Managing the Health Risks of Climate Change

Kristie L. Elbi, Ph.D., MPH

Professor, Global Health

University of Washington

Question for the Viewers

How would you describe your knowledge of the health risks associated with climate change?

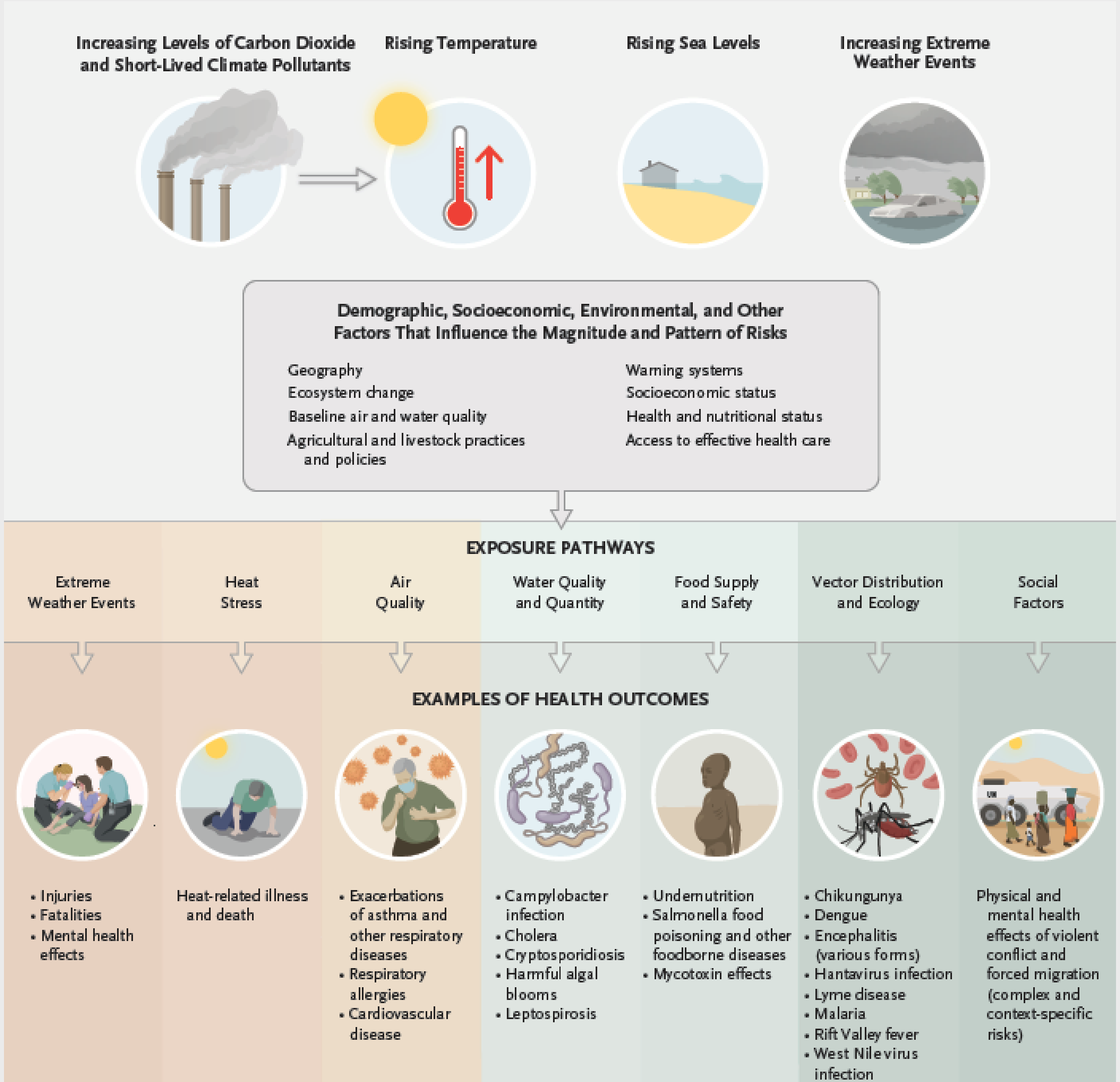
A. Very familiar

B. Somewhat familiar

C. Not at all familiar

D. Other (please type in chat)

IPCC 2022



Haines & Ebi 2019

Key conclusions of the IPCC 2022 chapter on human health

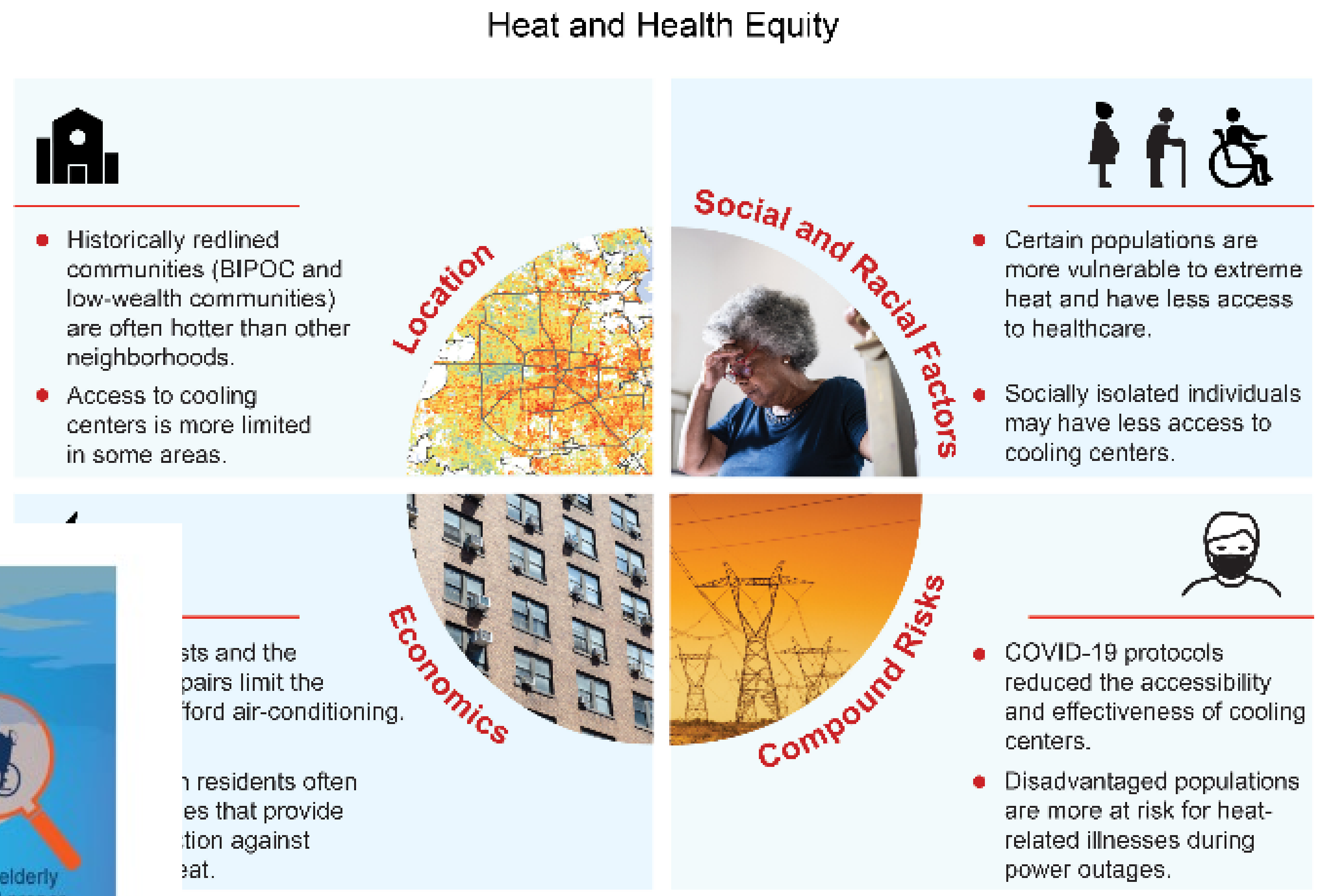
Observed impacts: *climate change is adversely affecting the physical health of people globally and mental health of people in assessed regions*

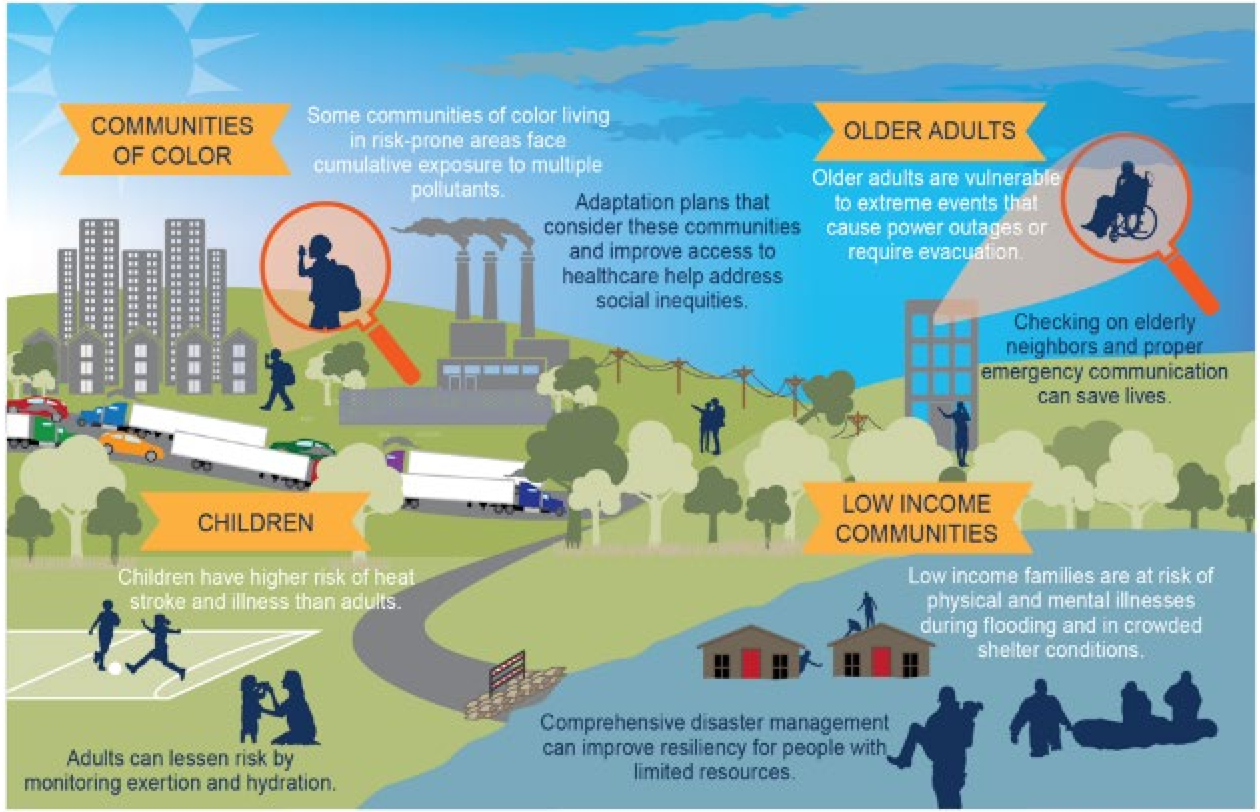
- Extreme heat events
- Vector-borne and zoonotic diseases
- Water and food-borne diseases
- Some mental health challenges
- Health services disrupted by extreme events such as floods

Projected risks

- Extreme events
  - Population exposure to heatwaves: increase with additional warming, strong geographical differences in heat-related mortality
- Food-borne, water-borne, and vector-borne diseases: increase under all levels of warming without additional adaptation
- Mental health (including anxiety and stress): increase in assessed regions

Exposure and vulnerability vary across populations





US NCA4 2018

US NCA5 2023

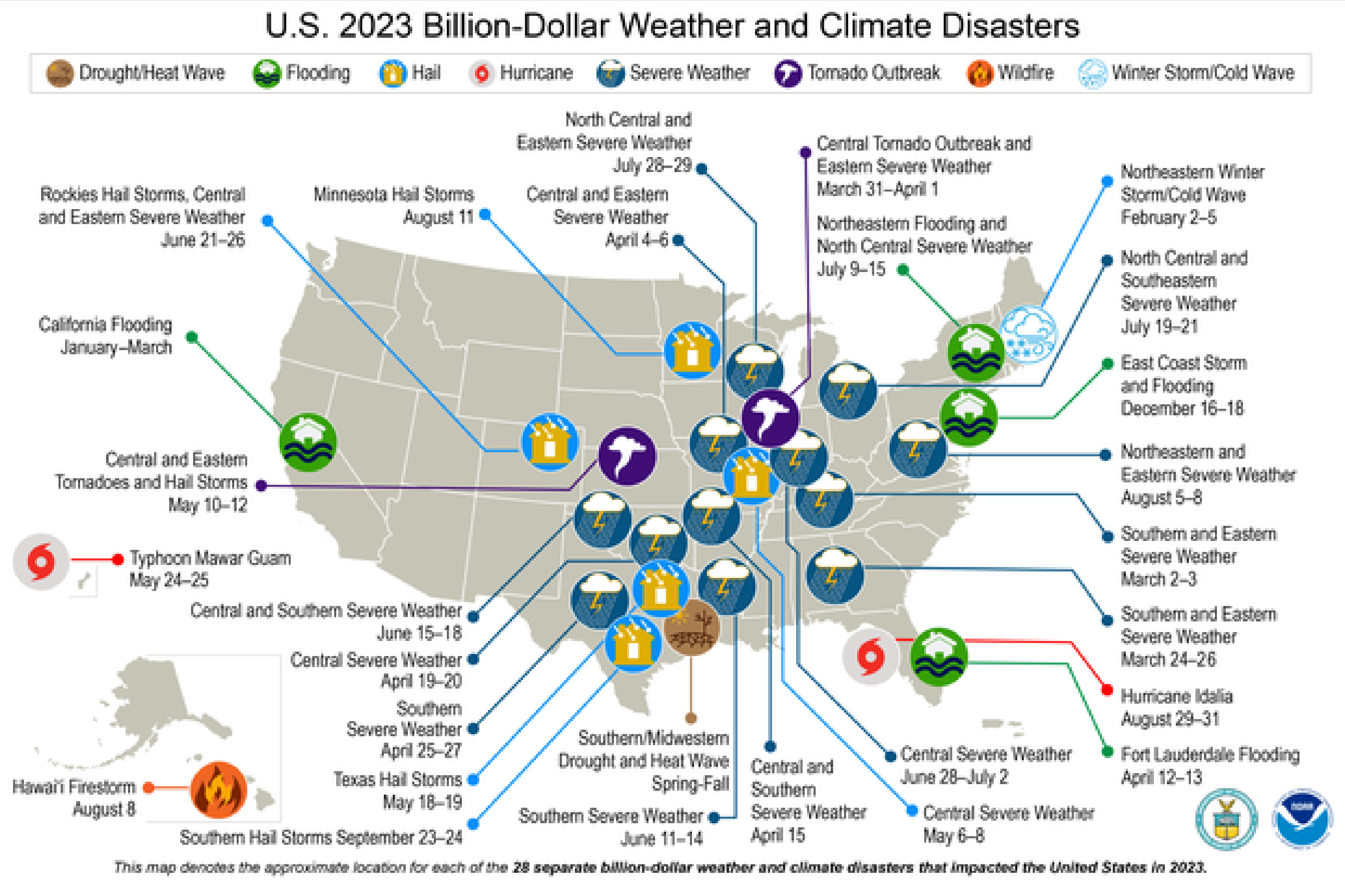
2023 significant economic loss events

USD 93 billion disaster losses in 2023

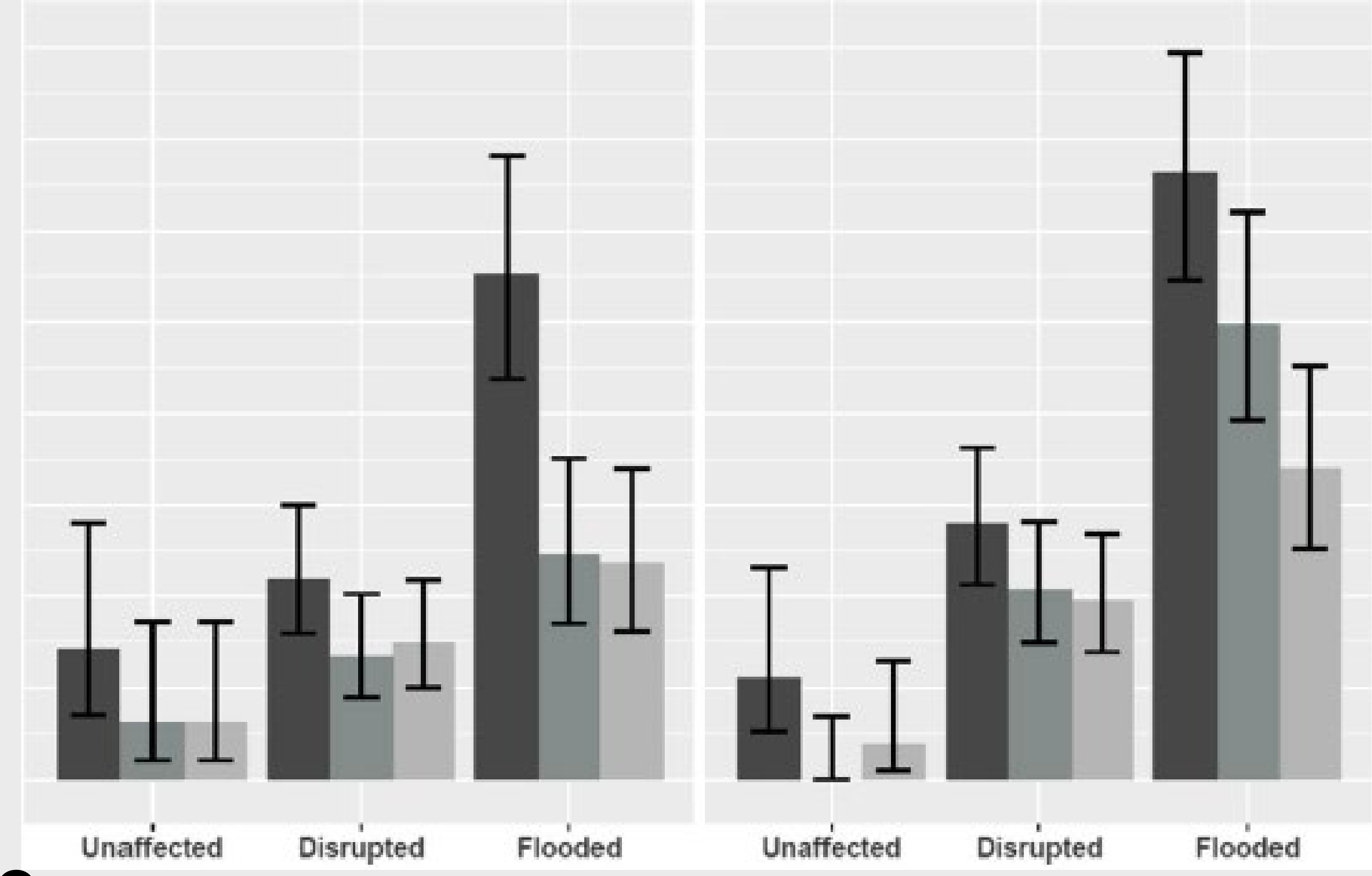
28 separate events

492 direct or indirect fatalities

>47,000 died in heatwaves in Europe



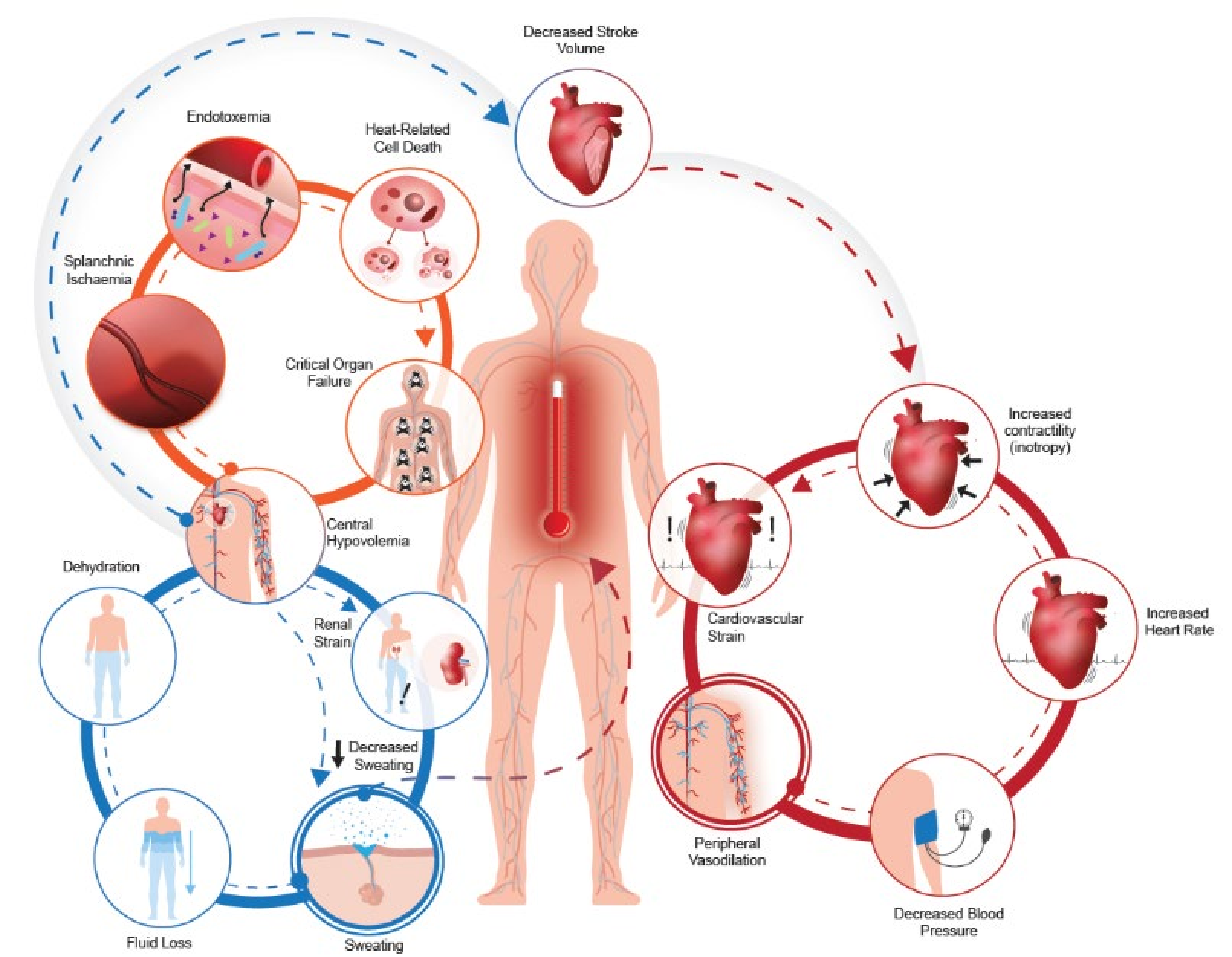
2013-2014 UK winter floods



In year 3, prevalence of probable PTSD in people who were flooded with persistent damage was 30%

Mulchandani et al. 2020

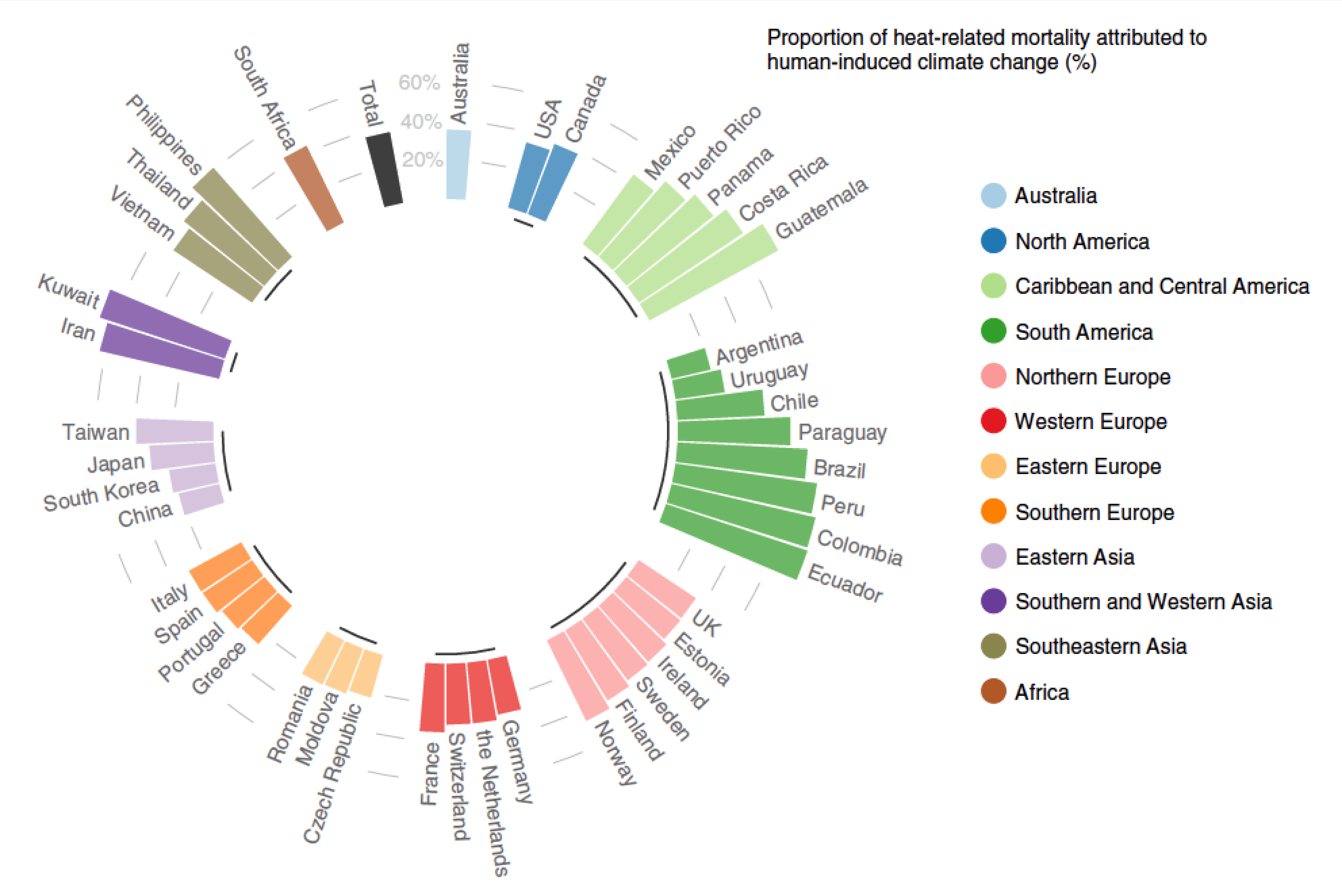
Physiological pathways of human health strain



Ebi et al. 2021

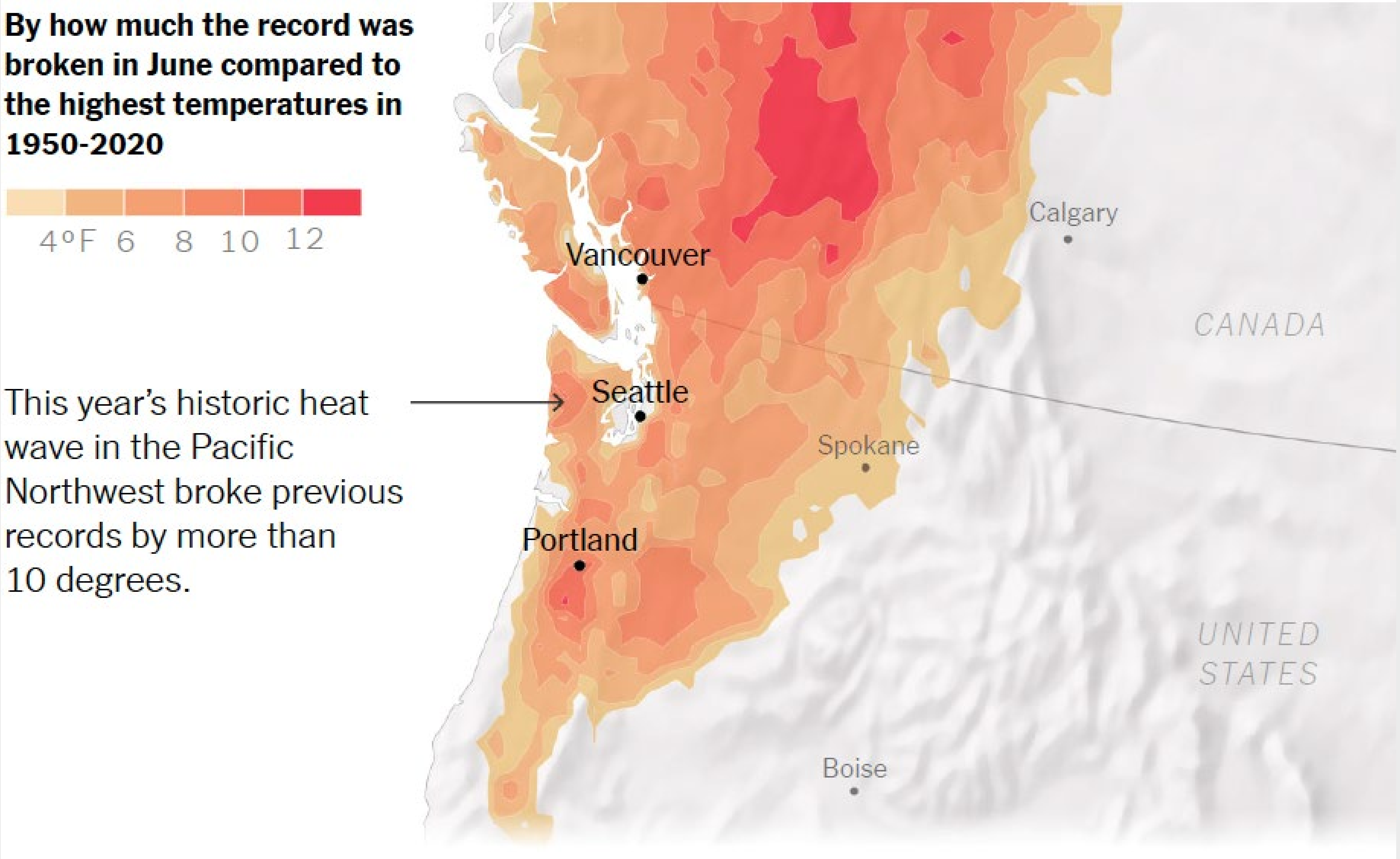
Exposure of vulnerable populations to heatwaves

- In 2013-2022, infants (children younger than 1) and people older than 65 years experienced, on average 108% more heatwave days than compared with 1986-2005
- Compared with 1986-2005, the number of heatwave days increased 94% globally
  - For infants, an increase of 4.4 days per year on average
  - For adults over 65 years, an increase of 4.8 days per year on average
- Combined with demographic changes, total person-days of exposure increased 134% for infants and 228% for older adults



Vicedo et al. 2021

https://www.worldweatherattribution.org



Source: ERA5 reanalysis (Copernicus/ECMWF) by Geert Jan van Oldenborgh.

Sustainable and accessible ways to keep cool

Mitigating climate change is vital, but inevitible rising temperatures means that identifying sustainable cooling strategies is also important. Strategies at the individual scale that focus on cooling the person instead of the surrounding air can be effectively adopted, even in low-resource settings.

Electric fans
- (+) Can provide effective cooling for young healthy adults up to 42°C in 50% humidity
- (−) Effectiveness is reduced with low humidity, and in older adults (>65 years), unless accompanied by self-dousing
- (−) Increases dehydration, but can be offset by drinking an extra glass of water per h

Self-dousing
- (+) Can reduce heat strain and dehydration up to 47°C if dousing is sufficient to keep the skin wet
- (+) Can be used during power outages
- (−) Low compatibility with high clothing coverage

Foot immersion*
- (+) Can reduce dehydration and thermal discomfort in hot and humid conditions
- (+) Can be used during power outages
- (−) Risk of slips and falls

* Feet immersed above the ankles in 20°C water

Wet clothing
- (+) Provides high evaporative heat loss without needing to sweat
- (+) Can be used during power outages
- (−) Clothing must be re-soaked roughly every 60 min

Electric fans can be used below these temperatures irrespective of humidity: 39°C Healthy young adults (aged 18 to 40 years); 38°C Healthy adults (aged over 65); 37°C Over 65s taking anti-cholinergic medication

Evaporative coolers
- (+) Can cool air temperatures in dry conditions
- (−) Minimal effect in high humidity
- (−) Risks creating mosquito breeding sites without proper maintainence

Misting fans
- (+) Lowers air temperatures in hot and dry conditions
- (−) Must be used in well ventilated or outdoor areas otherwise humidity increases offset any benefit
- (−) Risk of slips and falls

Ice towels*
- (+) Can reduce core temperature and cardiovascular strain in conditions up to 45°C
- (−) Requires access to ice
- (−) Labour-intensive to prepare

* Crushed ice wrapped in a damp towel applied to the neck and chest

Cold water ingestion
- (+) Can provide internal cooling
- (+) Water should be ingested at a temperature that is most palatable (~10°C) to ensure optimal hydration
- (−) If person has already started sweating, not effective at lowering core temperature

Read the full paper: Jay O, Capon A, Berry P, et al. Reducing the health effects of hot weather and heat extremes: from personal cooling strategies to green cities. The Lancet 2021. Published online August 19

Sustainable cooling strategies to protect health in heat-vulnerable settings

Heat extremes and hot weather are harming health. While mitigating climate change is vital, the inevitble rise in global temperature is expected to exacerbate these harms in future, and identifying opportunities for applying sustainable cooling strategies in heat-vulnerable settings is also important

	Aged care homes	Workplaces	Schools	Playing sports	Mass gatherings	Refugee camps	Slums
Individual-level strategies							
Electric fans	● [1]	●	●				
Self-dousing	●	●	●	●	●	● [2]	● [2]
Foot immersion	●						● [2]
Drinking cold water[3]	●	●	●	●	●		
Optimising clothing	●	● [4]	●	● [4]	●	●	●
Evaporative coolers	●	●	●				
Ice towels	●			●			
Wet clothing	●			●		●	

1=to be used up to 38°C; 2=if water sanitation allows; 3=at a temperature that is most palatable (eg, ~10°C); 4=without compromising any required protective equipment

	Aged care homes	Workplaces	Schools	Playing sports	Mass gatherings	Refugee camps	Slums
Building-level and urban-level strategies							
Adequate natural ventilation	●	●	●	●		●	●
Improved construction materials	● [5]	●	●	● [6]		● [7]	● [8]
Outdoor misting fans				●	●		
Rooftop sprinklers	●	●	●				
Shaded areas	●	●	●	●	●	●	●

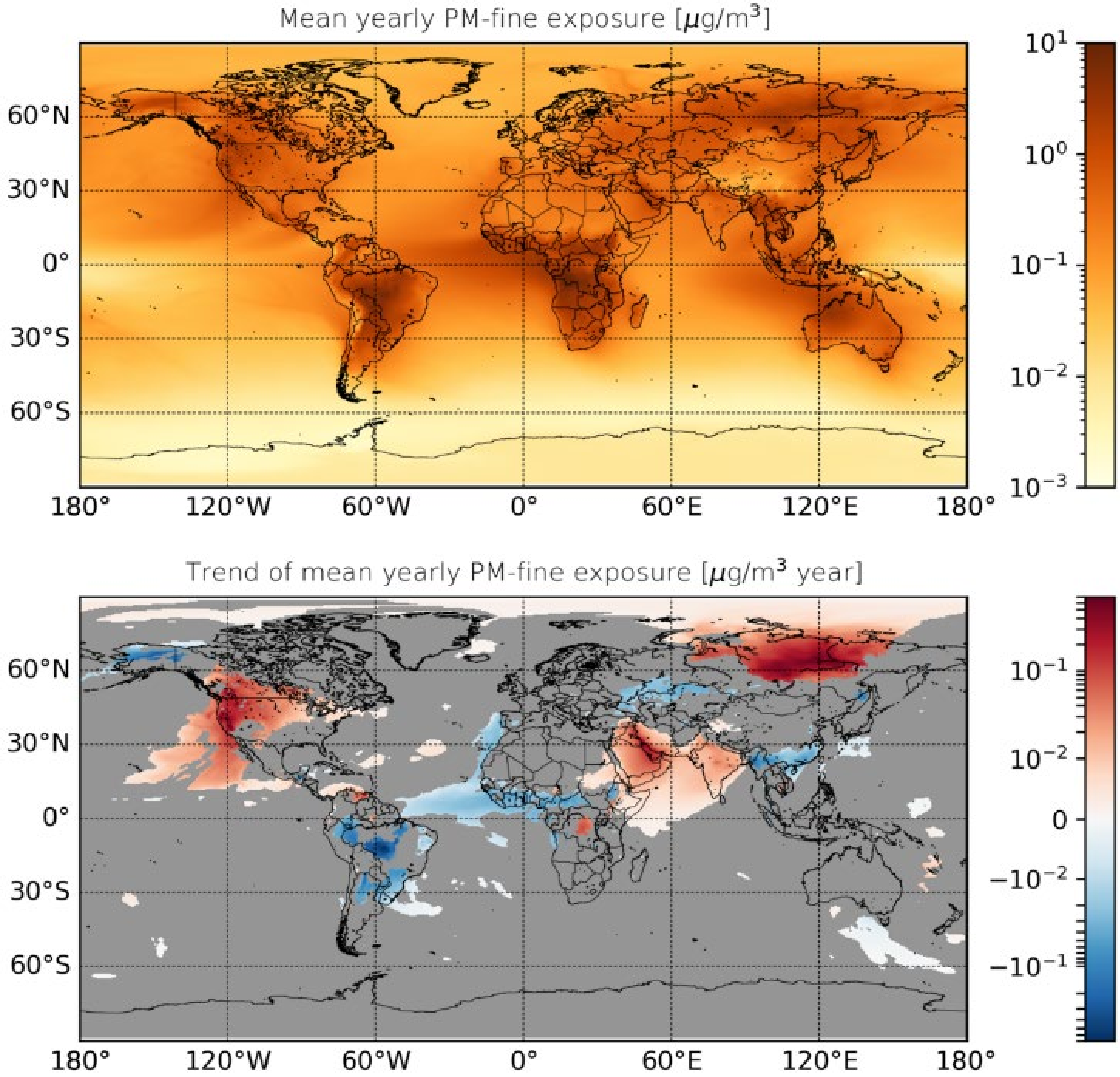
5=heat-reflective window glass; 6=playing surfaces that minimise heat retention and emitted radiation; 7=breathable tents; 8=insulating roofs and walls

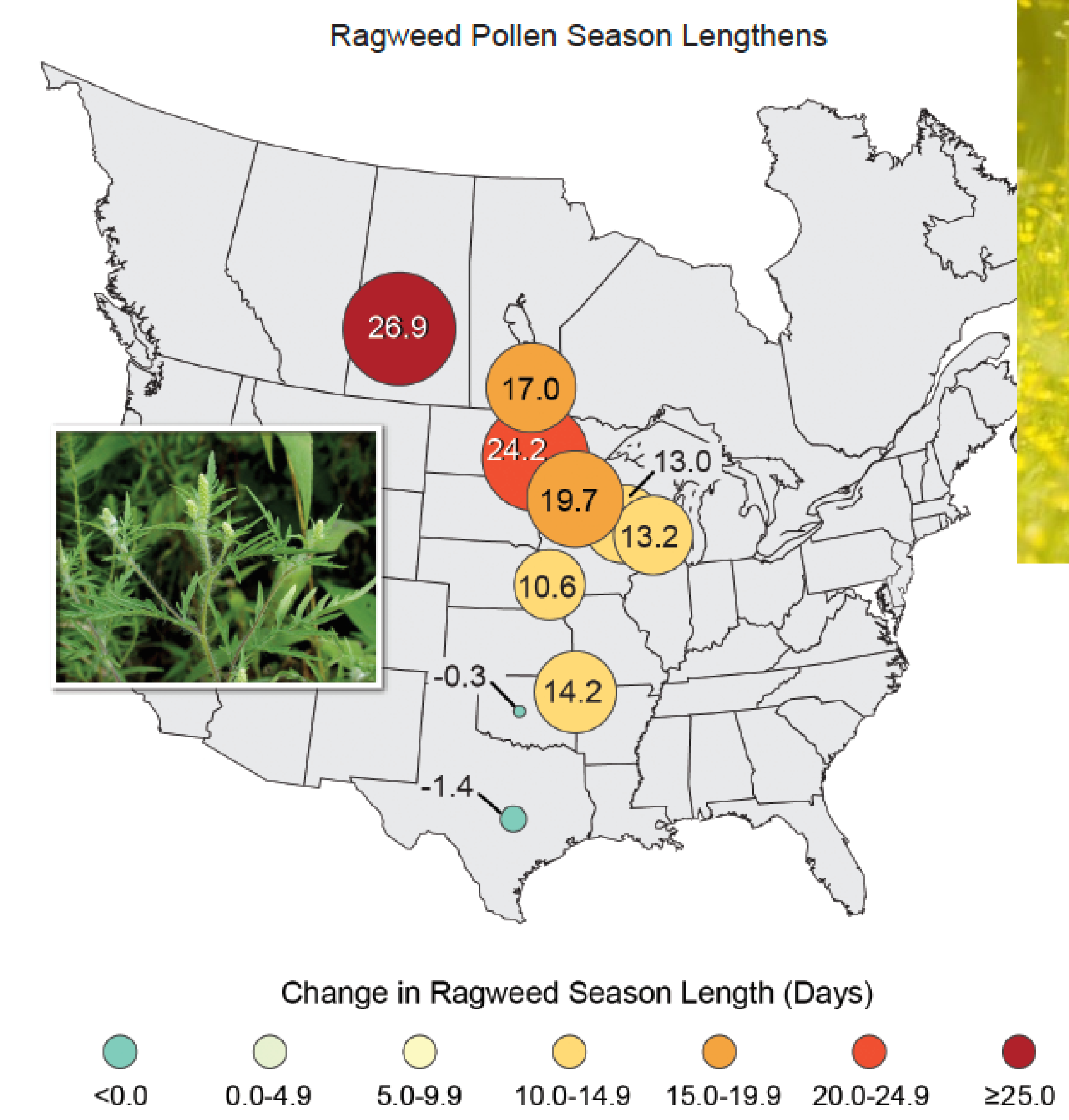
	Aged care homes	Workplaces	Schools	Playing sports	Mass gatherings	Refugee camps	Slums
Other strategies							
Extra physical activity breaks		●		●			
Hydration monitoring	●	●					

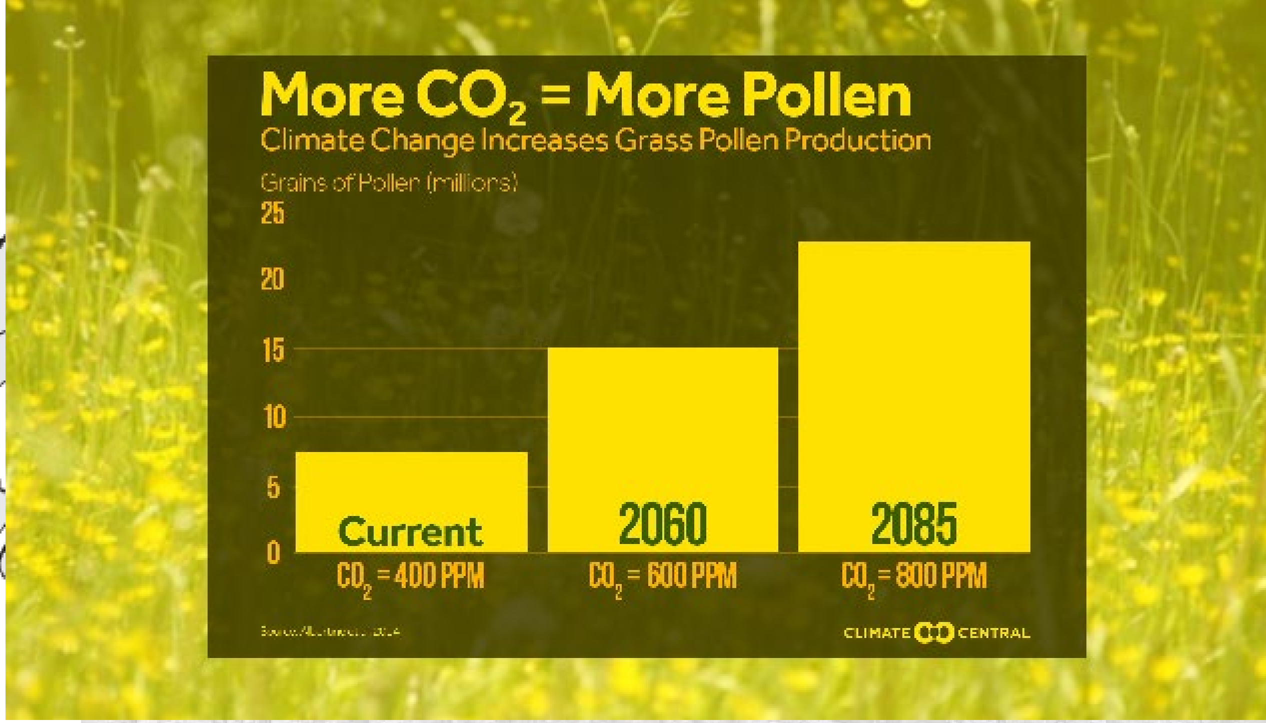
Read the full paper: Jay O, Capon A, Berry P, et al. Reducing the health effects of hot weather and heat extremes: from personal cooling strategies to green cities. The Lancet 2021. Published online August 19

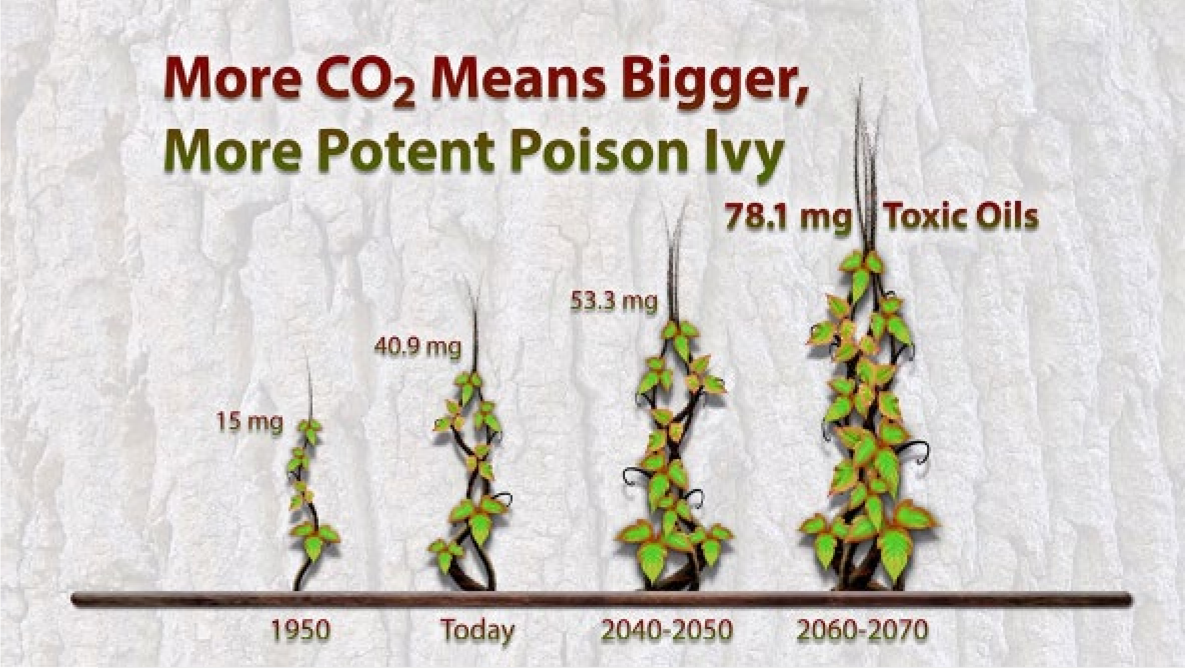
Jay et al. 2021

Gridded mean personal exposure to fire-induced PM and its 2003-2021 trend; only significant trends shown

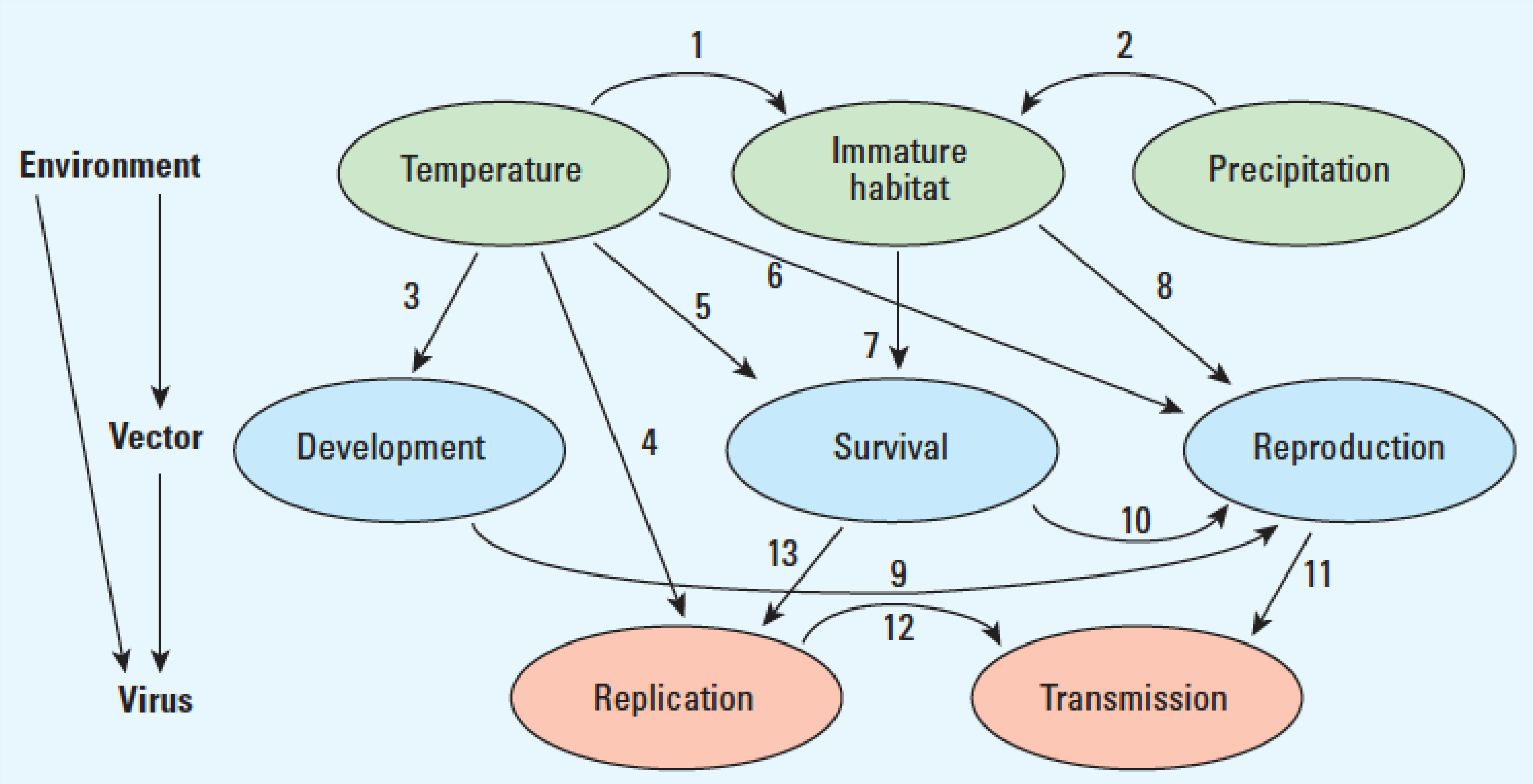



Ragweed Pollen Season Lengthens
26.9
17.0
24.2
19.7
13.0
13.2
10.6
-0.3
14.2
-1.4
Change in Ragweed Season Length (Days)
<0.0
0.0-4.9
5.0-9.9
10.0-14.9
15.0-19.9
20.0-24.9
≥25.0


More CO2 = More Pollen
Climate Change Increases Grass Pollen Production
Grains of Pollen (millions)
25
20
15
10
5
0
Current
2060
2085
CO2 = 400 PPM
CO2 = 600 PPM
CO2 = 800 PPM
CLIMATE CENTRAL


More CO2 Means Bigger,
More Potent Poison Ivy
78.1 mg Toxic Oils
53.3 mg
40.9 mg
15 mg
1950
Today
2040-2050
2060-2070

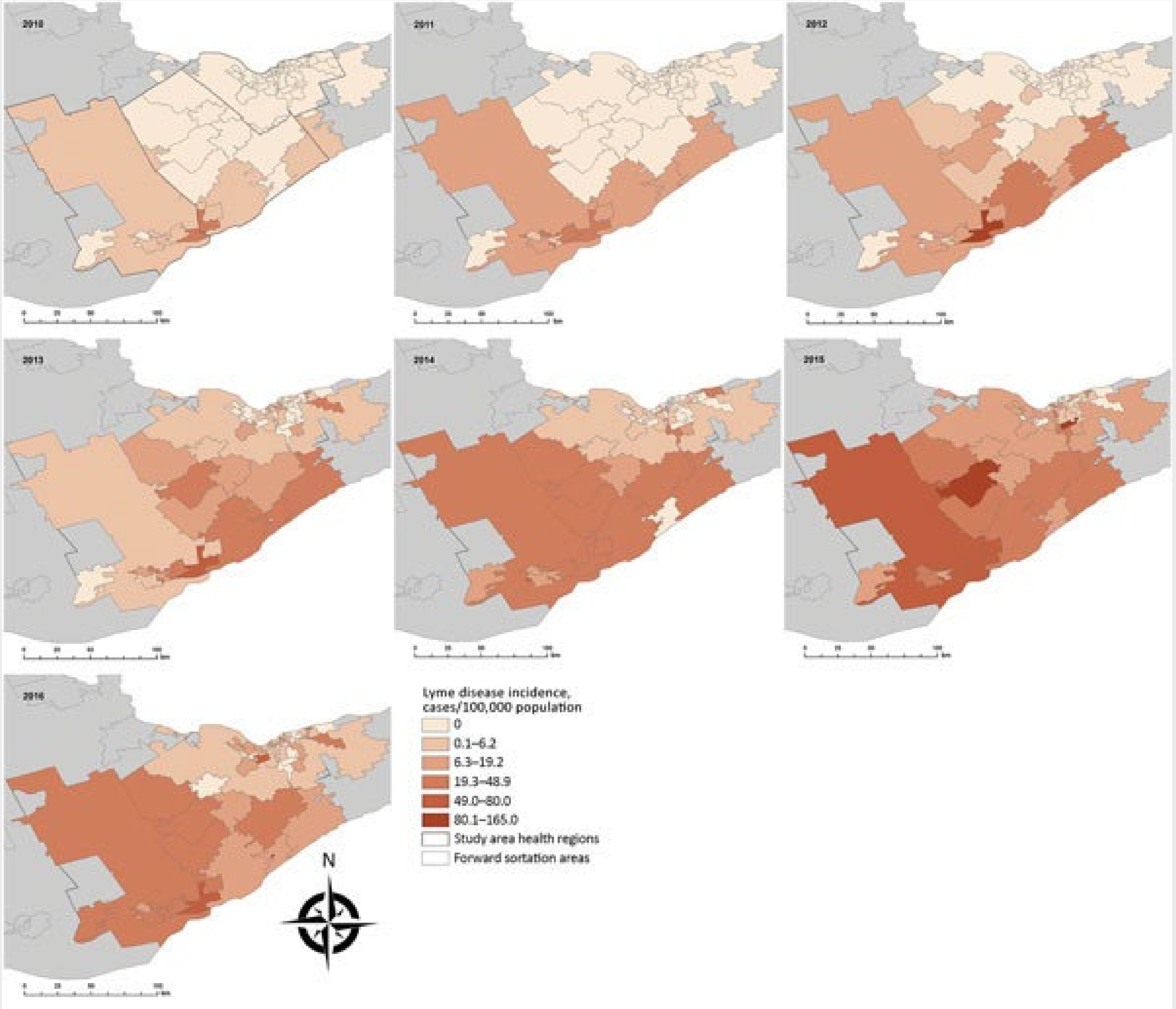
Biophysical influences on dengue ecology showing the interactions between climate variables, vectors, and the virus



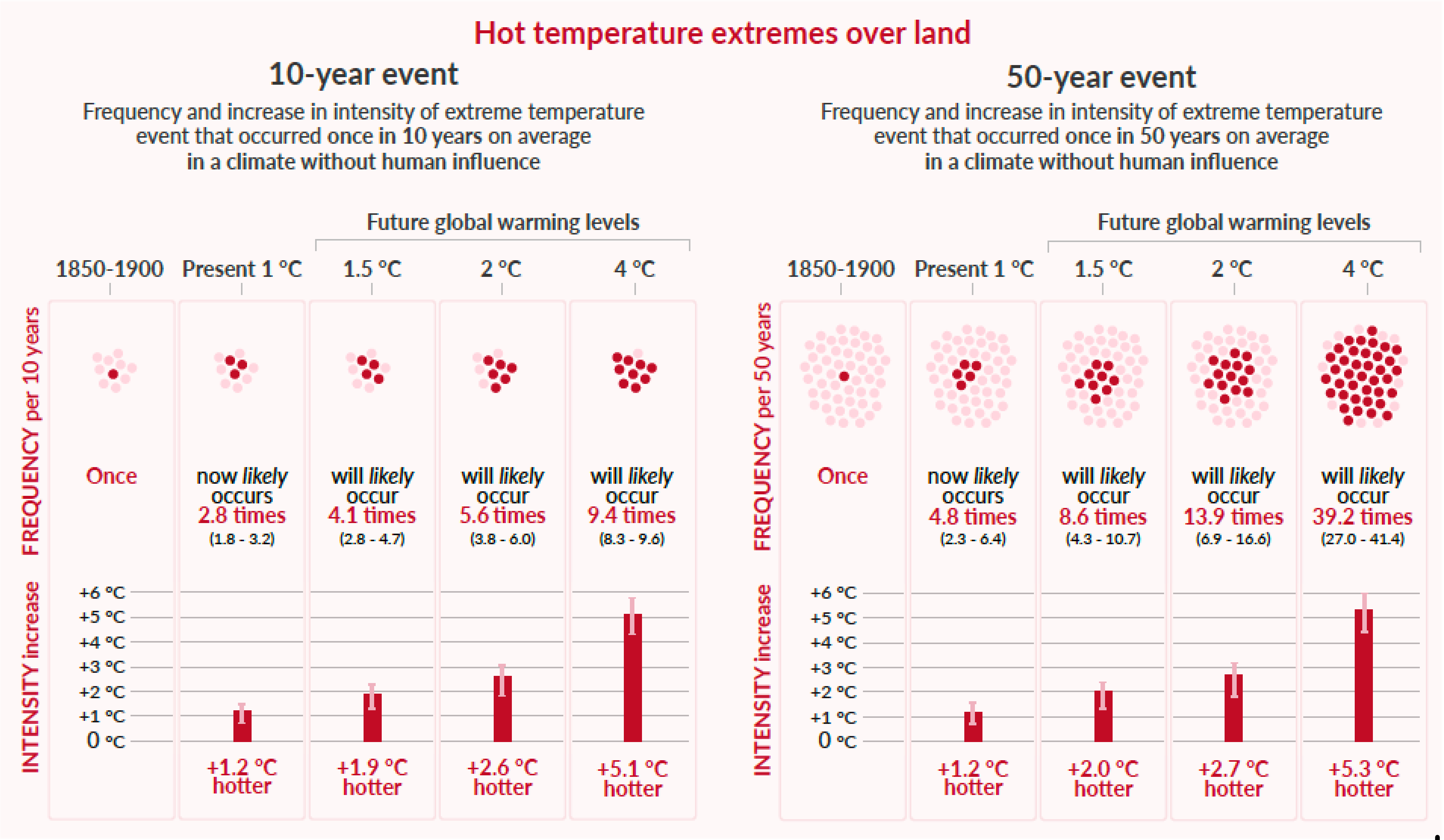
Morin et al. 2013

Spatiotemporal spread of human Lyme disease incidence, 2010-2016, three public health units in Eastern Ontario

Kulkarni et al. 2019



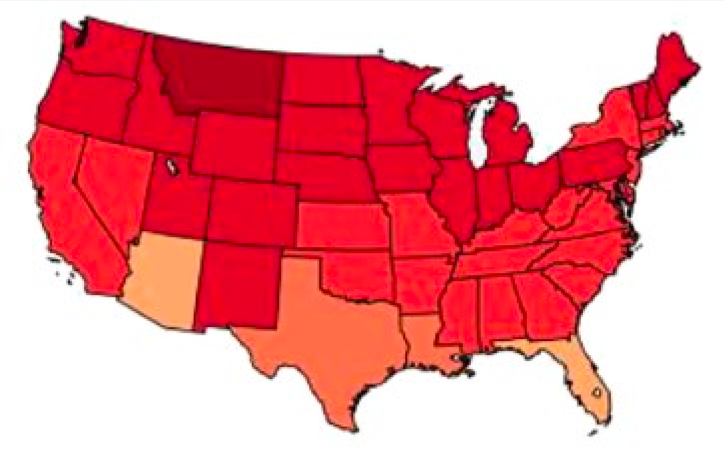
Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming

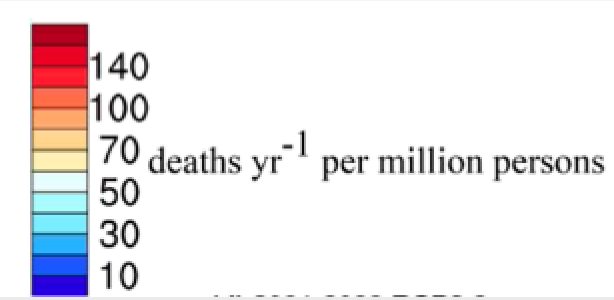


IPCC WGI 2021

Projected annual heat-related deaths in 2091-2099

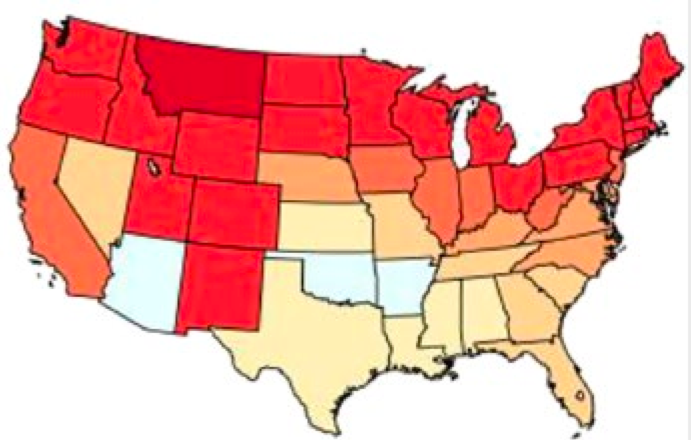
No adaptation; high emissions





No adaptation; low emissions

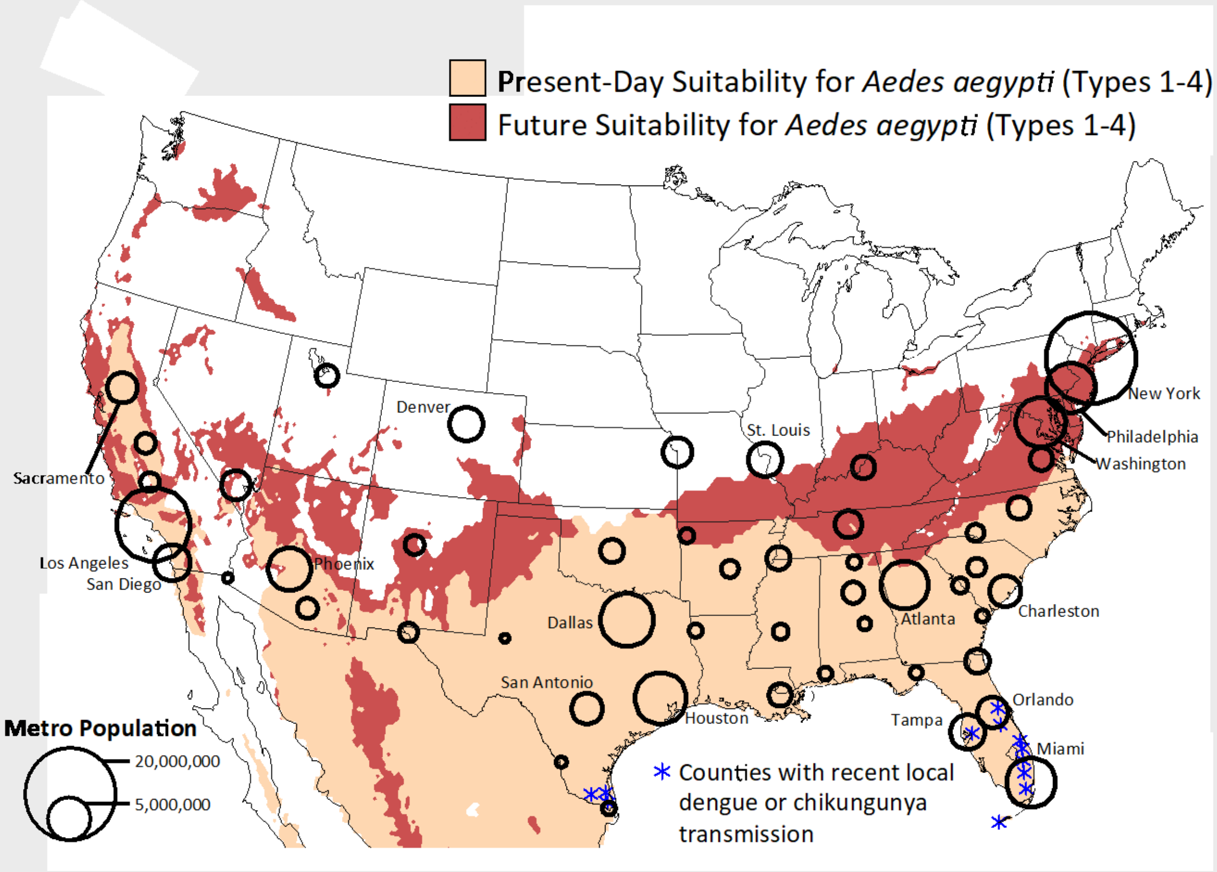
Adaptation; high emissions



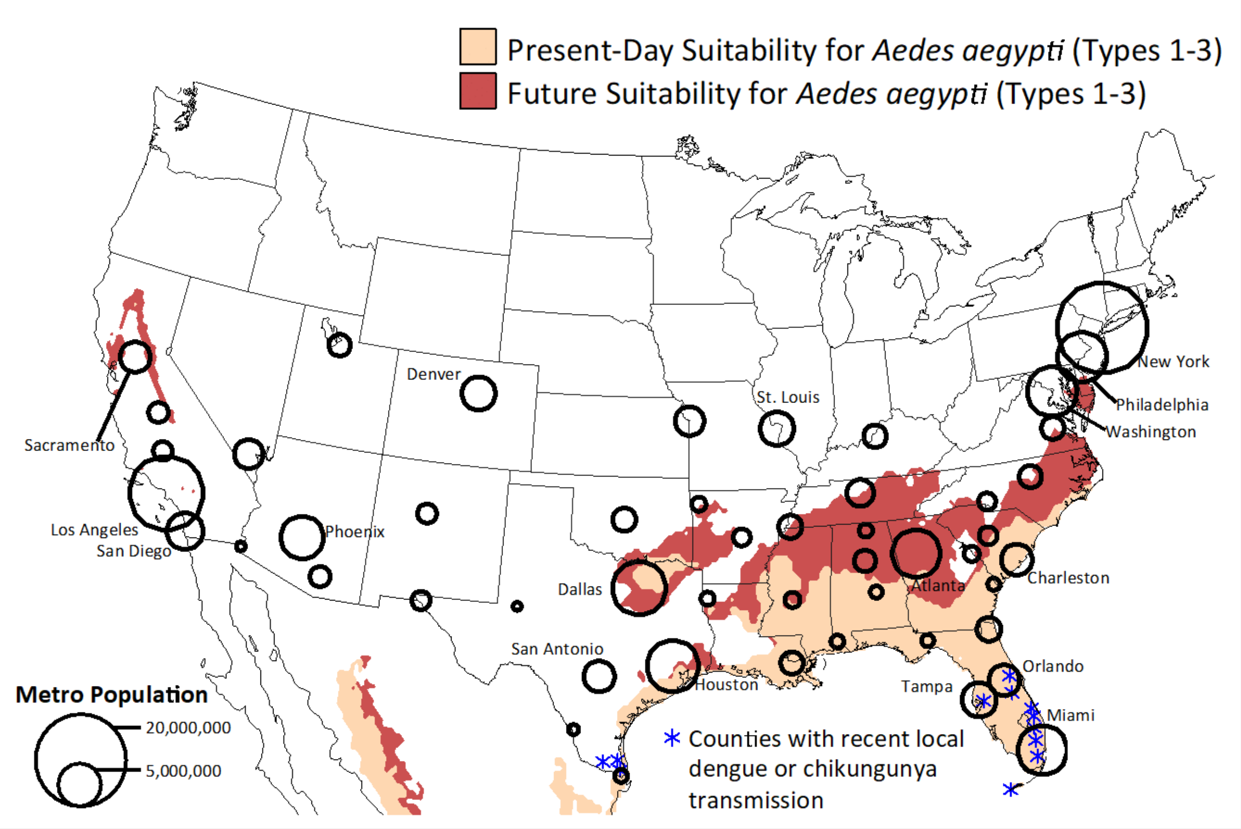
Adaptation; low emissions

Shindell et al. 2020

Ae. aegypti suitability



Ae. aegypti transmission suitability

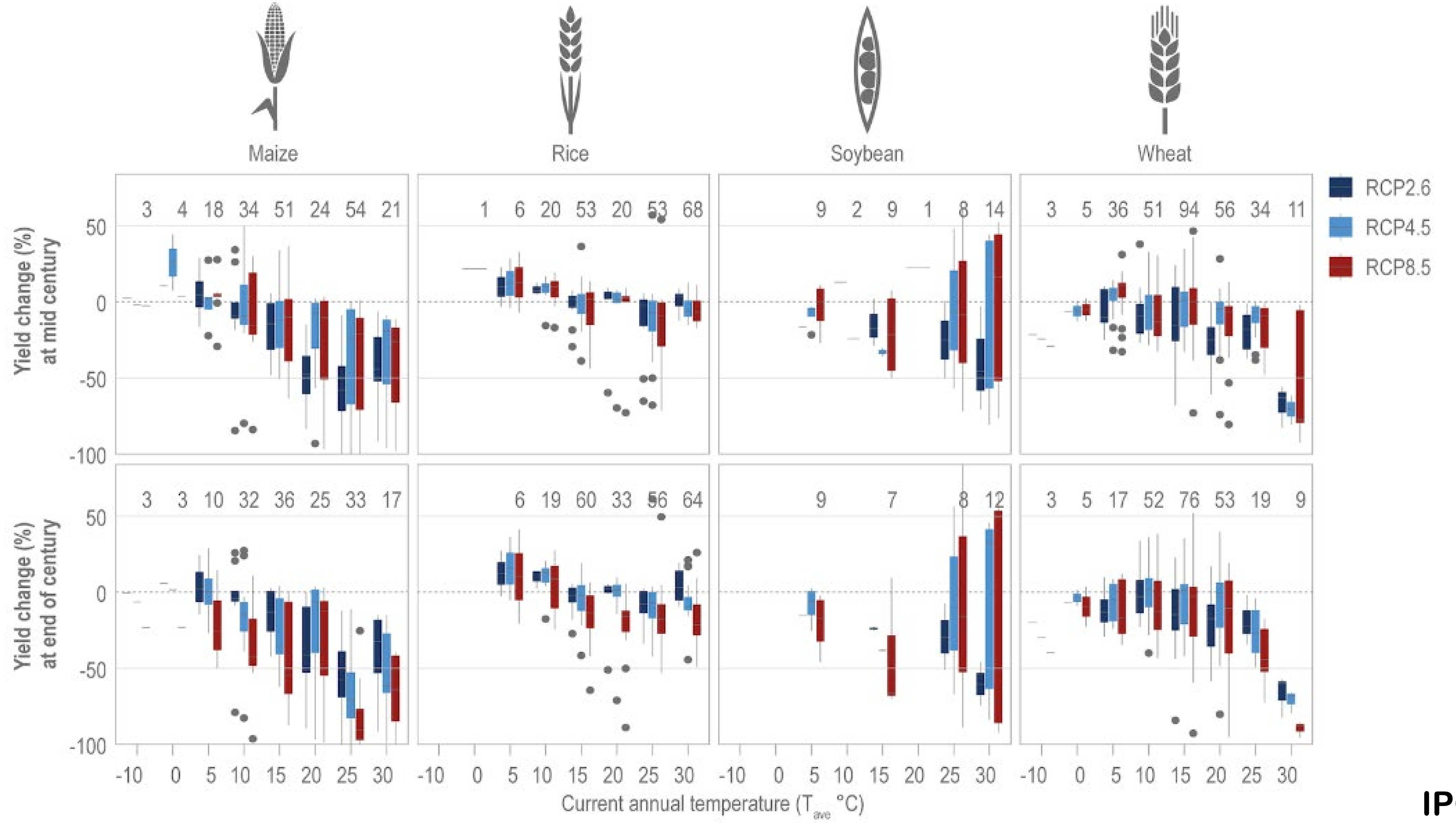


Map shows the range of the *Aedes aegypti* mosquito for present-day (1950-2000) and future (2061-2080; RCP8.5) conditions. Larger cities have higher potential for travel-related virus introduction and local virus transmission. Adapted from: Monaghan et al. (2016)

Projected yield changes relative to the baseline period (2001–2010) without adaptation and with CO_2 fertilization effects

Numbers are the number of simulations

(a) As a function of current annual temperature (T_{ave})



IPCC 2022

Higher CO2 concentrations alter the nutritional quality of C3 plants

CO_2 promotes plant growth

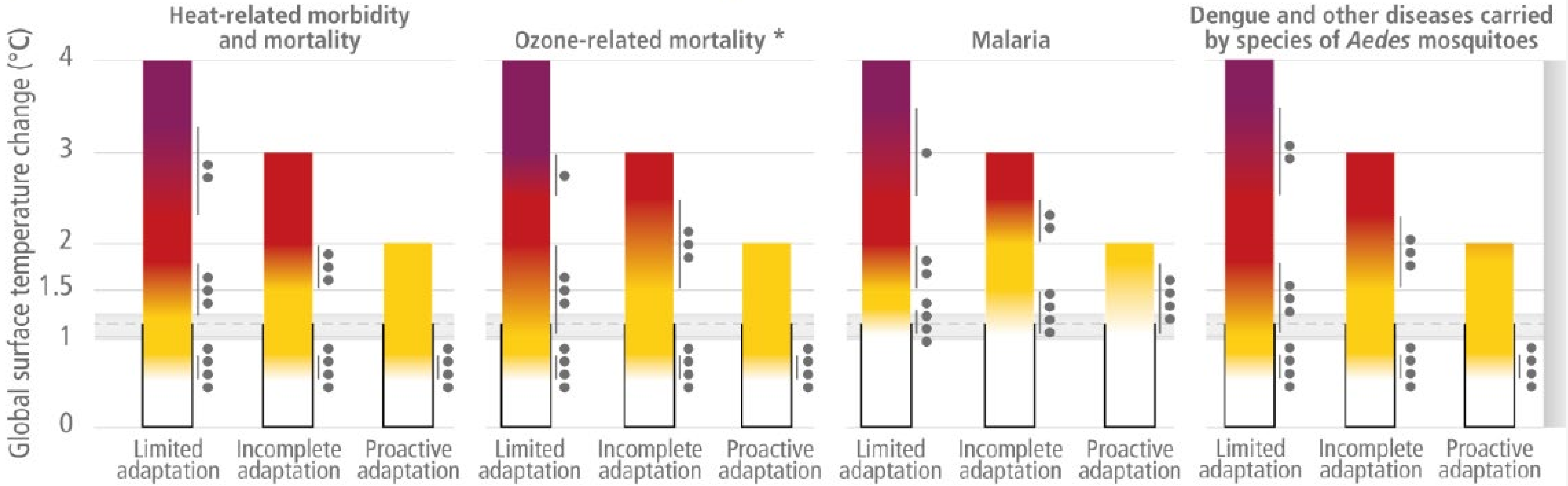
Less protein and essential micronutrients

- Protein (~~ -10%)
- B-vitamins (on average ~~ -30%)
- Micronutrients (~~ -5%)

More carbohydrates

Malnutrition "Hidden Hunger"

(e) Climate sensitive health outcomes under three adaptation scenarios



* Mortality projections include demographic trends but do not include future efforts to improve air quality that reduce ozone concentrations.

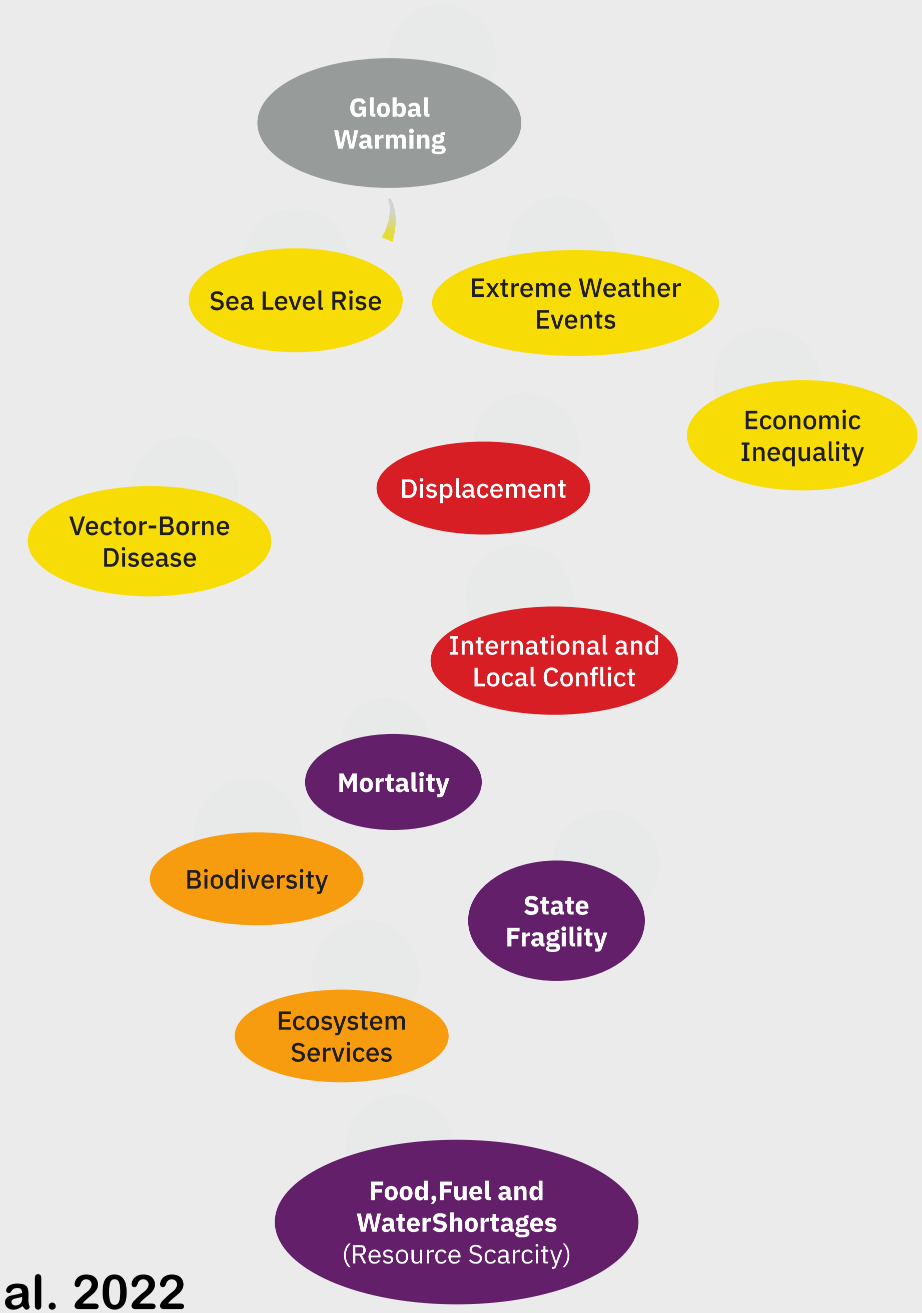
Scenario narratives

Limited adaptation: Failure to proactively adapt; low investment in health systems

Incomplete adaptation: Incomplete adaptation planning; moderate investment in health systems

Proactive adaptation: Proactive adaptive management; higher investment in health systems

Cascading global climate failures



Kemp et al. 2022

- **Extreme temperatures, droughts leading to crop failures and undernutrition increasing vulnerability to infectious diseases**
- **Floods, storms, and droughts leading to displacement increasing infectious disease outbreaks, including dengue and leishmaniasis**

Semenza et al. 2022

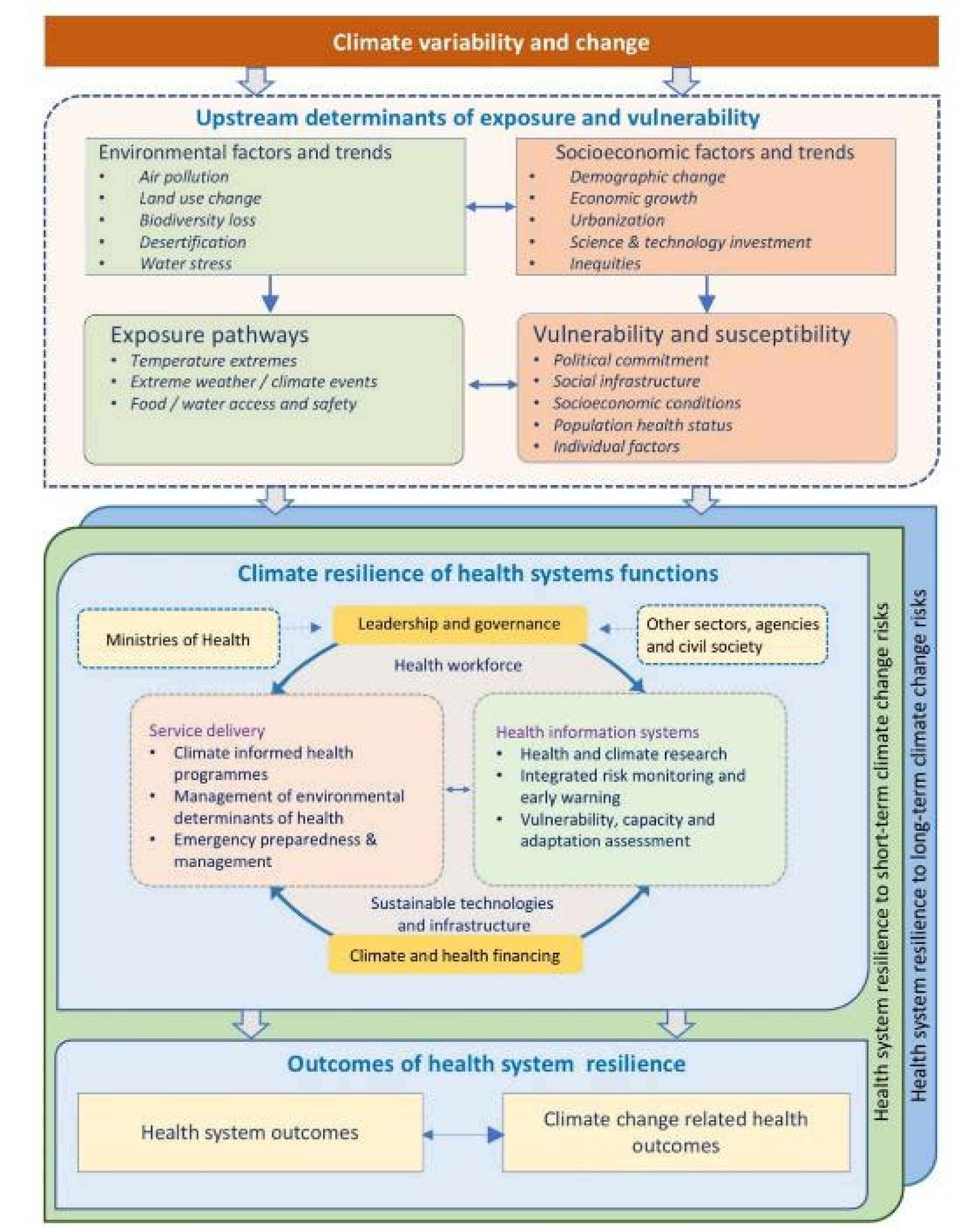
Effective adaptation options include

- Strengthening the resiliency of health systems
- Protect against exposure to climate hazards, particularly for those at highest risk
  - Heat Action Plans that include early warning and response systems
- Improve access to potable water, reducing exposure of water and sanitation systems to flooding and extreme weather and climate events, and improving early warning systems
- For mental health, improve surveillance, access to mental health care, and monitoring of psychosocial impacts from extreme weather and climate events
- Integrated adaptation approaches that mainstream health into food, livelihoods, social protection, infrastructure, water and sanitation policies

** Major constraint is limited investment

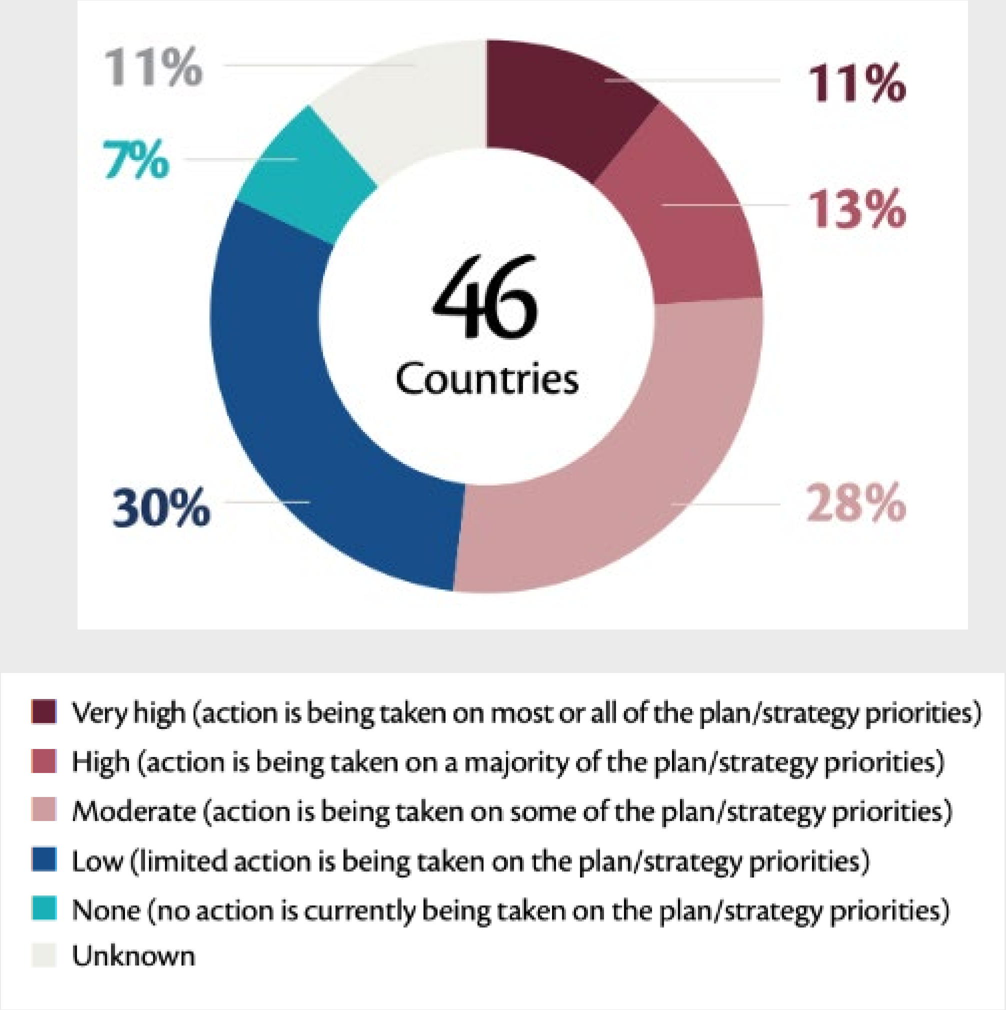
WHO framework for promoting climate-resilient health systems

- Recognize upstream determinants
- Systems-based approach to promoting climate-resilient health systems
- Health system and climate change health outcomes

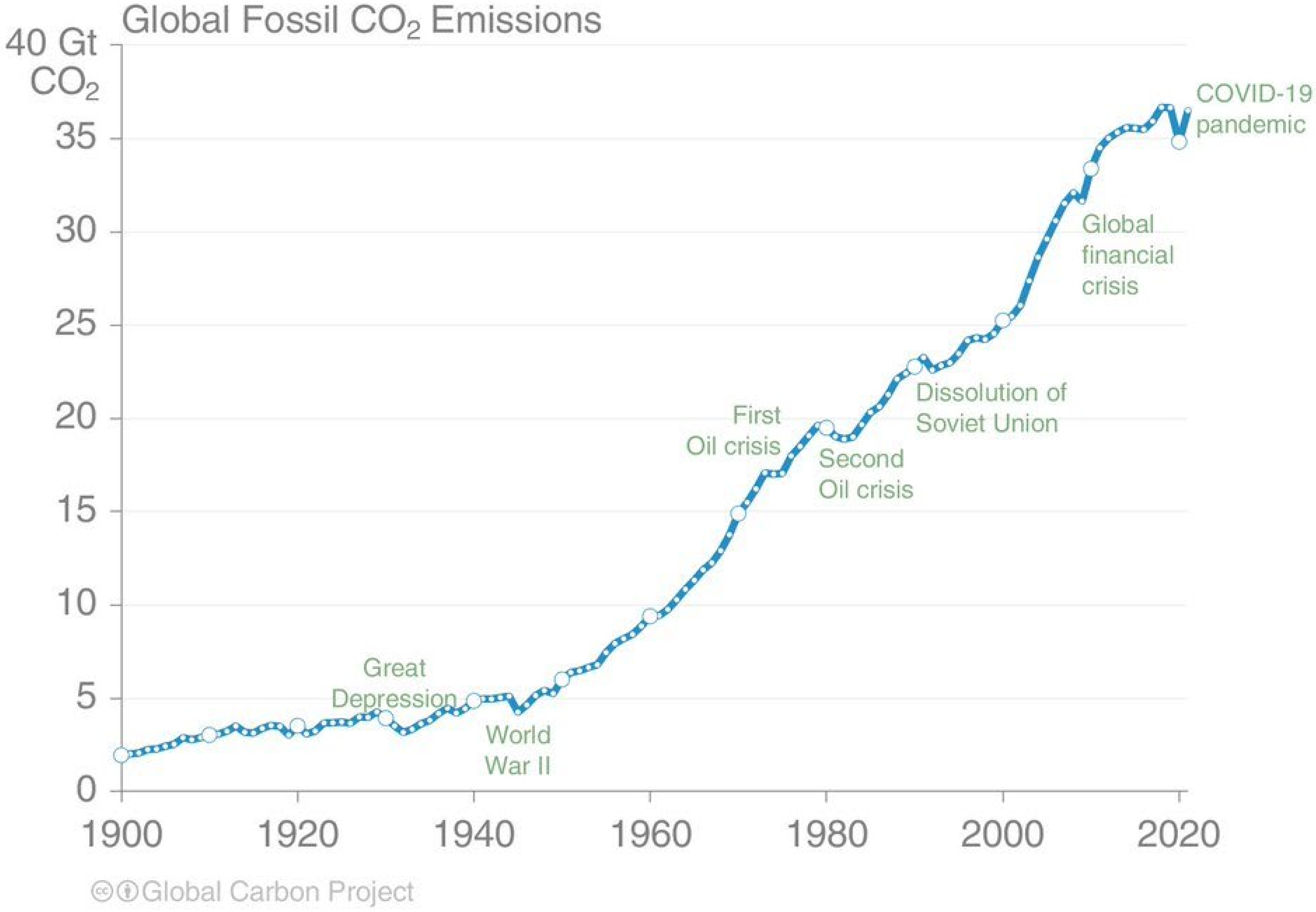


National health and climate change strategies

- In 2021, 49 of 95 countries reported having a national health and climate change strategies or plans in place
  - 48 had completed a V&A
  - Of which, 18 reported that the findings strongly influenced health policy
  - Only 9 reported that the findings strongly influenced resource allocation
  - Implementation remains a challenge, as well as equity issues – e.g., inclusion of gender considerations is limited

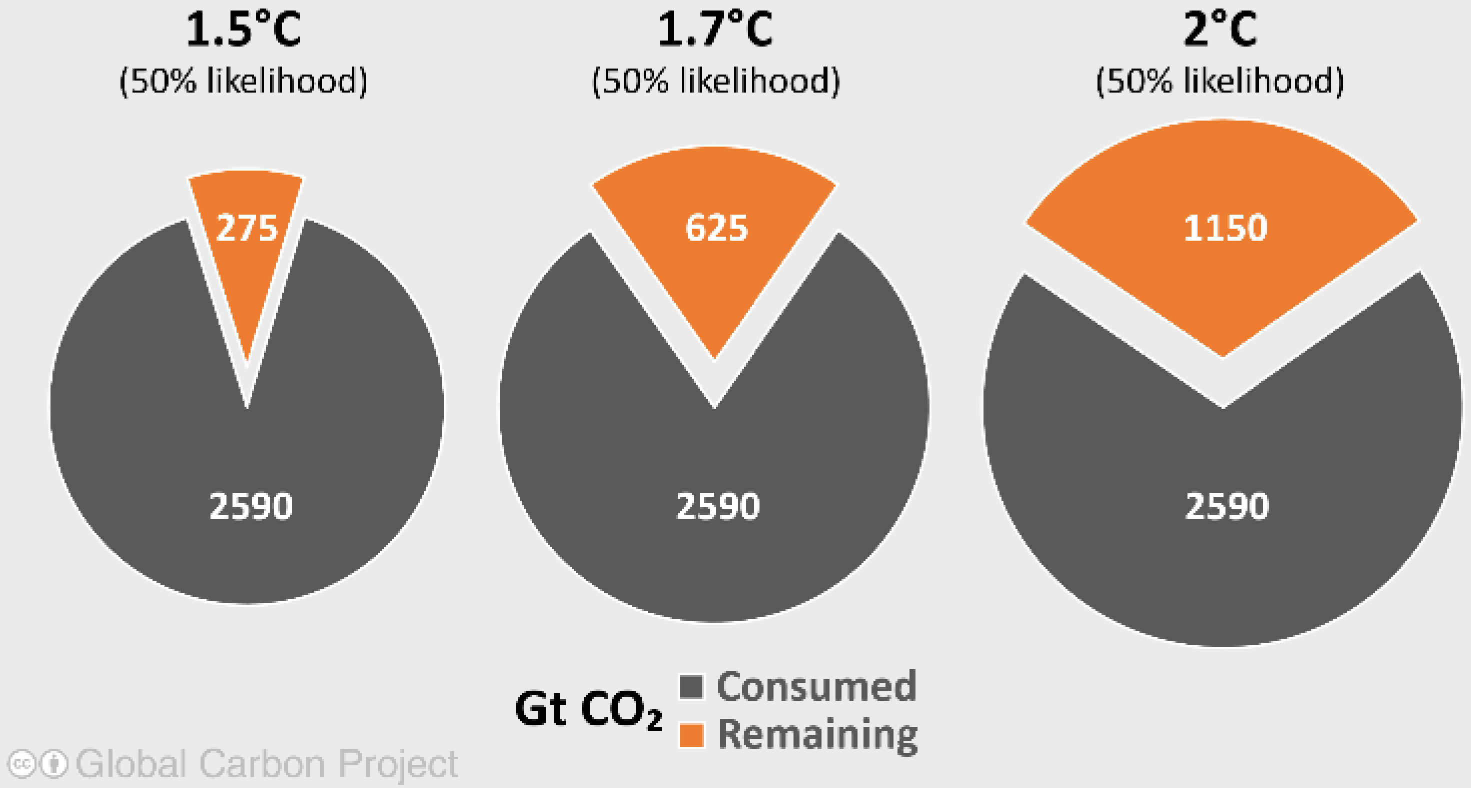


2022 Report of the Lancet Countdown; 2021 WHO Health and Climate Change Global Survey


Global Fossil CO_2 Emissions
40 Gt CO_2
35
30
25
20
15
10
5
0
1900
1920
1940
1960
1980
2000
2020
Great Depression
World War II
First Oil crisis
Second Oil crisis
Dissolution of Soviet Union
Global financial crisis
COVID-19 pandemic
Global Carbon Project

Remaining carbon budget

The remaining carbon budget to limit global warming to 1.5°C , 1.7°C and 2°C is
275 $GtCO_2$, 625 $GtCO_2$, and 1150 $GtCO_2$ respectively, equivalent to 7, 15 and 28 years from 2024.
2590 $GtCO_2$ have been emitted since 1850



The remaining carbon budgets is the average of two estimates (IPCC AR6 and Forster et al., 2023), both updated by removing the most recent emissions.
Quantities are subject to additional uncertainties e.g., future mitigation choices of non-CO_2 emissions
Source: IPCC AR6 WG1; Forster et al., 2023; Friedlingstein et al 2023; Global Carbon Project 2023

ENERGY

(emissions primarily from electricity production for homes, workplaces, schools, and hospitals)

Health benefits that arise from reduced air pollution

Mitigation measures that:
- Develop clean energy technologies
- Improve energy efficiency
- Change the energy system structure
- Expand renewable energy use
- Reduce fossil fuel use

Introduction of global carbon price >
▼ 1M prevented deaths by 2050

▲ 27% US solar energy increase >
US$298B in public-health benefits

AGRICULTURE

(emissions from animal and plant food production, and soil)

Health benefits that arise from eating a low-emissions diet

Mitigation measures that:
- Increase livestock farming efficiency
- Increase sustainable land management and use, eg regenerative agriculture practices
- Reduce fossil fuel use
- Reduce animal-based food production
- Reduce food transportation
- Improve agricultural technology

Transition to plant-based diet >
▼ 70% reduction in GHG emissions
▼ 10% prevented deaths by 2050

Replace 50% meat and dairy in UK >
▼ 37,000 prevented deaths from heart disease and cancer per year

BUILDINGS AND CITIES

(emissions associated with building materials, heating and cooking, and urban planning)

Health benefits that arise from clean and efficient buildings, compact cities, active living and reduced air pollution

Mitigation measures that:
- Reduce fossil fuel-powered energy use and incentivise renewable energy sources
- Increase energy efficiency
- Provide equitable, accessible, and affordable public transport
- Increase safe walking and cycling infrastructure
- Increase use of low-carbon building materials

Energy-efficient measures > reduce CO_2 emissions
▼ 55 Mt

2000–2016 green building standards >
▲ US$5.8B in climate and health benefits

INDUSTRIAL

(emissions from processes used to produce goods and materials)

Health benefits that arise from reduced toxins and air pollution

Mitigation measures that:
- Reduce emissions intensity
- Improve energy efficiency
- Expand renewable energy use
- Reduce fossil fuel use
- Increase the use of low-emission materials

65% renewable energy in China by 2050 >
US$222B worth of health benefits

Electrifying industrial sectors >
▼37M prevented premature deaths by 2060

TRANSPORT

(emissions from cars, buses, trucks, ships, trains, and planes)

Health benefits that arise from reduced air and noise pollution and increased physical activity

Mitigation measures that:
- Decrease the use of motor vehicles
- Where motor vehicles are used, prioritise public over private transport and increase use of low- or zero-emission (eg, electric) models
- Increase active transport (eg, walking, cycling) and public transport

▲ 18 mins increase in walking & cycling per day >
▼ 14% reduction in GHG emissions

Replace 10% car trips with cycling in NZ >
USD$308M saving in health costs

NATURE-BASED SOLUTIONS

(sustainable solutions that are supported by nature and address emissions associated with deforestation and ecosystem degradation)

Health benefits that arise from increased green space and its use

Mitigation measures that:
- Restore and increase land and soil health
- Improve freshwater and marine ecosystems
- Increase forestation, conservation, protected areas and urban greening

30 mins green space use per week >
reduce depression and high blood pressure

▲ 10% increased neighbourhood tree canopy >
▼ 400 prevented premature deaths per year

Bowen & Workman 2022

Co-benefits – early health gains from wise climate moves

Shifting 5% of short urban car trips to bicycles in New Zealand would save annually

- 22 million liters of fuel
- 116 deaths due to increased physical activity (vs. 5 extra road crash deaths)
- $200 million in health costs

ANZJPH 2011

Health co-benefits of clean energy in Wisconsin

- Wisconsin relies on externally-sourced fossil fuels for energy production
- Conversion to in-state clean energy sources:
  - Creates jobs (162,000 net)
  - Increases state GDP (5%)
  - Reduces GHG emissions (valued at $4.6b)
  - Results in substantial health co-benefits (valued at $21.1b) by reducing air pollution

COWS | BUILDING THE HIGH ROAD

Wisconsin Opportunity in Domestic Energy Production: The Economic and Health Benefits of 100% In-State Energy Production

David Abel, COWS, University of Wisconsin – Madison
Katya Spear, COWS, University of Wisconsin - Madison

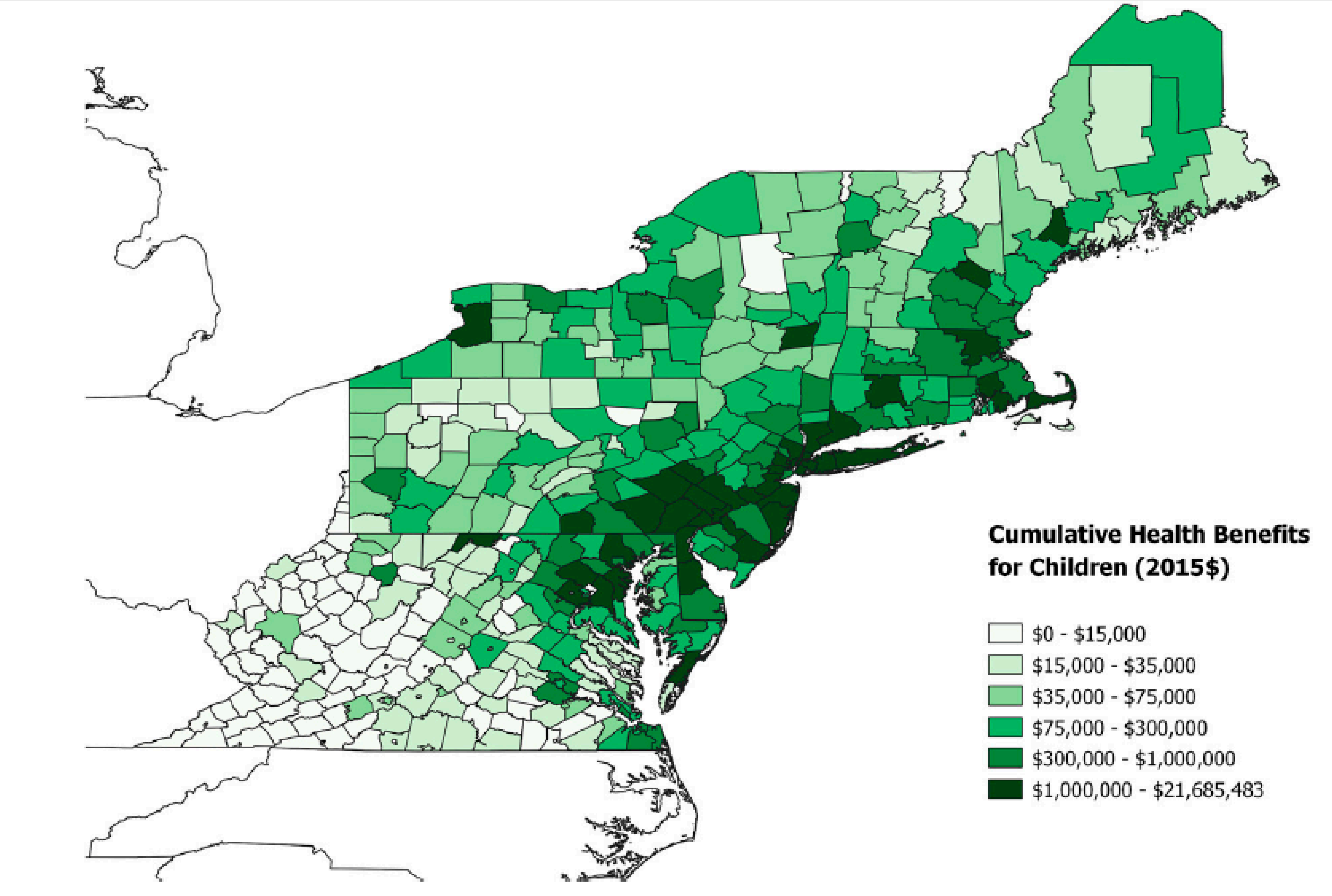
February 4, 2019

Prepared for Nick Nichols, Coordinator the Office of Sustainability, La Crosse County, Wisconsin

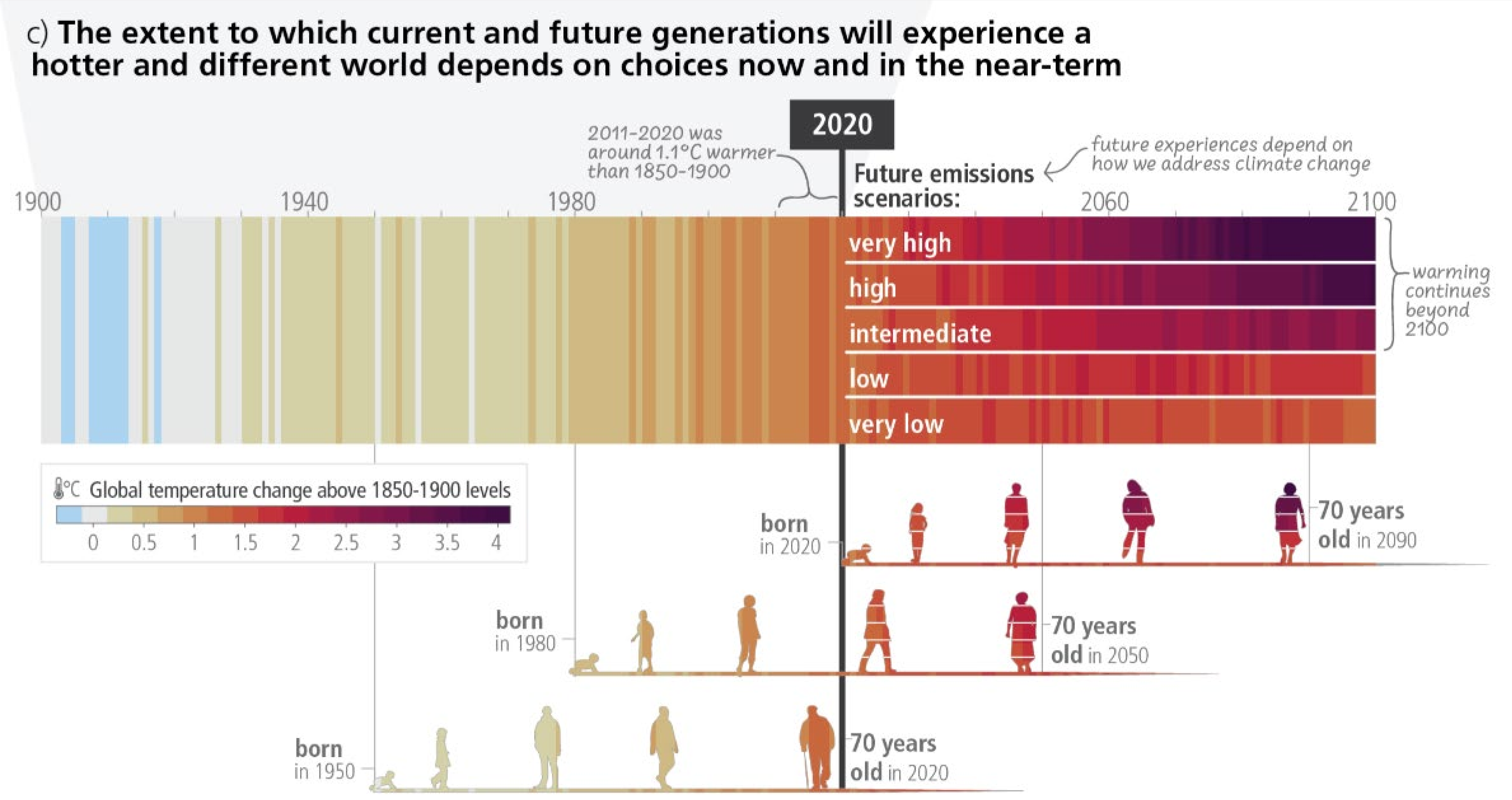
Summary

Wisconsin has a current (2016) **energy spending deficit of $14.4 billion** ($14.4 billion in expenditures leaves the state). With no substantial in-state fossil fuel resources, reliance on fossil fuels is hurting the Wisconsin economy. Transitioning to in-state energy resources would bring dollars and jobs back to the state of Wisconsin. Current primary energy consumption is 522 Terawatt-hours (TWh; 1781.1 trillion BTU – an energy unit conversion chart is provided at the end of the report) annually, and end-use energy is 377.8 TWh (1288.9 trillion BTU). In transitioning to an entirely electric economy, Wisconsin's consumption would decrease to an estimated 265.8 TWh (906.8 trillion BTU) primary energy or 223.0 TWh (760.8 trillion BTU) end-use energy annually. The decrease is from avoided conversion losses and the higher efficiency of electric equipment, primarily for vehicles and heating. 100% in-state production would directly **create an estimated 162,100 net jobs** (a 110% increase over the current 147,900 energy jobs in Wisconsin). Electricity prices are expected to remain comparable to current prices with an estimated increase of 10% per unit of energy (~$0.010/kWh). However, with increased investment in energy efficiency, we calculate a decrease in annual energy expenditures from $19.1 billion to $18.6 billion (a 3% decrease). The additional in-state spending ($14.4 billion - $0.5 billion) directly **increases state GDP by $13.9 billion,** or nearly 5%. In-state energy is estimated to **increase gross tax revenue on wholesale expenditures by $110.5 million plus $457.9 million in added income tax** from new jobs. The additional tax revenue could be used to offset added costs for the most difficult sectors to transition to in-state energy resources. Social and environmental benefits include reductions in **carbon dioxide (CO_2) emissions valued at $4.6 billion and air pollution exposure valued at $21.1 billion** in avoided human health damages. Therefore, for every MWh converted to in-state sources or saved through energy efficiency (167.2 TWh total would need to be met by new in-state sources), the emissions benefits would total $154 and $3.40 in tax revenue would be generated. In addition, one job is created for about every GWh converted. Unquantified impacts include impacts to water use, negotiation power, price stability, resiliency and grid performance, exports, improved urban design, comfort, land-use, and non-air-pollution-related health impacts. Many of these impacts would be overwhelmingly positive for Wisconsin. **The economic, social, and political benefits of in-state energy production support the implementation of policy to drive such a transition.**

Economic benefits of avoided cases of child health outcomes attributed to the U.S. Regional Greenhouse Gas Initiative by county, 2009 to 2014



Perera et al. 2020



c) The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near-term
2020
2011-2020 was around 1.1°C warmer than 1850-1900
Future emissions scenarios:
future experiences depend on how we address climate change
1900
1940
1980
2060
2100
very high
high
intermediate
low
very low
warming continues beyond 2100
°C Global temperature change above 1850-1900 levels
0
0.5
1
1.5
2
2.5
3
3.5
4
born in 2020
70 years old in 2090
born in 1980
70 years old in 2050
born in 1950
70 years old in 2020

IPCC 2023

COP28 UEA Climate and Health Declaration

- Place health at the heart of climate change
  - Deliver on the Paris Agreement
- Accelerate the development of climate-resilient, sustainable, and equitable health systems
  - Accelerate phase out of fossil fuels
  - Deliver on promises of US$ 100 billion annually in finance
- New finance commitments announced, including US$ 300 million from the Global Fund, US$ 100 million from the Rockefeller Foundation, and GBP 54 million from the UK government
  - Pledges totaled about US$ 1 billion

A Chat with Dr. Kristie Ebi

Sue Grinnell

Dr. Kristie Ebi

QUESTIONS?

To ask a question, please click the Q&A icon in the Zoom toolbar to open your Q&A Pod.

Resources

Climate Change 2023: Synthesis Report
Intergovernmental Panel on Climate Change
https://www.ipcc.ch/report/ar6/syr/

2023 Report of the Lancet Countdown on Health and Climate Change
The Lancet
https://www.lancetcountdown.org/2023-report/

NCA5
The Fifth National Climate Assessment
https://nca2023.globalchange.gov/

2021 WHO Health and Climate Change Survey Report
World Health Organization
https://www.who.int/publications/i/item/9789240038509