IMPACT of CLIMATE CHANGE ON INFECTIOUS DISEASES AND HUMAN HEALTH

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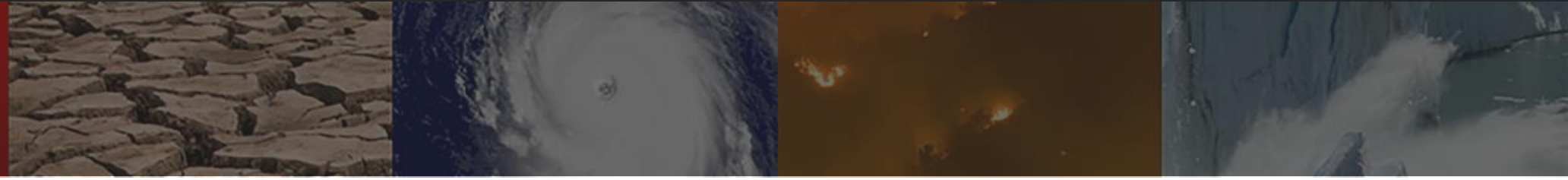
IDIC Seminar, 24 October 2025, Hong Kong

Outline



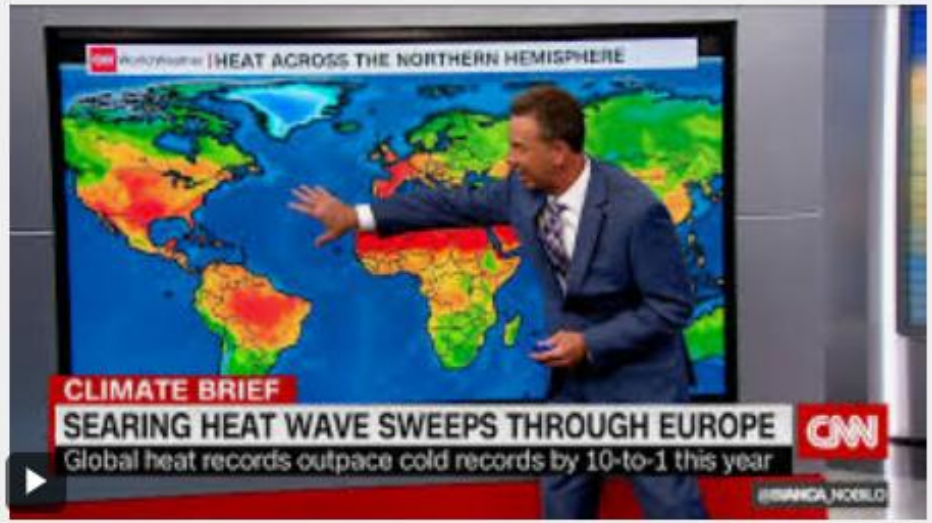
- To discuss the influence of climate change on infectious disease and human health


What comes to mind when you think about climate change?

Melting glaciers

Increasing sea level

Heat and Air pollution: something you can feel!



News / Trending / Top 10 / Top 10 countries that shattered national heat records: 2024 was the hottest year ever

Top 10 countries that shattered national heat records: 2024 was the hottest year ever

The World's Record Heat Waves: In a notable mention, the coldest continent on Earth, Antarctica, set a record in 2020, with summer temperatures at the Esperanza base surpassing 18°C.

THE HINDU
City
Monday, November 6, 2023
DELHI

Primary schools to remain shut till November 10 as air pollution spikes; entry of trucks restricted

Concentration of poisonous pollutant increases to over 20 times the WHO limit; monitoring body advises Delhi-NCR to consider odd-even rule for plying of vehicles; for Classes 6 to 12, Delhi schools given the option of teaching online

90 million people in U.S. under air quality alerts because of...

Watch >

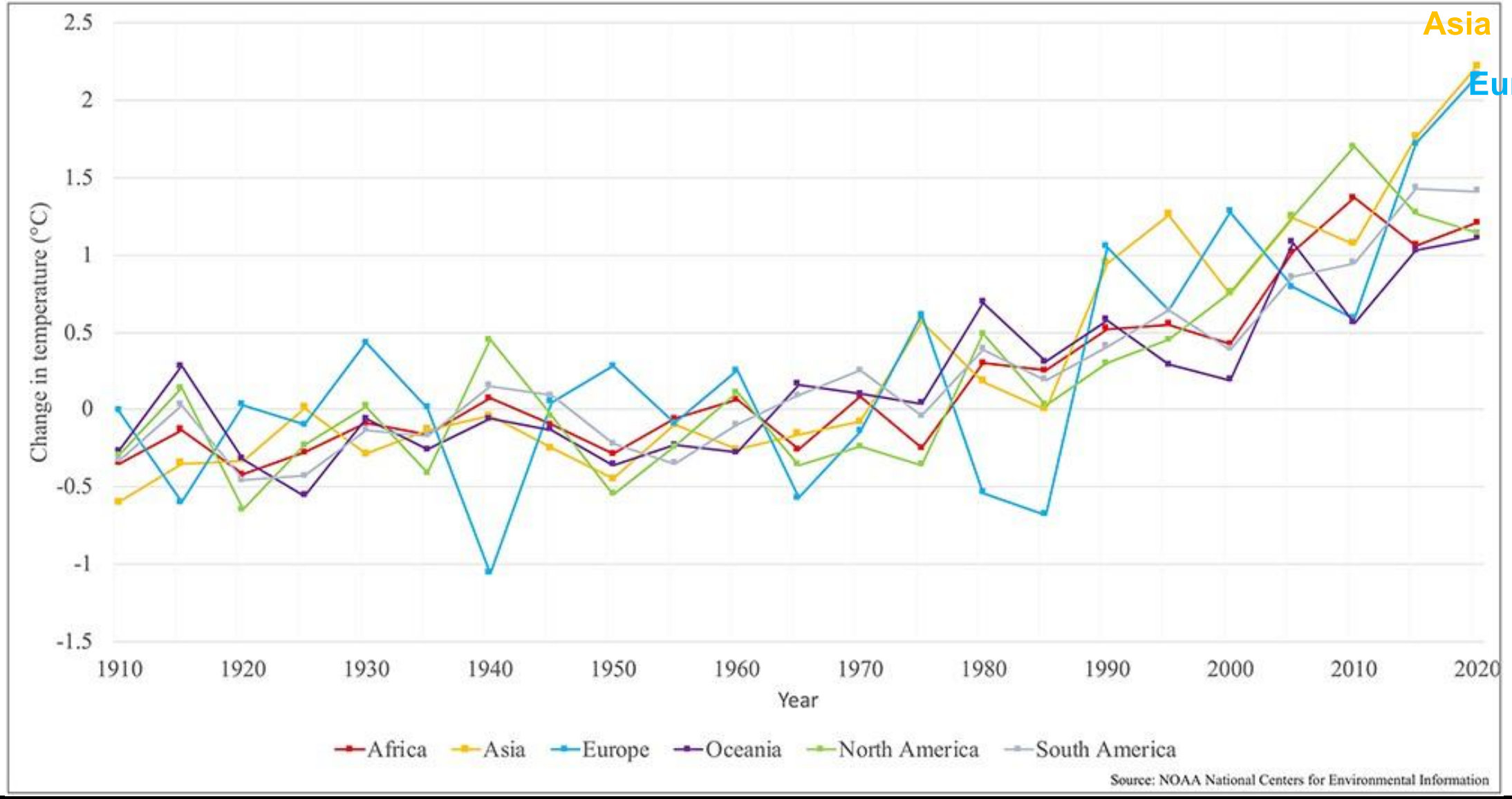
Uploaded: Jun 7, 2023

Climate change – definition

"Climate change refers to long-term shifts in **temperatures** and **weather patterns**. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions. But **since the 1800s**, **human activities** have been the main driver of climate change, primarily due to the burning of **fossil fuels** like coal, oil and gas."

https://www.un.org/en/climatechange/what-is-climate-change

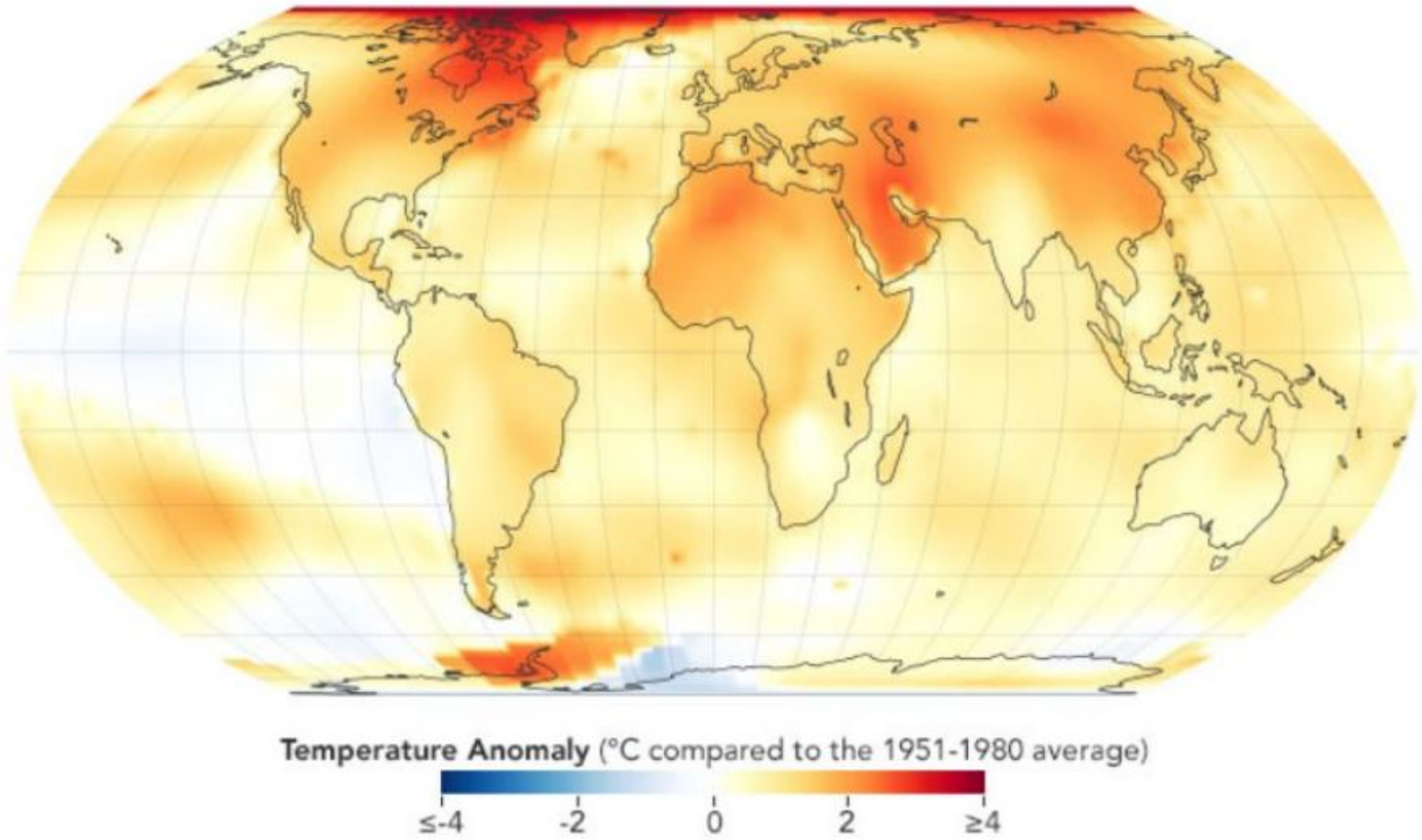
History of global temperature rising



Matsee W, et al. J Travel Med. 2023;30(4):taad072

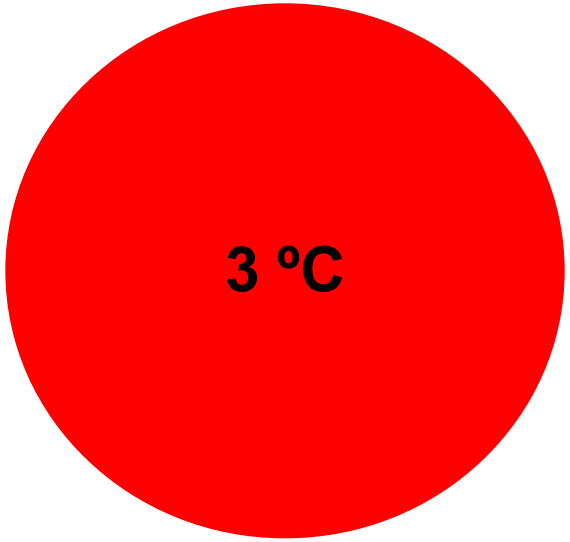
Global Temperature change

Heat map of temperature anomaly for comparison of 2017-2021 to an average of 1951-1980



Bell ML, et al. N Engl J Med. 2024 May 16;390(19):1793-1801.

Every degree matters



With the current pace, actual rise of average temperature by the end of 21st century will be 3 ºC.

https://www.un.org/en/climatechange/what-is-climate-change, https://www.ipcc.ch/report/ar6/syr/

Every degree matters

ipcc
INTERGOVERNMENTAL PANEL ON climate change

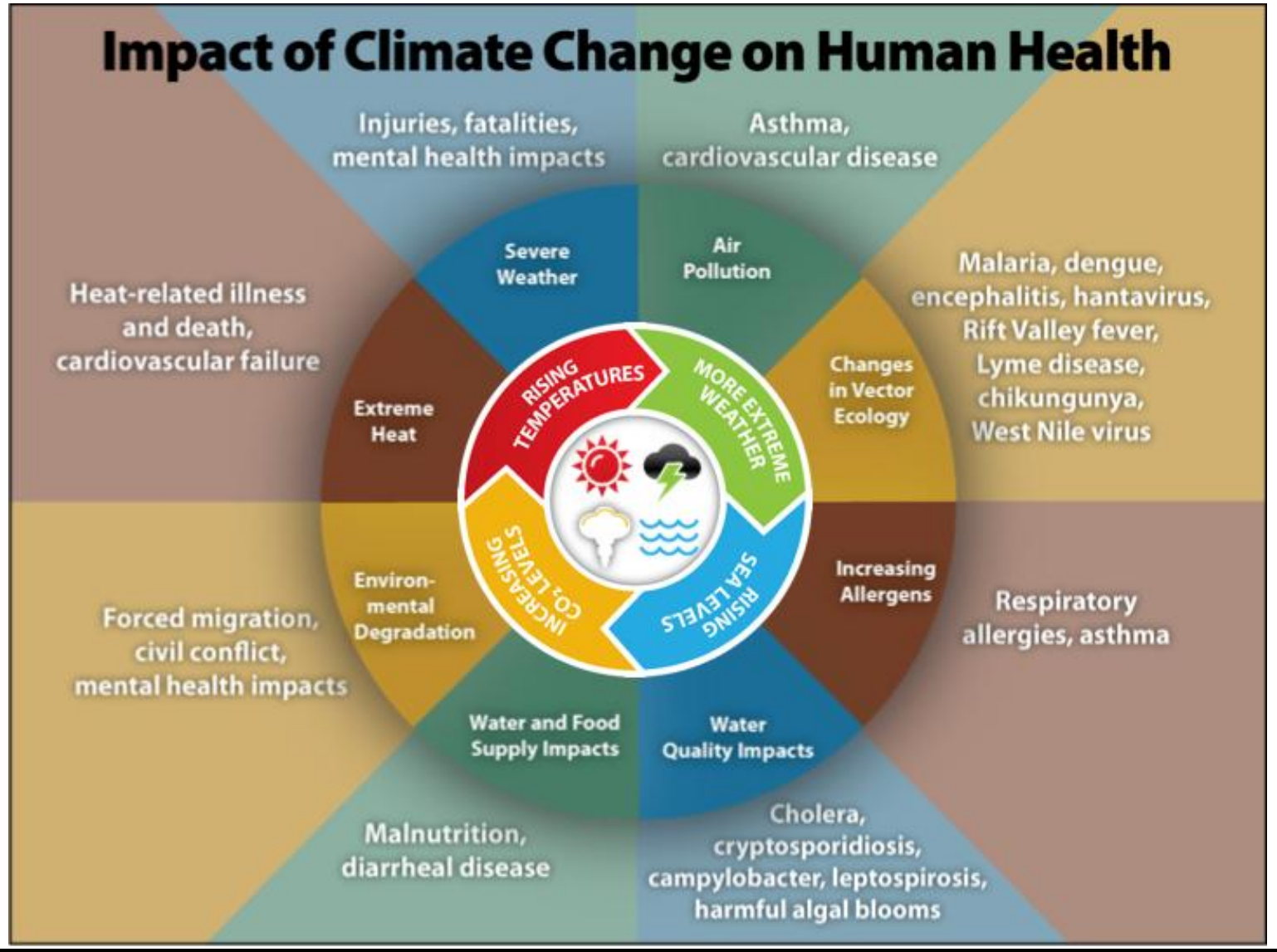
WMO UNEP

≤ 1.5 ºC

A limit of temperature rise which is tolerable for avoiding the worst of climate impact

https://www.un.org/en/climatechange/what-is-climate-change, https://www.ipcc.ch/report/ar6/syr/

Impact of climate change on human health



https://www.cdc.gov/climateandhealth/effects/default.htm

Pavement burn

Second-degree pavement burns

- Extreme heat events increase the risk of contact burns from hot surfaces in the environment
- Young children, older adults, unhoused persons, and persons with substance use disorder are at elevated risk for these types of burns.

Hess JJ. N Engl J Med. 2025 Apr 24;392(16):e40.

Heat-related illness

JTM Journal of Travel Medicine
International Society of Travel Medicine
Promoting healthy travel worldwide
Established 1991
Journal of Travel Medicine, 2023, 1–5
https://doi.org/10.1093/jtm/taad072
Perspective

Perspective

Heat-related illnesses are an increasing threat for travellers to hot climate destinations

Wasin Matsee, MD[1,2,*], Sakarn Charoensakulchai, MD[1] and Aisha N. Khatib, MD[3]

- Travelers from colder climate to the hot climate destination > > unable to acclimatization
- Affects travelers with extreme age, comorbidities, special itineraries, such as athletes or adventurous travelers, going to mass gathering events such as Hajj, Summer Olympics and World Cups and migrant workers working in construction sites

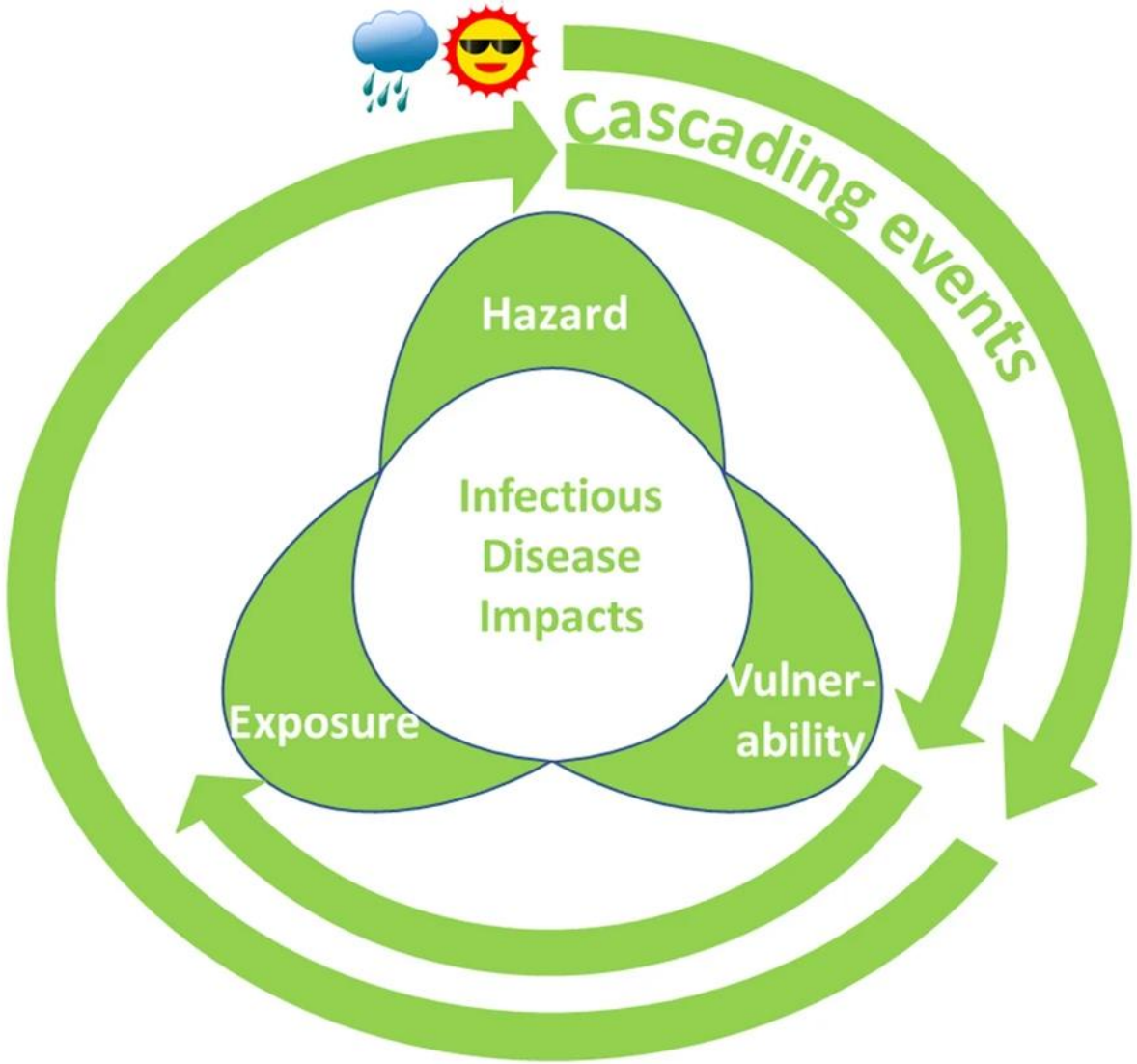
Victim(s)	Origin(s)	Activity	Year	Location	Temperature	Illness(es) and result(s)
44-year-old male and 38-year-old female	Netherlands and Germany	Broken car and trying to walk for help	2011	Joshua Tree National Park, California, USA	41 °C	Heat stroke. Died.
56-year-old female and 60-year-old male	UK	Hiking	2015	South Lykken Trail, Palm Springs, California, USA	40 °C	Heat exhaustion and dehydration. Rescued, but the female traveler died later.
75-year-old male and 73-year-old female	Germany	Hiking and get lost	2017	Trephina Gorge, Northern Territory, Australia	39.9 °C	Heat stress (unspecified) and dehydration. Died.
Two adults (unknown age)	Europe (unspecified country)	Motorbiking across desert and ran out of fuel	2017	Al Dhaid Desert, Sharjah, UAE	N/A	Heat exhausted and dehydration. Rescued and survived.
20-year-old male	Expatriate from Scotland living in Thailand	Exercising in heavy tracksuit	2017	Nakhon Ratchasima, Thailand	N/A	Heat stroke. Died.
Three adults (unknown age) and three-year-old toddler	Philippines	Hiking	2018	Standley Chasm, West McDonnel Ranges, Northern Territory, Australia	45 °C	Heat stroke. Rescued and survived.
Thousands of migrant workers	Various countries (particularly from India, Nepal and Bangladesh)	Outdoors working during construction project in World Cup 2022	2010-2020	Doha, Qatar	NA	Heat-related illnesses. Several people were hospitalized, repatriated or died.
Two adults (unknown age)	Asia (unspecified country)	Hiking	2021	Mountainous areas in Khor Fakkan, Sharjah, UAE	N/A	Heat stroke. Rescued and transferred to hospital.

Heat-related illness

Two adults (unknown age) and 1-year-old child	California, USA	Hiking	2021	Hites Cove Trail, Sierra National Forest, California, USA	41.7 °C to 42.8 °C	Heat stroke. Died.
22-year-old male	St. Louis, Missouri, USA	Hiking	2022	Badlands National Park, South Dakota, USA	42.2 °C	Heat exhaustion. Rescued but died later.
75-year-old male	Houston, Texas, USA	Hiking	2022	Big Bend National Park, Texas, USA	40 °C	Heat exhaustion. Died.
Six adults (unknown age)	N/A	Hiking	2022	Spur Cross Trail, Arizona, USA	42.8 °C	Heat exhaustion. One man died, five others were rescued and survive.
25-year-old male	Expatriate from Switzerland living in Thailand	Running	2022	Koh Chang, Trat, Thailand	N/A	Heat stroke. Admitted to ICU.

25 years old Swiss traveler attended ultra trail running in Thailand

Cascading risk from Infectious diseases



Cascading risks from infectious disease, due to a nexus of hazard, vulnerability, and exposure. Climatic hazards (e.g., extreme rain event or heat; outer spiral), amplified by societal vulnerabilities can trigger new hazards, such as floodwater contaminated with pathogens or high mosquito densities. Cascading events (inner spiral) caused by these infectious disease hazards and amplified by newly attained vulnerabilities can result in population exposure and give rise to water-borne or mosquito-borne disease outbreaks, respectively

Semenza JC, et al. *Infect Dis Ther*. 2022 Aug;11(4):1371-1390.

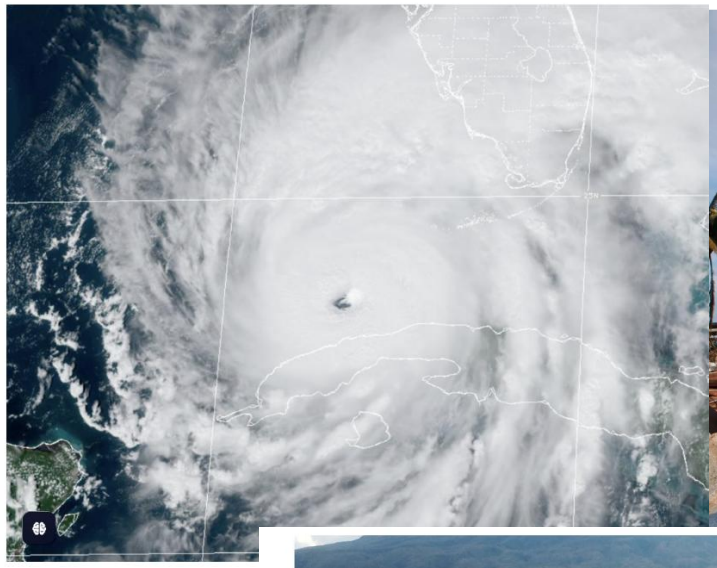
Combination matrix of climate hazards, vulnerabilitites, cascading risk and climate sensitive ID impacts

Climate Hazards	Vulnerability	Cascading risks	Climate-sensitive ID
Coastal flood	**Bio-medical**	**Cascading risk pathways from extreme precipitation and flooding**	*Borrelia* (Lyme)
Estuarine flood	Pregnant and breastfeeding women	Standing water serves as breeding ground for mosquitoes	Dengue virus
Flash flood	Immunocompromised populations	Flood water damages critical health care infrastructure	Tick-borne encephalitis
Fluvial (riverine flood)	Undernourished populations	Rain runoff from agricultural land and pastures results in turbid water runoff, which impedes water disinfection	*Vibrio spp.*
Storm surge/tides	Populations with high ID burden	Contamination of oyster farms from storm runoff that mobilizes and transports pathogens	*Leishmania*
Snowmelt flood	Populations with high chronic disease burden	Water treatment efficiency is overwhelmed or damaged by storm	*Campylobacter*
Surface water flooding	People with mental or physical disabilities	Storm water and floods overwhelm containment systems and discharge untreated waste water	Chikungunya virus
Glacial lake outburst flood	**Demographic**	Damage to critical water supply and sanitation infrastructure due to inundation	*Cryptosporidium*
	Age	Population displacement and inadequate sanitation infrastructure due to floods	*Giardia*
Low pressure or cyclone	Sex	**Cascading risk pathways from drought**	Hantavirus
Drought	Population movement	Crop failure, undernutrition, susceptibility to infectious diseases	Rift Valley Fever
Hail	**Geographic**	Concentration of pathogens in drinking water sources	*Salmonella*
Blizzard	Unplanned urban housing	Water collection at alternative (contaminated) sources due to water scarcity	*Shigella*
Cold wave	Flood risk zones	Intensified demand and sharing (e.g., with livestock) of limited water resources decreases water availability and quality	Vero toxin–producing *Escherichia coli*
Dzud	Drought risk zones	Cross-connections of water lines with sewer lines due to water shortages results in water contamination	West Nile virus
Freeze	Coastal storms and cyclone risk zones	Vector breeding in household water containers	*Cholera*
Frost (hoar frost)	Water-stressed zones	Poor water quality, hygiene and sanitation (WASH) due to water shortages	*Legionella*
Freezing rain	Food-insecure zones	Open defecation due to lack of WASH results in human exposure to pathogens	*Rickettsia*
Ground frost	**Socio-economic**	Low water availability augments travel distance to alternative (contaminated) sources	*Hepatatis A*
Heatwave	Poverty	**Cascading risk pathways from elevated temperature**	*Leptospira*
Thaw	Gender norms, roles, and relations	Longer transmission season for vector-borne diseases	*Tularemia*
Avalanche	Unsafe, informal occupation	Proliferation of marine bacteria at recreational beaches	Yellow fever virus
Mud flow	Reduced access to health care	Increased prevalence of pathogens in poultry flocks	*Yersinosis*
Rock slide	Reduced access to education	Extended pathogen survival and replication outside of host	*Anthrax*
Derecho	Unsafe water and sanitation	Runoff from areas affected by wildfires during heat waves compromises water quality	*Botulism*
Gale	Inadequate shelter	Reduced crop yields at higher ambient temperature	*Listeria*
Squall	**Socio-political**	Food spoilage due to behavior change (e.g., barbecue)	*Malaria*
Subtropical storm	Political instability	**Cascading risk pathways from sea-level rise**	*Coxiella* (Q Fever)
Tropical storm	Existence of complex emergencies or conflict	Inundation of drinking water supply and sanitation infrastructure	*Toxoplasma*
Tornado	Lack of freedom of speech and information	Saline intrusion into coastal aquifers and decline in soil and water quality	*Schistosoma*
Wind	Reduced civil rights and civil society movements	Damage of critical infrastructure (e.g., health care, first responders, electricity generation, transportation (e.g., fuel supply, streets, rail, airports, harbors), telecommunication, shelter, fuel extraction(e.g., natural gas, oil), water supply, agriculture, financial services)	Nairovirus (Crimean-Congo haemorrhagic fever)

Semenza JC, et al. *Infect Dis Ther*. 2022 Aug;11(4):1371-1390.

Examples of climate hazards, societal vulnerabilities, and cascading events resulting in infectious disease outbreaks

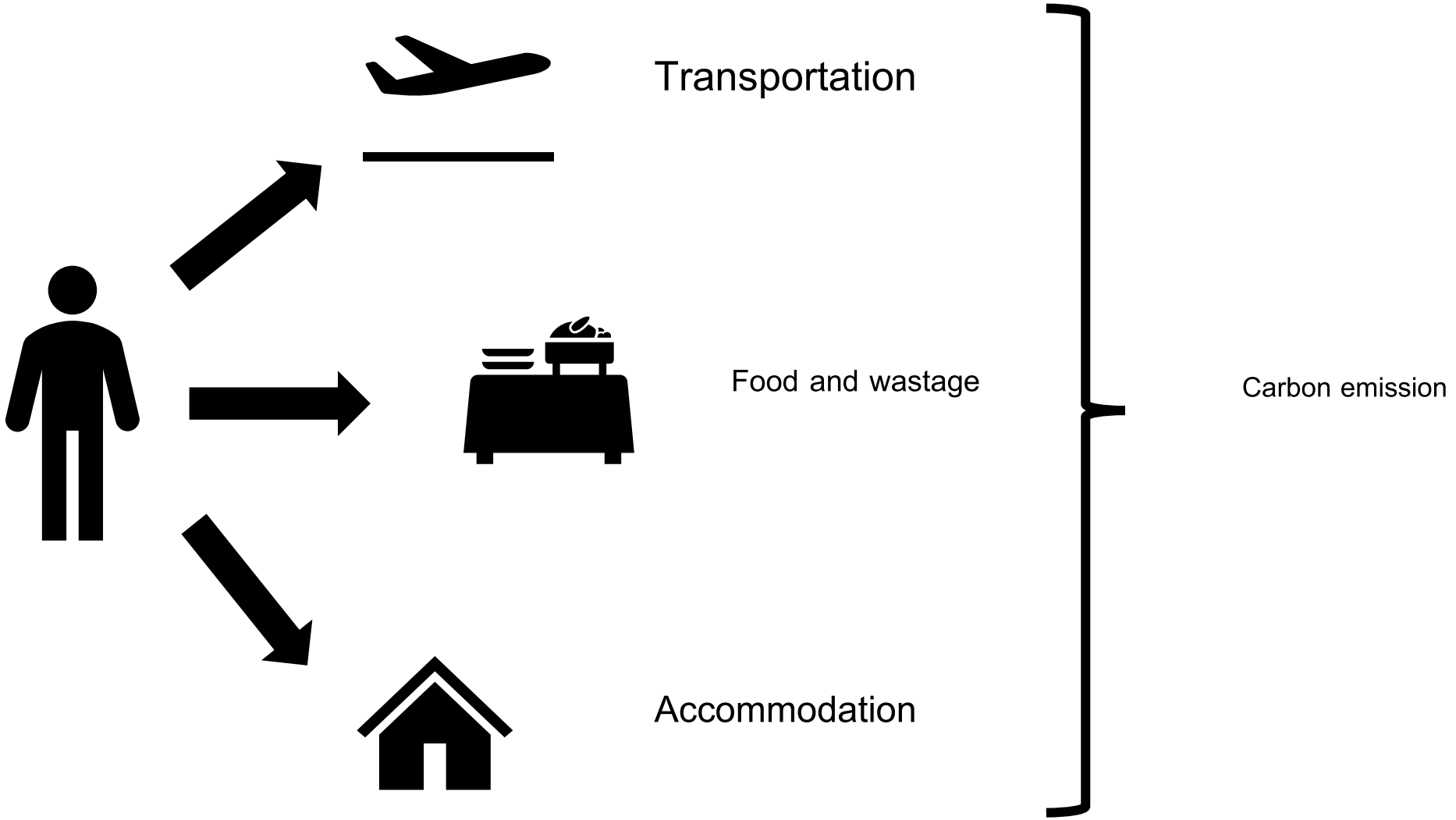
Climate hazard	Vulnerability and cascading events	Infectious disease outcome
Hurricane	Lack of WASH in mega-shelter after hurricane Katrina	Widespread outbreak of norovirus gastroenteritis among evacuees
Typhoon	Serious flooding in Metro Manila	Outbreak of Leptospirosis
Cyclones: Idai and Kenneth in Mozambique	Lack of access to safe water, poor sanitation, contact with stagnant floodwater, overcrowding in the camps for displaced people	Diarrheal diseases, malaria
Heavy rainfall and elevated temperature	Contamination of surface water by compromised WASH systems	Cholera outbreaks in Yemen



PHOTOGRAPH: CHARISM SAYAT/GETTY IMAGES

Semenza JC, et al. *Infect Dis Ther*. 2022 Aug;11(4):1371-1390.

Travel and climate change



Risk of climate change to travelers

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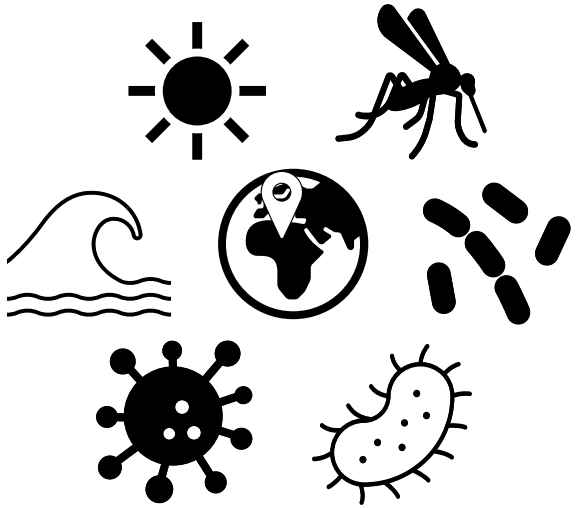
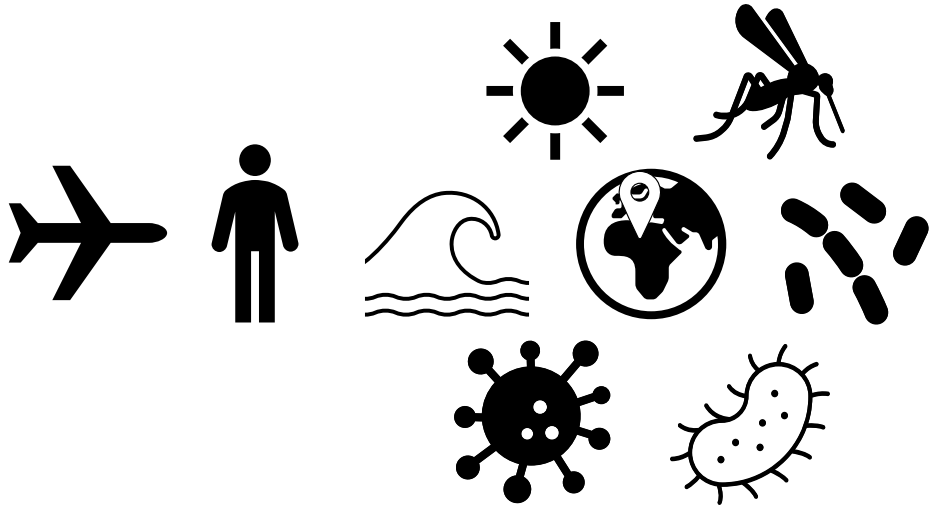


Travel destination

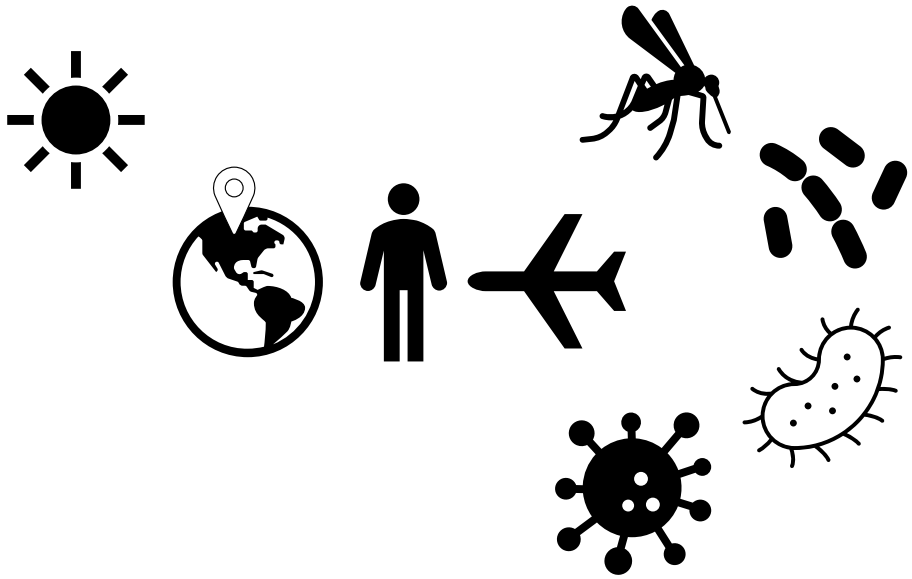
Risk of climate change to travelers

Home



Travel destination

Risk of climate change to travelers



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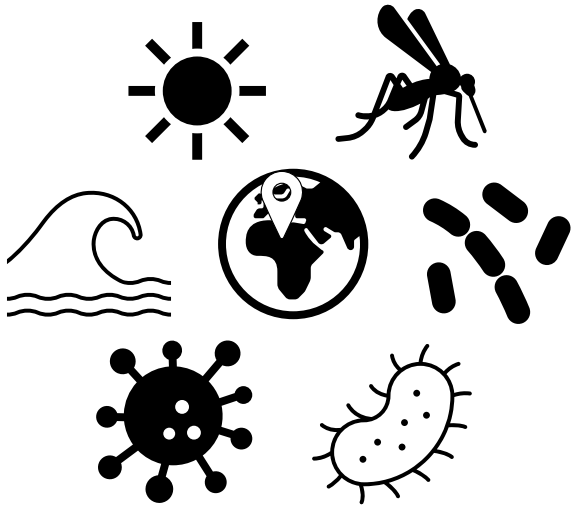
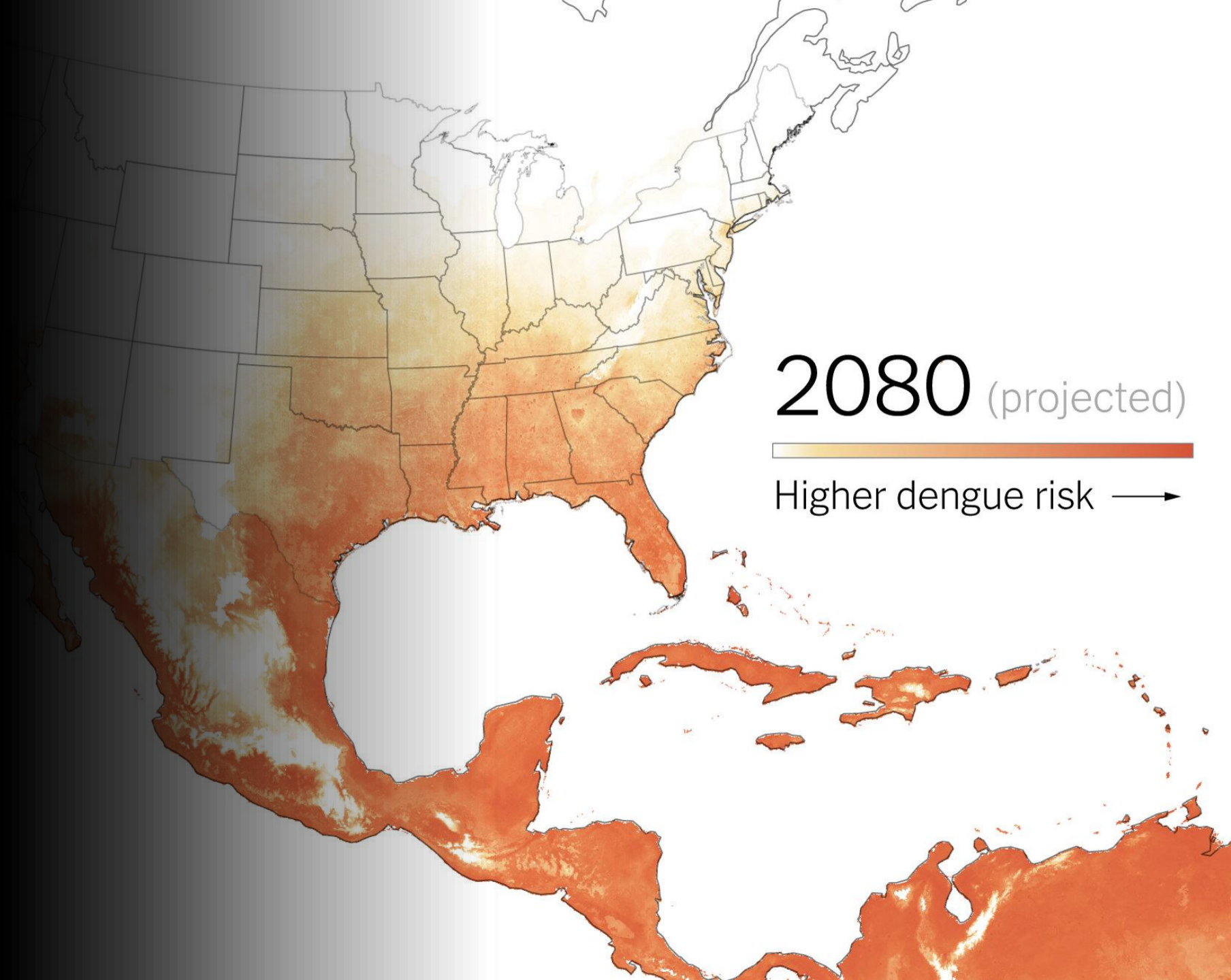


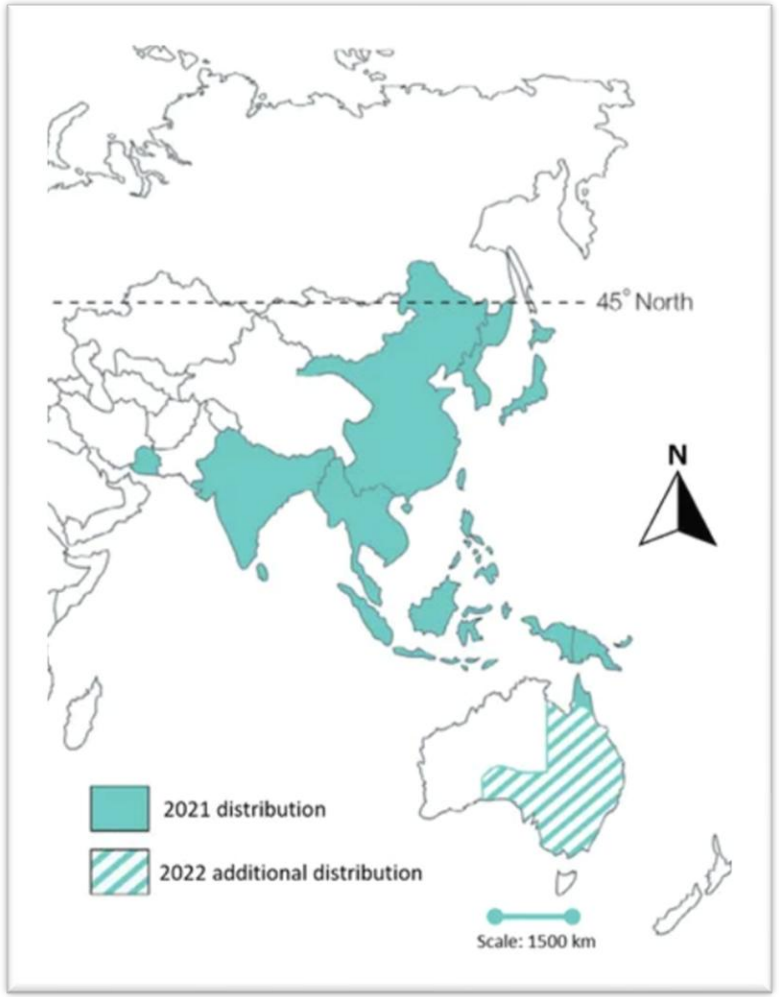
Travel destination

Vector-borne diseases



Japanese Encephalitis: Geographical distribution

Hills SL et al. 2020 CDC Yellow Book: Health Information for International Travel



Furuya-Kanamori L, et al. Trop Med Infect Dis. 2022 May 29;7(6):85.

ไวรัสไข้สมองอักเสบญี่ปุ่น ระบาดในพื้นที่น้ำท่วมของออสเตรเลีย

12 มีนาคม 2565, 08:22 น. 429 5

“ พื้นที่ประสบภัยน้ำท่วมชายฝั่งทะเลด้านตะวันออกของออสเตรเลีย กำลังเผชิญกับการแพร่ระบาดของไวรัสไข้สมองอักเสบญี่ปุ่นที่มียุงเป็นพาหะนำโรค ทำให้ต้องเร่งสั่งซื้อวัคซีนเพื่อป้องกันการระบาดขยายวงกว้าง ”

NEWS

Australia records fifth Japanese encephalitis death

The latest confirmed death has prompted health authorities to remind GPs of their role in vaccination uptake.

People among the high-risk groups are advised to avoid mosquito exposure and speak to their GP about vaccinations.

A man in his 60s who was diagnosed with Japanese encephalitis (JE) in early March died at Albury Base Hospital on Friday 20 May, marking the second JE death in the state, NSW Health has confirmed.

This brings Australia's death toll from the mosquito-borne virus to five, following the death of another New South Wales man in his 70s in February, and deaths in Victoria, Queensland and South Australia earlier this year.

https://www1.racgp.org.au/newsgp/clinical/japanese-encephalitis-ups-australia-s-death-toll-t

World Health Organization

Health Topics | Countries | Newsroom | Emergencies

Home / Disease Outbreak News / Item / Japanese Encephalitis - Australia

Japanese encephalitis - Australia

28 April 2022

Outbreak at a glance

As of 28 April 2022, a cumulative of 37 human cases of Japanese encephalitis (25 laboratory-confirmed cases and 12 probable cases) have been reported in four states in Australia with symptom onset dating back to 31 December 2021. This outbreak represents the first locally-acquired cases detected on the Australian mainland since 1998. Enhanced and targeted surveillance activities are ongoing to better understand the extent of transmission and to inform control activities. Further investigations are needed to assess the ongoing risk in Australia.

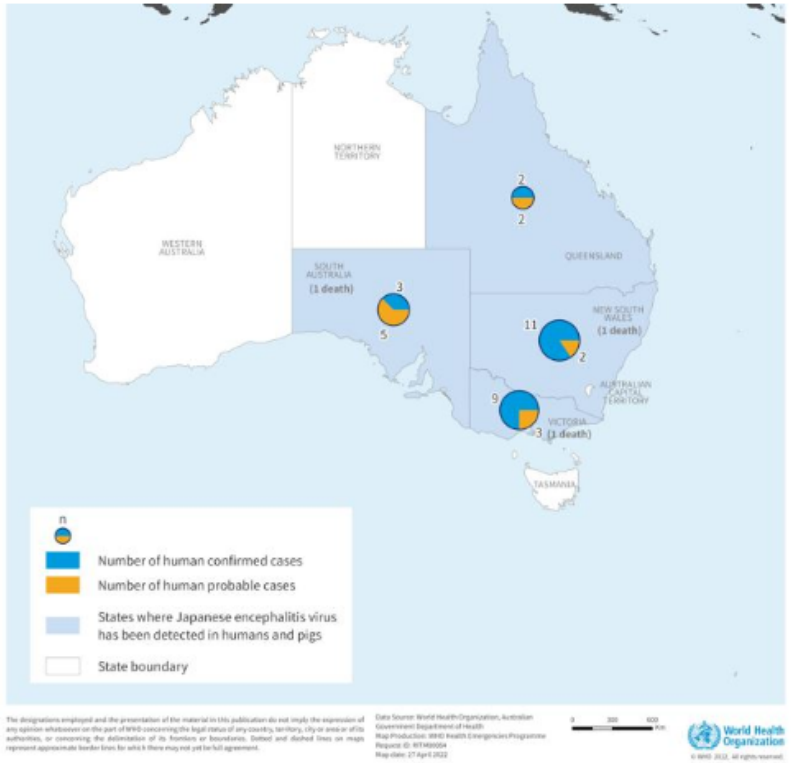
- **As of 25 Aug 2022**
- **40 human cases, 6 deaths of JEV**

https://www.who.int/emergencies/disease-outbreak-news/item/2022-DON365

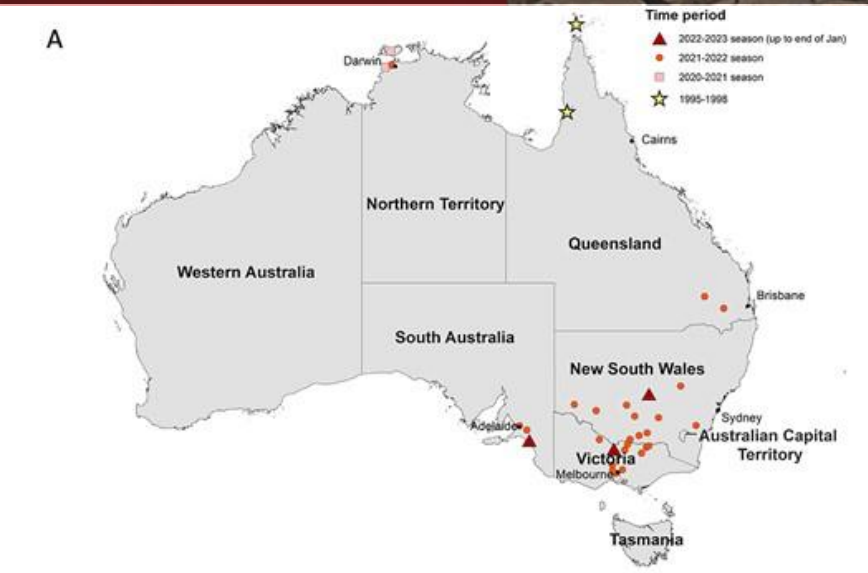
Description of the outbreak

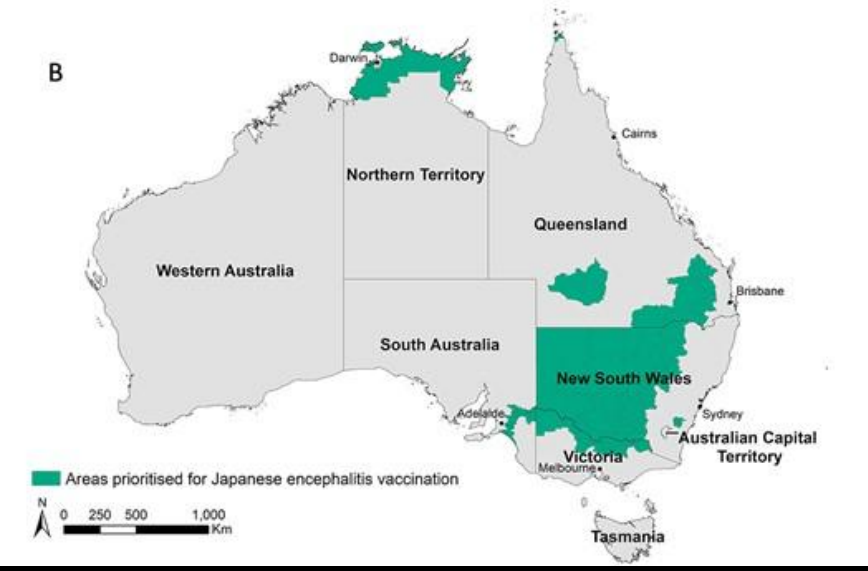
On 7 March 2022, the Australian health authorities notified WHO of three laboratory-confirmed human cases of Japanese encephalitis (JE). The first human JE case was reported on 3 March 2022 from Queensland. As of 28 April 2022, the Australian Government's Department of Health reported 37 cumulative confirmed and probable human cases of Japanese encephalitis virus (JEV) infection, including three deaths (2 confirmed, 1 probable). Twenty-five confirmed cases were reported from four states: New South Wales (11 cases, 1 death), Queensland (2 cases), South Australia (3 cases) and Victoria (9 cases and 1 death). In addition, 12 probable cases have been reported from: New South Wales (2 cases), Queensland (2 cases), South Australia (5 cases, 1 death) and Victoria (3 cases) (Figure 1).

Figure 1. Distribution of confirmed (n=25) and probable (n=12) human cases and deaths (n=3) of Japanese encephalitis (JE) and states in which JE virus has been detected in pigs, Australia, 2022.



Japanese encephalitis emergence in Australia





- La Niña increases precipitation in the interior of Australia, resulting in expanded habitat of waterbirds and *Culex* mosquitoes.
- US CDC indicates that JEV is mainly a concern around the Murray River and Outer Torres Strait Islands.
- However, cases in the current outbreak have also been reported in southern Queensland, other parts of rural NSW, and in the Top End of the Northern Territory.

McGuiness S, et al. J Travel Med. 2023;30(2):taad029, Mc Guiness S, et al. Curr Infect Dis Rep. 2023;25:111-22

Mosquitoes in higher elevation

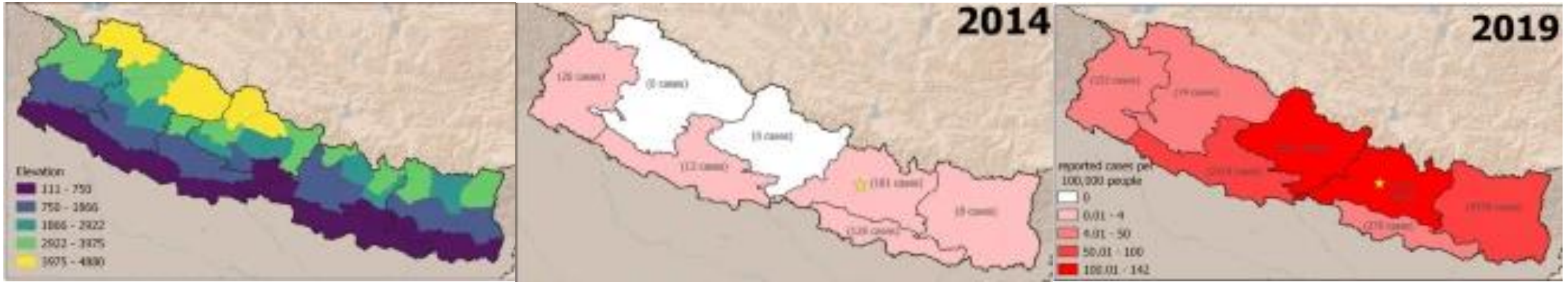
- Mosquitoes are believed to be habituated in areas with elevation ≤ 2000 m.
- Due to recent global warming, mosquitoes can go up higher elevation.
- Nepal had the clearest example of mosquito habitat shift to higher altitude.

Nepal's worst dengue outbreak is a wake-up call for action

Sanjeev M Bijukchhe, MSc ✉, Matilda Hill, BM BCH, Bipin Adhikari, DPhil, Ashis Shrestha, MD, Shrijana Shrestha, MD

Journal of Travel Medicine, Volume 30, Issue 7, October 2023, taad112, https://doi.org/10.1093/jtm/taad112
Published: 16 August 2023 **Article history** ▾

In 2022, Nepal faced its worst ever outbreak of dengue, with over 50 000 cases and >50 deaths reported across all 77 districts, with the highest number of cases in the capital city, Kathmandu.[1] Dengue is becoming increasingly prevalent at higher altitudes such as Kathmandu (altitude 1400 m) and has been attributed to rising temperatures (climatic changes) creating a conducive environment for Aedes mosquito breeding.[2] However, this number likely underestimated the true burden of the disease, as up to 80% of dengue infections can be mild or asymptomatic.[3] The epidemiological analysis of national data has shown an escalating trend over the years and worst is imminent as monsoon season looms closer.



Khatib AN. Curr Infect Dis Rep. 2023;25:77-85, Rijal KR, et al. Infect Dis Poverty. 2021;10(52), Bijukchhe SM, et al. J Travel Med. 2023;30(7):taad112, https://foreignpolicy.com/2023/10/06/nepal-disease-dengue-climate-change-global-warming-himalayas/

Mosquitoes in higher elevation

Malaria Prevention

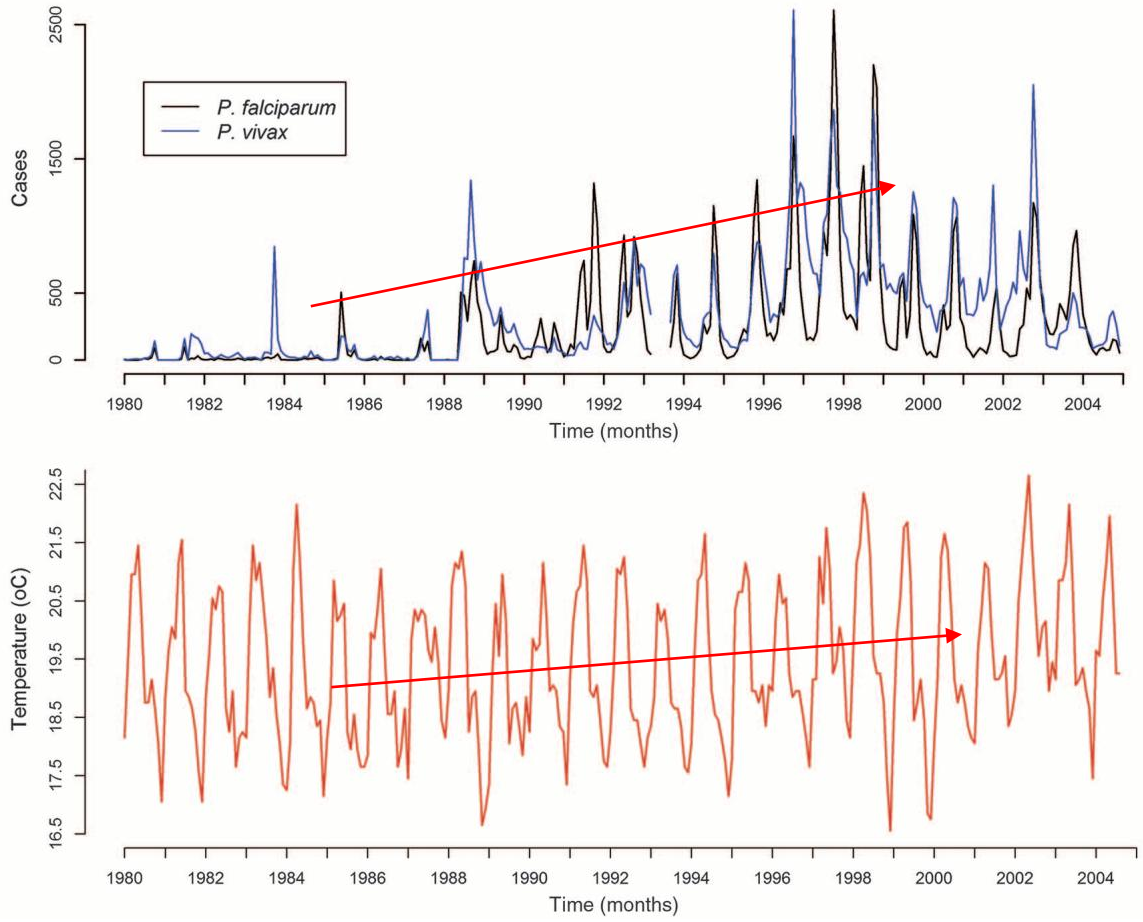
Transmission areas

- All areas <2,500 m (≈8,200 ft) elevation, except none in Addis Ababa (the capital)

Altitudinal Changes in Malaria Incidence in Highlands of Ethiopia and Colombia

A. S. Siraj,[1]* M. Santos-Vega,[2]* M. J. Bouma,[3] D. Yadeta,[4] D. Ruiz Carrascal,[5,6] M. Pascual[2,7]†

Increased in number of *Pf* and *Pv* cases in Debre Zeit, western Ethiopia (altitude 2040 m) (top) with increased temperature by 1 ºC in more than 378 months (bottom)



CDC Yellow Book 2024, Siraj AS, et al. Science. 2014;343(6175):1154-8, Diaz JH. J Travel Med. 2006;13(6):361-72

Mosquitoes in higher elevation

The resurgence of YF in 2025

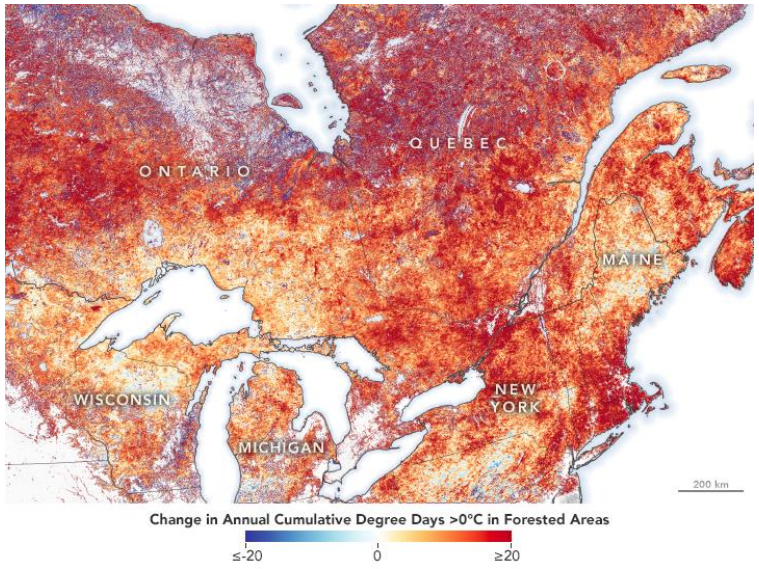
- **expanding urbanization**
- **environmental changes facilitating vector proliferation**
- **suboptimal vaccination coverage in some regions**

Barac A, et al. *Clin Microbiol Infect*. 2025 Jul 5:S1198-743X(25)00323-4.

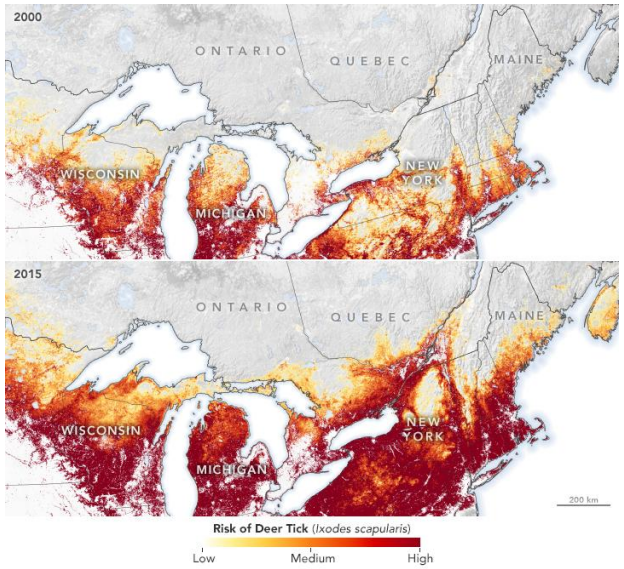
Increased vectors activities during summer

- In North America, ticks and mosquitoes thrive, elevating vector-borne disease risk in outdoor activities.
- Deer ticks die off in freezing temperatures, but warmer winters in Canada and New England are now allowing ticks to establish habitat further north.

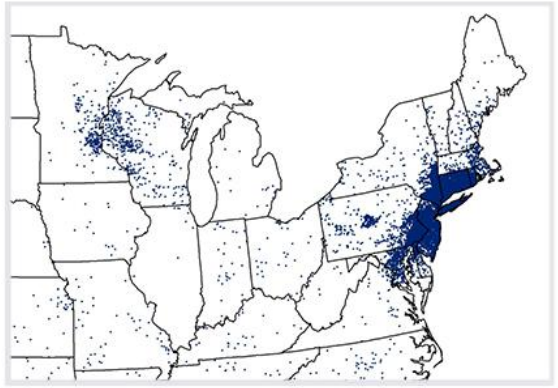
Change in temperature from 2000 to 2015



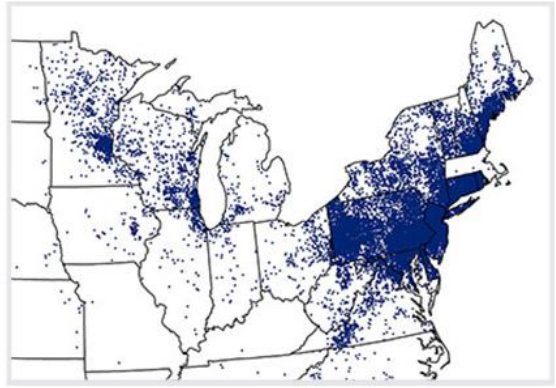
Ixodes ticks spread farther north from 2000 to 2015



Reports of Lyme Disease in 1996 vs 2018



1996

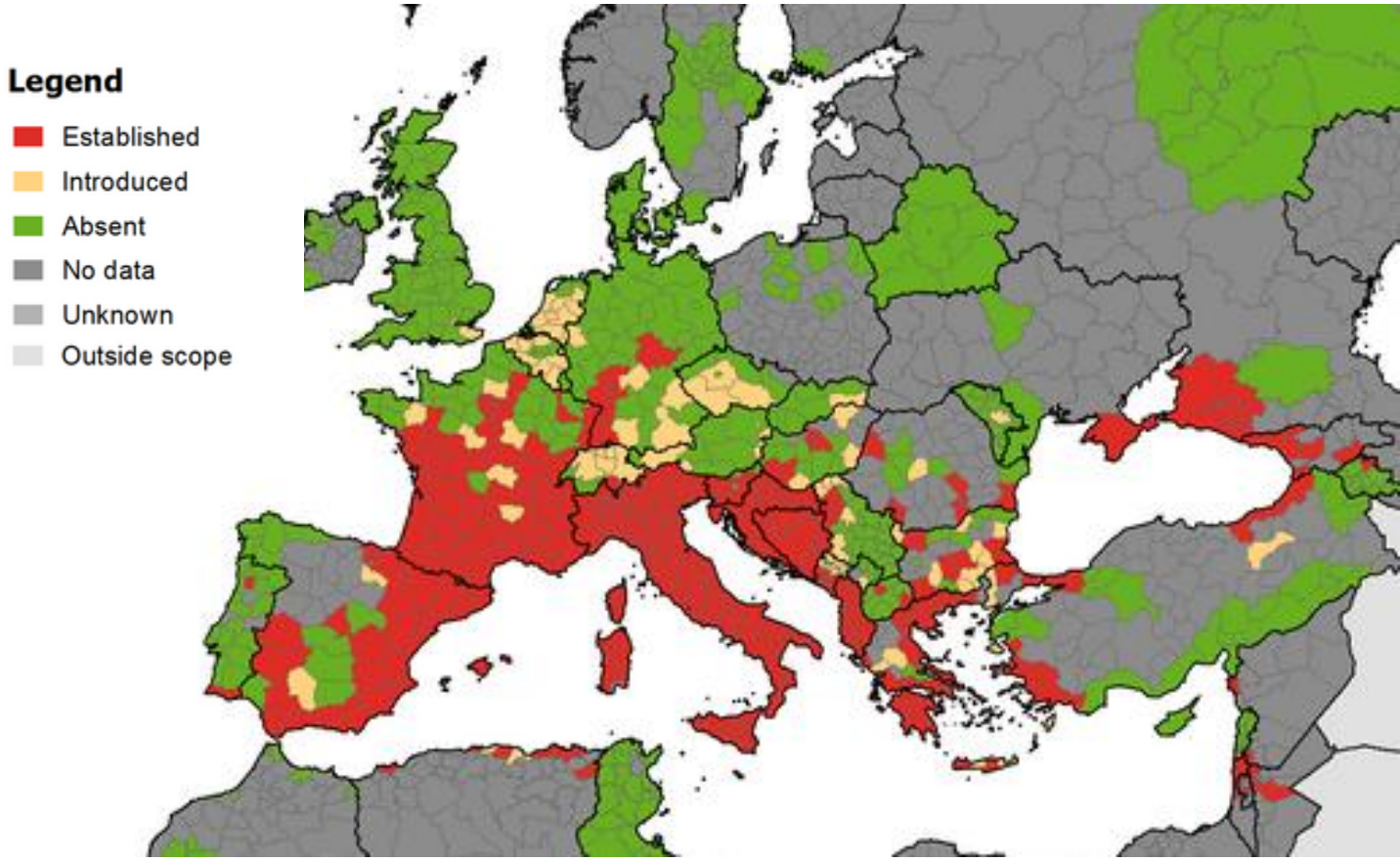


2018

Day J, et al. Clim Change. 2021;169(29), https://www.epa.gov/climate-indicators/climate-change-indicators-lyme-disease, https://earthobservatory.nasa.gov/images/148482/mapping-the-spread-of-lyme-disease

Vector-borne diseases spread from travel

- There is an established *Aedes* population in Europe.
- *Aedes albopictus* spread from old tire trade to new areas.
- Importation of vectors and vector-borne diseases to areas favored by warmer climate can result in autochthonous transmission.

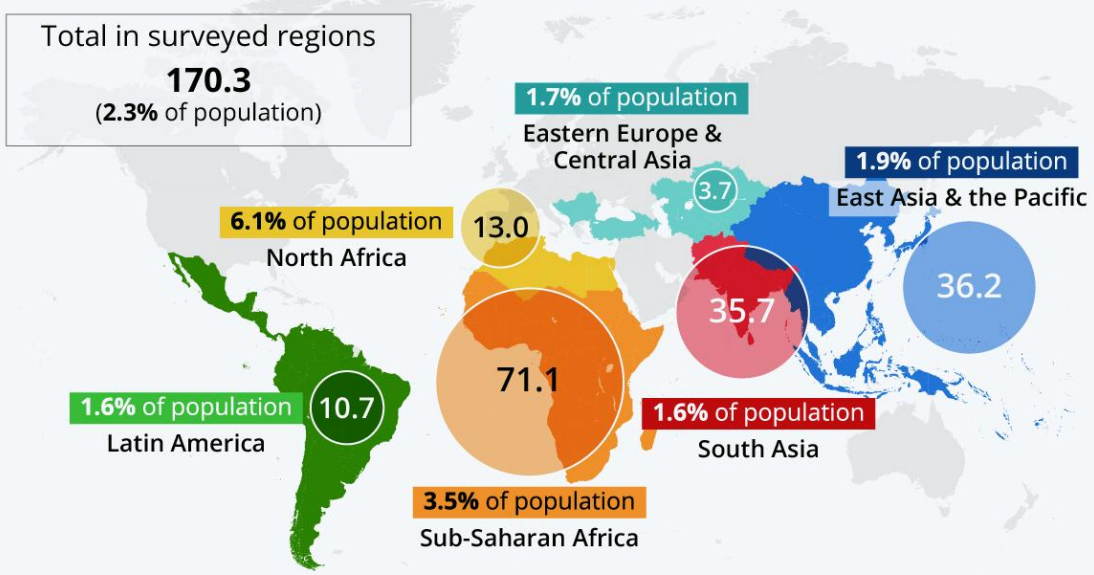


Zwar NA, et al. Aust J Gen Pract. 2022;51(11):879-83, https://www.ecdc.europa.eu/en/publications-data/aedes-albopictus-current-known-distribution-march-2022

Vector-borne diseases importation from migration

Climate Change, the Great Displacer

Average number of internal climate migrants by 2050 per region (in millions)*

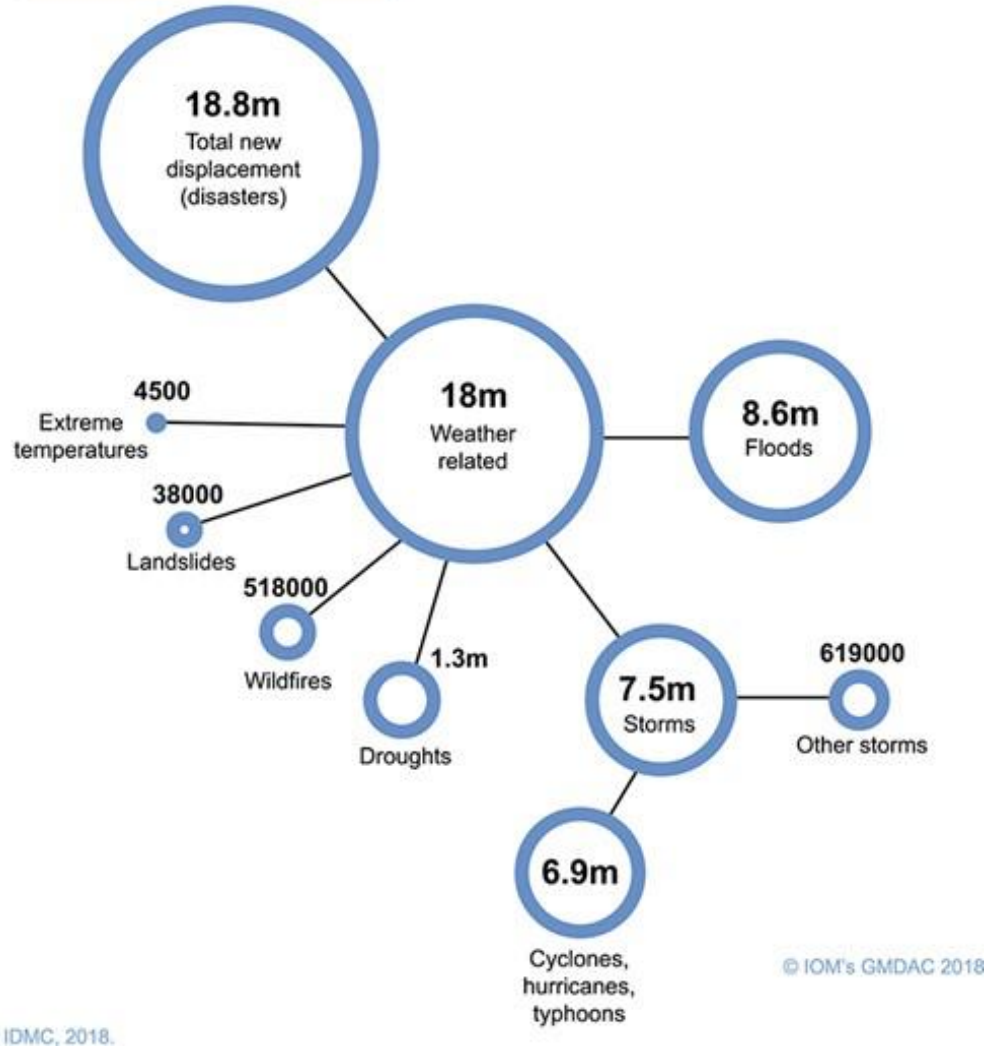


* Modeled on pessimistic reference = High emission & unequal development scenarios concerning water availability, crop productivity and sea-level rise

Source: World Bank

statista

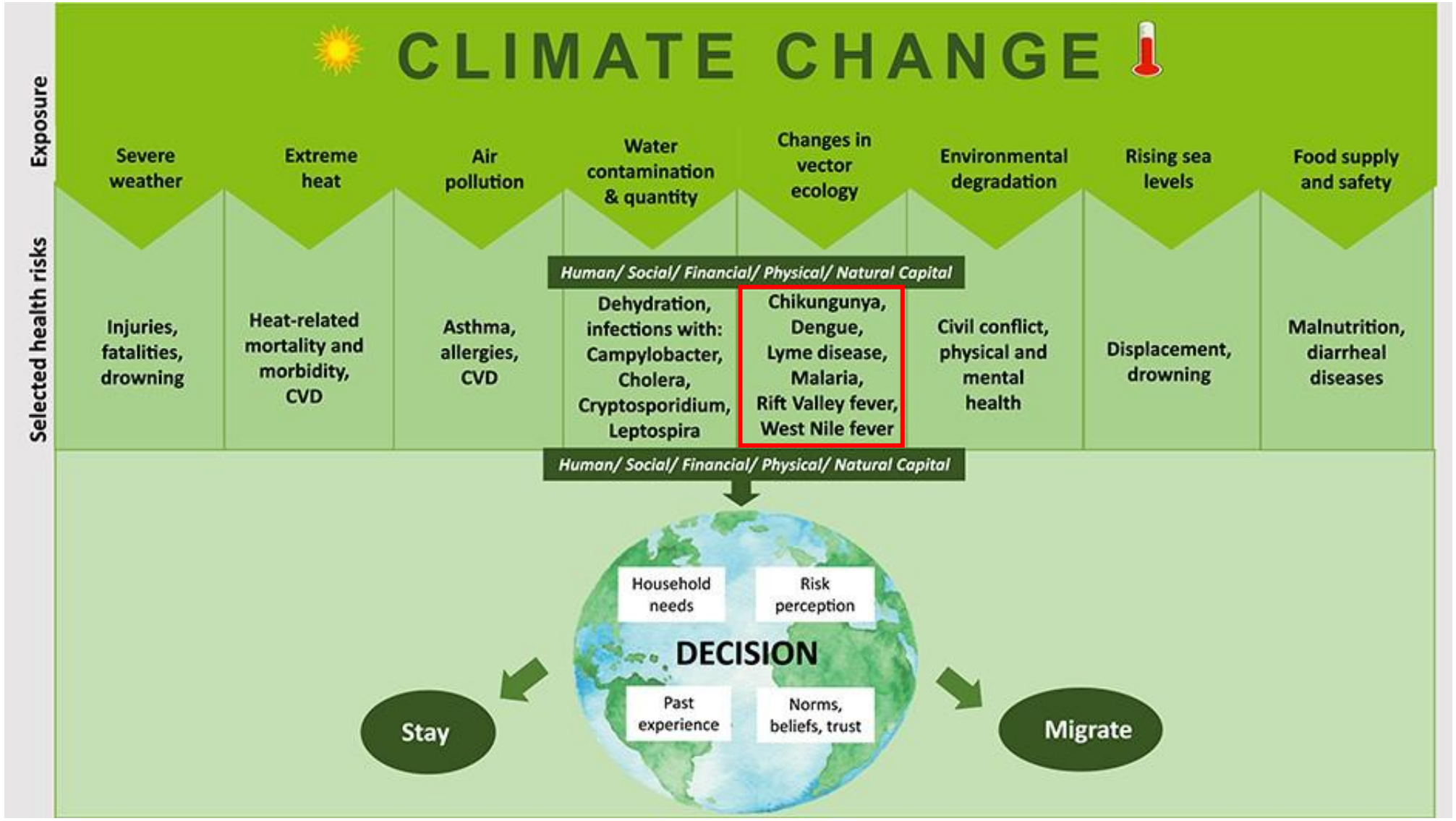
DISPLACEMENT PER DISASTER



Source: IDMC, 2018.

https://www.statista.com/chart/26117/average-number-of-internal-climate-migrants-by-2050-per-region/, IDMC 2018

Vector-borne diseases importation from migration



Semenza JC, et al. J Travel Med. 2019;26(5):taz026

Key Adaptation Strategies for Responding to Vectorborne Diseases

Community-Based Strategies

Strong public policies
(e.g., housing and land-use regulations)

Vector and disease surveillance programs

Vector-control programs

Early-warning and monitoring systems

Public-awareness and -engagement campaigns

Individual and Household Strategies

Awareness of the risk, signs, and symptoms of vectorborne diseases in the community or at travel destinations

Use of personal protective measures
(e.g., bed nets, window screens, insect repellent, protective clothing, tick checks, and vaccines)

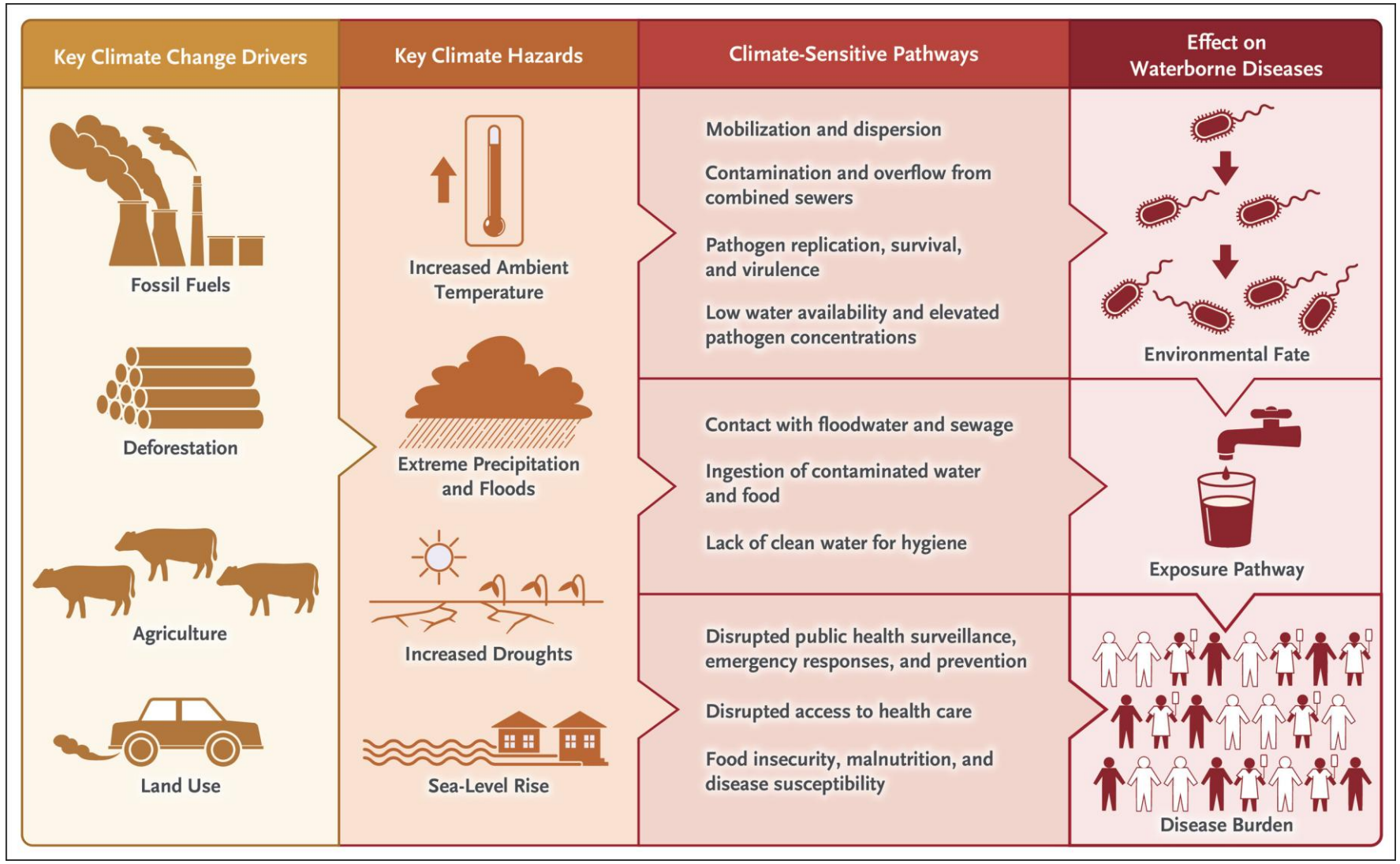
Seeking of medical attention for an acute febrile illness
(especially if signs and symptoms are compatible with vectorborne disease[s] in the community or at travel destinations)

Adherence to treatment plans

Thomson MC, et al. N Engl J Med. 2022 Nov 24;387(21):1969-1978.

Food and waterborne diseases

Pathways by Which Climate Change Drives the Burden of Waterborne Diseases



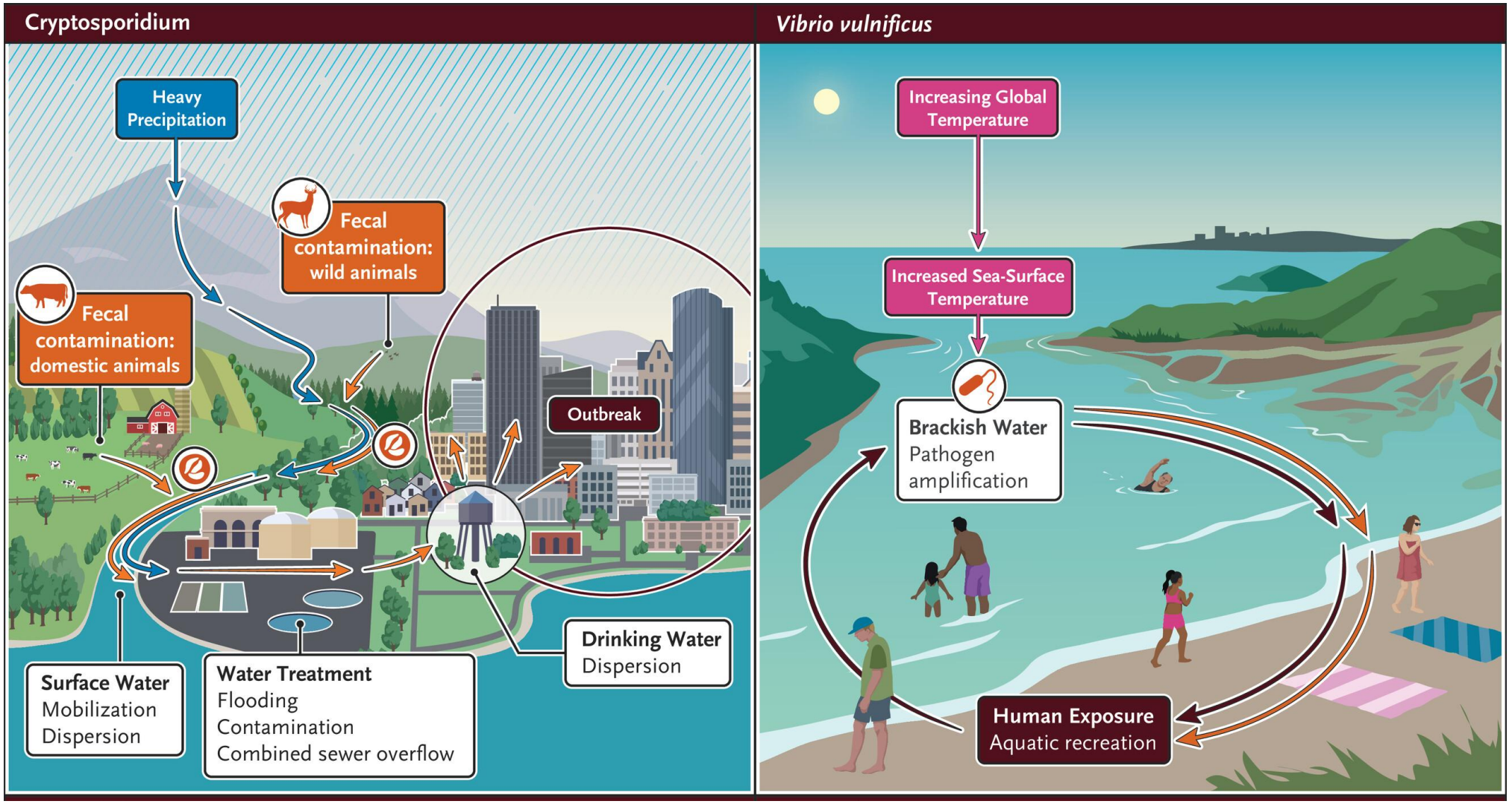
Semenza JC, et al. *N Engl J Med*. 2023 Dec 7;389(23):2175-2187.

Climate-Sensitive Pathways for Waterborne Diseases

- **INCREASED TEMPERATURE**
- **EXTREME PRECIPITATION AND FLOODING**
- **DROUGHTS**
  - Diminished river volume, with elevated pathogen concentrations, coincides seasonally with higher water demand
- **STORM SURGES AND SEA-LEVEL RISE**
  - After Hurricane Katrina made landfall on the U.S. Gulf Coast in 2005, vibrio infections resulting from exposure of wounds to floodwaters were observed
  - a cholera outbreak followed the massive flooding that occurred when Cyclone Idai struck the southeastern coast of Africa at Beira, Mozambique, in 2019.

Semenza JC, et al. *N Engl J Med*. 2023 Dec 7;389(23):2175-2187.

Examples of the Effects of Climate Change on Disease Transmission



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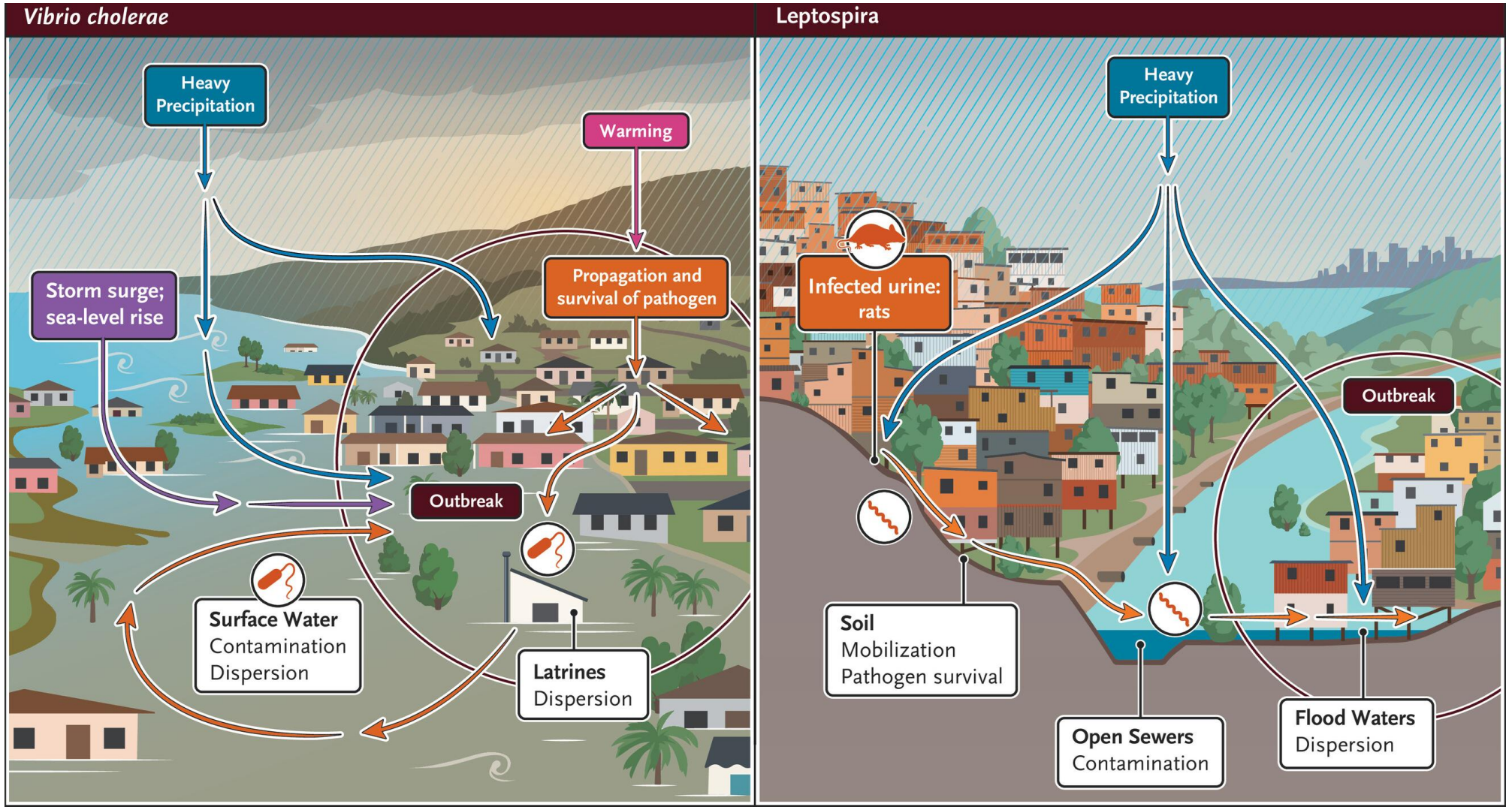
Examples of the Effects of Climate Change on Disease Transmission



Semenza JC, et al. *N Engl J Med*. 2023 Dec 7;389(23):2175-2187.

Spread of food-borne illness post-disasters

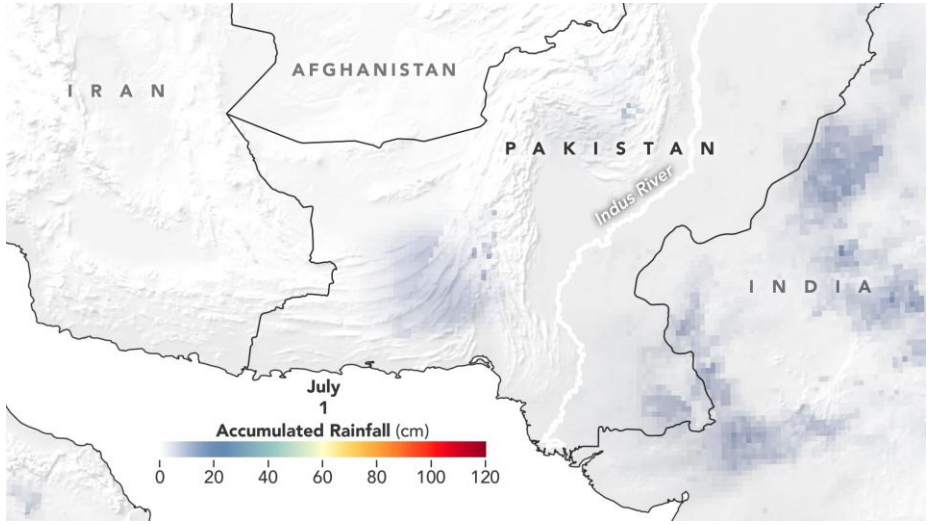
- Intensified cyclones heighten post-disaster flood and waterborne diseases, like cholera.
- Situations seen in post-flooding Pakistan.
- Relief personnel should prioritize prophylaxis and vaccination.

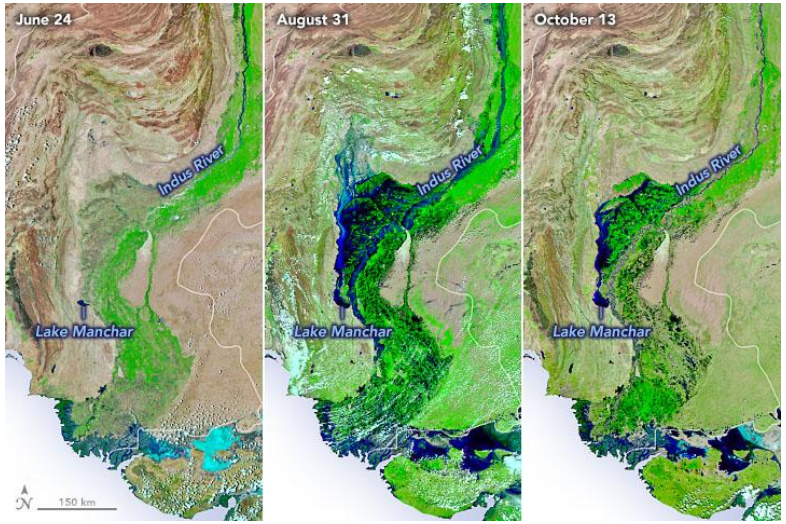
Cholera spike following monsoon floods in Pakistan: Challenges, efforts and recommendations (short communication)

Abdullah Malikzai, Khulud Qamar, Umer Usman Malik, Faryal Rafique, Sean Kaisser Shaeen

UN: 10 million lack safe water six months after Pakistan floods

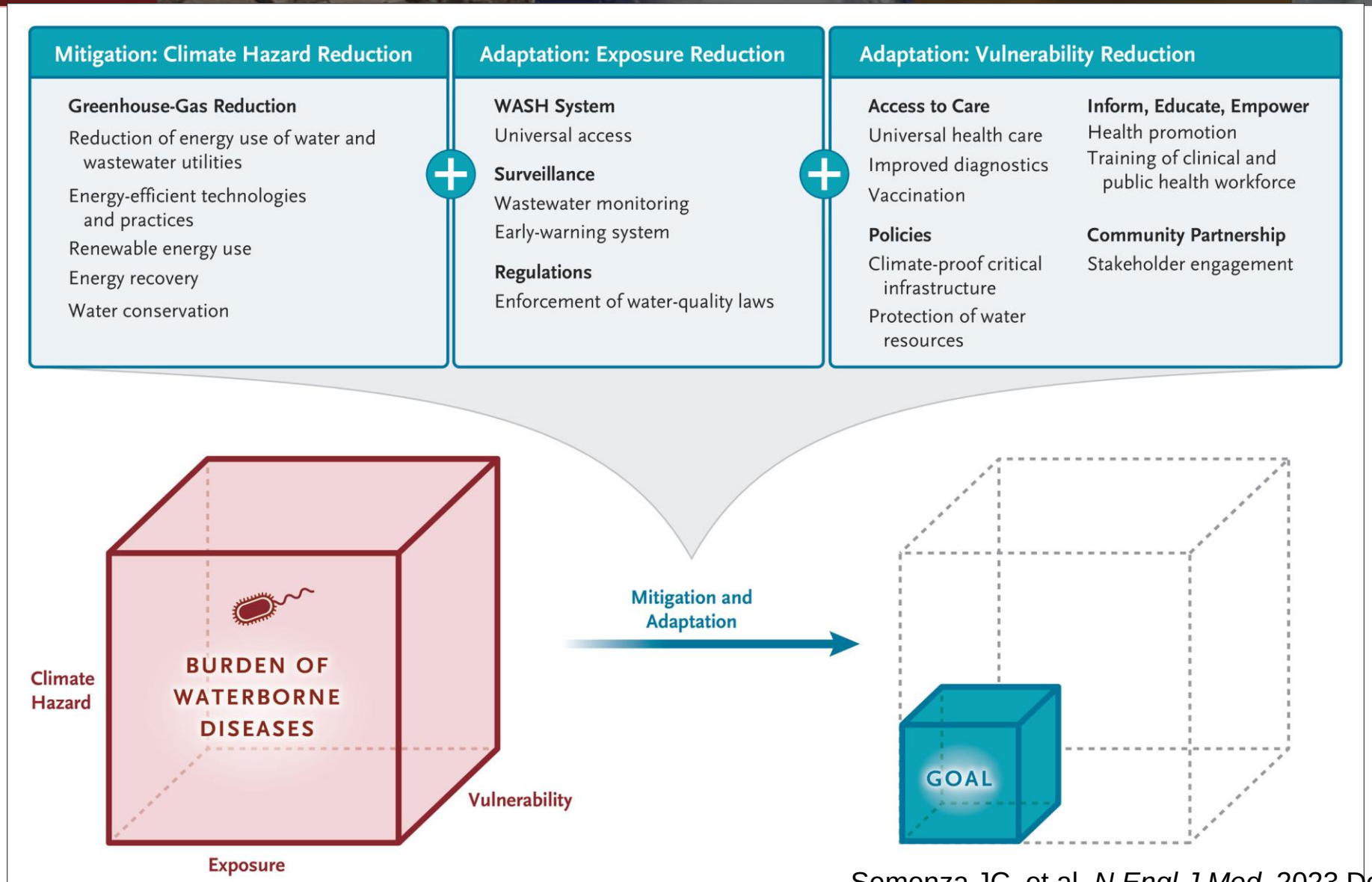
Families living in flood-affected areas have 'no alternative but to drink and use potentially disease-ridden water', UNICEF says.





Varo R, et al. Travel Med Infect Dis. 2017;29;6-7, Malikzai A, et al. Int J Surg Open. 2023;57:100652, https://earthobservatory.nasa.gov/images/150470/flood-woes-continue-in-Pakistan, https://www.aljazeera.com/news/2023/3/21/un-says-10-million-without-safe-water-in-flood-affected-pakistan

Reducing the Burden of Climate-Sensitive Waterborne Diseases through Mitigation of and Adaptation to Climate Change

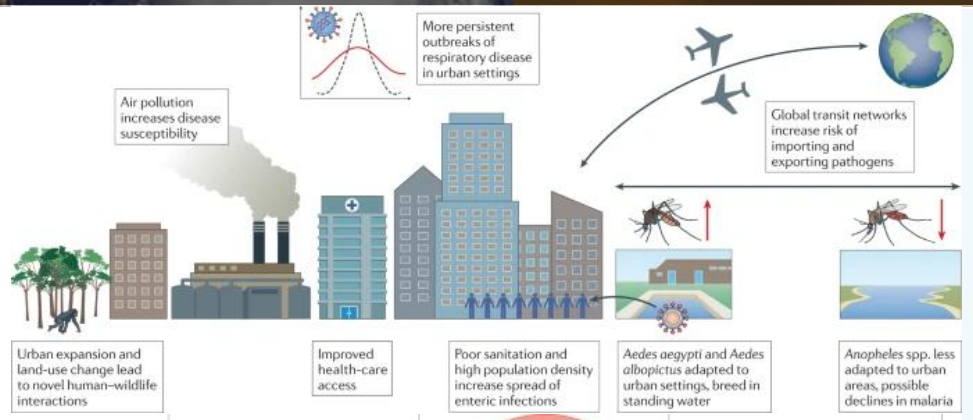


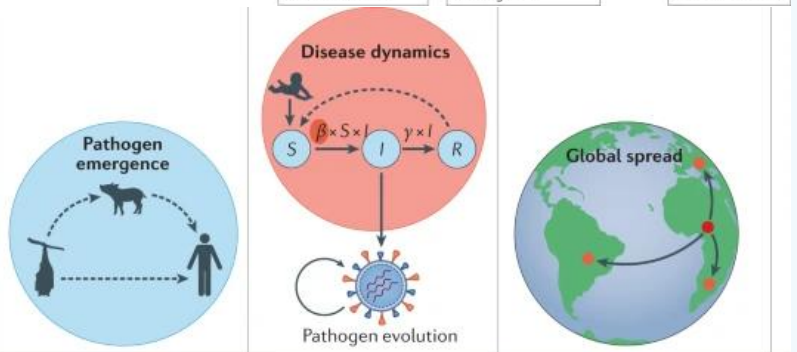
Semenza JC, et al. *N Engl J Med*. 2023 Dec 7;389(23):2175-2187.

Emerging and re-emerging infectious diseases

Risk for infectious diseases is increasing because of climate change

- Rapid transportation can influence the pace and range of infectious disease.
- Favorable climate helps imported diseases established in new areas.
- Importation of diseases to disease-free areas challenges diagnosis due to awareness and testing limitations.





Climatic change	Drives range shifts for reservoir species	Affects transmission and susceptibility	Affects the geographical range of vectors
Technological change			
Transportation	Improved global surveillance		Air transit and high-speed rail affect pace and range of spread
Health care		Vaccination affects dynamics	Improved care reduces burden
Demographic change			
Population growth and land use	Increased contact with reservoir species	Population numbers affect evolution, birth rates affect dynamics	Larger population travelling
Urbanization	Depends on species	Density affects contact rate	Urban population more connected
Ageing	Imunosenescence affects spillover risk	Ageing population increases transmission	Possible larger burden

As the climate changes, the risk also increases for health threats such as:

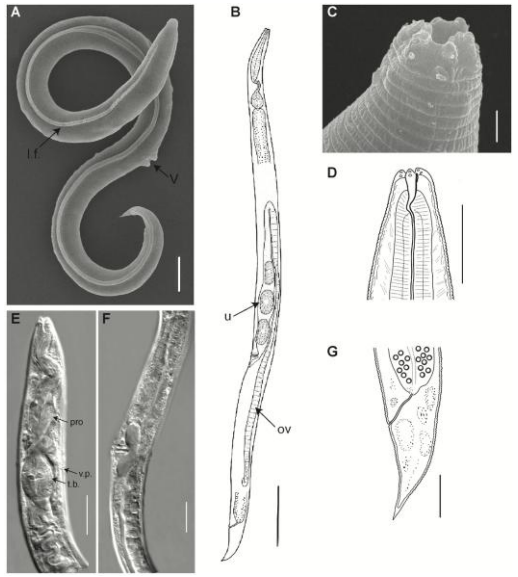
- Anaplasmosis
- Anthrax
- Antibiotic-resistant infections
- Cryptosporidiosis
- Dengue
- Ehrlichiosis
- Fungal diseases like valley fever and histoplasmosis
- Giardiasis
- Hantavirus
- Harmful algal bloom-associated illness
- Lyme disease
- Plague
- Rabies
- Spotted fever rickettsiosis
- Salmonellosis
- Vibriosis
- West Nile virus disease

Baker RE, et al. Nat Rev Microbiol. 2021;10:193-205, https://www.cdc.gov/ncezid/pdf/climate-change-and-infectious-diseases-H.pdf

Melting ice sheets may release ‘ancient’ pathogens

- Global warming may revive ancient pathogens locked up in the ice sheets.
- This may cause re-emerging infectious diseases to humans and animals.
- In 2016, a heat wave melted the permafrost in northern Siberia, subsequently exposing a carcass of reindeer, resulting in an anthrax outbreak.
- Some affected human population may include travelers to the glaciers and infected with or carried the diseases out to the outer world.

A worm has been revived after 46,000 years in the Siberian permafrost



***Panagrolaimus kolymaensis*, an ancient nematode species was revived in 2023 after having been locked up in the permafrost since the Ice Age.**

Climate change and glacier melting: risks for unusual outbreaks?

Ryan Varghese, BPharm[1,2,†], Pal Patel, BTech[3,†], Dileep Kumar, PhD[1,4,5,*] and Rohit Sharma, MD, PhD[6,*]

Take home message

Take home message

- Climate change can result in spread of vector-borne, food-borne and water-borne diseases, emerging and re-emerging infectious diseases, as well as arrays of environmental health hazards.
- Traveling is a crucial part of the spread of diseases in the era of climate change.
- Healthcare practitioners should be aware of the impending risks of diseases imported from foreign areas, as well as health hazards for travelers at travel destinations.
- There is urgent need to be aware and mitigate the impending threat of climate change.


Thank you