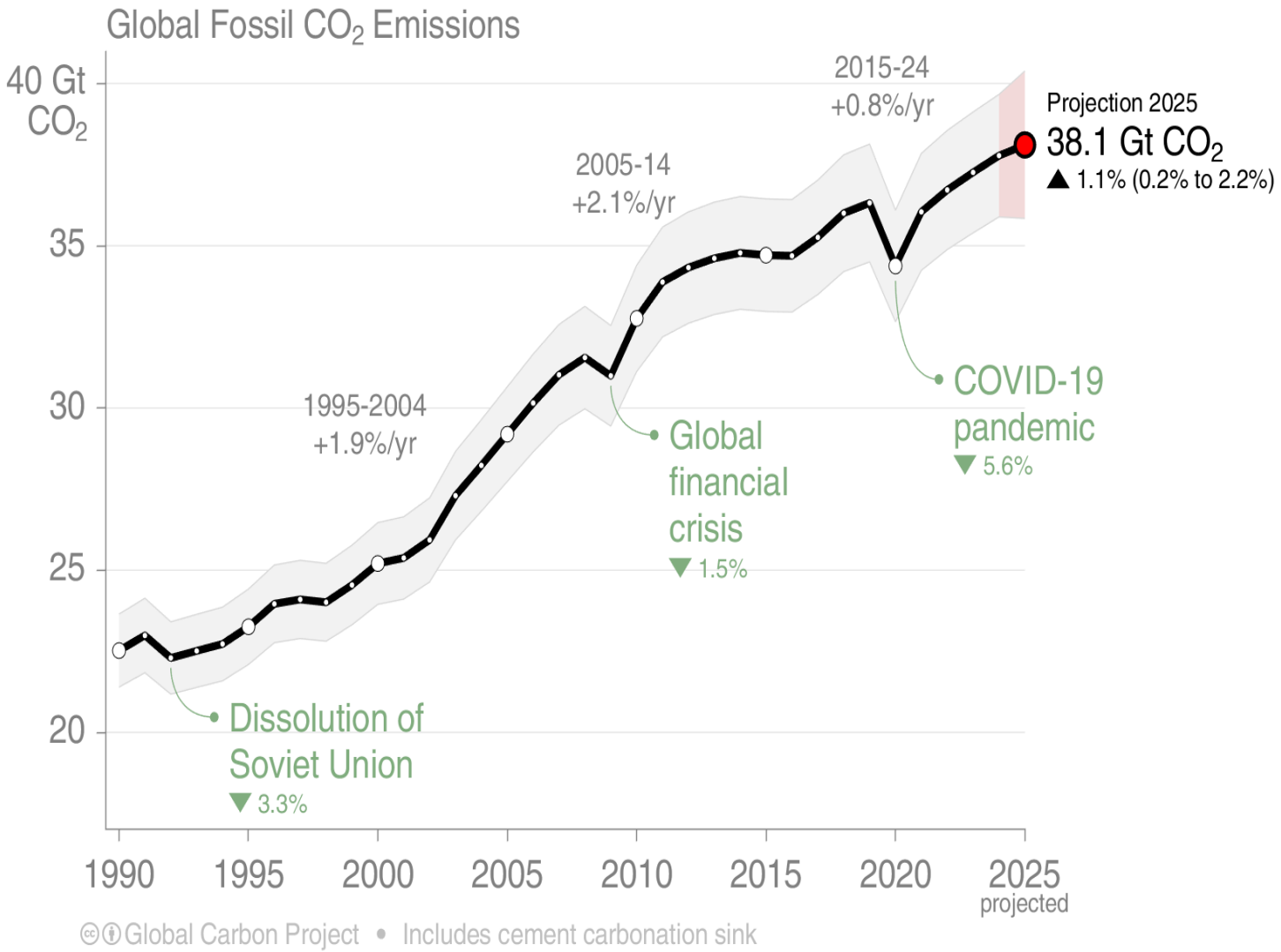
IPCC science relevant to water systems and the ocean

How it connects with financing climate action

Emeritus Professor Mark Howden AC FAA FTSE

Vice Chair, Working Group II, IPCC

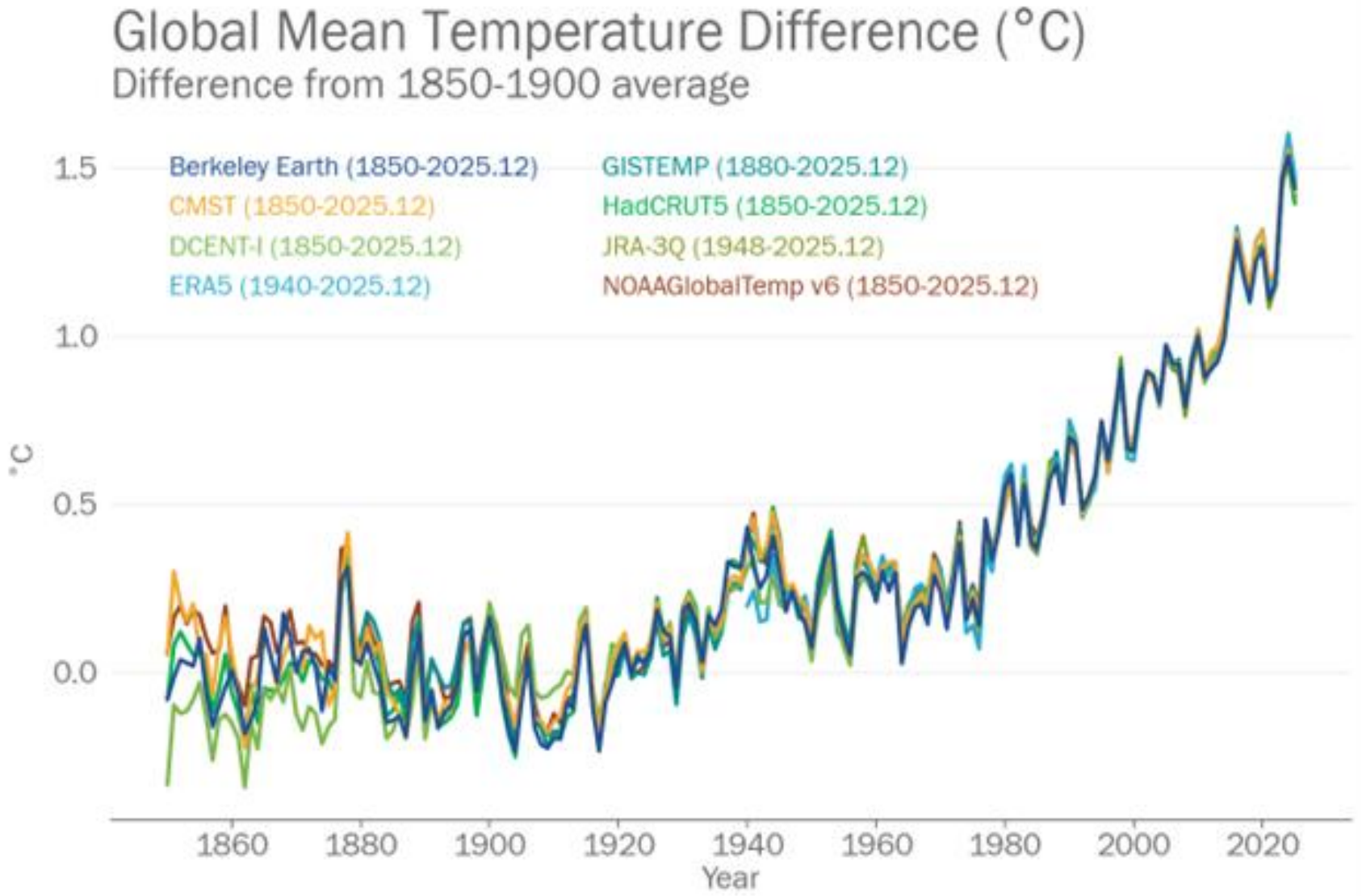
GHG emissions keep on rising



- Record CO_2 concentrations (430ppm): up by 3ppm and above 1.5°C-consistent pathways
- Record levels of methane, nitrous oxide and other GHGs
- Our carbon budget for 1.5°C is running out very quickly (about 3 years left): GHG emission reduction is urgent

Global Carbon Project 2026; Friedlingstein et al. 2025; IPCC 2021; Lamboll et al. 2023

Temperatures keep rising



- Warming is accelerating
- In 2025, the 3-year average temperature was over 1.5°C for the first time
- Likely to exceed 1.5°C this year or next on a trend basis
- High probability of record temperatures (again) this year and next
- Uncharted territory

WMO 2026; UNEP 2026; Copernicus 2026; Rantanen and Laaksonen 2024

The ocean is changing: heat, acidification and sea-level rise

- The ocean has absorbed most of the excess heat in the climate system
- Ocean warming is radically increasing marine heatwave risks and contributing to changes in marine ecosystems
- Human-caused CO_2 emissions are driving ocean acidification
- Global mean sea level is rising and will continue to rise for centuries primarily because of ocean warming and ice loss
- Sea-level rise creates increasing risks for humans, coastal settlements and other infrastructure, freshwater systems and ecosystems
- It interacts with increasing risk from cyclones/hurricanes/typhoons and storms
- There are increasingly long-lived financial and insurance risks: infrastructure decisions made today can be increasingly exposed to risks outside of design specifications

Ocean change leads to ecosystem and livelihood risks

Marine ecosystems

- Increasing ocean warming, acidification and deoxygenation are altering marine ecosystems
- Coral reefs are particularly exposed: risks are already very high and increase rapidly

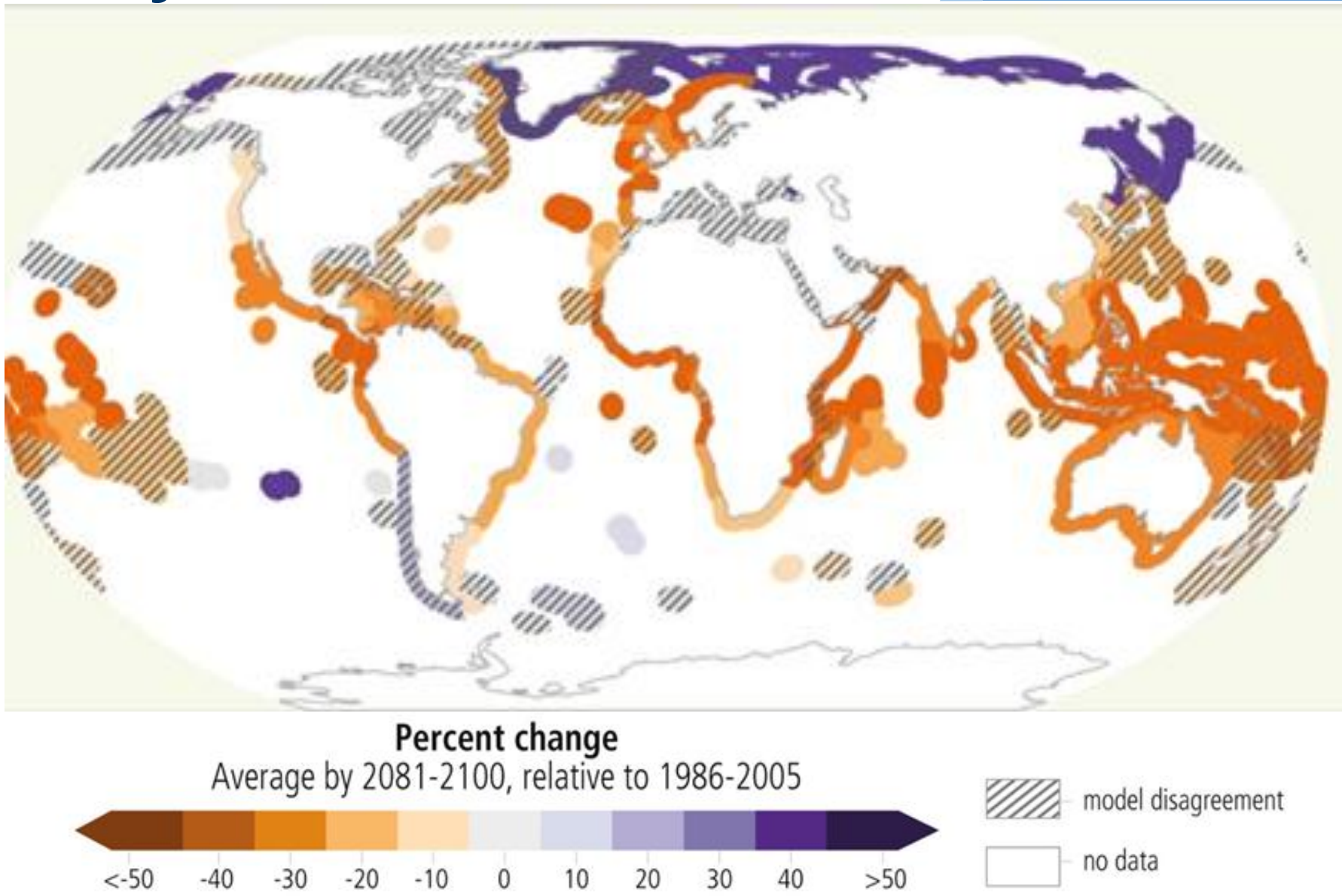
Fisheries and livelihoods

- Climate-driven changes in ocean conditions affect fish distribution, abundance and fisheries productivity
- Risks are particularly significant for communities and economies highly dependent on marine resources
- Small islands and coastal developing economies can face disproportionate consequences

Finance implication

- These are not only environmental losses: they translate into income, food security, employment and asset risks
- Protecting natural systems also protects economic assets and livelihoods

Climate change impacts fishery productivity



IPCC 2019

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The water cycle is intensifying and becoming more variable

- AR6 found widespread, non-uniform human-caused alterations of the global water cycle
- Variability and extremes are projected to increase faster than average changes in many regions
- A warmer atmosphere can hold exponentially more moisture, increasing moisture transport into weather systems
- Wet seasons and heavy precipitation events are becoming more extreme in many regions
- At the same time, reductions in rainfall in other areas and increases in atmospheric evaporative demand contributes to greater drought severity
- Groundwater depletion is already occurring in many parts of the world
- Water risks therefore arise from both too much water and too little water, sometimes within the same region or season

Drought risk increasing overall

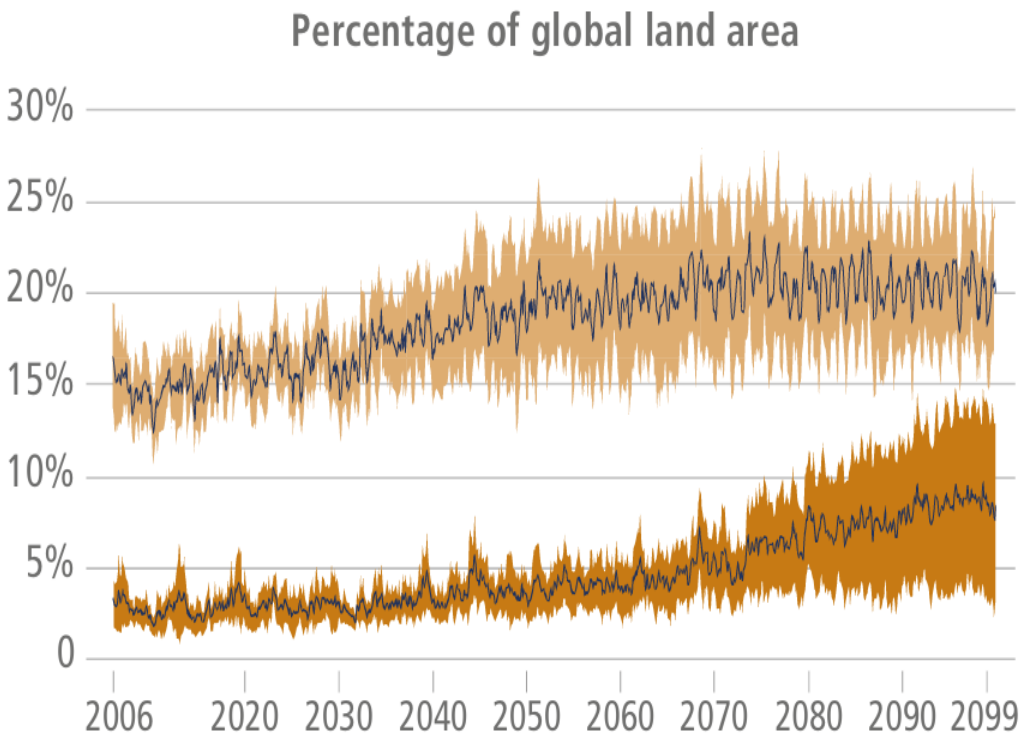
Droughts
change under RCP6.0**
relative to 1976–2005

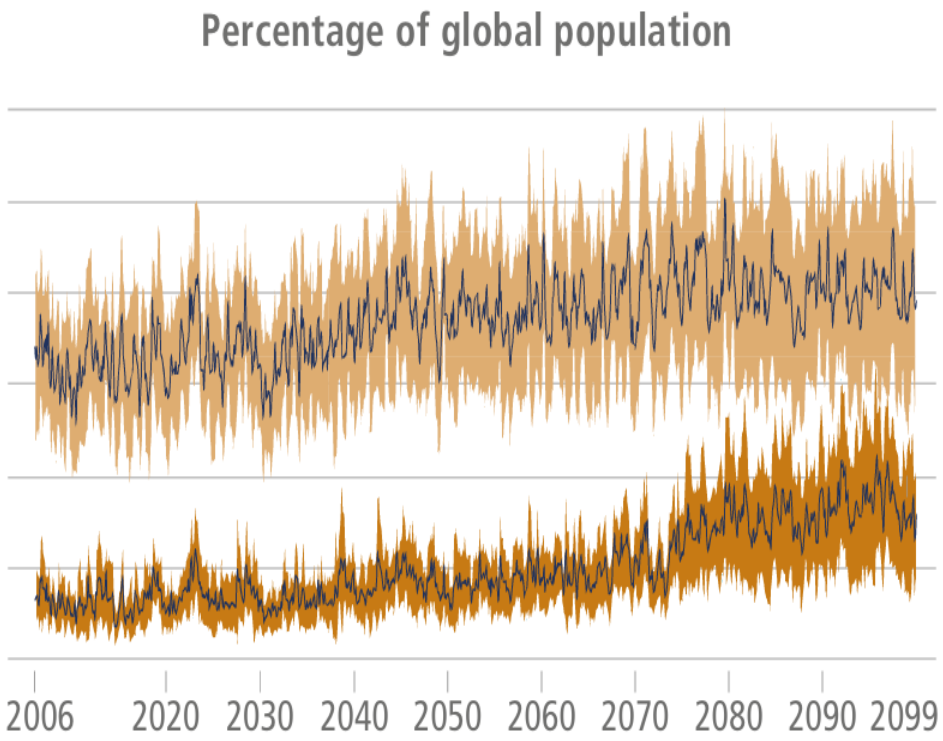
Moderate-severe

Extreme-exceptional

* = Population projections based on Shared Socio-Economic Pathway 2 (SSP2)

** = ~1.3°C to 2.5°C Global Warming Level between 2041–2060





AR6 WGII- TS 6b Drought evolution across the 21st century

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Cascading water risks

Water scarcity

- Roughly half of the world's population experiences severe water scarcity for at least part of the year, due to climatic and non-climatic factors
- Water-related risks increase with every part of a degree of warming

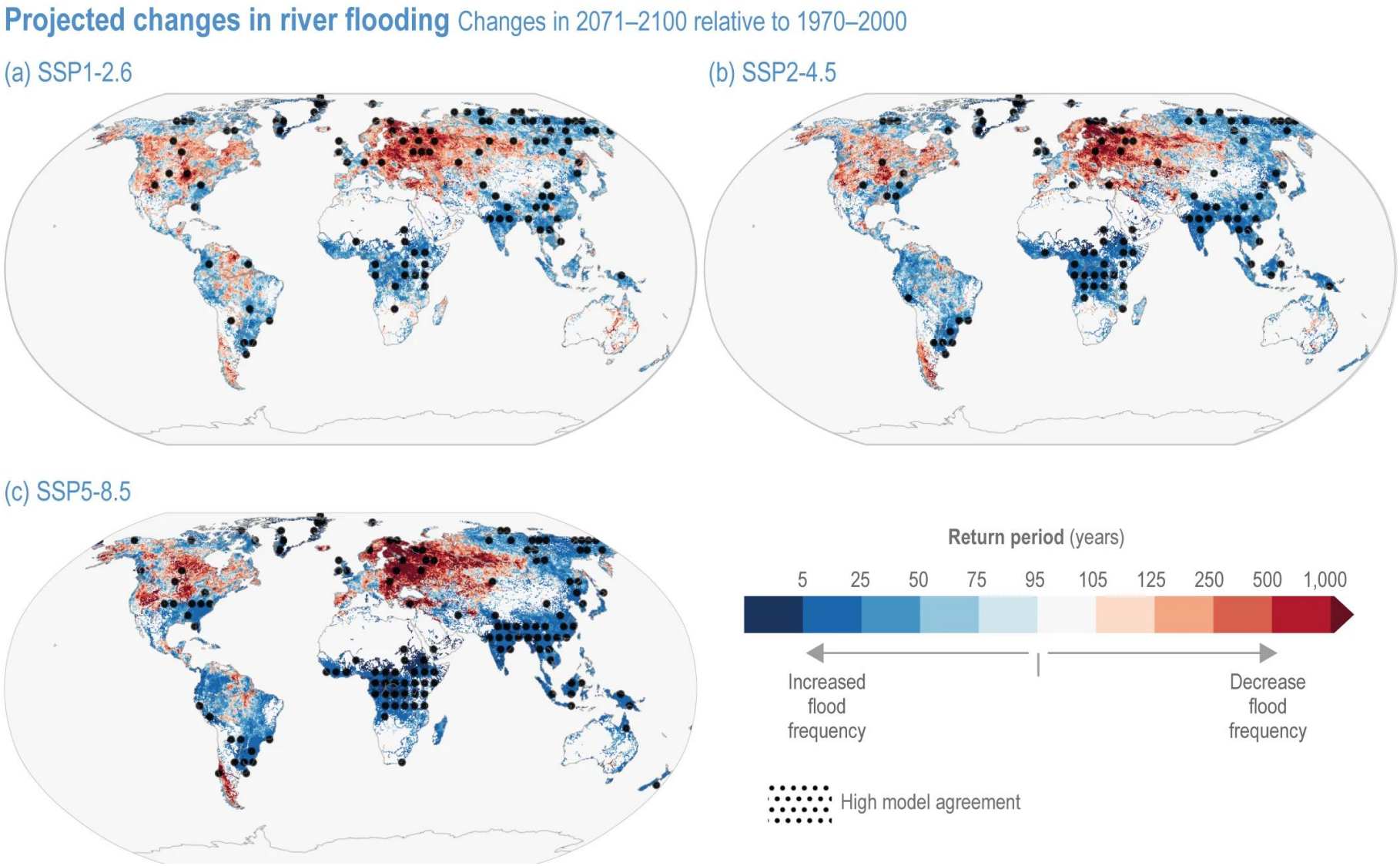
Extremes

- Floods account for a large share of recorded disaster events and are getting worse
- Droughts account for a disproportionately large share of disaster deaths and are getting worse
- Compound events (e.g. heat + drought + fire + smoke, drought + food-system stress, flooding + coastal salinization + health risks) … create cascading risks

Infrastructure & investment

- Water-related risks affect finance and insurance in agriculture, energy, cities, industry, ecosystems and health
- Water infrastructure can itself become maladaptive if it locks in unsustainable demand, increases exposure or increased GHG emissions

River flooding changes



AR6 WGII - Chapter 4, Fig 4.17 River flooding relative changes in 2070-2100

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The 'Finance Gap'

- Adaptation is already heavily concentrated on water-related hazards (around 60% of documented adaptation responses are related to water)
- Water receives a significant share of public and private adaptation finance but barriers to accessing finance remain particularly significant in low-income countries
- International public adaptation finance is insufficient relative to estimated needs
- Developing countries face particularly high economic damages relative to income
- Finance is unevenly distributed geographically and across sectors
- Tracking financial flows alone does not tell us whether investments are actually reducing climate risk

The cost of action *vs*. cost of inaction

- Emission-reduction has costs but delaying this action increases future climate impacts, adaptation costs and losses and damages even more
- Adaptation requires investment but its limits mean some impacts will remain (losses and damages: may require compensation)
- Our existing adaptation options will become less effective with ongoing climate change, requiring investment in developing new options
- Losses and damages will increase as climate risks intensify, increasing demands for responses
- Without sufficient emission reduction, the net costs of climate impacts, adaptation and losses and damages will be high and unevenly distributed
- Fossil-fuel subsidies continue to support emission-intensive activities, reinforcing future climate risks and diverting investment from climate action

SEVENTH ASSESSMENT CYCLE

INTERGOVERNMENTAL PANEL ON climate change

THANK YOU

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