

Climate change and health

Kristie L. Ebi, Ph.D., MPH





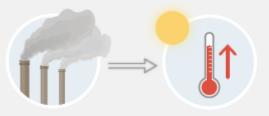


Increasing Levels of Carbon Dioxide and Short-Lived Climate Pollutants

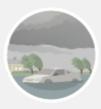
Rising Temperature

Rising Sea Levels

Increasing Extreme Weather Events







Demographic, Socioeconomic, Environmental, and Other Factors That Influence the Magnitude and Pattern of Risks

Geography Ecosystem change Baseline air and water quality Agricultural and livestock practices and policies

Warning systems Socioeconomic status Health and nutritional status Access to effective health care

EXPOSURE PATHWAYS

Extreme Weather Events Heat Stress

Air Quality

Water Quality and Quantity Food Supply and Safety

Vector Distribution and Ecology

Social Factors

EXAMPLES OF HEALTH OUTCOMES



effects





 Injuries Heat-related illness Fatalities and death Mental health



- of asthma and other respiratory diseases
- Respiratory allergies
- disease



- Exacerbations
- Cardiovascular
- Campylobacter infection Cholera
- Cryptosporidiosis
- Harmful algal blooms
- Leptospirosis

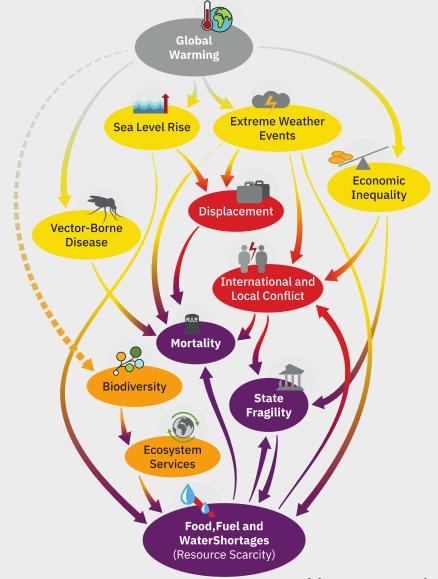


- Undemutrition Salmonella food
- poisoning and other
- Mycotoxin effects
- Chikungunya Dengue
- Encephalitis foodborne diseases (various forms)
 - · Hantavirus infection Lyme disease
 - Malaria
 - · Rift Valley fever
 - West Nilevirus infection
 - · Zika virus infection



Physical and mental health effects of violent conflict and forced migration (complex and context-specific risks)

Cascading global climate risks



Key conclusions of the IPCC 2022 chapter on human health

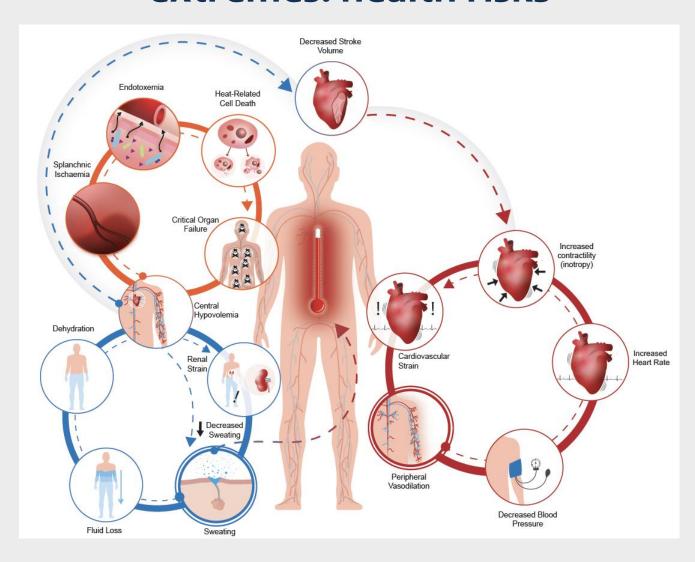
Observed impacts: climate change is adversely affecting the physical health of people globally and mental health of people in assessed regions

- 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

Hot weather and heat extremes: health risks

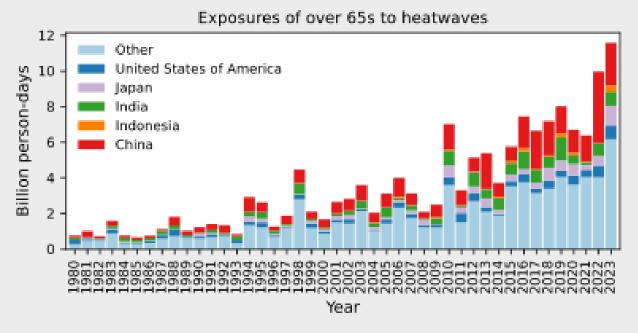


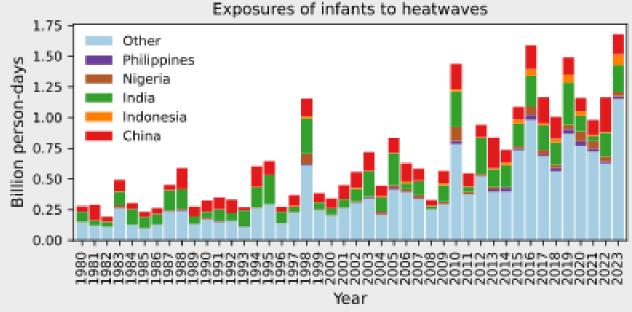
- People are unnecessarily suffering & dying in the heat
- Other heat-related effects include occupational health & productivity; increased sports injuries & illnesses; adverse pregnancy outcomes
- Physiological limits of heat tolerance are finite
 - Other factors substantially reduce these limits
- Climate change will continue to increase heat-related morbidity and mortality without urgent investments in research & risk management

Ebi et al. Lancet 2021

Exposure of vulnerable populations to heatwaves

In 2023, infants < 1 year and adults > 65 years experienced, on average, a record high of 13.8 heatwave days per person. There were 13.4 billion more person-days of heatwave exposure, compared with 1986-2005

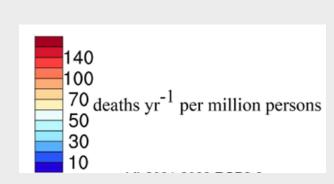




Projected annual heat-related deaths in 2091-2099

No adaptation; high emissions No adaptation; low emissions







Adaptation; high emissions

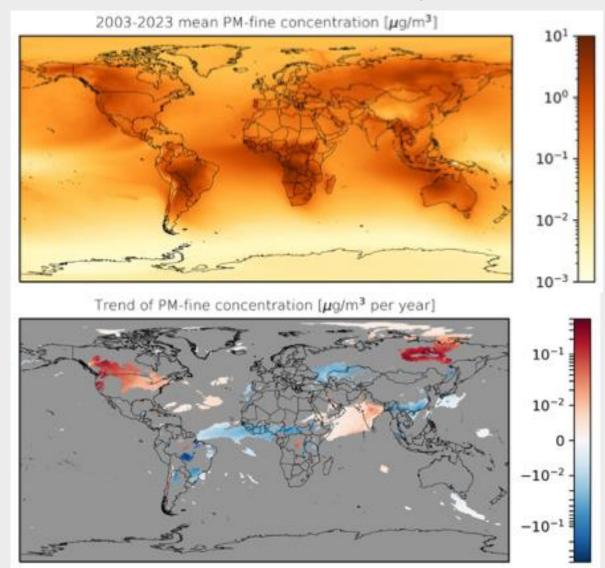


Adaptation; low emissions



Shindell et al. 2020

Gridded mean personal exposure to fire-induced PM and 2003-2021 trend

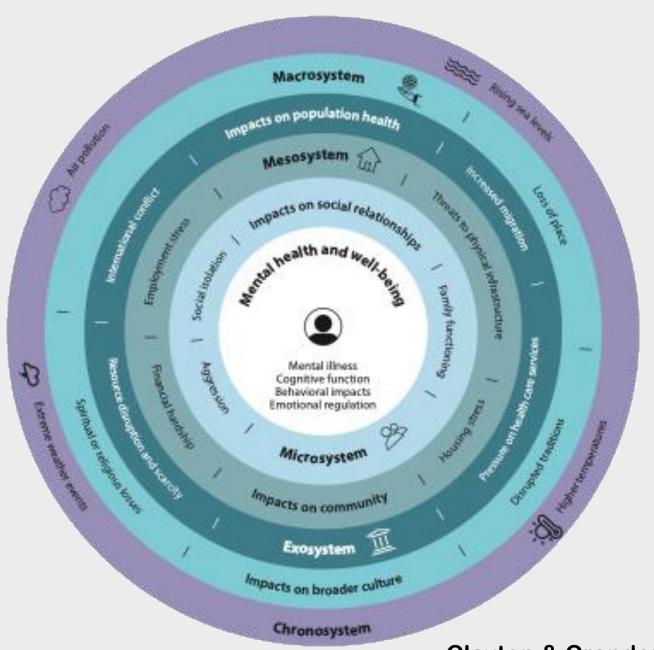


Short-term mortality impacts of wildfire smoke in Europe

- Cumulative RR for a 1 ug/m3 increase in firerelated PM2.5 was 1.009 for CVD mortality and 1.013 for respiratory mortality
- RRs higher for fire-related than non-fire-related PM2.5
- Using RR for total PM2.5 underestimated fire-related mortality by 93%

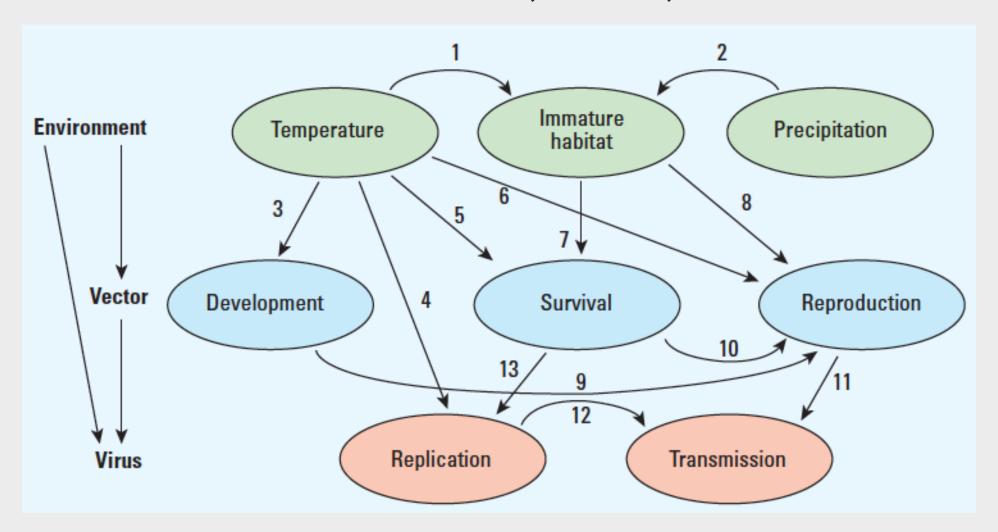
Alari et al. 2025

Impacts of climate change on mental health and well-being across multiple systems



Clayton & Crandon 2025

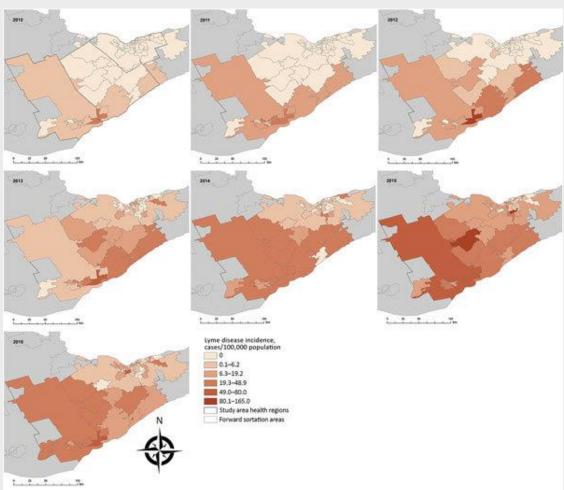
Biophysical influences on dengue ecology showing the interactions between climate variables, vectors, and the virus



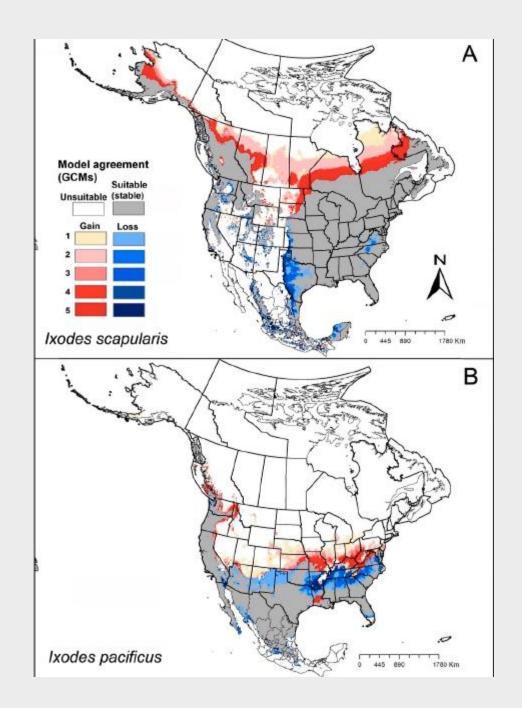
Lyme disease emergence in Canada

- Climate impacts Lyme disease risk:
 - Tick vector distributions & abundance
 - B. burgdorferi transmission cycle occurrence & efficiency
 - The likelihood of transmission to humans
- Surveillance demonstrated geographic pattern changed (latitude and altitude)
 - Geographic range associated with temperature trends
 - Changing temperatures attributed to climate change

Lyme disease incidence 2010-2016; Eastern Ontario



Potential geographic distribution of two species of Ixodes, present and 2050 under **RCP4.5**



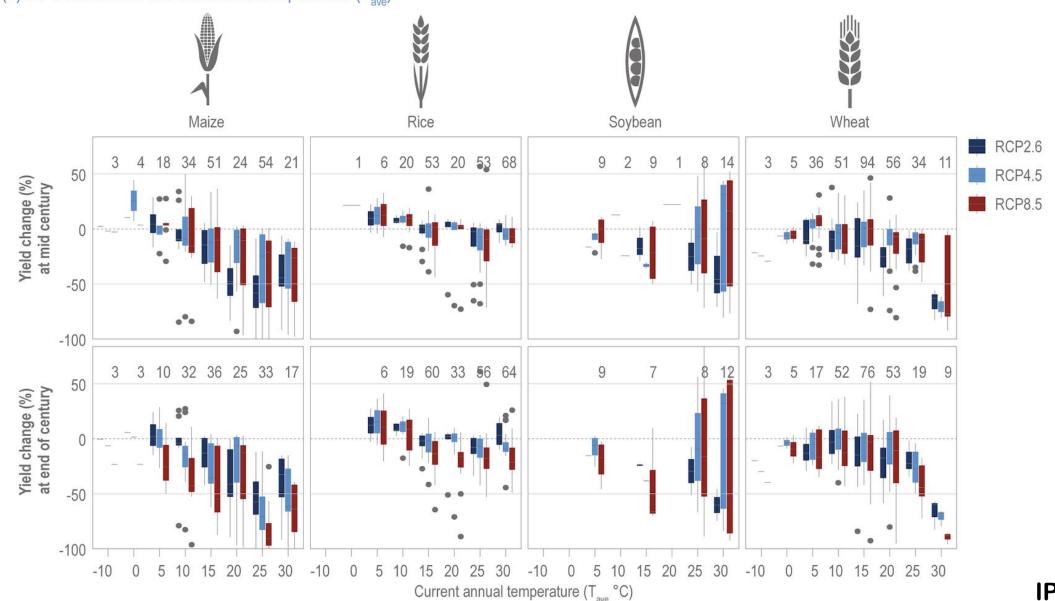
- Red indicates expansion of suitable areas under future conditions (dark red = high model agreement
- Blue indicates suitable in current time but not in the future (dark blue = high model agreement

Alkishe et al. 2021

Projected yield changes relative to the baseline period (2001–2010) without adaptation and with CO₂ fertilization effects

Numbers are the number of simulations

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



Higher CO₂ concentrations alter the nutritional density of C₃ plants

CO₂ promotes plant growth



Less protein and essential micronutrients



− Protein (~~ -10%)

B-vitamins (on average ~ -30%)

More carbohydrates

Micronutrients(~~ -5%)

Malnutrition "Hidden Hunger"

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

Health benefits of reducing greenhouse gas emissions

Howard et al. 2024

