Contagious Connection: Linking Climate Change to Infectious diseases

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THE CONVERSATION

Academic rigour, journalistic flair

58% of human infectious diseases can be worsened by climate change – we scoured 77,000 studies to map the pathways

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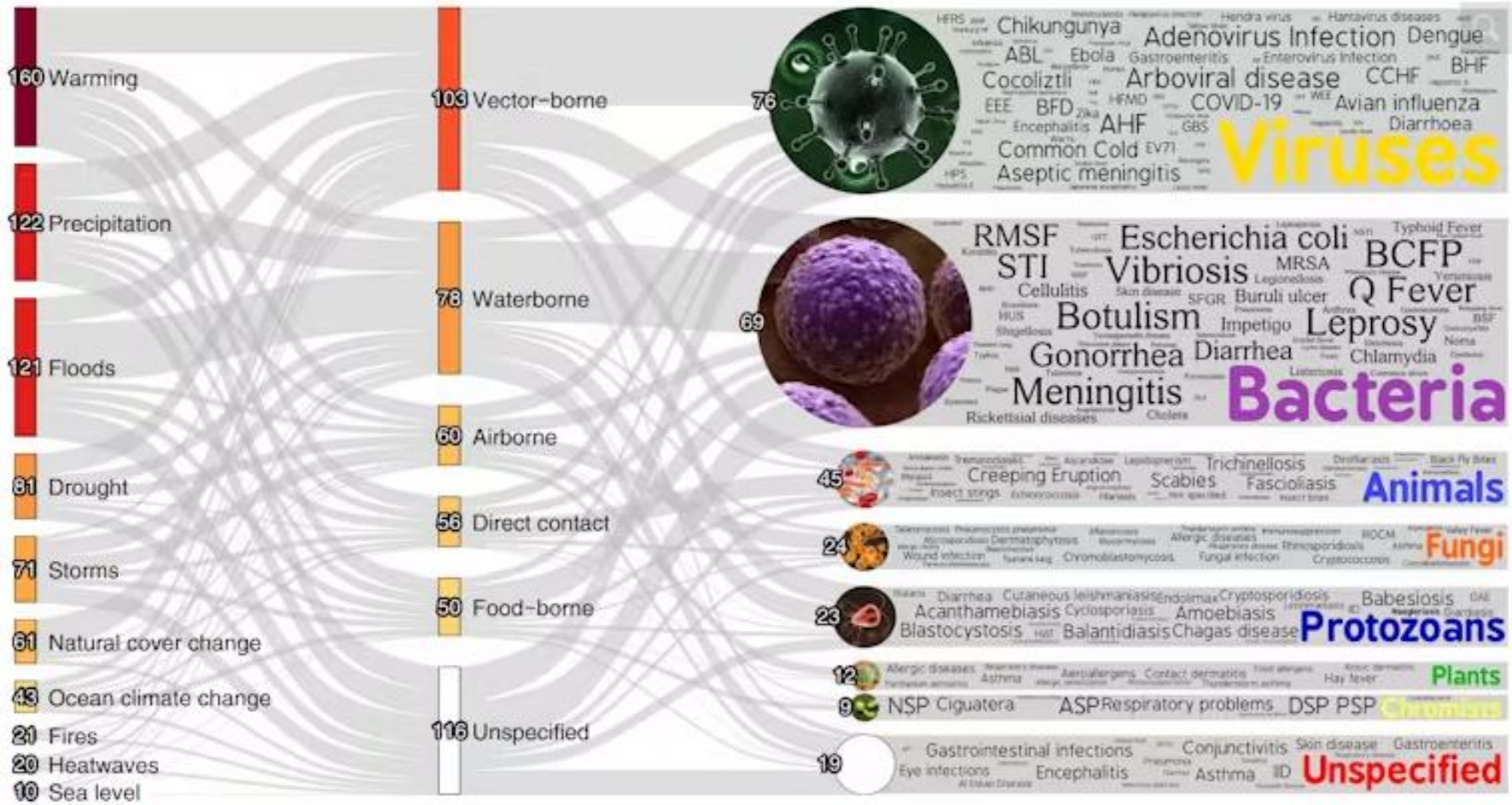
https://theconversation.com/58-of-human-infectious-diseases-can-be-worsened-by-climate-change-we-scoured-77-000-studies-to-map-the-pathways-188256

„Over half of known human pathogenic diseases can be aggravated by climate change“ (Mc Kenzie et al., 2022)



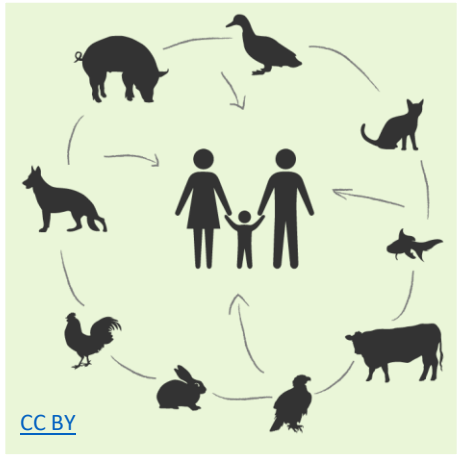
Mora, C., McKenzie, T., Gaw, I.M. *et al.* Over half of known human pathogenic diseases can be aggravated by climate change. *Nat. Clim. Chang.* **12**, 869–875 (2022). https://doi.org/10.1038/s41558-022-01426-1

Infections influenced by climate change (sample)

Vector – borne

Water – borne

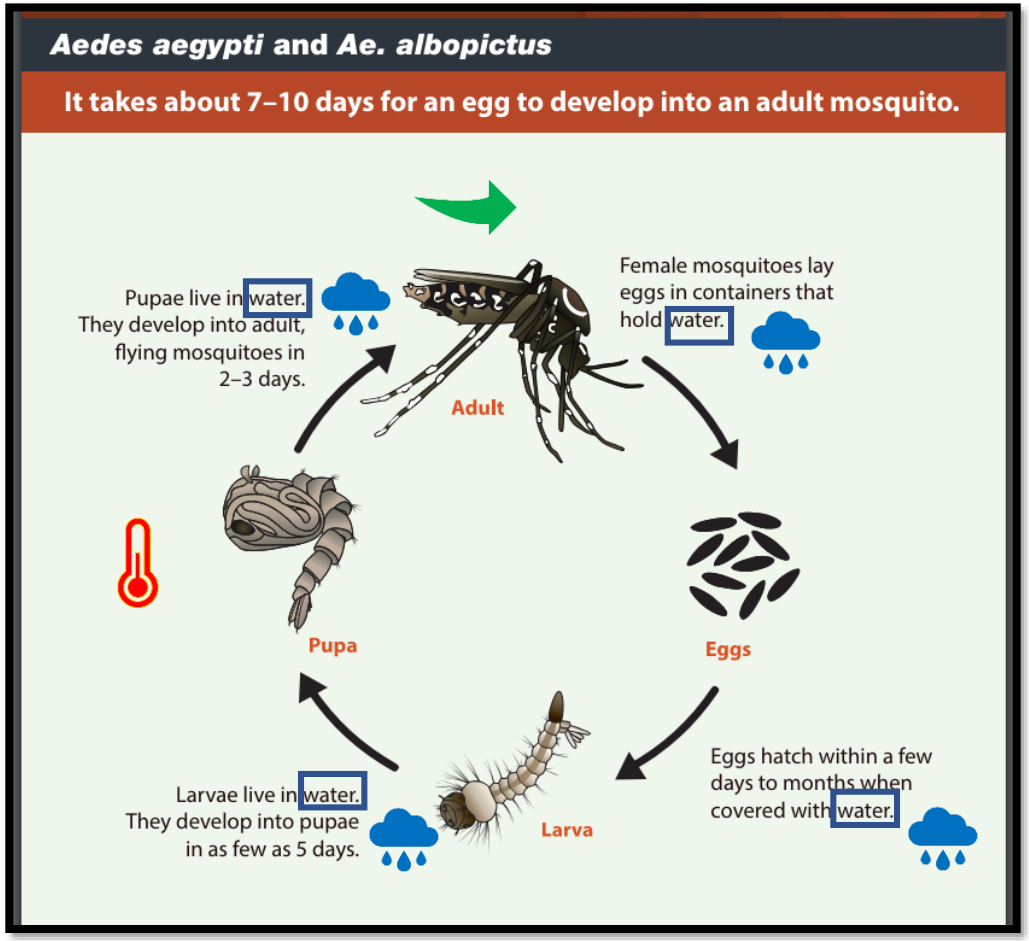
Zoonotic diseases



Food – borne

Vector – borne diseases

Vector-borne diseases – Mosquito life cycle



https://www.cdc.gov/mosquitoes/pdfs/aedeslifecycle-p.pdf

Precipitation patterns

- Mosquitos need water for their development. Aedes only need a little water. Anopheles eggs don't tolerate drying out, Aedes eggs can survive drying out for up to 8 months.

Temperature rise

- Aedes: Optimal temperature for development 25-30°C (unable to develop < 10°C or > 40°C)

Liu, Z., Zhang, et al. (2023). The effect of temperature on dengue virus transmission by Aedes mosquitoes. *Frontiers in Cellular and Infection Microbiology*, *13*, 1242173.

- Anopheles: water temperature 18-34°C (optimal temperature 27°C). Higher temperature -> rapid development of larvae (5-13d at 32°C, 10-38d at 18°C), but higher mortality

Asare, et al. (2016). Mosquito breeding site water temperature observations and simulations towards improved vector-borne disease models for Africa. *Geospatial Health*, *11*(s1)

Migration/Urbanisation

- Mosquitos feed on animals and humans
- Vector populations thrive with increase in food supply
- Spread of endemic diseases to new areas

United Nations | UN News
Global perspective Human stories

Spike in dengue cases due to global warming, warns WHO

Unsplash/Shardar Tarikul Islam | Common types of mosquito-borne diseases include Dengue, Yellow fever, Chikungunya and Zika.

21 July 2023 | Health

Global warming marked by higher average temperatures, precipitation and longer periods of drought, could prompt a record number of dengue infections worldwide, the World Health Organization (WHO) warned on Friday.

World Health Organization

Disease Outbreak News

Dengue - Global situation

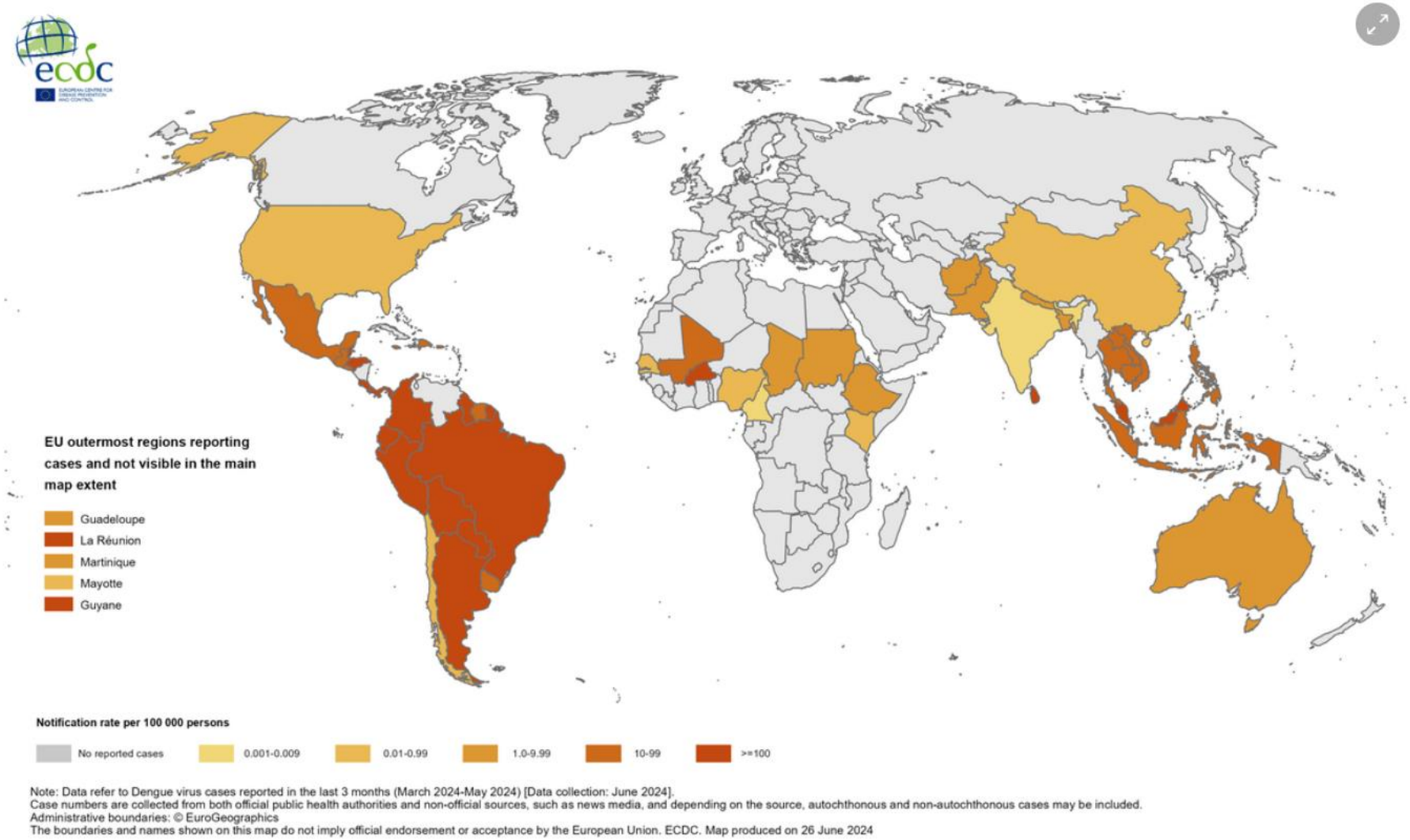
30 May 2024

Situation at a glance

As of 30 April 2024, over 7.6 million dengue cases HO in 2024, including 3.4 million confirmed cases, over 16 000 severe cases, and over 3000 deaths. While a substantial increase in dengue cases has been reported globally in the last five years, this increase has been particularly pronounced in the the end of April surpassing the annual high of 4.6 million cases in 2023. known active ddition, many endemic countries do not have strong detection and reporting mechanisms, so the true burden of dengue globally is underestimated. In order to control transmission more effectively, real-time robust dengue

- early start and longer duration of dengue transmission seasons in endemic areas;
- changing distribution and increasing abundance of the vectors (*Aedes aegypti and Aedes albopictus)*;
- consequences of climate change and periodic weather phenomena (El Nino and La Nina events) leading to heavy precipitation, humidity, and rising temperatures favouring vector reproduction and virus transmission;
- changes in the circulating serotypes within a country affecting population immunity;
- fragile health systems amid political and financial instability in countries facing complex humanitarian crises and large-scale population movements impairing the public health response;
- movement of people who are infected and goods that could carry the mosquito vectors.

Dengue cases worldwide - June 2024



Climate change could shift disease burden from malaria to arboviruses in Africa

Erin A Mordecai, Sadie J Ryan, Jamie M Caldwell, Melisa M Shah, A Desiree LaBeaud

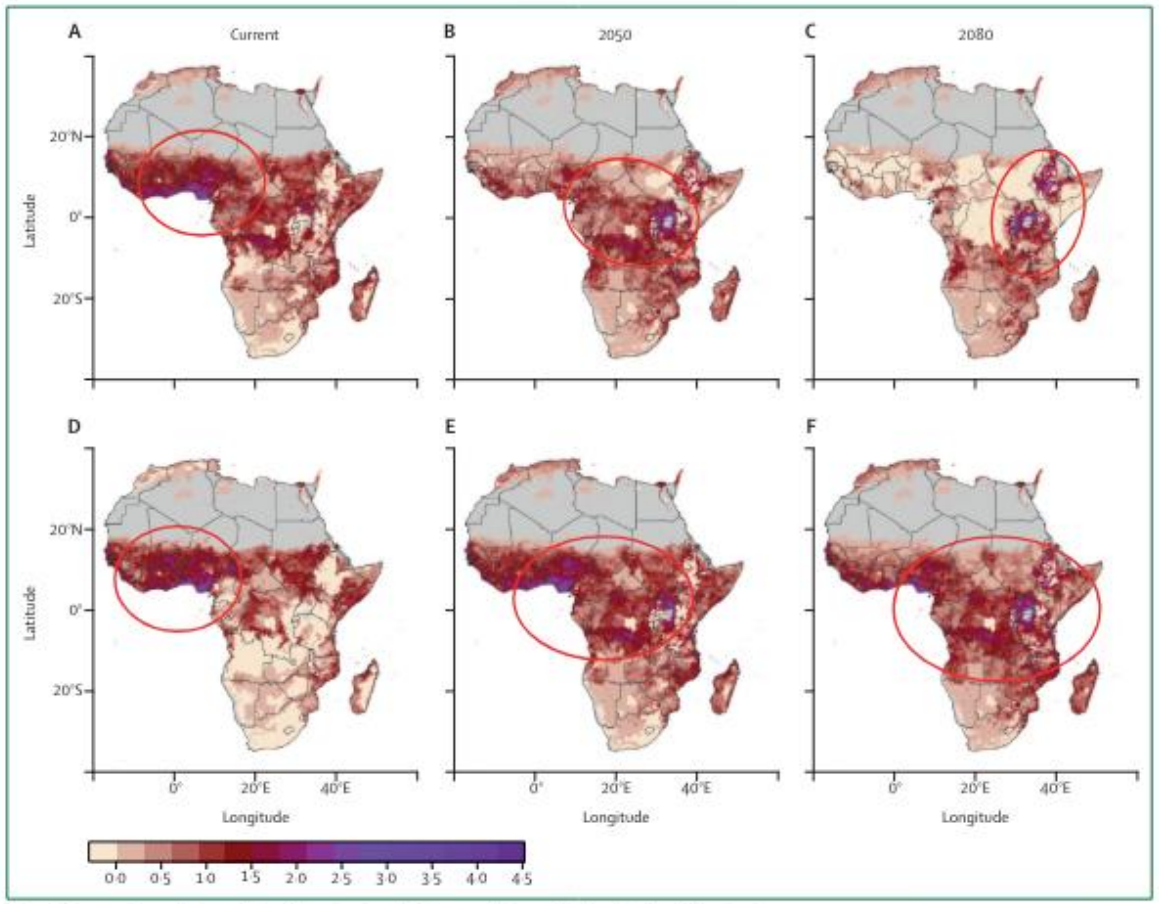


Figure 2: Temperature-driven malaria risk hotspot and *Aedes aegypti*-transmitted arbovirus risk hotspot

Arbovirus Infections (transmitted by Aedes mosquitos)

- Dengue fever
- Chikungunya
- Zika
- Yellow Fever
- Rift Valley Fever
- West Nile Fever

Ticks and Climate Change

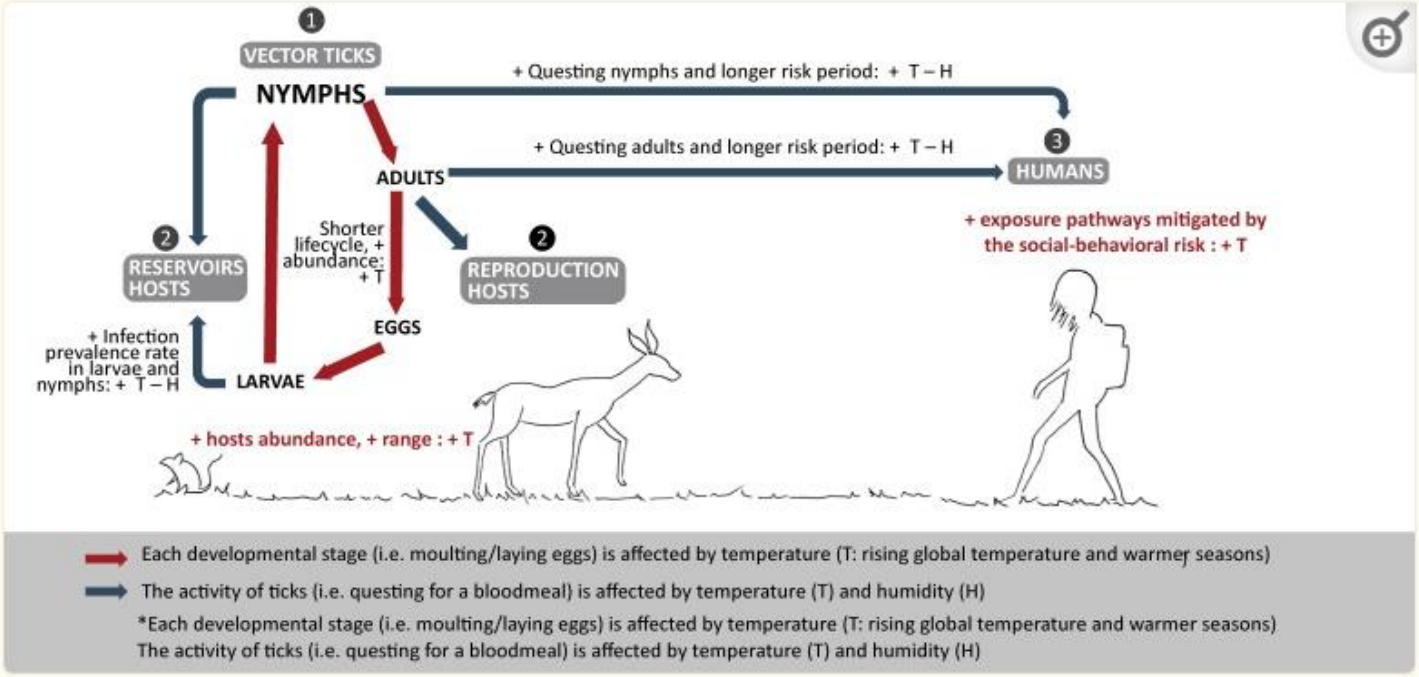


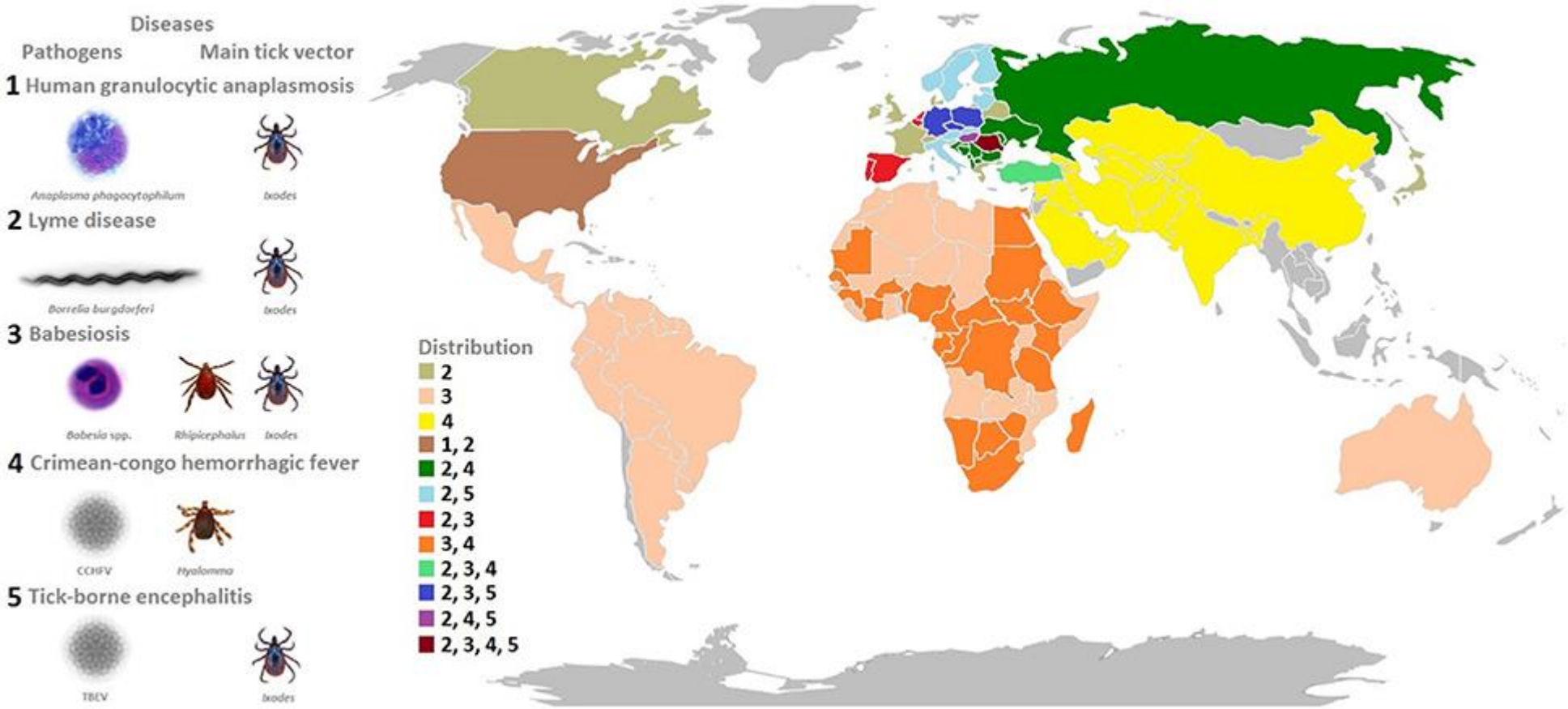
Figure 1

Weather and climate drivers that favor ticks' lifecycle and increase risk to humans

Adapted from Ogden & Lindsay, 2015 (5)

Bouchard, C., Dibernardo, A., Koffi, J., Wood, H., Leighton, P., & Lindsay, L. (2019). Climate change and infectious diseases: The challenges: N Increased risk of tick-borne diseases with climate and environmental changes. *Canada Communicable Disease Report*, *45*(4), 83-89. https://doi.org/10.14745/ccdr.v45i04a02

Tick-borne diseases worldwide (2017)



Antunes, S., Bonnet et al. (2017). Tick-Pathogen Interactions and Vector Competence: Identification of Molecular Drivers for Tick-Borne Diseases. Frontiers in Cellular and Infection Microbiology, 7, 259111. https://doi.org/10.3389/fcimb.2017.00114

Tsetse flies and Sleeping sickness

ENVIRONMENT

In Parched Zimbabwe, Climate Change Pushes Tsetse to New Areas

Health experts will monitor tsetse-caused sleeping sickness to stem its spread

A woman carries water as she walks thro

by Andrew Mambondiyani

August 16, 2022

Tsetse flies—which transmit tiny parasites that cause sleeping sickness, a potentially fatal disease—are migrating from their usual habitats to cooler parts of Zimbabwe due to climate change. As temperatures rise and make higher altitudes and cooler parts of the country more suitable for tsetse, it is more likely that the flies will bring sleeping sickness—also known as human African trypanosomiasis (HAT)—to areas that were once considered safe from the disease.

https://www.thinkglobalhealth.org/article/parched-zimbabwe-climate-change-pushes-tsetse-new-areas#:~:text=As%20temperatures%20rise%20and%20make,considered%20safe%20from%20the%20disease.

Water- and Food-born diseases

AUGUST 9, 2016 | 3 MIN READ

Deadly Bacteria Spread across Oceans as Water Temperatures Rise

Cholera bacteria and others arise in more places and in greater abundance

BY UMAIR IRFAN & CLIMATEWIRE

An illustration of cholera bacteria. ROYALTYSTOCKPHOTO, GETTY

https://www.scientificamerican.com/article/deadly-bacteria-spread-across-oceans-as-water-temperatures-rise/

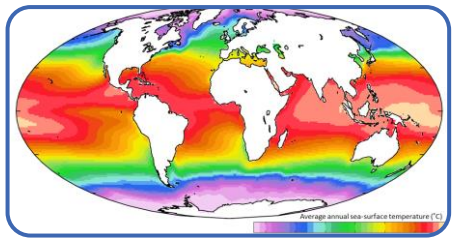
Water-borne diseases

Floods and heavy rainfalls

- Damage of sanitation systems
- Contamination of drinking water and crops with faecal matter

Droughts

- People and live stock are forced to use unsafe drinking water
- Poor hygiene conditions



Rise of water temperature

- Better conditions for replication of bacteria
- Spread of pathogens to new areas

El Niño-Induced Floods Devastate the Horn of Africa

Walter Mawere / CARE International

Flood displaced people in Belet Weyne. Photo: Action Aid Somalia.

https://reports.unocha.org/en/country/somalia/

World Health Organization

After decades of progress against cholera, cases are again on the rise, even in countries that had not seen the disease in years.

Cholera is an acute intestinal infection that spreads through food and water contaminated with the bacterium *Vibrio cholerae*, often from faeces. With safe water and sanitation, cholera can be prevented. It can kill within hours when not treated, but immediate access to treatment saves lives.

While the triggers for cholera outbreaks—like poverty and conflict—are enduring, climate change and conflict are now compounding the problem. Extreme climate events like floods, cyclones and droughts reduce access to clean water and create an ideal environment for cholera to thrive.

In 2022, 44 countries reported cholera cases, a 25% increase from the 35 countries that reported cases in 2021. This trend continues into 2023. The recent outbreaks have also been more deadly, with case fatality rates being the highest recorded in over a decade.

SCIENCE | AFRICA

Global heating may spread hepatitis E

Clare Roth
07/27/2022

Hepatitis E is common in countries like Bangladesh, where proper sanitation infrastructure is lacking and major flood events happen regularly

Image: Rashed Mortaza/DW

https://www.dw.com/en/more-flooding-drought-may-cause-hepatitis-e-to-spread/a-62609920

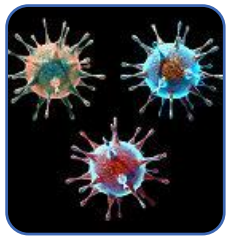
These forms of hepatitis — and hepatitis E especially — are largely transferred through water contaminated with fecal matter. Experts predict their spread will increase in the coming years as the climate continues to heat.

How hepatitis E spreads

"When you have a **flood**, the flood water can go into the sewers. And then when the floodwaters recede, you have sewage contamination. So, of course that water is contaminated with feces. That's a prime way to have transmission of hepatitis E," said Ayodele Majekodunmi, a researcher at the University of Ghana who has studied the spread of hepatitis E in sub-Saharan Africa.

"During dry weather, if the river recedes, you now have more concentrated water sources. Instead of everyone being able to take water from a flowing river, there are only a few pools left, and everyone is using those water sources. So, they get contaminated more easily," said Majekodunmi.

Food – borne diseases



Viruses

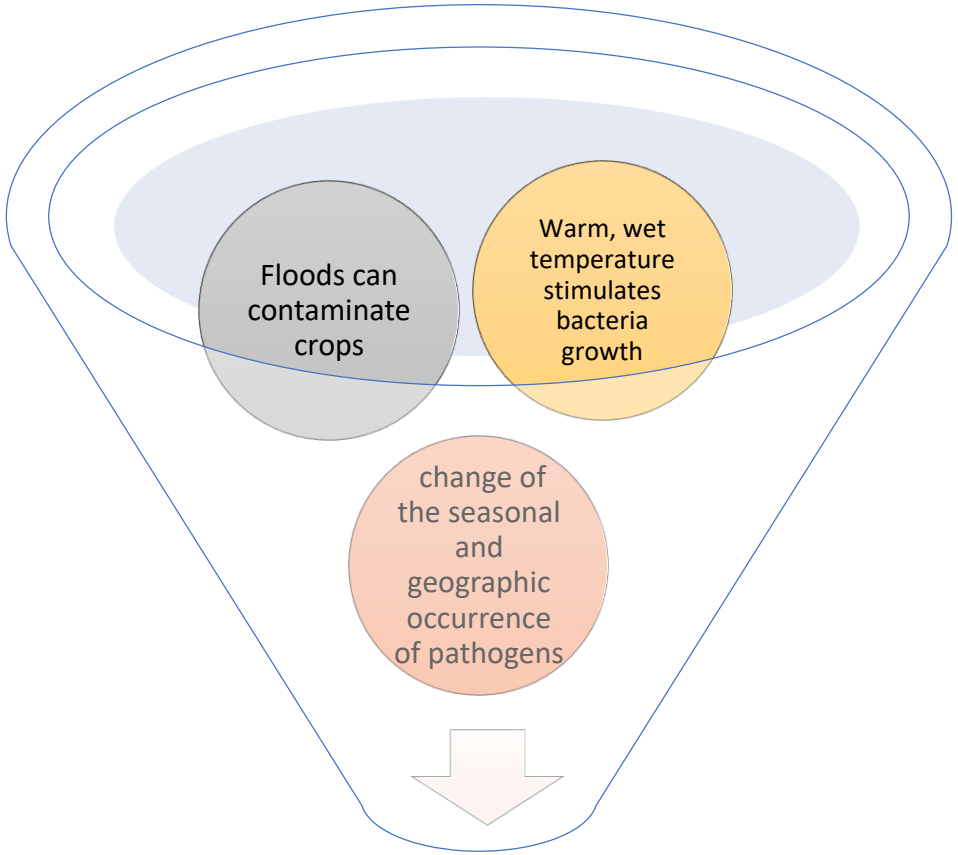
- e.g. Norovirus, Rotavirus

Bacteria

- e.g. Campylobacter, Salmonella, E.coli and Shigella

Parasites

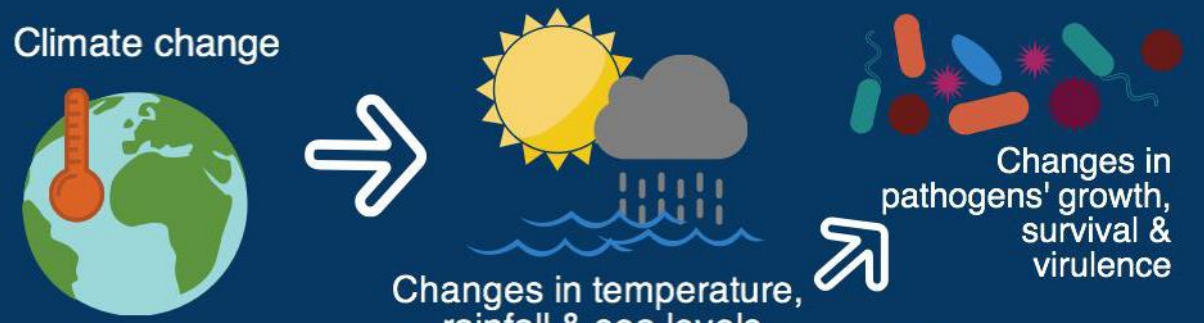
- e.g. Giardia, Cryptosporidium, Entamoebia and helminths



Higher concentration of pathogens on contaminated food and increase of bacterial populations during storage or transport (depending on time and temperature)

How Does Climate Change Affect Food Safety?

Climate change can increase food- and water-borne disease risks in many ways. Many pathogens, such as those responsible for cholera, are sensitive to changing temperatures, rainfall and extreme weather. This diagram summarises some of the main mechanisms:



Contamination of crops by faeces due to high levels of rainfall or flooding

Food scarcity can cause dietary shifts towards more 'unsafe' foods

Water scarcity during droughts can adversely affect hygiene and sanitation

THE GLOBAL CLIMATE & HEALTH ALLIANCE

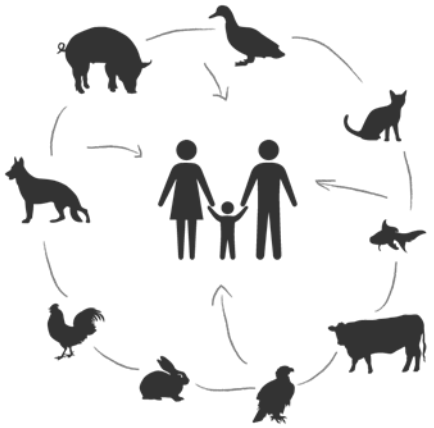
References

WHO, 2014: Food safety. Fact sheet N. 399 http://www.who.int/mediacentre/factsheets/fs399/en/

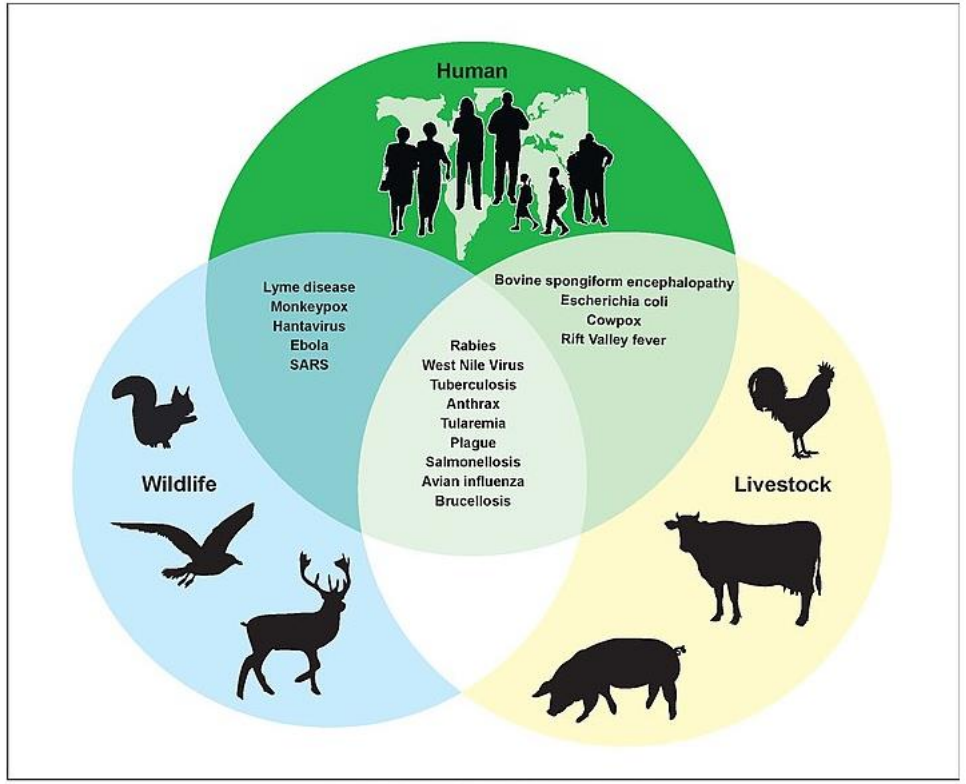
Smith, K.R., et al, 2014: Human health: impacts, adaptation, and co-benefits. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 709-754.

https://climateandhealthalliance.org/uncategorized/climate-change-and-food-safety/

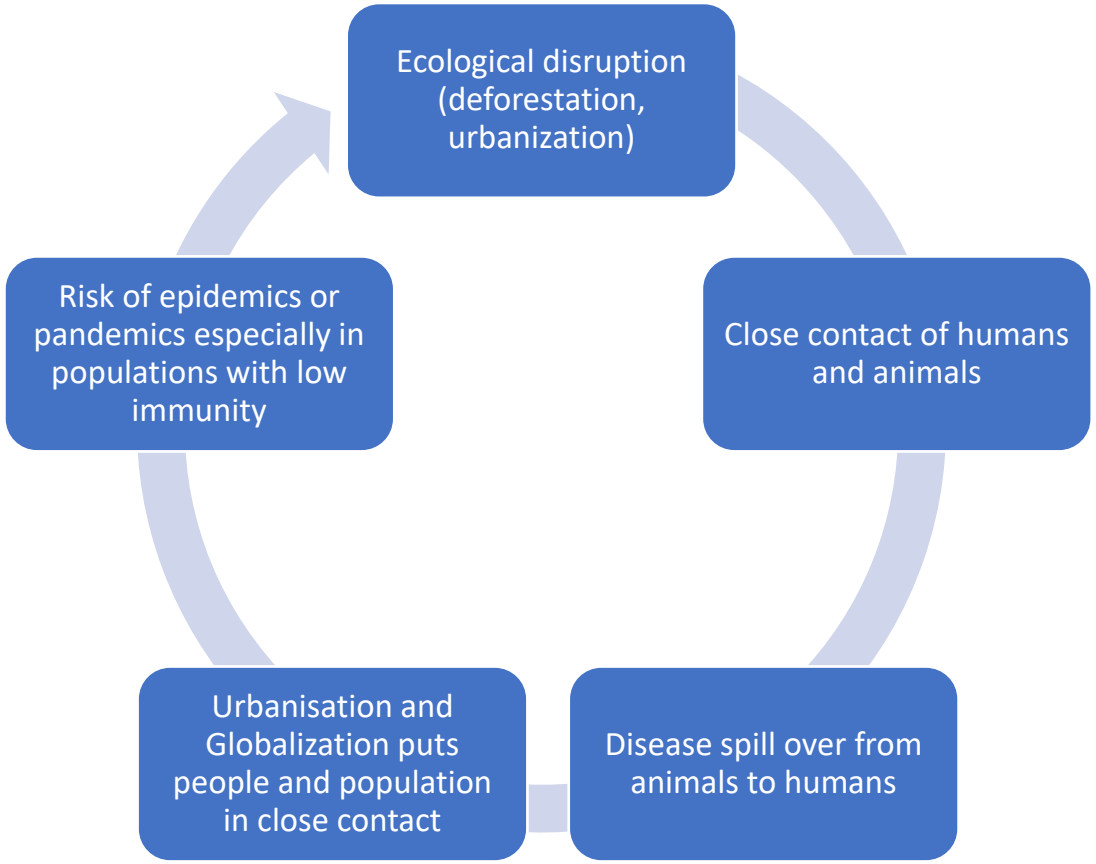
Zoonotic diseases



Zoonotic diseases



Source: GAO analysis of USGS data (data); Art Explosion (images).



Ebola

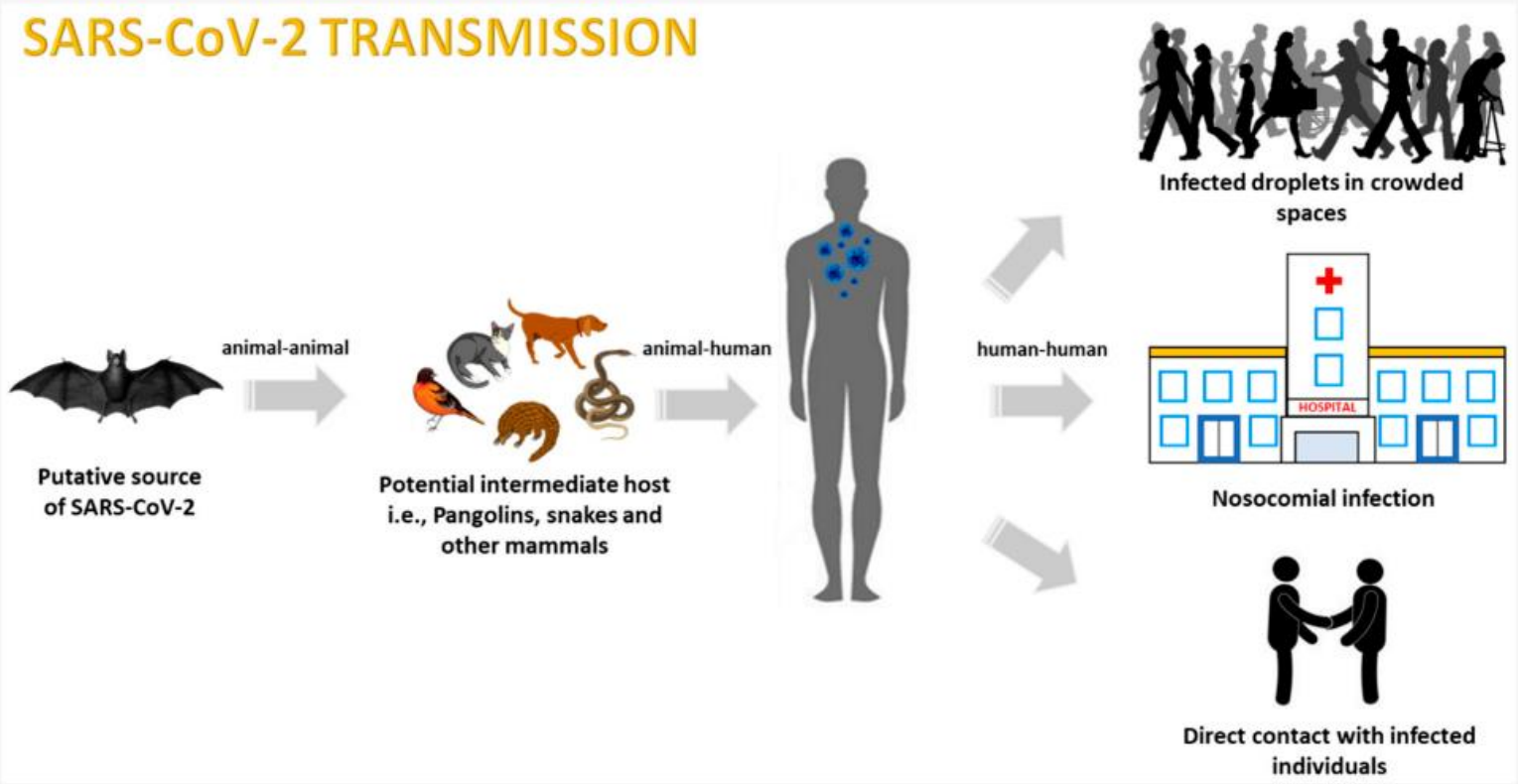
WHO: Rise in Ebola Outbreaks in Africa Linked to Climate Change

Doctors walk inside the Ebola isolation section of Mubende Regional Referral Hospital, in Mubende, Uganda, Sept. 29, 2022.

- The Ebola virus causes a severe, often fatal haemorrhagic fever, affecting primates and humans
- It is spread by fruit bats, porcupines and non-human primates to humans
- In the human population it spreads via bodily fluids and contaminated surfaces and material
- The 2014–2016 outbreak in West Africa was the largest outbreak since the discovery of the virus: More than 28 600 people had been infected and 11 325 people had died.

Zoonotic aspects of Covid-19

Figure 1. Representation of the zoonotic COVID-19 modes of transmission.



Sharma, A., Ahmad Farouk, I., & Lal, S. K. (2021). COVID-19: A Review on the Novel Coronavirus Disease Evolution, Transmission, Detection, Control and Prevention. *Viruses*, *13*(2), 202. https://doi.org/10.3390/v13020202

Monkeypox

BY COURTNEY TILLMAN IN CLIMATE CHANGE ON SEPTEMBER 28, 2022

Monkeypox and the Convergence of Climate, Ecological, and Biological Security Risks

The Origin and Spread of Monkeypox

Limited to the Congo Basin when the first human case was documented in 1970, monkeypox is now endemic within 10 countries in Central and Western Africa. By 2010, experts warned that monkeypox was increasing by significant margins, with habitation near wildlife among those with no prior vaccination history contributing significantly to the twenty-fold increase in cases. Despite these warnings, it was still alarming when the ongoing monkeypox outbreak was first detected outside of its endemic region on May 7, 2022. It has now spread to over 106 countries with over 56,400 confirmed cases, as of September 8th.

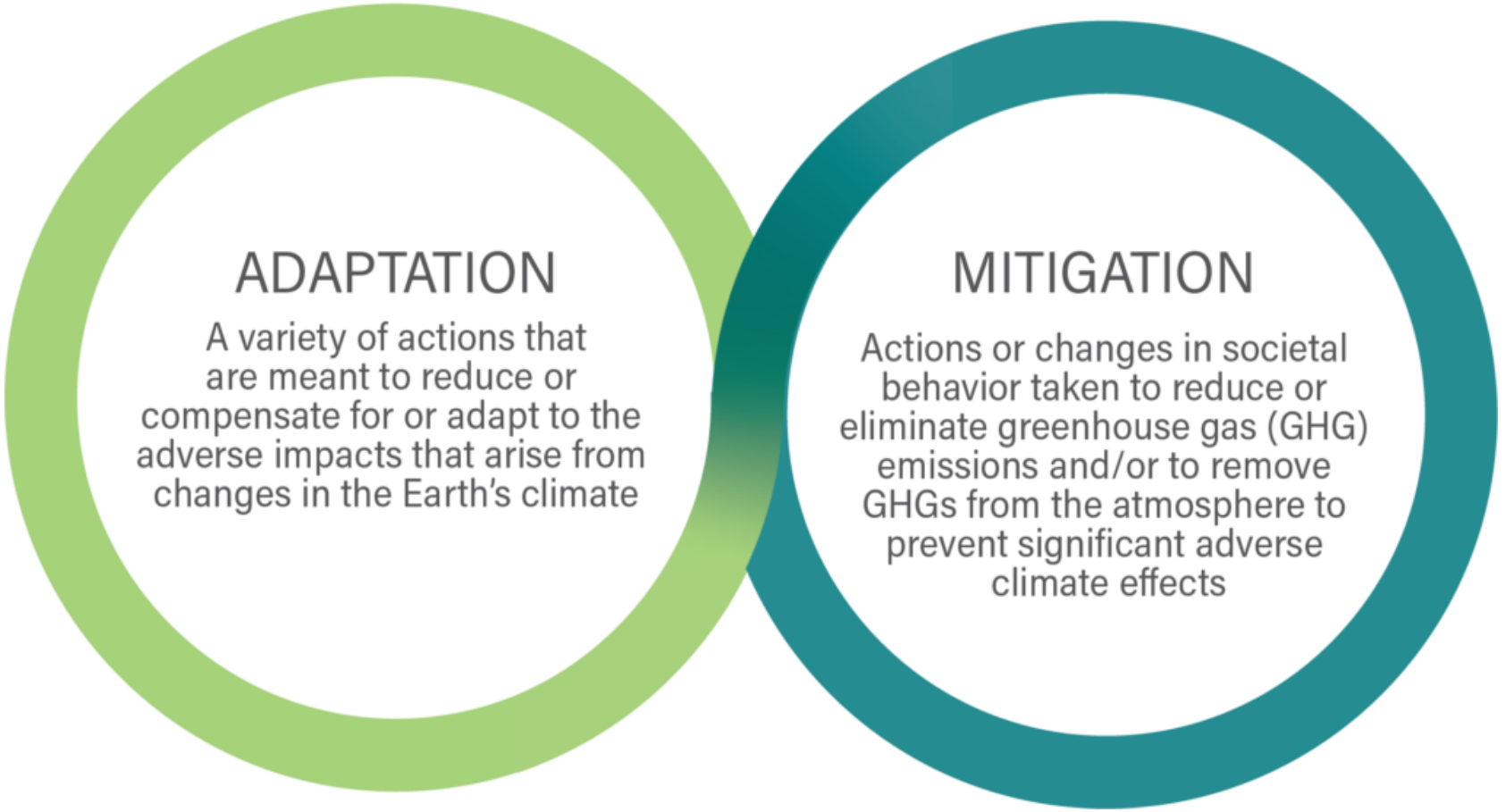
As experts seek to uncover what led to the recent surge of monkeypox from its endemic region to a global concern, many are highlighting the global trends exacerbating the emergence and impact of infectious diseases. The monkeypox virus jumps to humans from animal reservoirs, and is then spread within humans via extended skin-to-skin contact or physical exposure to a contaminated surface like bedding, clothing, and bodily fluids. Trends in deforestation and climate change have put human populations and animal reservoirs in greater contact with one another.

monkeypox virus jumps to humans from animal reservoirs, and is then spread within humans via extended skin-to-skin contact or physical exposure to a contaminated surface like bedding, clothing, and bodily fluids. Trends in deforestation and climate change have put human populations and animal reservoirs in greater contact with one another.

https://climateandsecurity.org/2022/09/monkeypox-and-the-convergence-of-climate-ecological-and-biological-security-risks/

And now…?

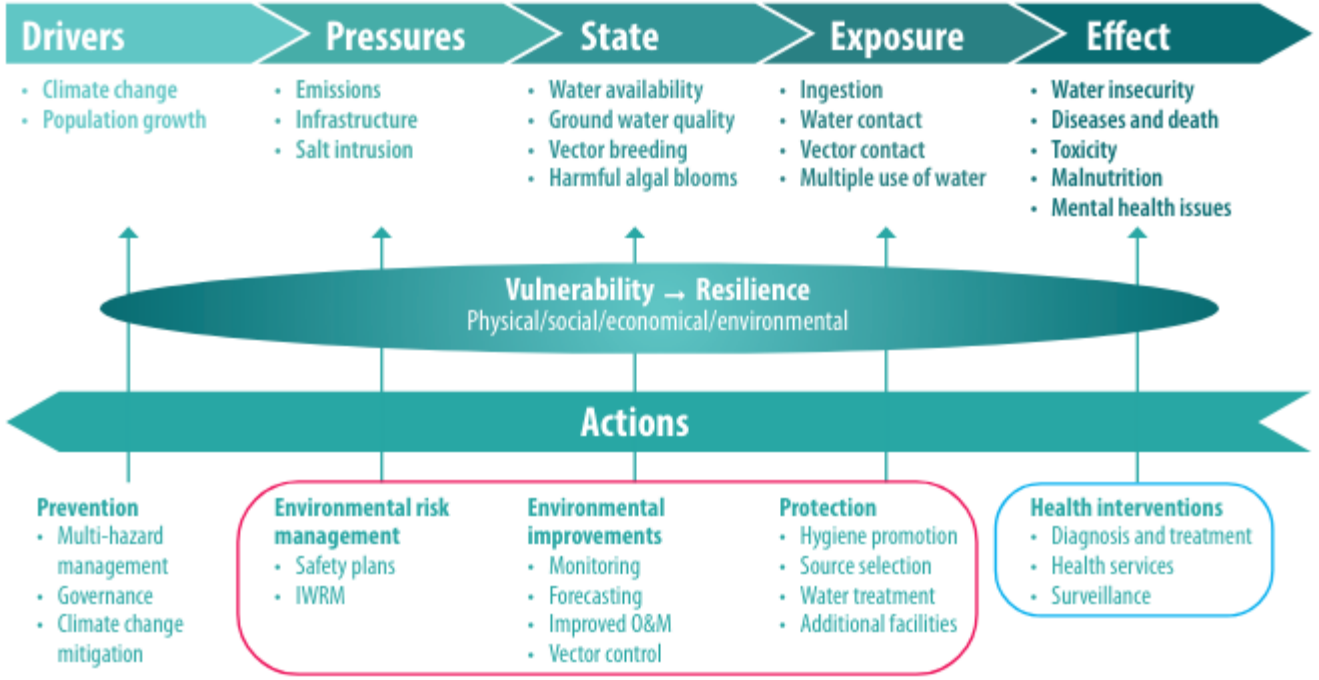
ADAPTATION VS. MITIGATION



https://eaest.com/insight/climate-change-adaptation-vs-mitigation/

Addressing climate change: Supplement to the WHO Water, Sanitation and Hygiene strategy 2018–2025

Draft DPSEEA framework for understanding the broader context and causal links between climate change, WASH, and health impact



Note: Some actions, such as WSPs and SSPs, may contribute to multiple categories, i.e. environmental risk management and protection.

Source: Deltares.

Example: Tanzania

3.1 Strategies

Adaptation remains a highest priority for Tanzania. This Strategy provides basis for identifying short, medium-and long-term adaptation activities designed to address existing and emerging

Adaptation remains a highest priority for Tanzania.

Adaptation Plans (NAPs) and Nationally Determined Contributions (NDCs) which identify medium-and long-term adaptation actions.

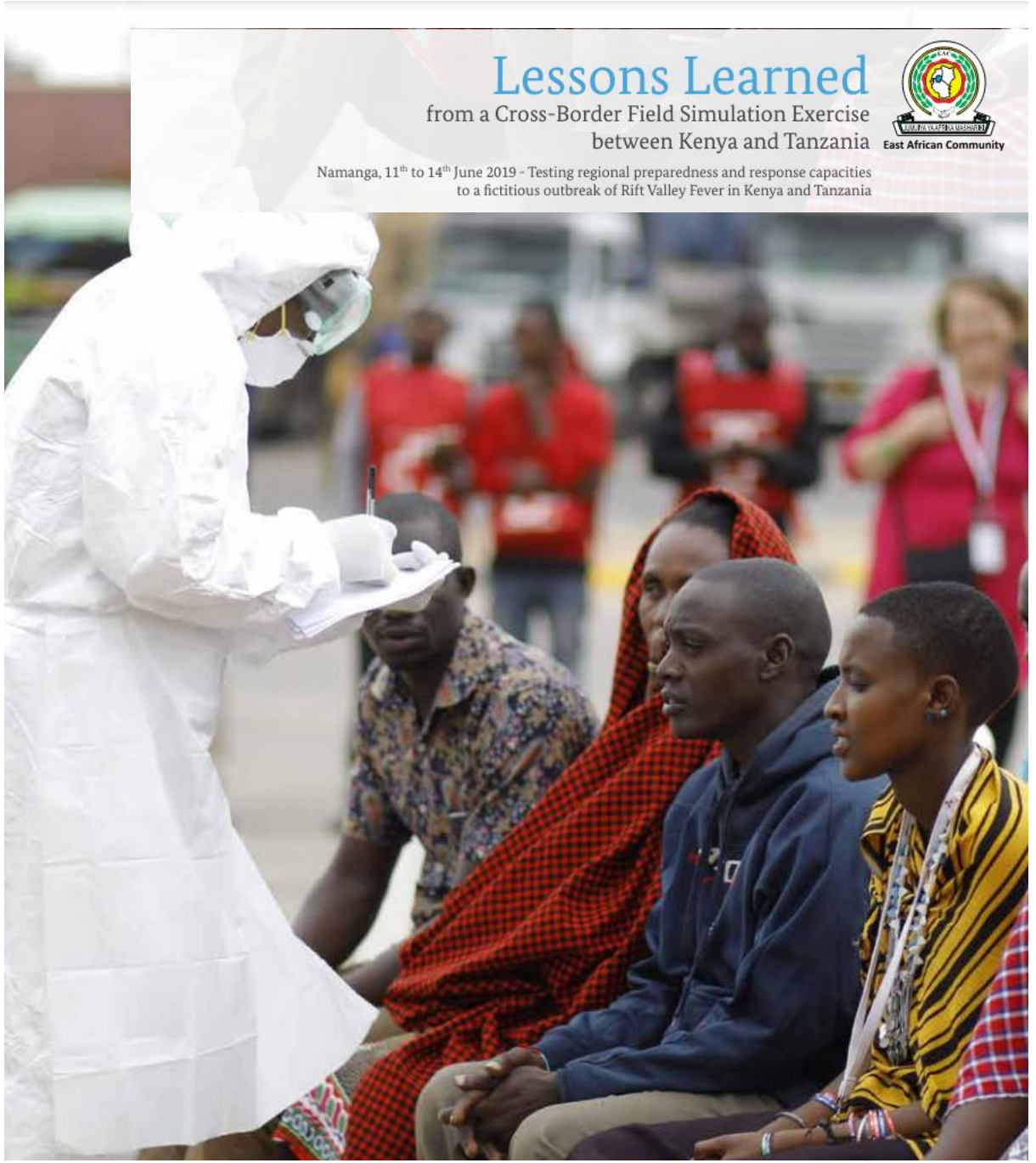
On the other hand, the United Republic of Tanzania participates in mitigation measures/activities in order to achieve economic development while contributing to reduction of greenhouse gas emissions. Owing to the

Tanzania participates in mitigation

Nationally Determined Contributions (NDC
and other inventory reports, different source
the proposed climate change mitigation action/intervention.

Lancet Countdown – 2023 report

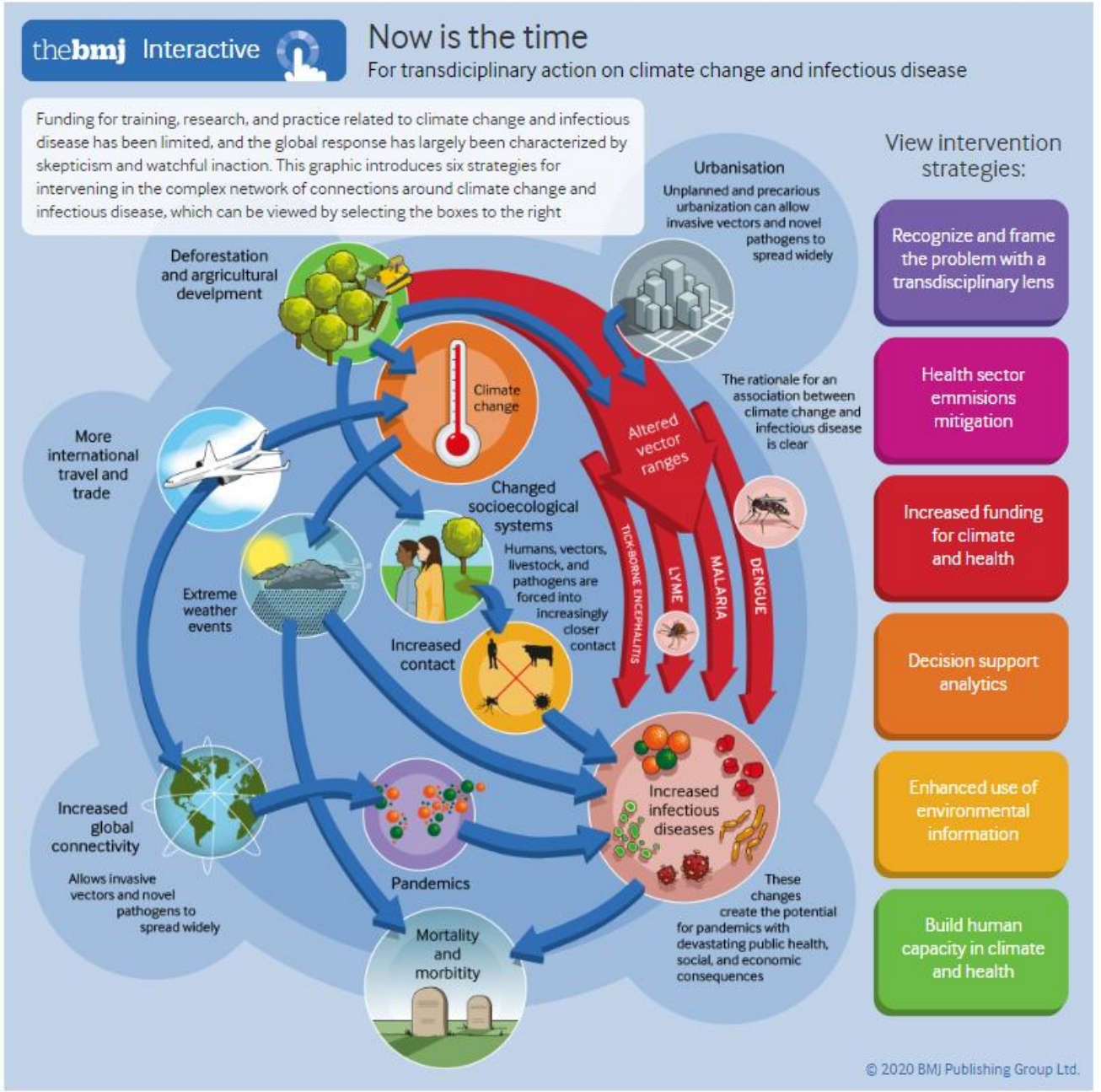
Prepare, Learn…



https://www.giz.de/en/downloads/giz2019-en-lessons-learnt-africa.pdf

…and act!

Now is the time!



https://www.bmj.com/communicable-diseases