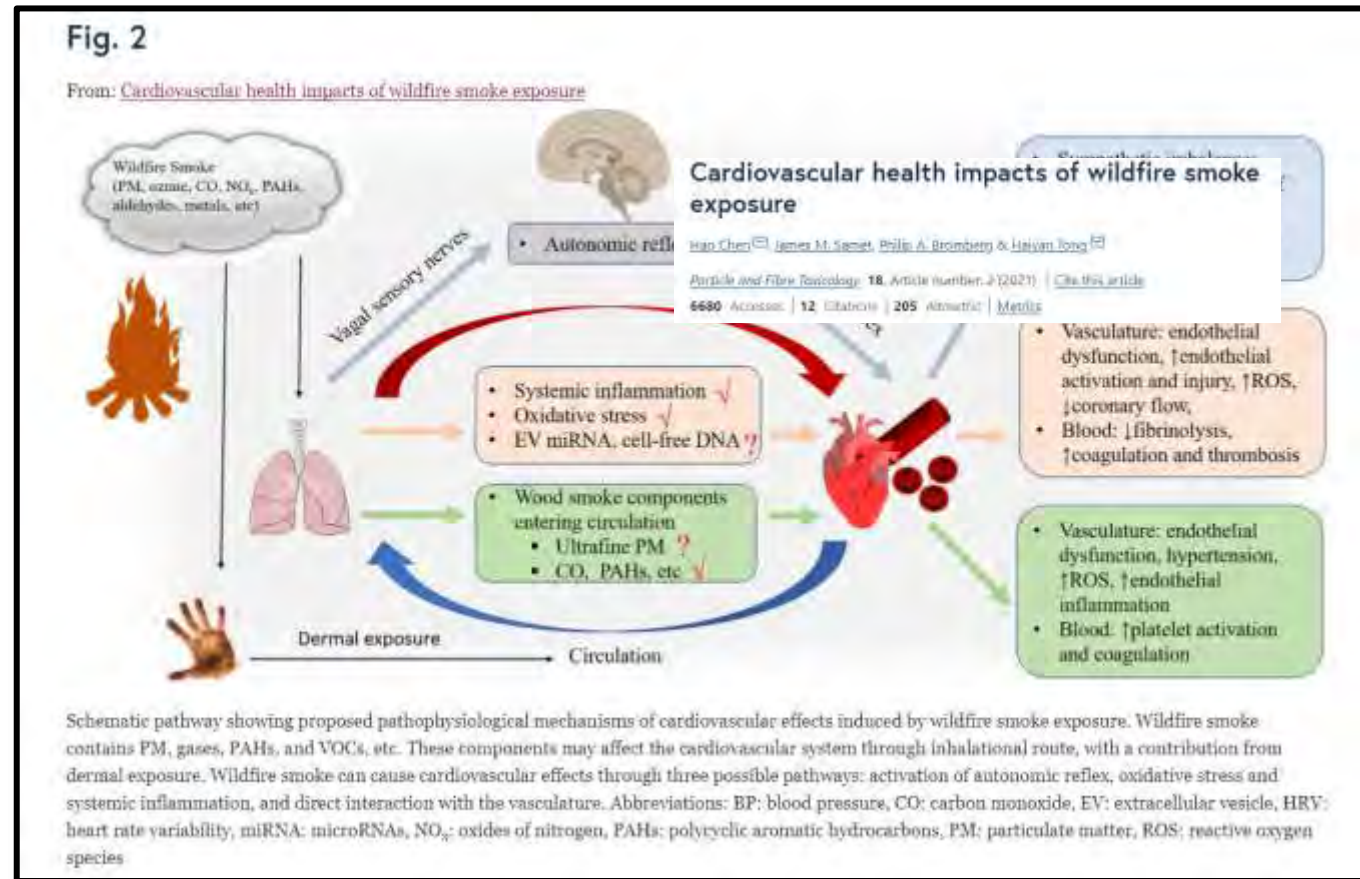
- Maternal hematologic transport of inhaled toxic chemicals
 - Increased levels of systemic inflammation
 - Changes in function of the autonomic nervous system
1. Kannan. Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework. *Environ Health Perspect.* 2006;114(11):1636-1642
 2. Brook. Insights into the mechanisms and mediators of the effects of air pollution exposure on blood pressure and vascular function in healthy humans. *Hypertension.* 2009;54(3):659-667
 3. US Environmental Protection Agency. Integrated Science Assessment (ISA) of ozone and related photochemical oxidants (final report, Feb 2013). US Environmental Protection Agency; 2013.

Bekkar B, Pacheco S, Basu R, DeNicola N. Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review. *JAMA Network Open.* 2020;3(6):e208243

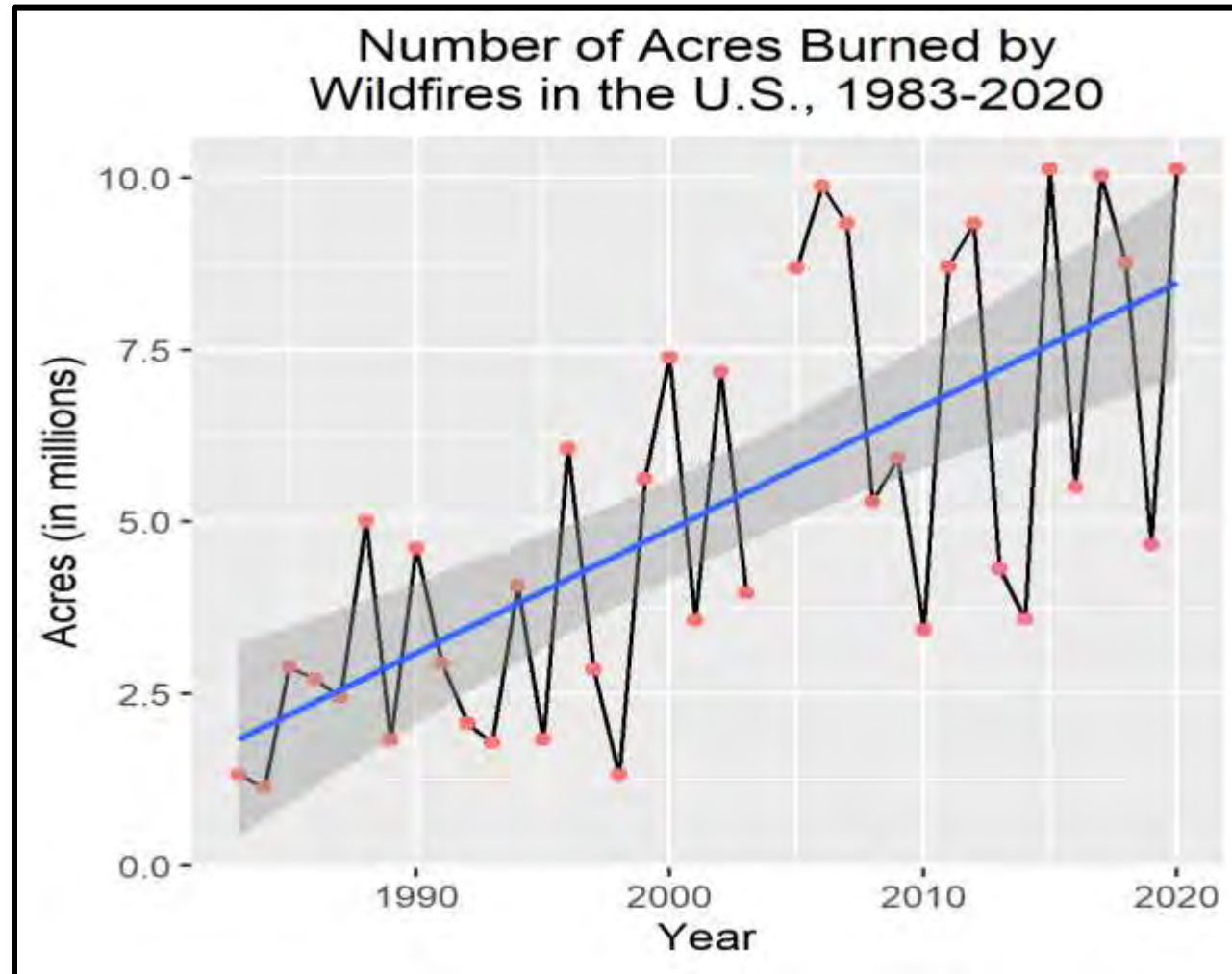
Wildfires

Wildfires smoke composition and effects

- Wildfire smoke is a mixture of gases and particles:
 - Carbon monoxide
 - Nitrogen oxides
 - **PM_{2.5}**
 - Polycyclic Aromatic Hydrocarbons (PAHs)
 - Volatile Organic Compounds (VOCs)
 - Other nasty stuff from burning buildings
- Smoke PM undergoes significant chemical changes while in the air
 - There is evidence that “aged” smoke is *more* toxic than “fresh” smoke due to its increased oxidation.
- Wildfire smoke can increase downwind Ozone levels, but doesn’t always



Wildfires in the U.S.




Wildfires smoke and asthma

- Wildfire smoke increased the risk for asthma morbidity during the 2013 wildfire season in Oregon.
- A 10 $\mu\text{g}/\text{m}^3$ increase in wildfire smoke increased risk in asthma diagnosis at emergency departments by 8.9%, office visit by 5.0%, outpatient visits by 6.5%; asthma rescue inhaler medication fills by 7.7%.

Journal of Exposure Science & Environmental Epidemiology

The association between wildfire smoke exposure and asthma-specific medical care utilization in Oregon during the 2013 wildfire season

[Ryan W. Gan](#), [Jingyang Liu](#), [Bonne Ford](#), [Katelyn O'Dell](#), [Ambarish Vaidyanathan](#), [Ander Wilson](#), [John Volckens](#), [Gabriele Pfister](#), [Emily V. Fischer](#), [Jeffrey R. Pierce](#) & [Sheryl Magzamen](#) 

Wildfire Health Effects – ICU Admissions

- Wildfire smoke PM_{2.5} around a hospital was associated with an increase in ICU admissions 5 days later.
- We estimate a potential doubling of ICU bed utilization under a simulated severe week-long “smoke wave”.

GeoHealth / Volume 5, Issue 5 / e2021GH000385

Research Article | [Open Access](#) | 

Associations Between Wildfire-Related PM_{2.5} and Intensive Care Unit Admissions in the United States, 2006–2015

Cecilia Sorensen, John A. House, Katelyn O'Dell, Steven J. Brey, Bonne Ford, Jeffrey R. Pierce, Emily V. Fischer, Jay Lemery, James L. Crooks 

First published: 16 March 2021

<https://doi.org/10.1029/2021GH000385>

Wildfire Health Effects – Mortality in Hemodialysis Patients

- Wildfire smoke exposure was positively associated with all-cause mortality among patients receiving in-center hemodialysis.
- A $10\text{-}\mu\text{g}/\text{m}^3$ increase in wildfire $\text{PM}_{2.5}$ associated with a 4% increase in all-cause mortality on the same day and 7% increase cumulatively over 30 days following.
- Risk was elevated following exposure for deaths occurring in nonclinical settings suggesting modification of exposure by place of death.

JASN

JOURNAL OF THE AMERICAN SOCIETY OF NEPHROLOGY

Mortality in US Hemodialysis Patients Following Exposure to Wildfire Smoke

Xi, Yuzhi^{1,2}; Kshirsagar, Abhijit V.³; Wade, Timothy J.⁴; Richardson, David B.²; Brookhart, M. Alan⁵; Wyatt, Lauren¹; Rappold, Ana G.⁴

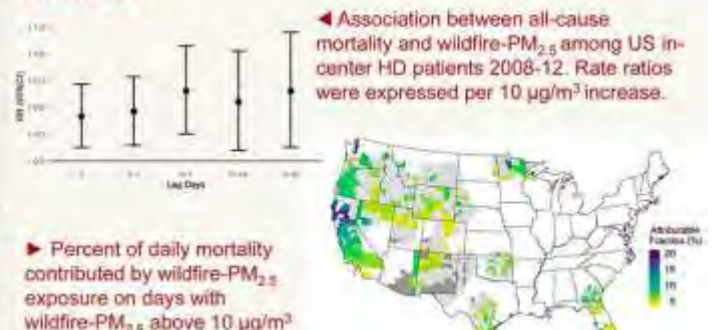
Mortality in US Hemodialysis Patients Following Exposure to Wildfire Smoke

METHODS

- ❖ Time-series regression analysis.
- ❖ N = 48,454 deaths identified with USRDS in hemodialysis patients
- ❖ 253 U.S. counties with dialysis clinics near a major wildfire 2008-2012.



RESULTS



CONCLUSION Exposure to fine particulate matter from wildfire smoke is associated with an immediate and persistent increase in mortality among patients receiving hemodialysis.

Wildfire Health Effects – Cardiac Arrest

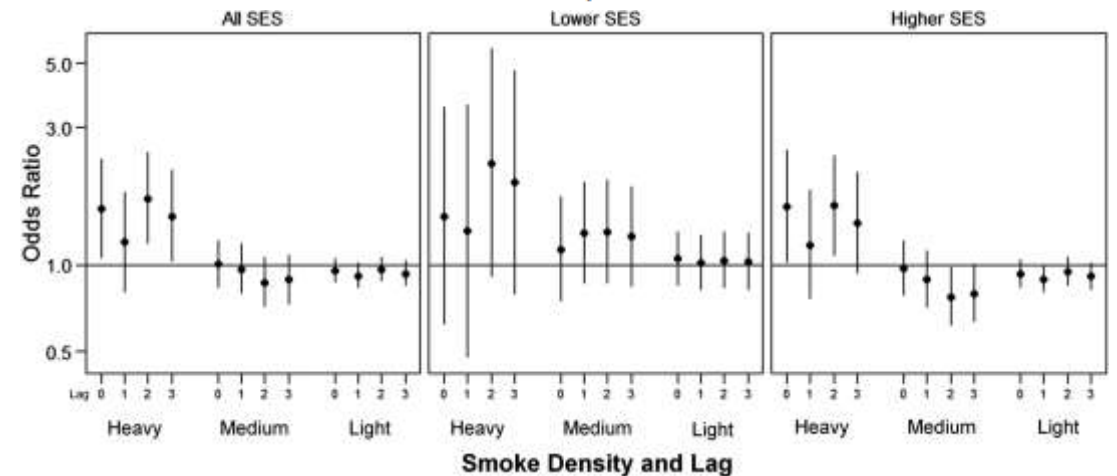
JAHA

Journal of the American Heart Association

Out-of-Hospital Cardiac Arrests and Wildfire-Related Particulate Matter During 2015–2017 California Wildfires

Caitlin G. Jones, Ana G. Rappold, Jason Vargo, Wayne E. Cascio, Martin Kharrazi, Bryan McNally, Sumi Hoshiko and with the CARES Surveillance Group

- Smoke exposures from wildfires likely have the potential to trigger fatal and near-fatal cardiac arrest.
- Risk was the highest on dense smoke days and the effects persisted for several days following the exposure.
- Healthcare professionals and emergency medical service responders may benefit from awareness of these results to counsel patients at increased risk from the adverse health effects of poor air quality and in particular wildfire smoke on ways to limit exposure.



Wildfire Health Effects – Cognitive Function

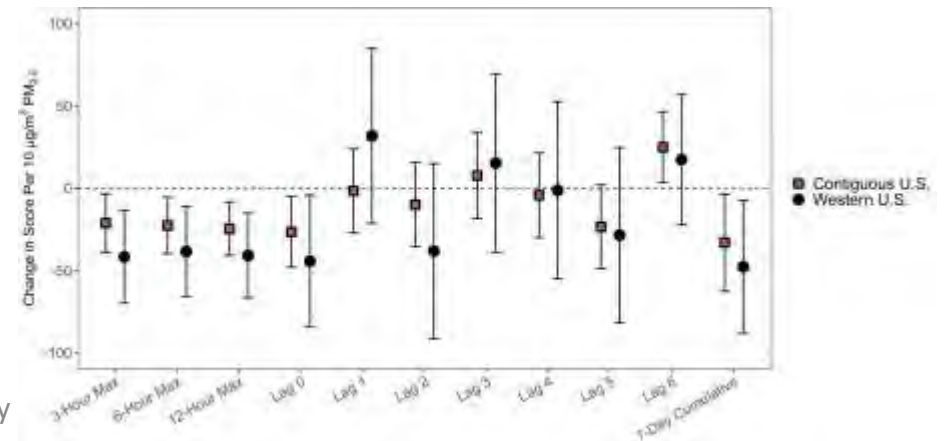
- Found evidence of significant associations between short-term exposure to PM_{2.5} and wildfire smoke and decreased attention in adults, as measured by Lumosity's *Lost in Migration* game
- The strongest associations with PM_{2.5} were observed within a short exposure window, showing that PM_{2.5} is associated with reduced attention within 3 h of exposure.

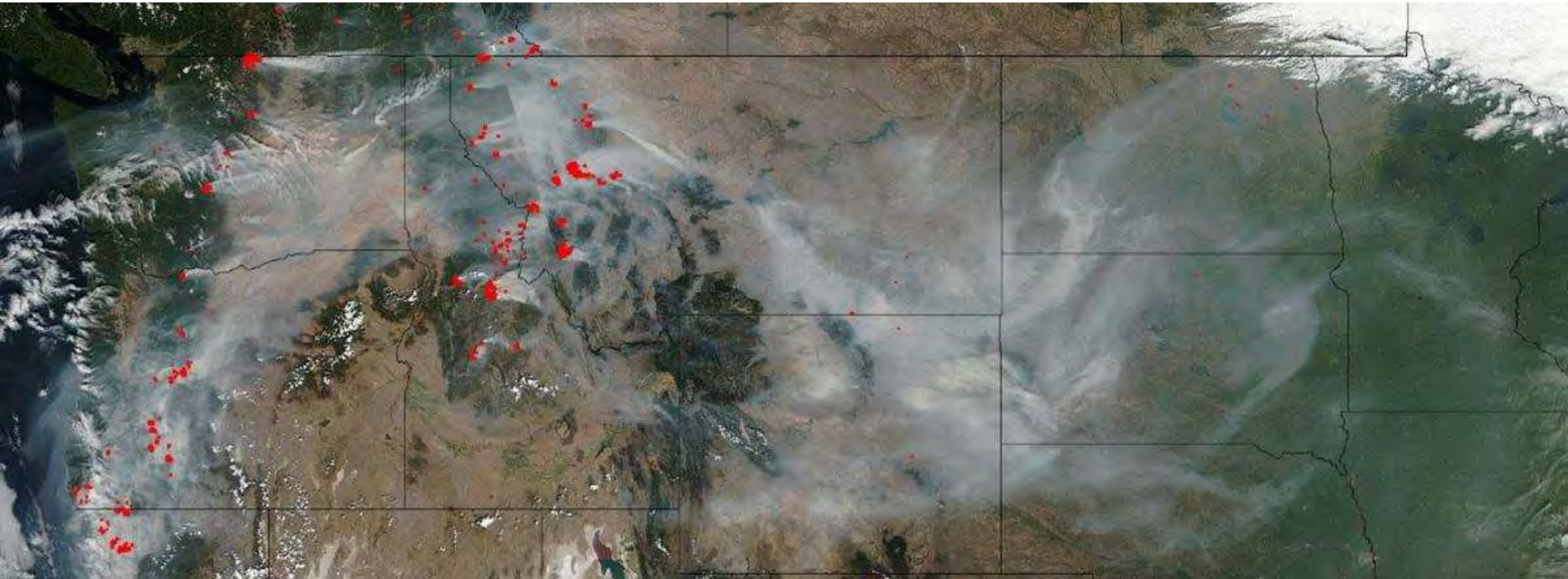


Short-Term Exposure to Wildfire Smoke and PM_{2.5} and Cognitive Performance in a Brain-Training Game: A Longitudinal Study of U.S. Adults

is companion of

Stephanie E. Cleland, Lauren H. Wyatt, Linda Wei, Naman Paul, Marc L. Serre, J. Jason West, Sarah B. Henderson, and Ana G. Rappold





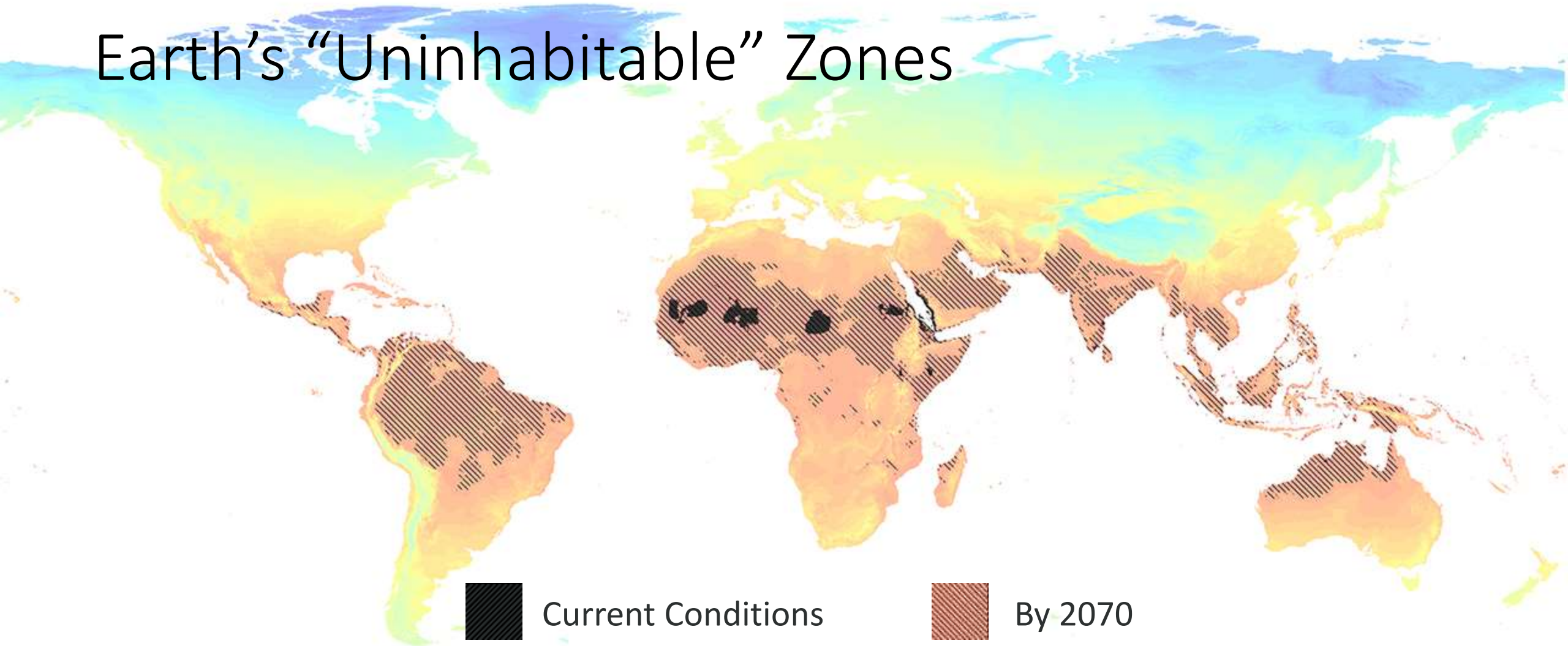
NASA composite satellite image from 11 September 2017, showing fires in the Cascades and Rockies and smoke as far east as the Great Lakes. (Image source Wikipedia; used under Creative Commons attribution-share alike 4.0 international license [user "Bri"]).

Mortality & Morbidity from Smoke Plumes

- 74% of the mortality and asthma morbidity attributable to smoke PM_{2.5} occurs outside the West, due to higher population density in the East.

Heat

Earth's "Uninhabitable" Zones

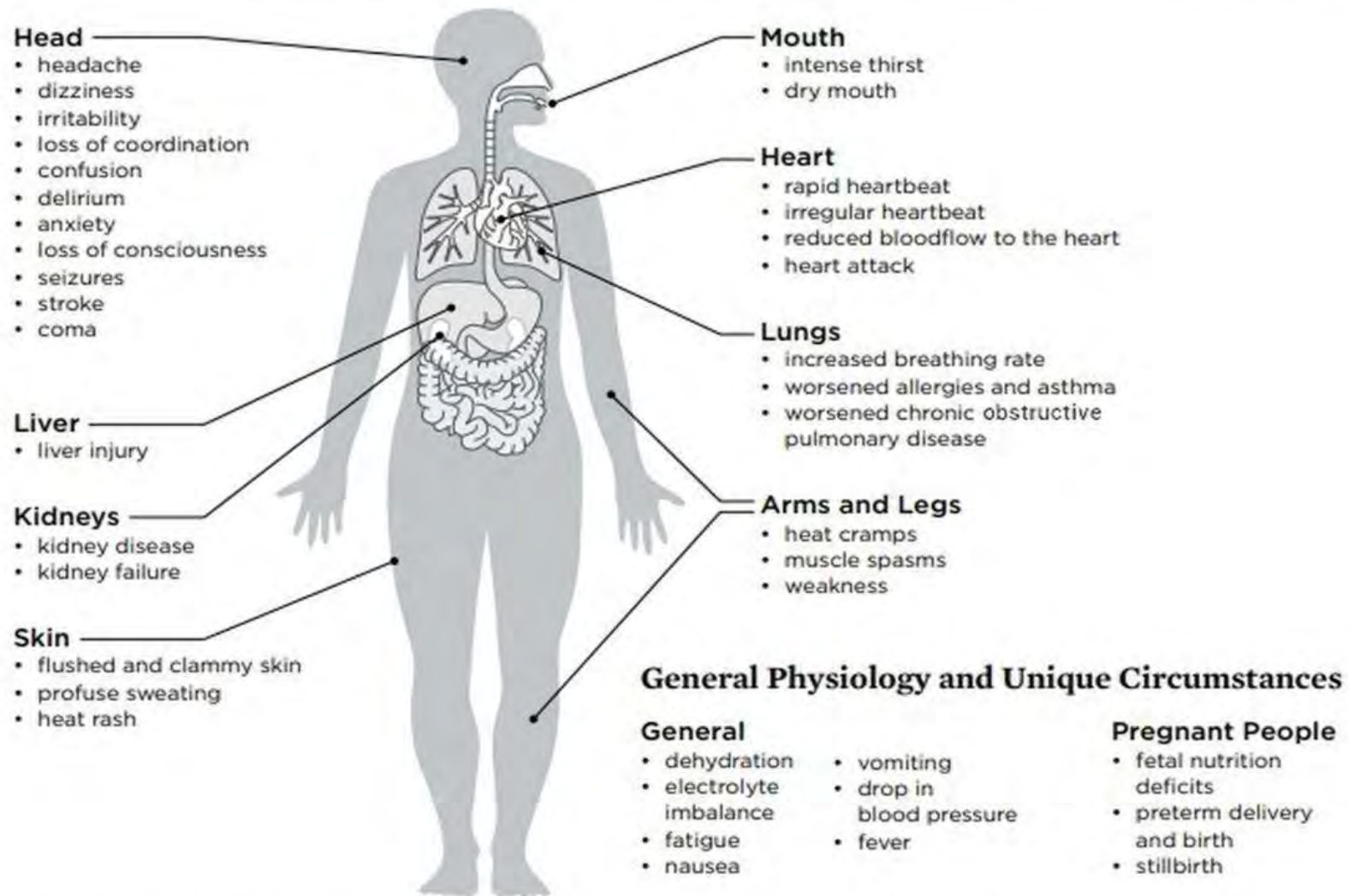


Current Conditions



By 2070

FIGURE 3. How Heat Affects Our Bodies



<https://www.ucsus.org/sites/default/files/attach/2019/07/killer-heat-analysis-full-report.pdf>

When temperature and humidity climb during extreme heat events, the body's cooling mechanisms become less effective. The symptoms shown here—ranging from minor annoyances to truly life-threatening issues—include both those that are indicative of heat-related illness and those that are signs of pre-existing conditions exacerbated by extreme heat.

SOURCES: BASU ET AL. 2012; BECKER AND STEWARD 2011; CURRIERO ET AL. 2002; DONOGHUE ET AL. 1997; GARCÍA-TRABANINO ET AL. 2015; GLAZER 2005; LUBER AND MCGEEHIN 2008; LUGO-AMADOR, ROTHENHAUS, AND MOYER 2004; AND SEMEZA ET AL. 1999.

Bekkar, B., Pacheco, S., Basu, R., Basu, R., & Denicola, N. (2020). Association of Air Pollution and Heat Exposure with Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review. *JAMA Network Open*, 3(6), 1–13.
<https://doi.org/10.1001/jamanetworkopen.2020.8243>

Table. Summary of Evidence Key Questions 1 Through 6

Exposure and outcome	Studies finding an association, No./total No.	Births/study, mean (SD)	Total births in millions	Increased risk, median (range), % ^a	Studies finding racial disparity, No./total No.	Notable findings ^b
Air pollution						
Preterm birth	19/24	318 960 (393 272)	7.3	11.5 (2.0-19.0) ^c	10/19	Preterm birth risk increased 52% for asthmatic mothers
Low birth weight	25/29	661 205 (878 074)	18.5	10.8 (2.0-36.0) ^c	13/25	Low birth weight risk increased 3% for each 5-km proximity to a solid waste plant
Stillbirth	4/5	1 020 975 (1 176 174)	5.1	14.5 (6.0-23.0) ^c	1/4	Stillbirth risk increased 42% with high third-trimester exposure
Heat						
Preterm birth	4/5	192 625 (207 995)	0.8	15.8 (9.0-22.0) ^d	2/4	Preterm birth risk increased 11.6% per 5. °C increase
Low birth weight	3/3	902 277 (985 803)	2.7	31.0 (13.0-49.0) ^d	1/3	Term birth weight decreased 16 g per IQR temperature increase
Stillbirth	2/2	115 943 (115 933)	0.2	NA ^e	2/2	Stillbirth risk increased 6% per 1 °C increase the week before delivery during the warm season

Abbreviations: IQR, interquartile range; NA, not applicable.

^a Risk presented as range from significant studies. The median is calculated from the range; a pooled analysis was not performed. For consistency, the whole pregnancy exposure was presented where possible.

^b Single study unless specified.

^c For whole pregnancy PM_{2.5} exposure.

^d For whole pregnancy heat exposure.

^e The only 2 studies on heat and stillbirth did not provide comparable outcomes that could be combined into a range with a median.

Mechanisms: Heat

Preterm Birth

- Dehydration via prostaglandin or oxytocin release
- Altered blood viscosity
- Inefficient thermoregulation
- Preterm premature rupture of membranes during the warm season.

1. Wolfenson. Secretion of PGF2alpha and oxytocin during hyperthermia in cyclic and pregnant heifers. *Theriogenology*. 1993;39(5):1129-1141.
2. Bouchama. Heat stroke. *N Engl J Med*. 2002;346(25):1978-1988.
3. Stan. Hydration for treatment of preterm labour. *Cochrane Database Syst Rev*. 2002;(2)
4. Ha. Acute associations between outdoor temperature and premature rupture of membranes. *Epidemiology*. 2018;29(2):175-182.

Bekkar B, Pacheco S, Basu R, DeNicola N. Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review. *JAMA Netw Open*. 2020;3(6):e208243.

Fetal Growth Restriction

- Reducing uterine blood flow
 - Altering placental-fetal exchange
1. Stan. Hydration for treatment of preterm labour. *Cochrane Database Syst Rev*. 2002;(2)
 2. Prada. Biological mechanisms of environmentally induced causes of IUGR. *Eur J Clin Nutr*. 1998;52
 3. Browne. Uterine artery blood flow, fetal hypoxia and fetal growth. *Philos Trans R Soc Lond B Biol Sci*. 2015;370(1663)

Stillbirth

- Premature labor
 - Lowering amniotic fluid volume
 - Damaging the placenta
 - Abruption
1. Li . Hot tub use during pregnancy and the risk of miscarriage. *Am J Epidemiol*. 2003;158(10):931-937
 2. He. Heat and pregnancy-related emergencies: risk of placental abruption during hot weather. *Environ Int*. 2018;111:295-300

Infectious Diseases

Tropical Diseases on the Move



West Nile Virus

Chikungunya

Cryptococcus Gattii Fungus

Zika Virus

Rift Valley Fever

Chagas Disease

Dengue Fever

Food Security: Quantity & Quality



(Mal)Nutrition

Is Food
Present?
Adequate?
Affordable?

- ▶ Over 3 million children a year die from hunger - 1/3 of pediatric deaths (WHO)
- ▶ 10% people on earth lack adequate food to lead a healthy lifestyle (WHO, 2021)
- ▶ 12% of Americans are food insecure (USDA, 2016)

Food insecurity has been associated with:
a greater risk of asthma and other chronic health conditions
low birth weight decreased learning obesity
depression anxiety misconduct

Seligman, H. Food Insecurity Is Associated with Chronic Disease among Low-Income NHANES Participants.

J Nutr. 2010



Projected Yield Declines For Each 1° C of Warming



These four crops make up two-thirds of human caloric intake.

Data: Chuang Zhao, et al., "Temperature increase reduces global yields of major crops in four independent estimates," *PNAS*, August 29, 2017.

Images: [Corn:] © EggHeadPhoto/Shutterstock; [Wheat:] © AlenKadr/Shutterstock; [Rice:] © ekotamak/Shutterstock; [Soy:] © Jiang HongYan/Shutterstock



Rising concentrations of CO₂ are threatening global nutrition by reducing levels of nutrients (including zinc, iron, copper, magnesium and calcium) in food crops like rice, wheat and soybeans.

• The Untold Story: Displacement

- Pictured: Alaska



<http://www.npr.org/sections/thetwo-way/2016/08/18/490519540/threatened-by-rising-seas-an-alaskan-village-decides-to-relocate>

Wildfire and counseling

Surgical masks also offer 60-70% protection with a snug fit.

Cloth masks offer no benefit for wildfire smoke.

Three Key Factors Required for a Respirator to be Effective

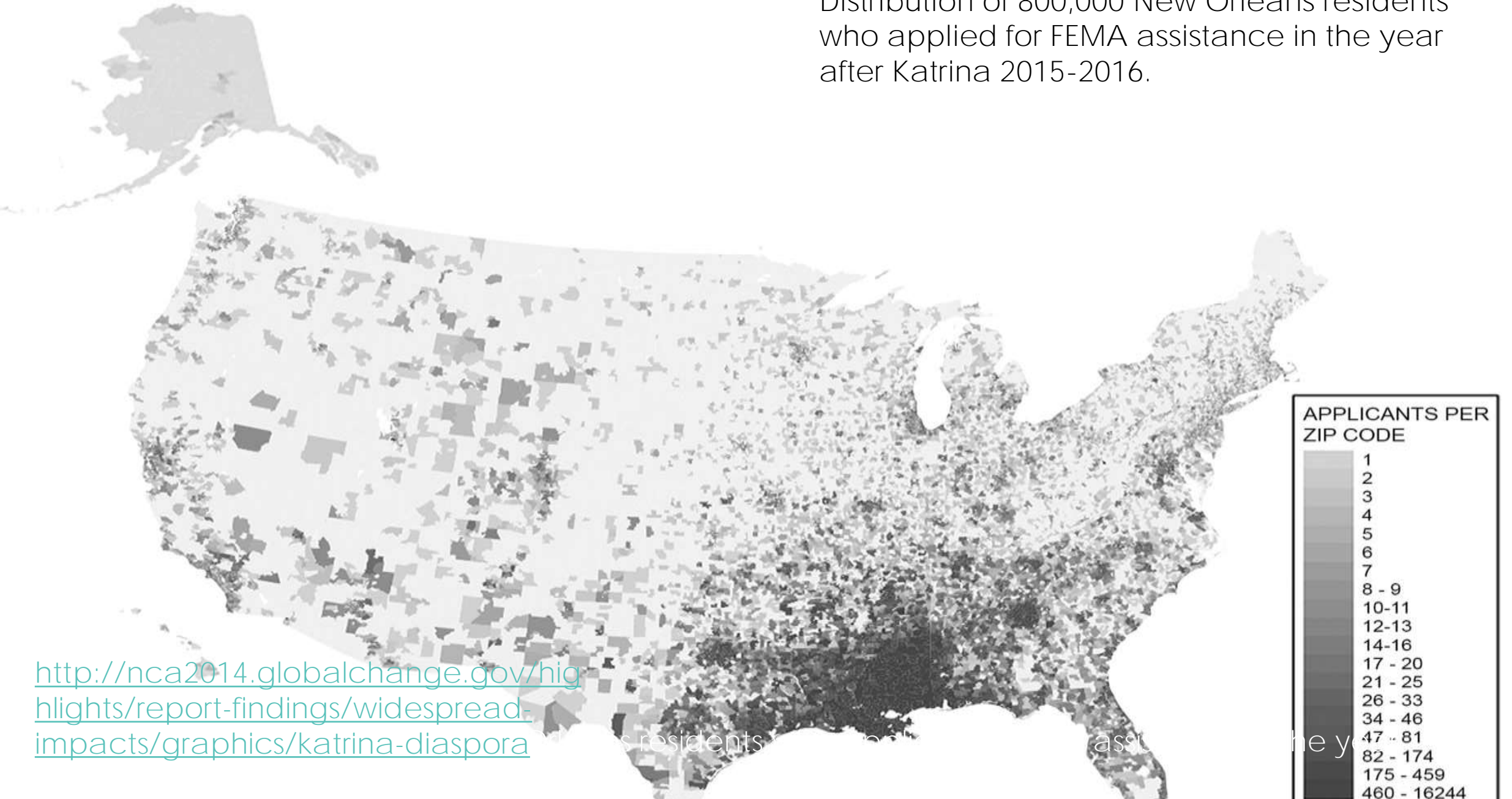
Correct* **Incorrect**

- ① The respirator must be put on correctly and worn during the exposure.
- ② The respirator must fit snugly against the user's face to ensure that there are no gaps between the user's skin and respirator seal.
- ③ The respirator filter must capture more than 95% of the particles from the air that passes through it.

*If your respirator has a metal bar or a molded nose cushion, it should rest over the nose and not the chin area.

- There are now KN-95 respirators on the market for children. KN95s are often NOT NIOSH approved.
- An older child (usually >7) using an adult small N-95 can reduce their exposure to PM2.5 by 80%
- Signs of a poor fit include
 - Feeling movement of air on your face along the seal of the respirator
 - Fogging of your glasses
 - Lack of pressure being built up inside the respirator on exhalation.

Distribution of 800,000 New Orleans residents who applied for FEMA assistance in the year after Katrina 2015-2016.



<http://nca2014.globalchange.gov/highlights/report-findings/widespread-impacts/graphics/katrina-diaspora>

United States: Internal Displacement

- 2022: 3.4 million people forced to evacuate their homes due to natural disasters (US Census Bureau)
- 2008-2021: average 800,000/yr displaced by disasters (Internal Displacement Monitoring Centre)
- 2022: 40% return home in one week; 12% remain displaced for 6 months; ~16% never return home (US Census Bureau)



<https://www.pexels.com/photo/homes-destroyed-by-war-11797375/>



• Mental Health



<https://image.shutterstock.com/image-photo/silhouette-man-feeling-sad-worried-260nw-2130636083.jpg>

- **Violent behavior, suicide, alcohol and substance abuse all increase with increased heat.**
- **PTSD, anxiety, and depression are common after severe weather events.**
- **Some psychotropic medicines interfere with heat regulation**
- **Solastalgia, eco-anxiety**

Wildfires and mental health

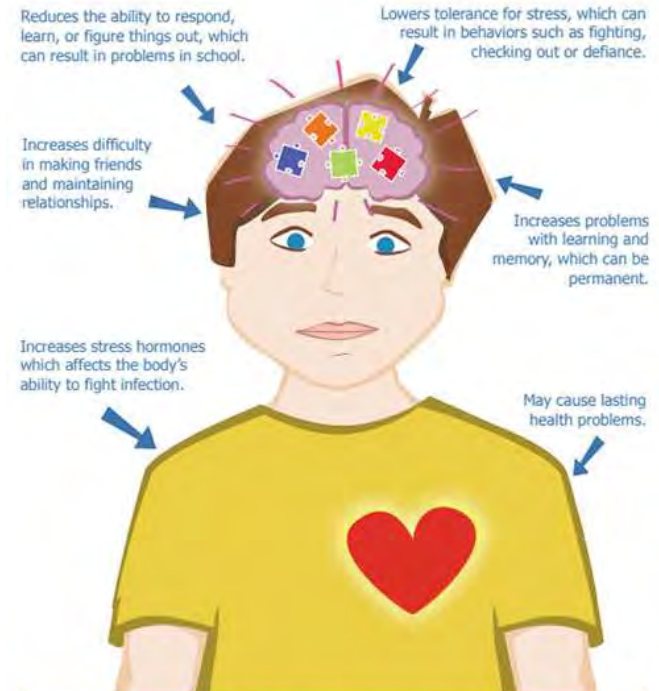
Children need safe, stable, and nurturing environments to thrive. Disasters (particularly recurrent ones like hurricanes/wildfires) expose children repeatedly to these events.

Worsening disasters due to climate change threaten both the long-term physical and mental health of children



How do ACEs affect health?

Through stress. Frequent or prolonged exposure to ACEs can create toxic stress which can damage the developing brain of a child and affect overall health.



A Survival Mode Response to toxic stress increases a child's heart rate, blood pressure, breathing and muscle tension. Their thinking brain is knocked off-line. Self-protection is their priority. In other words: "I can't hear you! I can't respond to you! I am just trying to be safe!"

Climate crisis and mental health

“The will to survive and endure can be the deciding factor between a child who overcomes adversity and thrives and a child who never makes it to adulthood. But how long can we ask people born in the wrong ZIP code to “rise above” and persevere in circumstances beyond their control, no matter how central the idea of overcoming is to our archetypal American identity?”

- *Dr. Mona Hanna-Attisha “I’m sick of asking children to be resilient.”
New York Times, 5/12/20*

ipcc

INTERGOVERNMENTAL PANEL ON climate change

Climate Change 2022

Impacts, Adaptation and Vulnerability

Summary for Policymakers



WGII

Working Group II contribution to the
Sixth Assessment Report of the
Intergovernmental Panel on Climate Change



U.S. Global Change
Research Program

Fourth National Climate Assessment

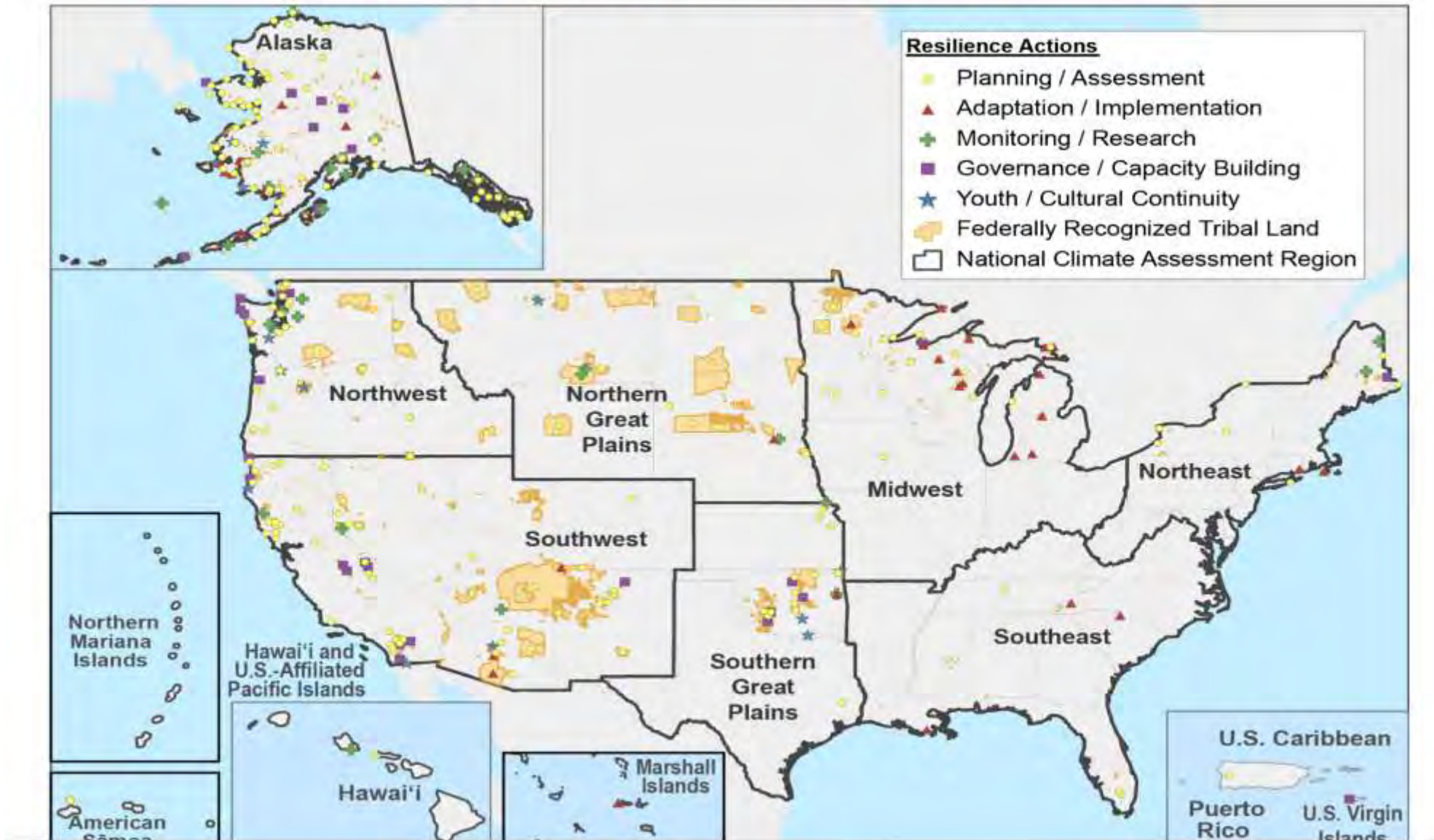


Volume II

Impacts, Risks, and Adaptation in the United States

(U.S.)

Indigenous Peoples' Climate Initiatives and Plans



MAP: NCA4
https://nca2018.globalchange.gov/downloads/NCA4_Ch15_Tribes-and-Indigenous-Peoples_Full.pdf



https://thenaturalhistorymuseum.org/wp-content/uploads/2019/11/https___cdn.ev buc_.com_images_78846361_301788313360_1_original.jpeg



PHOTO: PHOTO:
<https://www.wlu.ca/academics/research/reports/gnwt-report/assets/images/banners/scotty-creek-sign.jpg>



<https://travelyourway.net/wp-content/uploads/2019/02/the-arctic-national-wildlife-refuge-is-the-new-bears-ears.jpg>



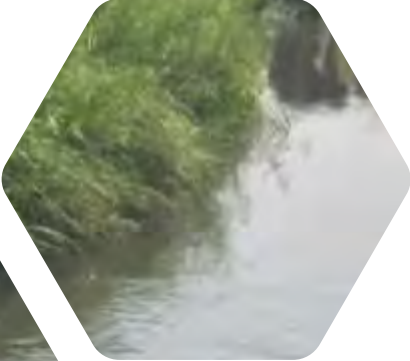
<https://www.atlasobscura.com/articles/indigenous-research-conservation-canada-arctic>



<https://ensia.com/features/traditional-ecological-knowledge-megafire-forest-fire-california-drought/>



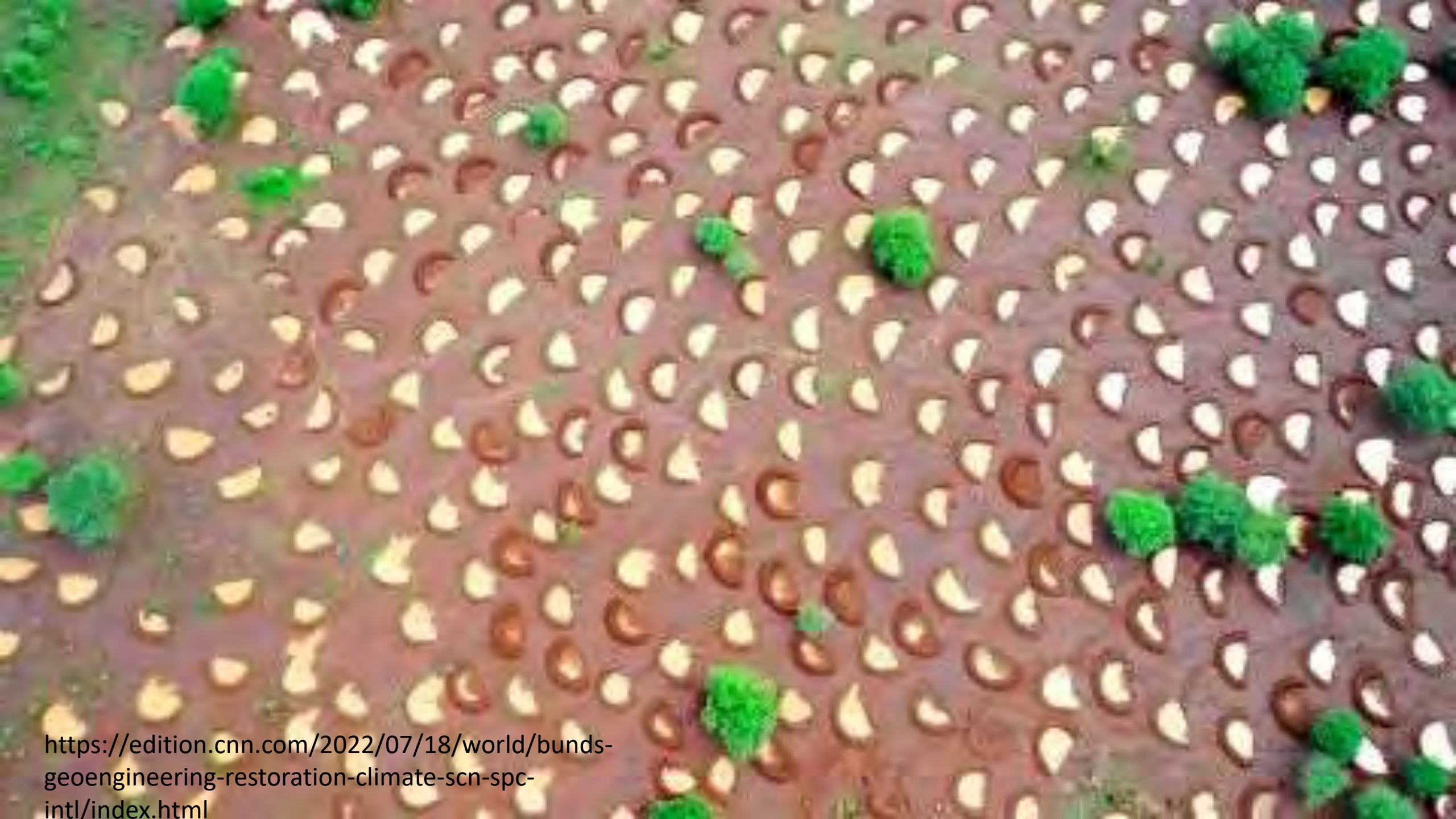
C2H2 Video, Montana <https://www.youtube.com/watch?v=2k5-IVNUpP4>



<https://blackfeetclimatechange.com/what-kind-of-future-do-we-want/the-blackfeet-nation-is-adapting/ksik-stakii/>



<https://edition.cnn.com/2022/07/18/world/bunds-geoengineering-restoration-climate-scn-spc-intl/index.html>



<https://edition.cnn.com/2022/07/18/world/bunds-geoengineering-restoration-climate-scn-spc-intl/index.html>



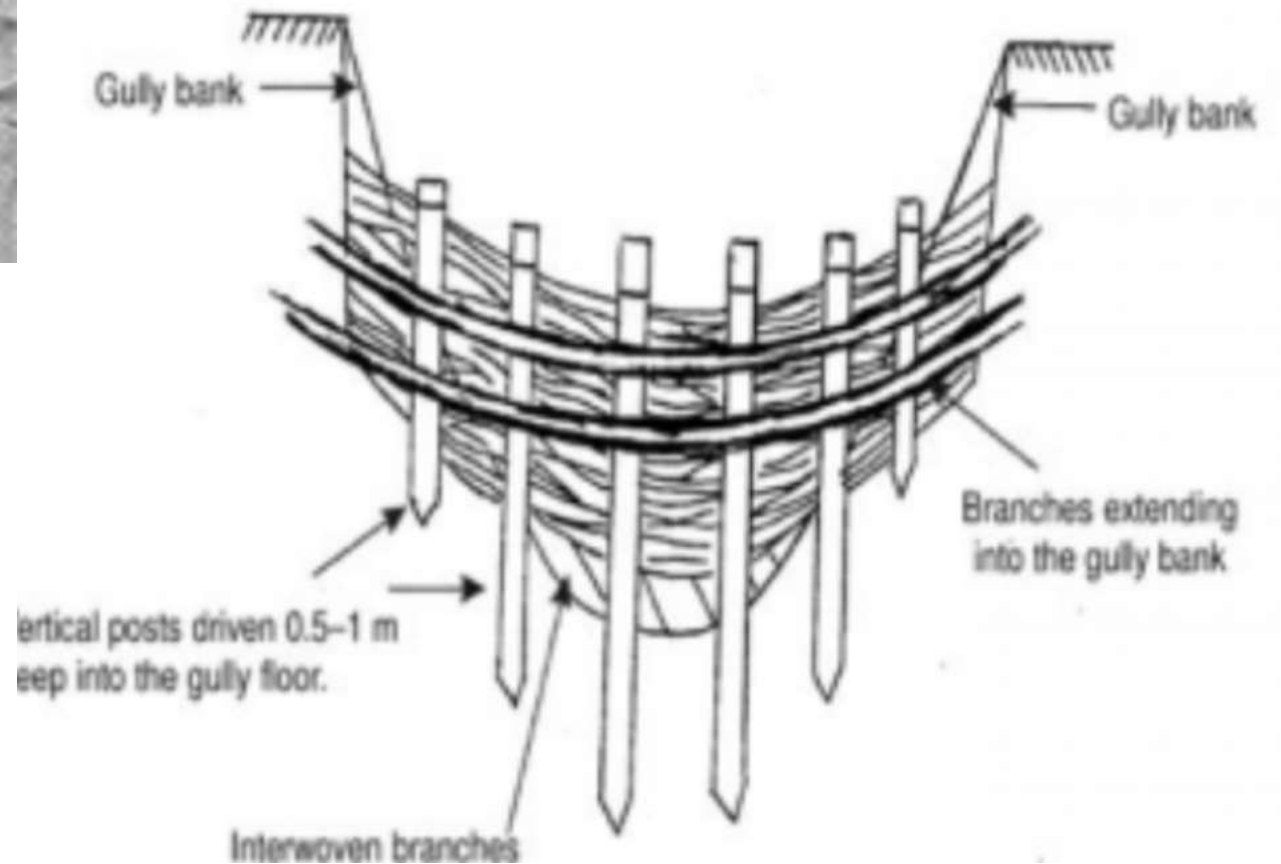
<https://edition.cnn.com/2022/07/18/world/bunds-geoengineering-restoration-climate-scen-spc-intl/index.html>



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<https://edition.cnn.com/2022/07/18/world/bunds-geoengineering-restoration-climate-scn-spc-intl/index.html>



Source: Norton, J. B., Borannie Jr., F., Peynetsa, P., Quandelacy, W., and Siebert, S. F. (2002). Native American methods for conservation and resotration for semiaric ephemeral streams. Journal of Soil and Water Conservation. 57 (2). Online: <http://www.uwyo.edu/esm/faculty-and-staff/jay-norton/papers/norton3.pdf>



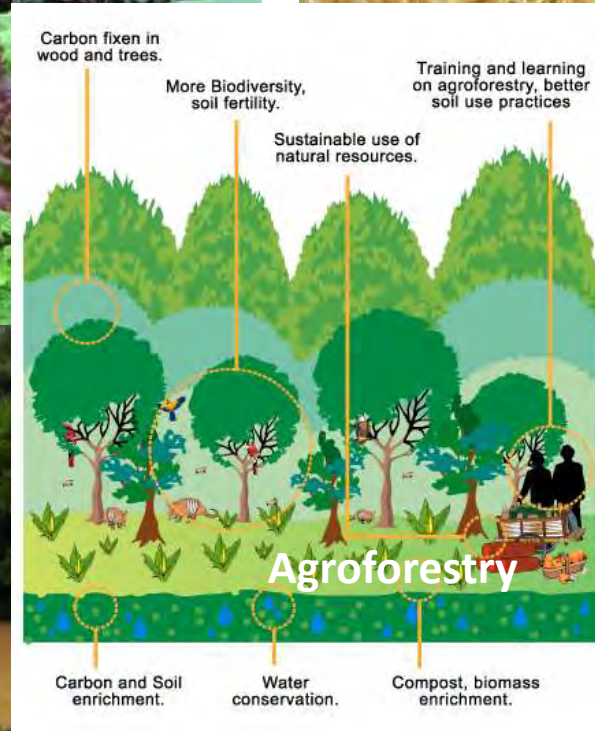
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-
- **”If indigenous peoples had the same level of access to land and resources in finance that non-indigenous peoples have in agriculture, my hypothesis is that there would actually be greater production of food.”**
 - **Mikaila Way, Leader of FAO’s indigenous peoples’ unit in North America.**



<https://c8.alamy.com/comp/J2HER0/buffalo-herd-roams-on-the-great-plains-of-the-blackfoot-nation-reservation-J2HER0.jpg>



Polyculture. <https://familyfoodgarden.com/wp-content/uploads/2016/03/polyculture-e1457894521563.jpg>

[The Mesoamerican Permaculture Institute](https://www.ecoideaz.com/wp-content/uploads/2016/08/Pioneers-of-Rainwater-Harvesting-in-India-Ayyappa-Masagi-3.jpg?fit=1200%2C675&ssl=1) (*Instituto Mesoamericano de Permacultura*, IMAP) is a Mayan-run, Mayan owned nonprofit organization in Guatemala

Rainwater harvesting. <https://i0.wp.com/www.ecoideaz.com/wp-content/uploads/2016/08/Pioneers-of-Rainwater-Harvesting-in-India-Ayyappa-Masagi-3.jpg?fit=1200%2C675&ssl=1>

Crop Rotation. <https://qph.fs.quoracdn.net/main-qimg-e31fbd06f9cc0347b962dfd67aff251>

Intercropping. <https://agragamee.org/wadi-tribal-development-project/>



<https://media.istockphoto.com/photos/nature-picture-id959600898?k=6&m=959600898&s=612x612&w=0&h=VviuldGsCRZzuFdv0pb6lJSof4OrQVZRMiYPT2DgAfo=>



- [https://il3.picdn.net/shutterstock/videos/2709983/thumb/1.jpg?i10c=img.resize\(height:160\)](https://il3.picdn.net/shutterstock/videos/2709983/thumb/1.jpg?i10c=img.resize(height:160))
- <https://www.sjdhomes.com.au/z-range/>





https://www7.nau.edu/itep/main/tcc/images/tribes/img_SWjemezPrjMap.jpg



INDIGENOUS
ENERGY INITIATIVE

CLIMATE
CHANGE
IS REAL

WE ARE NOT



OVARY-ACTING



Doing
something
makes us feel
better.

(even when our side does not 'win')

P



https://animals.sandiegozoo.org/sites/default/files/inline-images/polar_bear_cub_1.jpg



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<https://thumbs.dreamstime.com/z/happy-kids-painted-hands-smiling-posing-white-background-funny-children-international-children-s-day-indian-asian-72977489.jpg>

101
12

Human Health has replaced the polar bear and has become the new face of climate change.

<https://pricetags.ca/wp-content/uploads/2019/02/healthy-communities.jpg>



Everything done to lower emissions and decrease air pollution improves human health!

- Sustainable agriculture/farmers markets – healthier for people and the planet
- Transition to renewable energy
- Improvement in public /shared transportation, increased walkability and bikeability
- Planting trees – removes air pollution, decreases water runoff, stores carbon, improves our mental and physical health.

Climate Change Poses Risks but provides Opportunities Related to Health



- The 2015 *Lancet Commission on Climate Change and Health* report stated: “The effects of climate change are being felt today, and future projections represent an unacceptably high and potentially catastrophic risk to human health.”
- BUT it also underscored:
Tackling climate change could be the greatest global health opportunity of the 21st century.



AMA adopted a new
policy declaring
climate change a
public health crisis
In June 2022



Alliance of Nurses for Healthy Environments

▶ WHO WE ARE

- ▶ The Alliance of Nurses for Healthy Environments (ANHE) is the only national nursing organization focused solely on the intersection of health and the environment.

<https://envirn.org>



The Medical
Society Consortium
ON CLIMATE & HEALTH

**Umbrellas about 30 major medical societies
– AAP , ACOG, ACP, MMA to work on climate
issues together**

<https://medsocietiesforclimatehealth.org/about/>

Global Consortium on Climate Health Education(GCCHE)



 COLUMBIA | MAILMAN SCHOOL
OF PUBLIC HEALTH
GLOBAL CONSORTIUM ON
CLIMATE AND HEALTH EDUCATION

Global Consortium on Climate and Health Education



gcche.mailman.columbia.edu

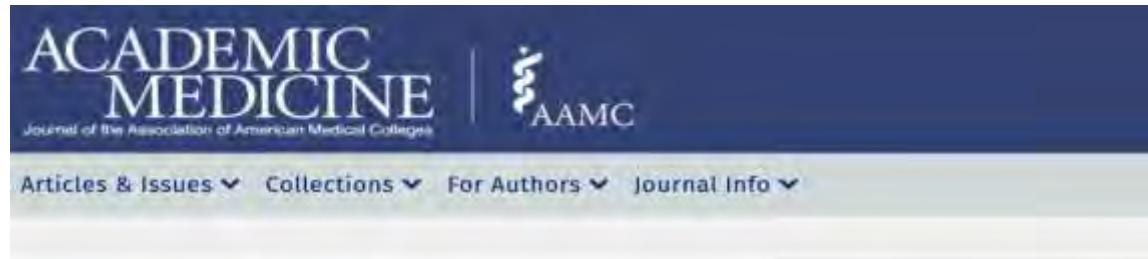


AAP Chapter Climate Advocates Before and After Data (36 m)

- Resolutions: 1
- Committees: 1
- Legislative Blueprints contain energy/climate concerns: 0
- Resolutions: 21, several in process
- *Committees: 28, several in process
- Website Presence: 19
- E-newsletters: many
- EH/CC in annual meeting: 5
- Legislative Blueprints contain energy/climate concerns: 11

Education Sub-Committee

- Research on what parent's want
- Patient-facing materials
- Physician-facing materials
- Medical School and Residency Curricula
- Board Inclusion



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ARTICLE: PDF ONLY

Climate Change and the Practice of Medicine Essentials for Resident Education

Phillipsborn, Rebecca Pass MD, MPA; Sheffield, Perry MD, MPH; White, Andrew MD; Osta, Amanda MD; Anderson, Marsha S. MD; Bernstein, Aaron MD, MPH [Author Information](#)

Academic Medicine: September 8, 2020 - Volume Publish Ahead of Print - Issue -

doi: 10.1097/ACM.00000000000003719 [Add to Library](#) [Get PDF](#)

Impact of Climate Change on Pediatric Health Care

Sponsor: American Board of Pediatrics

This activity contains 20 article-based self-assessment questions that address how climate change is affecting pediatric health care and highlights the disproportionate impact climate change has on communities of color.

Bookmark Activity

MOC Points: 10

Cost: Contact sponsor

Eligible for CME Credit

Expires: Jun 08, 2024

[View](#)



Desflourane, a common anesthesia gas, is 2500 x as potent as CO₂, very expensive, and can be recycled



The U.S. Healthcare System contributes 8-10% of our carbon emissions

One doctor in Portland OR saved his hospital \$1M the first year they focused on sustainability

One pediatrician got several hundred docs to sign on to sustainability, resulting in Seattle Children's making the strongest climate commitment of any hospital to date

17,000 Hospitals are part of HCWH

<https://www.noharm.org>


<https://practicegreenhealth.org>



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100's of practices**

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A large, circular industrial fan with a metal mesh cage is the central focus of the image. It is mounted on a ceiling. In the foreground, a man in a dark shirt is sitting on a red metal chair, looking towards the fan. In the background, several other people are visible, including a man in a light blue shirt and a woman in a red shirt. The setting appears to be a large, open-plan community center or a cooling center with high ceilings and large windows.

Clean air centers and cooling centers

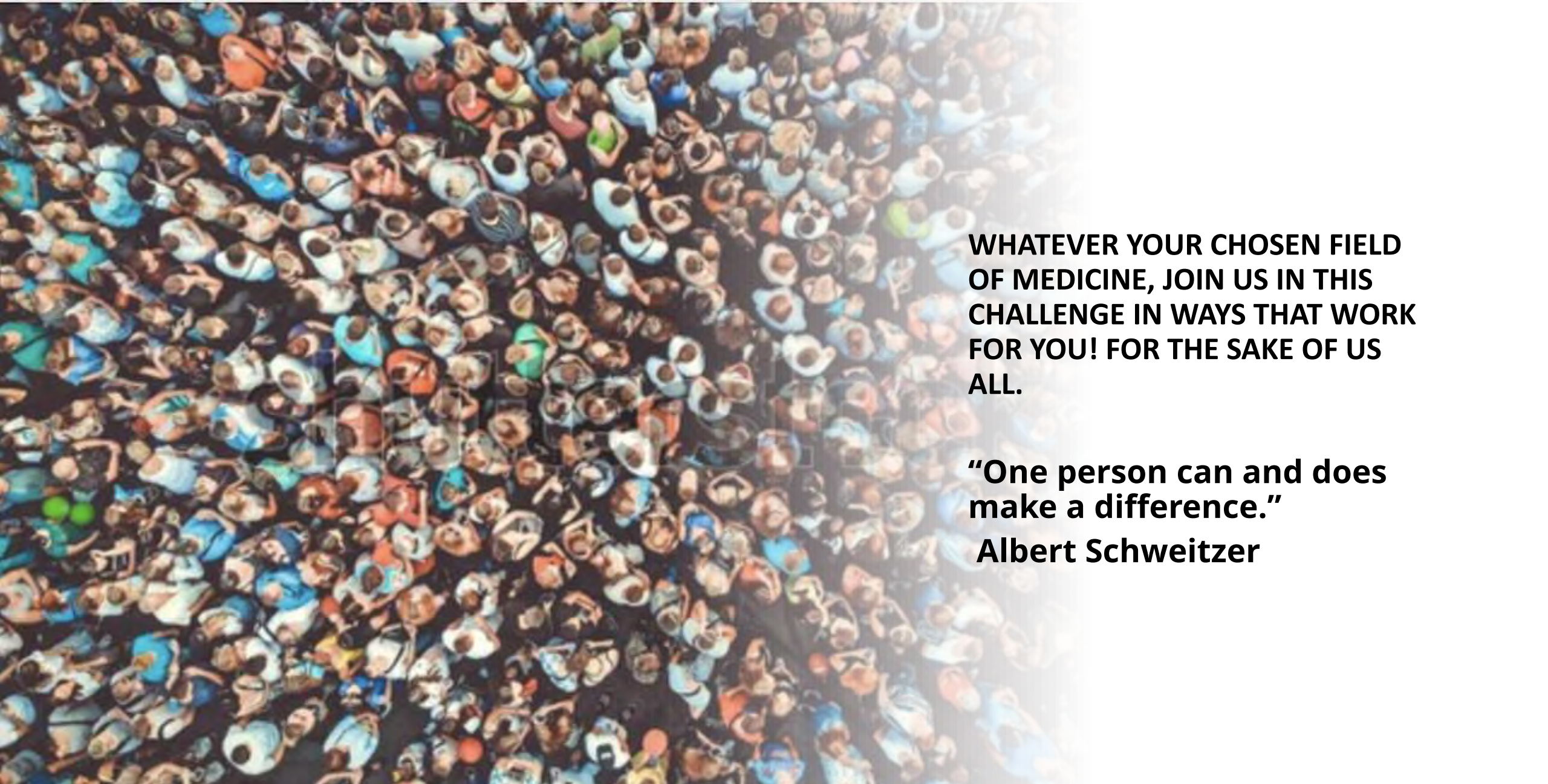
<https://wtop.com/wp-content/uploads/2017/06/cooling-centers.jpeg>



PHOTO: <https://www.airnow.gov/sites/default/files/inline-images/AirNowApp.png>

https://img.thrfun.com/img/234/197/make-your-own-box-fan-air-filter_tx3.jpg





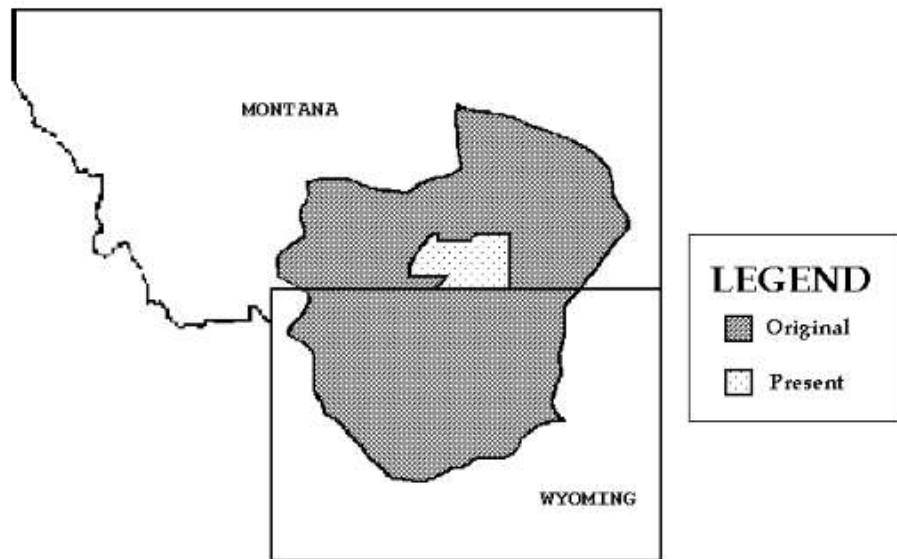
**WHATEVER YOUR CHOSEN FIELD
OF MEDICINE, JOIN US IN THIS
CHALLENGE IN WAYS THAT WORK
FOR YOU! FOR THE SAKE OF US
ALL.**

**“One person can and does
make a difference.”
Albert Schweitzer**

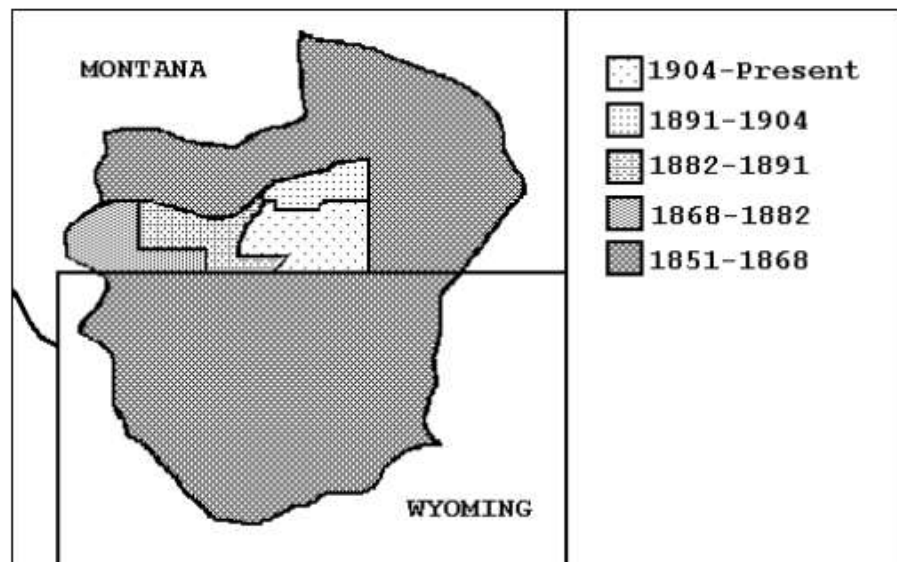
Crow Water, Community Health, and Climate Change

JoRee LaFrance

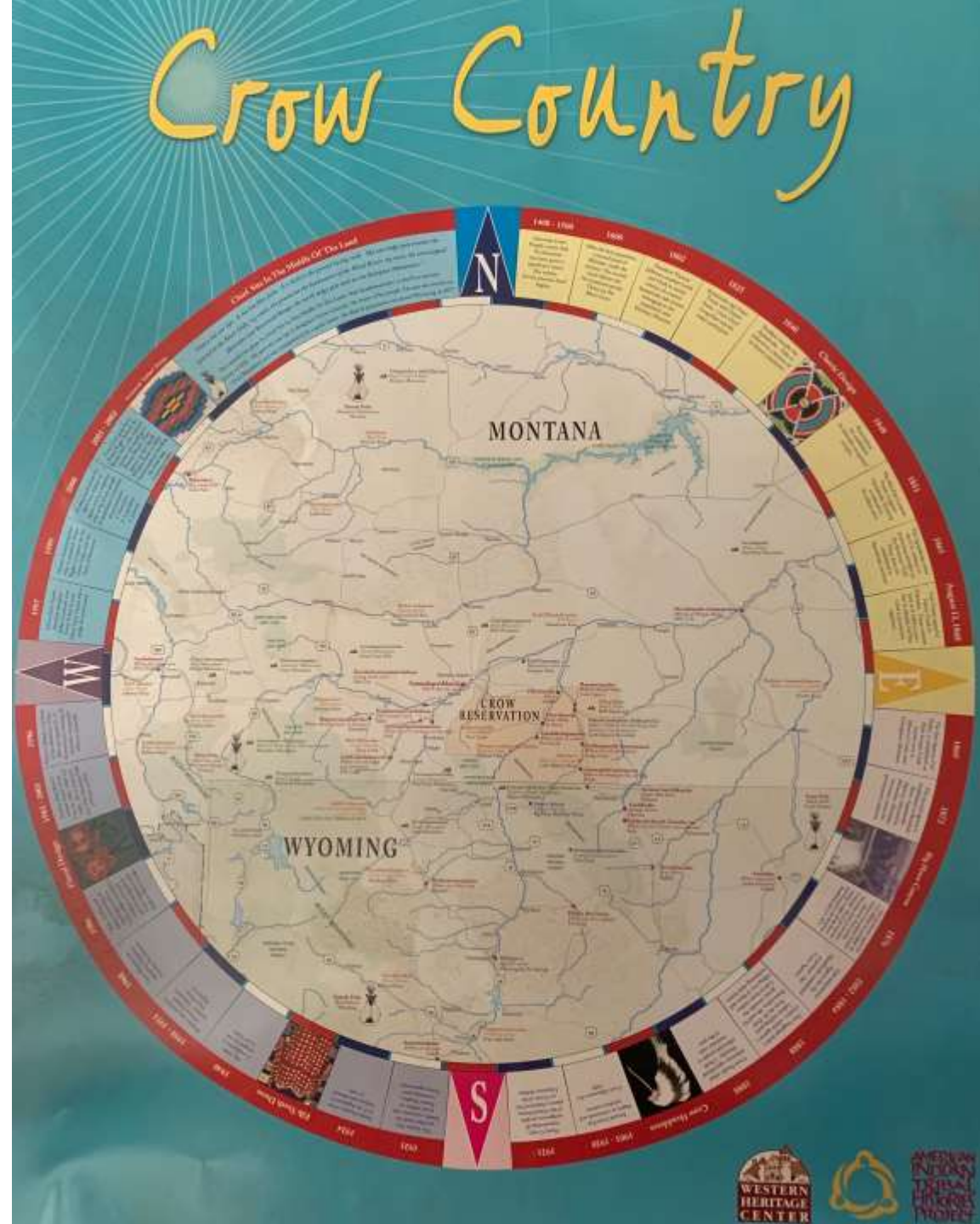




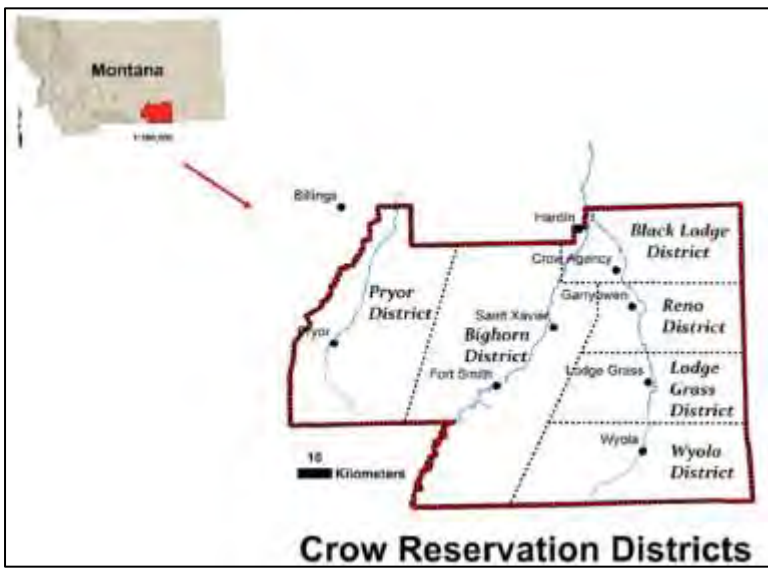
Map 1: Original Apsáalooke land holdings and present reservation



Map 2: Apsáalooke lands reduced by treaties and agreements



Apsáalooke



Methodology

Support



Collection



Sensor



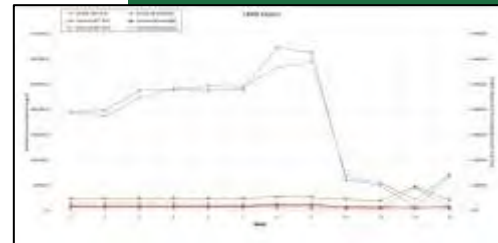
Processing



Communication

Sources	Health Risks	Protection
<ul style="list-style-type: none">Found in private wells and surface waters on Crow ReservationAbandoned mining sitesNaturally occurring in rocksConsequence of fertilizer application	<ul style="list-style-type: none">Can be inhaled, ingested or absorbed through skinLinked to diabetesCan cause cancerDamage kidneysCan cause bone problemsCan cause lung cancer from breathing in dust	<ul style="list-style-type: none">Test drinking water for uranium contaminationFilter drinking water if drink filtered water/bottled waterReach out to neighbors for water testing (CHSC or MJD, Boseman Well Water Education Program)Support local efforts

Results



Analysis



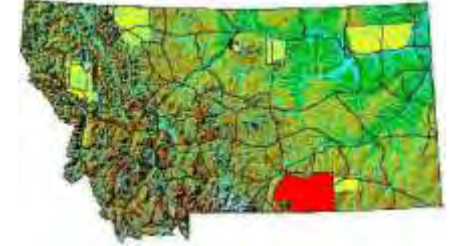




Crow Environmental Health Steering Committee 2005 – present



*Addressing our Tribal Environmental Health
Priorities: Water & Community Health*





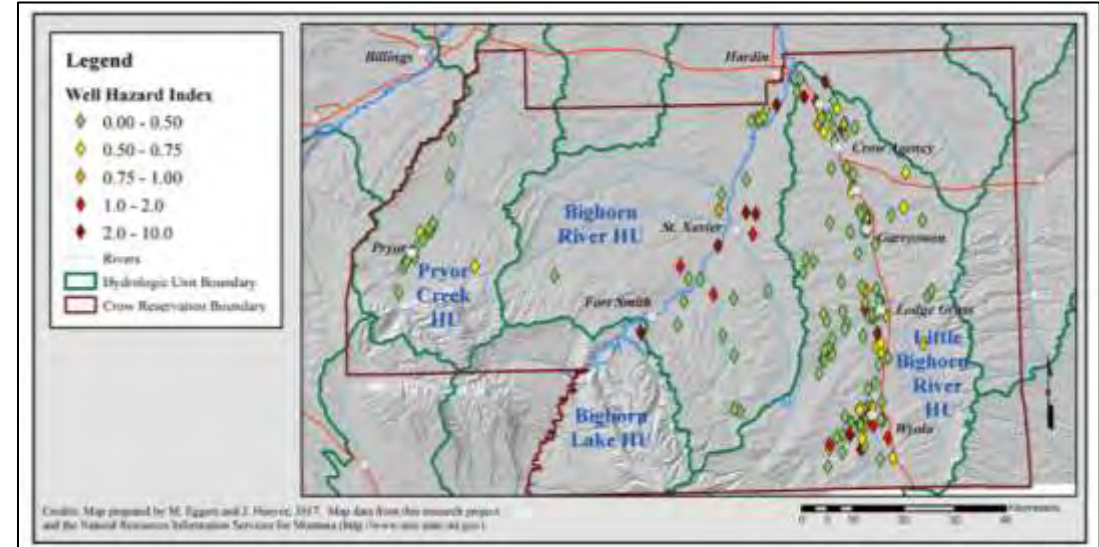
The CEHSC researches home wells, surface water, as well as the impacts of climate change on water and health. We work to increase families' access to safe drinking water.



Water and Community Health Challenges



Spring flooding, late summer drought



Cumulative health risk from uranium, arsenic, nitrate and manganese in home well water



Failing home plumbing, including wells and septic systems



Deteriorating public water and wastewater infrastructure.

Absence of Climate Change Adaptation Planning

There is no planning for climate change impacts of increased spring flooding, worsening summer droughts, wells drying up nor municipal surface water sources being entirely depleted by increased irrigation:

- Summer '22: Home wells are drying up, leaving families to haul water for all uses.
- Surface water source for our largest town's public water supply is close to drying up entirely in late summer.



The Indian Health Service Hospital was closed for months when spring flooding swamped the public water supply lift station located in an old river oxbow.

Poor Environmental Enforcement

- Below the ground surface, there is a dumping ground resulting from a century of neglect and abandonment.
- Cleaning up unanticipated underground hazards is costly and delays water line installation schedules.
- Severe microbial contamination of the river during spring runoff challenges the water treatment plant.



Abandoned underground storage tank discovered across the street from the elementary school during the water line project.

Change Rippling Through Our Waters and Culture

Interviewed Apsáalooke elders and knowledge-holders about changes they have witnessed across the Apsáalooke landscape.

Apsáalooke Knowledge:

Qualitative research design

In depth interviews with tribal members on climate and ecological change

Content Analysis of interviews

Collection of themes revealed by interviews

Western Science:

Historical data (quantitative)

Climate data projections

Graphing

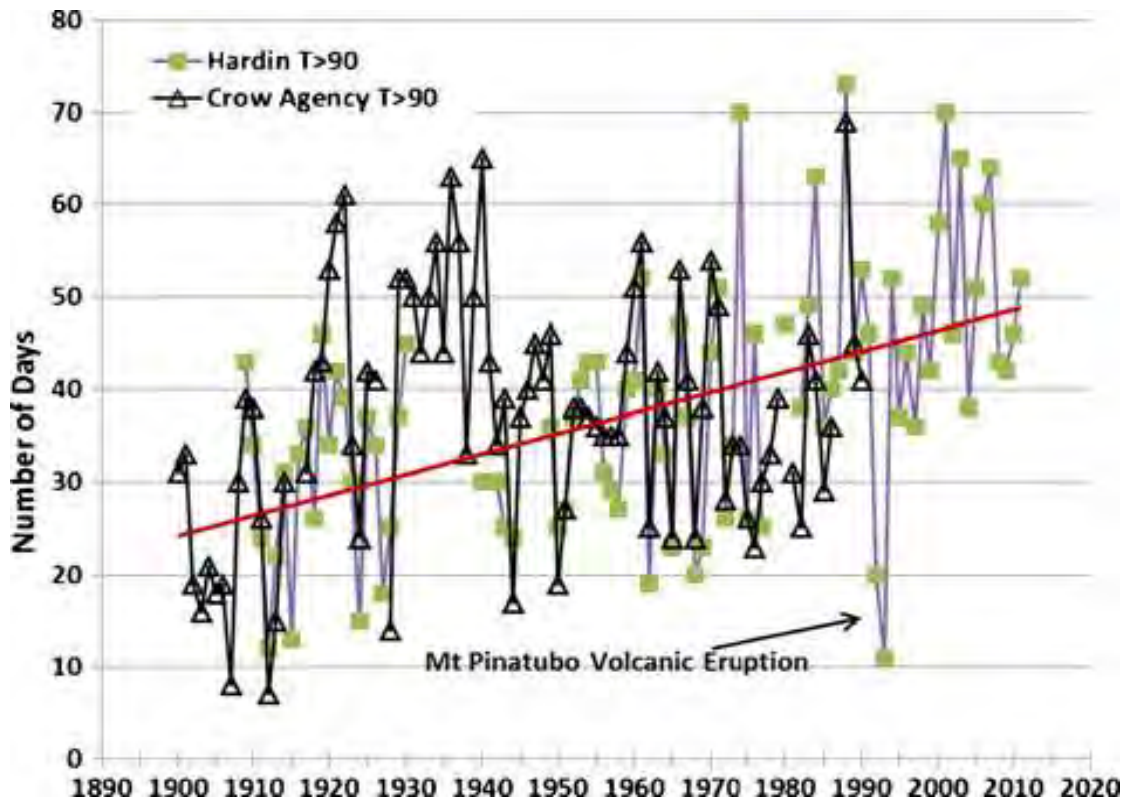
Technology (Use and Implementation)

UNIVERSITIES COUNCIL ON WATER RESOURCES
JOURNAL OF CONTEMPORARY WATER RESEARCH & EDUCATION
ISSUE 169, PAGES 61-78, APRIL 2020

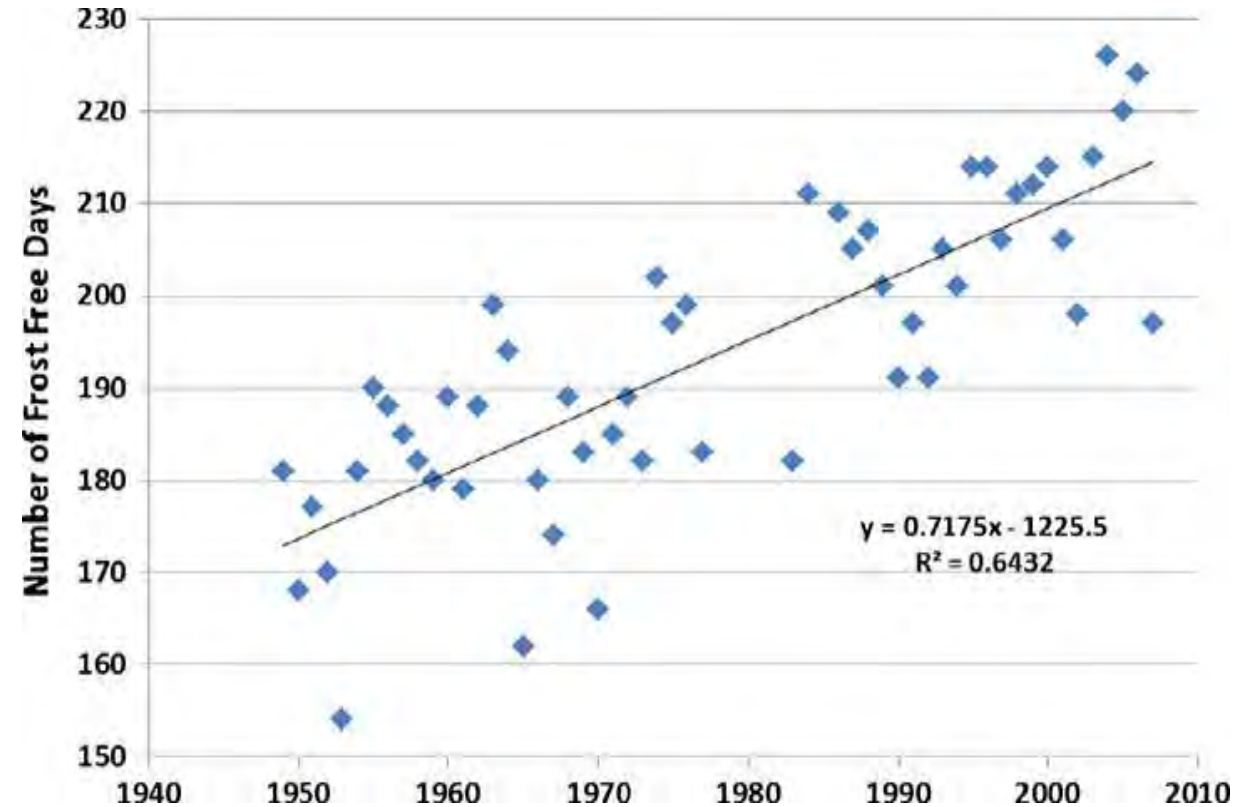
Change Rippling through Our Waters and Culture

*Christine Martin^{1,2,3}, John Doyle^{1,2,3,4,5}, JoRee LaFrance^{2,6}, Myra J. Lefthand^{1,2,3},
Sara L. Young^{2,3,7}, Emery Three Irons^{1,2,3}, Margaret J. Eggers^{3,5}

Climate Change and Heat in Crow



Number of days per year with temperature exceeding 90 °F (32 °C) has doubled in the past century in Hardin and Crow Agency, MT.



Number of frost free days per year in Hardin, MT, calculated from historic daily observations. (Data source: National Climate Data Center.)

Apsáalooke Knowledge: Winters are Milder

“I think that the winters are different. There’s fewer days that are subzero that I would observe. It seems to me that I used to count on a month of subzero weather maybe 6-weeks especially in January and February. And not before Christmas or not before the holiday or the new year. I remember a lot more snow but maybe it’s just because of the hard work that you have to do when there’s snow.”



Apsáalooke Knowledge: Winter Weather Patterns are Changing

“Winter is coming later. Snowfall is coming later in the fall. The freezing period for the fall is coming later so the leaves are falling later as well. Warmer temperatures in the fall. Decrease in precipitation for the spring indicated by the amount of mud outside. Snowpack in the mountains is melting sooner so you are able to go into the mountains in June when they would usually go up in July.”



Apsáalooke Knowledge: Longer, Hotter Summers

“We have a few days of hot weather in March, then some in April but the hot weather comes in June and lasts until September, it’s longer, the heat, it appears to me to be longer and hotter real or more uncomfortable.”



Apsáalooke Knowledge: Increasing Wildfires

“There are more fires now days and they’re more severe and more widespread and they do more damage. To me it’s all obvious and apparent that we in fact are in global warming... When it rains, the mud slides washes away everything...”

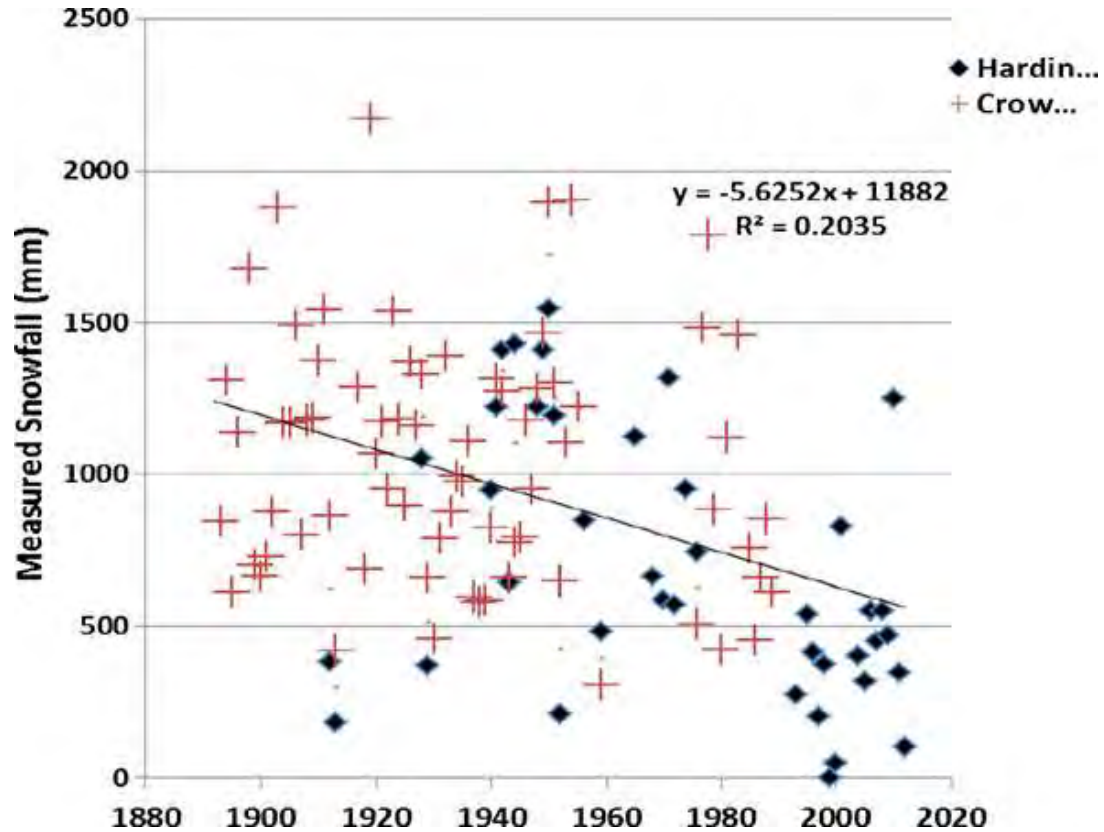


2012 fires just east of Crow Agency

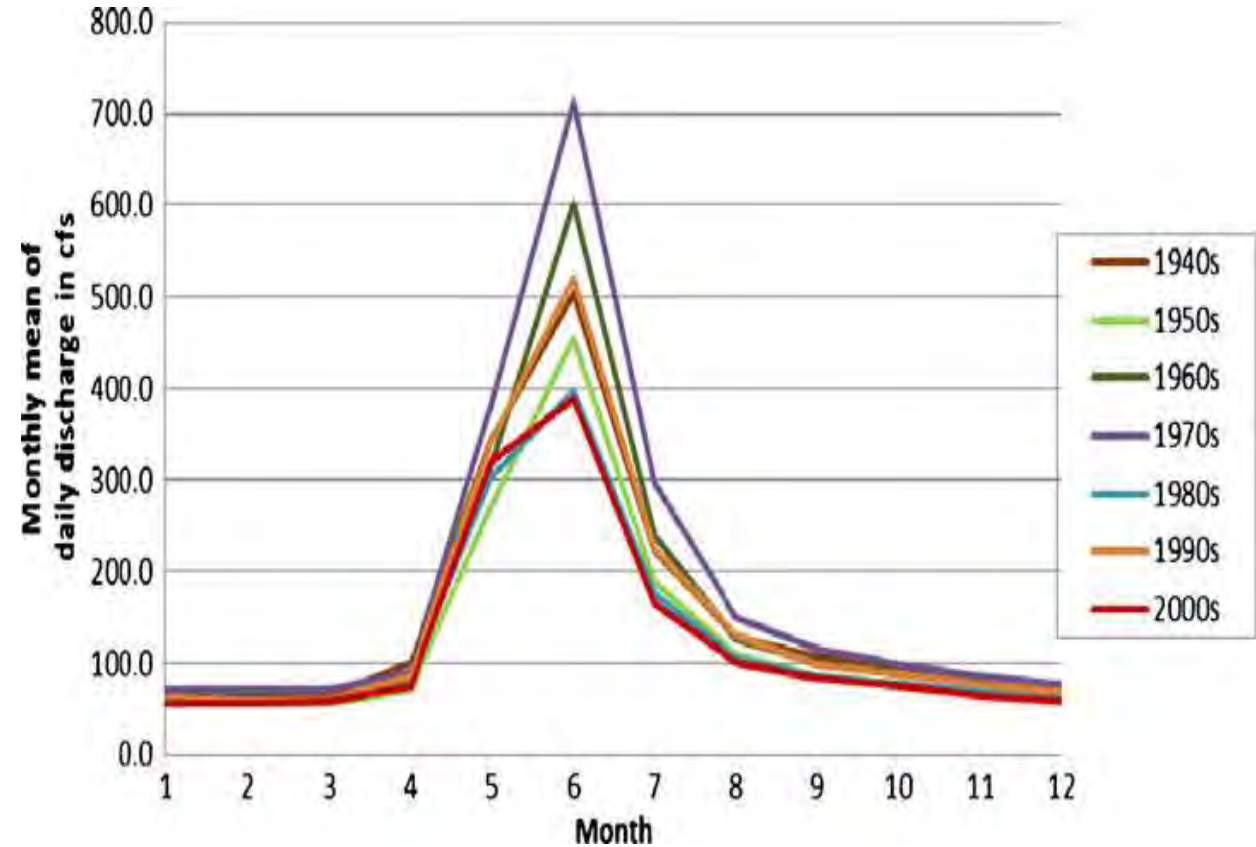


2021 Little Bull Elk Canyon Wildfire

Climate Change and Crow Water

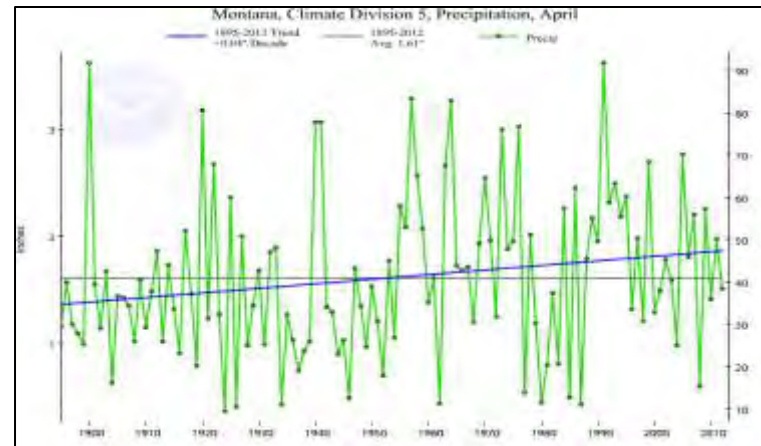
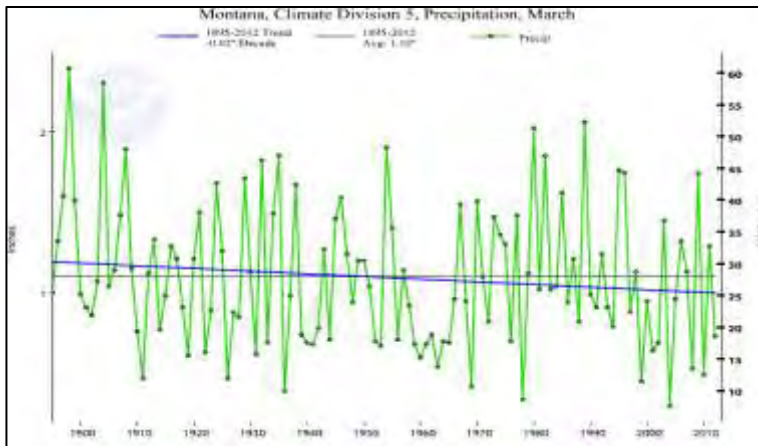
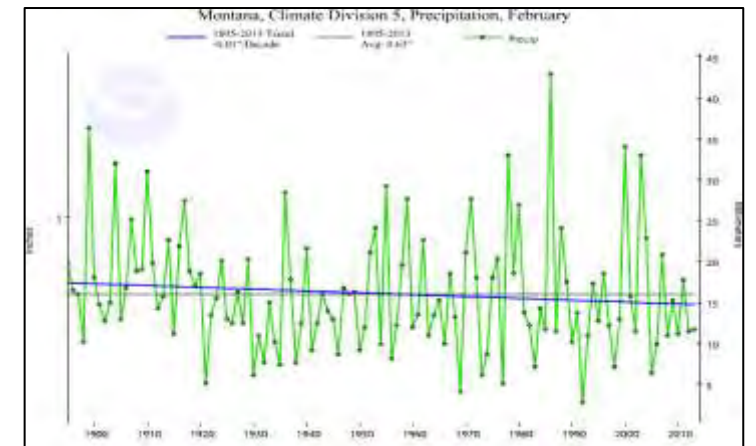
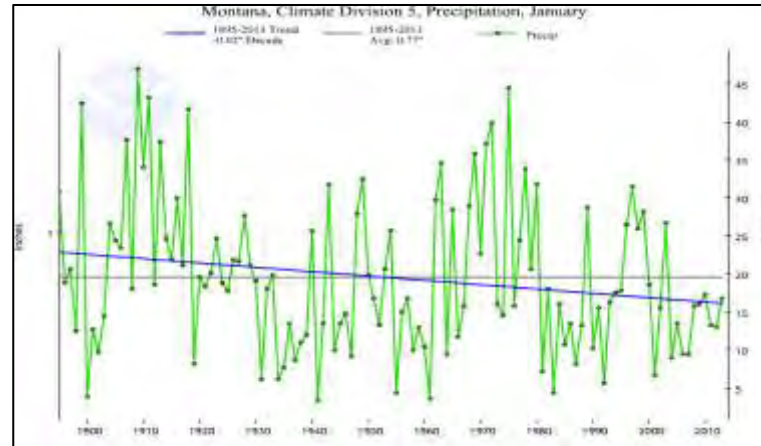
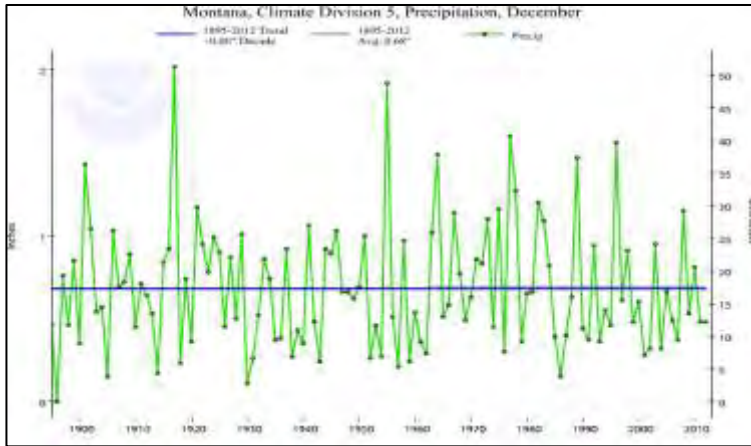


Annual snowfall in millimeters from Hardin MT (1912–2012) and Crow Agency MT (1895–1990) observation sites, calculated in water years.



Monthly averages of daily mean discharge by decade for Little Bighorn River at State Line near Wyola, Montana (station 06289000). (Data source: USGS 2012)

Declining Annual Precipitation



The decline in winter snowpack is not being made up during other seasons; average annual precipitation in MT Climate District 5 has been declining by 0.11" per decade.

Apsáalooke Knowledge: Winter snowfall is declining

“When I was a child back in the ‘70s the snow was very deep every year to where I remember there was snow drifts every year and they were at least 3-6 feet high. We used to build tunnels in them every year when we were kids. Nowadays, in the winter, we don’t see that drift that high. Nowadays, the snow drifts are about 6 inches to a foot high.”



Apsáalooke Knowledge: Severe spring floods are more frequent

“... that floodwater came through their houses, and that house is condemned. For people that is such a hardship because we just don't have to money to relocate. So they just had to let their house dry out and move back in, even with the same carpet. So that was a community health concern.”



Apsáalooke Knowledge: Spring ice break-up has become ice melt

“Ice break-up is a rare commodity. I recall a time when they would float down the river on ice chunks that were about 9-inches thick and the size of a car hood. Ice jams haven’t occurred for years. The ice break-ups don’t happen like they used to and if they do, the timing is off..”



Apsáalooke Knowledge: Less rainfall

“We are losing the annual precipitation that we enjoyed in the years that have gone by. All we can do is just have memories and hope that eventually the cycle will come back to that time when we had ample moisture and we were at leisure with plant life, berry picking, root gathering and other ceremonial activities that go on here year after year.”



Apsáalooke Knowledge: Loss of plants, riparian plants



“I think when my family was younger we did a lot of just going around in the mountains, hunting and camping. When I get next to the rivers, what I am doing is usually searching for things. Like I am looking for mint or I am picking berries of different kinds. Or maybe I am looking for wild onions and carrots and things. And those things changed, they’ve changed a lot. I feel like I can hardly ever find mint where I would use to find it a lot. And that is really usually along waterways. So there is a difference in growth. Why? I don’t know. But why plants move around so much, I just don’t know. But I do think that it probably has to do with water and the season of time when the water is available. There are places where I used to constantly go for certain things that I have had to look for new places because things just aren’t growing where they [used to be].”

Apsáalooke Knowledge: Loss of amphibians

“When we were little we used to catch and release frogs and that was part of our activity at the river... there would just be tons of frogs in those little water holes next to the river, and turtles and salamanders... We used to see who could find the most... there was about 5 or 6 of us playing that game where we could each collect our own frogs... But now when I go over there, the frogs are still there but they’re not all along the river like they used to be... you kind of have to hunt them out.”



Apsáalooke Knowledge: Loss of riparian berries

“There used to be a bunch of patches of raspberries and now they only know of one or two patches...The chokecherries weren’t as delicious, they weren’t as sweet. None of them are as sweet as they used to be. That might have something to do with the decrease in bees... or the frost and thawing period, or it could be the late precipitation. Because if you are not getting the water then you are not growing as early in the season...”



Conclusion

Crow faces water insecurity for both public and private water supplies.
Climate changes are only making this worse.

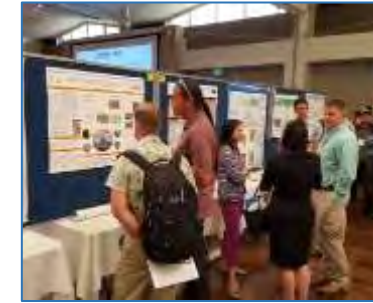
Obstacles to addressing these challenges include:

- lack of knowledge of infrastructure funding sources;
- the need for many kinds of expertise, including legal;
- the lack of long-term stability of Tribal government personnel;
- the complex jurisdictional issues affecting many aspects of infrastructure design, contracting and construction;
- regulatory gaps where there is no Tribal or federal equivalent to State laws and regulations;
- a legacy of no infrastructure planning and poor environmental enforcement;
- severely limited funding for infrastructure operation and maintenance.

Legislative and policy changes could remove some of the many obstacles Tribes face in providing safe drinking water for their members.

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Crow Environmental Health Steering Committee

Acknowledgements

Crow Environmental Health Steering Committee

John Doyle – EPSCoR, NIH PI/PD Little Big Horn College (LBHC)

Myra Lefthand, MSW – LBHC Program Director

Sara Young, MEd – NAU Tribal research consultant

Christine Martin, MS – USDA PI/PD LBHC

Emery Three Irons, MS – Crow WASH Coordinator, LBHC

Non-voting academic partner – Dr. Mari Eggers

JoRee LaFrance – Mentee, Crow doctoral student at UAZ

Plenty Doors Community Development Corporation

Charlene Johnson, PD Executive Director

Charitina Fritzler, PD Program Director

Little Big Horn College

President David Yarlott PhD, Dean Bullchief, Dean Old Coyote, CFO Aldean Good Luck, CIO Frank Cooper & many dedicated staff

25+ LBHC Science majors over past years

MSU Bozeman Collaborators

Dr. Vanessa Simonds, Health & Human Development

Dr. Ellen Lauchnor, Civil Engineering

Dr. Stephanie Ewing, Land Resources Environmental Science

Dr. Rob Walker, Chemistry & MT EPSCoR team

Dr. Julia Haggerty, Institute on Ecosystems

Dr. Rebecca Mueller & colleagues

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Other Principal Investigators/Collaborators

Dr. Johnnye Lewis, Dr. Melissa Gonzales, Dr. Debra Mackenzie et al., NIH P50 Center for NA Environmental Health Equity, University of New Mexico

Dr. Joseph Hoover, Montana State University Billings, NIH P50

Dr. Margaret Hiza Redstter, U Washington Bothell

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*References provided upon request.

Ahookaashiile!

