

The Limits to Climate Change Adaptation

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The Essential Truth About Climate Change in Ten Words

The basic facts of climate change, established over decades of research, can be summarized in five key points:

IT'S REAL

IT'S US

EXPERTS AGREE

IT'S BAD

THERE'S HOPE

Global warming is happening.

Human activity is the main cause.

There's scientific consensus on human-caused global warming.

The impacts are serious and affect people.

We have the technology needed to avoid the worst climate impacts.

IPCC AR6 definition

Limit to adaptation:

The point at which an actor's objectives (or system needs) cannot be secured from intolerable risks through adaptive actions.

IPCC AR6 definitions

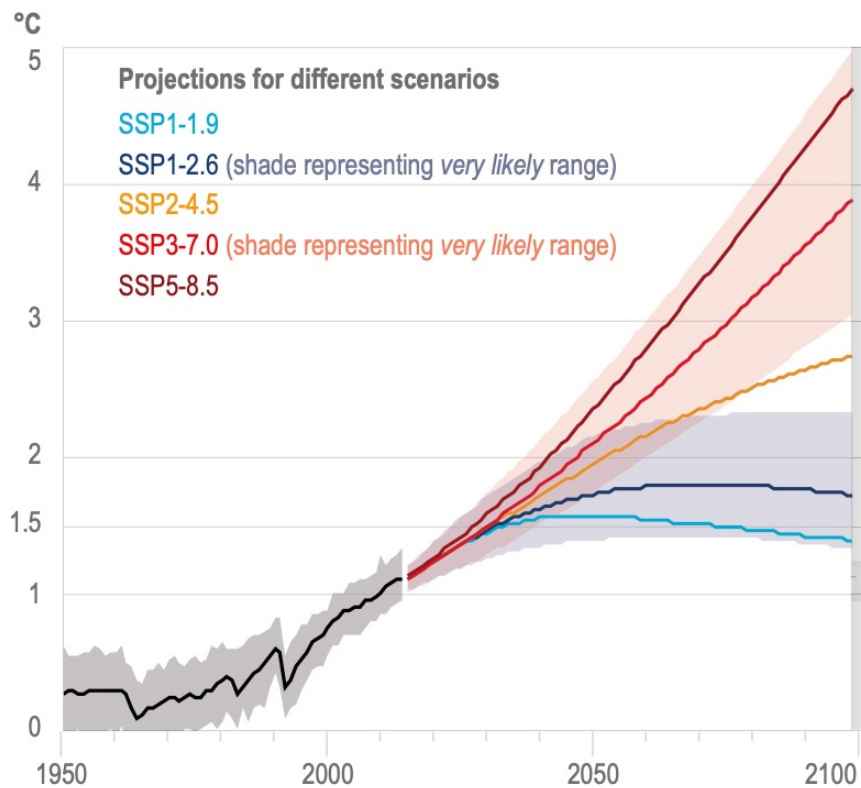
- **Hard** adaptation limit – No adaptive actions are possible to avoid intolerable risks.
- **Soft** adaptation limit – Options may exist but are currently not available to avoid intolerable risks through adaptive action.



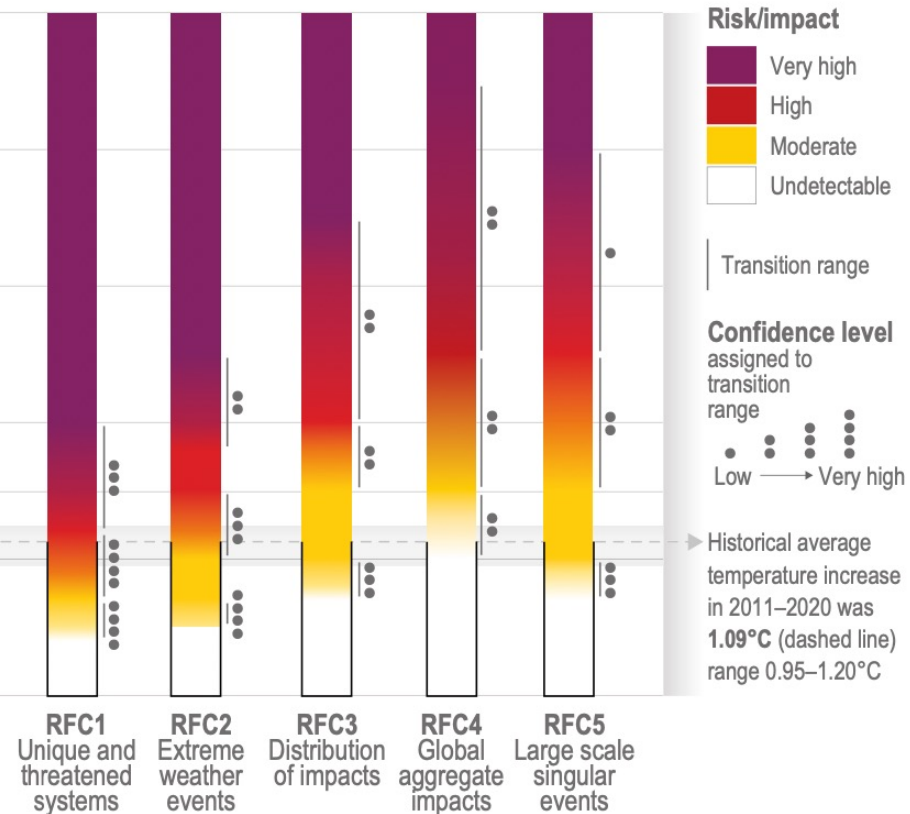
There are limits to adaptation

- Even effective adaptation cannot prevent all losses and damages
- Above 1.5° C some natural solutions may no longer work.
- Above 1.5° C, lack of fresh water could mean that people living on small islands and those dependent on glaciers and snowmelt can no longer adapt.
- By 2° C it will be challenging to farm multiple staple crops in many current growing areas.

(a) Global surface temperature change
Increase relative to the period 1850–1900

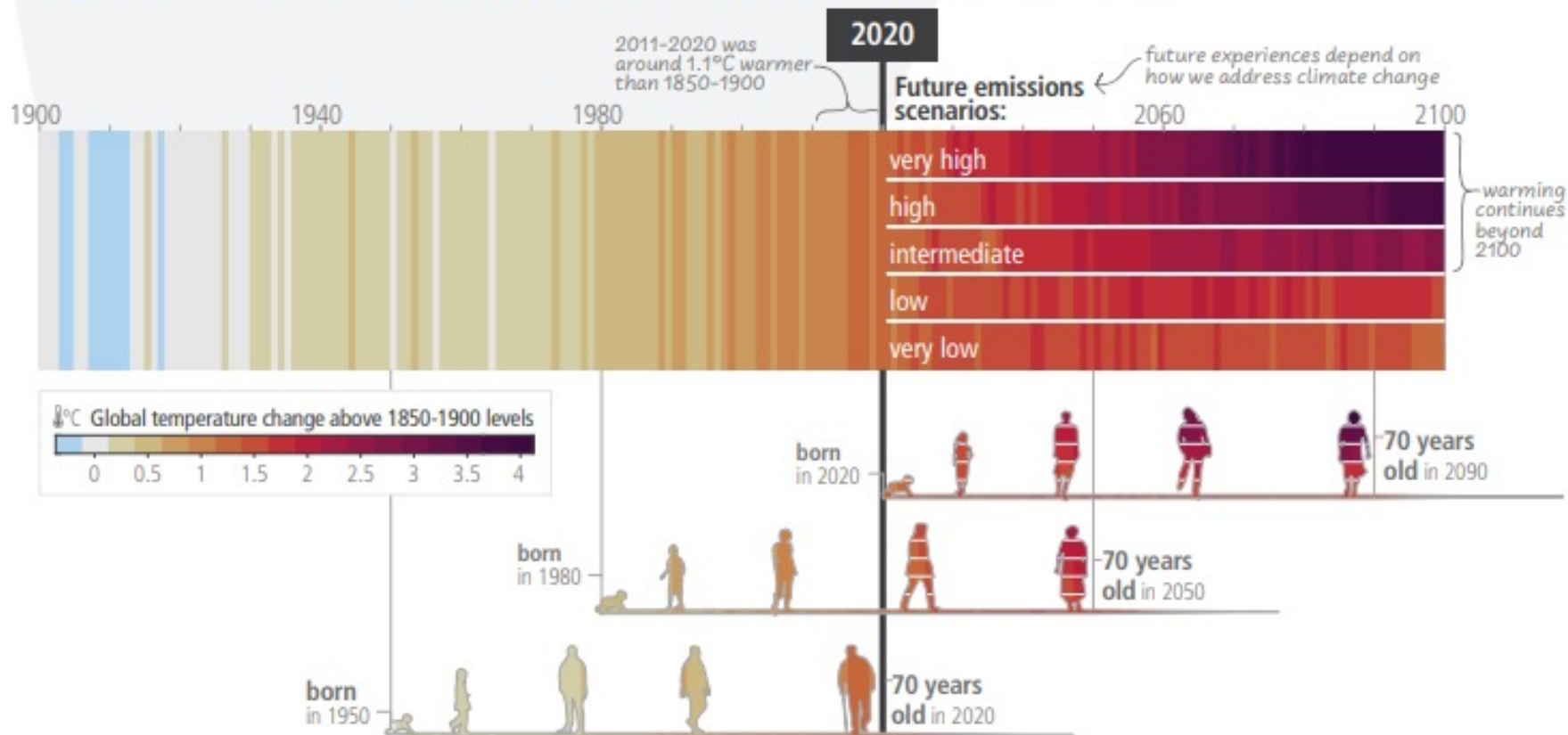


(b) Reasons for Concern (RFC)
Impact and risk assessments assuming low to no adaptation



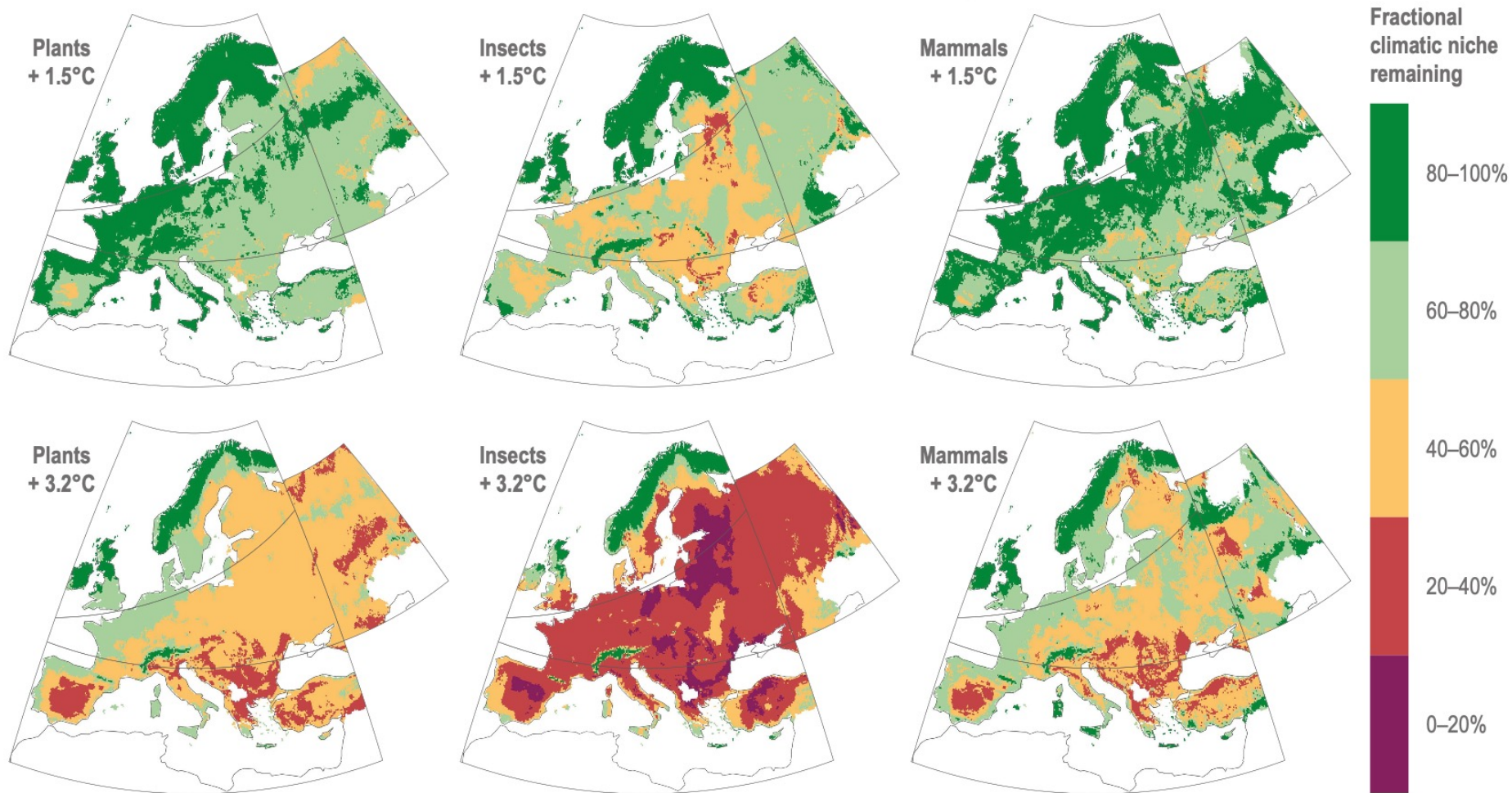
Source: IPCC AR6 WGII SPM, Fig. SPM.3

c) The extent to which current and future generations will experience a hotter and different world depends on choices now and in the near term



Species projected to remain in suitable climate conditions in Europe

Source: IPCC AR6 WGII, Chap 13



Indicative adaptation limits in cities, settlements and key infrastructure in Europe

Economic activities and leisure	Supply of energy & water	City/ town	Household/ Building
<p>Technical limits</p> <p>Limited resources for implementing adaptation</p> <p>Technological limits</p>	<p>Technical limits</p> <p>Technical/ management measures not possible due to plant characteristics</p>	<p>Technical limits</p> <p>Limited efficacy of measures under high/ rapidly changing climate hazards</p>	<p>Technical limits</p> <p>Physical characteristics of building stock</p>
<p>Socio-economic limits</p> <p>High investments needed</p> <p>Small size of enterprises</p>	<p>Socio-economic limits</p> <p>High installation costs for large-scale adaptation</p> <p>Too risky investments when in highly vulnerable locations</p>	<p>Socio-economic limits</p> <p>High investments to upgrade municipal facilities</p> <p>High installation cost for new infrastructure</p>	<p>Socio-economic limits</p> <p>Low probability hazards prohibit adaptation payoff</p> <p>Poverty</p> <p>Comfort and safety</p>
<p>Environmental & regulatory limits</p> <p>Limited water resources</p> <p>Shift to other locations is prohibited</p> <p>Limited areas for expansion</p>	<p>Environmental & regulatory limits</p> <p>Limited water resources</p> <p>Competitive water uses</p>	<p>Environmental & regulatory limits</p> <p>Space constraints for expanding green infrastructure</p>	<p>Environmental & regulatory limits</p> <p>Legislation on buildings and appliances</p>

Source: IPCC AR6 WGII, Chap 13

Figure 13.21 | Indicative adaptation limits in cities, settlements and key infrastructures in Europe (Table SM13.16)

Since 1950, **extreme hot days** and **heavy precipitation** have become more common



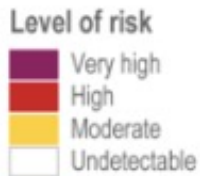
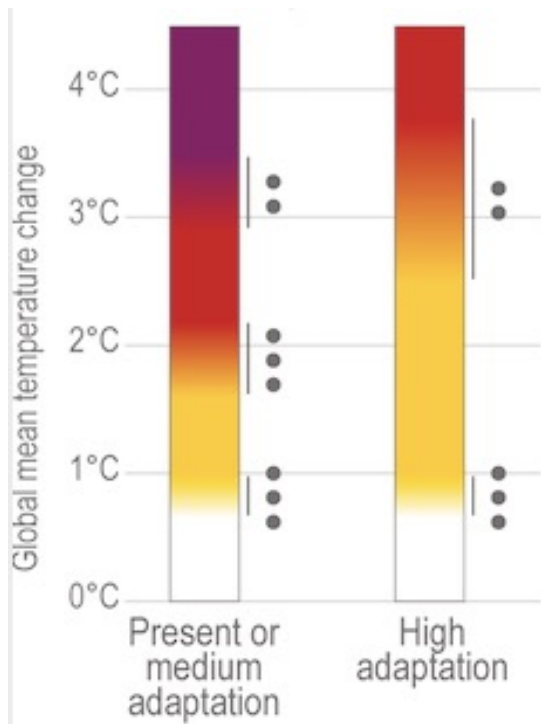
There is evidence that anthropogenic influences, including increasing atmospheric **greenhouse gas concentrations**, have changed these extremes

Heat waves kill

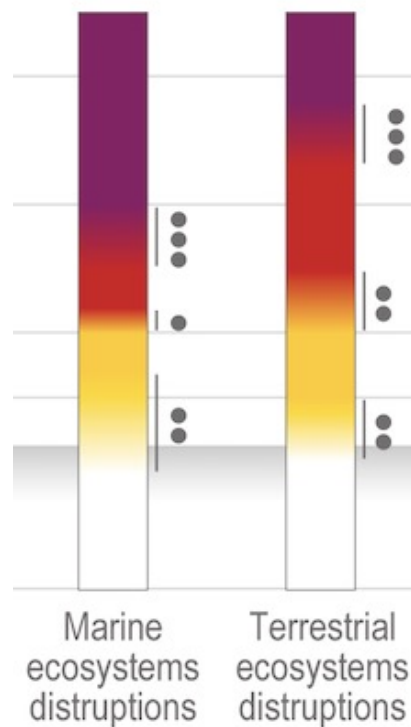


Une personne âgée dans un couloir des urgences du centre hospitalier de Versailles en août 2003. | AFP PHOTO MARTIN BUREAU

Heat stress, mortality and morbidity

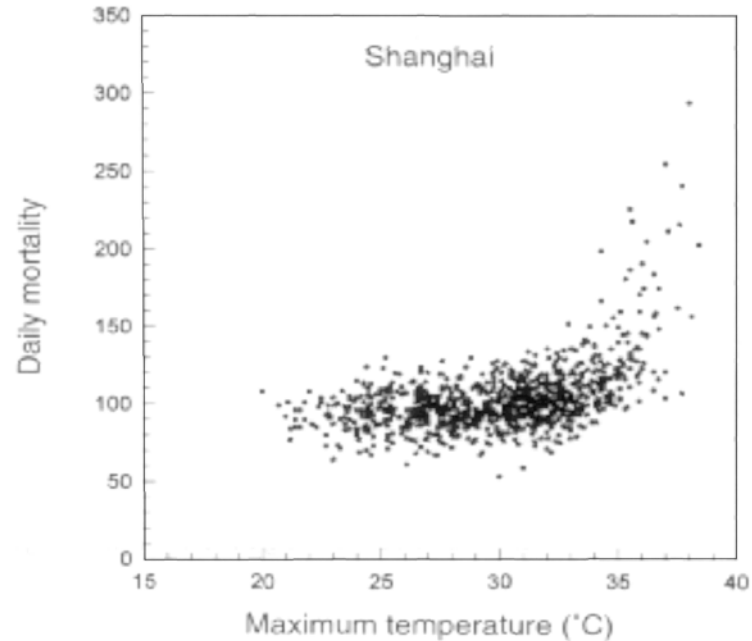


Ecosystems



Source: IPCC AR6 WGII, Chap 13

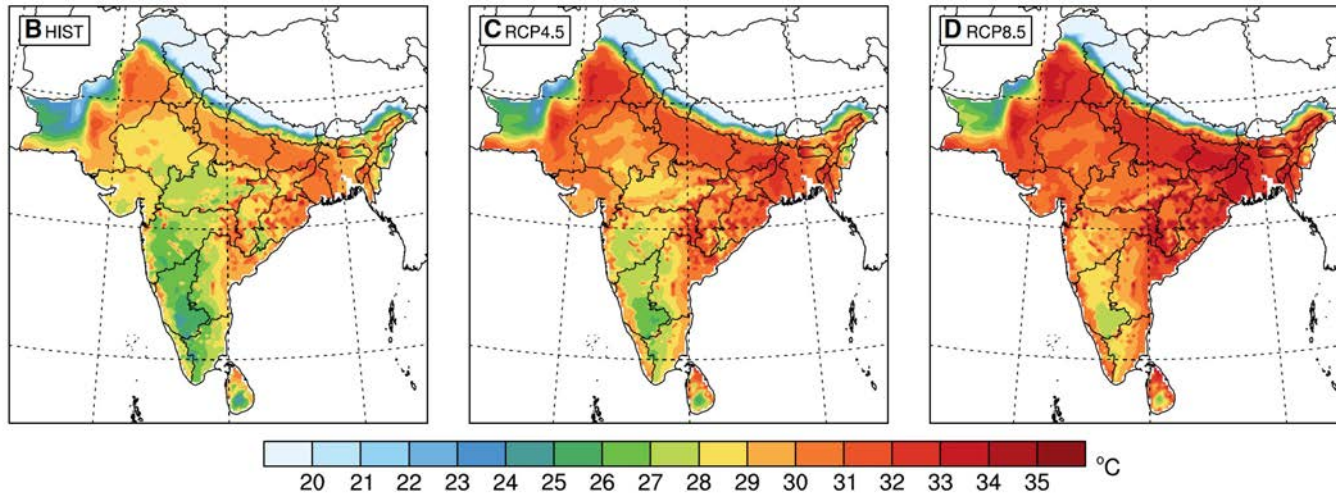
Relationship between maximum temperature and mortality in Shanghai, China, 1980-89



Référence : CLIMATE CHANGE AND HUMAN HEALTH, 1996

Jean-Pascal van Ypersele (vanyp@climate.be)

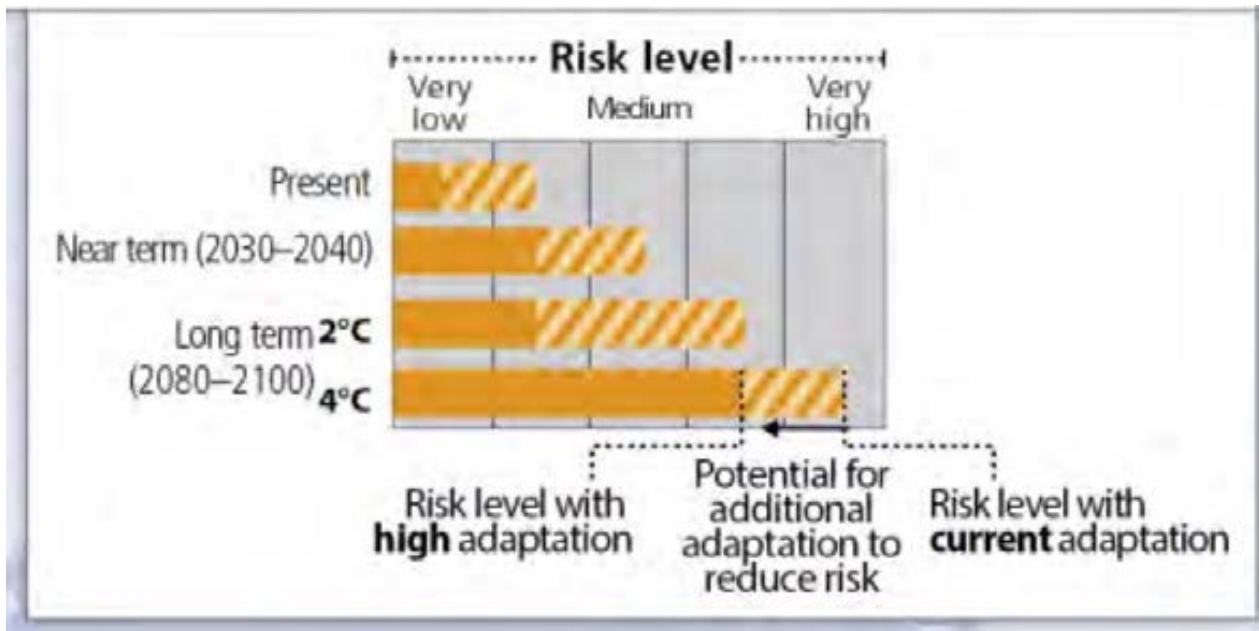
Maximum wet bulb temperature in South Asia (°C) (35°C during 6 hours is considered deadly)



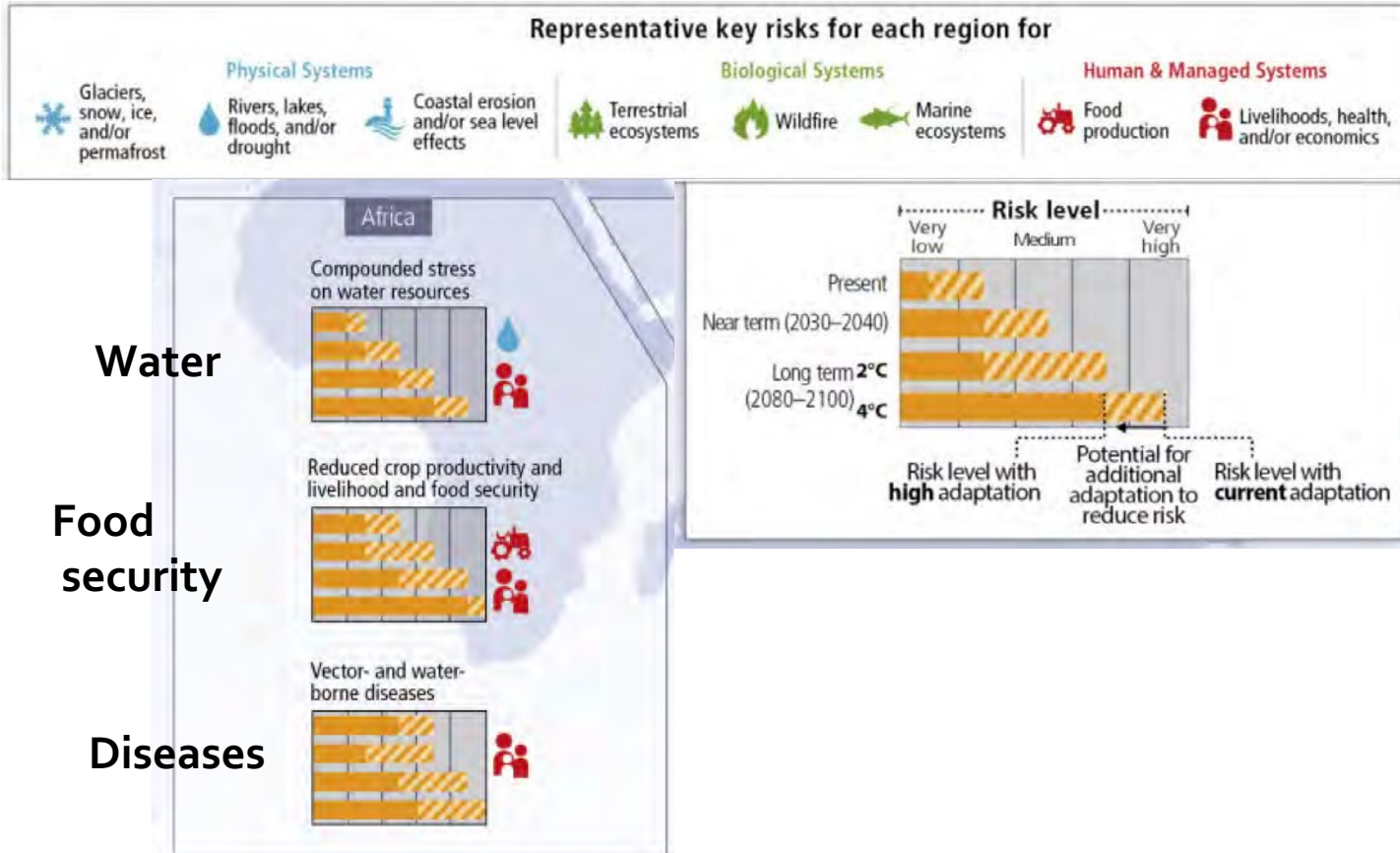
Spatial distributions of bias-corrected ensemble averaged 30-year TWmax for each GHG scenario: HIST (1976–2005) (B), RCP4.5 (2071–2100) (C), and RCP8.5 (2071–2100) (D).

Source: Im et al., 2017 « Deadly heat waves projected in the densely populated agricultural regions of South Asia », Science advances.

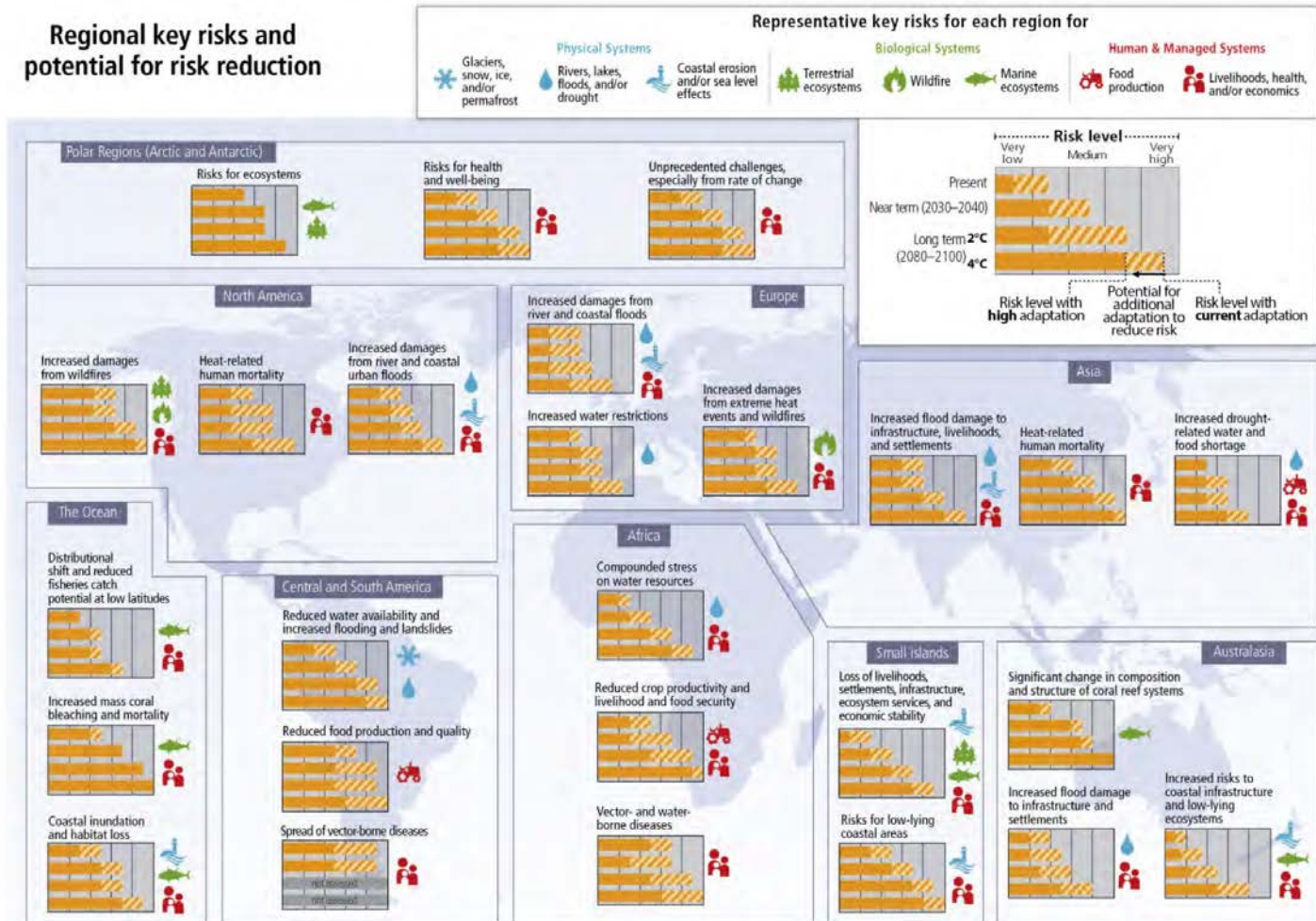
Regional key risks and potential for risk reduction through adaptation



Regional key risks and risk reduction through adaptation: Africa

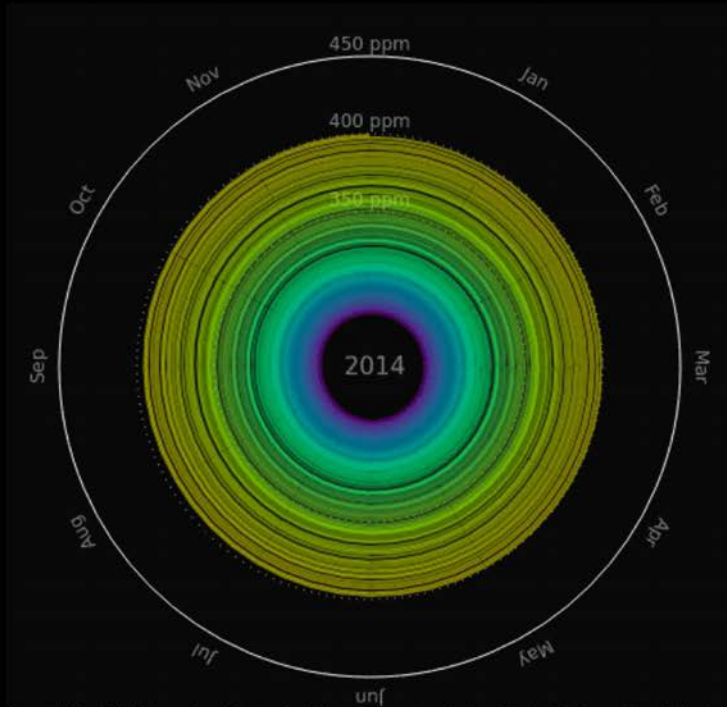


Regional key risks and potential for risk reduction

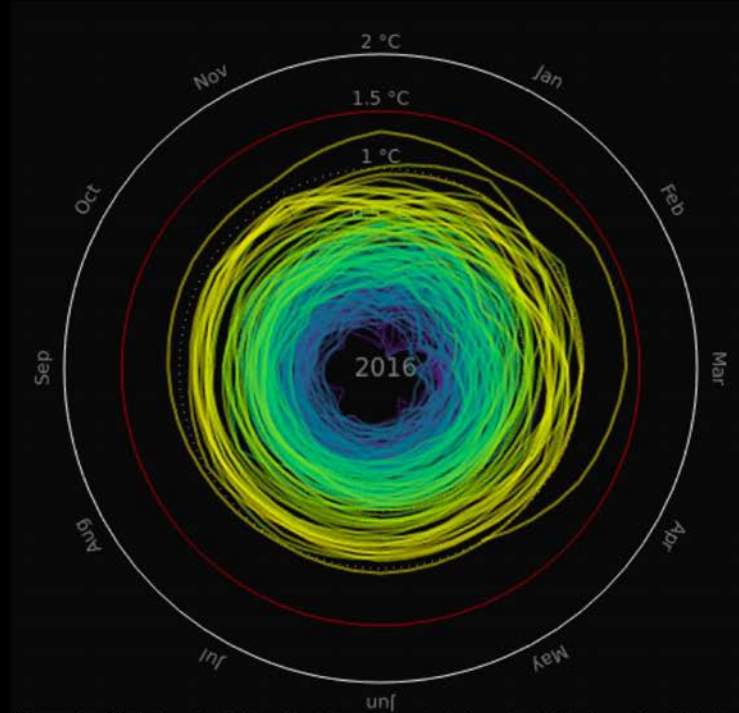


IPCC, AR5, SPM, Figure SPM.8

CO₂ Concentration and Temperature spirals



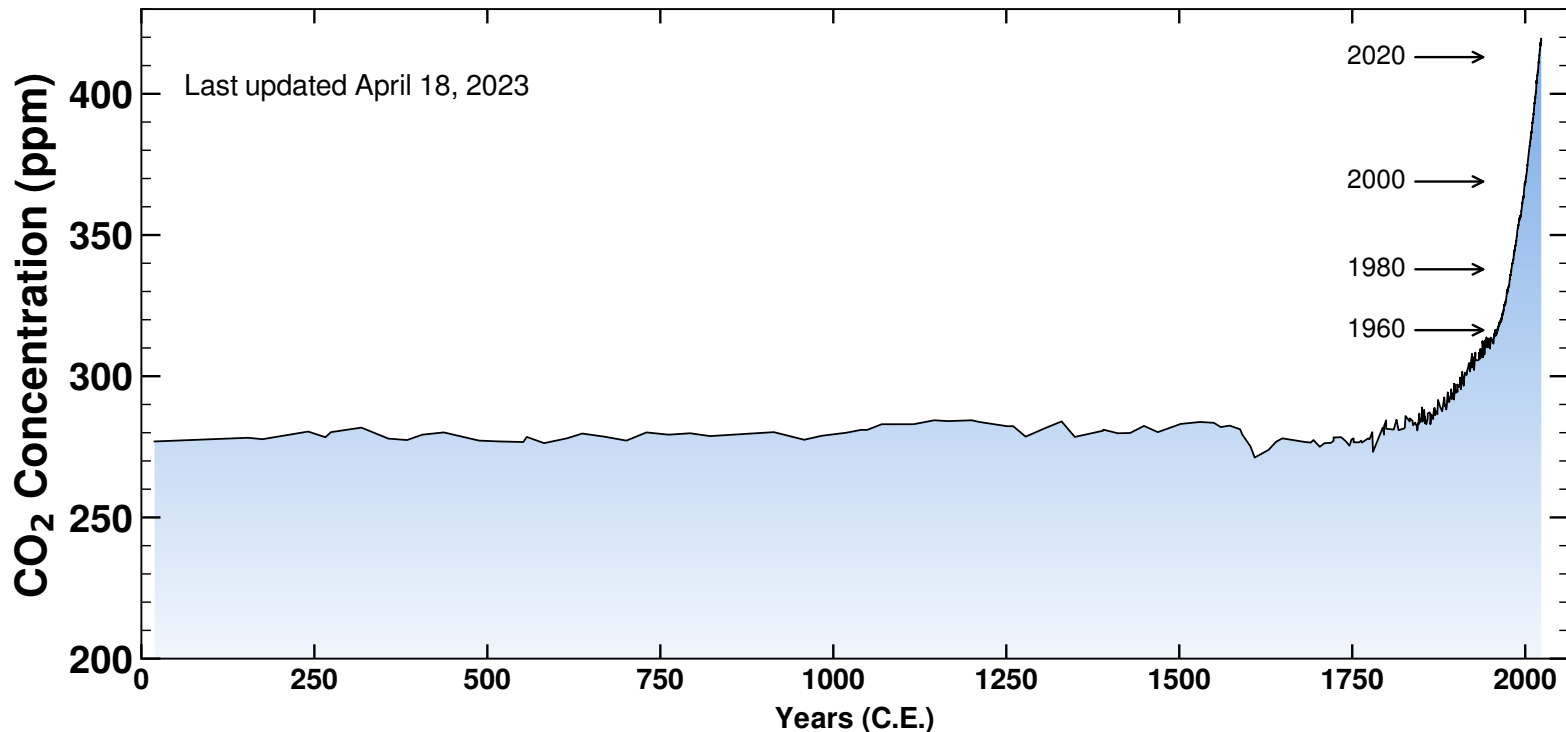
Concentration Spiral pik-potsdam.de/primap-live/ & climatecollege.unimelb.edu.au, Gieseke, Meinshausen. Thx to Ed Hawkins



Temperature Spiral pik-potsdam.de/primap-live/ & climatecollege.unimelb.edu.au, Gieseke, Meinshausen. Thx to Ed Hawkins

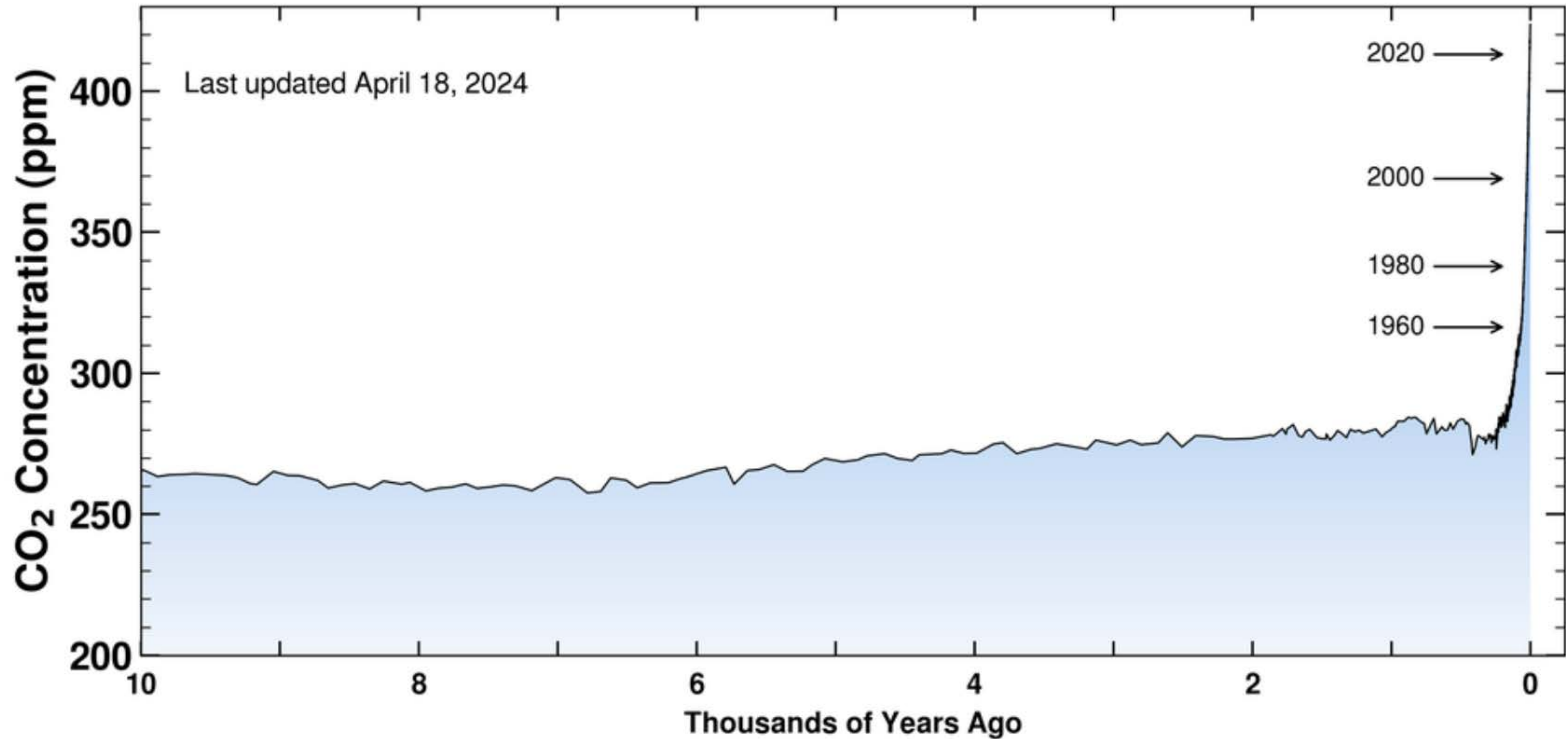
CO₂ Concentration since 1850 and Global Mean Temperature in °C relative to 1850 – 1900
Graph: Ed Hawkins (Climate Lab Book) – Data: HadCRUT4 global temperature dataset
Animation available on <http://openclimatedata.net/climate-spirals/concentration-temperature/>

CO₂ Concentration 18 April 2023: 424,03 ppm (Keeling curve + last 2000 years)



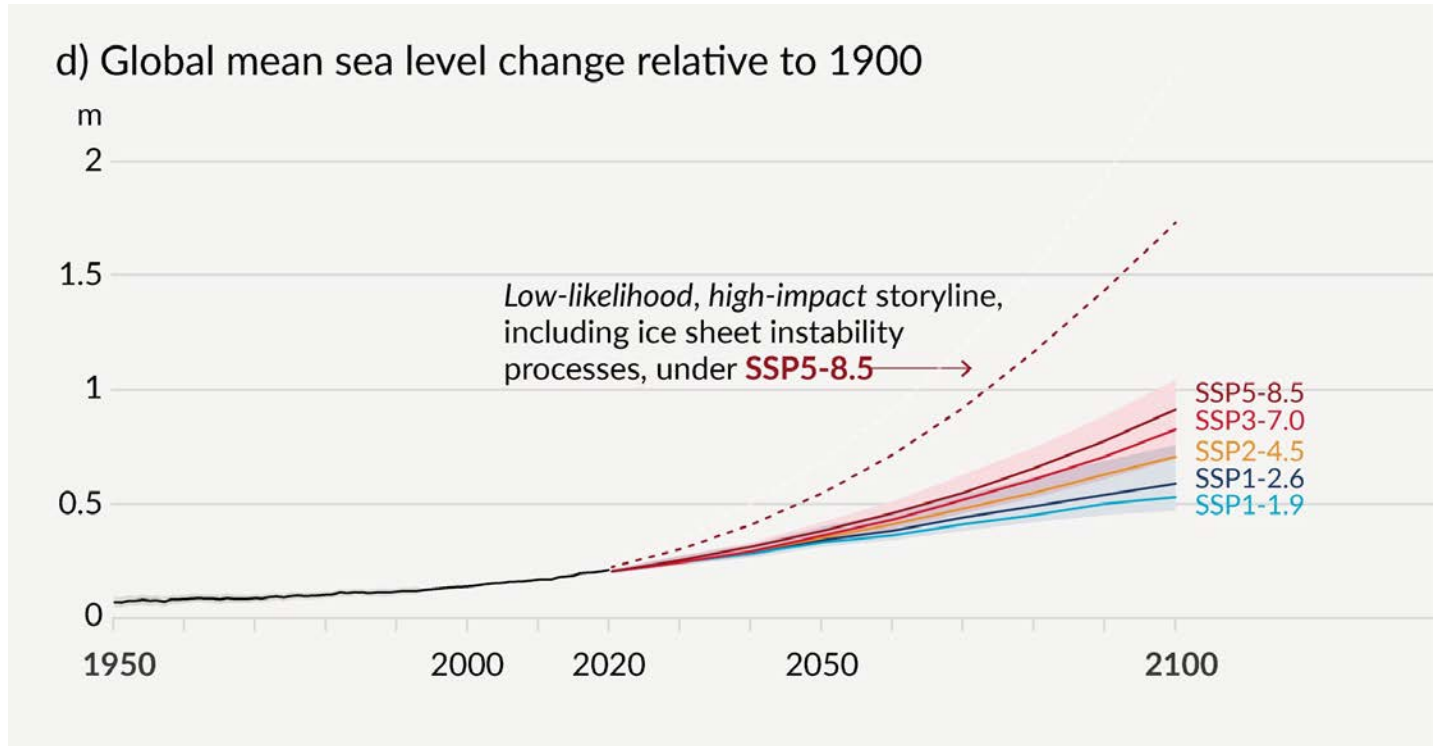
Source: scripps.ucsd.edu/programs/keelingcurve/

CO₂ Concentration 18 April 2024: 427,14 ppm (Keeling curve + last 10000 years)



Source: scripps.ucsd.edu/programs/keelingcurve/

Human activities affect all the major climate system components, with some responding over decades and others over centuries *Figure SPM.8*

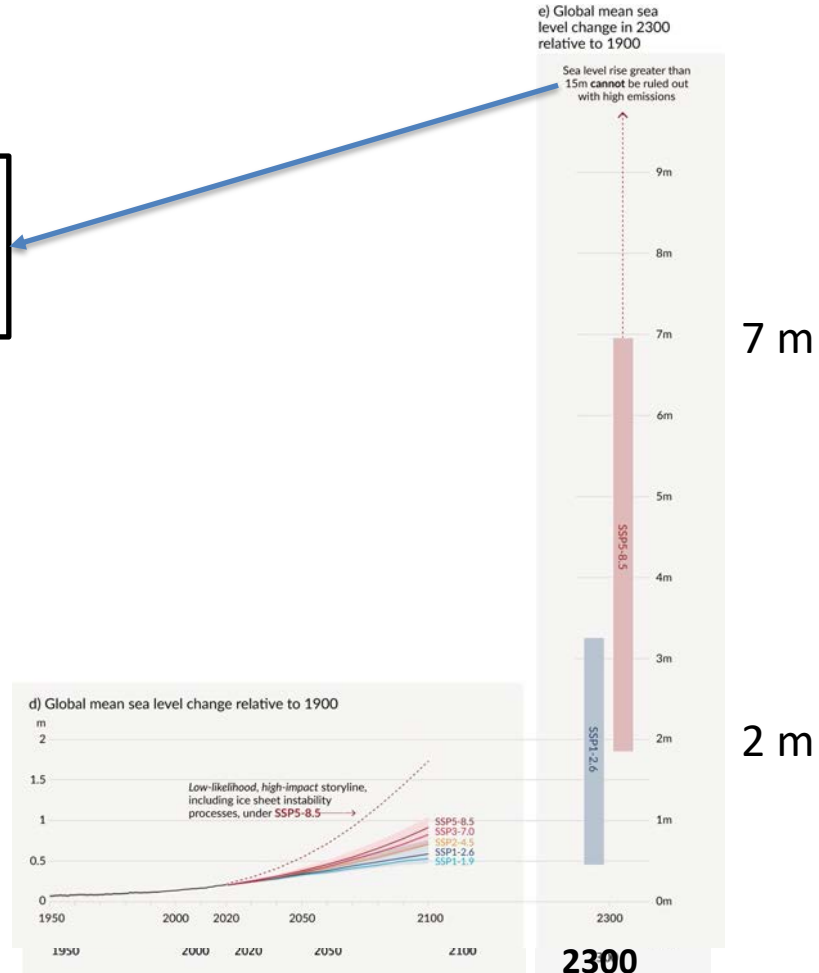


IPCC SIXTH ASSESSMENT REPORT

Working Group I – The Physical Science Basis

Figure SPM.8

« Sea level rise **greater than 15 m** cannot be ruled out with high emissions » (in 2300)

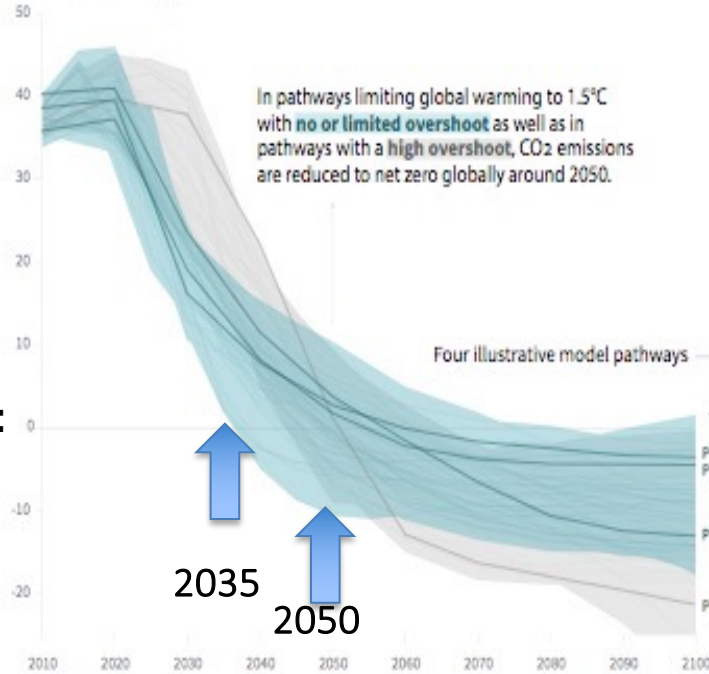


Why net zero emissions are needed as soon as possible

Emission pathways compatible with below 1.5° C warming:

Global total net CO₂ emissions

Billion tonnes of CO₂/yr



Net ZERO:

2035

2050

Timing of net zero CO₂

Line widths depict the 5-95th percentile and the 25-75th percentile of scenarios



Pathways limiting global warming to 1.5°C with no or low overshoot

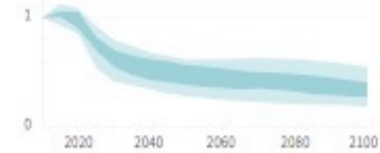
Pathways with high overshoot

Pathways limiting global warming below 2°C (Not shown above)

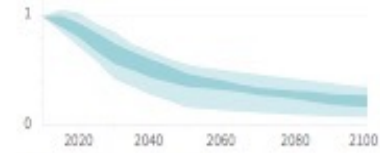
Non-CO₂ emissions relative to 2010

Emissions of non-CO₂ forcers are also reduced or limited in pathways limiting global warming to 1.5°C with **no or limited overshoot**, but they do not reach zero globally.

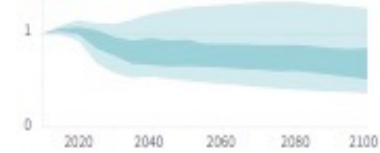
Methane emissions



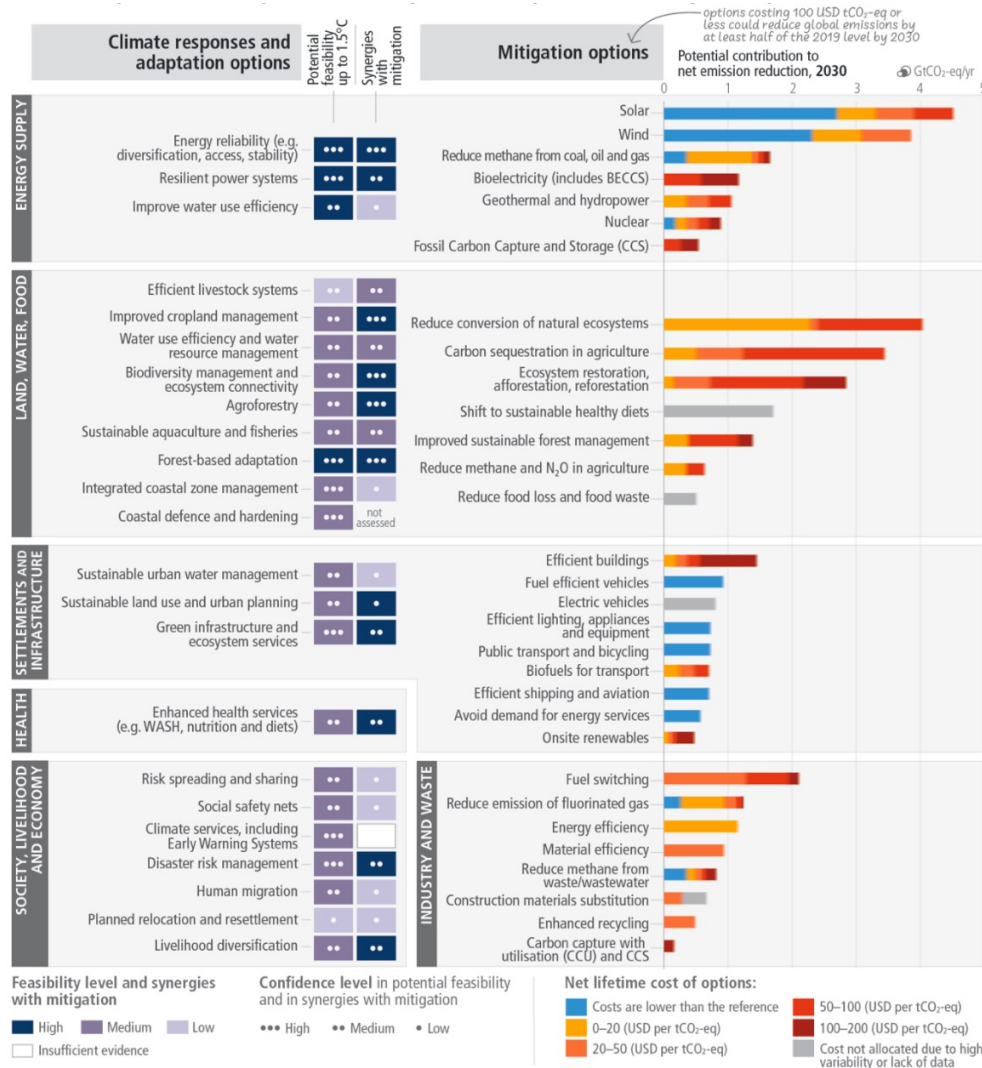
Black carbon emissions



Nitrous oxide emissions



Feasibility of climate responses and adaptation, and potential of mitigation in the near-term



Climate responses and adaptation options

Potential feasibility up to 1.5°C
Synergies with mitigation

Energy reliability (e.g. diversification, access, stability)



Resilient power systems



Improve water use efficiency

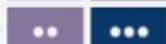


ENERGY SUPPLY

Efficient livestock systems



Improved cropland management



Water use efficiency and water resource management



Biodiversity management and ecosystem connectivity



Agroforestry



Sustainable aquaculture and fisheries



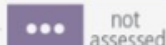
Forest-based adaptation



Integrated coastal zone management



Coastal defence and hardening



LAND, WATER, FOOD

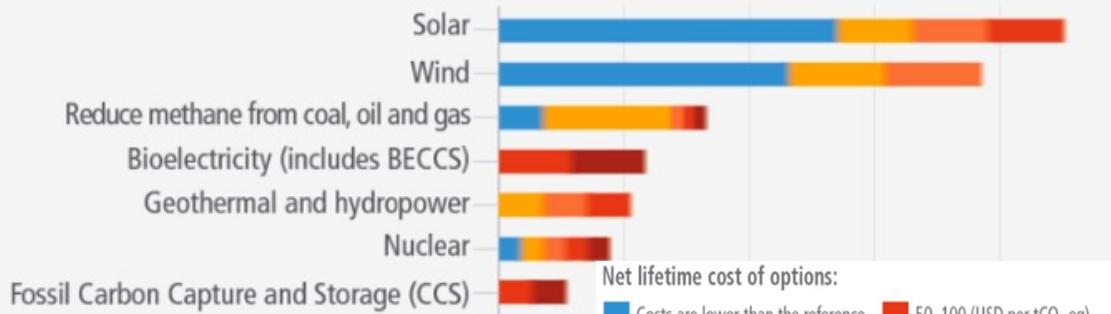
Mitigation options

Potential contribution to net emission reduction, 2030

GtCO₂-eq/yr

0 1 2 3 4

options costing 100 USD tCO₂-eq or less could reduce global emissions by at least half of the 2019 level by 2030

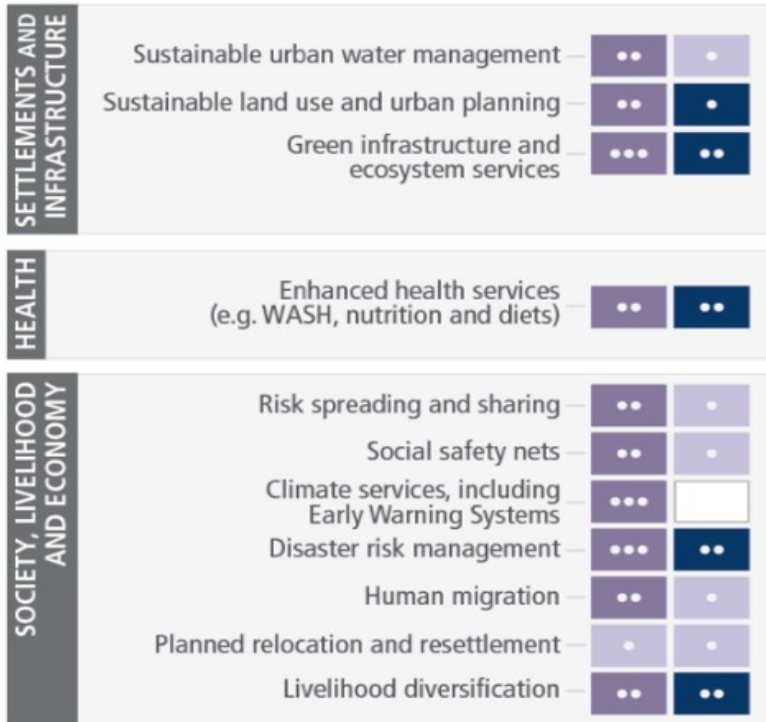


Net lifetime cost of options:



Climate responses and adaptation options

Potential feasibility up to 1.5°C
Synergies with mitigation



Feasibility level and synergies with mitigation

High Medium Low
Insufficient evidence

Confidence level in potential feasibility and in synergies with mitigation

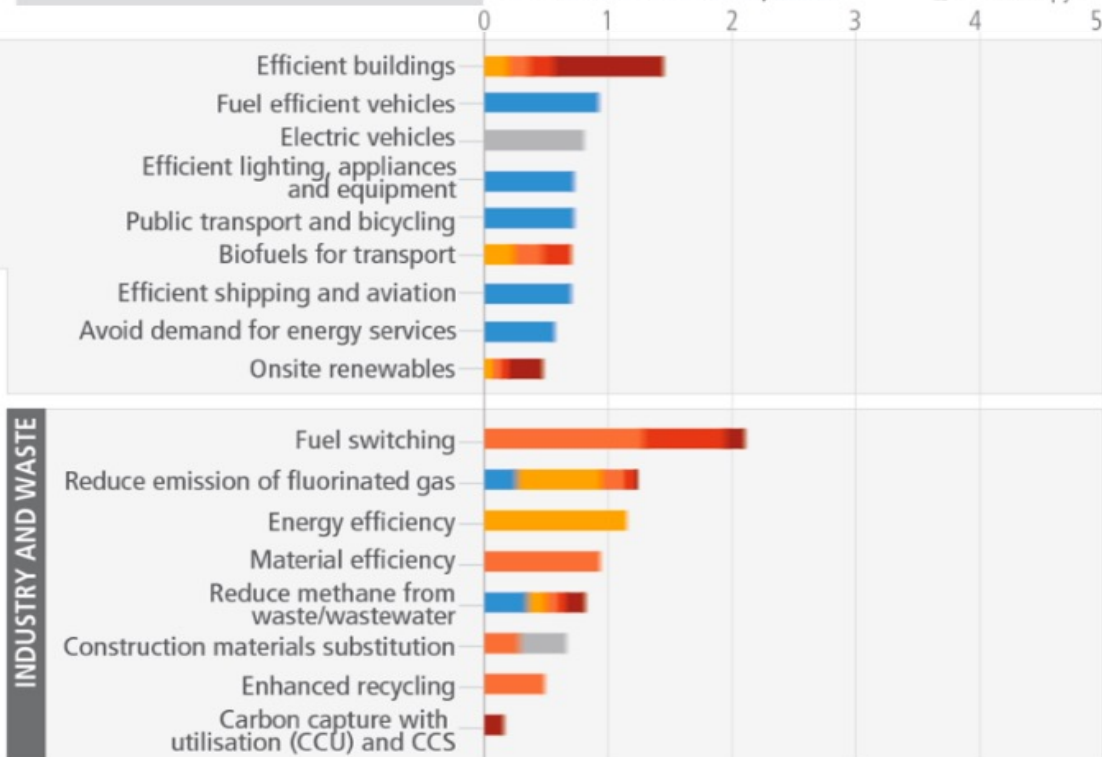
High Medium Low

IPCC AR6 SYR Fig SPM.7a (bottom)

Mitigation options

Potential contribution to net emission reduction, 2030

GtCO₂-eq/yr



Net lifetime cost of options:

Costs are lower than the reference
0-20 (USD per tCO₂-eq)
20-50 (USD per tCO₂-eq)
50-100 (USD per tCO₂-eq)
100-200 (USD per tCO₂-eq)
Cost not allocated due to high variability or lack of data

Many co-benefits of taking climate action out of its SILO:



SUSTAINABLE DEVELOPMENT GOALS

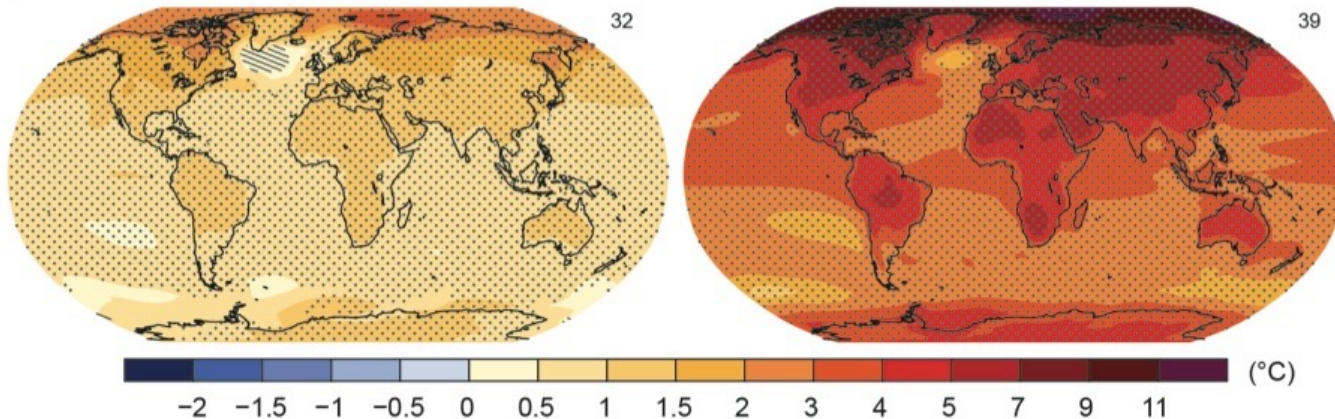


RCP2.6

RCP8.5

Change in average surface temperature (1986–2005 to 2081–2100)

Fig. SPM.8



Humanity has the choice

Lettre N°27: Impacts et adaptation en Europe et en Afrique

Novembre 2022

- Impacts des changements climatiques sur les systèmes humains et naturels en Europe
- Efficacité et faisabilité des options d'adaptation
- Biodiversité : quand le climat ne convient plus aux espèces
- Une météo qui favorise les feux de forêt
- En Afrique, des risques et impacts élevés



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Draguignan, France, 2010

Santarém, Portugal, 2017



Glacier de Brisdal, Norvège, 2019

Liège (Angleur), Belgique, 2021



Ardennes françaises, 2022

Tellin (Bure), Belgique, 2022



La Wamme, Jemelle, Belgique, 2022

Kenya, 2006

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Sud de l'Éthiopie, 2011

Barrage de Theewaterskloof, Afrique du Sud, 2018

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<https://plateforme-wallonne-giec.be/Lettre27.pdf>

S'inscrire à la Newsletter de la plateforme via le QR code

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- www.climate.be/vanyp : my slides (under « conferences »)
- www.ipcc.ch : IPCC
- www.realclimate.org : answers to the merchants of doubt arguments
- www.skepticalscience.com : same
- www.plateforme-wallonne-giec.be : IPCC-related in French, Newsletter, latest on permafrost emissions
- **Twitter: @JPvanYpersele & @IPCC_CH**