Complete the Planetary Health Survey (5-10 minutes)

Check your email for your unique survey link:

- Email was sent this morning
  - Sent from Christa Wagner, PhD
  - Subject line: Planetary Health in the Curriculum
- If you cannot find the email, please raise your hand
- Do not forward your email to others with the link (it is unique!)

Please see the **Informational Letter** on Brightspace and within your email for more information and contacts for any questions.

MEDICAL COLLEGE OF WISCONSIN

Climate Change, Gastroenteritis, and Malnutrition: What Physicians Should Know from the Inside Out

Mike Bodenhausen, MD
Internal Medicine PGY1

Will Graft, MD
Internal Medicine & Psychiatry PGY3

Elizabeth Auckley, MD
Internal Medicine PGY3

Joanne Bernstein, MD
M4 Climate Change and Human Health, Course Director

December 17, 2025

MEDICAL COLLEGE OF WISCONSIN

Learning objectives

1. Understand that human health and planetary health are directly linked, and climate change is a public health crisis
2. Define climate justice and list populations most vulnerable to climate change
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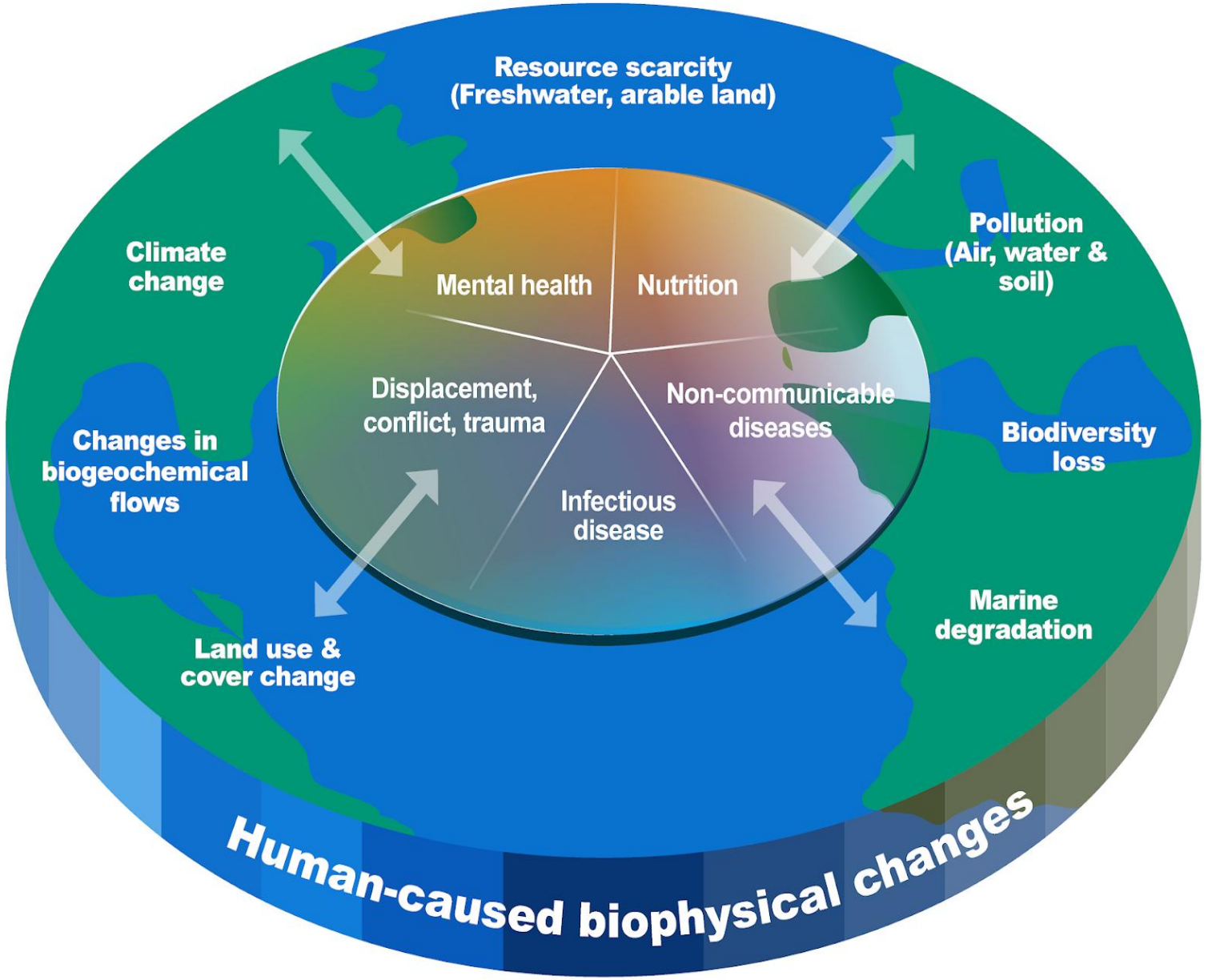
Planetary Health



Human-caused changes to earth systems that interact in complex ways to affect human health.

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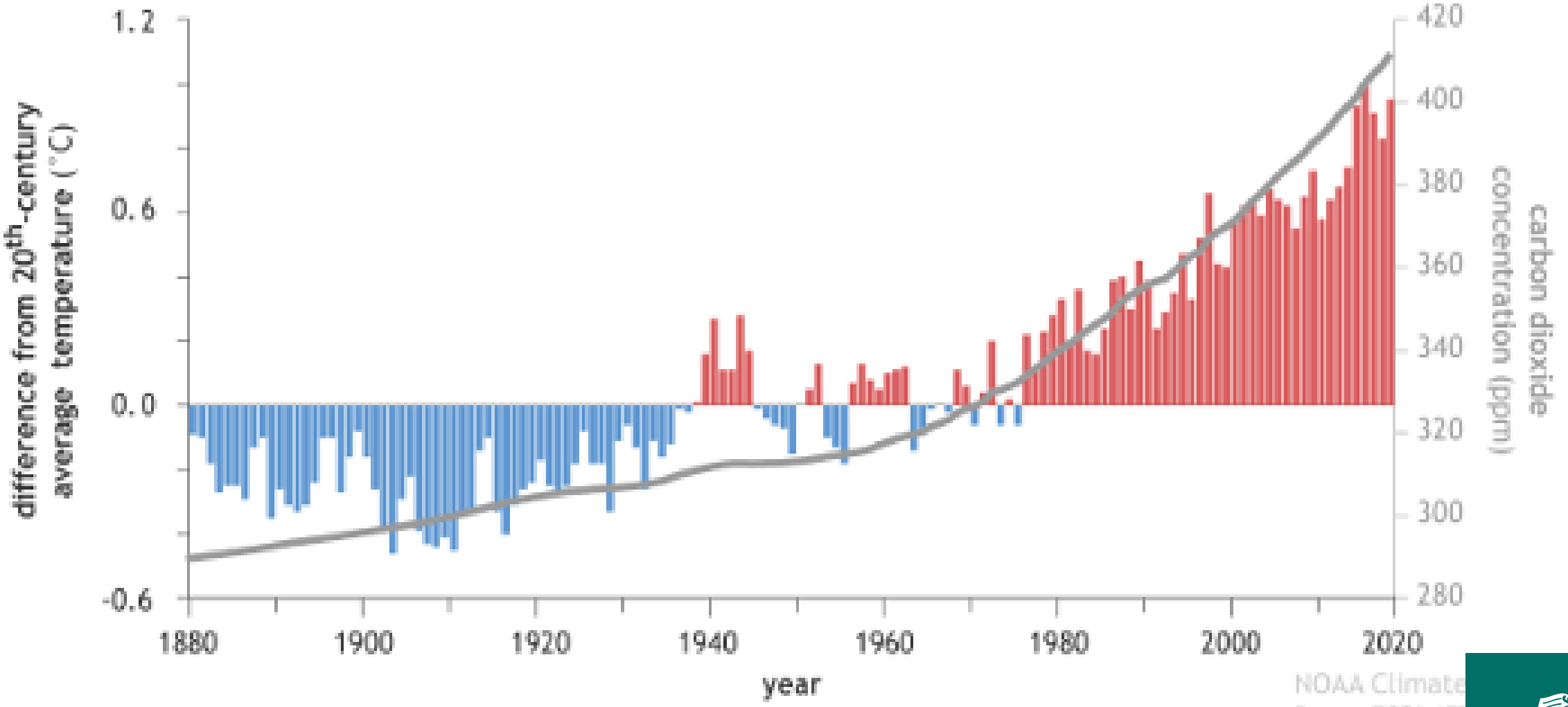

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Planetary Health

https://www.globalgiving.org/learn/cost-to-end-climate-change/

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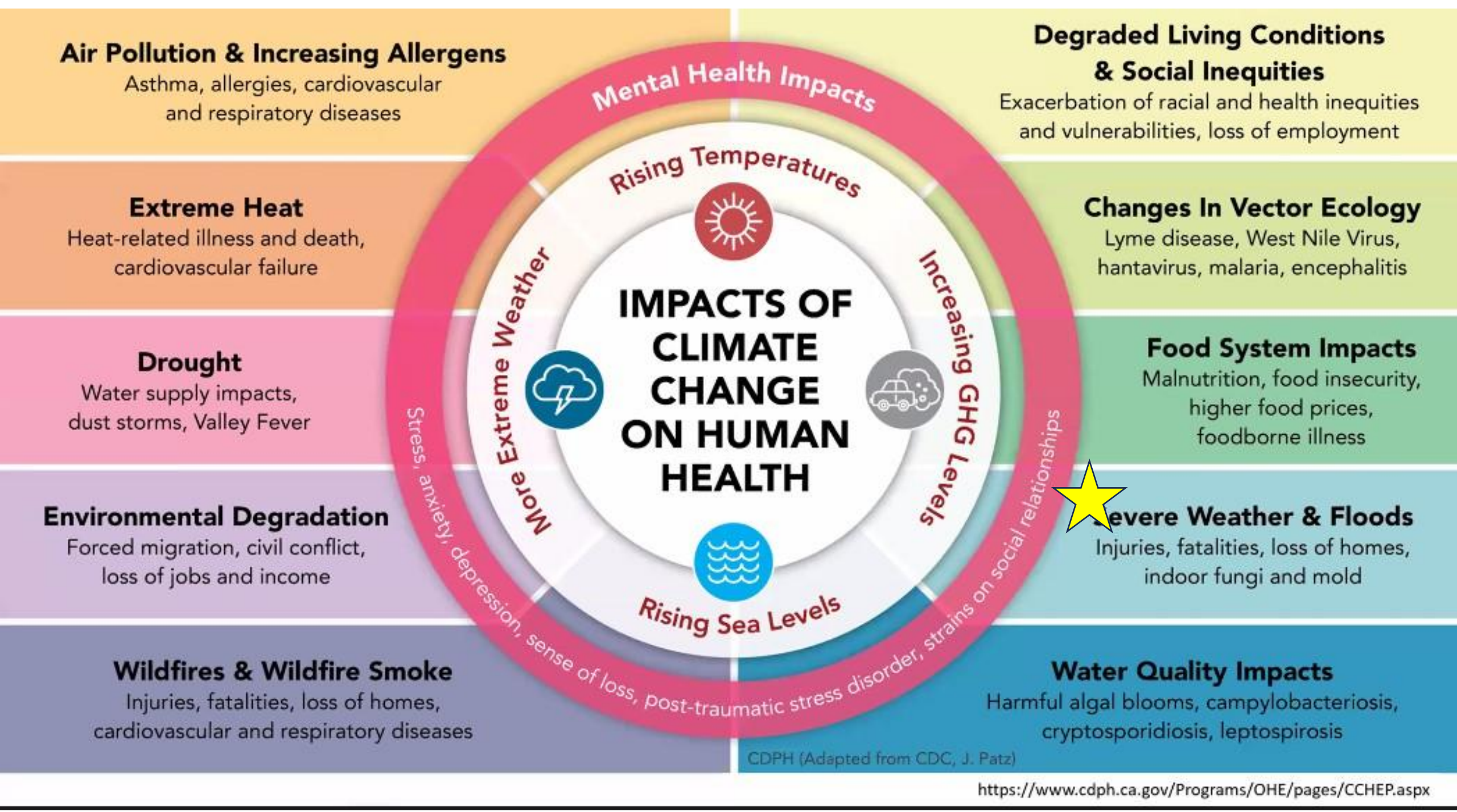

https://www.cdph.ca.gov/Programs/OHE/pages/CCHEP.aspx

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Define Climate Justice

- Recognizes the disproportionate impacts of climate change on low-income communities and communities of color around the world, the people and places least responsible for the problem.
- "Managing disasters, especially those that are climate-induced, calls for reducing vulnerabilities as an essential step in reducing impacts"

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Who is vulnerable to Climate change impacts?

Most vulnerable populations

- Children
- Pregnant women
- Elderly individuals
- People with chronic illnesses and allergies
- People with limited resources
- Student athletes

VULNERABILITY = EXPOSURE + SENSITIVITY + ADAPTIVE CAPACITY

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Vector Borne GI Illness

- Higher temperatures & shifting precipitation are the *perfect storm* for foodborne illnesses to proliferate
- HEAT
  - Decreases biodiversity of soil and water
  - Increases levels of E Coli, shigella, lactococcus, Vibrio in agriculture
  - increases *Salmonella* spp., *E. coli*, and *Campylobacter jejuni* in food supplies.
- For every 1°C rise in temperature, the risk of bacterial infection from *Salmonella* and *Campylobacter* increases by 5%

CANCER RISK

Rio P, Caldarelli M, Gasbarrini A, Gambassi G, Cianci R. The Impact of Climate Change on Immunity and Gut Microbiota in the Development of Disease. Diseases. 2024 Jun 3;12(6):118. doi: 10.3390/diseases12060118. PMID: 38920550; PMCID: PMC11202752.

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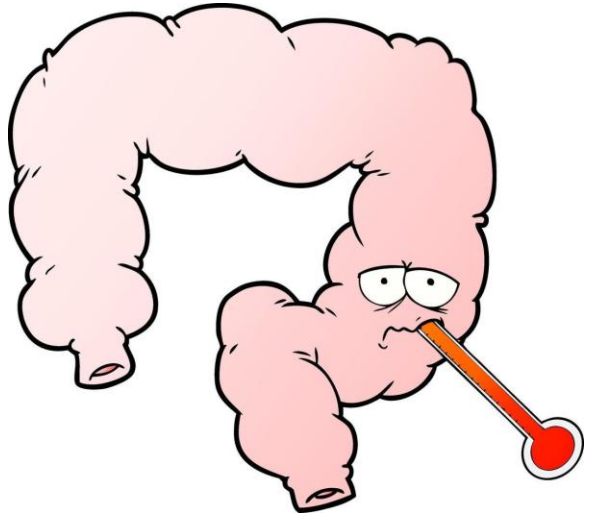
Vector Borne **GI Illness**

- COLD 
  - Reduced richness of micronutrients of soil
  - increases gut permeability
  - More colonic cell apoptosis
  - Inflammation
  - oxidative stress

CANCER RISK



Rio P, Caldarelli M, Gasbarrini A, Gambassi G, Cianci R. The Impact of Climate Change on Immunity and Gut Microbiota in the Development of Disease. Diseases. 2024 Jun 3;12(6):118. doi: 10.3390/diseases12060118. PMID: 38920550; PMCID: PMC11202752.

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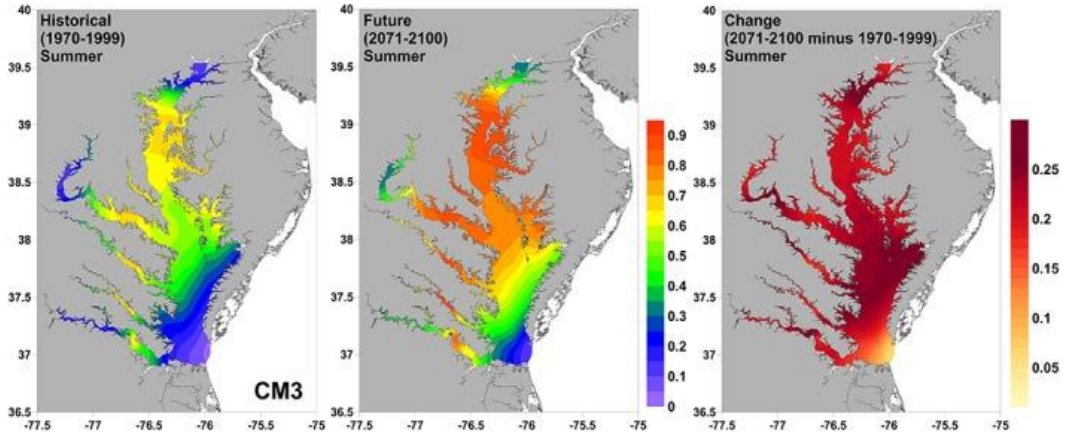
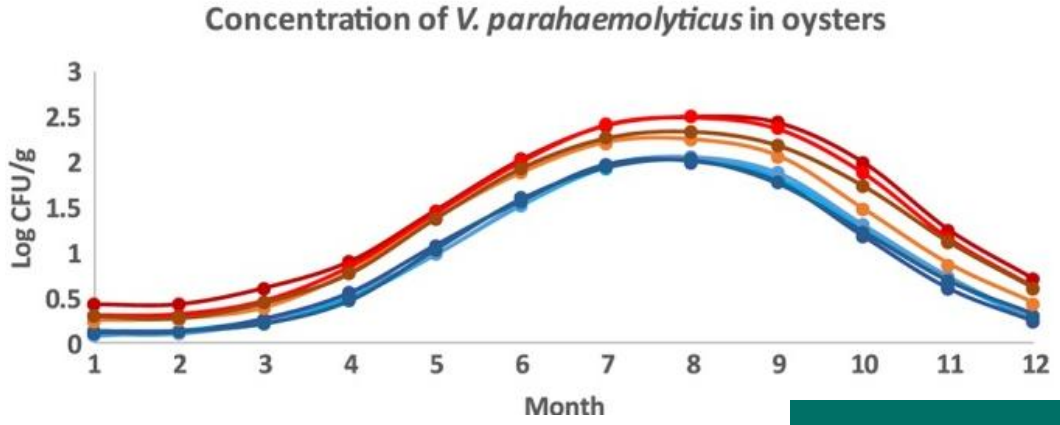
Case Study: *Vibrio* in Chesapeake Bay

- *V. parahaemolyticus* and *V. Vulnificus are endemic to the US*
  - 34,000 cases with $360 million in health care costs
- *V. cholerae*, *V. parahaemolyticus*, and *V. Vulnificus* occur naturally in the Chesapeake Bay
- *Vibrio* infections may be increasing in coastal oceans in association with HEAT





- Climate change may cause increases in season length and spatial habitat for *V. vulnificus* and *V. parahaemolyticus* in the Chesapeake Bay

Muhling BA, Jacobs J, Stock CA, Gaitan CF, Saba VS. Projections of the future occurrence, distribution, and seasonality of three *Vibrio* species under a high-emission climate change scenario. Geohealth. 2017 Sep 26;1(7):278-296. doi: 10.1002/2017GH000089. PMID: 32158993; PMCI

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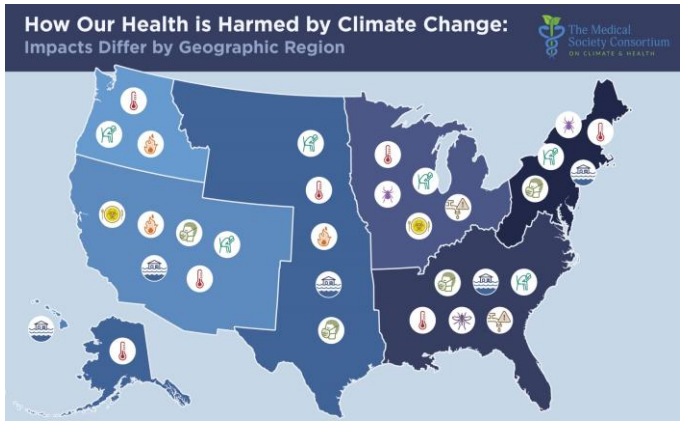
What else?

- Climate-related stressors impair the efficacy of the epithelial barriers
  - first line of defense against pathogens
  - hyperstimulate the innate immunity
  - affect the adaptive one
- Storms, extreme temperatures, etc.
  - encourage human social gathering for safety
    - INCREASE transmission of communicable pathogens
- Climate-related hazards aggravate over half of infectious diseases impacting humans worldwide



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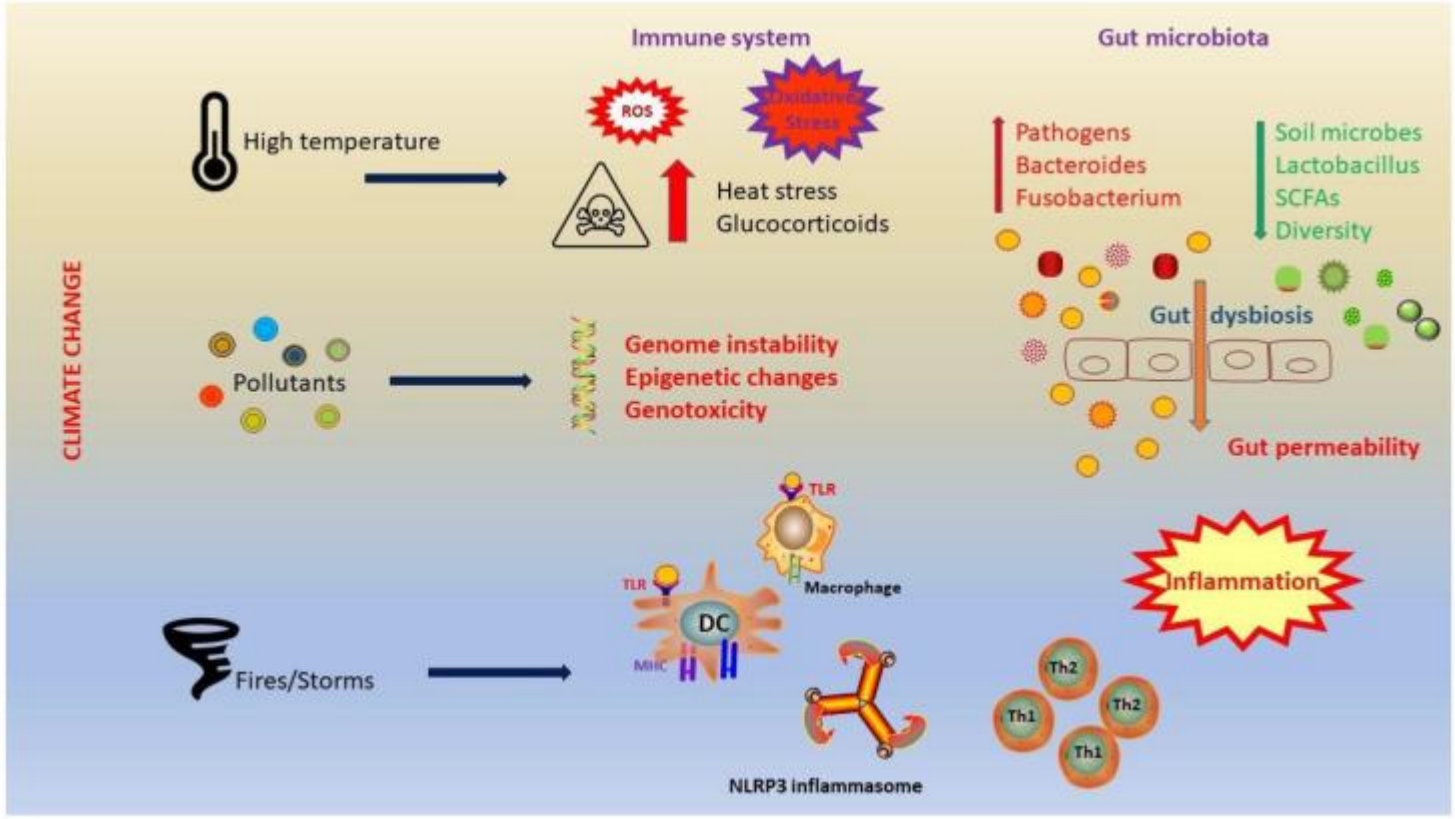
A moment for the Gut Microbiome



- Heat causes a shift in microbiota:
  - Increases in *Bacteroides* and *Fusobacterium*
- Mimics gut microbiome in malnutrition
- Leads to elevated gut permeability and inflammation

Rio P, Caldarelli M, Gasbarrini A, Gambassi G, Cianci R. The Impact of Climate Change on Immunity and Gut Microbiota in the Development of Disease. Diseases. 2024 Jun 3;12(6):118. doi: 10.3390/diseases12060118. PMID: 38920550; PMCID: PMC11202752.

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Climate Change and Our Food

- Rising temperatures in the Great Plains
  - Reduced yield in maize, soybeans, and wheat on American farms
- Climate-caused extreme drought and changes to riparian habitats
  - decreased yield in seafood and marine food (waterfowl, crab, and oysters)
- Increased heatwaves and droughts in 2021 vs 1981-2010
  - 127 million more people with significant food insecurity
- Microplastics decrease photosynthesis, leading to loss in food production
  - Estimated loss in seafood and crop production is **9.56% of global supply**

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Discussion: Malnutrition

Name a population **at risk** for malnutrition due to climate change and WHY

VULNERABILITY = EXPOSURE + SENSITIVITY + ADAPTIVE CAPACITY

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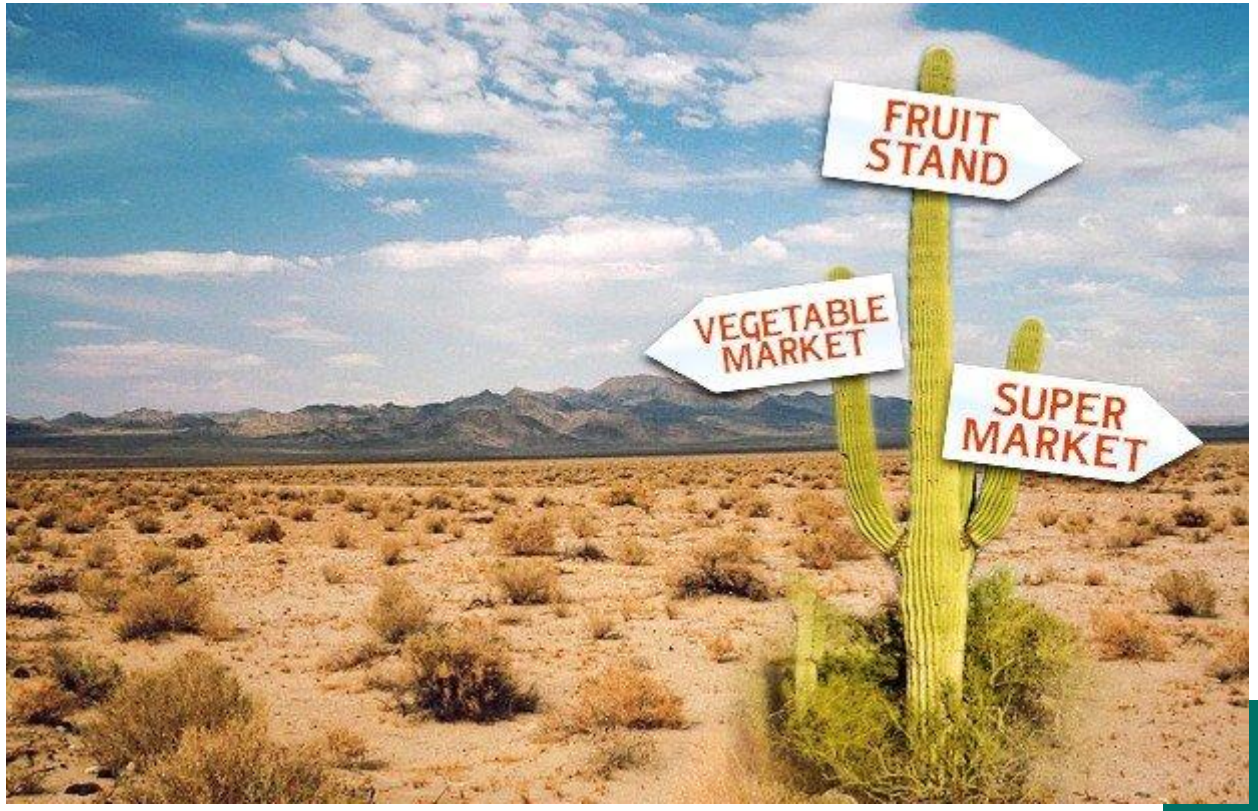
Food Deserts

- Children
- Pregnant women
- Elderly individuals
- People with chronic illnesses and allergies
- People with limited resources
- Student athletes
- **Cirrhosis patients**
- **IBD patients**
- **IBS/functional disease**
- **Pancreas patients**
- **Celiac patients**



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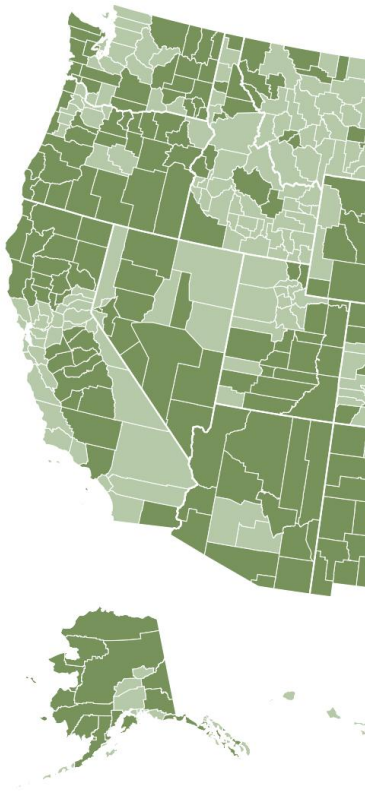
Food Insecurity and Climate Change

Food insecurity is the distance someone has to travel to obtain food, and how much food they can afford

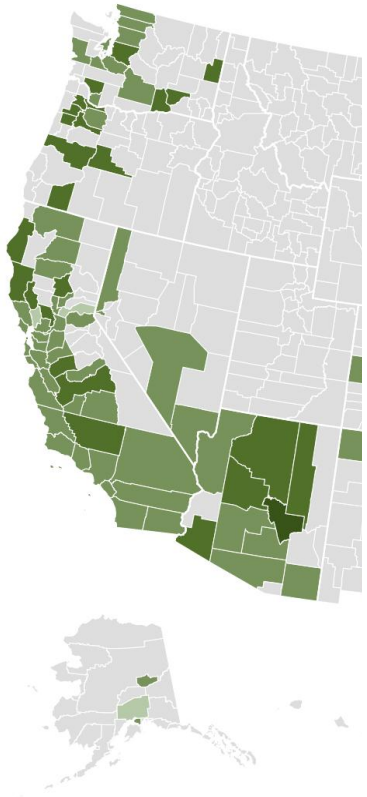
Vulnerability variables	Evidence for vulnerability	Value of variable for resilient food system
Population–resource conditions		
Availability of food	Insufficient calories or nutrients	Balance of available resources and population size reduces risk of shortfall
Diversity of available, accessible food	Inadequate range of resources responsive to varied conditions	Diverse portfolio reduces risk, increases options (9)
Health of food resources	Depleted or degraded resources, habitats	Healthy habitats contribute to managing risk and change (26, 49)
Social conditions		
Connections	Limited connections with others experiencing different conditions	Social networks expand access to food and land (26) and are sources for risk pooling (49)
Storage	Insufficient, inaccessible storage	Stored foods reduce risk in times of shortage
Mobility	Inability to move away from challenging food conditions	Movement to alternative places, landscapes, and social groups offers potential for addressing resource shortfall through access to food/land (49)
Equal access	Unequal control and distribution of land, water, and food resources	Equal access avoids challenges to coping and adaptive capacity in disaster risk management
Barriers to resource areas	Physical barriers limiting access to key resource areas	Lack of barriers enhances capability of people to provision themselves with food

Food Insecurity

VULNERABILITY = EXPOSURE + SENSITIVITY + ADAPTIVE CAPACITY



Overall



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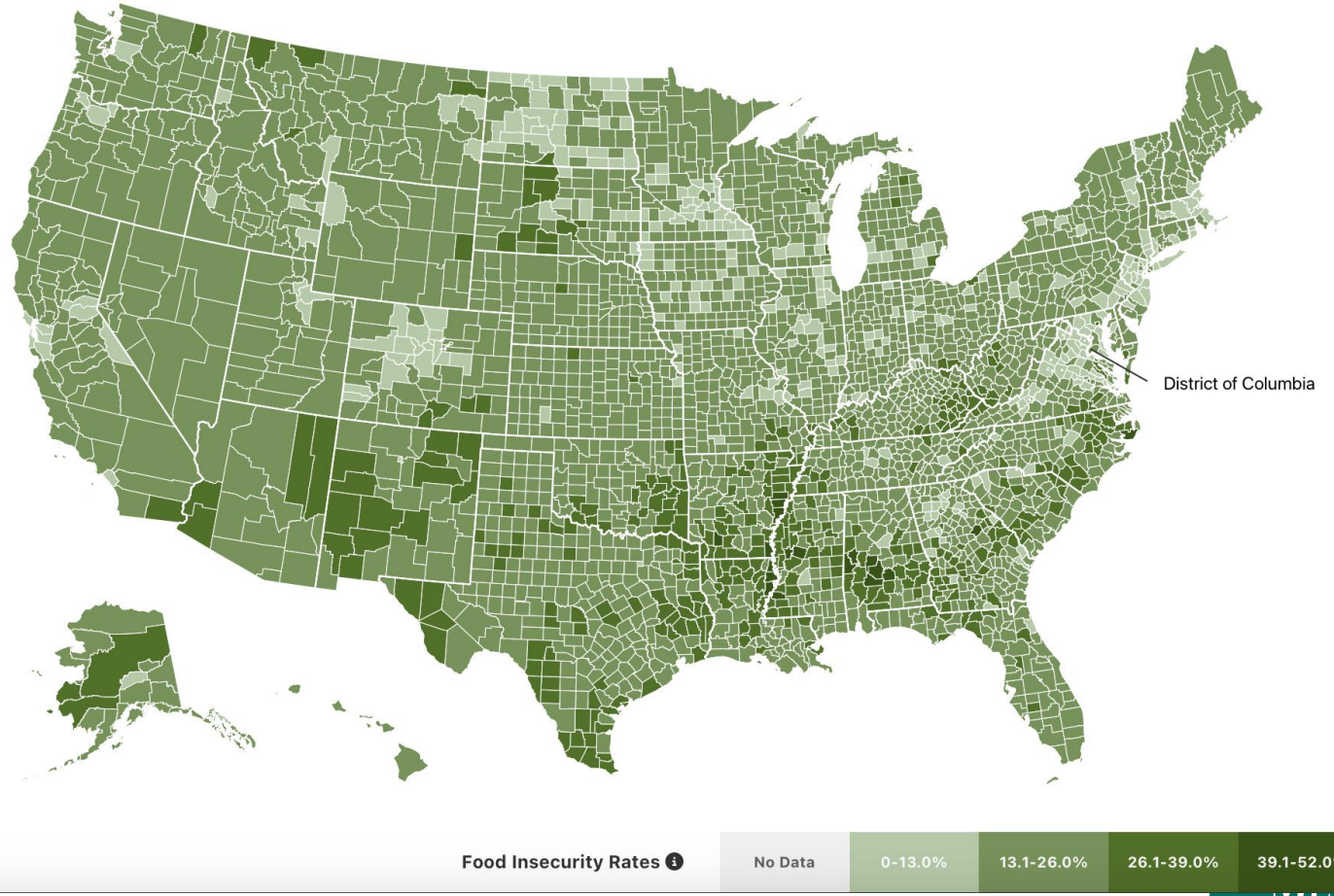

Children

https://map.feedingamerica.org/county/2022/senior-60-plus

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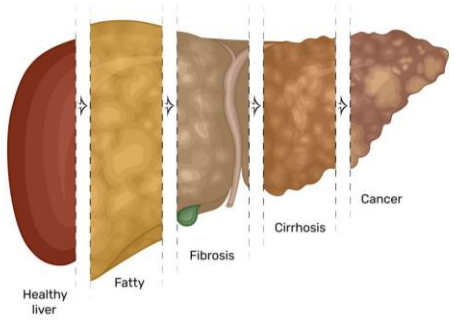
Special GI populations

- IBS
  - “Solastalgia” represents a modern concept aimed at comprehending the connections between human wellbeing and ecosystem health.
- IBD
  - exacerbations of IBD correlated with extreme temperatures and seasonal fluctuations
- Liver
  - high temperatures liver ischemia and hepatocyte necrosis,
    - resulting from peripheral vasodilation and splanchnic vasoconstriction.
- Pancreas
  - extreme heat = pancreatic cytotoxicity



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Gastrointestinal Climate Disease

Impacts of Environmental Change on Digestive Health

Increasing Temperatures:

A. Direct effects: Pancreatic, intestinal, and hepatic injury. Exacerbation of IBD. Epigenetic effects.

B. Decreasing Access to Quality Food and Nutrition: Malnutrition. Increase in MAFLD, IBD incidence of CD from processed food. Hepatic cancer from aflatoxins.

C. Decreasing Access to Quality Water: Ingestion of poor-quality water with increased risk of infection and exposure to chemical pollution. Decreasing food production. Effects of drought.

Increasing Extreme Weather, Hurricans, Storms, and Flooding:

A. Physical and mental health injury.

B. Infrastructure damage. Interruption of medical care. Supply chain disruption.

C. Increased flooding: Associated with infection from Norovirus, Adenovirus, Rotavirus. Cryptosporidium, Giardia. Campylobacter, Yersinia, Clostridium Difficile, Shigella, Salmonella, pathogenic E Coli, Vibrio Cholera. Amebiasis. Leptospirosis, Hepatitis A, Hepatitis E. Schistosomiasis, Ancyclostoma duodenale, Ascaris, Trichuris, and liver flukes.

Decreasing Air Quality

A. Eosinophilic esophagitis, appendicitis, irritable bowel syndrome, IBD. Esophageal, colon and hepatic cancer. MAFLD.

B. Wildfires with infrastructure loss, groundwater pollution and generation of particulate matter.

Increasing Migration and Conflict

Leddin D. The Impact of Climate Change, Pollution, and Biodiversity Loss on Digestive Health and Disease. Gastro Hep Adv. 2024 Mar 2;3(4):519-534. doi: 10.1016/j.gastha.2024.01.018. PMID: 39131722; PMCID: PMC11307547.

MEDICAL COLLEGE OF WISCONSIN

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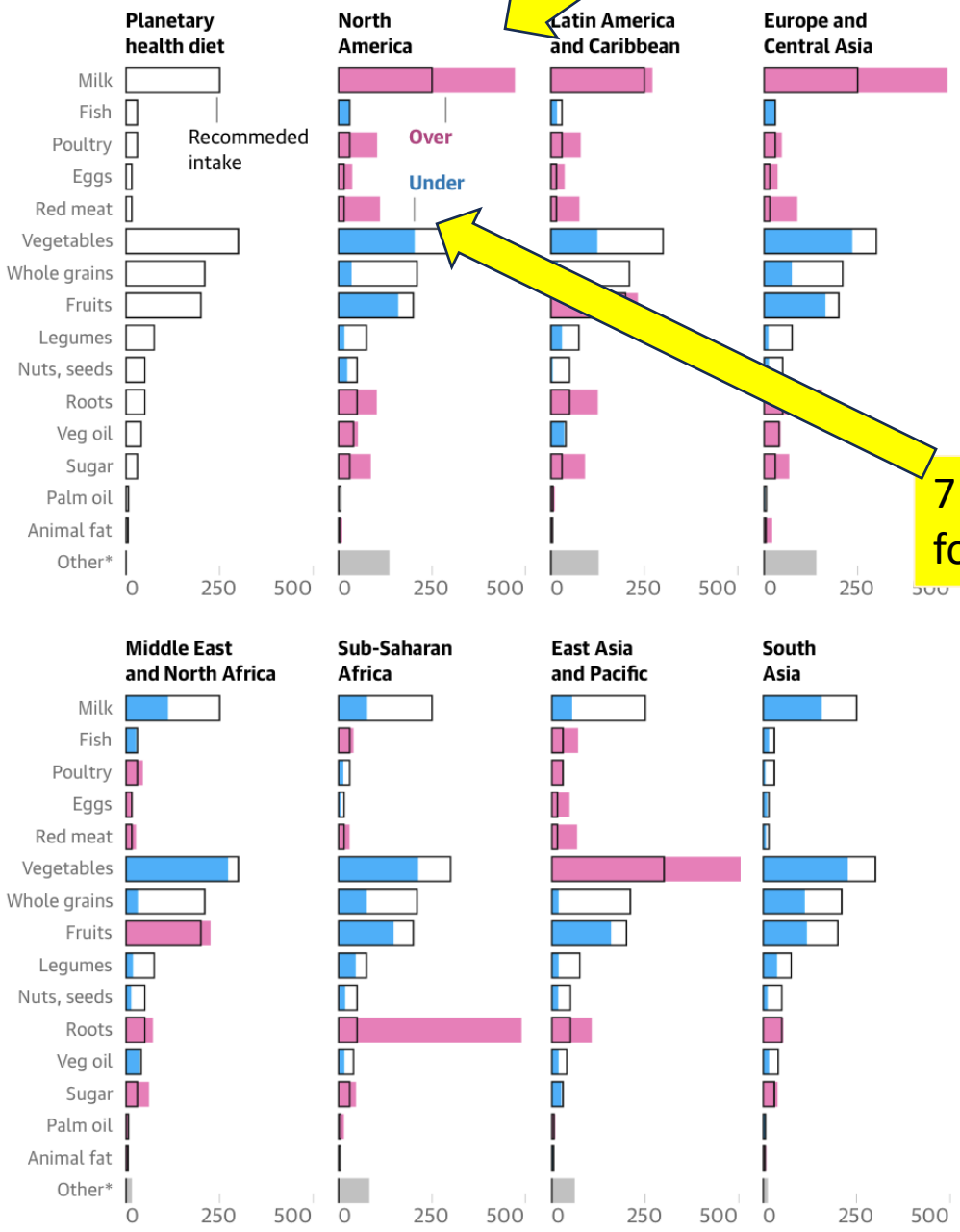
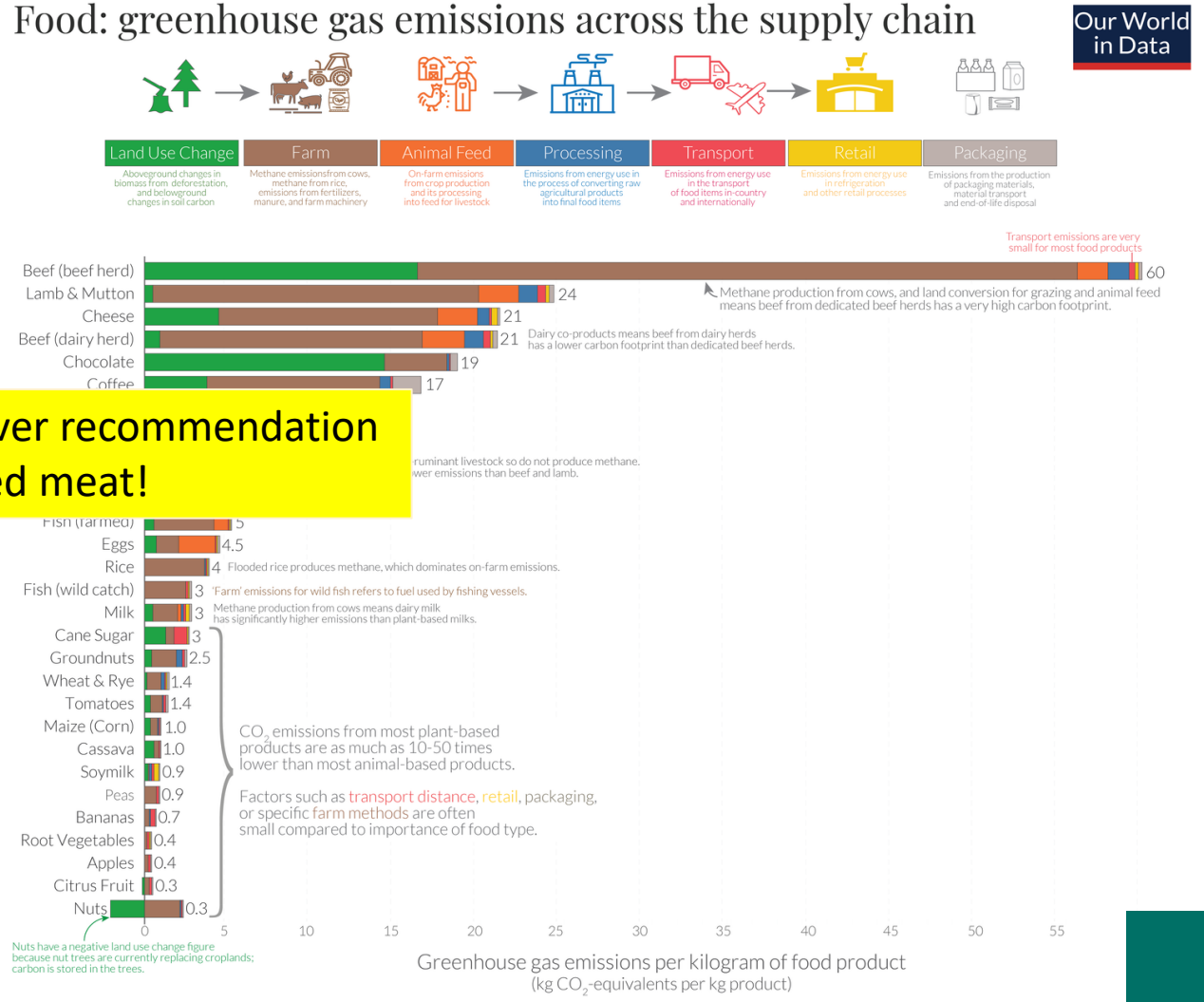
Planetary health diet v current diets

Adult diets in 2020 v planetary health recommendation — per capita intake in grammes



7 x over recommendation for red meat!



Note: Greenhouse gas emissions are given as global average values based on data across 38,700 commercially viable farms in 119 countries.
Data source: Poore and Nemecek (2018). Reducing food's environmental impacts through producers and consumers. *Science*. Images sourced from the Noun Project.
OurWorldinData.org – Research and data to make progress against the world's largest problems.

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What is your dietary carbon footprint?

- https://harvard-foodprint-calculator.github.io/

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Your Diet's Annual Environmental Impact[1]

328kg 3,971g 379,337L

CARBON NITROGEN WATER

328kg of Carbon is below the
also below the 680kg maxi

Your Diet's

910

CARB

910kg of Carbon is below the US nationa
maximum upper limit of a sustainable die

For your reference, emitting 910kgs of C
polar ice every year.[4,5] 10,880g of Nitrog
additional 240 pounds of fertilizer every
every day![7]

1,69

CARB

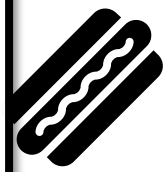
1697kg of Carbon is below the US national per capita average of 1750kg carbon emissions every year[2] but above the 680kg maximum upper limit of a sustainable diet necesary to prevent climate catastrophe.[3]

For your reference, emitting 1,697kgs of Carbon is equivalent to burning 195 gallons of gasoline or melting 28 cubic feet of polar ice every year.[4,5] 22,098g of Nitrogen waste is equivalent to emitting an additional 6,585kgs of carbon or polluting an additional 487 pounds of fertilizer every year.[1,4] 620,688L of water consumption is equivalent to using 13 bathtubs of water every day![7]

Elizabeth's diet: vegetarian

The PHD recommends plant-rich, flexible diets, including:

- Fruits and vegetables - at least five portions a day
- Whole grains - three to four portions a day
- Nuts - one portion per day
- Legumes (beans, peas, lentils) - one portion per day
- Dairy - one serving of milk, yoghurt or cheese portions a day
- Eggs - three to four a week
- Chicken - two portions a week
- Fish - two portions a week
- Red meat - one portion a week



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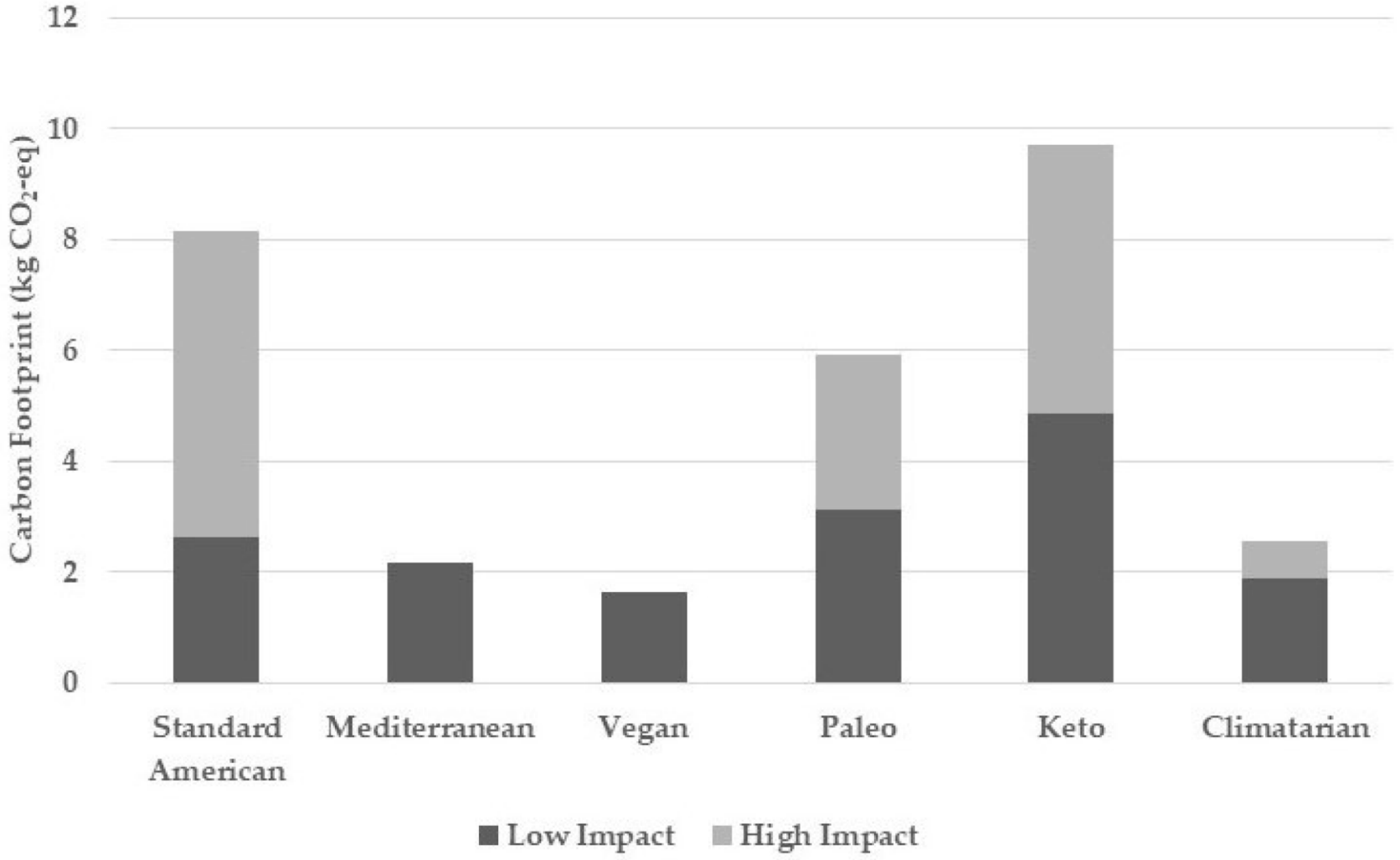
Comparing common diets' climate impact



"Climatarian diet"

- Local, seasonal, and fresh food
- Plant-based, avoiding ruminant meats (beef, lamb, goat) and moderate intake of pork, poultry, and sustainable fish
- "Flexitarian"

https://climatarian.com/eating-climatarian/

Dixon KA, Michelsen MK, Carpenter CL. Modern Diets and the Health of Our Planet: An Investigation into the Environmental Impacts of Food Choices. *Nutrients*. 2023; 15(3):692.

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What is one dietary change you could make to improve your health and lower your carbon footprint?

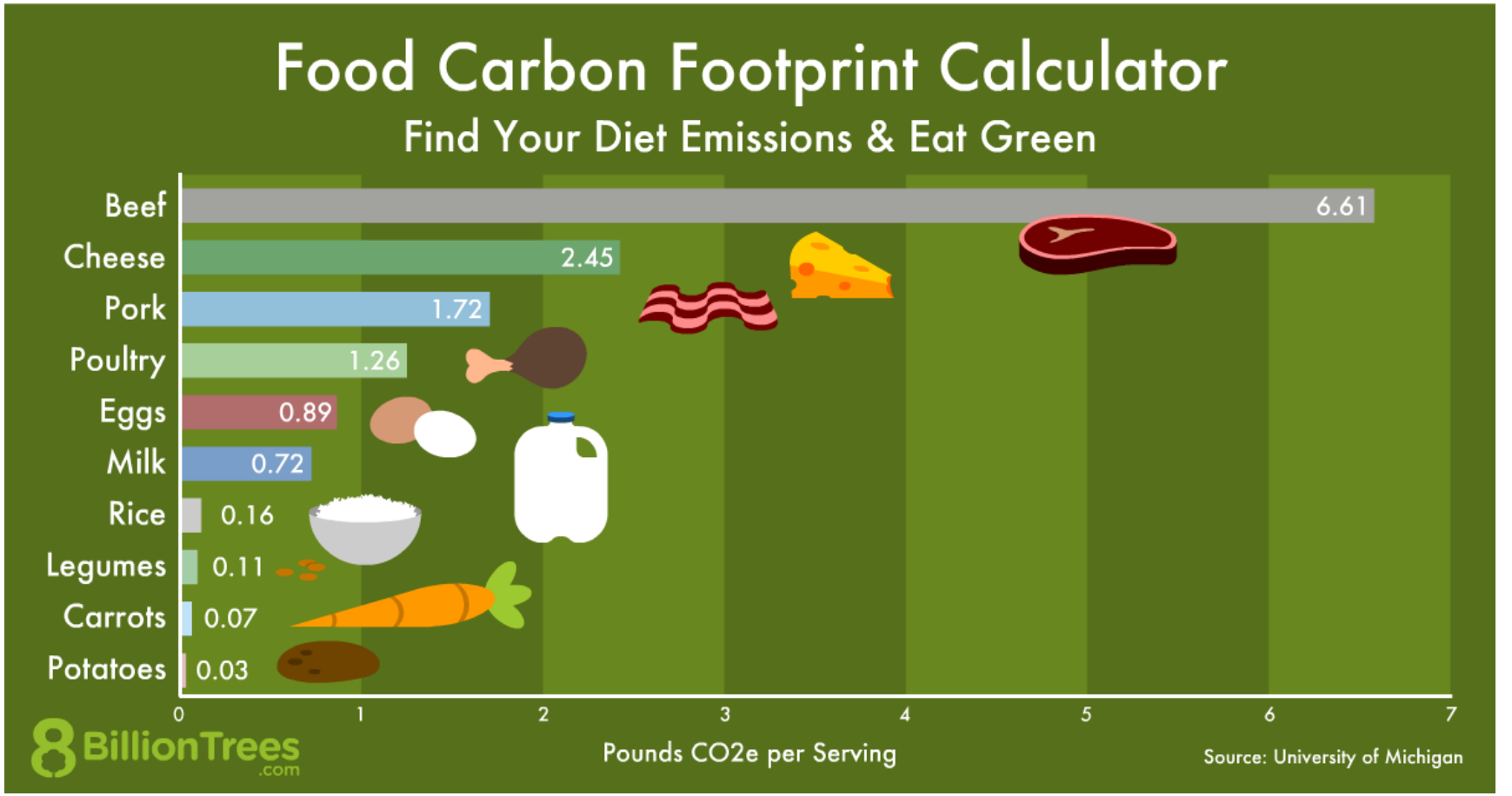

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TABLE 4-9. SUMMARY OF THE ANNUAL CRADLE-TO-CONSUMER ENVIRONMENTAL FOOTPRINT OF U.S. FLW

Environmental Impact	Environmental Footprint			
	Total (Standard Units)	Per Person	Percentage of U.S. Cradle-to-Consumer Food System Footprint	Percentage of U.S. Footprint
Land Use	560,000 km² • (140 million acres)	1,800 m² ⚑ (19,000 sq ft)	16% of agricultural land •	–
Water Use [a]	22 trillion L • (5.9 trillion gallons)	71,000 L ⚑ (19,000 gallons)	17% of freshwater used •	5%
Pesticide Application	350 million kg [b] (780 million pounds)	1 kg • (2.5 pounds)	–	–
Fertilizer Application	6,350 million kg • (14 billion pounds)	20.2 kg •, [b] (44.5 pounds)	42% of total fertilizers used	–
Energy Use	2,400 million GJ (664 billion kWh)	7.7 GJ • (2,140 kWh)	20% of energy used	2%
GHG Emissions	170 million $MTCO_2e$ •	540 kg CO_2e ⚑	16% of GHG emissions •	2%

• = calculated
⚑ = personal communication with author
[a] Blue water use.
[b] Accounts for only consumer FLW

FIGURE 4-9. ANNUAL CRADLE-TO-CONSUMER ENVIRONMENTAL FOOTPRINT OF U.S. FLW

This figure depicts the annual environmental footprint of producing, storing, processing, packaging, distri
that is ultimately lost or wasted in the United States. Data Source: U.S. EPA (2021a); USCB (2021); Paga
(2020); U.S. DoE (2020); Vittuari et al. (2020); U.S. EPA (2018); Toth and Dou (20

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Med student impact – how can you get involved?

- Here at MCW
  - Center for Sustainability, Health, and the Environment (SHE)
  - MS4SF
  - Phase 3 Climate Change and Human Health selective
  - Stay tuned for the Climate and Health workshop coming February 2026 from Dr. Bernstein and Dr. Wagner!

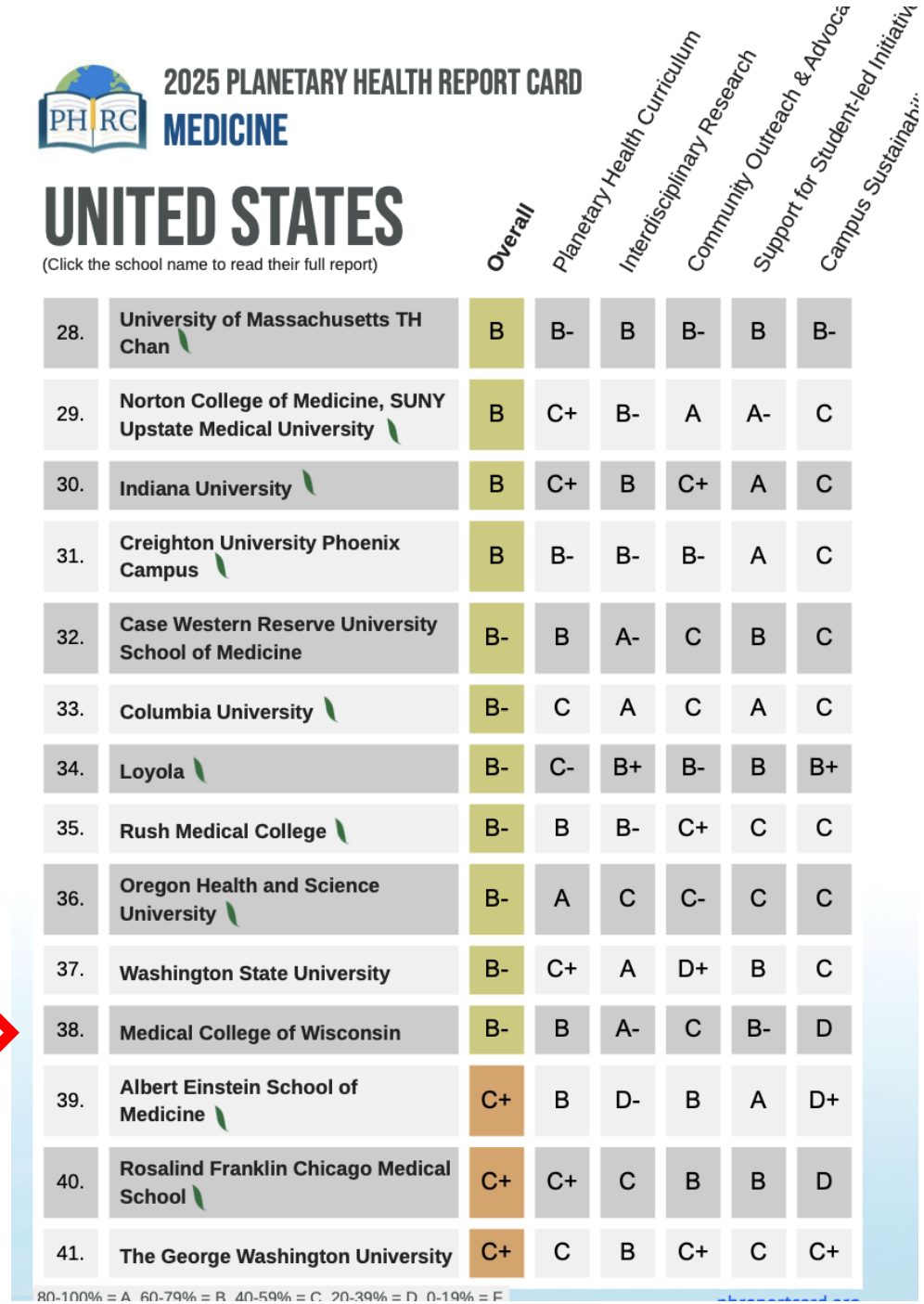
Med student impact – how can you get involved?

- State-wide
  - Healthy Climate Wisconsin
    - https://www.healthyclimatewi.org/
  - Local advocacy with elected representatives – they listen!!

Join MCW's Team

PLANETARY HEALTH REPORT CARD

Email Katie McShea to learn more!
Kmcshea@mcw.edu



2025 PLANETARY HEALTH REPORT CARD
MEDICINE

UNITED STATES

(Click the school name to read their full report)

		Overall	Planetary Health Curriculum	Interdisciplinary Research	Community Outreach & Advoca	Support for Student-led Initiativ	Campus Sustainab
28.	University of Massachusetts TH Chan	B	B-	B	B-	B	B-
29.	Norton College of Medicine, SUNY Upstate Medical University	B	C+	B-	A	A-	C
30.	Indiana University	B	C+	B	C+	A	C
31.	Creighton University Phoenix Campus	B	B-	B-	B-	A	C
32.	Case Western Reserve University School of Medicine	B-	B	A-	C	B	C
33.	Columbia University	B-	C	A	C	A	C
34.	Loyola	B-	C-	B+	B-	B	B+
35.	Rush Medical College	B-	B	B-	C+	C	C
36.	Oregon Health and Science University	B-	A	C	C-	C	C
37.	Washington State University	B-	C+	A	D+	B	C
38.	Medical College of Wisconsin	B-	B	A-	C	B-	D
39.	Albert Einstein School of Medicine	C+	B	D-	B	A	D+
40.	Rosalind Franklin Chicago Medical School	C+	C+	C	B	B	D
41.	The George Washington University	C+	C	B	C+	C	C+

80-100% = A, 60-79% = B, 40-59% = C, 20-39% = D, 0-19% = F

References

- https://www.globalgiving.org/learn/cost-to-end-climate-change/
- https://medsocietiesforclimatehealth.org/reports/medical-alert/
- Roos N, Kovats S, Hajat S, et al. Maternal and newborn health risks of climate change: A call for awareness and global action. Acta Obstet Gynecol Scand. 2021;100:566–570. https://doi.org/10.1111/aogs.14124
- Thomson MC, Stanberry LR. Climate Change and Vectorborne Diseases. N Engl J Med. 2022 Nov 24;387(21):1969-1978. doi: 10.1056/NEJMra2200092. PMID: 36416768.
- Nelson MC, Ingram SE, Dugmore AJ, Streeter R, Peeples MA, McGovern TH, Hegmon M, Arneborg J, Kintigh KW, Brewington S, Spielmann KA, Simpson IA, Strawhacker C, Comeau LE, Torvinen A, Madsen CK, Hambrecht G, Smiarowski K. Climate challenges, vulnerabilities, and food security. Proc Natl Acad Sci U S A. 2016 Jan 12;113(2):298-303. doi: 10.1073/pnas.1506494113. Epub 2015 Dec 28. PMID: 26712017; PMCID: PMC4720298.
- Belsey-Priebe M, Lyons D, Buonocore JJ. COVID-19's Impact on American Women's Food Insecurity Foreshadows Vulnerabilities to Climate Change. Int J Environ Res Public Health. 2021 Jun 26;18(13):6867. doi: 10.3390/ijerph18136867. PMID: 34206797; PMCID: PMC8296854.
- Agostoni C, Baglioni M, La Vecchia A, Molari G, Berti C. Interlinkages between Climate Change and Food Systems: The Impact on Child Malnutrition-Narrative Review. Nutrients. 2023 Jan 13;15(2):416. doi: 10.3390/nu15020416. PMID: 36678287; PMCID: PMC9865989.
- Farooq MS, Uzair M, Raza A, Habib M, Xu Y, Yousuf M, Yang SH, Ramzan Khan M. Uncovering the Research Gaps to Alleviate the Negative Impacts of Climate Change on Food Security: A Review. Front Plant Sci. 2022 Jul 11;13:927535. doi: 10.3389/fpls.2022.927535. PMID: 35903229; PMCID: PMC9315450.
- Rio P, Caldarelli M, Gasbarrini A, Gambassi G, Cianci R. The Impact of Climate Change on Immunity and Gut Microbiota in the Development of Disease. Diseases. 2024 Jun 3;12(6):118. doi: 10.3390/diseases12060118. PMID: 38920550; PMCID: PMC11202752.
- Leddin D. The Impact of Climate Change, Pollution, and Biodiversity Loss on Digestive Health and Disease. Gastro Hep Adv. 2024 Mar 2;3(4):519-534. doi: 10.1016/j.gastha.2024.01.018. PMID: 39131722; PMCID: PMC11307547.
- Muhling BA, Jacobs J, Stock CA, Gaitan CF, Saba VS. Projections of the future occurrence, distribution, and seasonality of three *Vibrio* species in the [illegible] under a high-emission climate change scenario. Geohealth. 2017 Sep 26;1(7):278-296. doi: 10.1002/2017GH000089. PMID: 32158993; PMCID: PM[illegible]
- https://map.feedingamerica.org/county/2022/senior-60-plus
- R. Zhu, Z. Zhang, N. Zhang, H. Zhong, F. Zhou, X. Zhang, C. Liu, Y. Huang, Y. Yuan, Y. Wang, C. Li, H. Shi, M.C. Rillig, F. Dang, H. Ren, Y. Zhang, & B. Xi [illegible] estimate of multiecosystem photosynthesis losses under microplastic pollution, Proc. Natl. Acad. Sci. U.S.A. 122 (11) e2423957122, https://doi.org/10.1073/pnas.2423957122 (2025).
- https://refed.org/uploads/refed_roadmap2030-FINAL.pdf

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