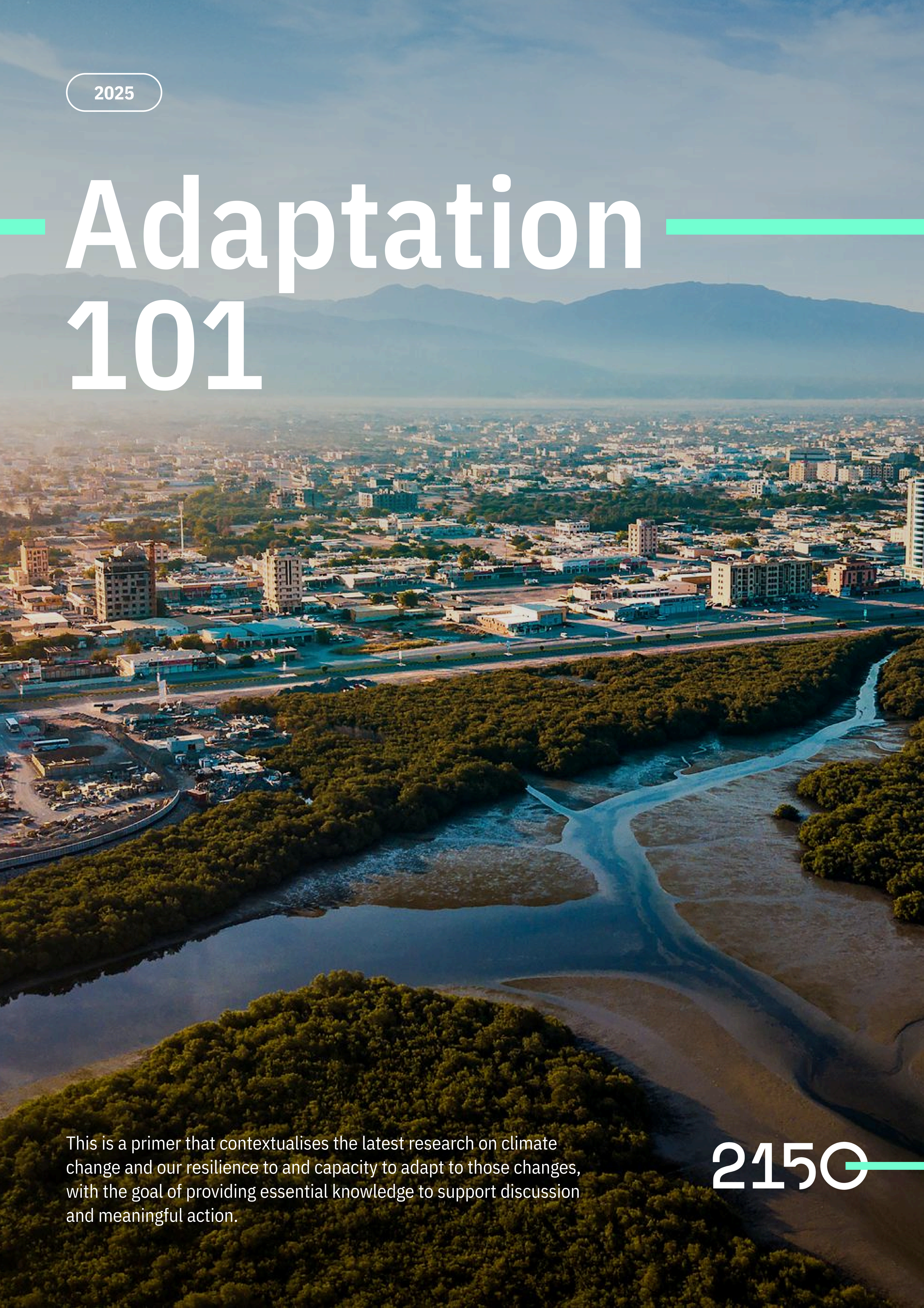


2025

Adaptation 101

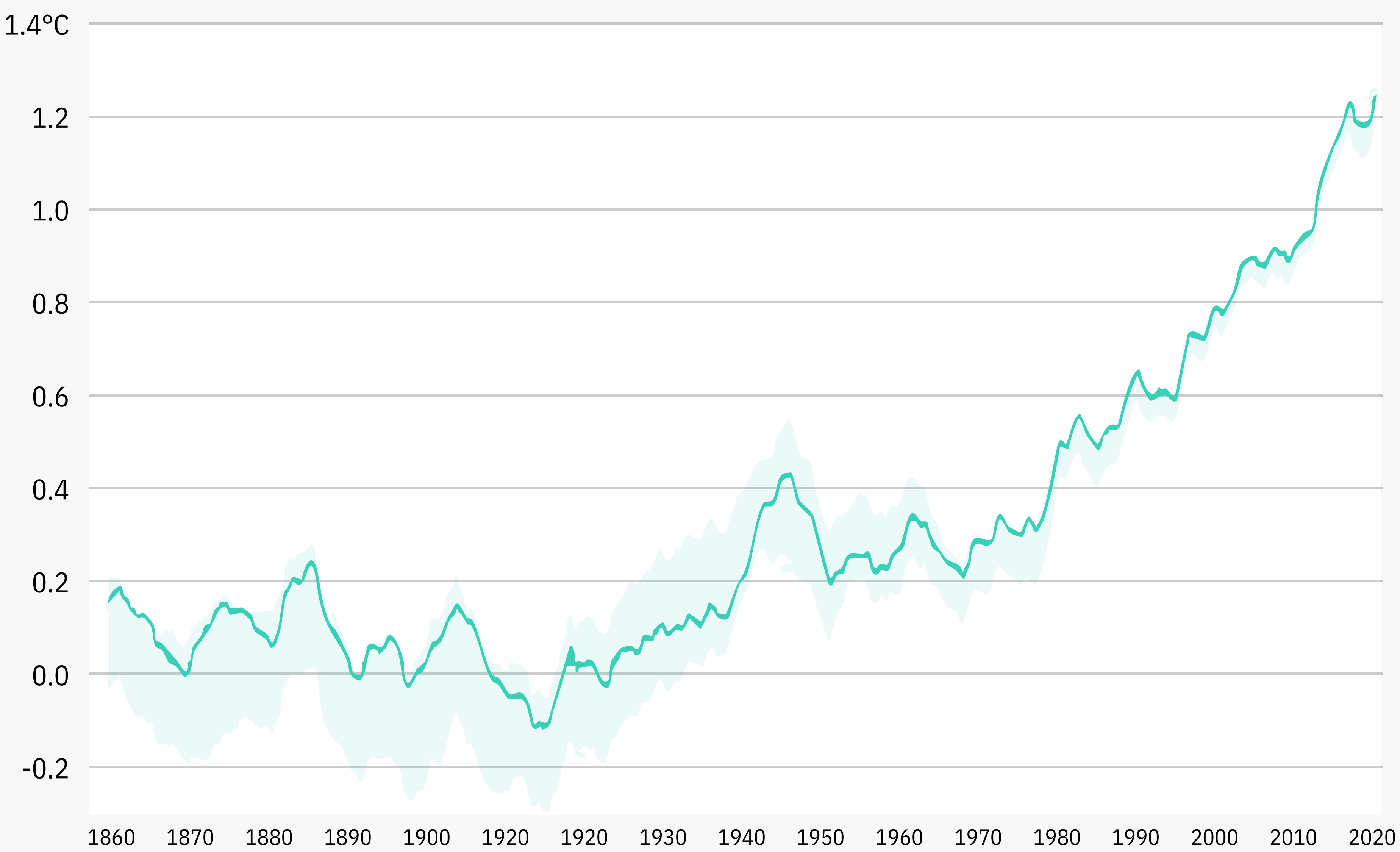
This is a primer that contextualises the latest research on climate change and our resilience to and capacity to adapt to those changes, with the goal of providing essential knowledge to support discussion and meaningful action.

2150

We are in a new climate age

Human-induced climate change is **already affecting** many climate and weather extremes in every region across the globe.

Increase in global average temperature



Source: Copernicus Climate Change Service. Dark green line represents readings from NOAA Global Temp v6 & shaded areas min–max range for the HadCRUT5 (Met Office Hadley Centre).

Record breaking warming:

+1.3°C

above the pre-industrial (1850 - 1900) average over the past five years

Source: Copernicus Climate Change Service

+1.55°C

above the pre-industrial (1850 - 1900) average in 2024

Source: World Meteorological Organization

Heatwaves

Temperature rises are increasing the frequency and intensity of heatwaves.

- Midlatitude and semi-arid regions are experiencing their hottest days at 1.5 to 2 times the rate of global warming.
- In May 2024, India potentially experienced its hottest recorded temperature when Delhi reached 52.3°C (126.1°F), prompting school closures nationwide.

Heavy Precipitation

The frequency, intensity and total volume of rainfall is increasing.

- For every 1°C rise in average temperature, the atmosphere can hold up to around 7% more moisture.
- In May 2024, the state of Rio Grande do Sul in Brazil experienced the equivalent of 3 months of rainfall in 2 weeks. In the Autumn of 2024, deadly floods hit much of central Europe and Spain.

Drought

Increased atmospheric evaporative demand and changing precipitation patterns are driving increases in intensity and/or duration of drought events in some regions.

- The drought in the Amazon rainforest in the second half of 2023 was the region's worst drought since modern records began.

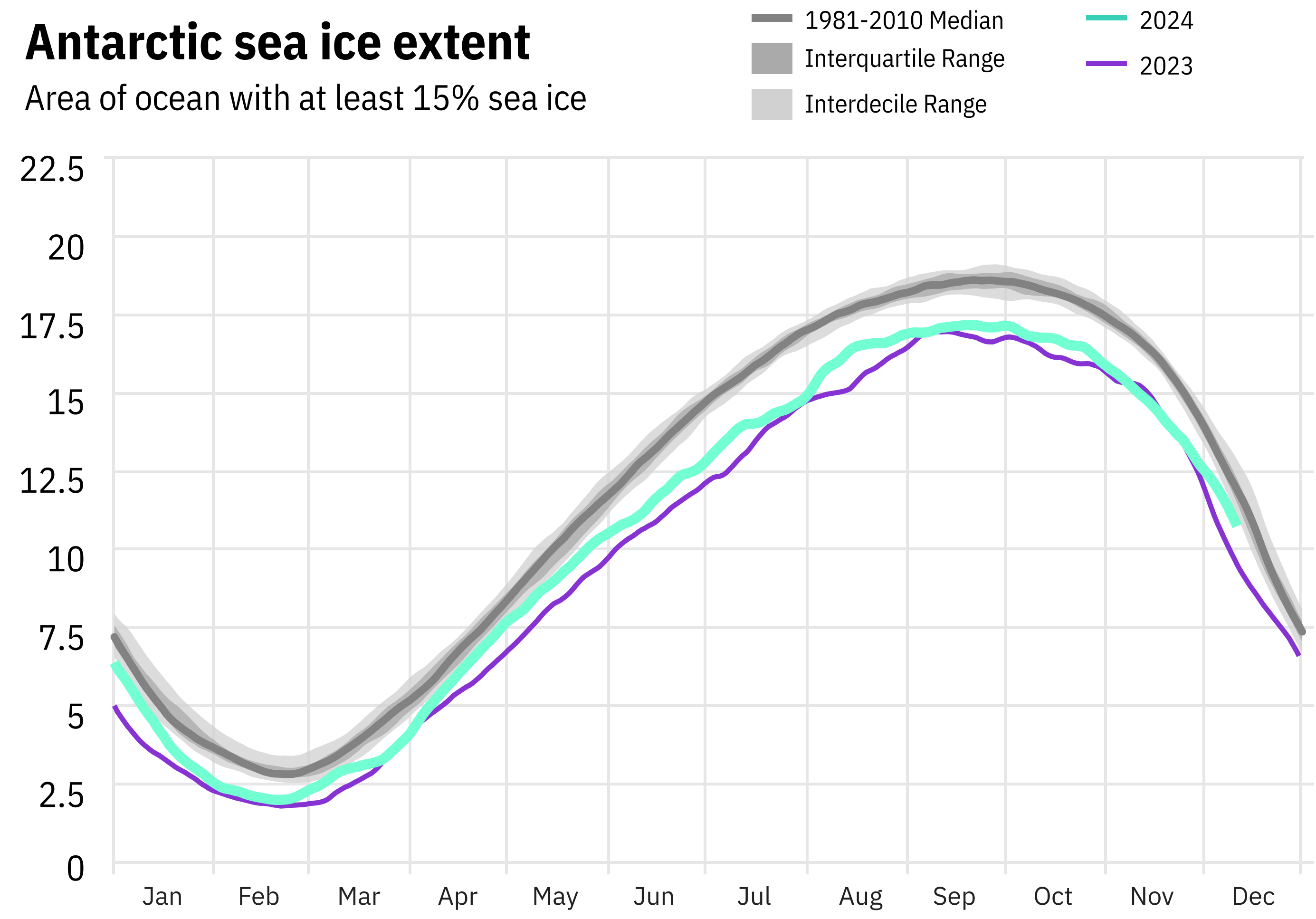
Sources: IPCC (2021). Climate Change 2021: The Physical Science Basis; IPCC (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

Reduced Polar Ice

Both Arctic and Antarctic sea ice extent has decreased, with particular acceleration in recent years. The Arctic will likely become ice free during summer before 2050.

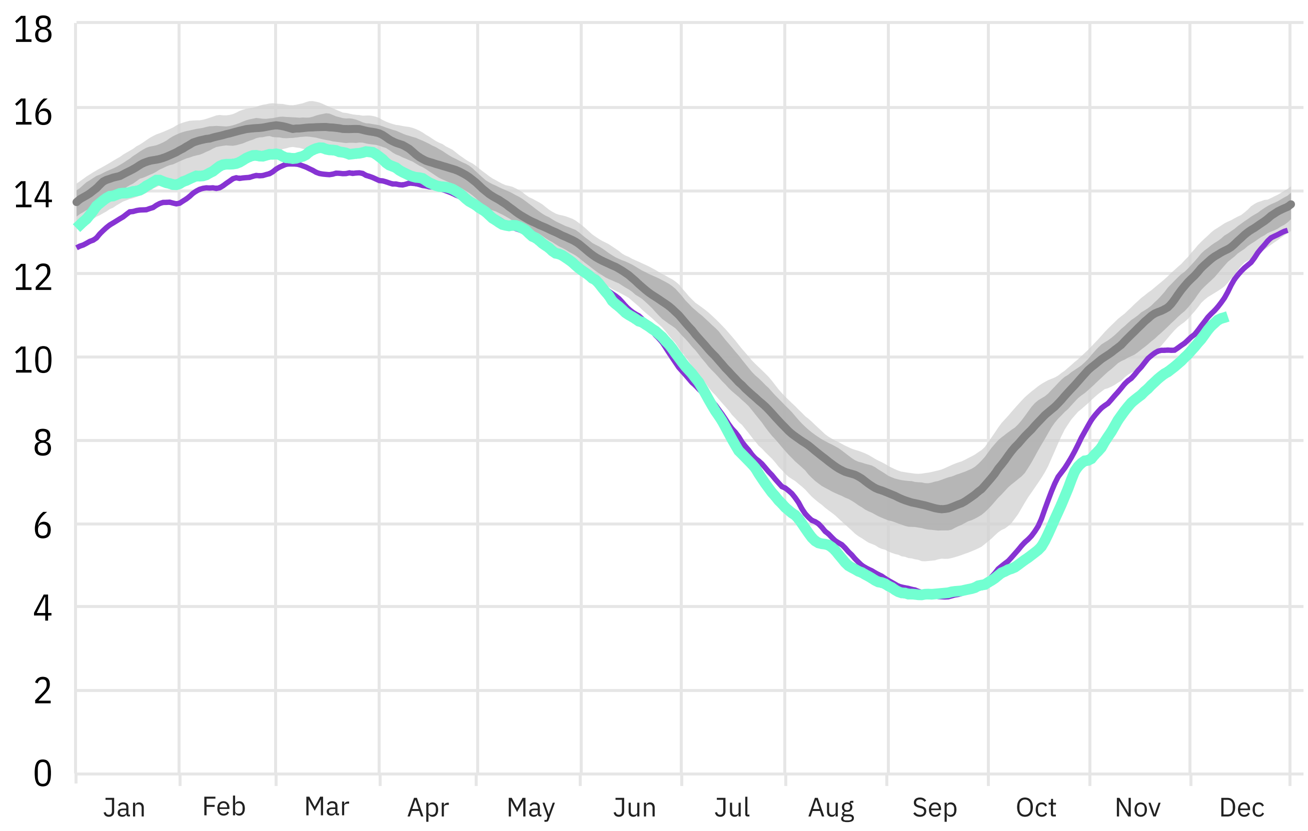
Antarctic sea ice extent

Area of ocean with at least 15% sea ice



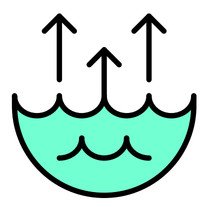
Arctic sea ice extent

Area of ocean with at least 15% sea ice



Source: National Snow and Ice Data Center

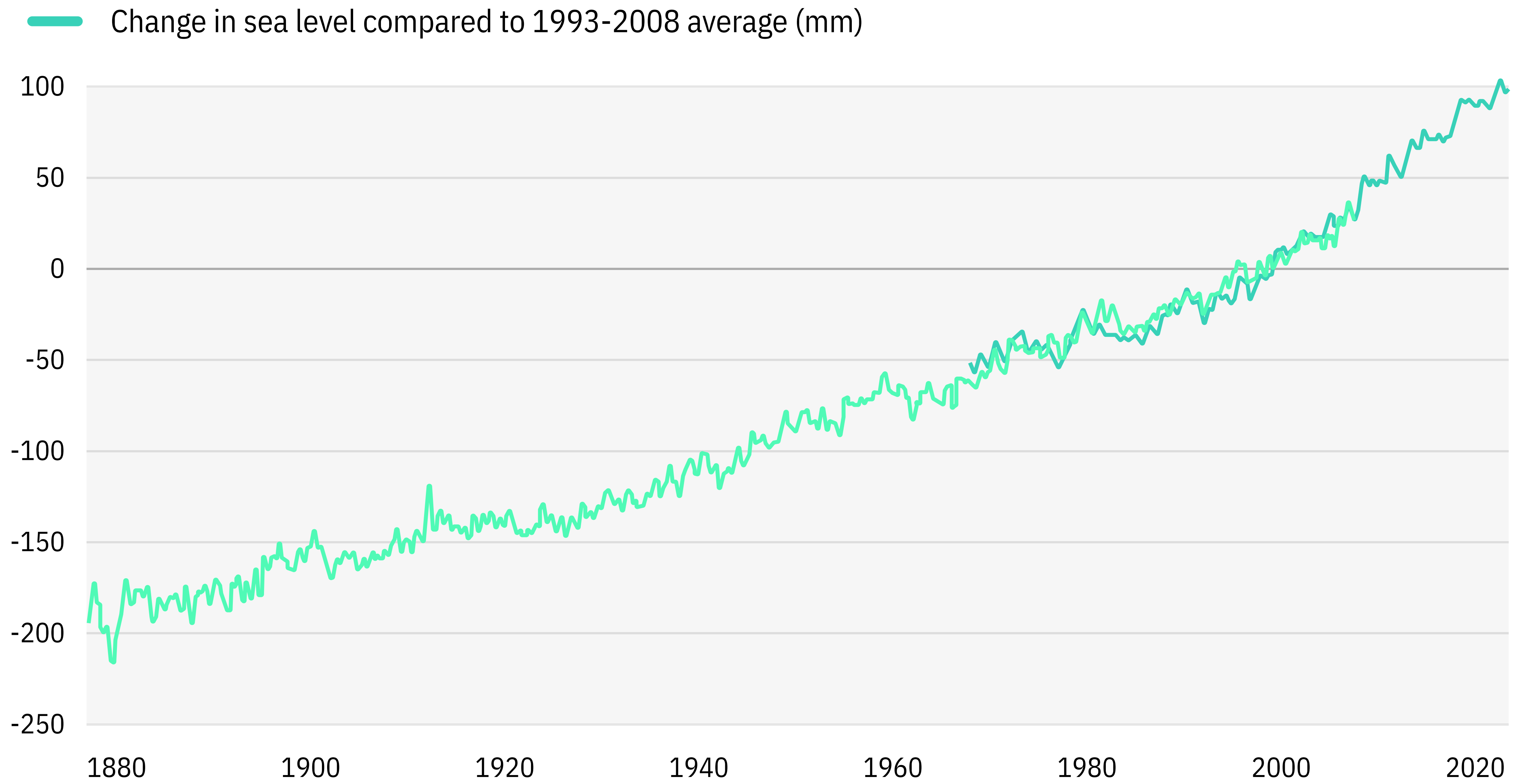
Global Sea Levels



+21-24 cm

Global sea levels have risen about 21 - 24 cm since 1880, due to a combination of melting glaciers and ice sheets and thermal expansion of seawater as it warms.

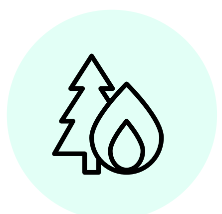
Source: NOAA (2023). Seasonal (3-month) sea level estimates from Church and White (2011) (light green) and University of Hawaii Fast Delivery (dark green).



Tropical Cyclones (hurricanes, cyclones, typhoons)

Increase in the expected wind speeds and associated precipitation of tropical cyclones / hurricanes.

- The 2024 Atlantic hurricane season saw 11 hurricanes (vs. 7 average) with 5 major hurricanes (above Cat 3), and is estimated to have caused total economic losses of $500 billion.



Wildfires

Climate change is is expected to increase fire frequency, especially where precipitation remains the same or is reduced.

- Canada faced its worst wildfire season on record in 2023, with over 18 million hectares burned. In the first nine months of 2024, over 370,000 hectares of forest were destroyed by wildfires in Europe.

Sources: IPCC (2021). Climate Change 2021: The Physical Science Basis; IPCC (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

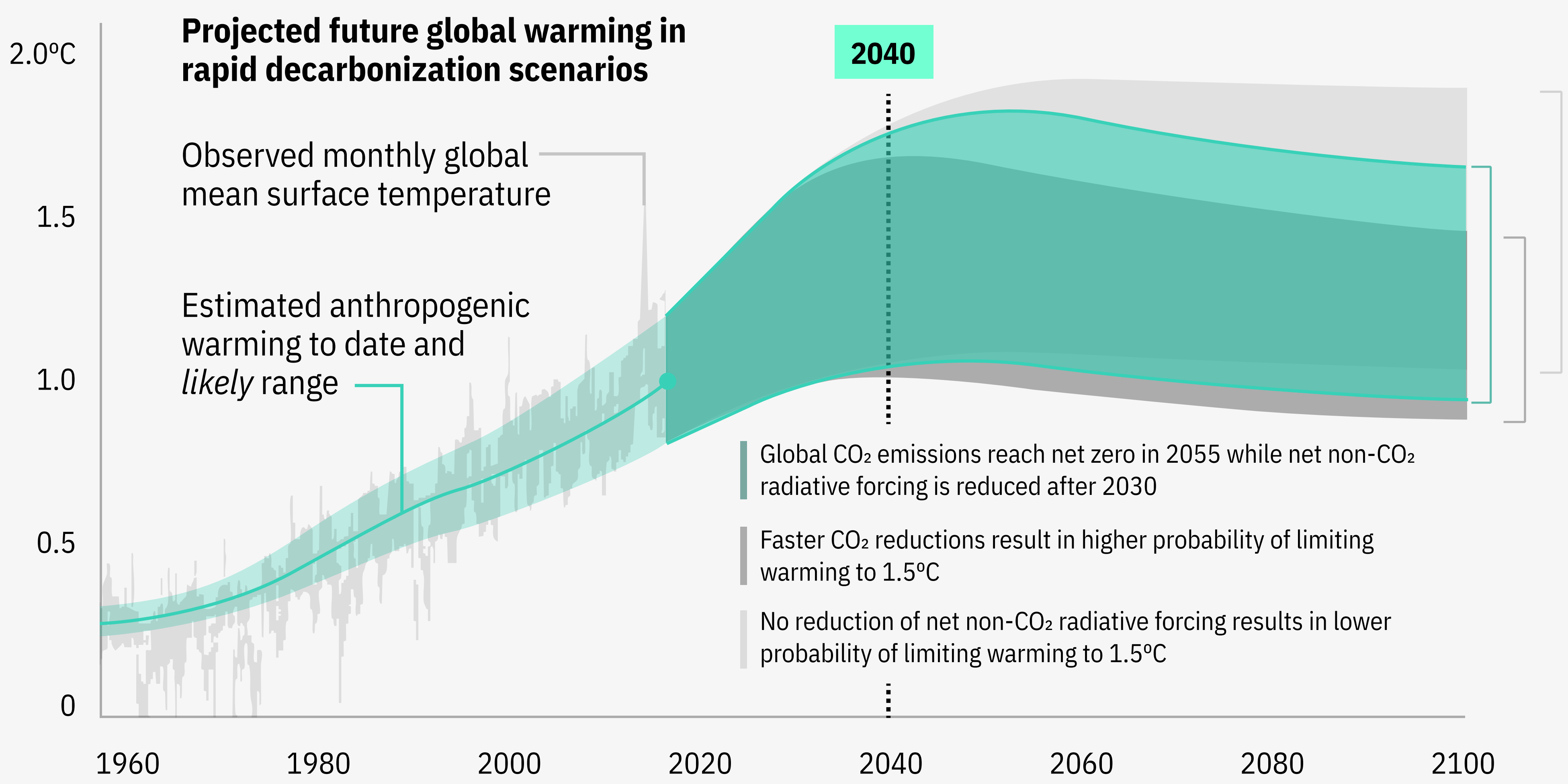
There will be further warming until emissions hit net zero

We are likely to overshoot 1.5ºC of warming by the early 2030s at the current pace of emissions. Even the most accelerated decarbonization scenarios yield global temperature rises to around 1.5ºC by mid-century.

The extent of warming we are likely to experience through 2040 is largely determined

with divergence coming from differing timelines to net zero within the century.

Source: IPCC (2018). Global Warming of 1.5ºC.



Even a 1.5ºC world carries new climate risks

These often scale non-linearly with every increment of warming

	Climate Change Impact	1.5ºC Warming	2.0ºC Warming
Heat	% of population exposed to severe heat at least once every 5 years	14%	37%
	% of population exposed to more than 20 days of deadly heat annually by 2100	48%	54%
	Number of days per year with highs above 35ºC, bias adjusted	51.5	60
	Increase in frequency of historic 1-in-10 year heat events	4.1x	5.6x
	Increase in frequency of historic 1-in-50 year heat events	8.6x	13.9x
Drought	Additional people from today living in urban areas exposed to water scarcity from severe droughts	350 million	411 million
	Increase in frequency of historic 1-in-10 year agricultural and ecological drought events	2.0x	2.4x
Flood	Global population exposed to flooding	24%	30%
	Annual flood damage losses from sea level rise	$10.2 tn	$11.7 tn
Sea-level Rise	Amount of sea level rise by 2100	0.40 meters	0.46 meters
Fire	% increased probability of extreme wildfire events	47%	89%
Tropical Cyclones	Median projected increase in proportion of tropical cyclones that reach category 4-5	10%	13%

Sources: IPCC (2018). Global Warming of 1.5ºC; IPCC (2021). Climate Change 2021: The Physical Science Basis; IPCC (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

We need to prepare for the impacts of climate change

We will experience further effects of climate change as emissions continue. To prepare, we will need to adapt to new conditions while becoming more resilient to the harms they could cause.

Climate Adaptation: Adaptation refers to adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects. It refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change.

Climate Resilience: Climate resilience is the ability to anticipate, prepare for and respond to hazardous events, trends or disturbances related to climate. Improving climate resilience involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks.

Noting that changes in our climate take many forms

The effects of climate change will not be evenly distributed, and will manifest in new climate conditions across the globe. These major categories of changes are called:

Climate Hazards

A climate hazard is a climate condition with the potential to harm natural systems or society. Examples include heatwaves, droughts, heavy precipitation events and sea level rise.

The risks stemming from these hazardous conditions are defined as "physical climate risks". Hazards and physical climate risks can be categorized by duration and what form they take.

Acute

Risks that are event-driven, including increased severity of extreme weather events, such as cyclones, hurricanes, heat or cold waves or floods.

Chronic

Longer-term shifts in climate patterns, including sustained higher temperatures, sea level rise, changing precipitation patterns that may cause sea level rise or chronic heat waves.

Climate hazards can be further categorized into the natural systems they will affect

Hazard	Temperature Related	Wind Related	Water Related	Solid Mass Related
Acute	Heat wave	Extreme wind events (hurricane)	Drought	Landslide
	Wildfire	Storms	Flood	Extreme mass movement
	Cold wave/frost		Extreme precipitation events	
Chronic	Heat stress	Changing wind patterns	Water stress	Coastal erosion
	Permafrost thawing		Sea-level rise	Soil erosion
	Surface temperature change		Changing precipitation patterns	Soil degradation
	Water temperature change (fresh & marine)		Ocean acidification	
	Temperature variability			

Sources: EBRD TCFD Guidelines; EU Commission Delegated Regulation 2021/2139

We can limit some risks stemming from climate change

The impacts we and our environment will feel from climate change can be mitigated by addressing the factors that would exacerbate their harms. These factors are:

Exposure

The presence of people and species, natural systems and economic or social assets in places and settings that could be adversely affected by climate change.

Example: urban exposure to the heat island effect

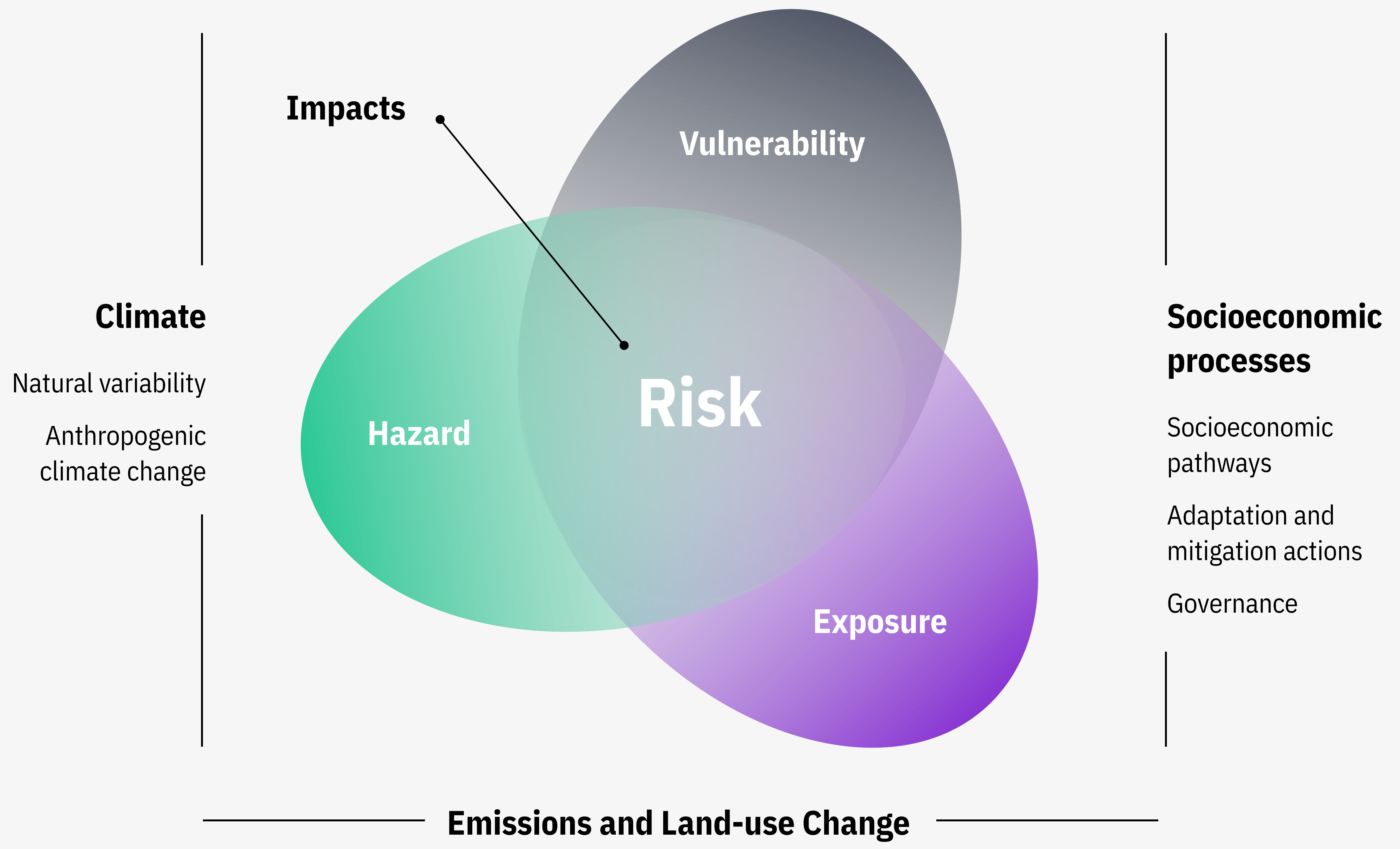
Vulnerability

The propensity or predisposition to be adversely affected by climate change including sensitivity or susceptibility to harm and lack of capacity to cope and adapt

Example: populations lacking access to cooling due to affordability

Climate Risks are the resulting matrix of interactions between climate hazards, exposure and vulnerability of the affected human or natural system. Adaptation is the result of limiting the damages from climate risks through dedicated responses in the face of a changing climate.

Climate Risk Matrix



Along with physical climate risks, another category called "transition climate risks" consider risks stemming from the transition to a low carbon economy and away from fossil fuels. This report focuses on physical risks. More information on transition risks is available through the TCFD's recommendations.

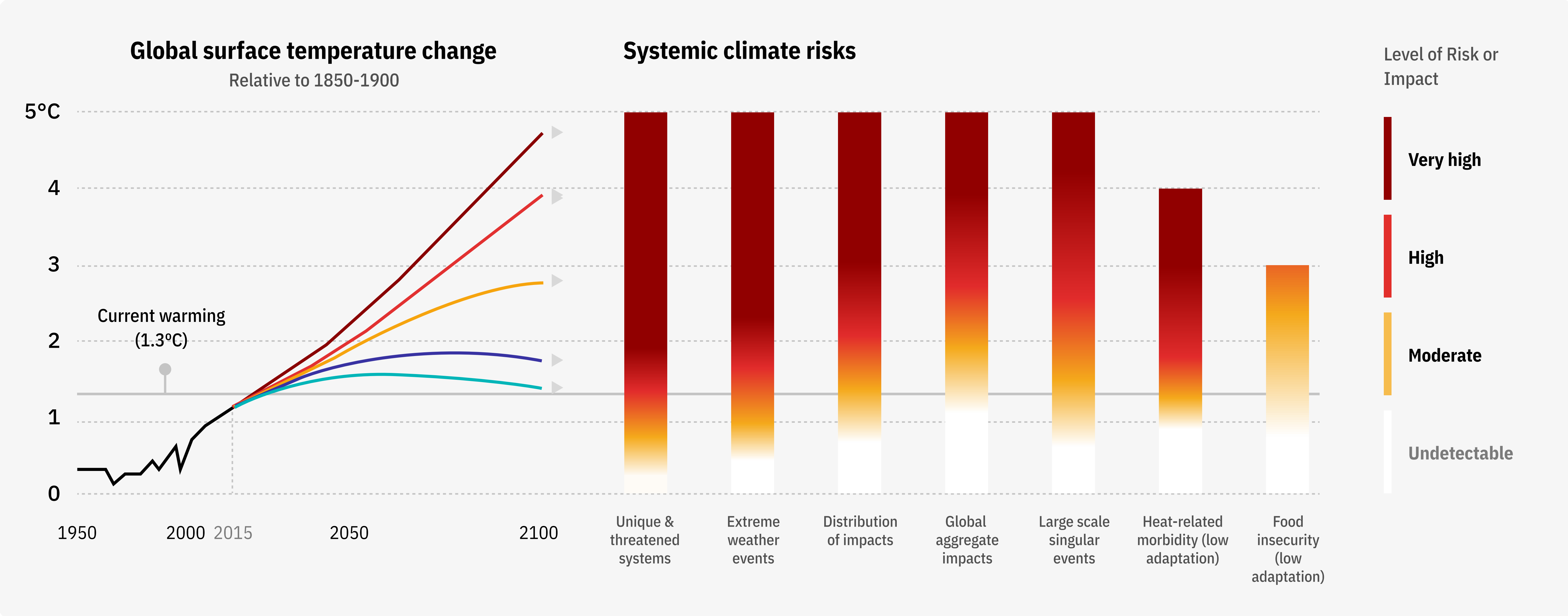
Source: IPCC. (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

Risk are increasing with every increment of warming

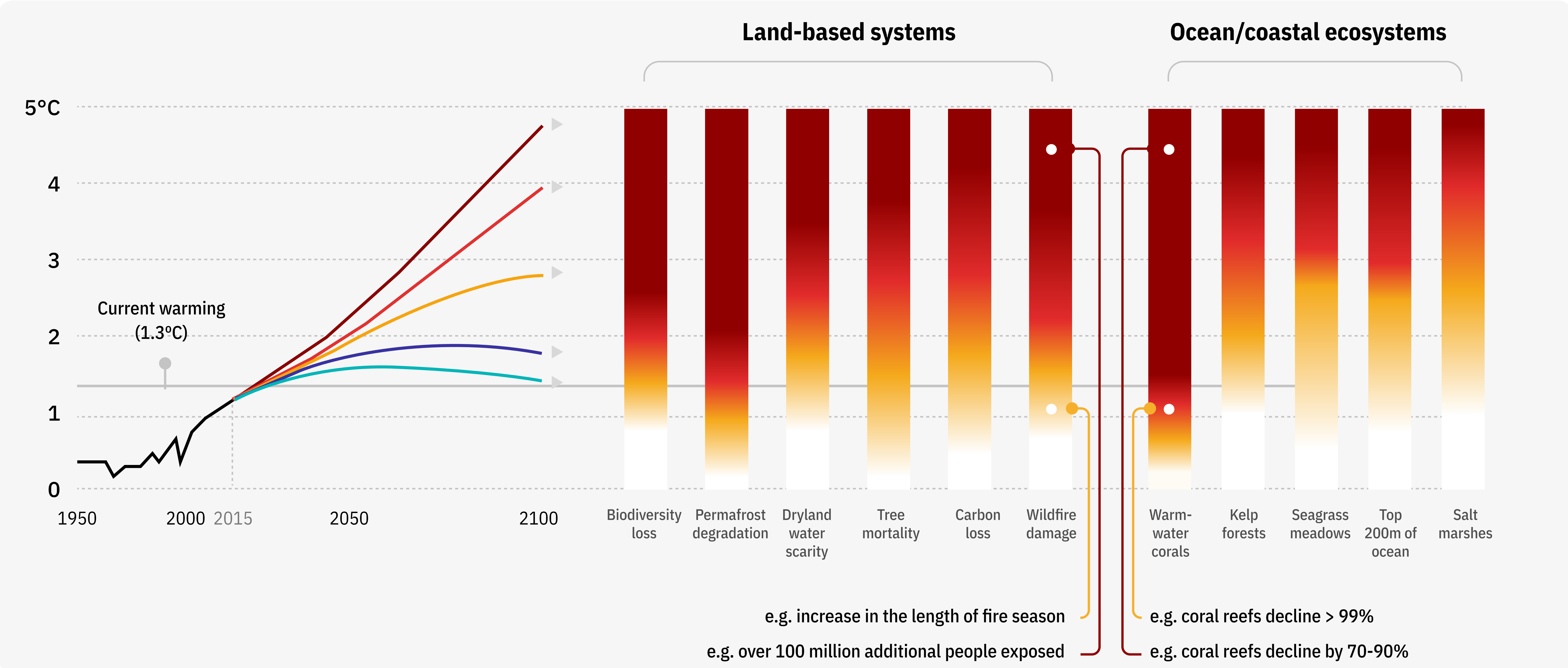
Climate change scenarios

- **Very Low** — **SSP1-1.9 -** Paris Agreement alignment - Global emissions cut to meet net-zero by 2050, with negative emissions after. Warming peaks at 1.5°C in mid-century.
- **Low** — **SPP1-2.6 -** Sustainable pathway - Net-zero after 2050, with negative net emission increasing to 2100. Temperatures stabilize at 1.8°C by 2100.
- **Intermediate** — **SSP2-4.5 -** Middle-of-the-road - Emissions stay constant to 2050, but do not reach net-zero by 2100. Warming reaches 2.7°C by 2100.
- **High** — **SSP3-7.0 -** Regional rivalry - Global emissions steadily rise through the century, doubling by 2050, with warming reaching 3.6°C by 2100.
- **Very High** — **SSP5-8.5 -** Fossil fuel rich development - Global emissions double by 2050, and warming reaches 4.4°C by 2100.

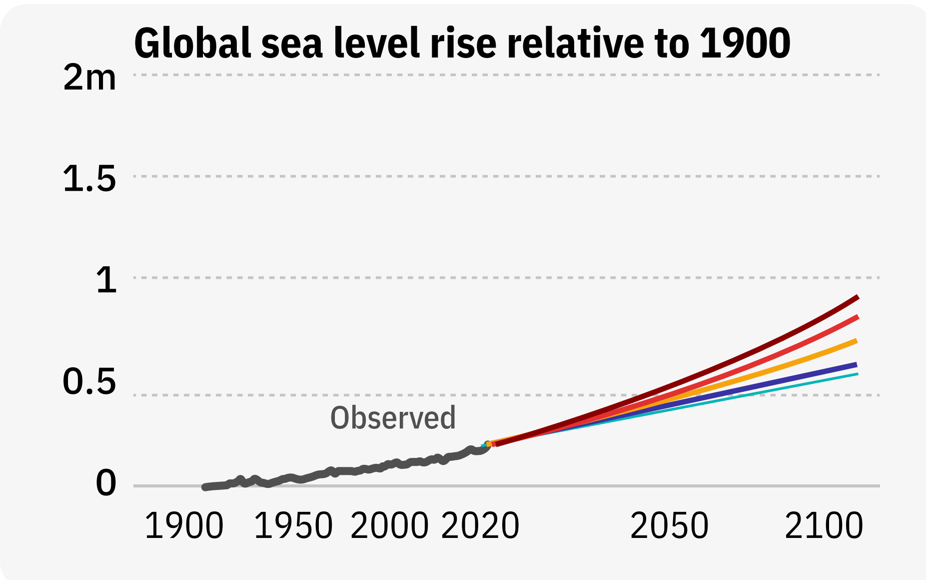
High risks are now assessed to occur at lower global warming levels

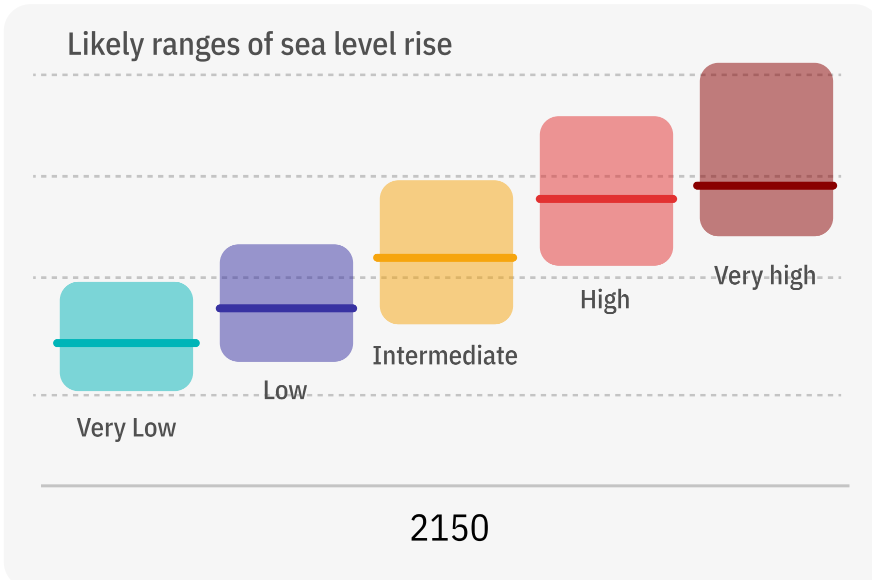


Risks differ by system



Sea level rise will continue for millenia, but how fast and how much **depends on future emissions**



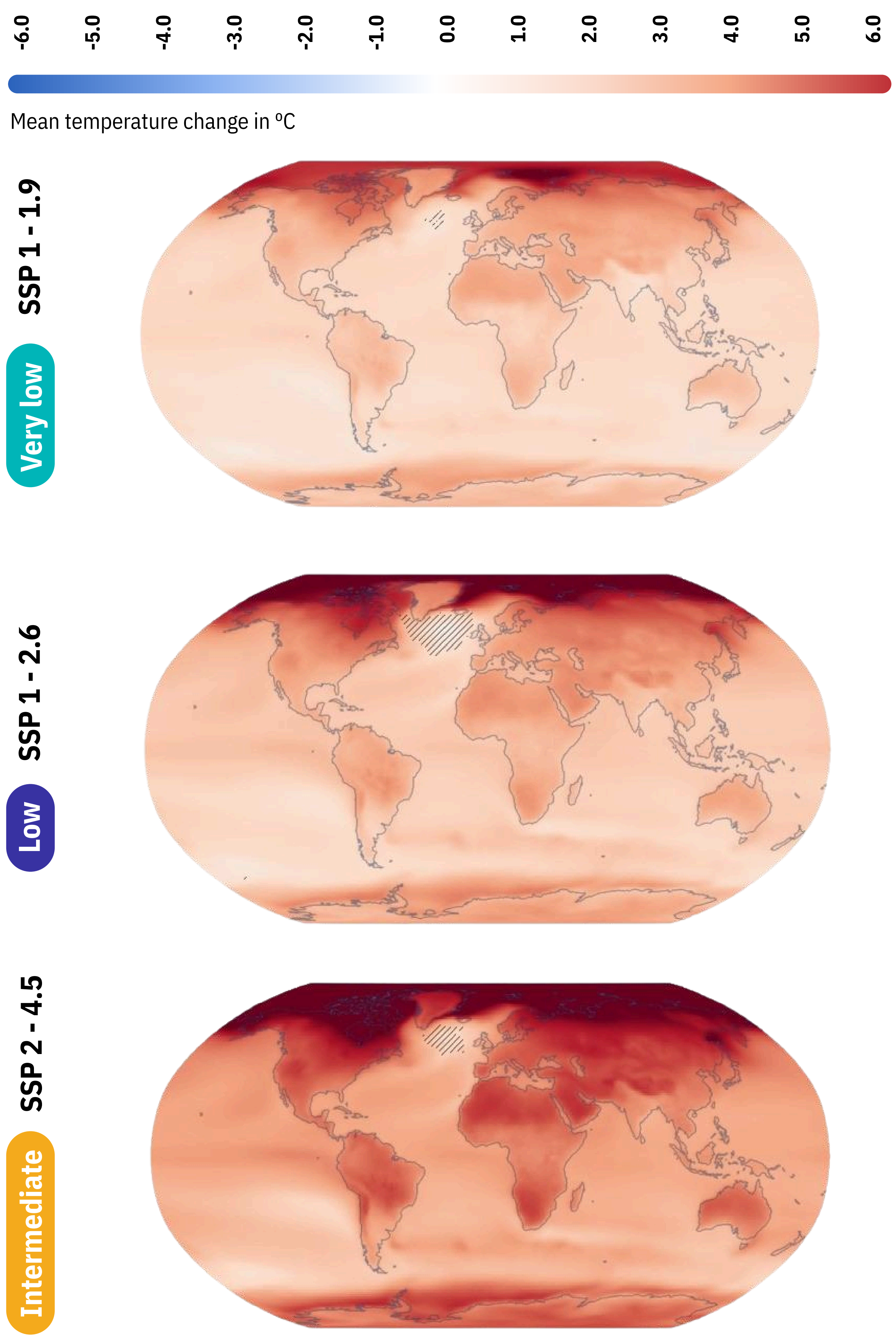


Sources: IPCC (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation; IPCC (2023). Climate Change 2023: Synthesis Report

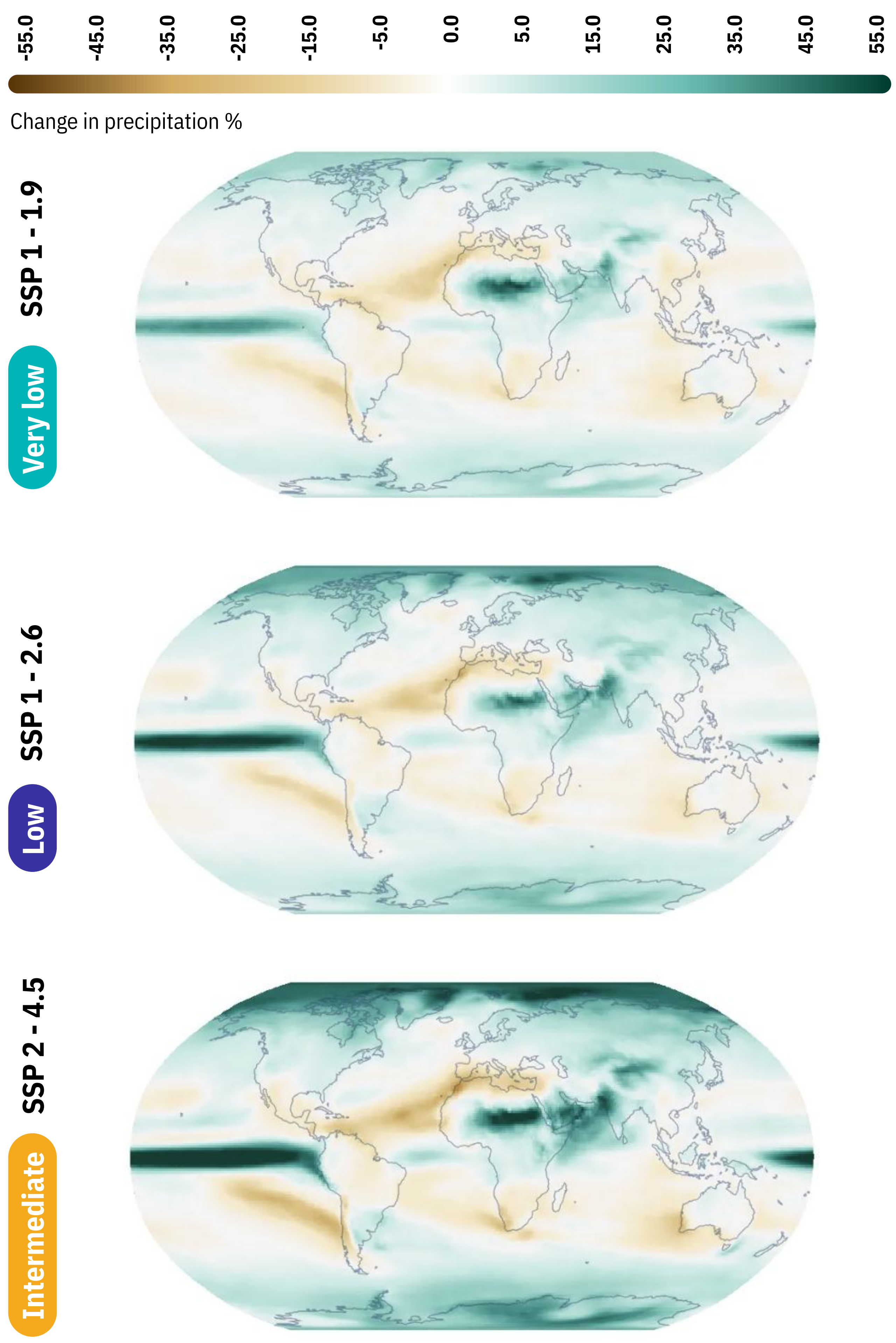
The impacts of climate change are not evenly distributed

Every part of the globe will experience climate change differently. A harsh reality is that those areas projected to bear the worst impacts from climate change have often contributed the least to historic greenhouse gas emissions. The extent to which populations can adapt to climate change will be similarly unequal.

Increased temperature to 2100



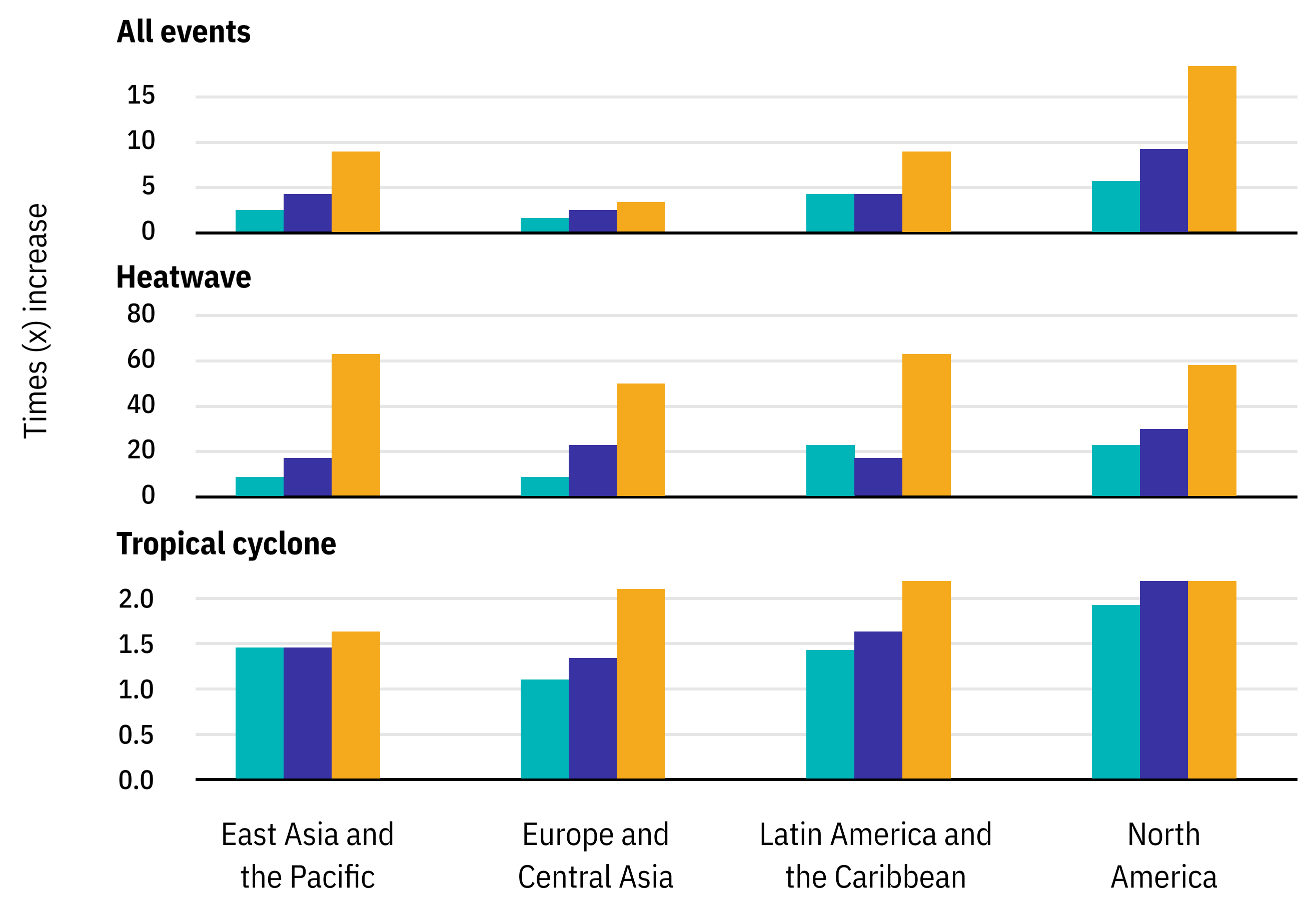
Changes in precipitation to 2100

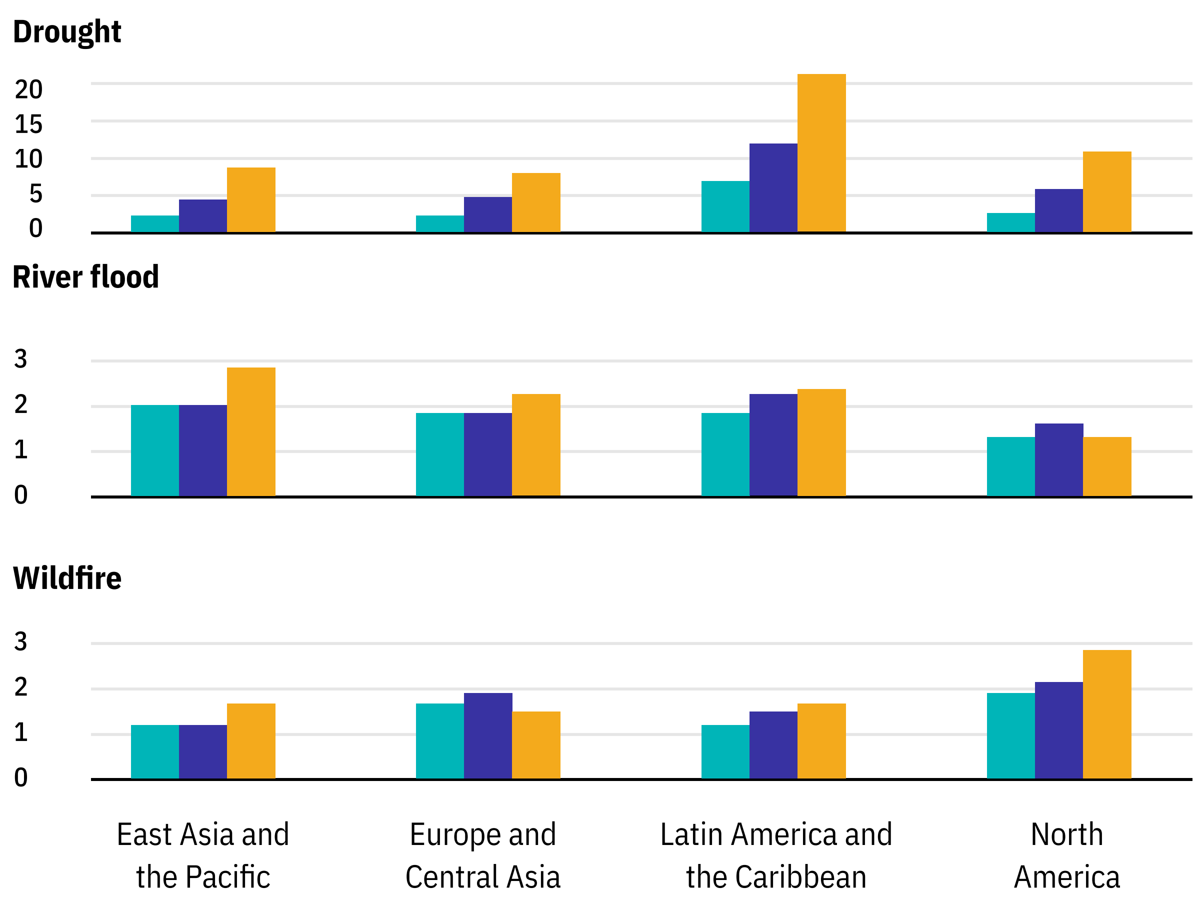


Source: IPCC WGI Interactive Atlas: Regional information

Change in population exposed to extreme weather

C° Warming 1.5°C 2°C 3°C





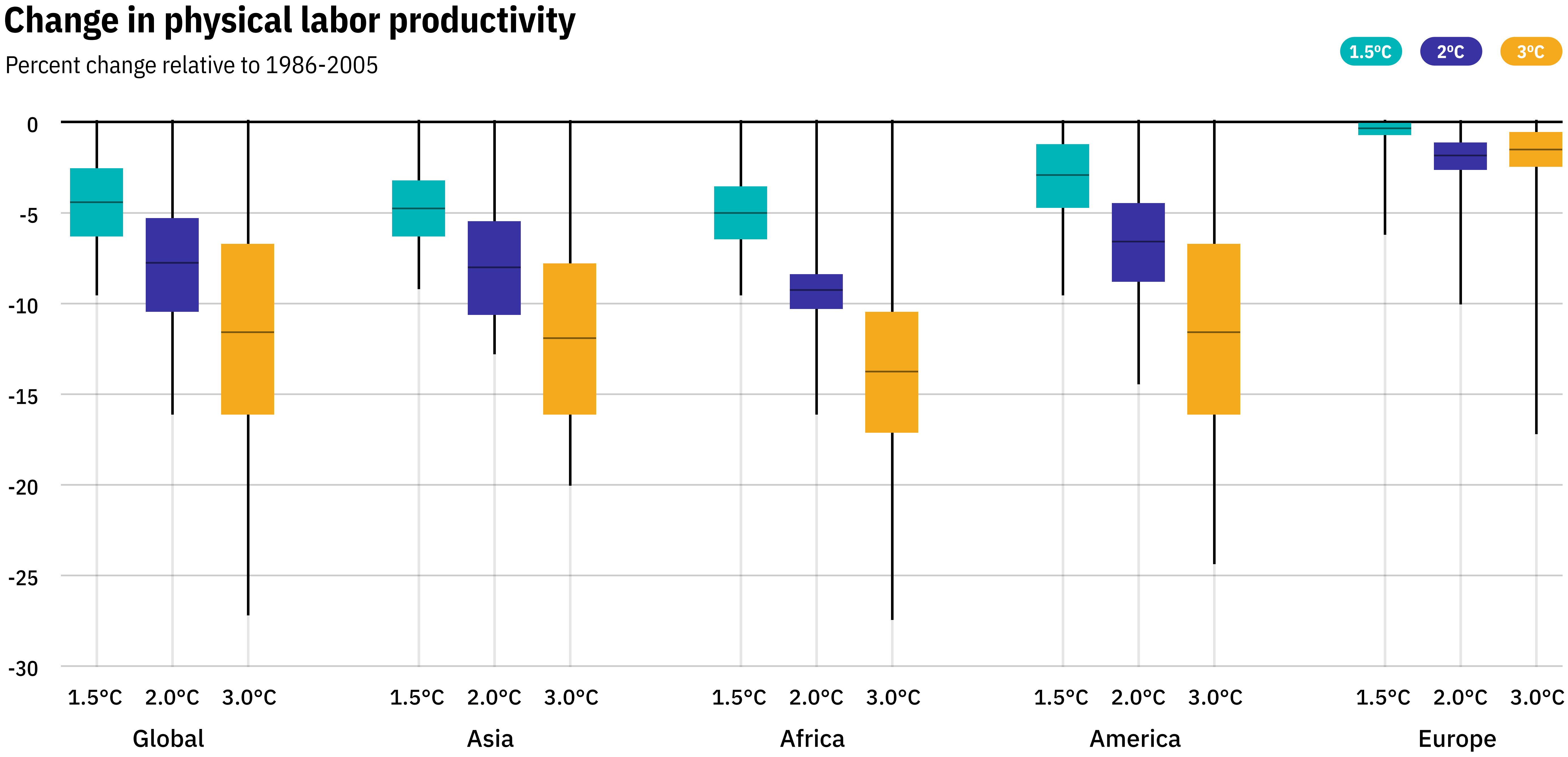
Source: NGFS (2021)

Increased temperatures and humidity will reduce capacity to work outdoors

Climate change will negatively affect agricultural and other manual labor, where conditions become unsuitable for workers thereby reducing potential outputs. As the level of thermal comfort decreases, it can become more difficult to perform physical and cognitive tasks causing labor productivity to decline.

Change in physical labor productivity

Percent change relative to 1986-2005



Source: NGFS (2021)

In scenarios of greater warming, industries with high levels of outdoor labor will need to adapt to extreme temperatures by changing working practices, or risk losing productive capacity. Under the current warming trajectory, projections estimate a loss of 2.2 - 3.8% in total working hours worldwide by 2030. This is a productivity loss of 80 million to 136 million full-time jobs and economic losses around $2,400 billion in 2030.

Source: ILO (2019)

2.2 - 3.8% **Loss in total global working hours in 2030**

$2,400b **Economic losses from reduced labor in 2030**

There is a gap in urban adaptation

Our adaptative capacities to climate change are unequal. There is a large variation across regions and populations, often driven by levels of income where the poorest are most adversely affected. This gap in adaptation will be particular visible in cities.

Adaptative capacity of urban populations across regions

Source: IPCC (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

Cities and urban populations are on the front lines of climate change

>50%

Over half the global population already lives in cities — a figure set to rise to 68% by 2050.

75%

Cities consume 75% of global energy and house much of the world's key infrastructure.

80%

Cities generate more than 80% of global GDP.

Cities magnify the impacts of climate hazards

Extreme urban heat: Many of the worlds largest cities will be exposed to deadly temperature and humidity levels at 2°C warming. The urban heat island effect can increase surface temperatures in urban areas by as much as 10–15°C compared to surrounding regions.

Urban flooding: Cities are often built on flood-prone areas, both riverine and coastal. More than 90% of urban areas are coastal and >1 billion people located in low-lying cities are expected to be at risk from coastal-specific climate hazards by 2050. Urban flood risk is also magnified by expansion of impermeable surfaces that impact the drainage of flood waters.

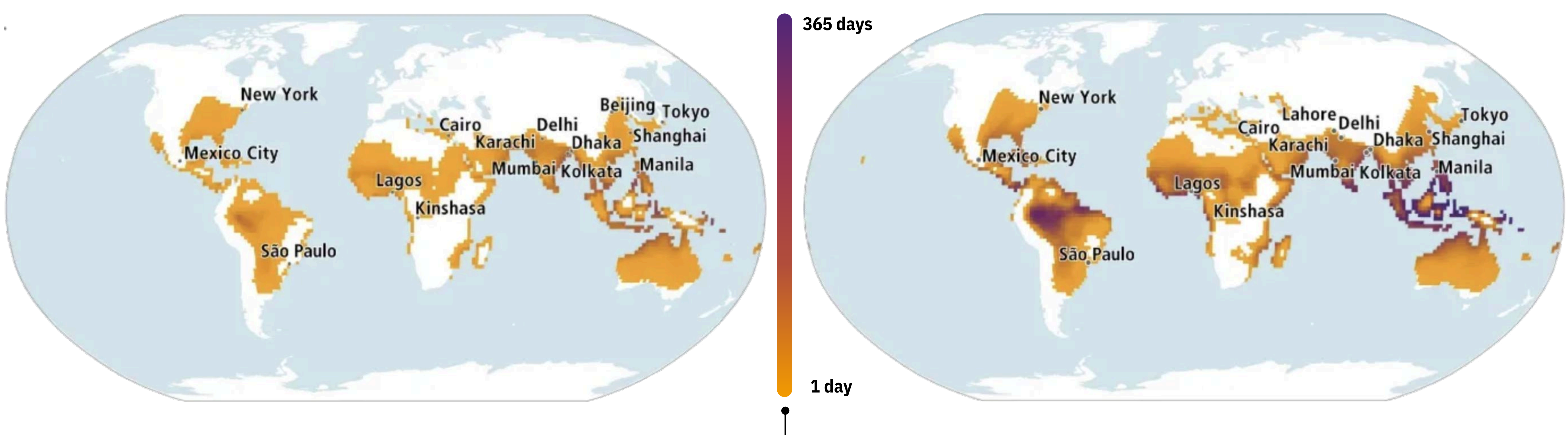
Urban drought: One in four of the world's largest cities are in water stress and source their water from up to 500 km away. At just 2°C warming, an additional >400 million urban residents than today are estimated to be exposed to water scarcity from severe droughts.

Global distribution of population exposed to potentially deadly conditions from extreme heat and relative humidity

SSP - 2-4.5 Intermediate

Historical (1991 - 2005)

Mid-Century (2041 - 2060)



Days per year when air temperature and humidity conditions pose a risk of death

Source: IPCC. (2022). Climate Change 2022: Impacts, Vulnerability, and Adaptation

Cities & sea level rise

Coastal flooding from sea level rise will affect major populations centres, with South and Southeast Asia most severely affected where 9 out of the top 10 cities most exposed to coastal flooding in 2070 are located. Just those nine will see 76 million people exposed to sea level rise hazards.

Source: EEA (2007)

Crossing tipping points will mean we have to adapt to a new normal

The impacts of climate change are not a continuum. Certain levels of warming will push Earth systems beyond critical thresholds forcing them to reorganise, often abruptly or irreversibly. These are called “tipping points”.

Once crossed, we cannot get back to the previous condition within human lifetimes. Adapting to the new normals becomes the only option.

Our current warming trajectory has Earth crossing 7 tipping points within the next 20 to 30 years.

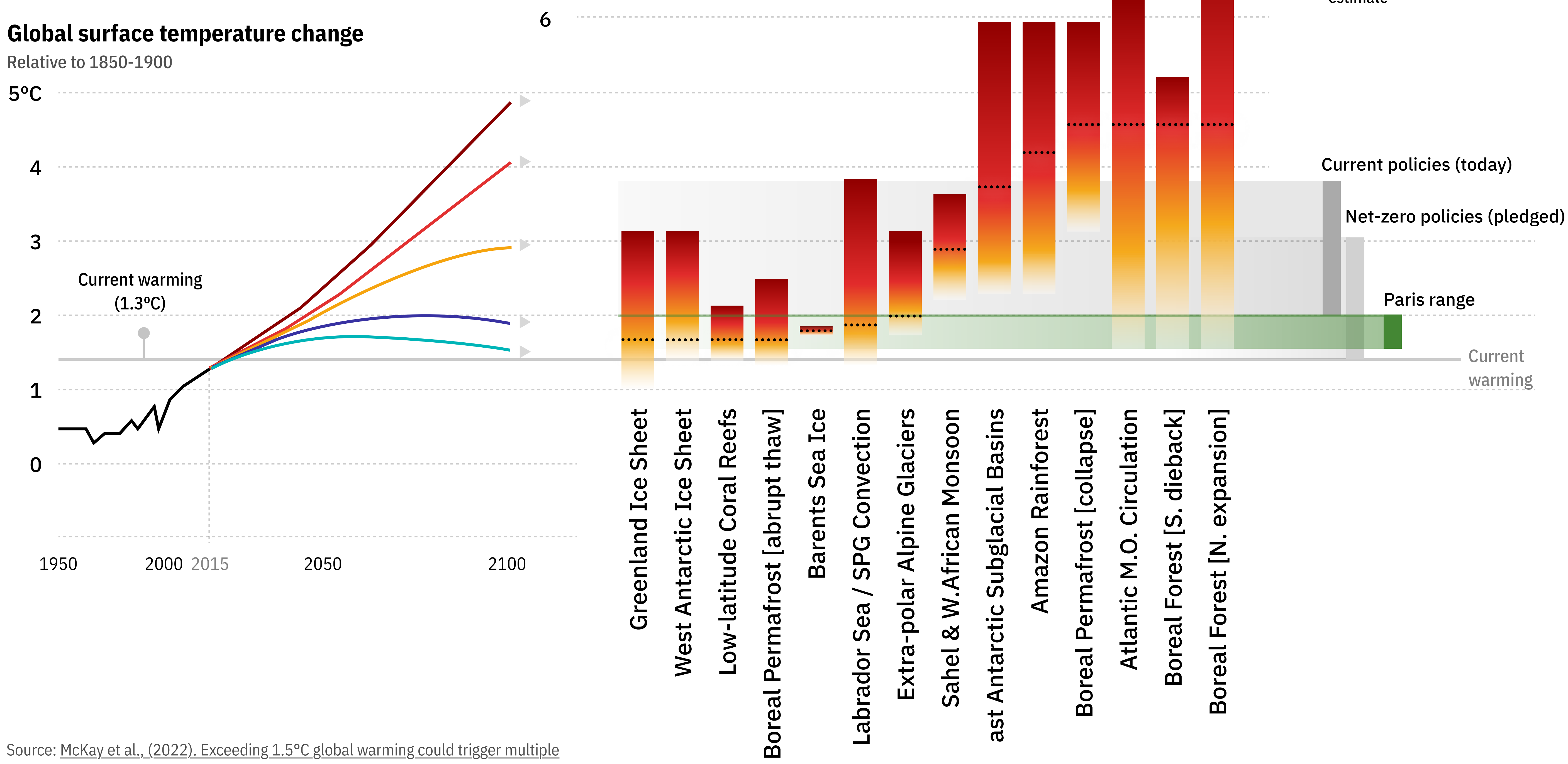
At +1.5ºC warming

- **Greenland Ice Sheet** - self-propelling melt creating a pathway to collapse
- **West Antarctic Ice Sheet** - self-sustaining retreat of parts of the ice sheet as sea water permanently spills beyond the grounding line
- **Low-latitude Coral Reefs** - irreversible loss of algae and coral above certain water temperatures
- **Boreal Permafrost [abrupt thaw]** - rapid thawing of permafrost in the Boreal region releasing stored GHGs

From +1.5ºC - 2.0ºC

- **Barents Sea Ice** - abrupt loss of winter ice affecting atmospheric circulation and European climate
- **Sub-Polar Gyre Convection** - breakdown of south flow of cool northwest Atlantic water affecting weather and sea levels in eastern North America and Europe.
- **Extra-polar Alpine Glaciers** - melt and irreversible loss of glaciers outside of polar regions

Likelihood of crossing various tipping points at different warming levels

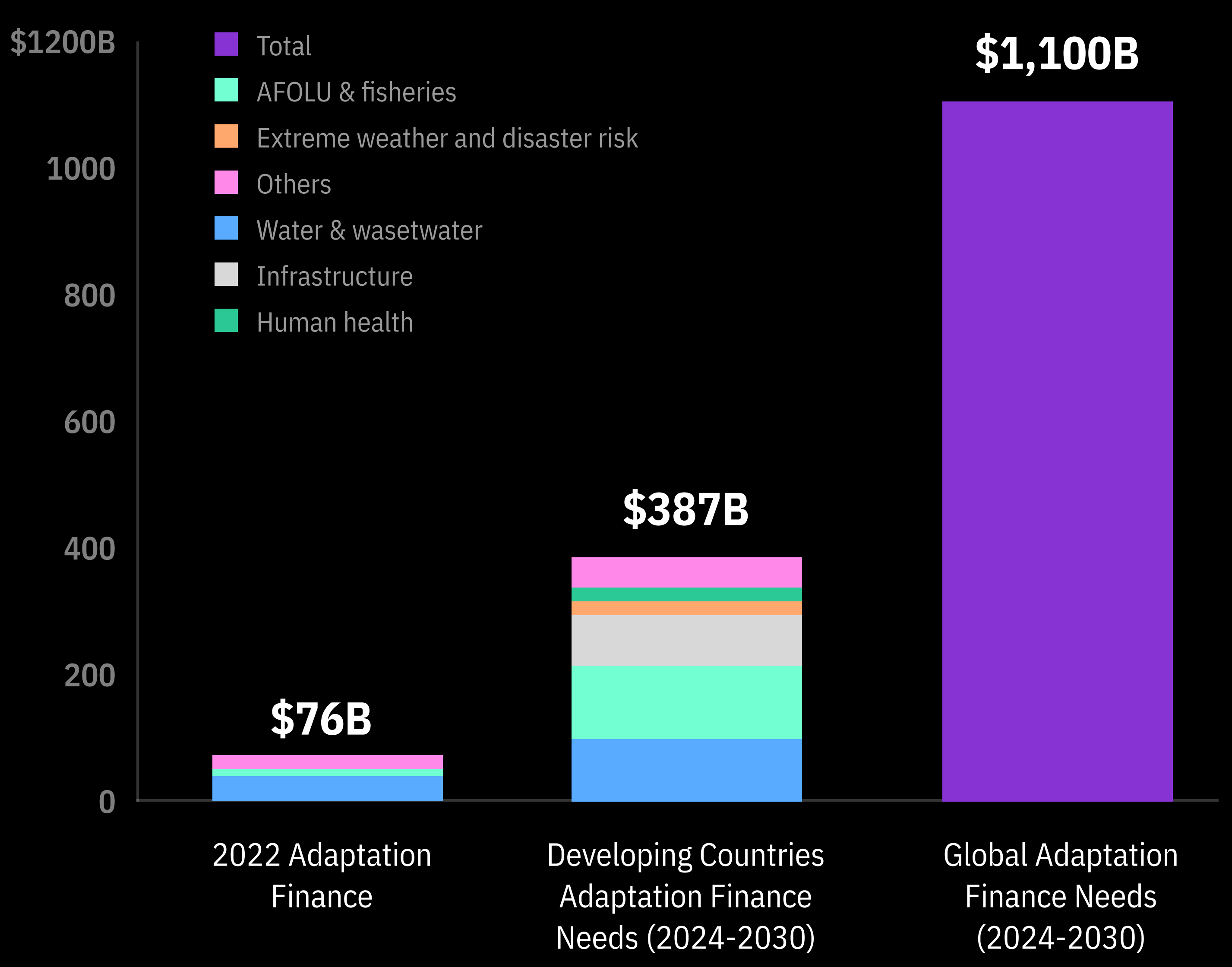


Source: McKay et al., (2022). Exceeding 1.5°C global warming could trigger multiple climate tipping points, Science.

The adaptation funding gap

We have a chance to invest in our adaptation today

Current adaptation finance flows are well below global needs. Rapid collective action is needed to bridge the adaptation funding gap.



$76B

2022 adaptation finance — Just 5% of the total $1.46 trillion in global climate finance in 2022*.

Source: CPI (2024) *Information on climate adaptation finance from public domestic budgets and the private sector remains opaque

$387B

Annual adaptation financing needs (NDCs, NAPs) in developing countries up to 2030.

Source: UNEP (2024)

$1,100B

Global adaptation financing needs per year between 2021–2030 according to Nationally Determined Contributions*.

Source: CPI (2024) *Could be much higher given only 60 / 160 countries NDCS have estimated finance needs for adaptation.

Inaction costs more than immediate action

Adaptation solutions can reduce the escalating climate-related losses associated with higher levels of warming.

	1.5°C scenario	3°C scenario
Total annual direct losses to GDP due to climate-related risks and impacts 2025-2100	$14T	$31T
Global GDP loss (in %) from chronic physical risks* by 2050	7.5%	15%
Global GDP loss (in %) from acute physical risks* by 2050	4%	8%

Sources: CPI (2024); NGFS (2024)

4:1 benefit-cost ratio

Investing $1.8 trillion globally from 2020 to 2030 across 5 key adaptation solutions* could yield **$7.1 trillion in net benefits**.

Source: GCA (2019) *The five areas considered for this estimate are early warning systems, climate-resilient infrastructure, improved dryland agriculture crop production, global mangrove protection, and investments in making water resources more resilient.

What are the solutions to adapt and build resilience?

Addressing climate risks and building resilience will require an all-the-above approach. We will need to integrate adaptation considerations and solutions into our infrastructure, ecosystem management and wider economy. The following is a high-level overview of the major levers in biomes, human health and monitoring systems that can drive adaptation to climate change.

These solutions need to be coupled with efforts to mitigate emissions to net zero. These levers are detailed in 2150's Climate 101 report.

Adaptation Solutions

Cities & Infrastructure

- Early warning systems, resilient urban planning, climate risk assessments and climate insurance provision
- Sustainable water management and monitoring systems
- Sustainable cooling systems including passive cooling and efficient space cooling
- Resilient and intelligent energy infrastructure, buildings and transport systems
- Urban nature-based solutions including green and blue spaces
- Grey infrastructure including flood and stormwater management and coastal protection

Agriculture & Food Security

- Climate-resilient farming measures
- Climate-resilient crops and climate-resilient livestock management
- Agricultural water and soil management
- Agricultural environment monitoring
- Agriculture and livestock disease management
- Agriculture and livestock residue and waste management
- Resilient post-harvest processing and distribution

Water

- Wastewater treatment and recycling
- Water efficiency and demand management
- Water supply system and storage
- Maintaining of sustainable water supply
- Monitoring and early warning systems for water resources
- Integrated land and water resource management
- Water-related disaster risk management including riverine and coastal flood protection

Sources: UPEPCCC (2021)

Forestry & Land

- Climate-resilient forest resources production
- Forest disaster risk management
- Forest carbon sink and other ecosystem service management
- Forestry and land ecosystem restoration
- Forest and land ecosystem change detection and prediction

Marines, Fisheries & Coastal Zones

- Coastal zone risk retention using soft structures like beaches, coral reefs, dunes and wetlands
- Coastal zone risk retention using hard structures like seawalls, breakwaters, groynes and revetments
- Early warning systems, risk management and disaster prevention
- Coastal environment monitoring and risk assessment/ prediction
- Disease management of marine resources
- Marine ecosystem service management
- Production of marine resources and aquaculture

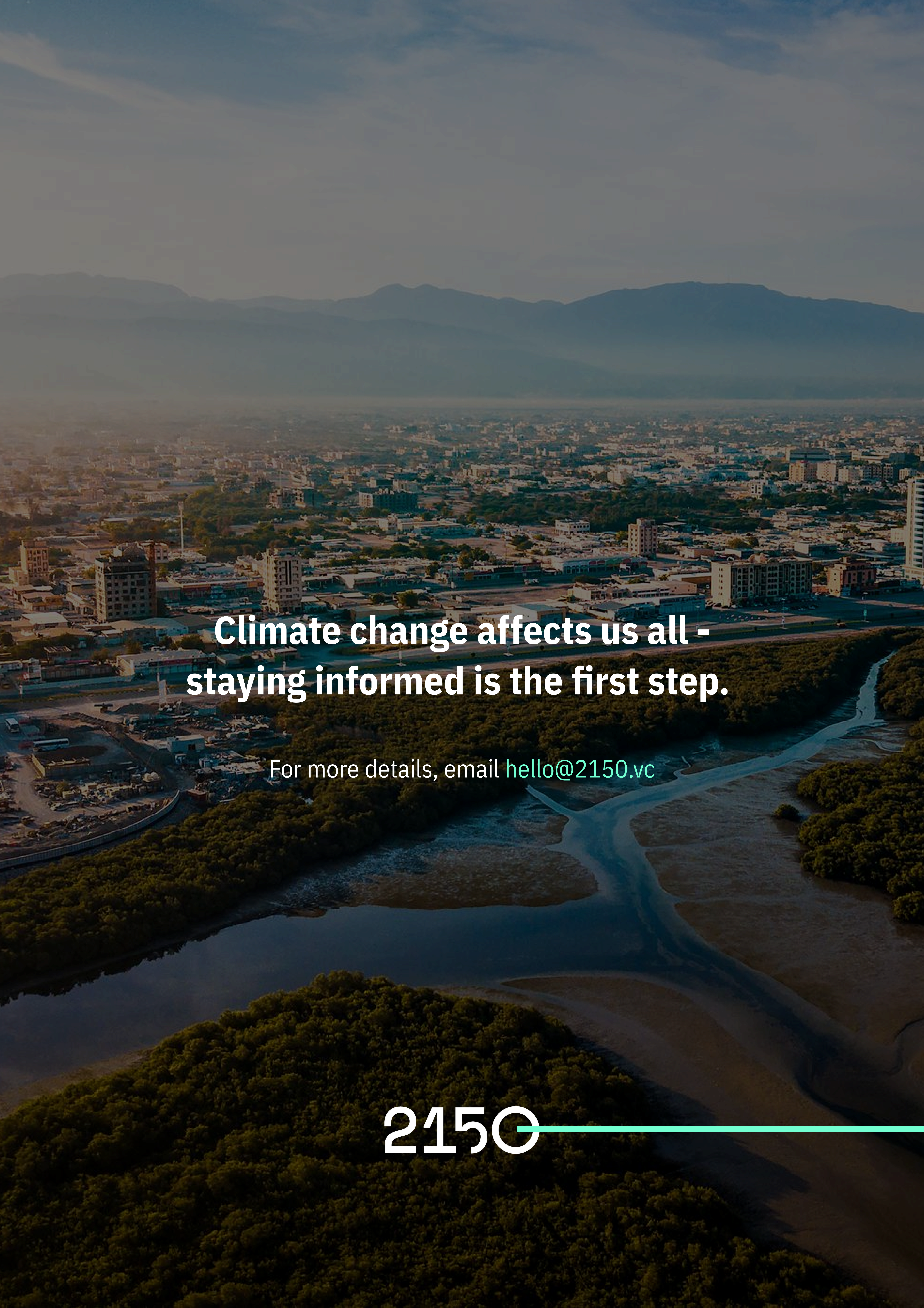
Health

- Emergency medical services
- Advanced IT systems in the health sector
- Prevention and control of infectious and vector-borne diseases
- Public health services
- Vaccination programs
- Food safety, food security and nutrition

Climate Change Forecasting & Monitoring

- Physical climate risk analysis, prediction and assessment
- Real time conditions monitoring for disaster response
- Near term forecasting for early warning systems
- Climate change monitoring and modeling
- New insurance products including parametric insurance
- New models for insurance such as catastrophe modelling

Sources: UPEPCCC (2021)



Climate change affects us all - staying informed is the first step.

For more details, email hello@2150.vc

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