



HEIDELBERG  
UNIVERSITY  
HOSPITAL



HEIDELBERG  
INSTITUTE OF  
GLOBAL HEALTH



# Climate Change and Health Impact, adaptation and response

Valérie R. Louis, Msc, PhD

[valerie.louis@uni-heidelberg.de](mailto:valerie.louis@uni-heidelberg.de)

Heidelberg Institute for Global Health (HIGH)

**Global Health Lecture Series**  
**Summer Semester 2021**

**22/04/2021**  
**Earth day 2021**



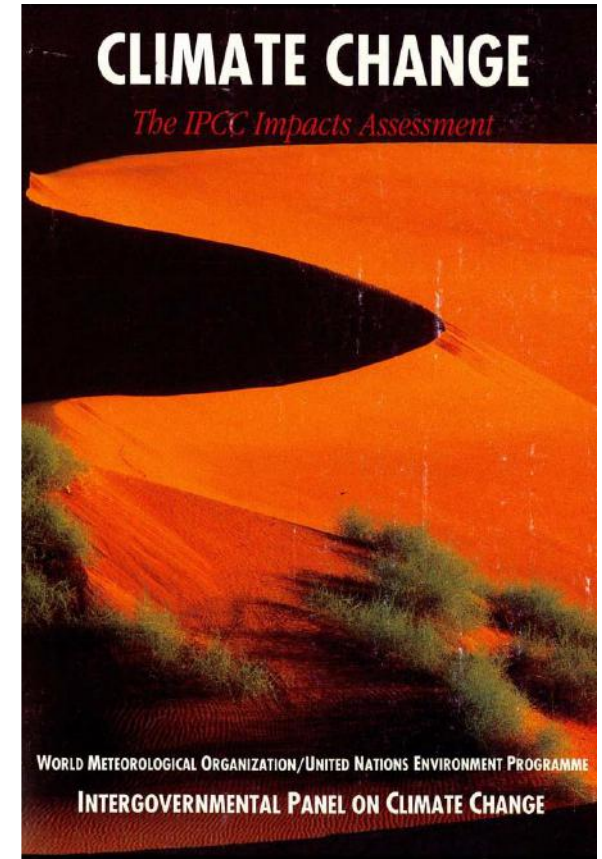
# Overview

- Background
- What **outcomes** of climate change (CC) can we expect?
- What outcomes of CC on **health** can we expect?
- What can we do?
  - Adaptation
  - Mitigation & health co-benefits
- Conclusions

# Earth Day (since 1970)

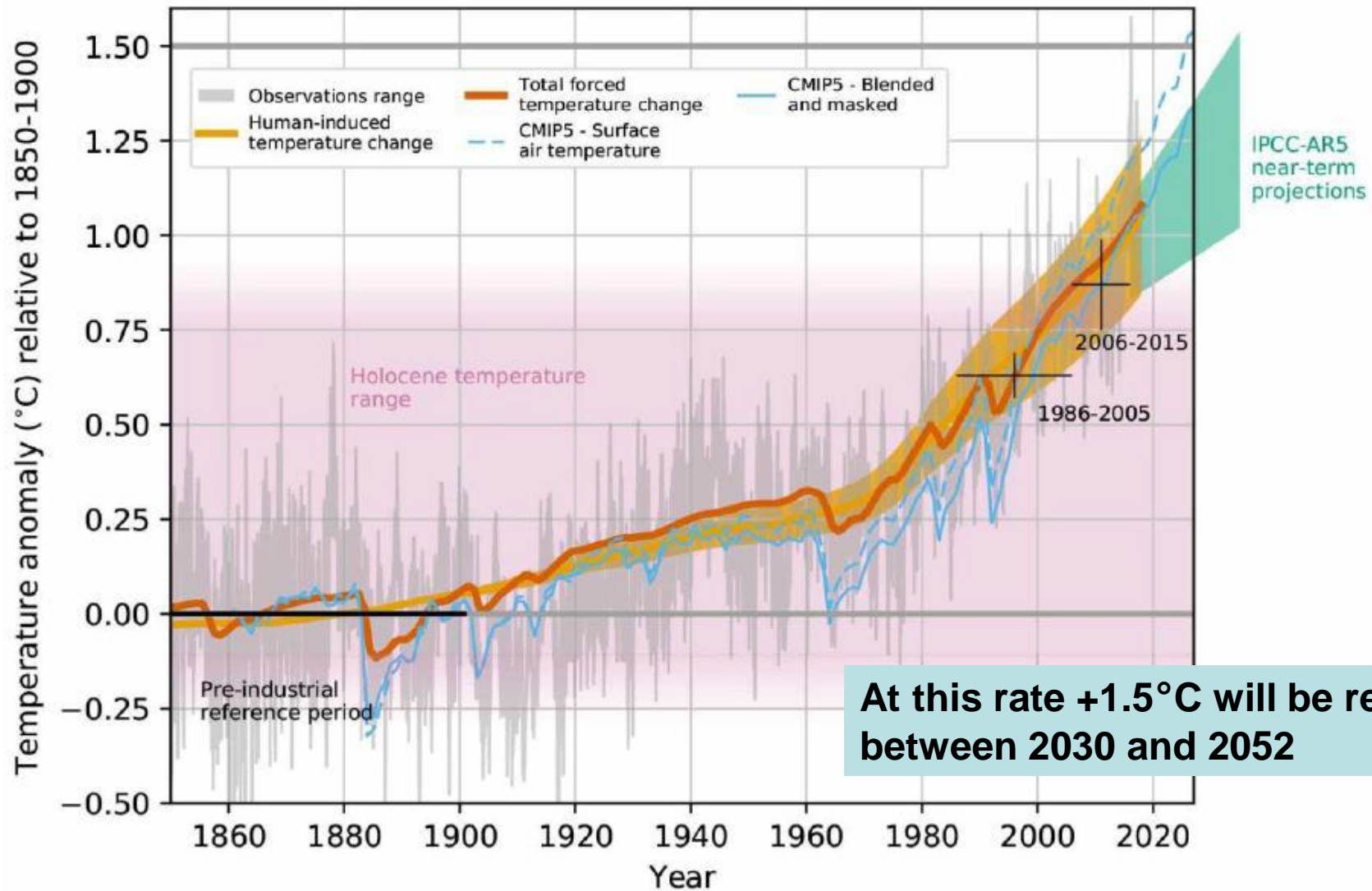


The Blue Marble by the crew of Apollo 17 (1972)



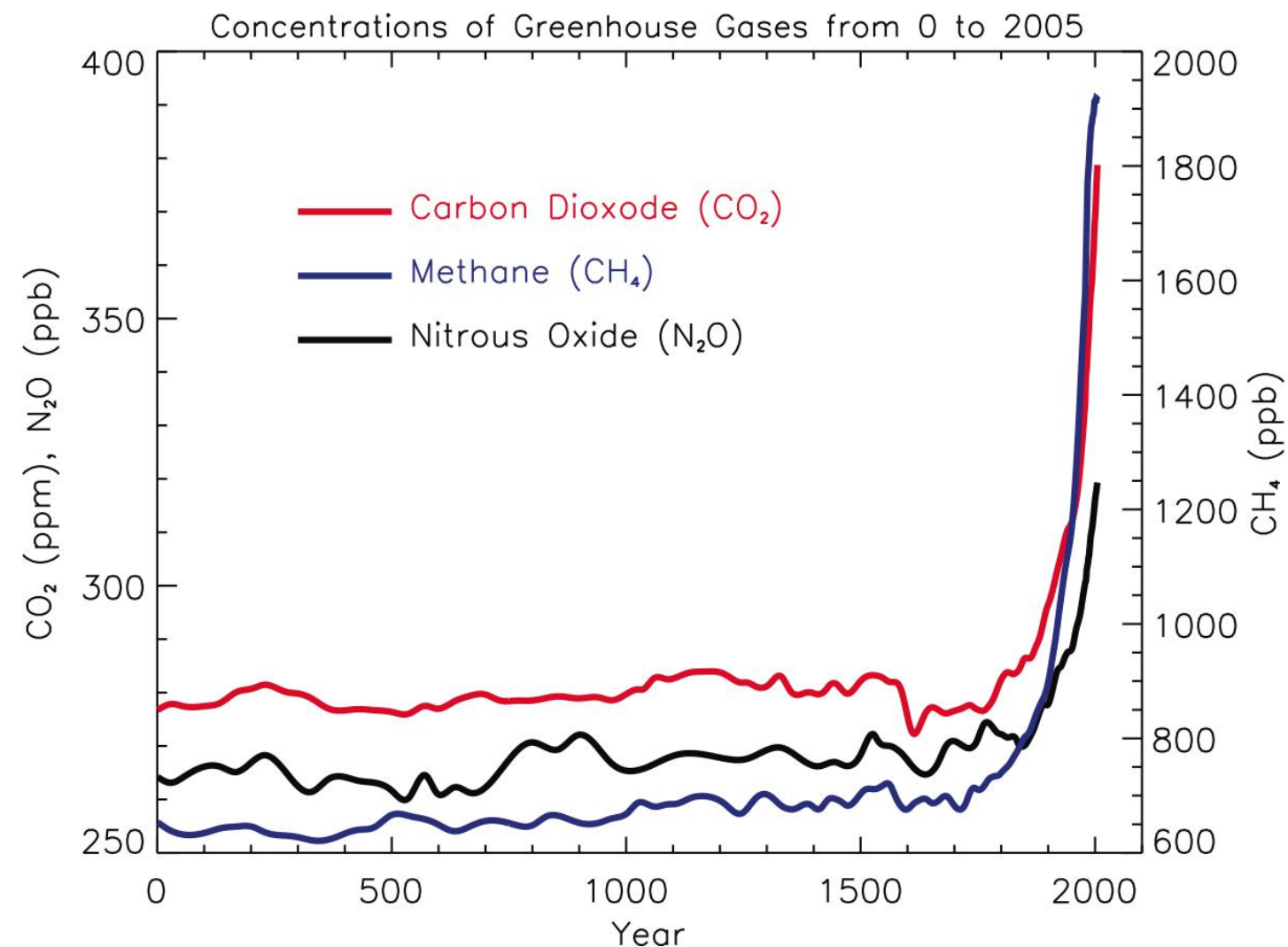
IPCC, First report, July 1990

# Global warming



Source: IPCC sr15\_chapter1.pdf

# Increased concentrations of greenhouse gases (GHG) in the atmosphere



## GHG:

- Water vapor
- Carbon dioxide ( $\text{CO}_2$ )
- Methane ( $\text{CH}_4$ )
- Ozone ( $\text{O}_3$ )
- Nitrous oxides ( $\text{NO}_x$ )
- Sulfur oxides ( $\text{SO}_x$ )

+

- Climate-altering pollutants (CAP):
- black carbon (fine particulate matter)

# Anthropogenic greenhouse gases in the atmosphere

- More **emission of greenhouse gases from:**
  - Burning of fossil fuel
  - Agriculture (rice paddies, cattle)
- Reduction of “carbon sinks”: deforestation, land use change

Carbon sinks:

- plant biomass
- soil
- oceans



# Sources of anthropogenic greenhouse gases

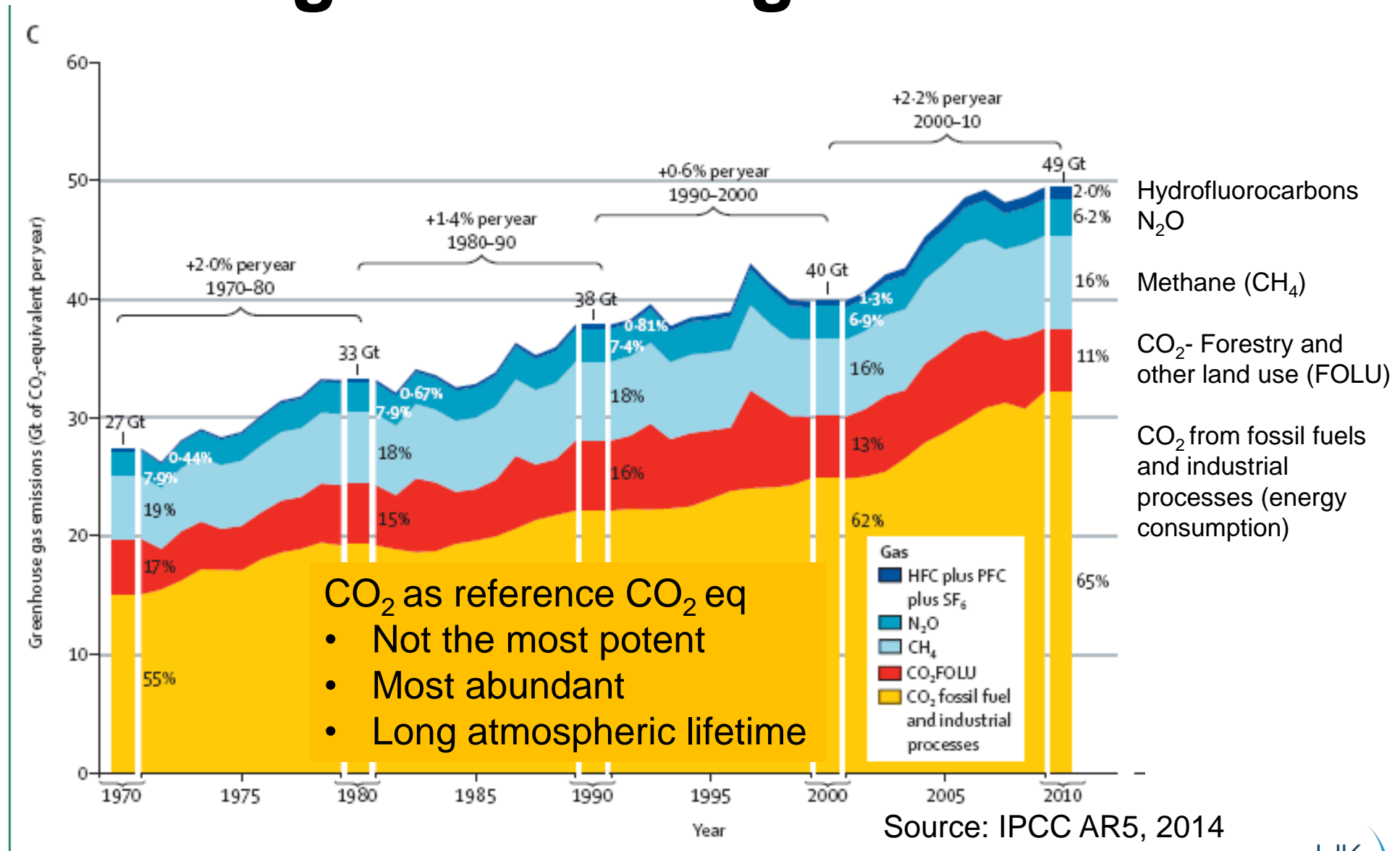
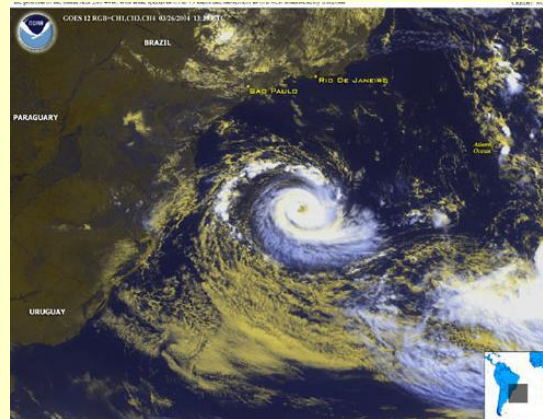


Figure 8: Sources of greenhouse gas emissions (source: IPCC, 2014<sup>2022</sup>)

Allocation of total greenhouse gas emissions in 2010 (49.5 Gt CO<sub>2</sub> equivalent per year) across the five sectors examined in detail in this report

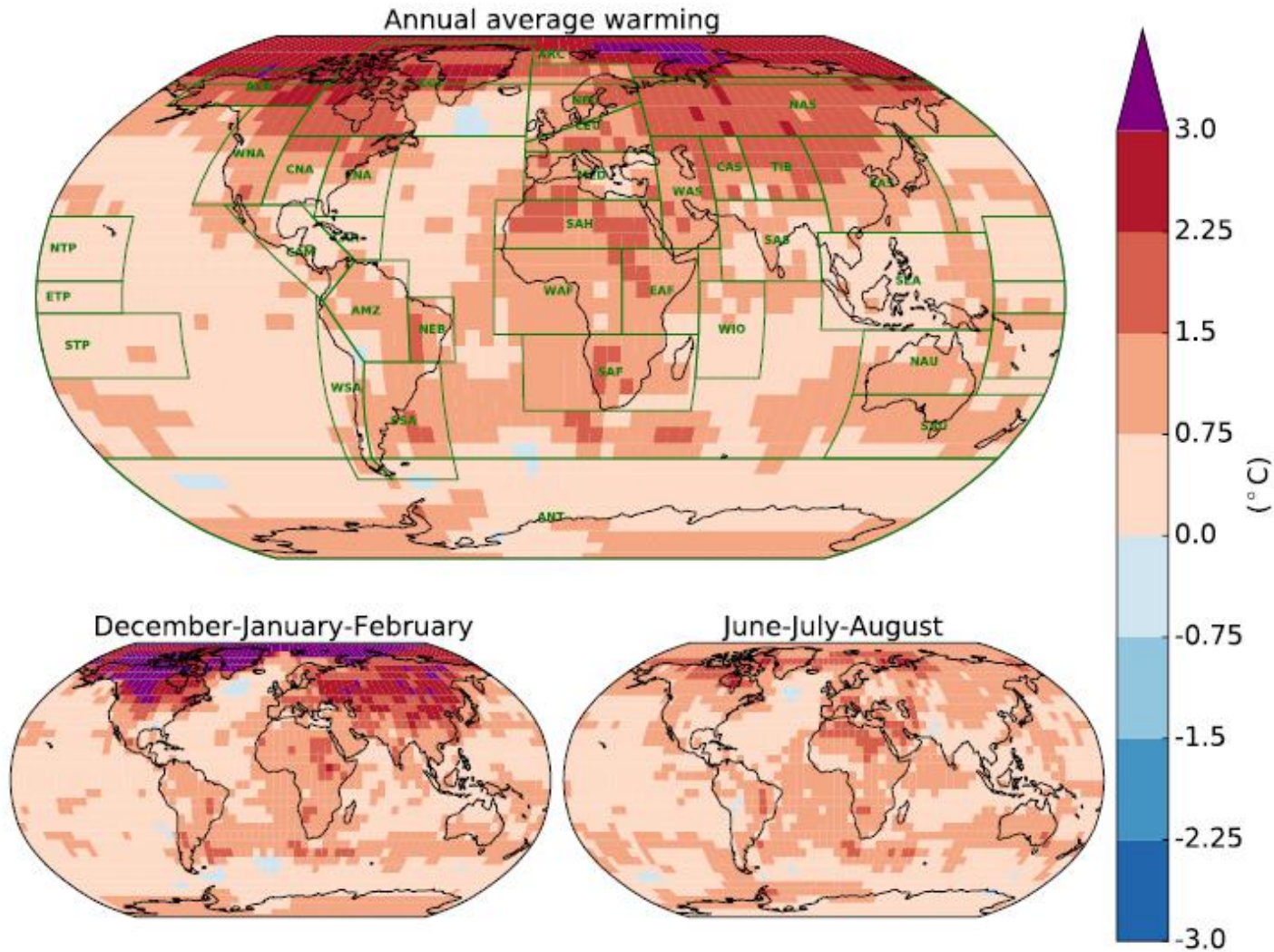
# What outcomes of climate change can we expect?





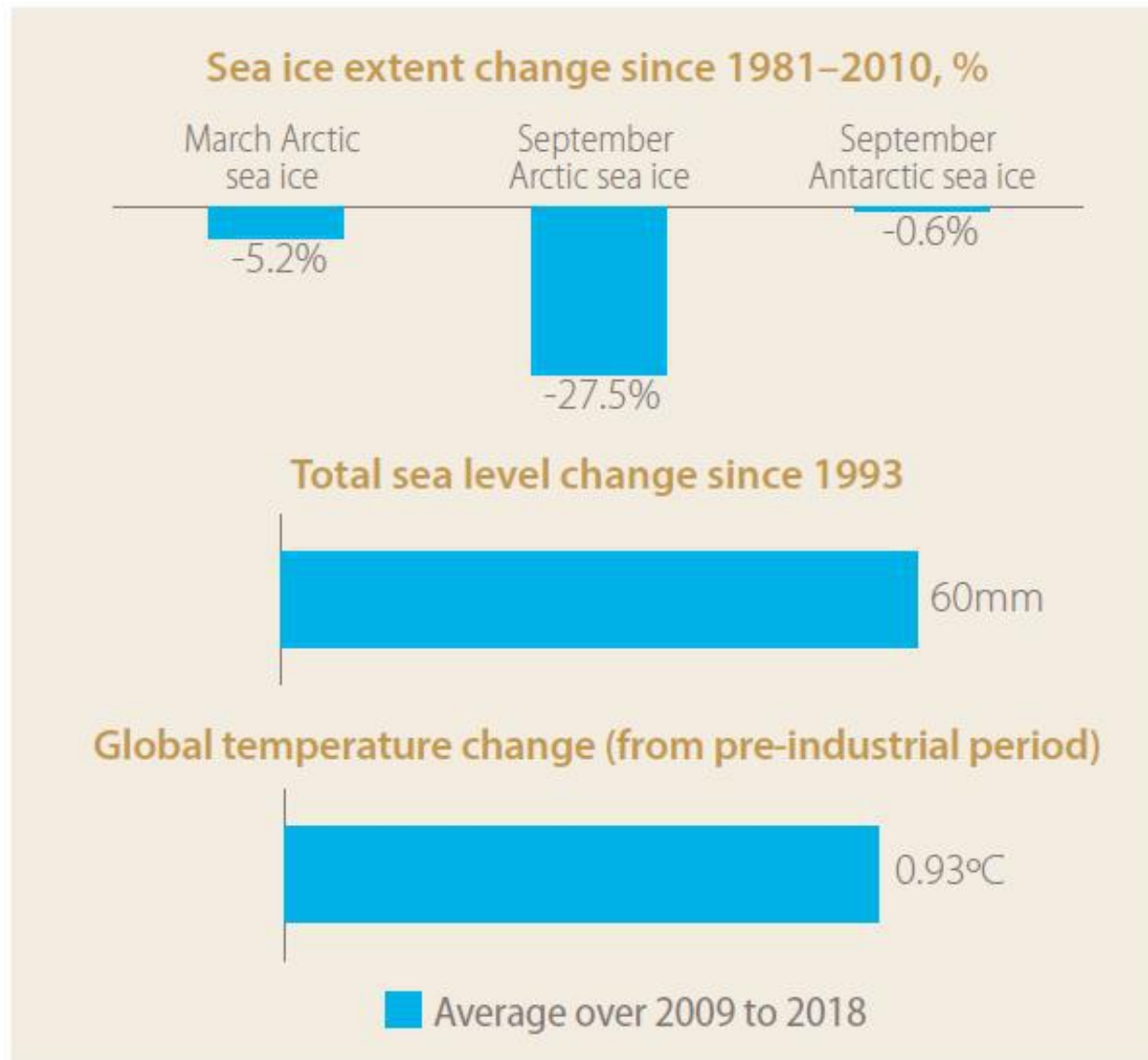
# Regional and seasonal warming

Regional warming in the decade 2006-2015 relative to preindustrial



Source: IPCC sr15\_chapter1.pdf

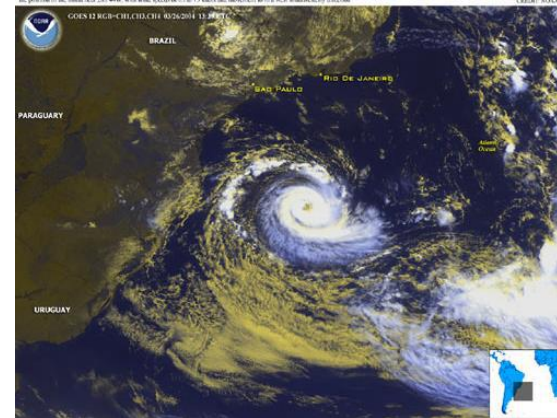
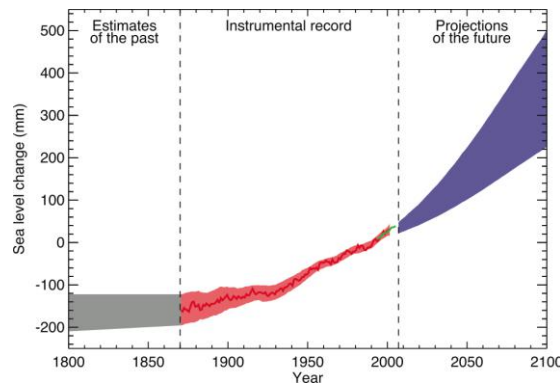
# Shrinking sea ice, elevated sea levels



Source: Independent Group of Scientists appointed by the Secretary-General, *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*, (United Nations, New York, 2019).

# Expected outcomes of climate change

- Global warming => Climate change at **regional** level
- Changes in precipitation patterns
- Increased weather variability
- Increased **frequency** and **strength** of extreme weather events (storms, floods, droughts, heat waves)
- Sea level rise
- Ocean acidification



# Intergovernmental Panel on Climate Change (IPCC) Oct 2018, special report

- **Human activities are estimated to have caused approximately 1.0°C of global warming** above pre-industrial levels, with a likely range of 0.8°C to 1.2°C.
- Warming from anthropogenic emissions from the pre-industrial period to the present will **persist for centuries to millennia**
- Mitigation options consistent with 1.5°C pathways are associated with **multiple synergies and trade-offs across the Sustainable Development Goals (SDGs)**



<http://www.ipcc.ch/report/sr15/>

# Within the context of the Sustainable Development Goals

Take urgent action to combat climate change and its impacts

<https://sustainabledevelopment.un.org/sdg13>



# Human activity induces climate change: rising CO<sub>2</sub> levels, increasing mean temperatures



Source: Independent Group of Scientists appointed by the Secretary-General, *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*, (United Nations, New York, 2019).



"A CAR, A CAR, MY PLANET FOR A CAR!..."

Floods, droughts, storms, heat waves,...

# What outcomes of CC on health can we expect?





# Links between CC and Human Health

## CLIMATE CHANGE

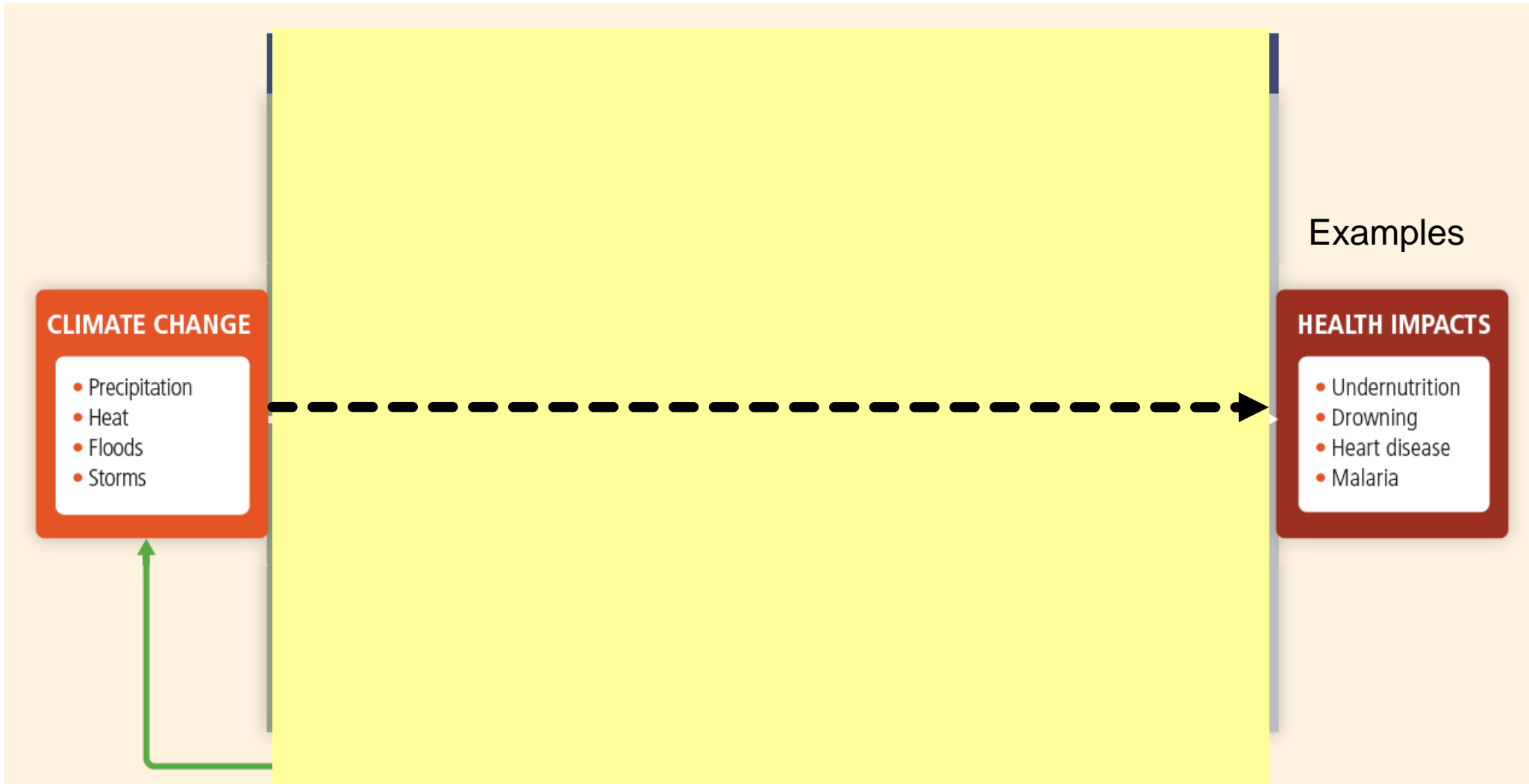
- Precipitation
- Heat
- Floods
- Storms

# What impacts?

...

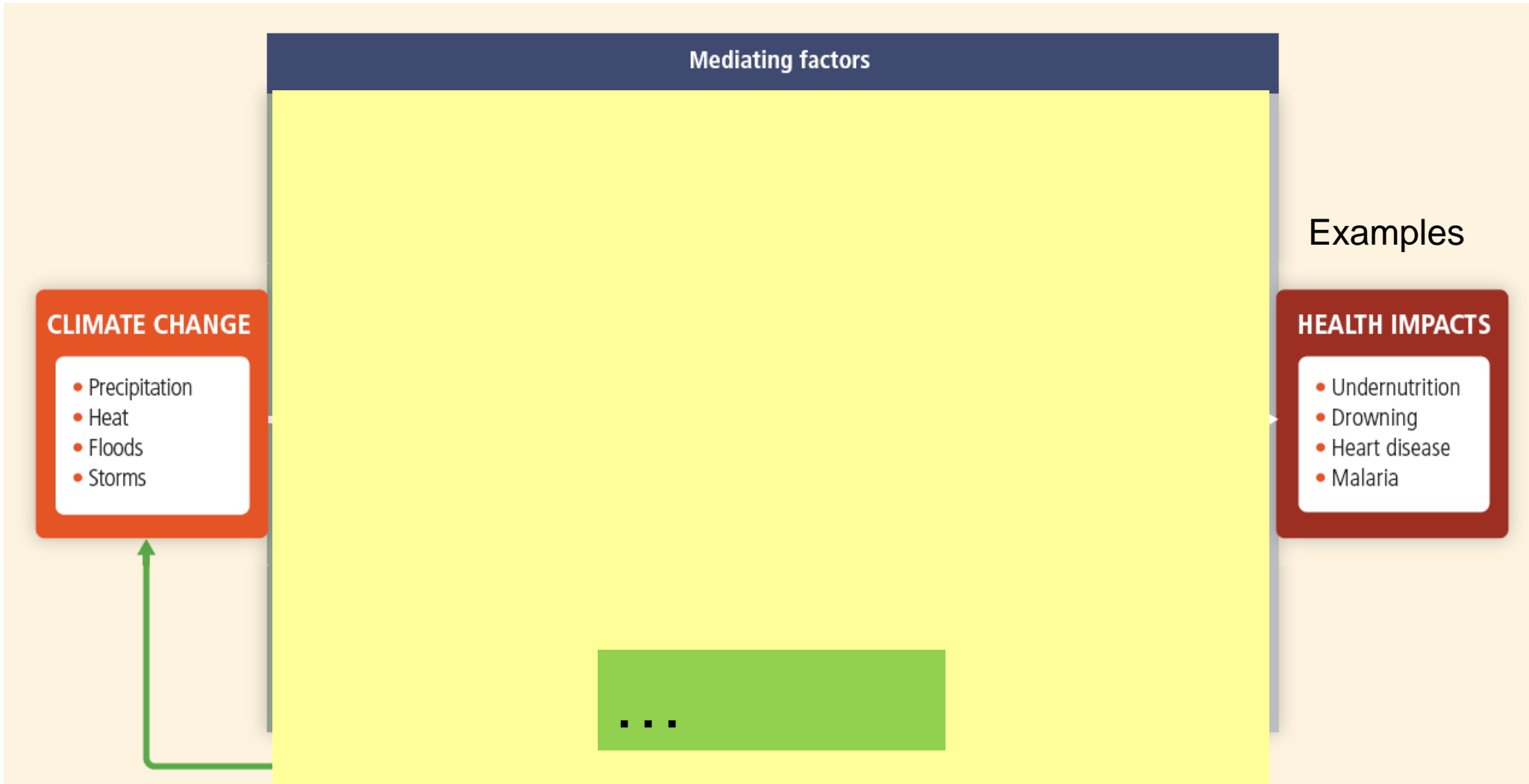
Source IPCC 2014

# Links between CC and Human Health

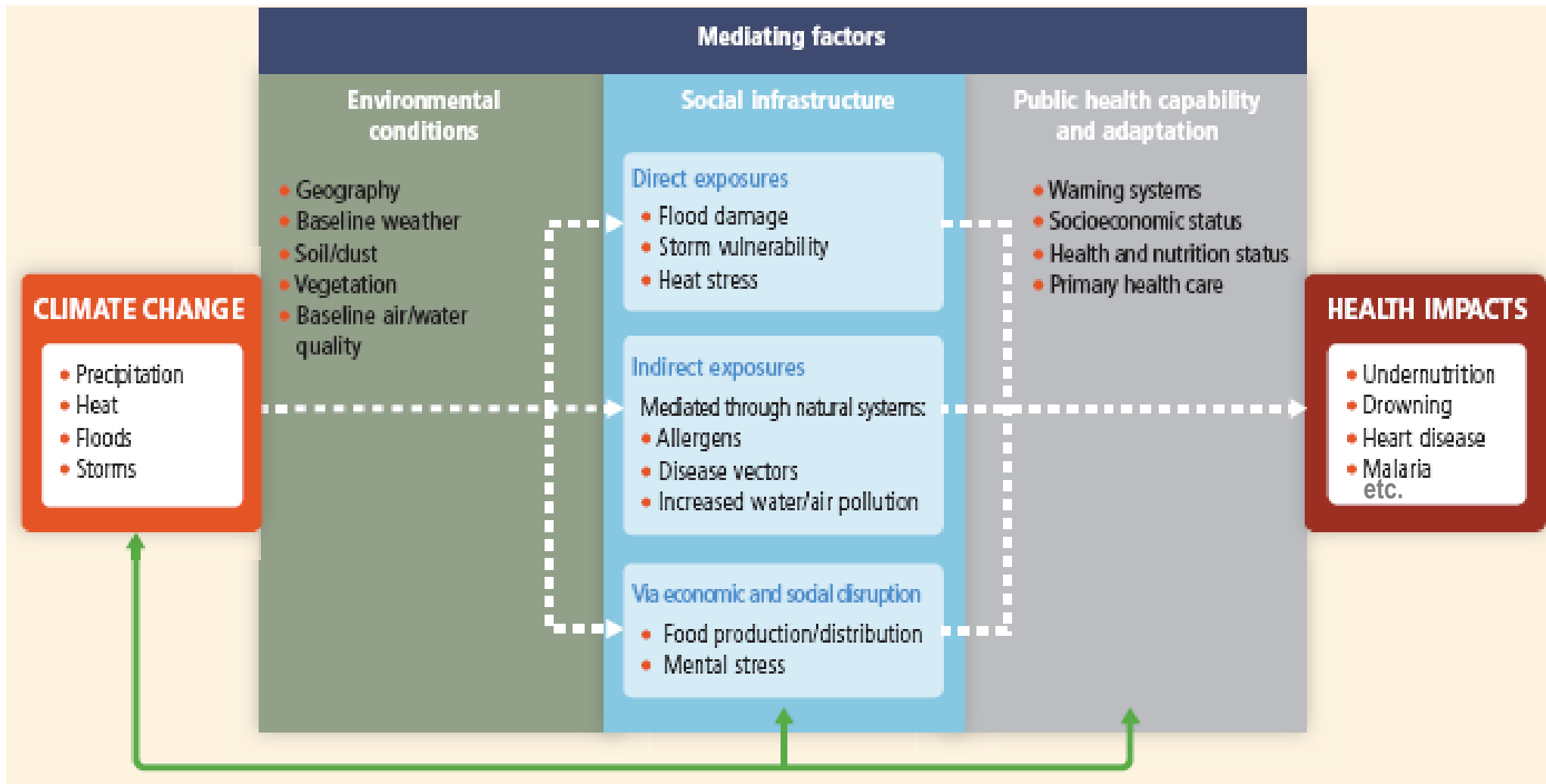


Source IPCC 2014

# Links between CC and Human Health



# Links between Climate Change and Human Health



# WHETHER YOU LIVE IN A...



Rural village



Small island or coastal town



Big city

## CLIMATE CHANGE THREATENS YOUR HEALTH

**Drought, floods and heat waves** will increase.



**Vector-borne diseases**, like malaria and dengue virus will increase with more humidity and heat.

### Basic necessities will be disrupted...



#### FOOD

Hunger and famine will increase as food production is destabilised by drought.



#### AIR

Pollution and pollen seasons will increase leading to more allergies and asthma.



#### WATER

Warmer waters and flooding will increase exposures to diseases in drinking and recreational waters.

Between 2030 and 2050 climate change is expected to cause

# 250 000 ADDITIONAL DEATHS PER YEAR

due to malaria, malnutrition, diarrhoea and heat stress.



World Health Organization

#ClimateChange

# WHO IS AT RISK OF CLIMATE CHANGE?

Those **living in poverty**, as well as **women, children and the elderly**.

**Outdoor workers** and people **living with chronic medical conditions**.

**Children are the most vulnerable** due to long exposure to environmental risks.

**EVERYONE**  
**EVERYWHERE**

Those living in **megacities, small island developing states** and other **coastal, mountainous and polar regions**.

Countries with **weak health systems** will be least able to prepare and respond.



World Health Organization

# Health impact: Increased mortality and morbidity

## Short-term effects

### Direct and indirect impacts

- Injuries, drowning, ...
- Health System Insufficiency
- Shortage of Medicines
- Communicable & infectious diseases
  - Diarrheal diseases: cholera, dysentery
  - Acute respiratory infections
  - Vector-borne

# Health impact: Increased mortality and morbidity

Long-term effects:

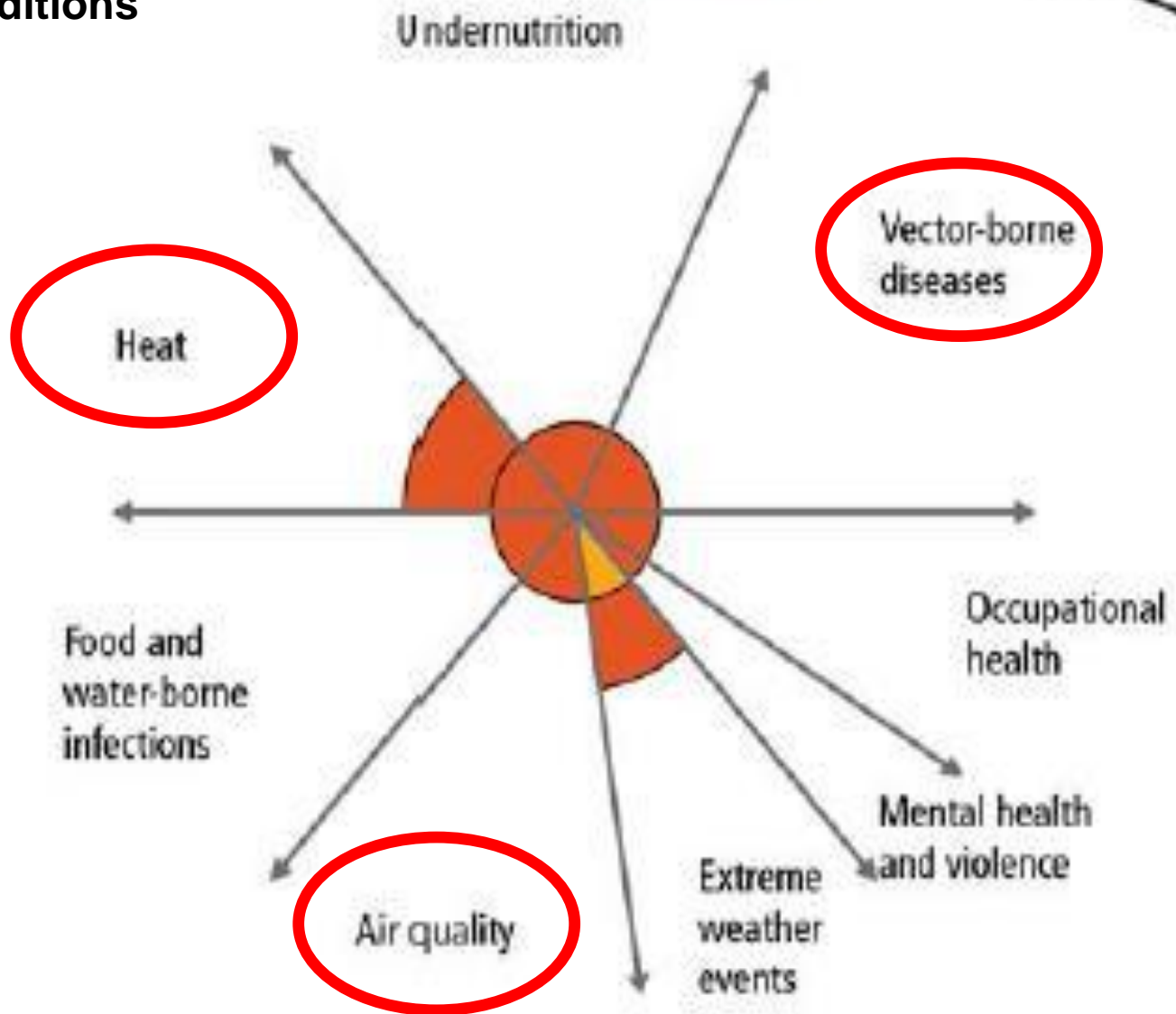
- Land use change / agricultural failure
- Malnutrition
  - > increased susceptibility to infectious disease
- Disabilities
- Mental health
  - Post Traumatic Stress disorder (PTSD) ; depression; anxiety



# Health Risks

Under current climatic conditions

Present

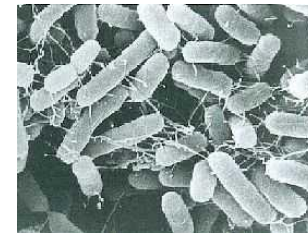


# Examples

- Climate-sensitive infectious diseases (including vector-borne diseases)

# Climate-sensitive infectious diseases

- Vector-borne diseases:
  - Dengue, malaria, West Nile Virus
  - Lyme disease, Tick-borne encephalitis
- Food-borne diseases:
  - Salmonellosis
- Water-borne diseases
  - Diarrheal diseases
  - Cholera
- Rodent-borne diseases
  - Hantavirus: change in rodent habitat



# Mechanisms

## 1. Temperature: biological processes are temperature-dependent

- When hotter, pathogens develop faster (virus, bacteria, protozoans)
- When hotter, vector develop faster (ticks, mosquitoes) & feed more often
- There is an optimal temperature range (upper limit)



## 2. Precipitation:

- Presence of water (e.g. puddles): vector habitat (mosquito larvae); vector survival
- Timing of precipitation: occurrence of flooding, disappearance of water bodies
- Oral-fecal route



## 3. Humidity: can affect pathogen or vector survival

# Tick borne encephalitis in Germany

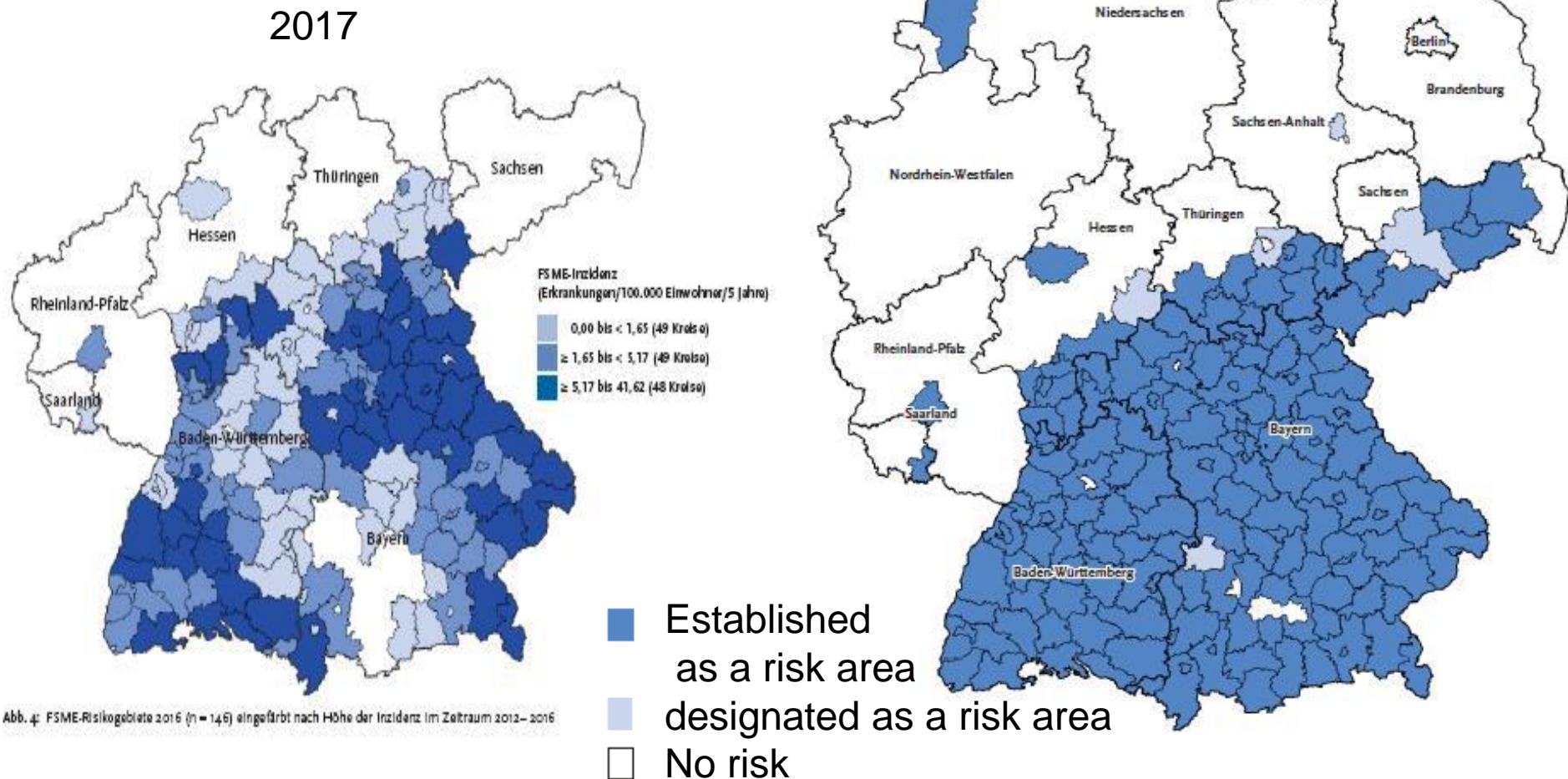
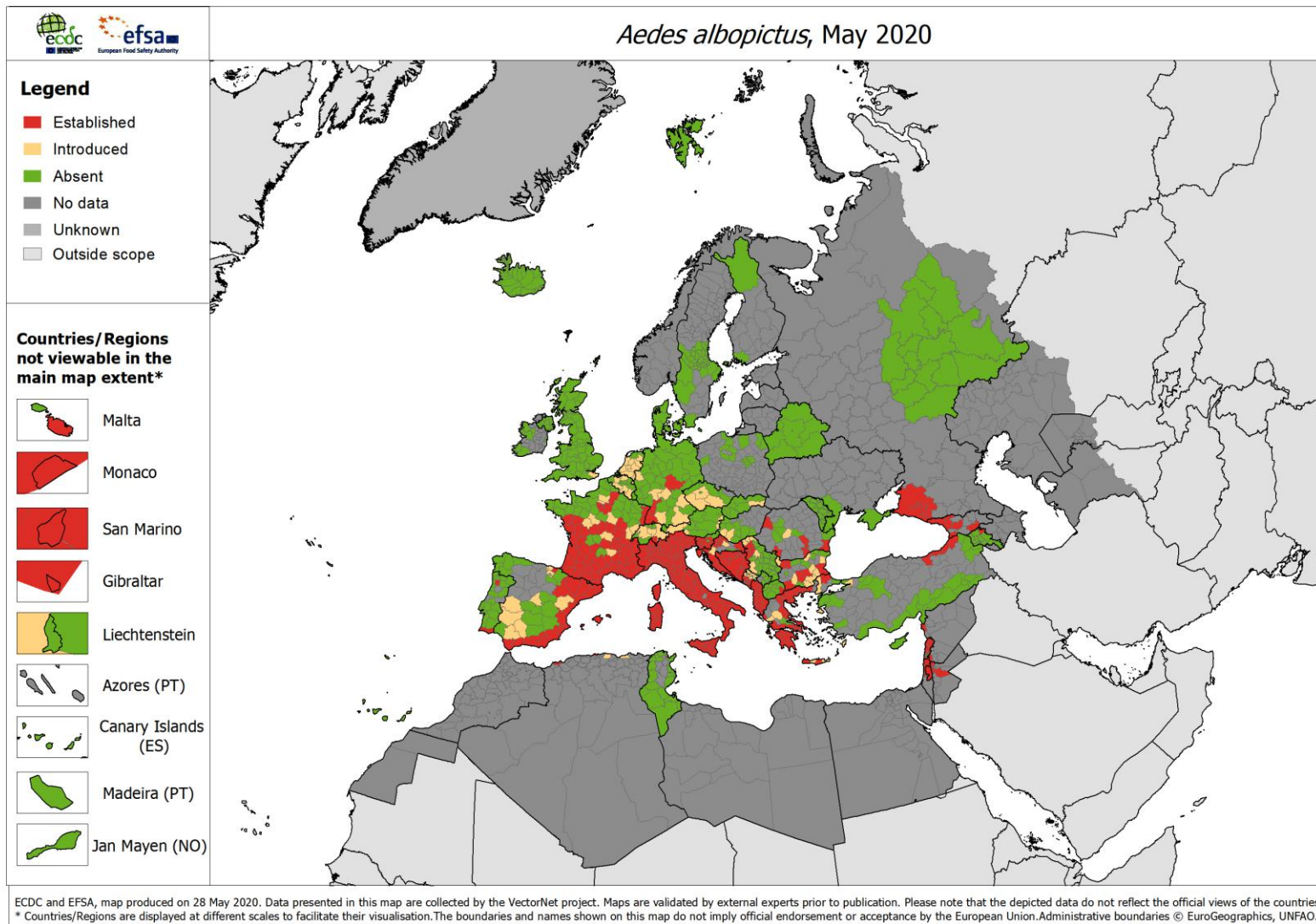


Abb. 4: FSME-Risikogebiete 2016 (n = 146) eingefärbt nach Höhe der Inzidenz im Zeitraum 2012–2016

# *Aedes albopictus* in Europe: Vector of dengue, chikungunya, Zika,...



# Climatic risk map for chikungunya transmission in Europe

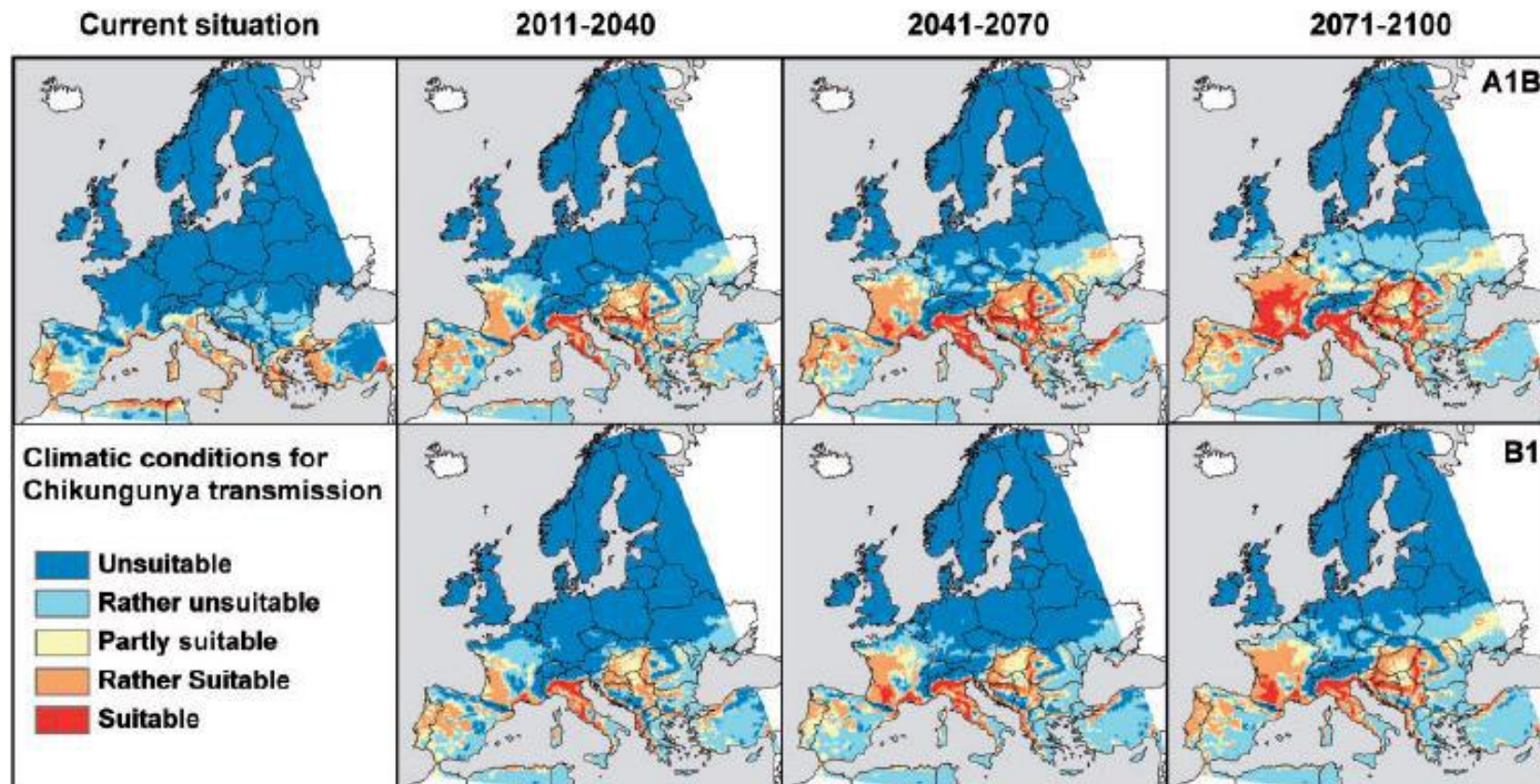
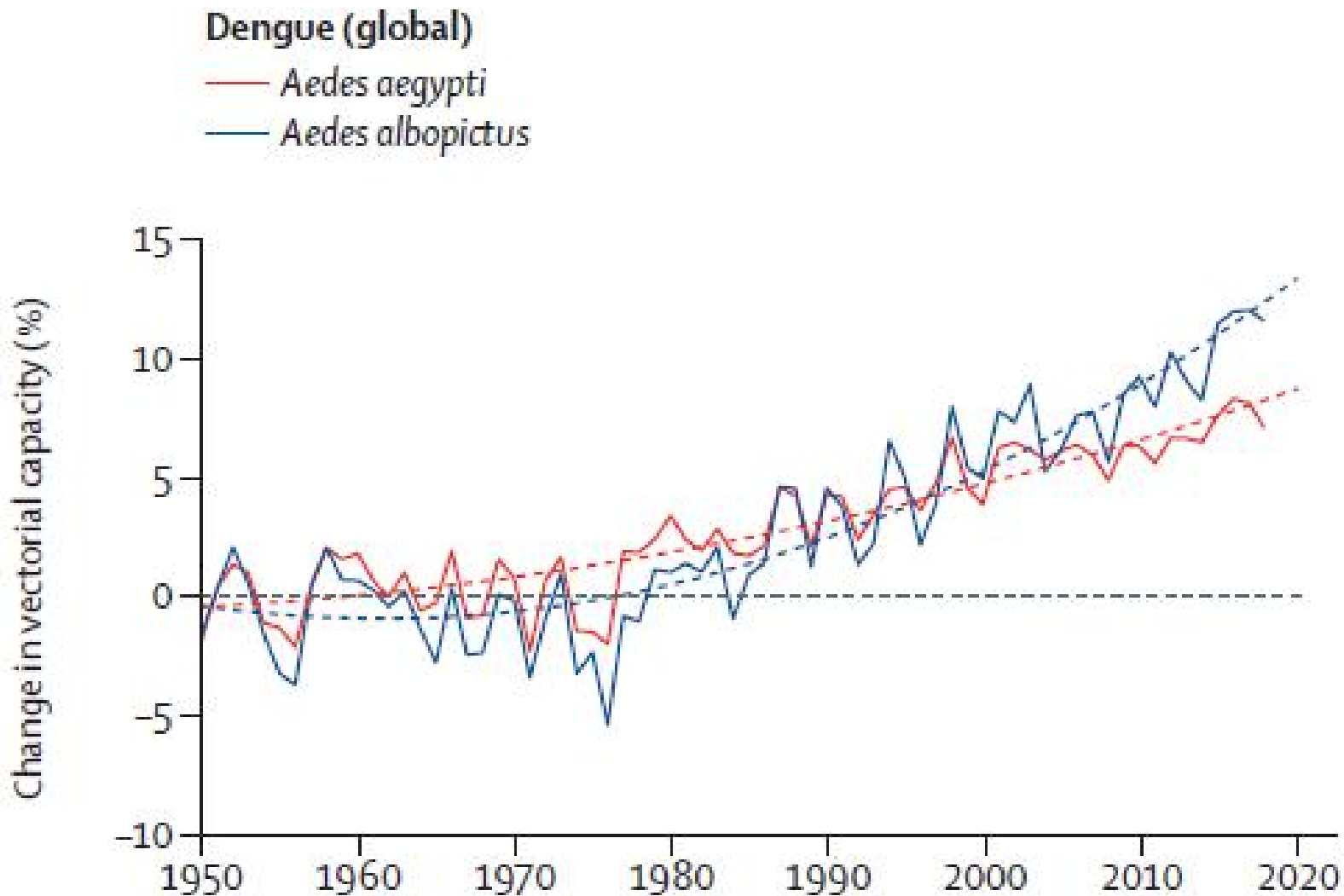


Figure 1 Climatic risk map for chikungunya transmission in Europe generated by combining temperature requirements of the chikungunya virus with the climatic suitability of the vector *Ae. albopictus*.<sup>3</sup> Projections for different time-frames are based on two emission scenarios (A1B and B1) from the Intergovernmental Panel on Climate Change, implemented in the regional climate model COSMO-CLM.

# Dengue



15.0% increase for dengue caused by *Aedes albopictus* in 2018

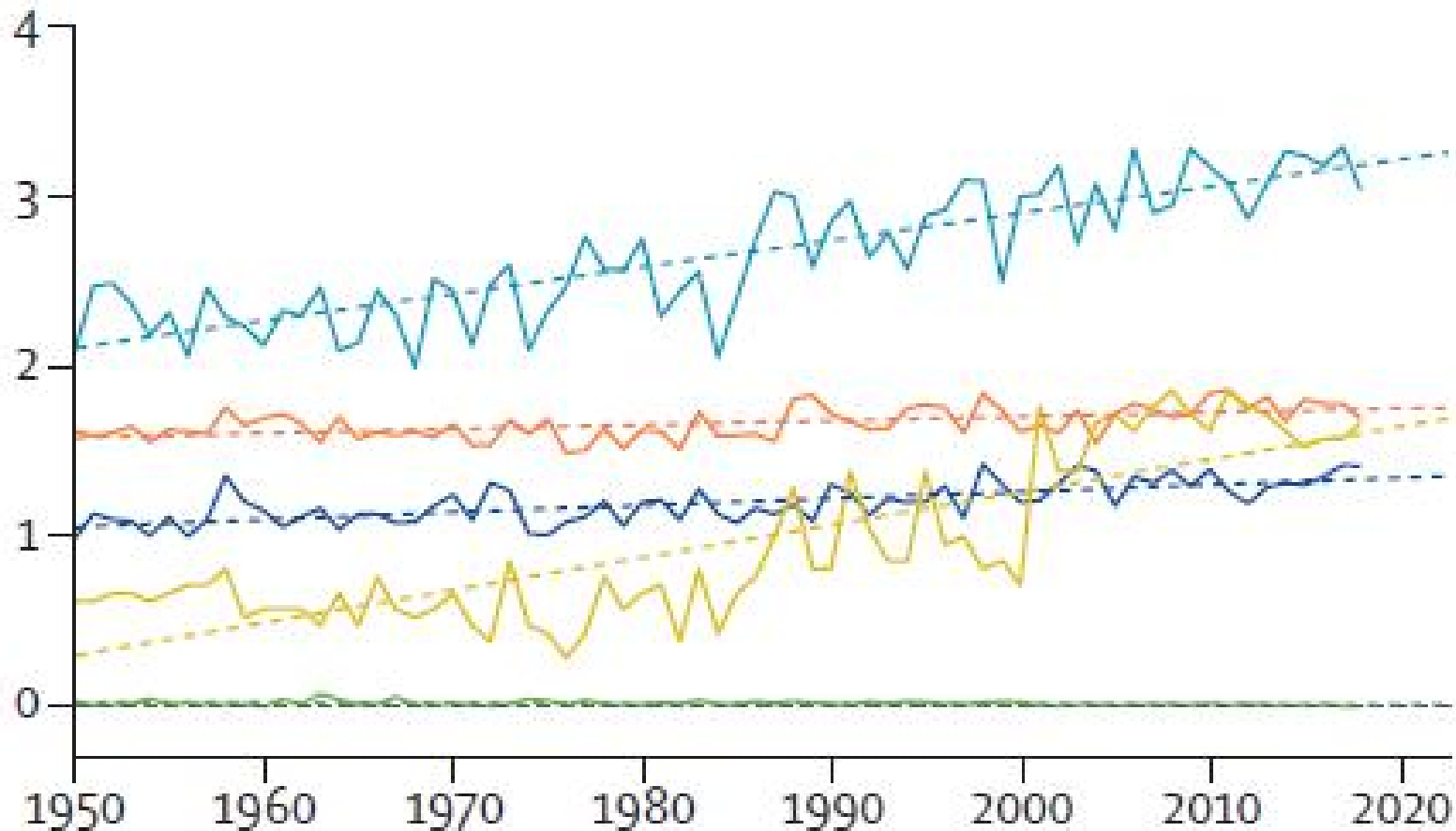
The 2020 report of the Lancet Countdown on health and climate change:  
responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70



# Malaria in Highland Areas

## Malaria (highland areas)

- African region
- Eastern Mediterranean region
- Region of the Americas
- South-East Asia region
- Western Pacific region



The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# Examples

- Heat / hot days

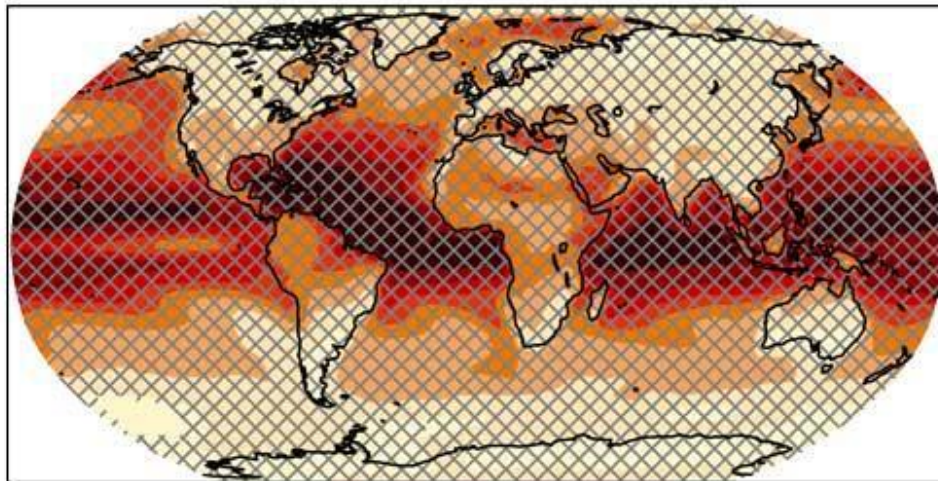
# Increased number of “hot days”

- The **number of hot days** is projected to increase in most land regions, with highest increases in the tropics (high confidence).
- **Temperature-related morbidity and mortality:** The magnitude of projected heat-related morbidity and mortality is greater at 2°C than at 1.5°C of global warming (very high confidence)
- **Urban heat islands** often amplify the impacts of heatwaves in cities (high confidence).

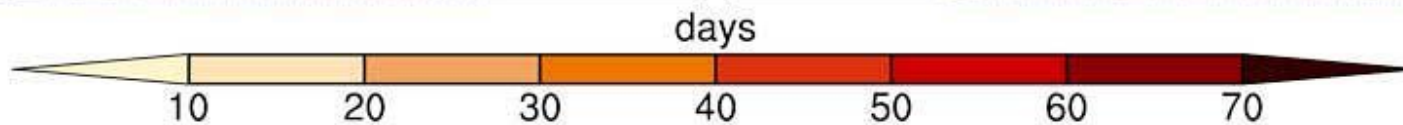
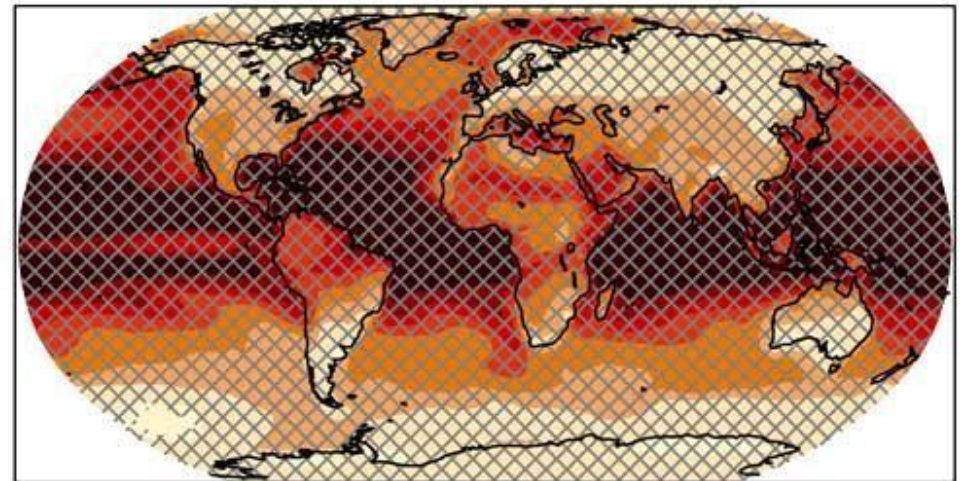
Source: (IPCC SR 15, Chap3, Oct 2018)

# Change in the number of hot days (NHD)

Change in number of hot days (NHD) at 1.5°C GMST warming

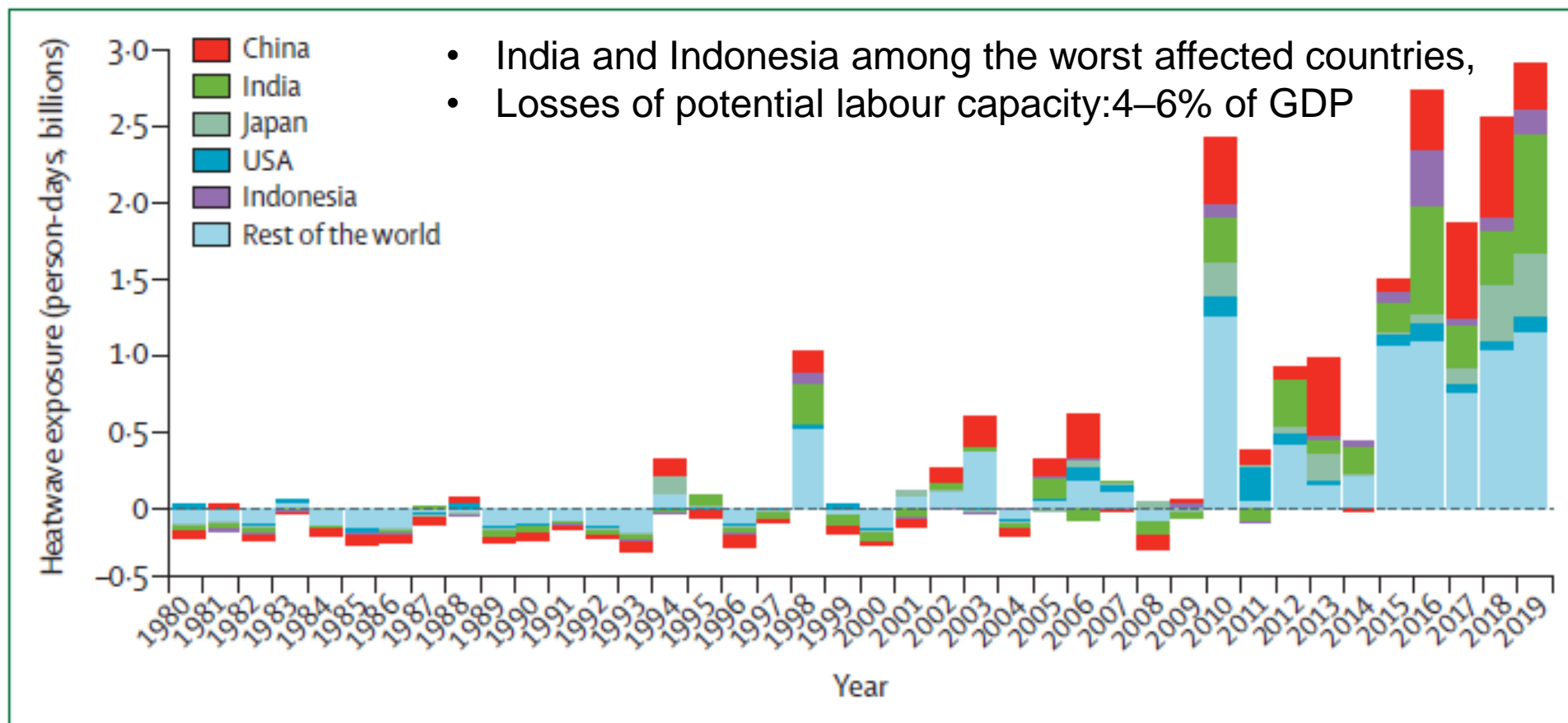


Change in number of hot days (NHD) at 2.0°C GMST warming



<http://www.ipcc.ch/report/sr15/>

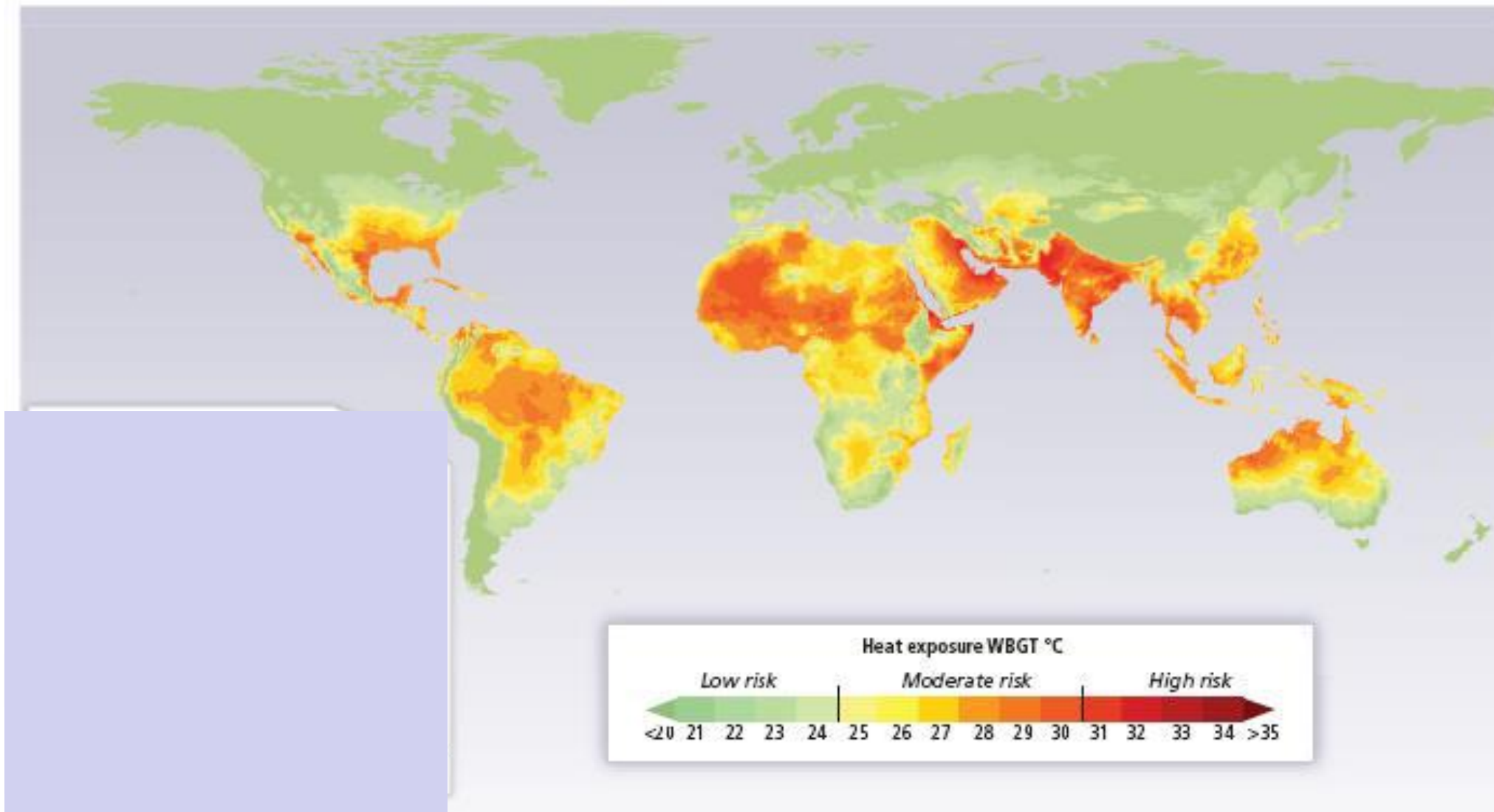
# Change in days of heatwave exposure relative to the 1986–2005 baseline in people older than 65 years



**Figure 1: Change in days of heatwave exposure relative to the 1986–2005 baseline in people older than 65 years**

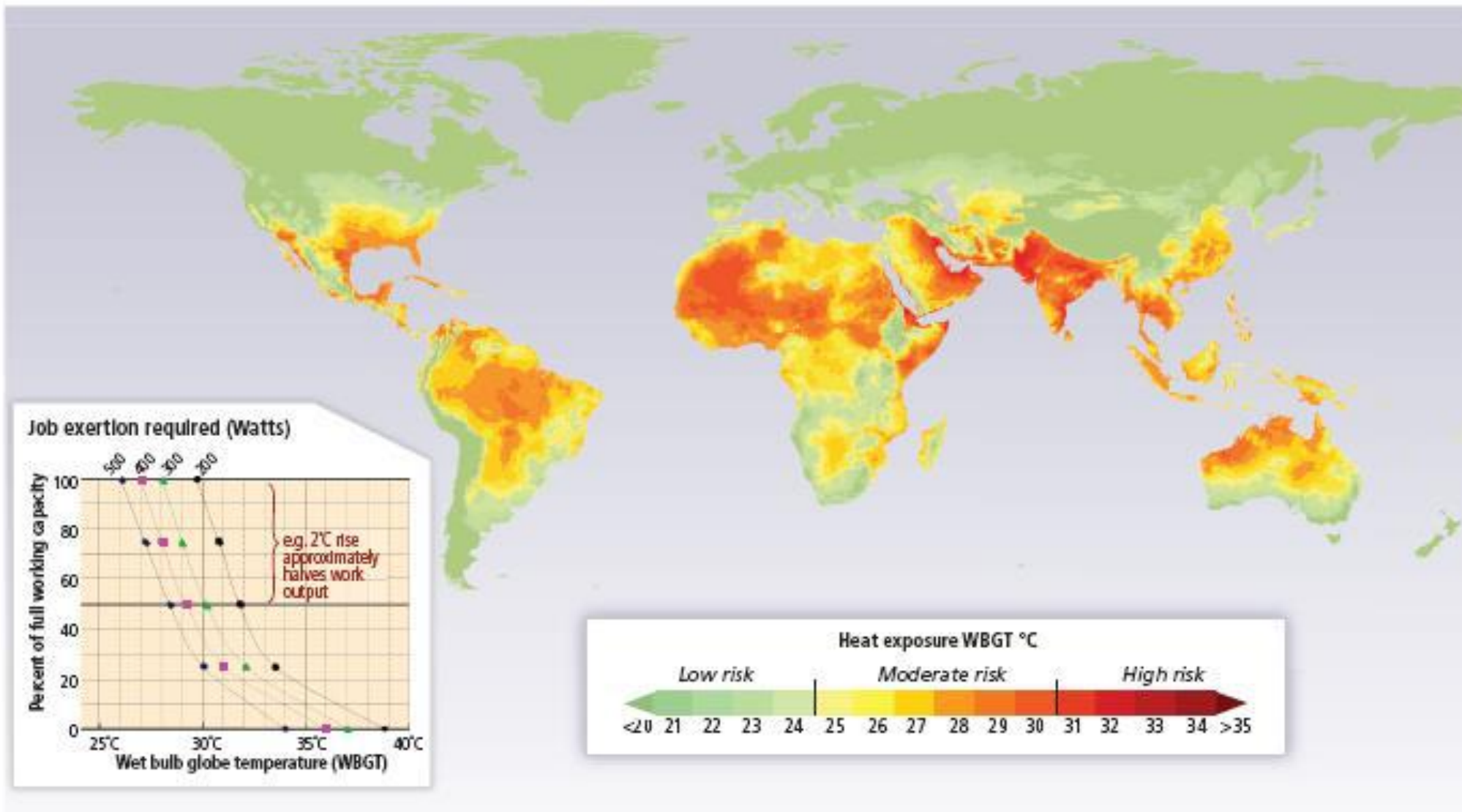
- Additional 475 million persons exposed to heatwave globally in 2019
- Since 2000, 53.7% increase in heat-related mortality in 65+
- 296 000 heat-related deaths in 2018

# Heat Impact



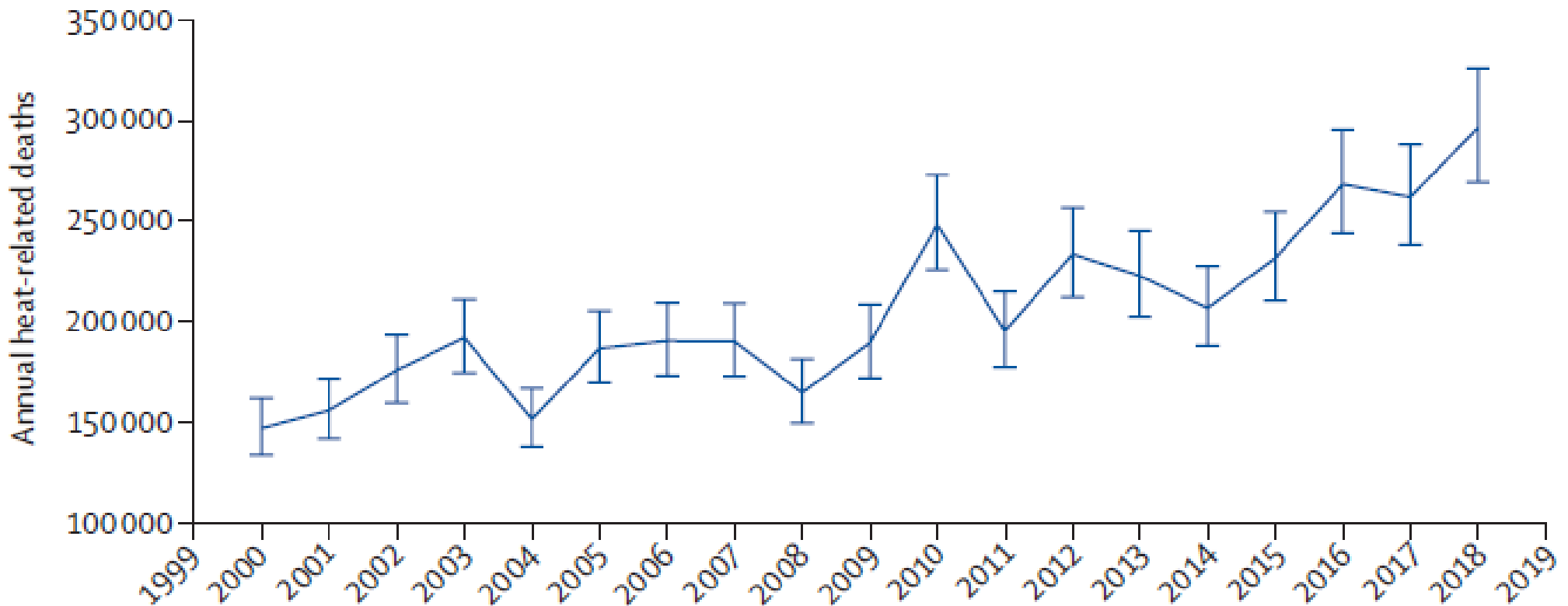
<http://www.ipcc.ch/report/sr15/>

# Heat Impact



<http://www.ipcc.ch/report/sr15/>

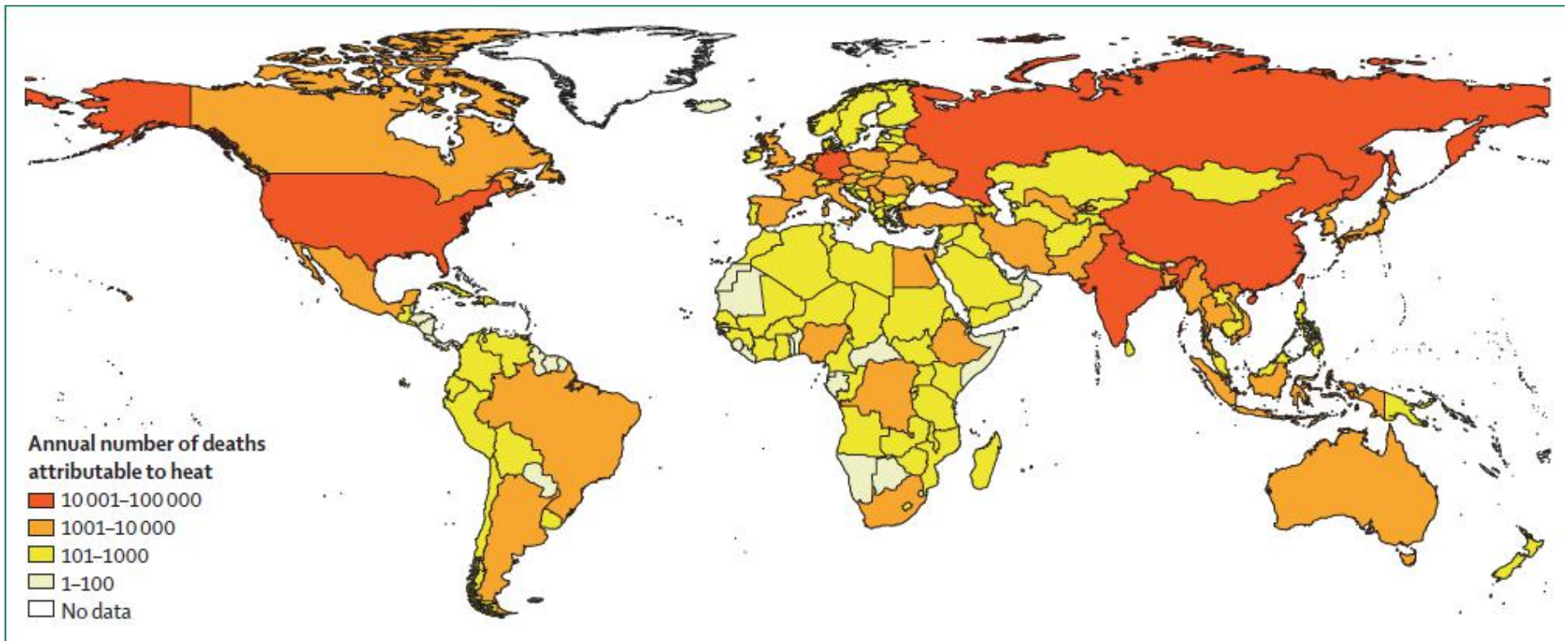
# Global heat-related mortality for populations older than 65 years



The 2020 report of the Lancet Countdown on health and climate change:  
responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70



# Annual heat-related mortality 65+ year old, 2014 - 2018



The 2020 report of the Lancet Countdown on health and climate change:  
responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# Examples

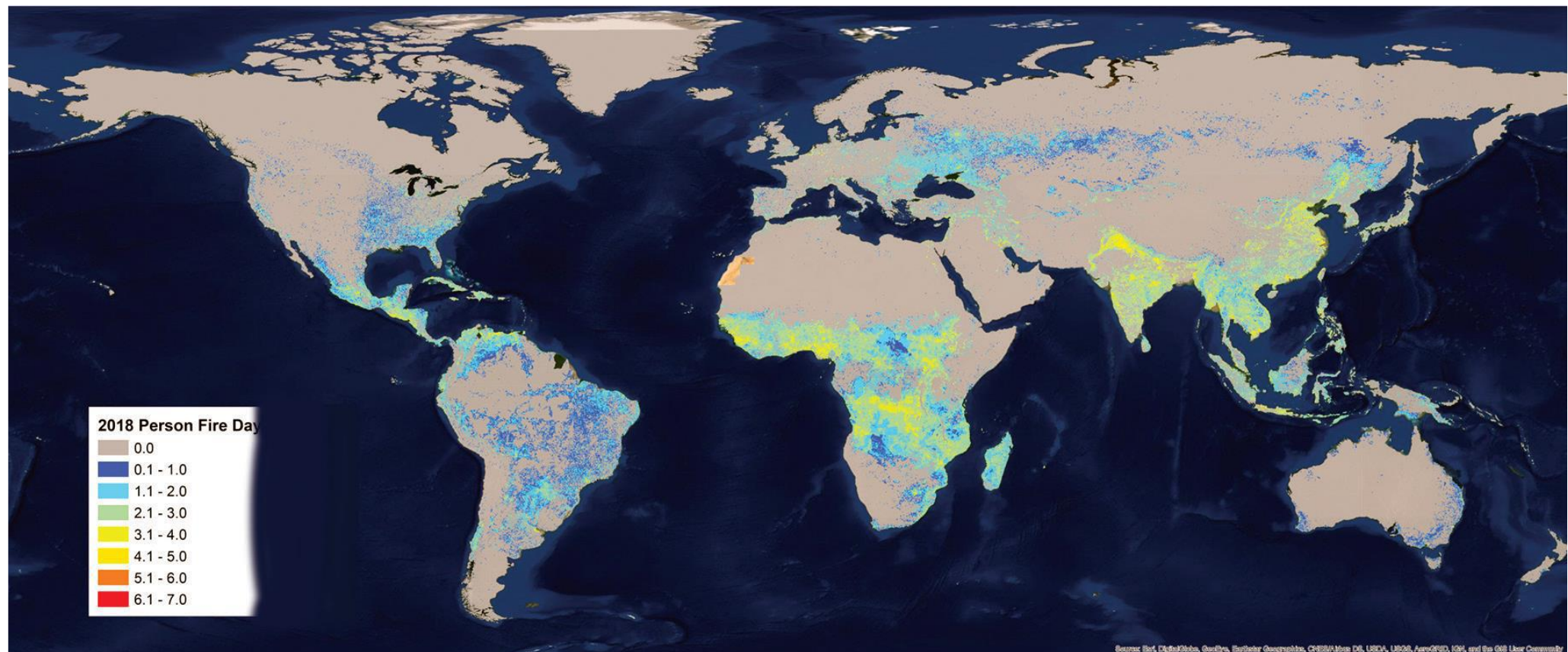
And also...

# Weather Extremes

- From 2015 to 2020 have shown the **fingerprints** of climate change in **76 floods, droughts, storms, and temperature anomalies**.
- Increased number of days people were exposed to a **very high or extremely high risk of wildfire**
- **67%** of global cities surveyed expected climate change to seriously compromise their public health assets and infrastructure

The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# Exposure to wildfires



- -> Displacement
- -> Air pollution

The 2019 report of The *Lancet* Countdown on health and climate change: ensuring that the health of a child born today is not defined by a changing climate. Watts et al. *Lancet* 2019; 394: 1836–78

# Exposure to wildfires

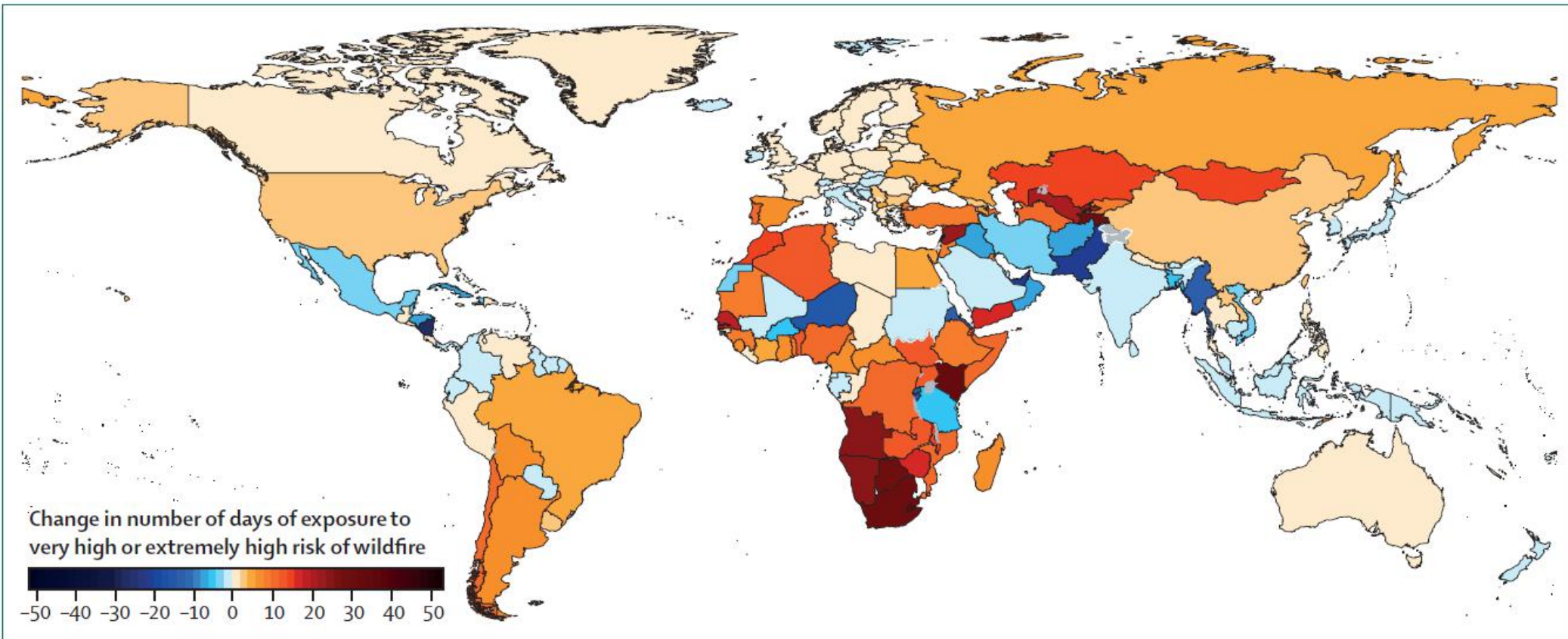


Figure 4: Population-weighted average changes in the number of days of exposure to very high or extremely high risk of wildfire in 2016–19 compared with 2001–04

The 2020 report of the Lancet Countdown on health and climate change:  
responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# Long term effects

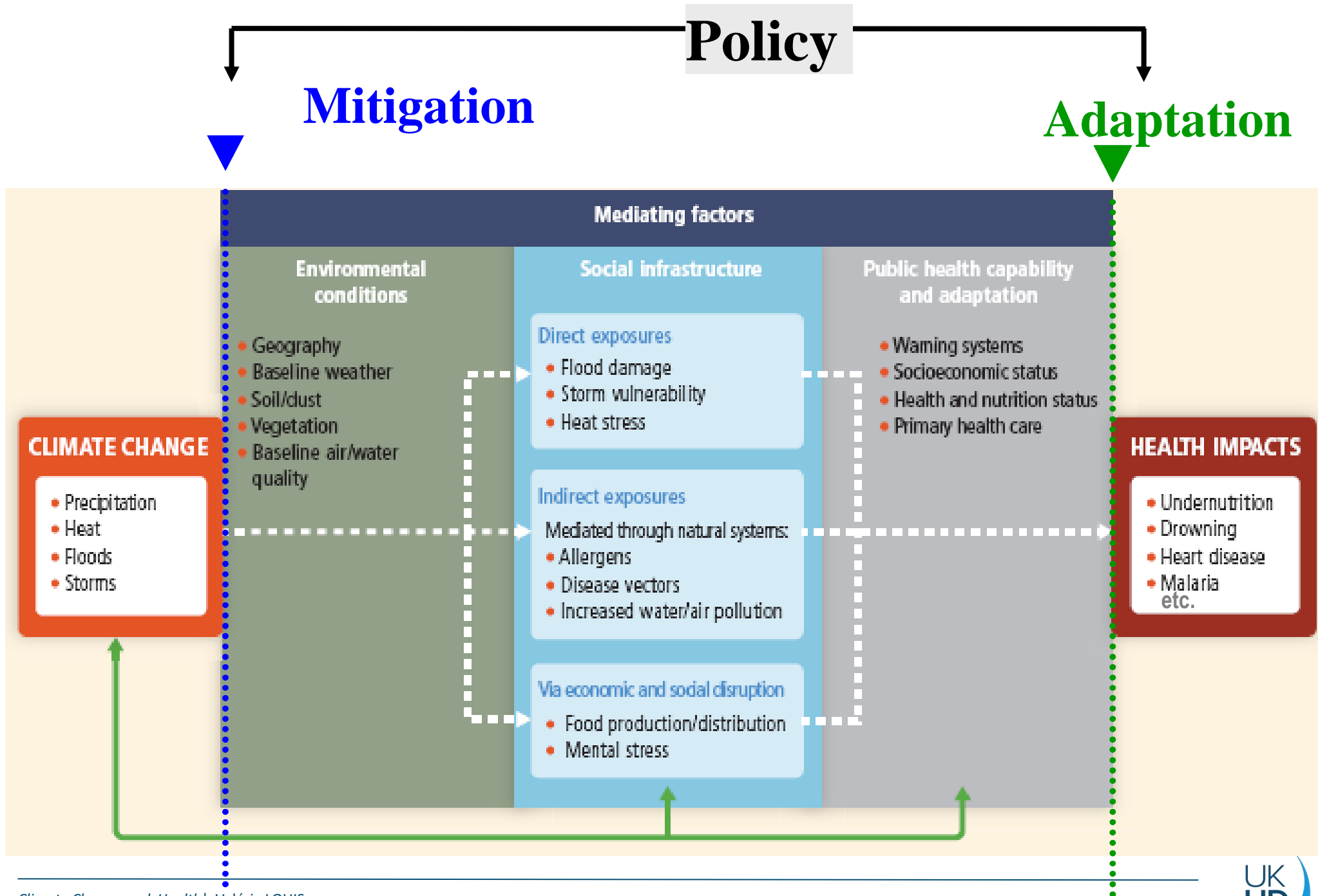
- **Global food security** threatened by rising temperatures and increases in the frequency of extreme events
- From 1981 to 2019, **crop yield** potential downward trend:
  - **maize** (5.6%),
  - **winter wheat** (2.1%)
  - **soybean** (4.8%)
  - **rice** (1.8%)
- Increased risk of malnutrition:
- Potential population displacement
- Between 145 million people and 565 million people face potential **inundation from rising sea levels**

Source: The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# What can we do?

## (Public Health) Responses

- Mitigation
- Health Co-Benefits
- Adaptation





# WHAT CAN WE DO ABOUT CLIMATE CHANGE?

We can do a lot to protect ourselves, our families, and future generations.

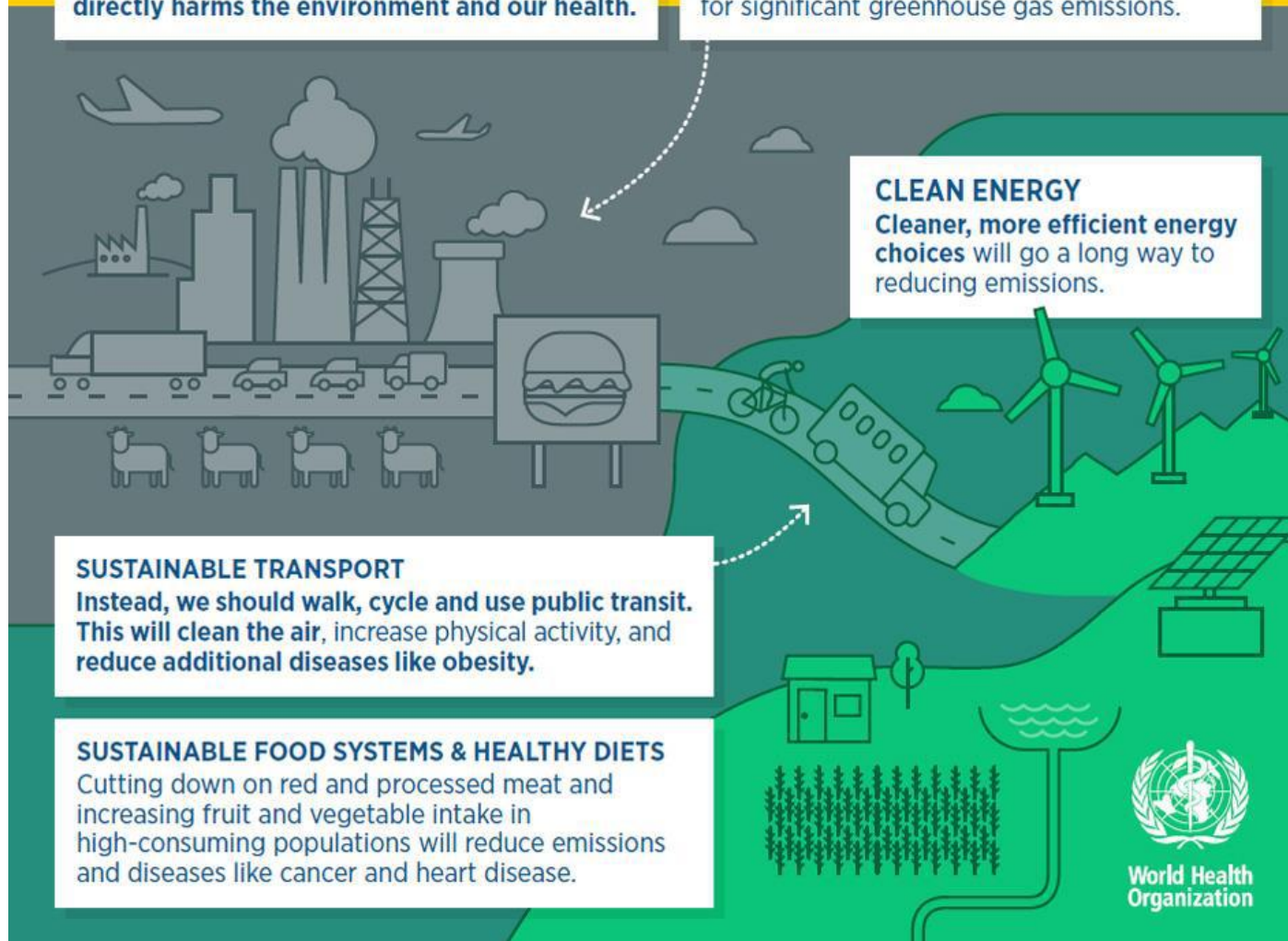
**Our transport systems are inefficient, polluting and drive CO2 into the atmosphere, which directly harms the environment and our health.**

**The same can be said of our energy and food systems.** The livestock sector is responsible for significant greenhouse gas emissions.

**CLEAN ENERGY**  
Cleaner, more efficient energy choices will go a long way to reducing emissions.

**SUSTAINABLE TRANSPORT**  
Instead, we should walk, cycle and use public transit. This will clean the air, increase physical activity, and reduce additional diseases like obesity.

**SUSTAINABLE FOOD SYSTEMS & HEALTHY DIETS**  
Cutting down on red and processed meat and increasing fruit and vegetable intake in high-consuming populations will reduce emissions and diseases like cancer and heart disease.



<http://www.who.int/globalchange/climate/infographics/en/>

# Climate change mitigation

**Definition:** an anthropogenic intervention to reduce the anthropogenic forcing of the climate system;  
it includes strategies to reduce greenhouse gas sources and emissions and to enhance greenhouse gas sinks.



# Climate change mitigation

- **Reduce** green house gases emissions (energy consumption) to avoid dangerous warming
  - > Increase **energy efficiency**
  - > Promotion of low-carbon energy use: "**decarbonizing**" the economy
- Can also be applied within the health system (e.g. "**green**" **hospitals**, better waste management)

# Renewable energy sources

- Solar energy
- Wind
- Geothermal
- Hydropower (river dams)
- Bio-energy
- Ocean wave and tidal energy



# Mitigation in the Health Sector

## HEALTHY HOSPITALS HEALTHY PLANET HEALTHY PEOPLE

Addressing climate change  
in health care settings

The health-care sector, which was **responsible for 4-6% of GHG emissions in 2017**, is taking early but important steps to reduce its own emissions .

(Source: Lancet countdown 2020)



<b>2. Leading by example. Reducing the health sector's climate footprint.....</b>	<b>6</b>
2.1 Health co-benefits.....	6
2.2 Economic co-benefits .....	8
2.3. Social co-benefits.....	9

# Seven elements of a climate-friendly hospital

## 1 Energy efficiency

Reduce hospital energy consumption and costs through efficiency and conservation measures.

## 2 Green building design

Build hospitals that are responsive to local climate conditions and optimized for reduced energy and resource demands.

## 3 Alternative energy generation

Produce and/or consume clean, renewable energy onsite to ensure reliable and resilient operation.

## 4 Transportation

Use alternative fuels for hospital vehicle fleets; encourage walking and cycling to the facility; promote staff, patient and community use of public transport; site health-care buildings to minimize the need for staff and patient transportation.

## 5 Food

Provide sustainably grown local food for staff and patients.

## 6 Waste

Reduce, re-use, recycle, compost; employ alternatives to waste incineration.

## 7 Water

Conserve water; avoid bottled water when safe alternatives exist.

# The health benefits of tackling climate change

An Executive Summary for *The Lancet* Series



**"If properly chosen, action to combat climate change can, of itself, lead to improvements in health. The news is not all bad."**

<http://www.who.int/globalchange/publications/wtx057673.pdf?ua=1>

# Climate Change Mitigation: Ancillary Effects or CO-BENEFITS

- Primary benefits
  - reductions in the expected long-term consequences of global warming; avoided damages of climate change
- Co-benefits (or ancillary benefits)
  - economic, social, environmental, public health and other benefits independent of any direct benefits from mitigating climate change
- **Health co-benefits**
  - Benefits of climate change mitigation strategies that have a positive effect on health




# Health co-benefits of climate change mitigation –

## Examples



...

# Health co-benefits of climate change mitigation - Examples

Action	Benefit for climate (climate mitigation)	Benefit for health
<b>Reduce fossil fuel combustion from industries and vehicles</b>	Reduce CAP emissions (CO <sub>2</sub> , black carbon, CO, CH <sub>4</sub> , NO <sub>x</sub> , SO <sub>x</sub> )	-Improve local air quality: reduce cardio-respiratory deaths/hospitalisations
<b>Increase public transport and active travel in urban areas</b> 	Reduce CAP emissions (CO <sub>2</sub> , black carbon, CO, CH <sub>4</sub> , NO <sub>x</sub> , SO <sub>x</sub> )	-Increase physical activity (walking, cycling) -Reduced obesity, non-communicable disease burden, -Health service costs averted; -Increase social contact and wellbeing
<b>Reduction of household solid fuel combustion (cooking, heating)</b>	Reduces CAP emissions (CO <sub>2</sub> , CO, black carbon, CH <sub>4</sub> )	-Reduce exposure to indoor air pollution, associated chronic and acute respiratory illnesses, lung cancer, low birth weight and stillbirths
<b>Reduced red meat (from ruminant) consumption</b>	Reduce CO <sub>2</sub> and methane (CH <sub>4</sub> ) emissions	-Reduce risks of some disease: cancer; heart disease (meat fat content).
...		

# Example: air pollution

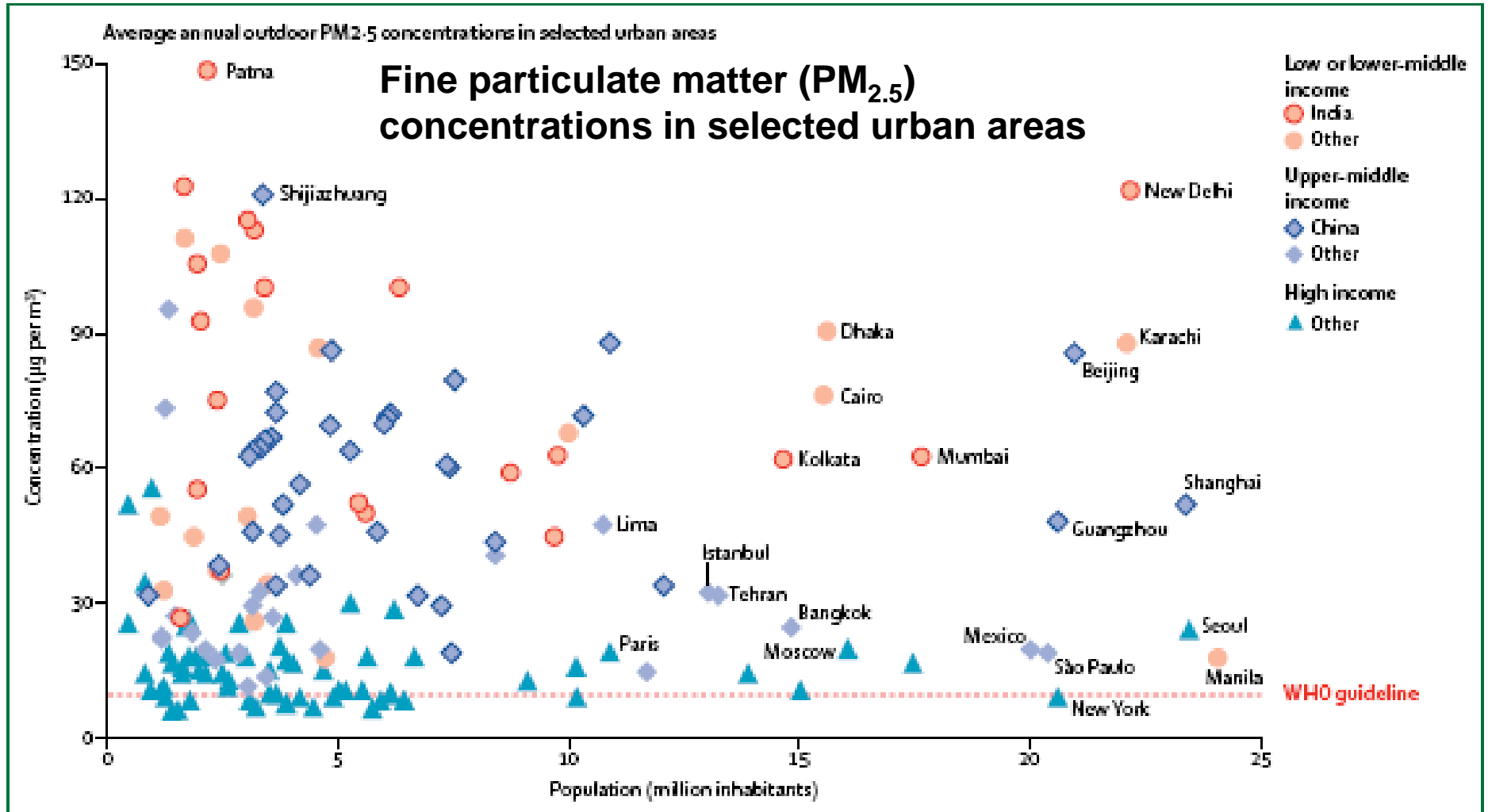
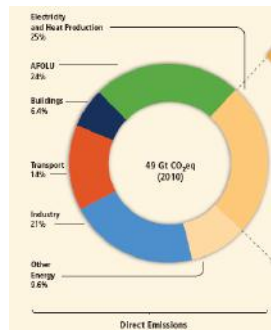


Figure 2: Average annual outdoor PM<sub>2.5</sub> concentrations in selected urban areas  
 Reproduced by permission of IEA, 2016.<sup>46</sup>

# Tackling air pollution: a synergetic process



Large impact:  
35% of GHG  
Emissions

**Air pollution**  
Ambient, household  
->reducing emission of  
pollutants

Potential for large and  
rapid improvement



Large impact:  
3 million deaths  
from PM<sub>2.5</sub> exposure in 2012

**Climate change  
mitigation**

->reducing emissions  
of climate-altering pollutants

**Health impacts**

->reducing emissions  
of harmful pollutants

# Urban “greenness”

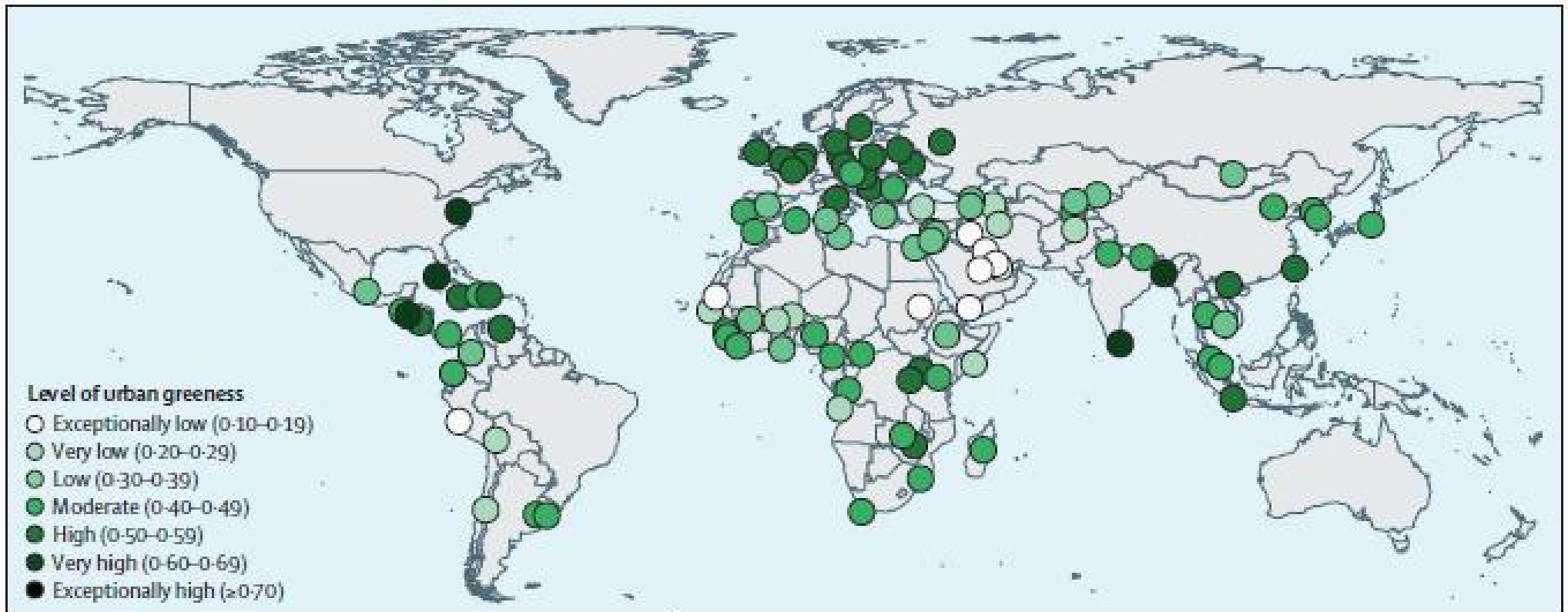


Figure 9: Urban greenness in capital cities with more than 1 million inhabitants in 2019

## “Green” and “blues” spaces in urban areas

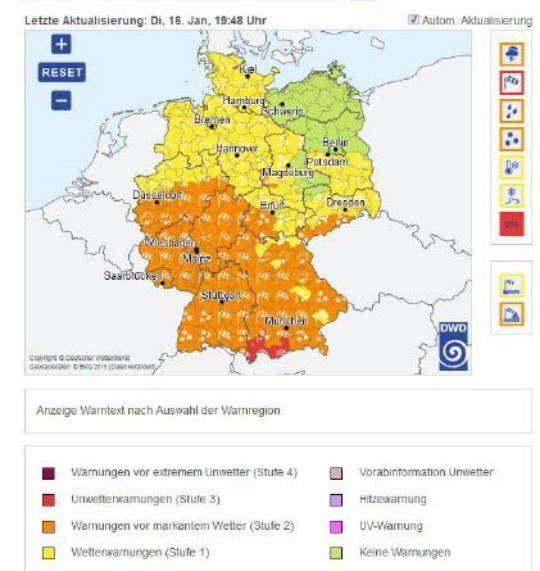
Source: The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises Watts et al. *Lancet* 2021; 397: 129–70

# Adaptation to climate change

- **Definition:** Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
- Various types of adaptation: anticipatory, autonomous and planned adaptation

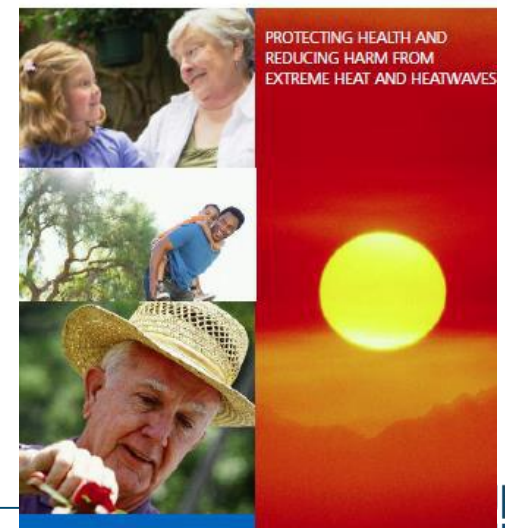
# Adaptation – a necessity

- **Early warning systems**
- Improve preparedness and contingency plans
- Enhance awareness and public education
- Use data in public-health programs and planning



NHS

heatwave PLAN FOR ENGLAND



# Strategies to reduce the health impacts of climate change (IPCC 2014)

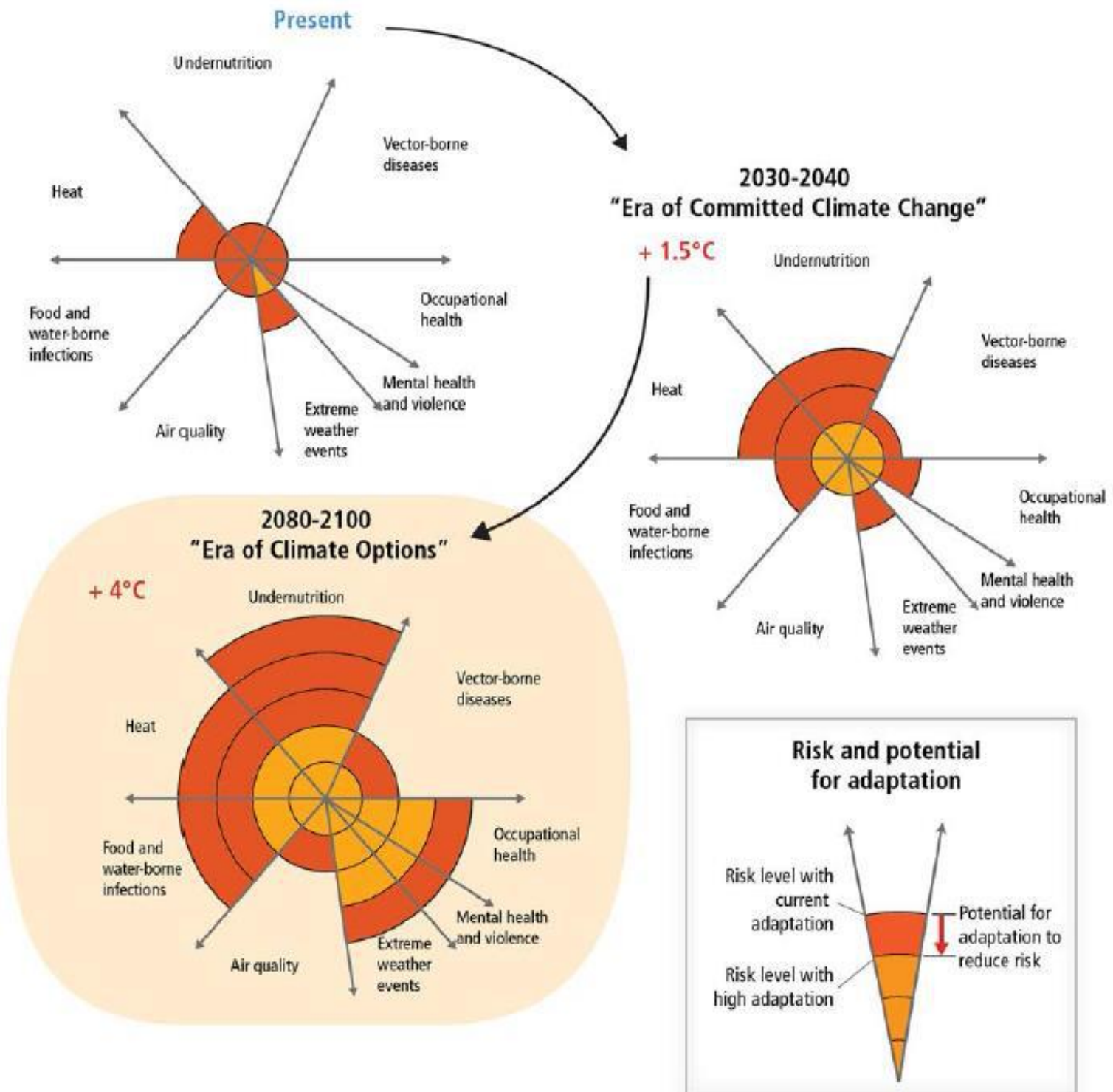
- Accelerate public health and medical interventions to **reduce the present burden of disease –particularly in poor countries**
- **Management of the environmental determinants** of health water and sanitation, infectious disease surveillance, and **strengthening the resilience of health systems** to extreme weather events.
- **Alleviation of poverty** - a necessary condition for successful adaptation.



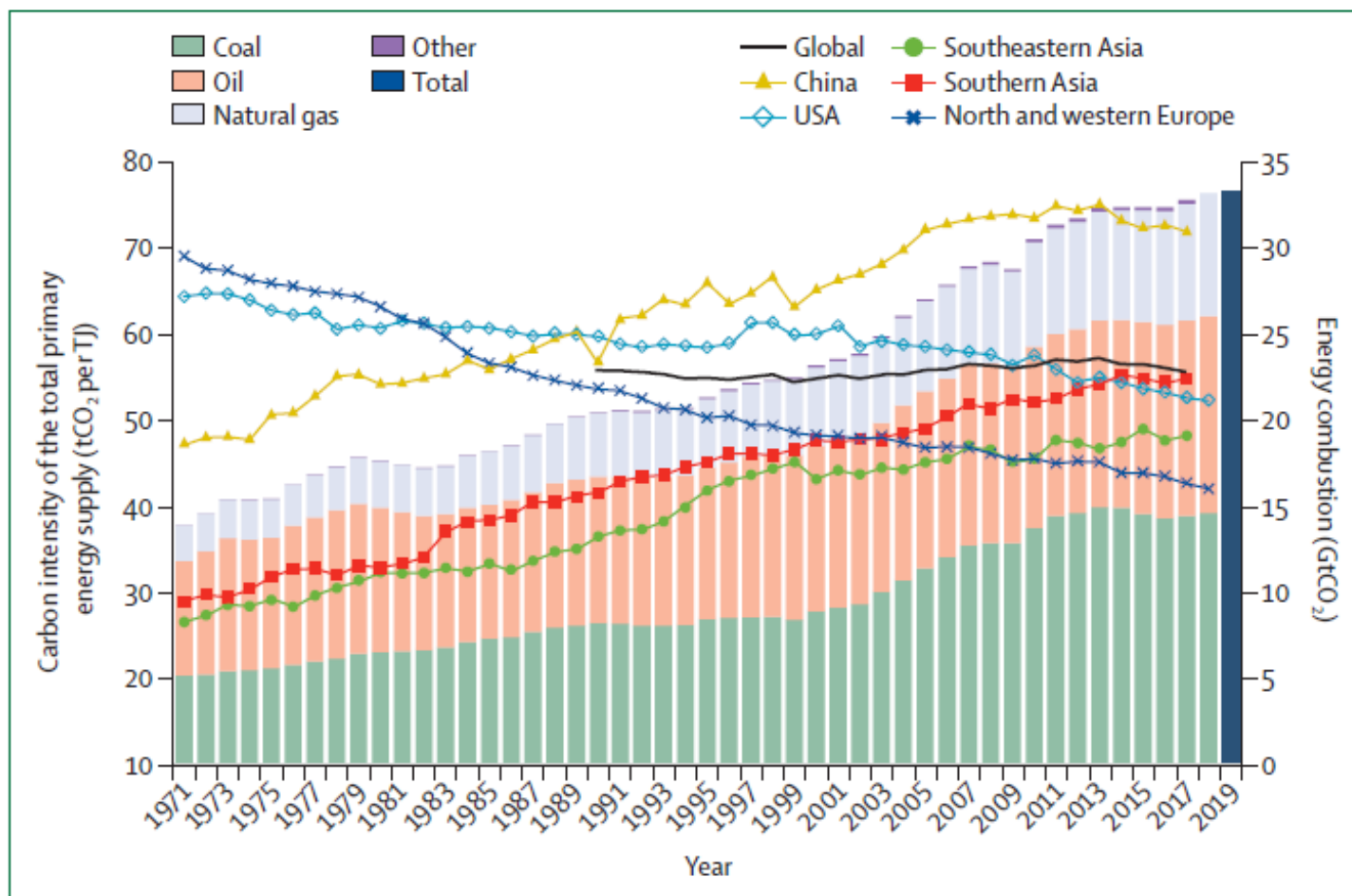
# Health system adaptation strategies to climate change

- Strengthen health systems in general
  - Protect infrastructure (electricity, communications)
  - Staff training, motivation, retention
  - Apply conventional control strategies (e.g. bednets)
  - Drug and vaccine stocks
- Prepare health systems specifically
  - Develop and apply early warning systems
  - Raise public awareness on specific risks
  - Focus on geographically + socially vulnerable groups
  - Prioritize

# Summary and Conclusion



# Carbon intensity of the total primary energy supply and global CO<sub>2</sub> emissions by fuel type, 1971–2019



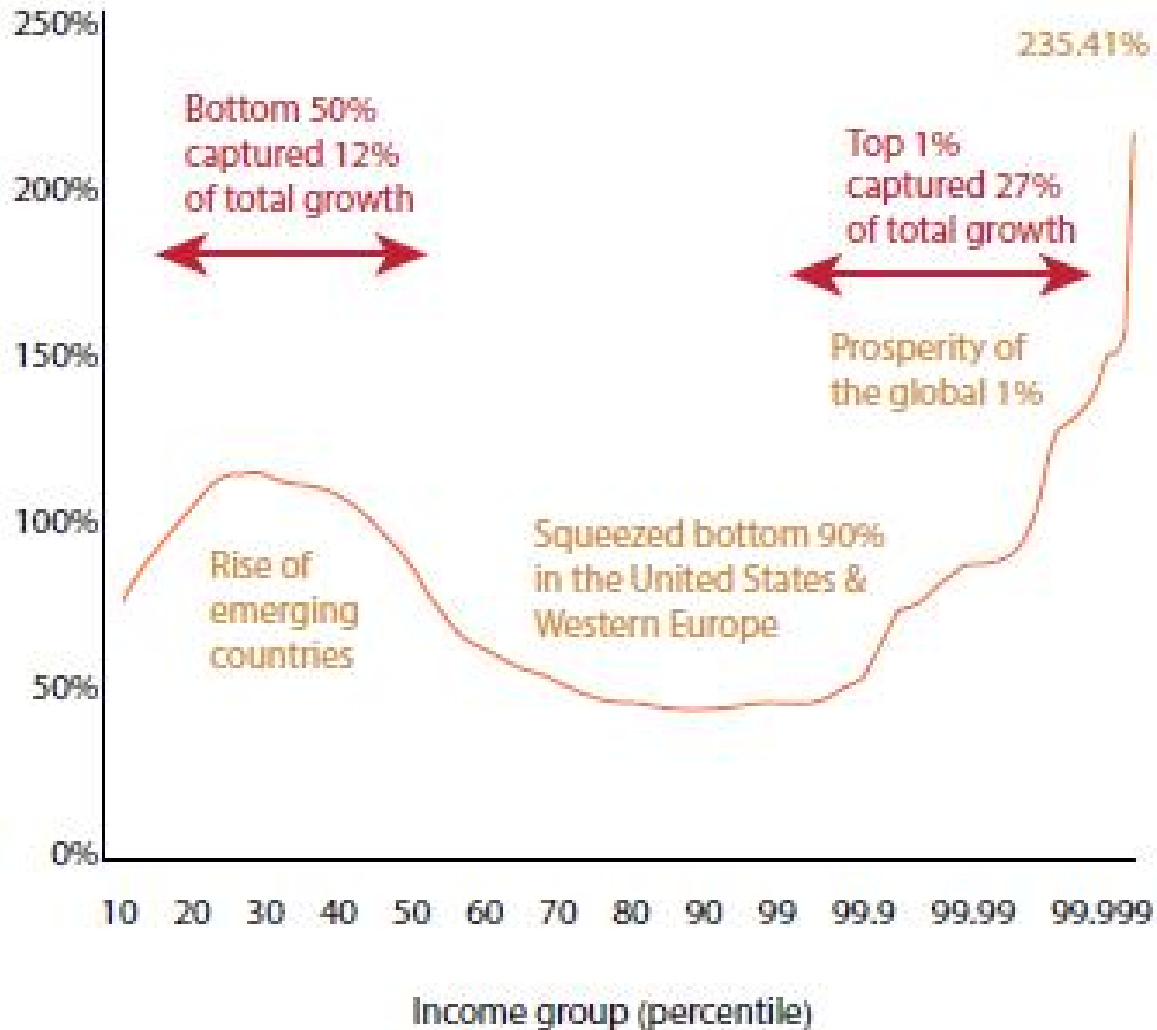
- “Decarbonizing” the economy
- Increase efficiency of energy use
- Reduce energy use

**Figure 11: Carbon intensity of the total primary energy supply for selected regions and countries and global CO<sub>2</sub> emissions by fuel type, 1971–2019**

Carbon intensity trends are shown by a trend line (primary axis) and global CO<sub>2</sub> emissions by stacked bars (secondary axis). This carbon intensity metric estimates the tCO<sub>2</sub> for each unit of total primary energy supplied (tCO<sub>2</sub> per TJ). For reference, the carbon intensity of fuels are as follows: coal, 95–100 tCO<sub>2</sub> per TJ; oil, 70–75 tCO<sub>2</sub> per TJ; and natural gas, 56 tCO<sub>2</sub> per TJ. CO<sub>2</sub>=carbon dioxide. tCO<sub>2</sub>=tonnes of carbon dioxide.

# Global Inequality and Growth

## Global inequality and growth, 1980–2016



Source: Independent Group of Scientists appointed by the Secretary-General, *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*, (United Nations, New York, 2019).

# Conclusion

- Limits to health adaptation
- Health is a universal argument
- Issue of justice and equity – in space and time
- A limited window of opportunities
- Expect more crisis to come - COVID19 pandemic an added burden
- “Decarbonizing” the economy
- Action urgently needed!



# Resources

- **IPCC: Chap 11: Human Health: Impacts, Adaptation, and Co-Benefits**

<https://www.ipcc.ch/report/ar5/wg2/human-health-impacts-adaptation-and-co-benefits/>

- **Lancet commission on climate change**

<https://www.thelancet.com/countdown-health-climate>

- **Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development, (UN, 2019).**

- **A Planetary Health perspective on the climate crisis and COVID-19 | Prof. Sabine Gabrysch – Dec 2020** <https://www.youtube.com/channel/UCq1N2-NlgCvU8n9QbH0tjwQ>

- <https://climate.nasa.gov/>

- ...



# Thank you for your attention

