CGE Training materials - Mitigation Assessment

Module A

Climate Change

Consultative Group of Experts (CGE)

United Nations
Climate Change Secretariat

Outline

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I. How is the climate changing?

II. How is the changing climate impacting humans?

III. Why is the climate changing?

IV. What are effects on sustainable development?

Module objectives and expectations

The objective of this module is to provide the participants with an introduction to key issues related to climate change mitigation including:

- The current state of climate change science
- Impacts of climate change on human development, including the link to adaptation activities and sustainable development
- Key sources, sinks, and sectors of greenhouse gas (GHG) emissions

Expectation: Participants will have a broad but sound understanding of key issues related to climate change, motivating participants on the rationale and urgency of global Green House Gas (GHG) mitigation, the benefits of mitigation actions, and how these might fit with other national priorities.

MODULE A1

HOW DO WE KNOW THE EARTH'S CLIMATE IS CHANGING?

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The information basis:

The Intergovernmental Panel on Climate Change (IPCC)

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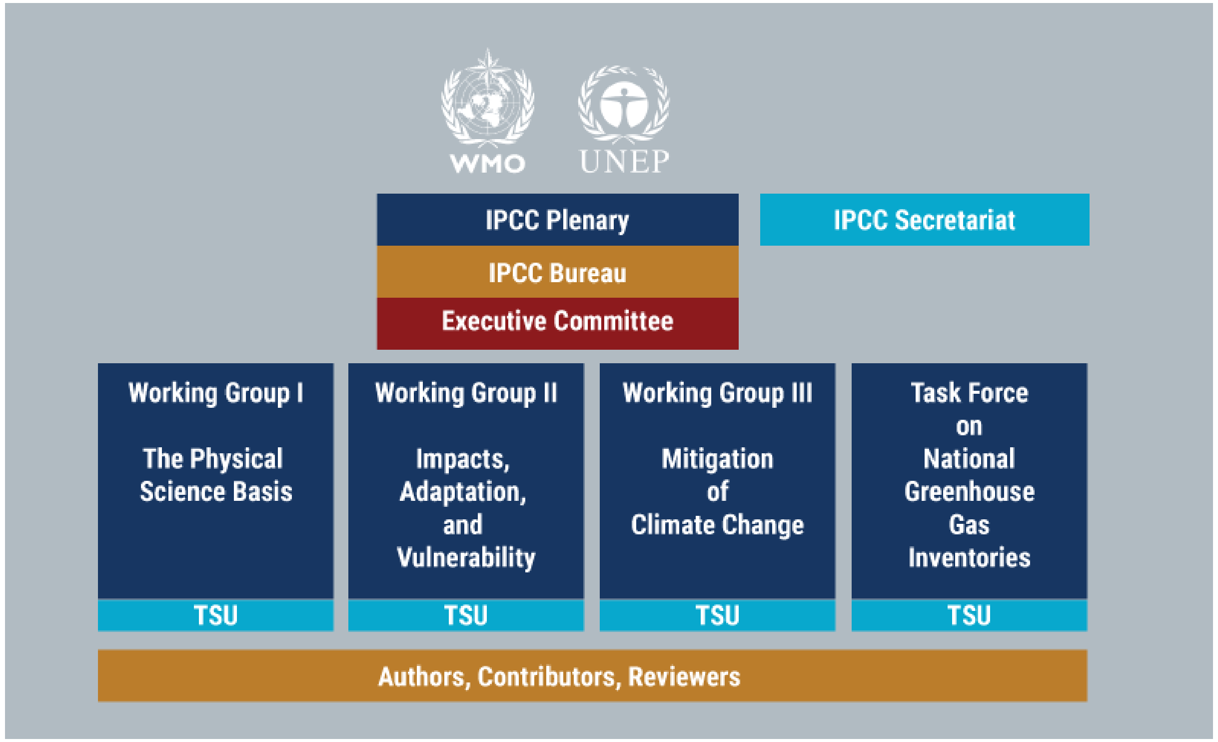
The IPCC is the leading source of scientific consensus and understanding on climate change:

- 195 member governments
- Hundreds of authors from across the globe
- Thousands of expert reviewers
- Based on thousands of peer-reviewed articles in scientific journals and technical publications



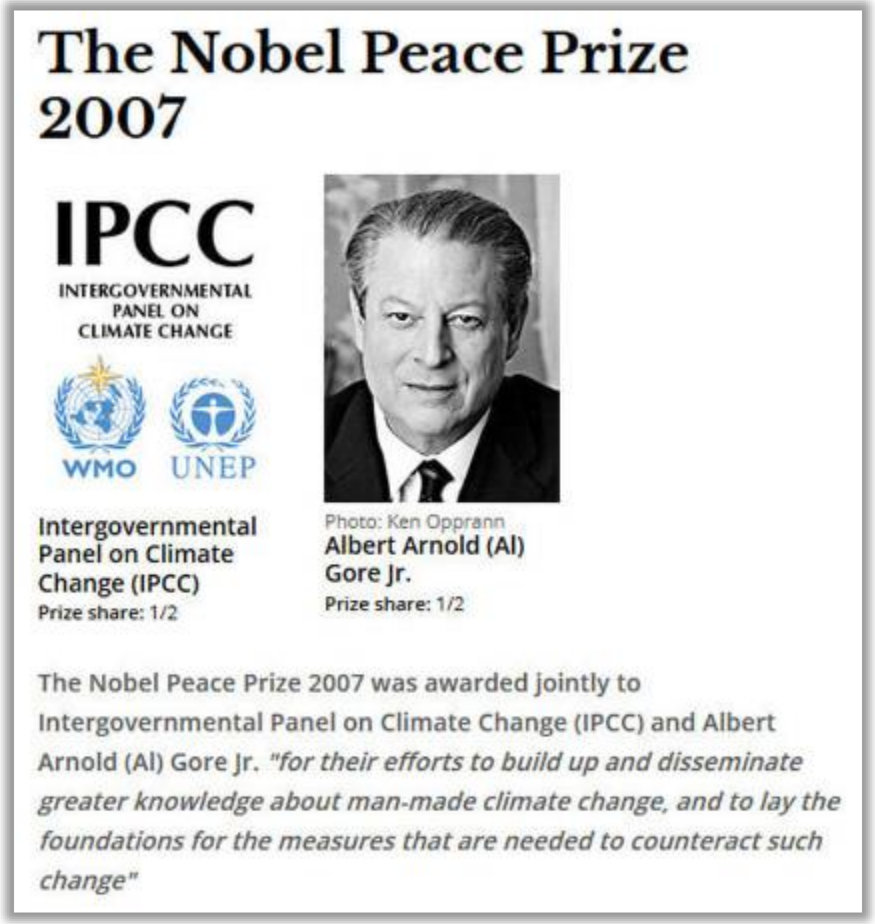
The information basis: IPCC Reports

The IPCC prepares comprehensive **Assessment Reports** about the state of scientific, technical and socio-economic knowledge on climate change, its impacts and future risks, and options for reducing the rate at which climate change is taking place.

It also produces **Special Reports** on topics agreed to by its member governments, as well as **Methodology Reports** that provide guidelines for the preparation of greenhouse gas inventories.

Through its assessments, the IPCC determines the state of knowledge on climate change. It identifies where there is agreement in the scientific community on topics related to climate change, and where further research is needed.

The reports are drafted and reviewed in several stages, thus guaranteeing objectivity and transparency. The latest assessment report is....



The Sixth Assessment Report (AR6)

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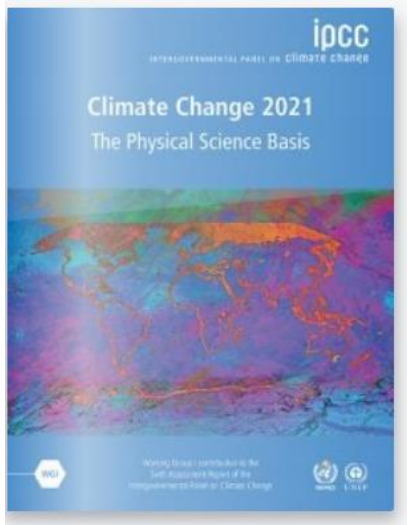
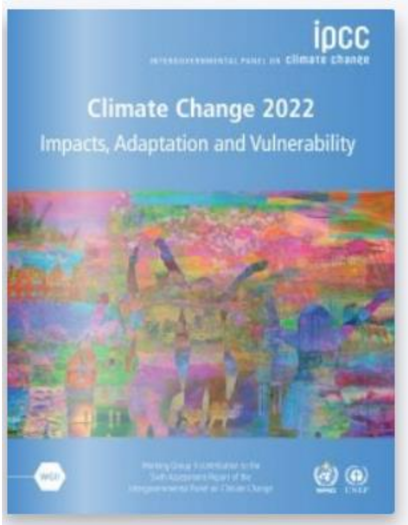


Working group 1

The Physical Science Basis

September 2021

https://www.ipcc.ch/report/ar6/wg1/

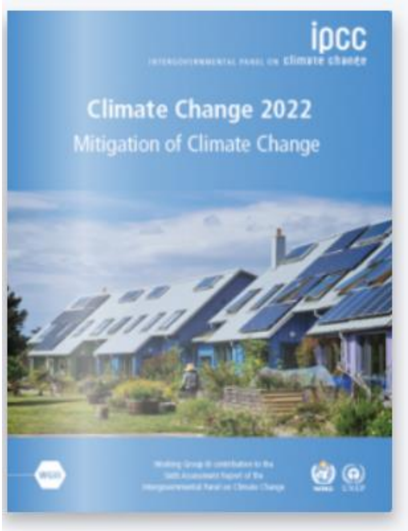


Working group 2

Impacts, Adaptation and Vulnerability

February 2022

https://www.ipcc.ch/report/ar6/wg2/



Working group 3

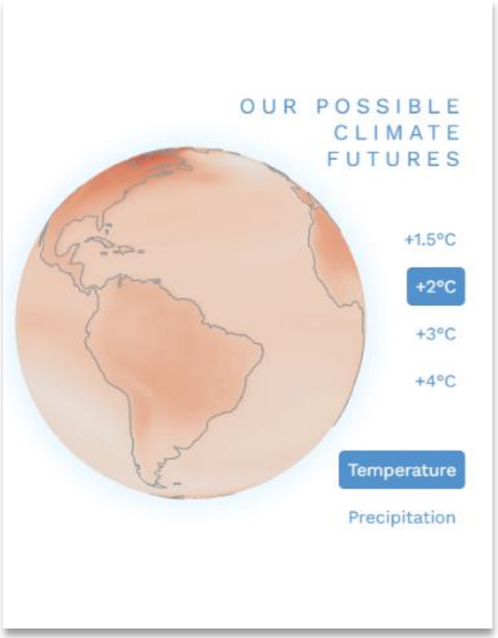
Mitigation of Climate Change

April 2022

https://www.ipcc.ch/report/ar6/wg3/

More information and tools than ever before

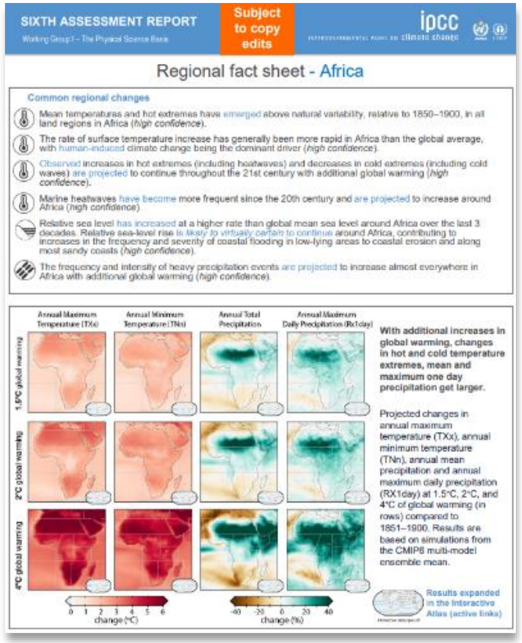
United Nations
Climate Change Secretariat



WGI Interactive Atlas

Flexible spatial and temporal analyses

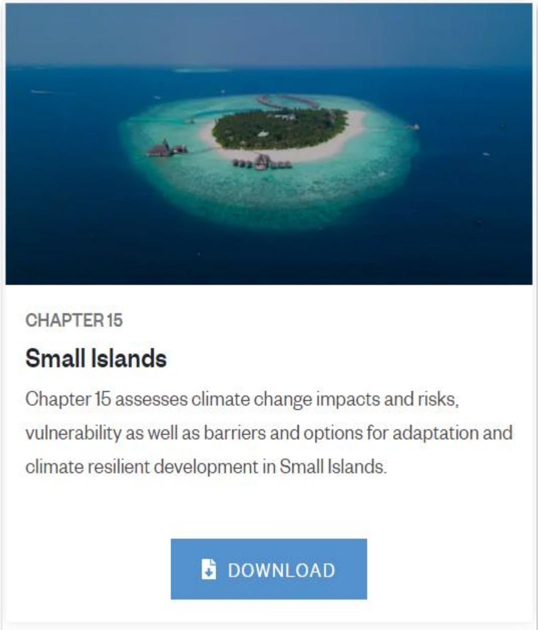
https://interactive-atlas.ipcc.ch/



WGI Regional Fact Sheets

Regional analysis

https://www.ipcc.ch/report/ar6/wg1/resources/factsheets



WGII Regional Analysis Chapters

Detailed regional analysis of impacts and adaptation efforts

https://www.ipcc.ch/report/ar6/wg2/

Key messages: The physical science basis

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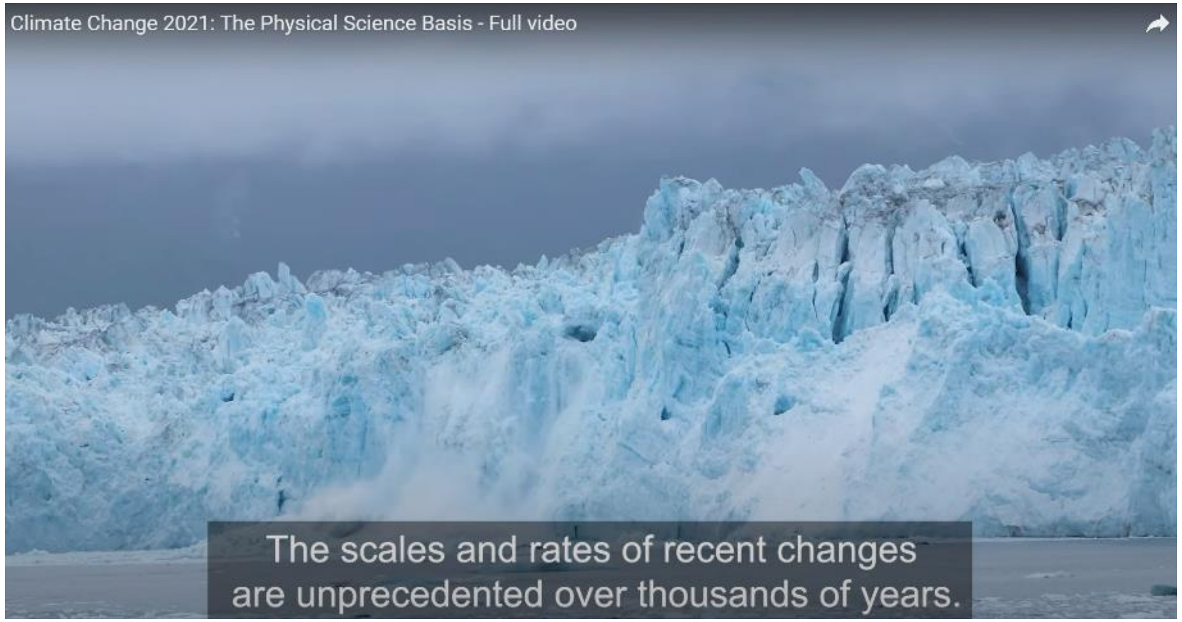
- Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.
- Unless there are immediate, rapid, and large-scale reductions in greenhouse gas emissions, limiting warming to 1.5°C will be beyond reach.
- It is indisputable that human activities are causing climate change, making extreme climate events, including heat waves, heavy rainfall, and droughts, more frequent and severe.
- There's no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.



Watch the video on: https://www.youtube.com/watch?v=e7xW1MfXjLA

Warming is unprecedented

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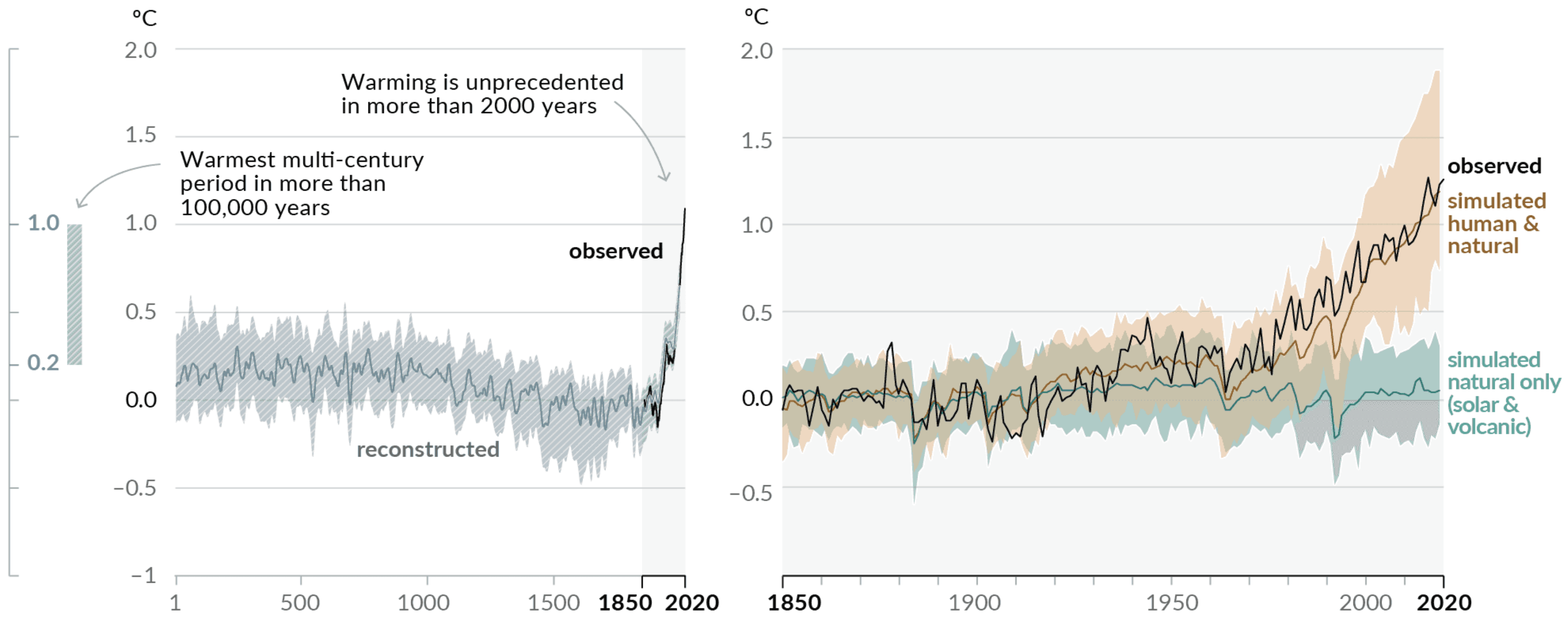
Human influence has warmed the climate at a rate that is unprecedented in at least the last 2000 years

Changes in global surface temperature relative to 1850–1900

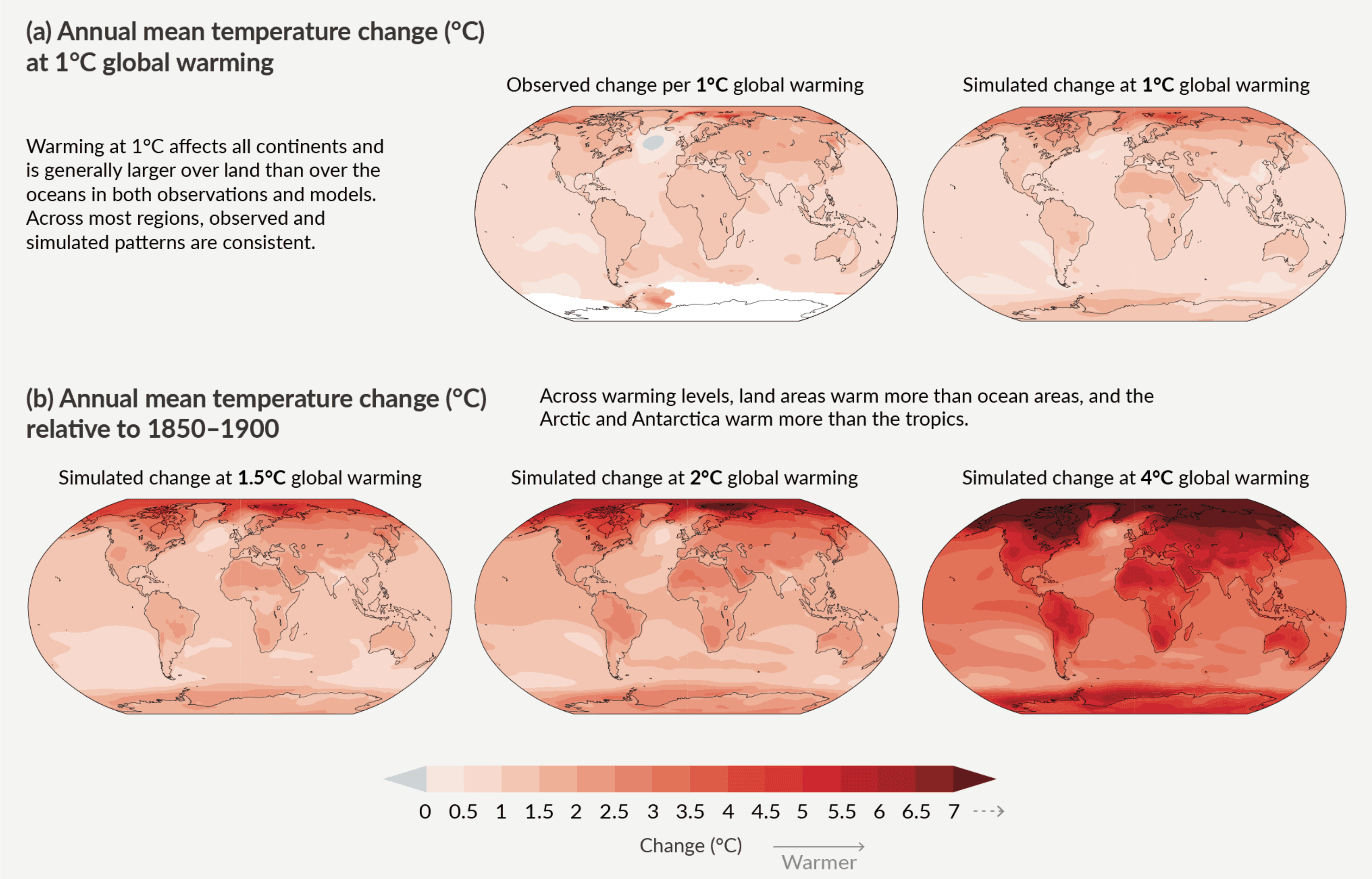
(a) Change in global surface temperature (decadal average) as reconstructed (1–2000) and **observed** (1850–2020)

(b) Change in global surface temperature (annual average) as **observed** and simulated using human & natural and only natural factors (both 1850–2020)



The analysis clearly shows that warming has never been this rapid… and that natural factors cannot explain the rapid change

Observed and simulated temperature change



With increasing warming, effects get larger for all regions, but some will experience more pronounced changes

Sea ice, ocean acidification and sea level rise

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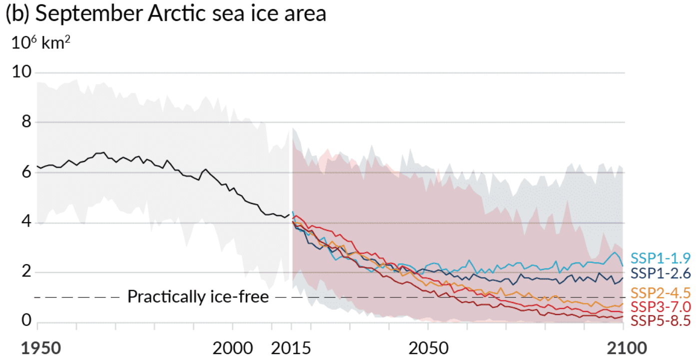
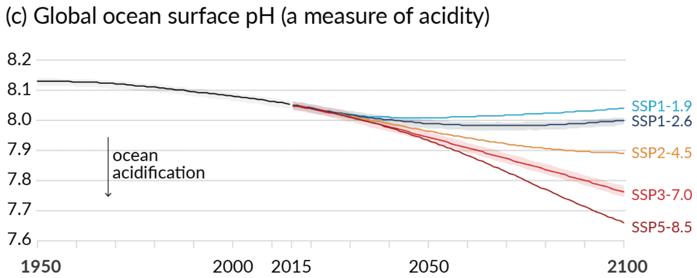
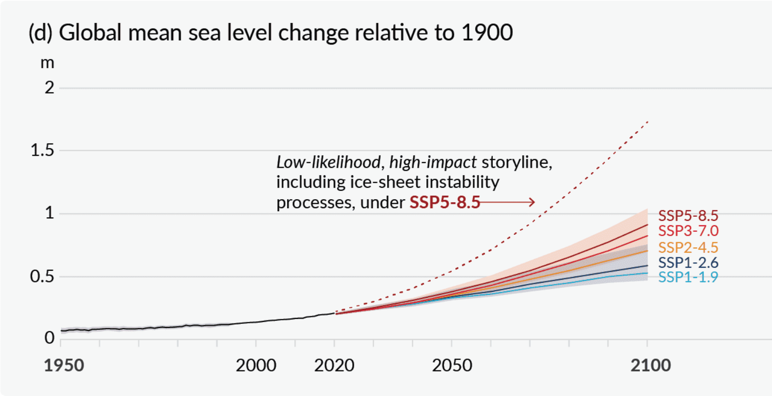


The Arctic is projected to be practically ice-free near mid-century under intermediate and high GHG emissions scenarios.



Oceans are projected to increasingly acidify, with detrimental effects on sea life.



Sea level rise projections are highly uncertain but could see as much as 1 meter under likely scenarios by 2100 and up to 3 meters by 2300.

Climate change effects on extremes

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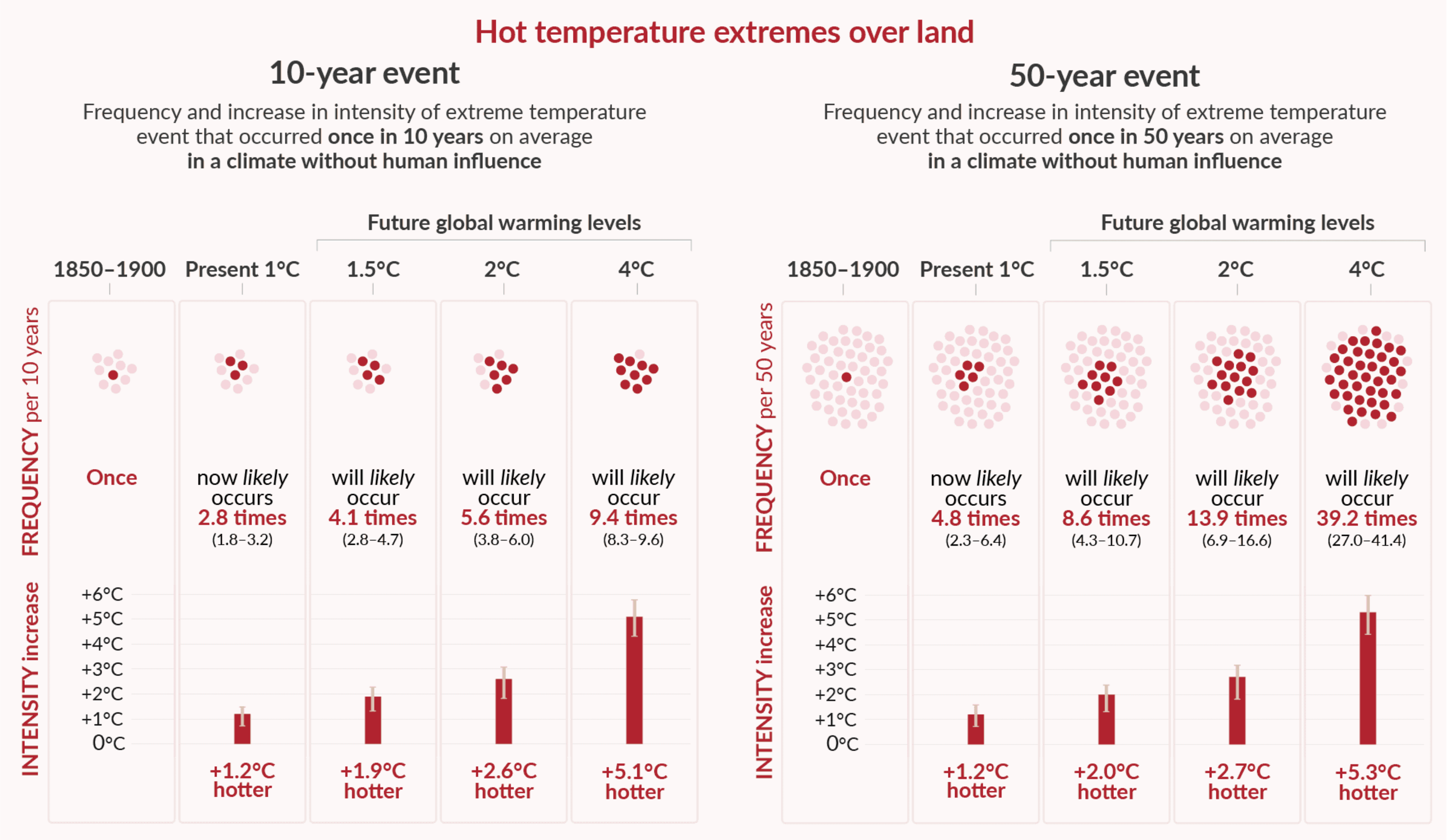
Projected changes in extremes are larger in frequency and intensity with every additional increment of global warming



Previously rare events will become more frequent and increase in intensity.

Similar effects are expected for heavy precipitation and agricultural and ecological droughts*.

* In drying areas

MODULE A2

HOW DOES CLIMATE CHANGE IMPACT LIFE AND PROCESSES ON EARTH?

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Key messages: Impacts, adaptation and vulnerability

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- Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability.
- Across sectors and regions the most vulnerable people and systems are observed to be disproportionately affected.
- Global warming, reaching 1.5°C in the near-term, would cause unavoidable increases in multiple climate hazards and present multiple risks to ecosystems and humans.
- Beyond 2040 and depending on the level of global warming, climate change will lead to numerous risks to natural and human systems.
- Climate change impacts and risks are becoming increasingly complex and more difficult to manage.

Watch the video on:
https://www.youtube.com/watch?v=SDRxfuEvqGg

From climate impacts to human systems

Drivers

	Slow onset impacts	Extreme events
Temperature	Warming trend	Heat waves
Precipitation	Change in rain patterns	Flooding Drought
Oceans	Sea level rise Ocean acidification	Storm surges

→

Impact on human systems

Water	Food	Health	Infrastructure	Socio-economic
• Availability of clean drinking water • Availability of water for agriculture • Availability of water for thermal cooling (e.g. in power plants) • Availability of water for indus-trial production • Salination from sea level rise	• Decreasing fisheries yields • Decreasing livestock yields	• Increase in vector-born diseases • Increase in heat-stress related diseases • Malnutrition • Ozone-related diseases • Injuries from extreme events	• Damage from extreme events (floods, storm surges) • Loss through sea level rise • Damage to materials from heat • Disruption to supply chain systems	• Migration from affected areas • Disruption of economic activity • Loss of jobs & livelihoods, esp. in agriculture, fisheries & tourism • Increasing inequality • Social & political unrest

↓

Impact on human lives

Increased deaths through:

- Diseases (vector-born, contaminated drinking water)
- Malnutrition
- Heat stress
- Extreme weather events

The 'Reasons for Concern' (RFC) framework shows high risk areas even at 1.5°C and 2 °C warming

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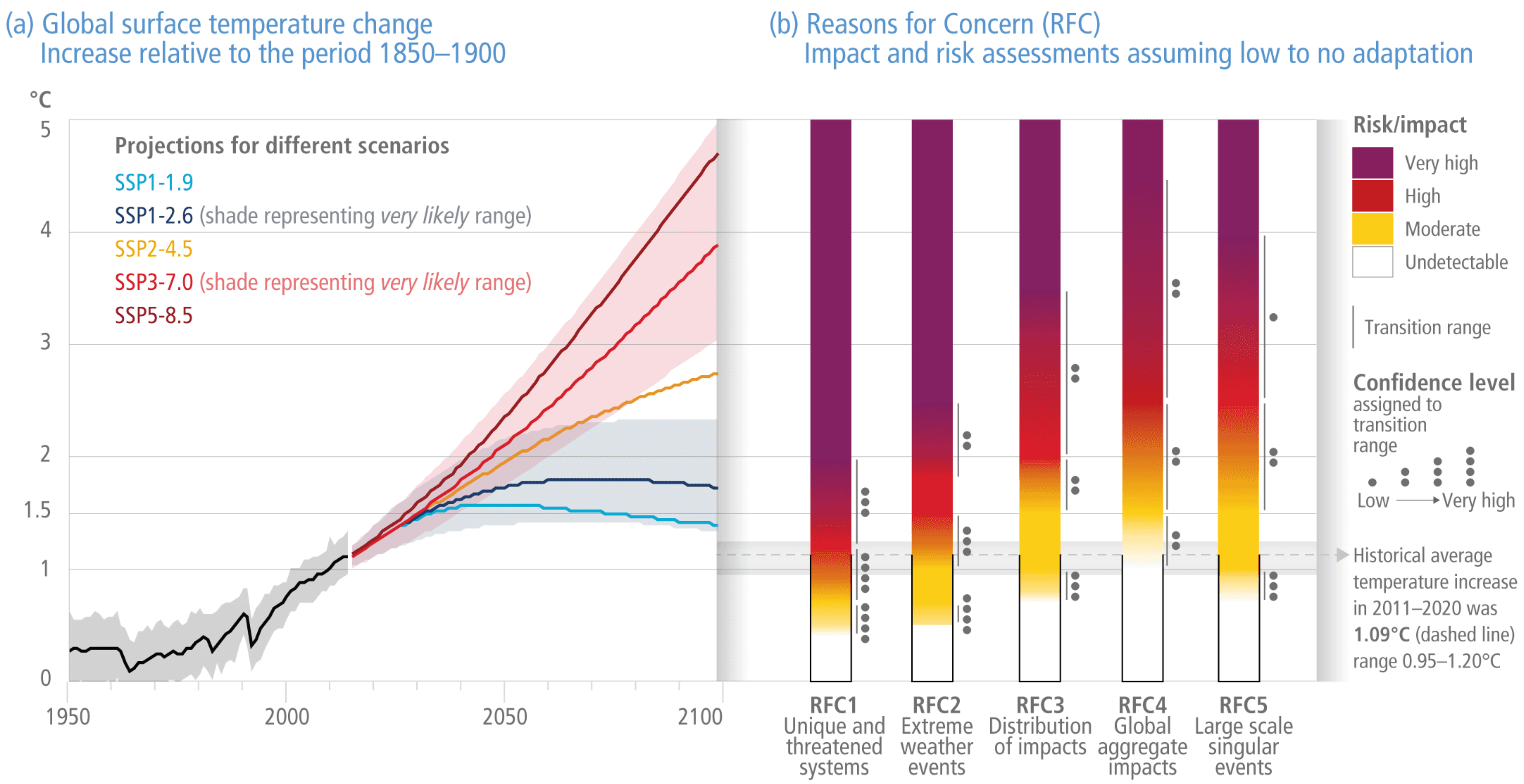

Key RFC risks

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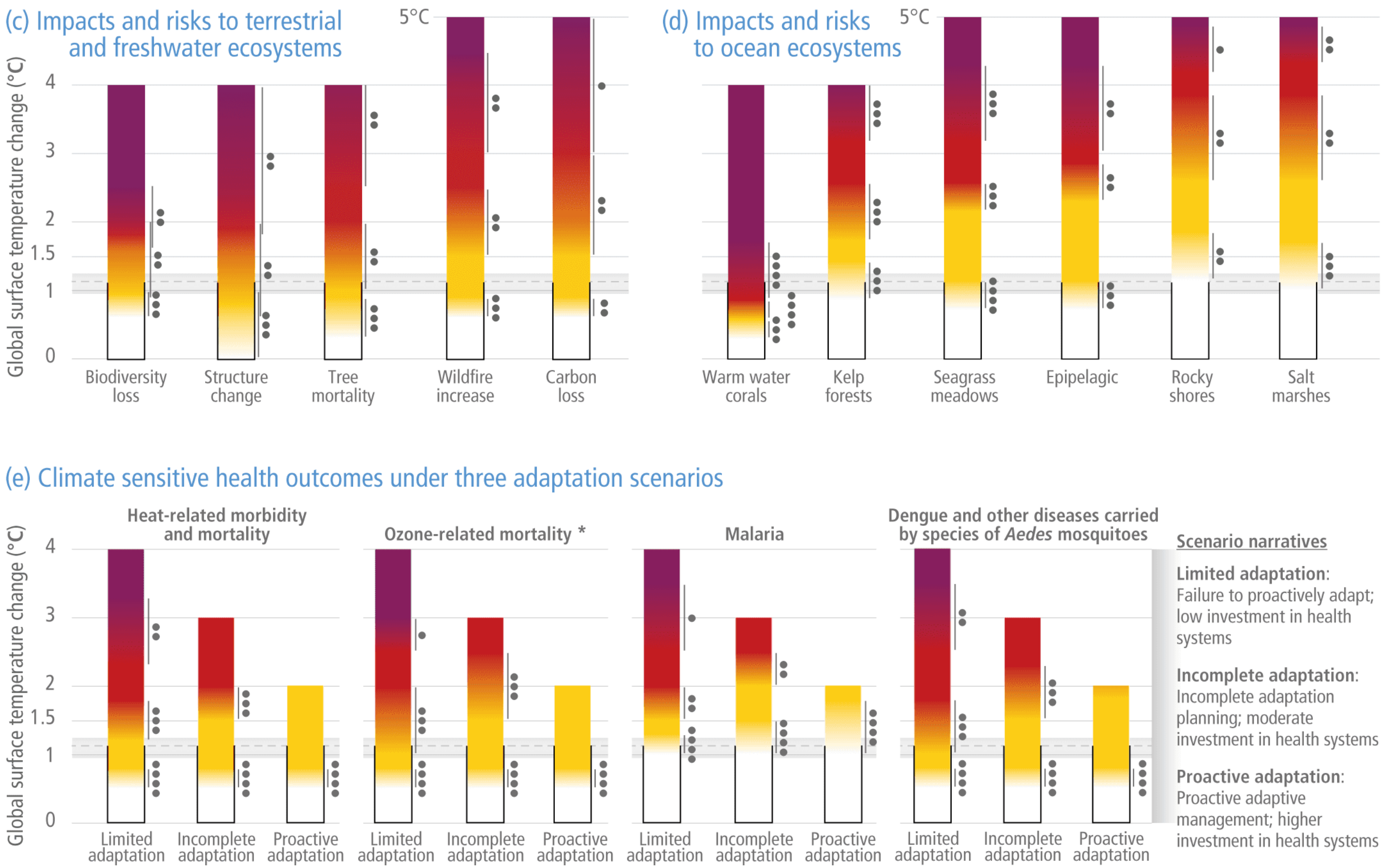
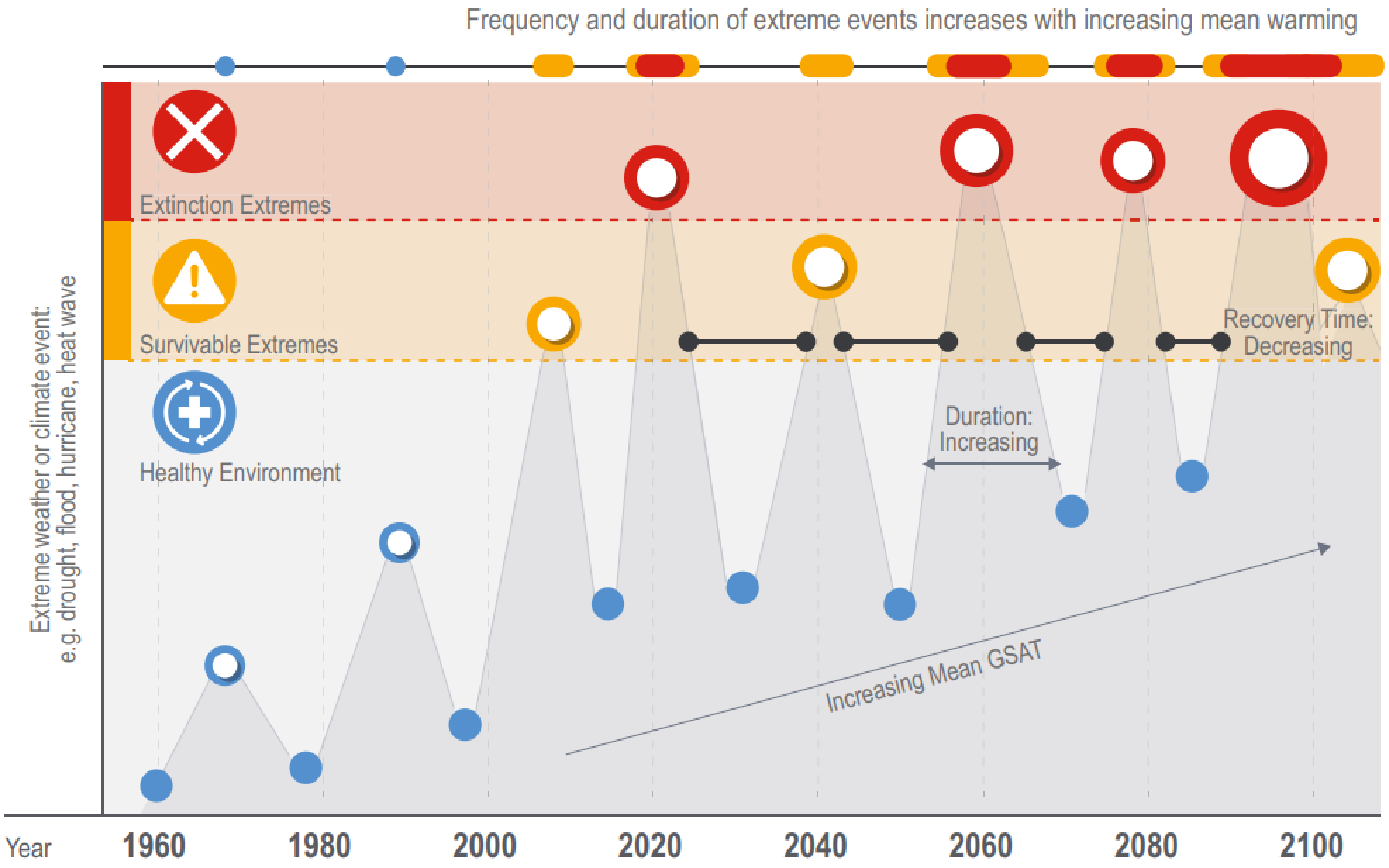


* Mortality projections include demographic trends but do not include future efforts to improve air quality that reduce ozone concentrations.

The risk analysis shows that even current levels of warming (1.09°C, dashed line) already pose medium risk in many areas.

Health risks largely depend on the level of adaptation, but also already exist at current levels of warming.

Effects of extreme event changes on extinction risk



Increasing frequency and intensity will impact the ability of systems to recover and develop adaptation strategies.

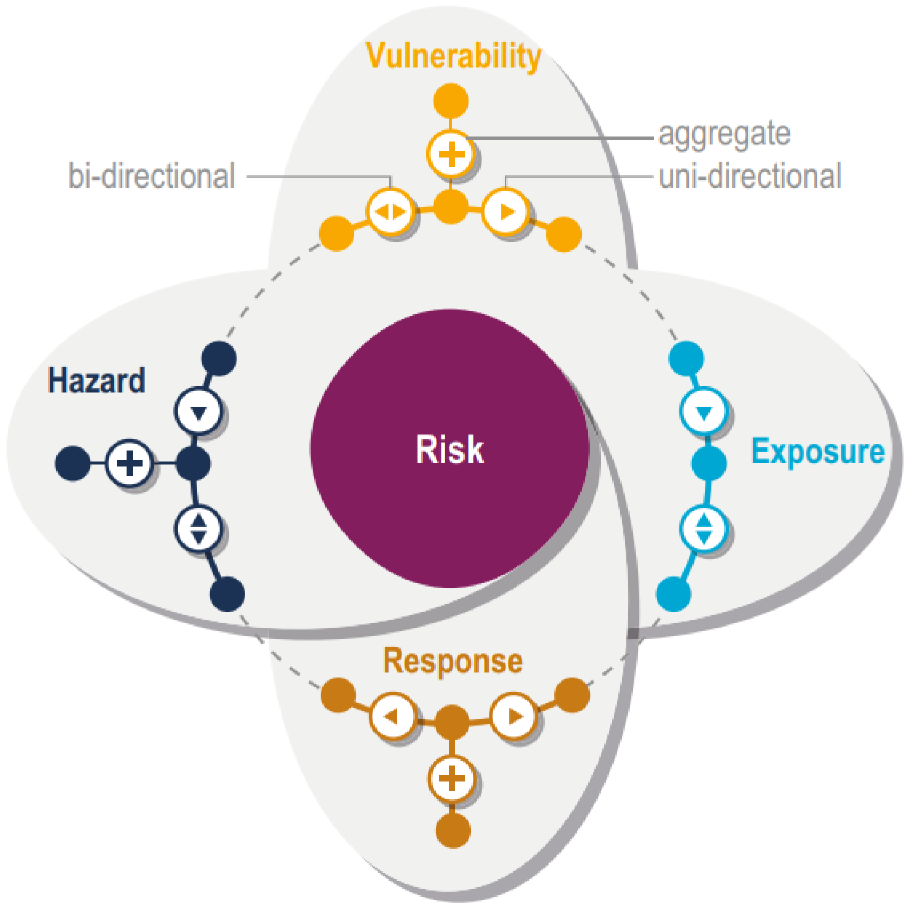
This can, amongst other effects, lead to species extinction.

The IPCC risk assessment framing

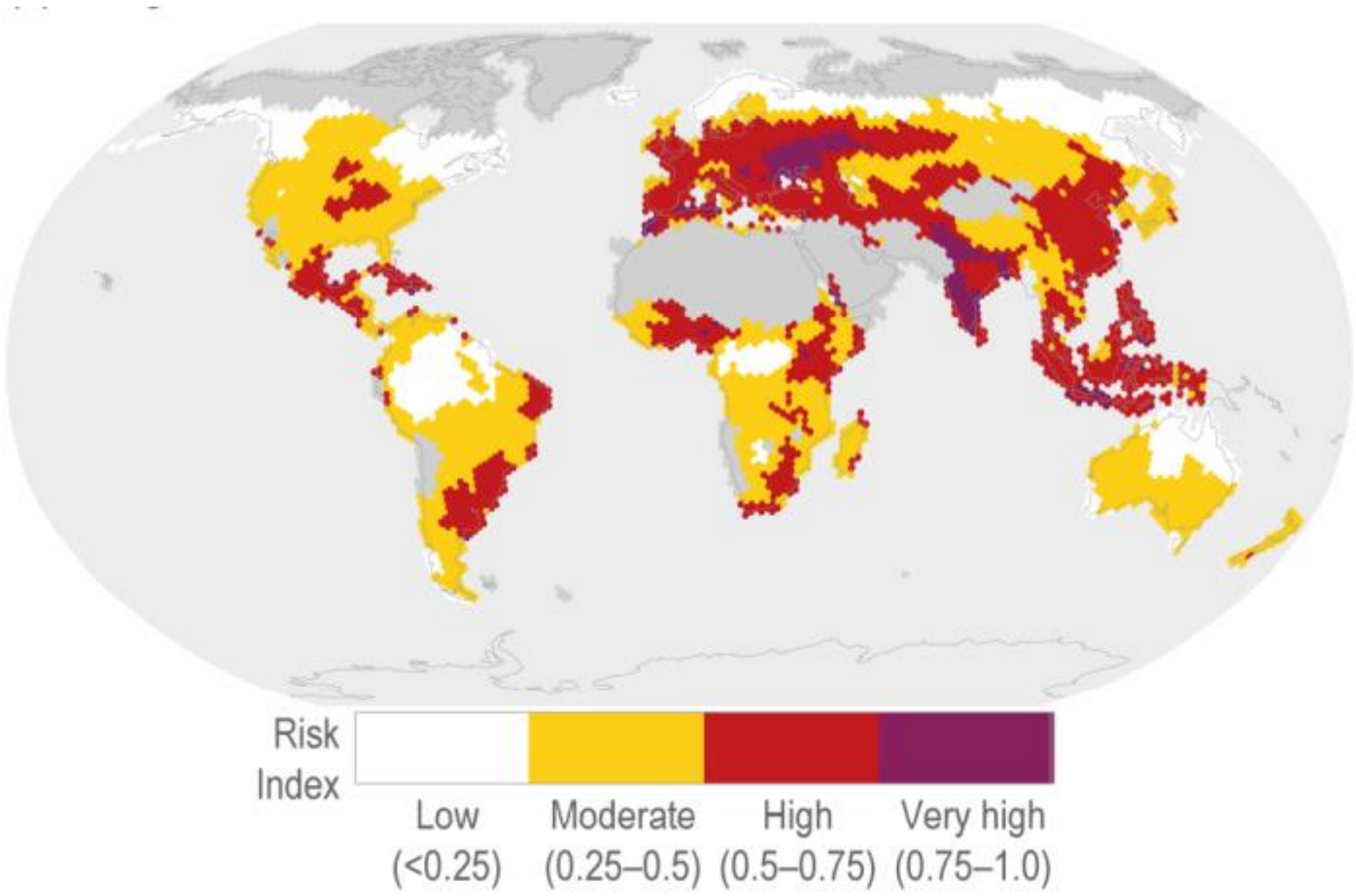
Risk provides a framework for understanding the increasingly severe, interconnected and often irreversible impacts of climate change on ecosystems, biodiversity, and human systems.

The risk of climate change impacts can be usefully understood as resulting from dynamic interactions among climate-related hazards, the exposure and vulnerability of affected human and ecological systems, and also responses.

New: The risks of climate change responses include the possibility of responses not achieving their intended objectives or having trade-off or adverse side effects for other societal objectives. This includes responses in the form of adaptation as well as mitigation measures.



Example: Risk index for drought



Major drought events worldwide have had substantial societal and ecological impacts, including:

- reduced crop yields,
- shortages of drinking water,
- wildfires causing deaths of people, very large numbers of animals and impacting the habitats of threatened species, and
- widespread economic losses.

Observed global and regional impacts on human systems attributed to climate change

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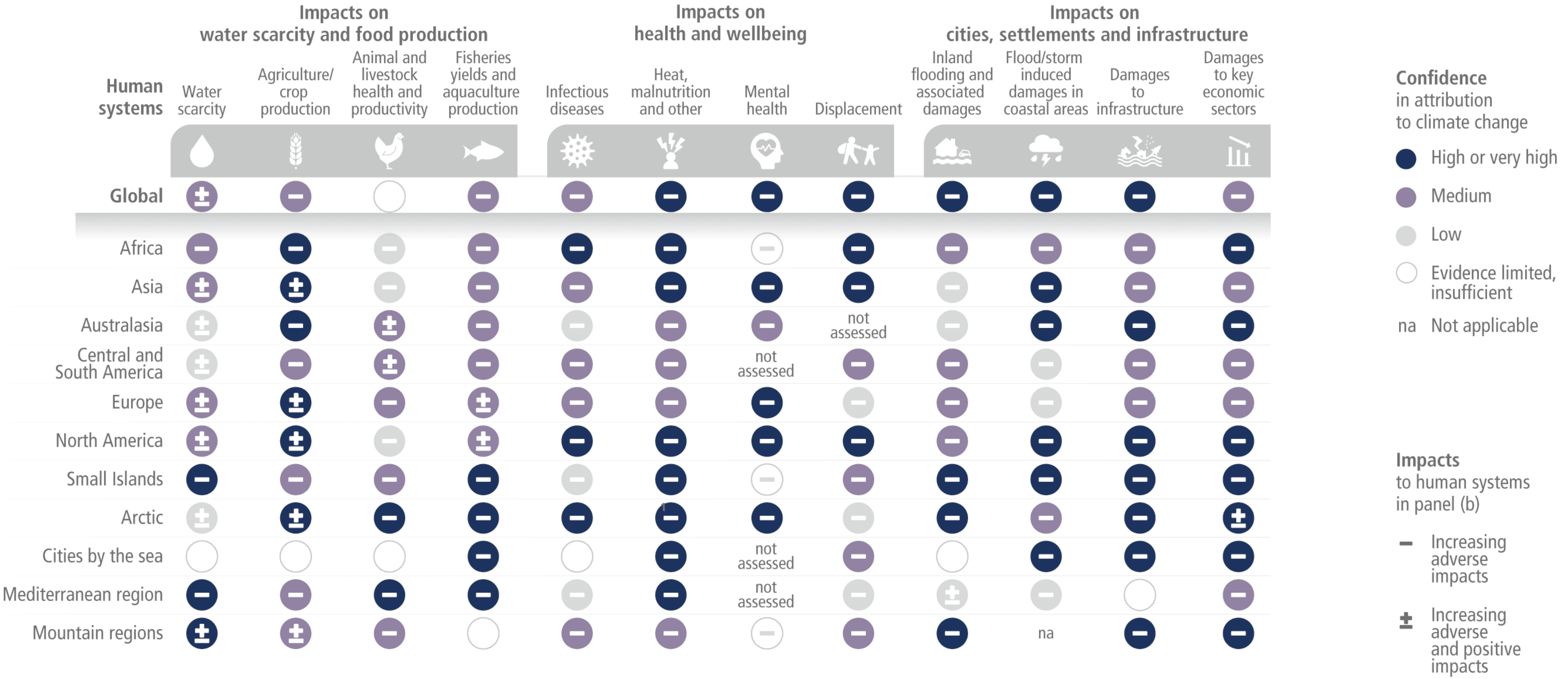


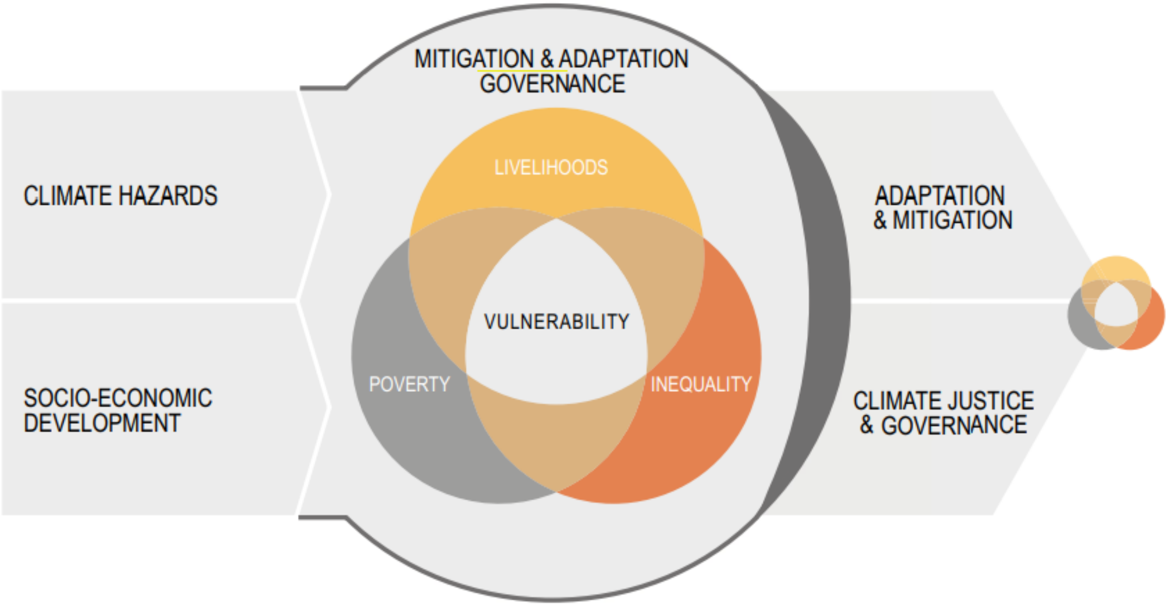
Developing countries are the most vulnerable

Adverse impacts of climate change, development deficits and inequality exacerbate each other. Existing vulnerabilities and inequalities intensify with adverse impacts of climate change.

High impacts on livelihoods in developing countries:

- Large share of the economy is in climate sensitive sectors
- Some areas are prone to natural disasters

Observed livelihood impacts are concentrated in South Asia, Africa, Central America and in SIDS.

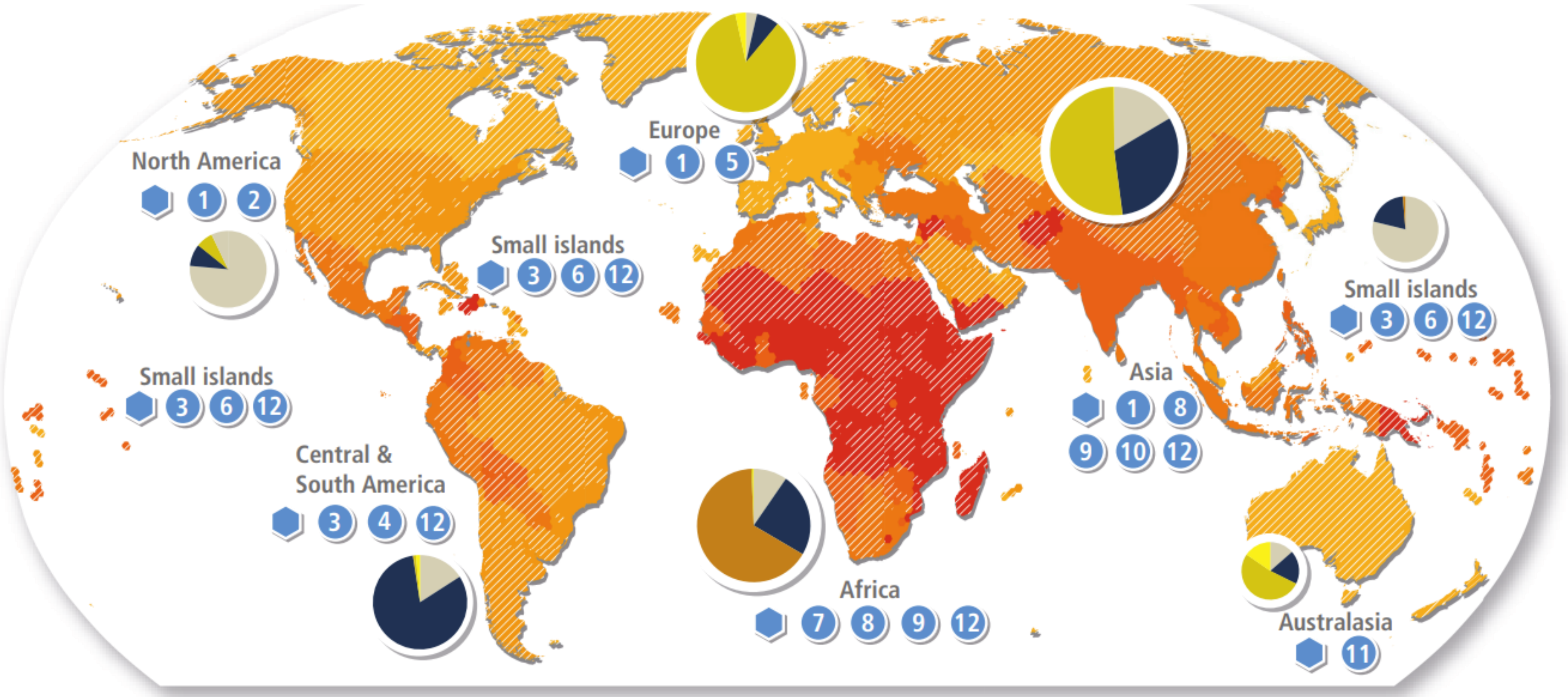


Low adaptive capacity:

- Limited financial, institutional, technological capacity
- Limited access to knowledge

Age, **gender**, **socio-economic class**, **ethnicity** and **race** are also recognised as important to the vulnerability of individuals, within developing countries, but also in developed countries.

Overview of geographic distribution of vulnerability



Pie charts

Flood Storm Drought Heat Wild Fires

The size of the pie charts show average mortality per hazard event per region between 2010 and 2020.
The slices of pie charts show the distribution of deaths from a particular hazard.

Observed human vulnerability shows that global hotspots are not just single countries, but often emerge within regional clusters, particularly in Africa, but also in Asia and Central America

Relative vulnerability
- Very high
- High
- Medium
- Low
- Very low

Population density
- High
- Low

Key findings: Vulnerability

- Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change.
- Global hotspots of high human vulnerability are found particularly in West-, Central- and East Africa, South Asia, Central and South America, Small Island Developing States and the Arctic.
- Between 2010–2020, human mortality from floods, droughts and storms was 15 times higher in highly vulnerable regions, compared to regions with very low vulnerability.
- Particularly the urban and rural landless poor face difficulties rebuilding assets following one-off disasters or a series of shocks caused by extreme climate and weather events.

Water availability & flooding

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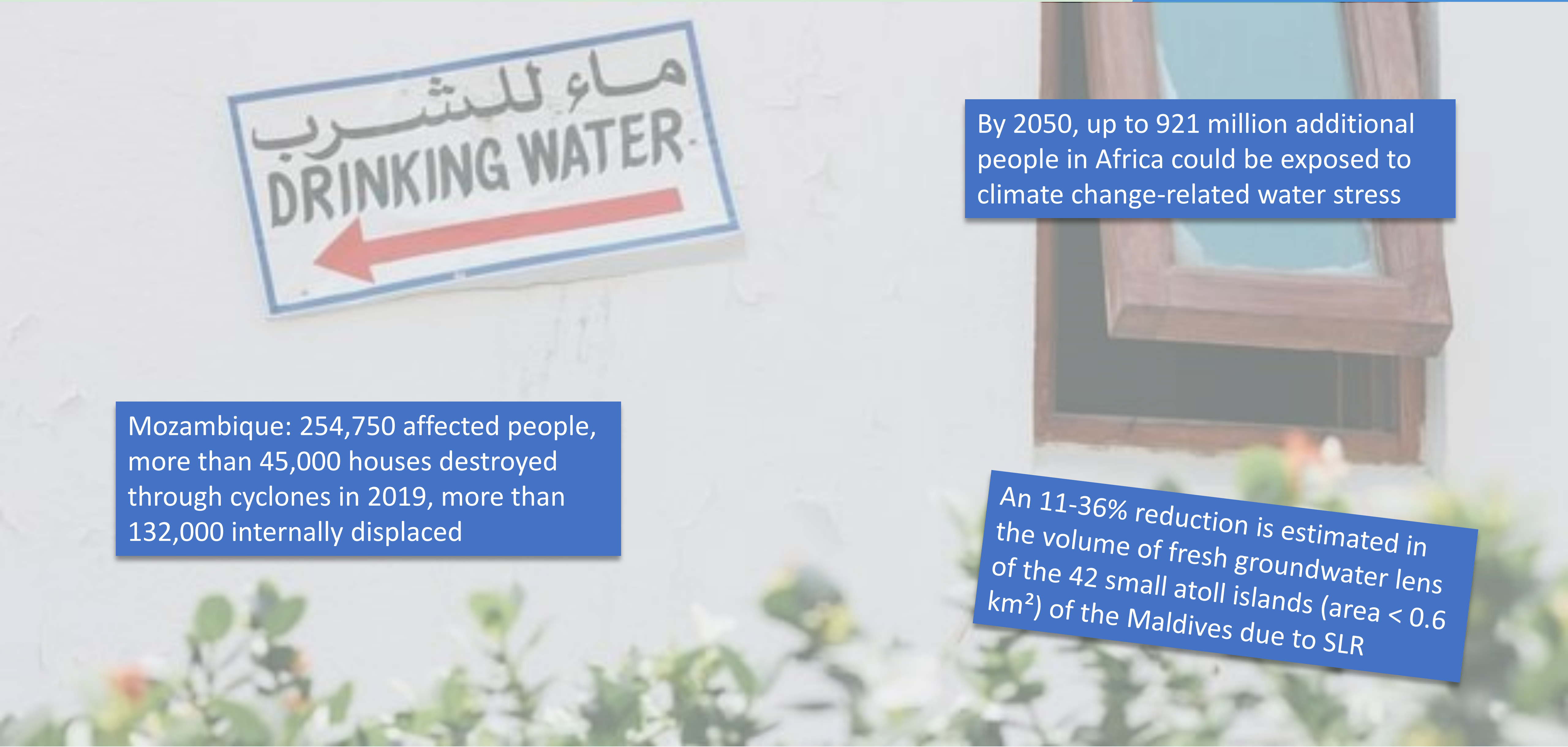

By 2050, up to 921 million additional people in Africa could be exposed to climate change-related water stress

Mozambique: 254,750 affected people, more than 45,000 houses destroyed through cyclones in 2019, more than 132,000 internally displaced

An 11-36% reduction is estimated in the volume of fresh groundwater lens of the 42 small atoll islands (area < 0.6 km^2) of the Maldives due to SLR

Agricultural yields and food security

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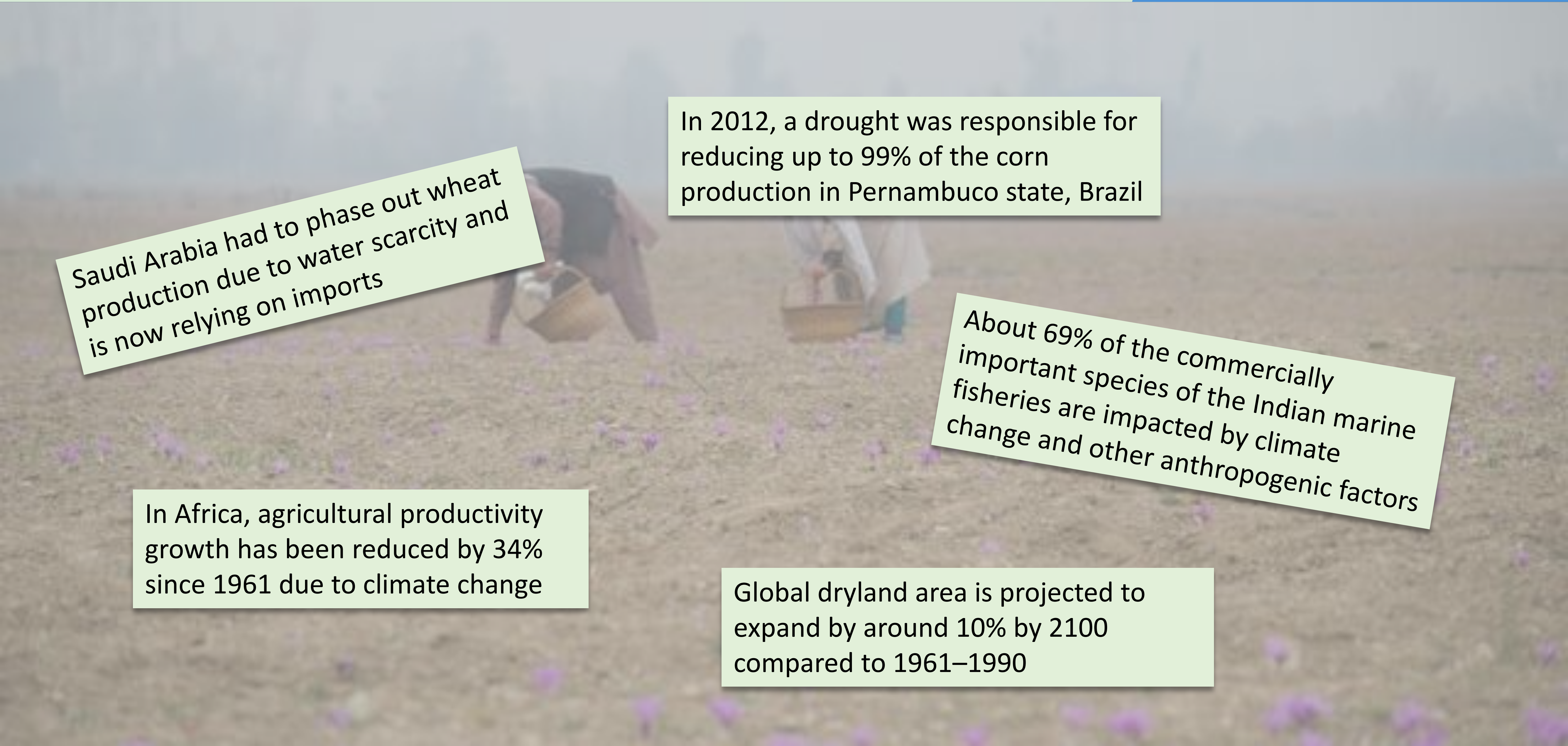

In 2012, a drought was responsible for reducing up to 99% of the corn production in Pernambuco state, Brazil

Saudi Arabia had to phase out wheat production due to water scarcity and is now relying on imports

About 69% of the commercially important species of the Indian marine fisheries are impacted by climate change and other anthropogenic factors

In Africa, agricultural productivity growth has been reduced by 34% since 1961 due to climate change

Global dryland area is projected to expand by around 10% by 2100 compared to 1961–1990

Sea level rise and coastal flooding

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63 million people in East and South Asia are at risk of a 100-year flooding event

Disruption of local economic activity in Annapolis, Maryland and loss of areas and settlements in Micronesia and Solomon Islands have been attributed to relative SLR

Twelve of the top 20 countries exposed to SLR and associated flood events are in Asia

10% or more of the population of many SIDS lives in areas at risk of chronic coastal flooding or permanent inundation by 2100.

Area loss from sea level rise in Bangladesh is projected to lead to production losses of 31-40%

MODULE A3

WHY IS THE EARTH'S CLIMATE CHANGING?

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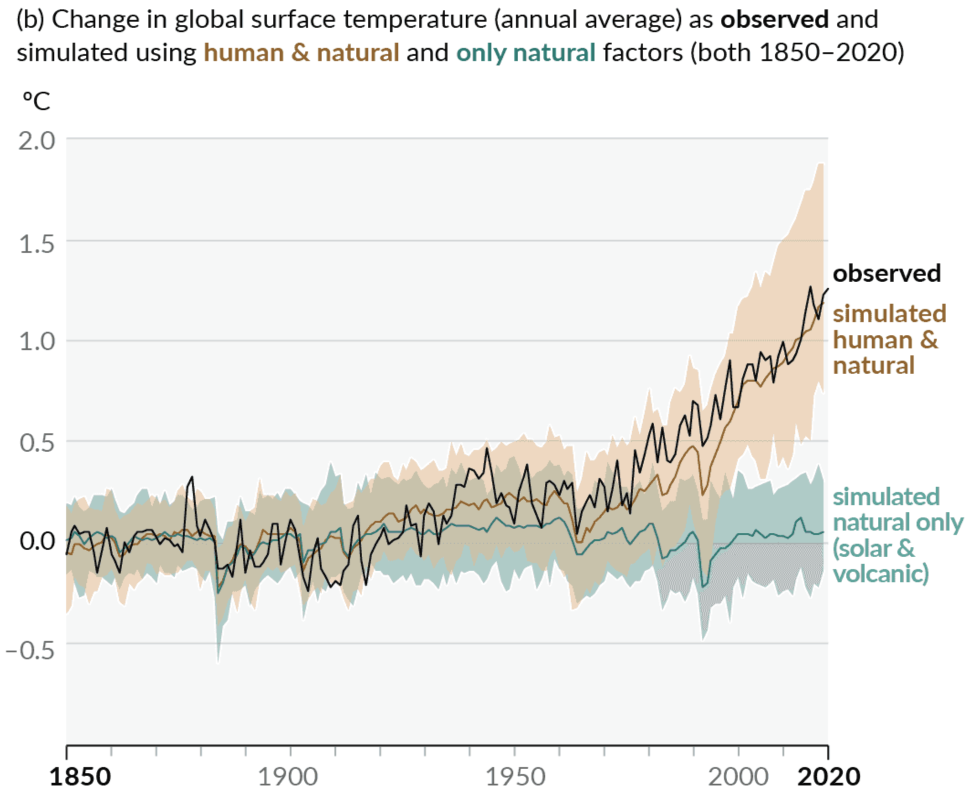
Climate change is driven by human activity



Human induced factors influencing climate change

Increases in the atmospheric concentrations of:

- Greenhouse gases (GHG): The greenhouse gases trap infrared radiation near the surface, warming the climate.
- Aerosols: on average cool the climate by increasing the reflection of sunlight.

Emissions stem from burning fossil fuels, land use and other sources.

Natural factors influencing our climate

- Solar activity: variations in the sun's activity, which alter the amount of incoming energy from the sun.
- Large volcanic eruptions: increase the number of small particles (aerosols) in the upper atmosphere.
- Orbital changes: operate on very long time scales.

However, they cannot explain the observed temperature increase.

Estimating GHG emissions

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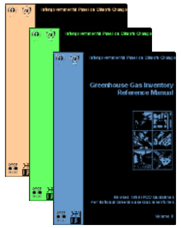
- Because of its influence on our climate, understanding the level and structure of GHG emissions is important to enable robust and effective mitigation measures.
- National GHG inventories are a core element of UNFCCC reporting and rely on methodologies developed by the IPCC.

Relevant for reporting under the Paris Agreement (Enhanced Transparency Framework) for all Parties

Relevant for non-Annex I reporting under the Convention

Relevant for Annex I reporting under the Convention



Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories

2006 IPCC Guidelines for National Greenhouse Gas Inventories

2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

GHGs and global warming potentials (IPCC)

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Global warming potentials are used to enable the analysis of the contribution of different greenhouse gases to global warming.

They represent the combined effect of the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation in comparison to the properties of CO_2.

Greenhouse Gas	GWP-100 AR2	GWP AR4	GWP AR5	GWP AR6
Carbon Dioxide (CO_2)	1	1	1	1
Methane (CH_4)	21	25	28 30 (fossil)	27 (biogenic & fossil combustion) 29.9 (fugitive & process)
Nitrous Oxide (N_2O)	310	298	265	273
"F-gases" Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6)	140 - 23,900	92 – 22,800	4 – 23,500	164 – 25,184

GHGs: Sources and sinks

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Individual gases occur in some sectors or through some activities more frequently than in others.

The table below provides an overview of where gases are most commonly emitted (sources) or removed (sinks).

Greenhouse Gas	Principal sources and sinks
Carbon Dioxide (CO_2)	Fossil fuel use, land use change (oceans, terrestrial biosphere)
Methane (CH_4)	Fossil fuel mining/distribution, livestock, rice agriculture, landfills
Nitrous Oxide (N_2O)	Agriculture and associated land use change
"F-gases" Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulphur Hexafluoride (SF_6)	Industrial processes

GHG emission development by gas

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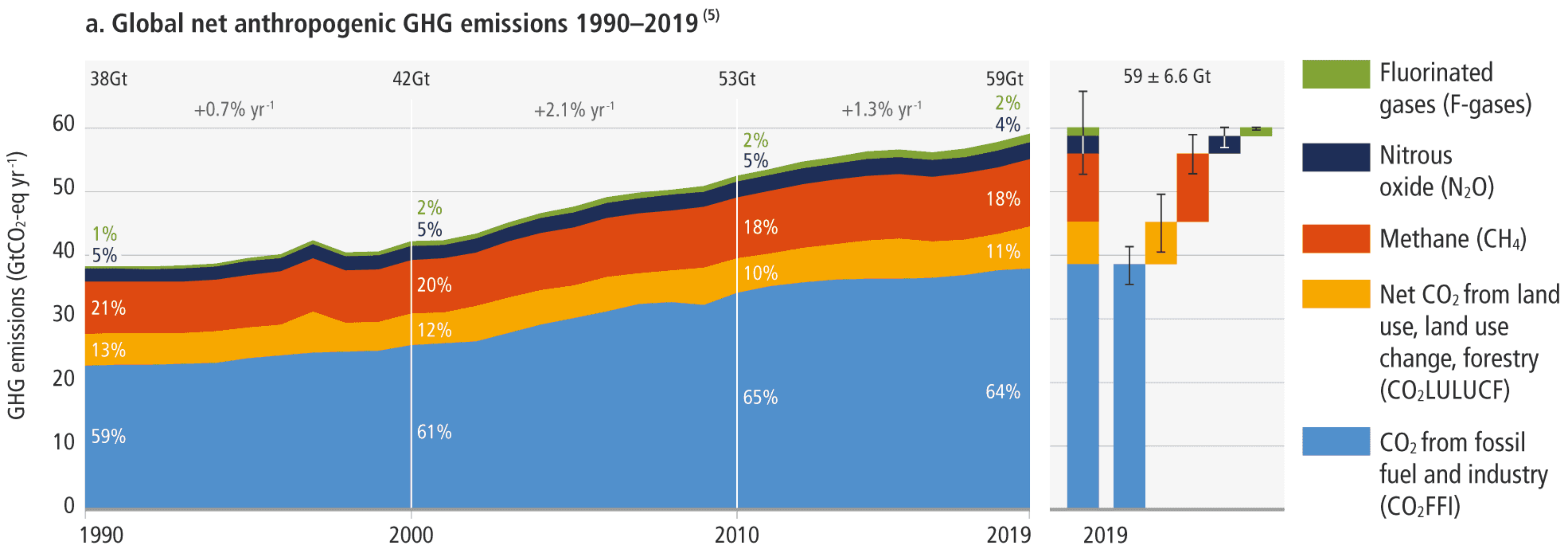
Global net anthropogenic emissions have continued to rise across all major groups of greenhouse gases.



Emissions by sector 2019

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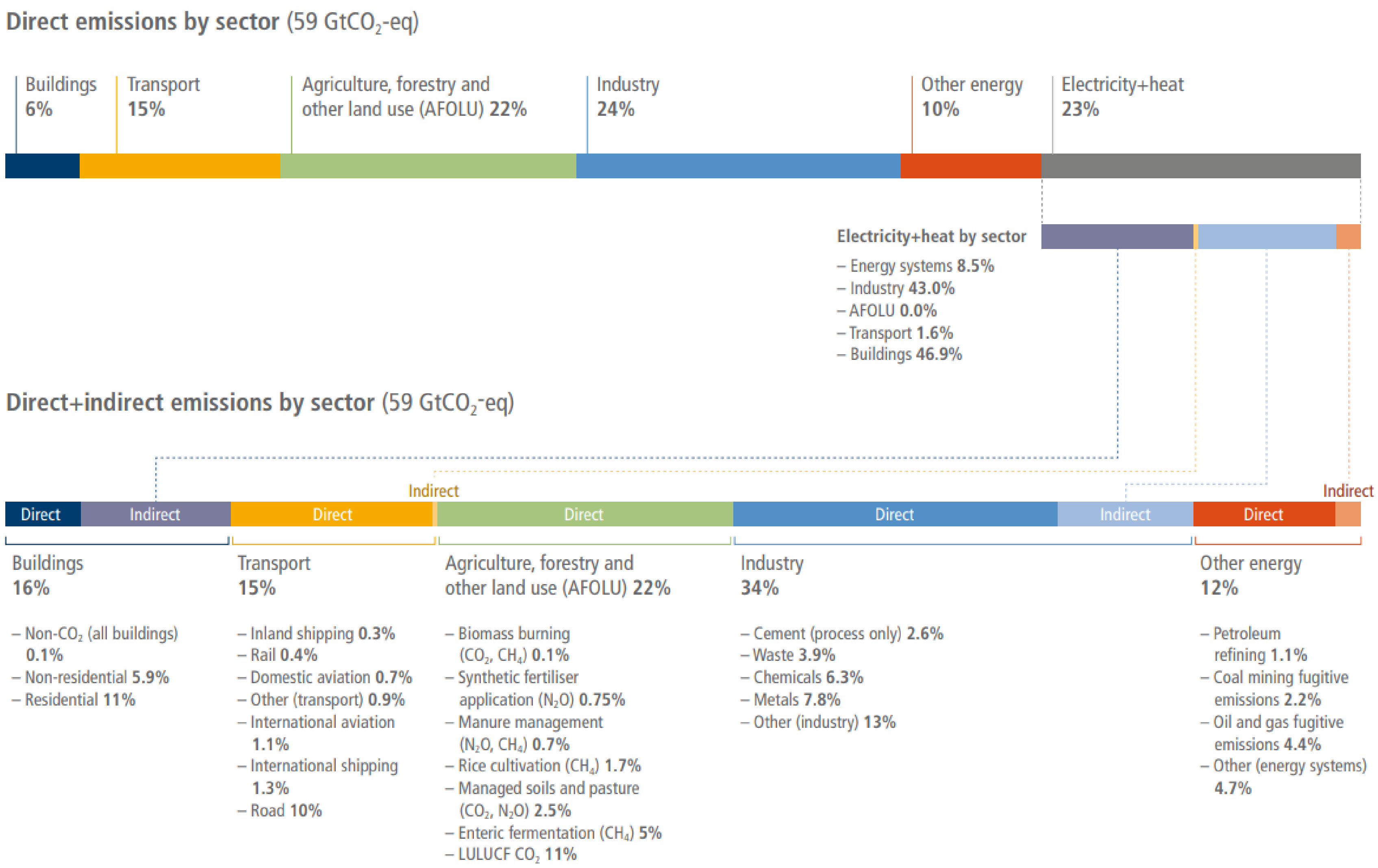
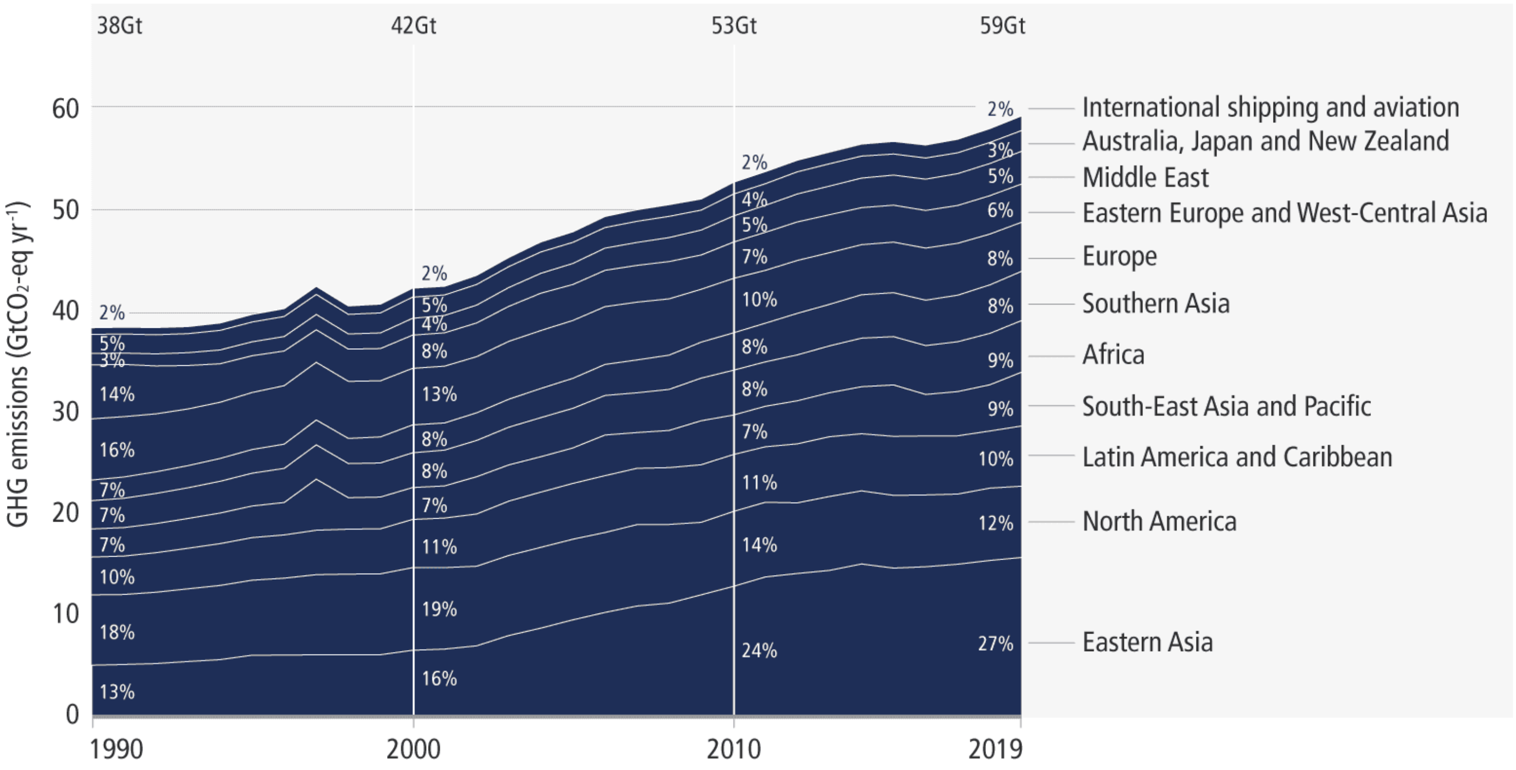
Industry, buildings and transport make up **44%** of global GHG emissions, or **66%** when the emissions from electricity and heat production are reallocated as indirect emissions.

Another important sector is AFOLU, which is a key sector in some regions.



Emission trends by region

Global net anthropogenic GHG emissions by region 1990-2019



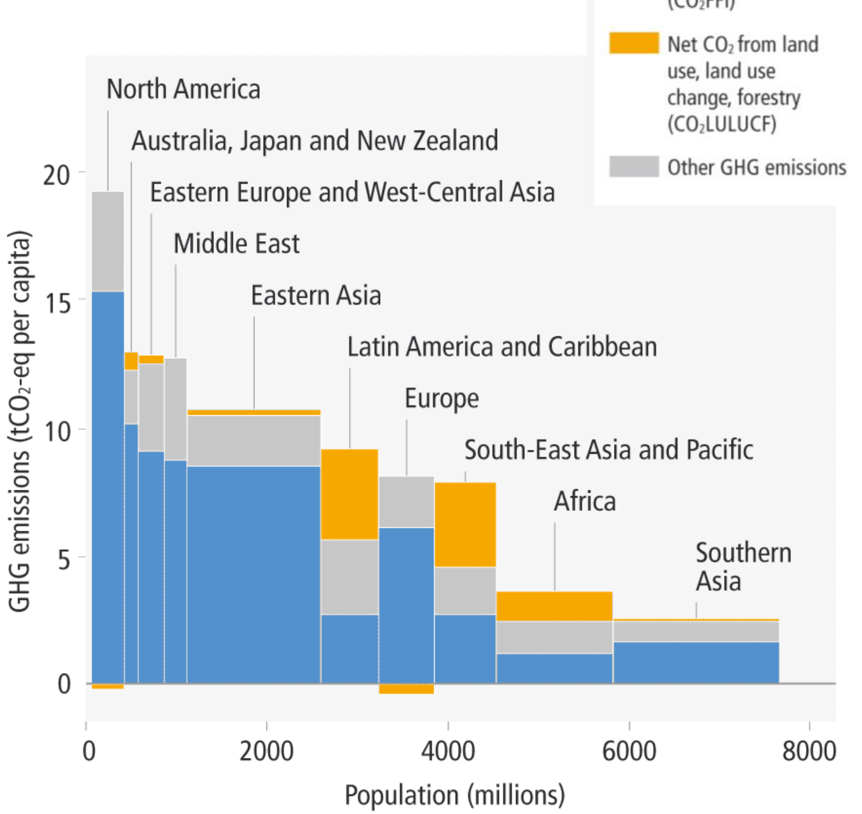
Global emissions have increased by 55% between 1990 and 2019.

The share in global emissions has increased most significantly in Eastern Asia - from 13% to 27%.

Differences in per capita emissions and GHG profile

- Per capita emissions in North America are more than 7 times higher than in Southern Asia, the region with lowest per capita emissions of 2.6 tCO_2e/person.
- In three regions – LAC, SEA and Africa – net emissions from LULUCF play a major role, while emissions in other regions stem mainly from fossil fuels and industry.
- Only in North America and Europe the LULUCF sector acts as a net sink, although uncertainties are high.
- Average global per capita net anthropogenic GHG emissions increased from 7.7 to 7.8 tCO_2e/person between 1990 and 2019.

GHG emissions in tonnes CO_2e per capita by region in 2019



MODULE A4

WHAT ARE EFFECTS ON SUSTAINABLE DEVELOPMENT?

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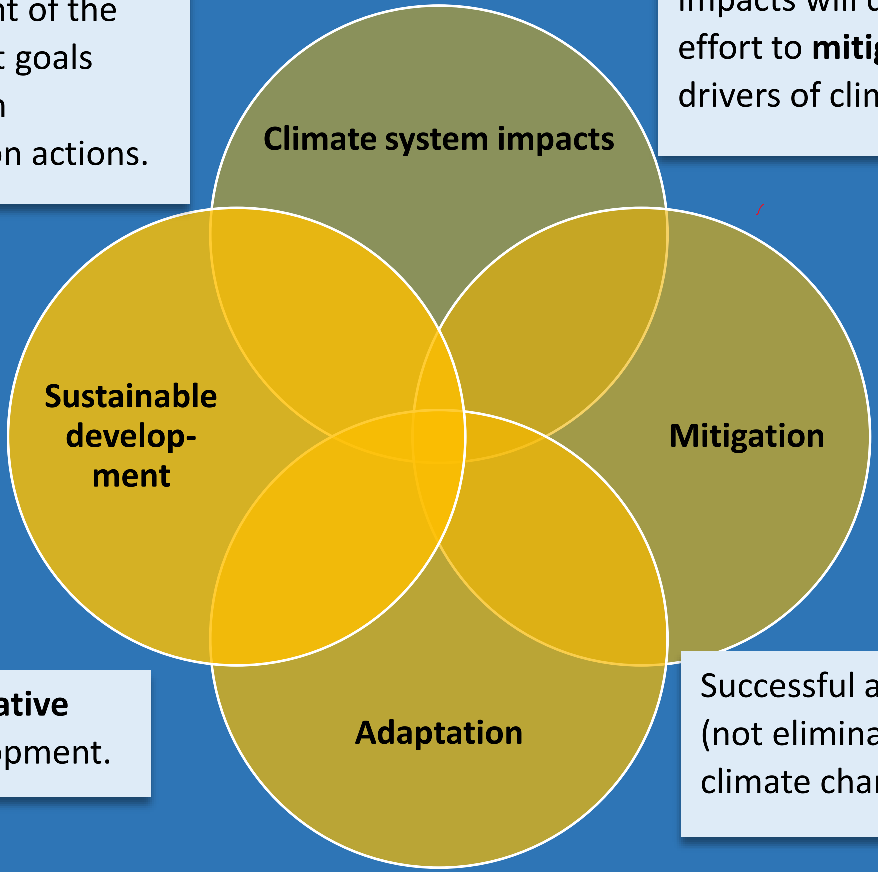
A complex system of interactions

The impacts of climate change **threaten** the achievement of the Sustainable development goals (SDGs) and the long-term effectiveness of mitigation actions.

The severity of climate change impacts will depend on the global effort to **mitigate** human induced drivers of climate change.



The level of development influences the **ability** of individuals and countries for mitigation and adaptation

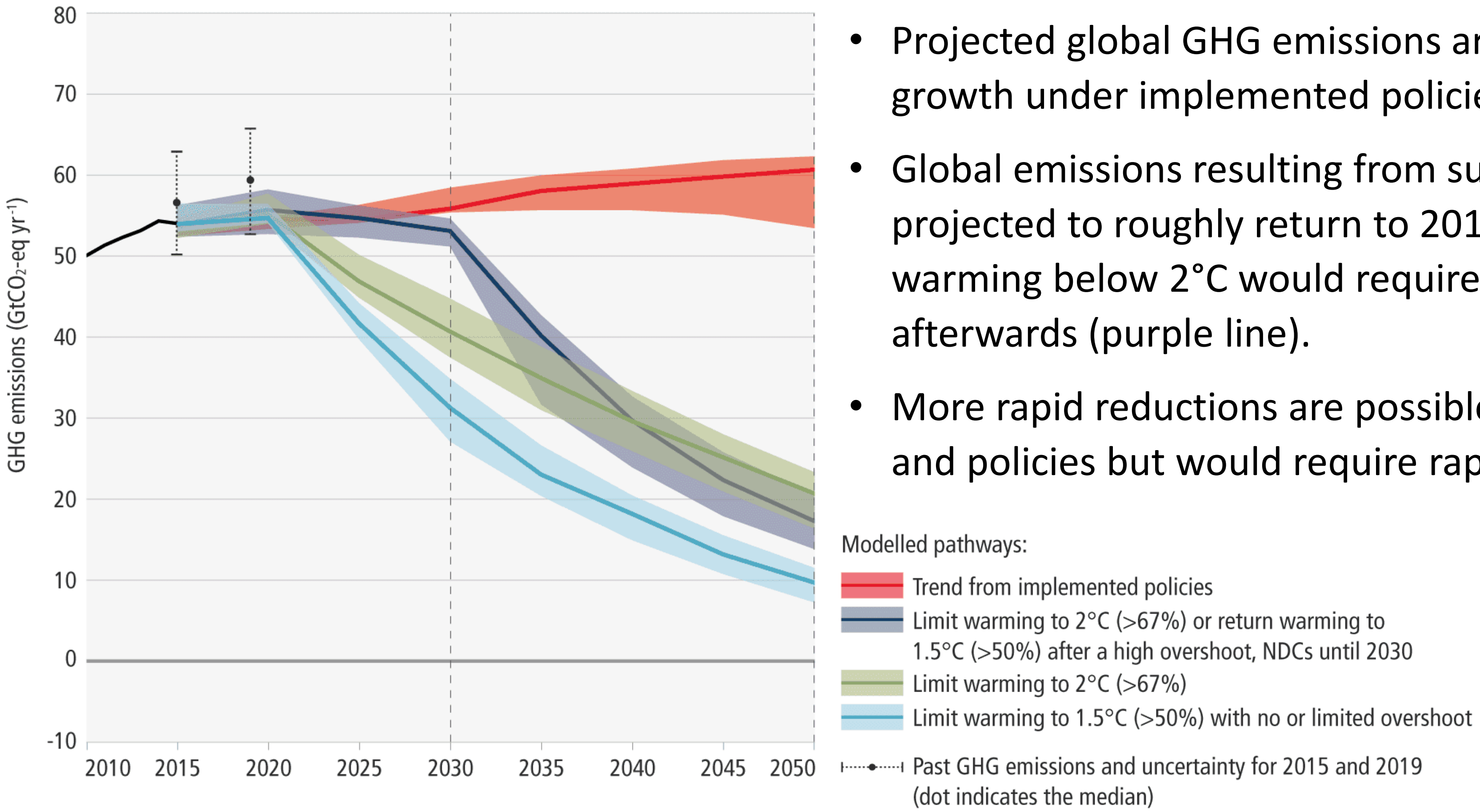
More or less progress on mitigation will determine the **need** for adaptation.

Maladaptation can have **negative effects** on sustainable development.

Successful adaptation can **reduce** (not eliminate) the **risk** from climate change.

Mitigation, adaptation and sustainable development efforts can provide **synergies** or pose **trade-offs**.

Mitigation: limiting impacts is still possible



- Projected global GHG emissions are projected to continue growth under implemented policies (red line).
- Global emissions resulting from submitted NDCs are projected to roughly return to 2015 levels by 2030. Limiting warming below 2°C would require more rapid reductions afterwards (purple line).
- More rapid reductions are possible with known technologies and policies but would require rapid implementation.

Paris Agreement objective:

"Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels."

Mitigation: economic effects of action vs. inaction

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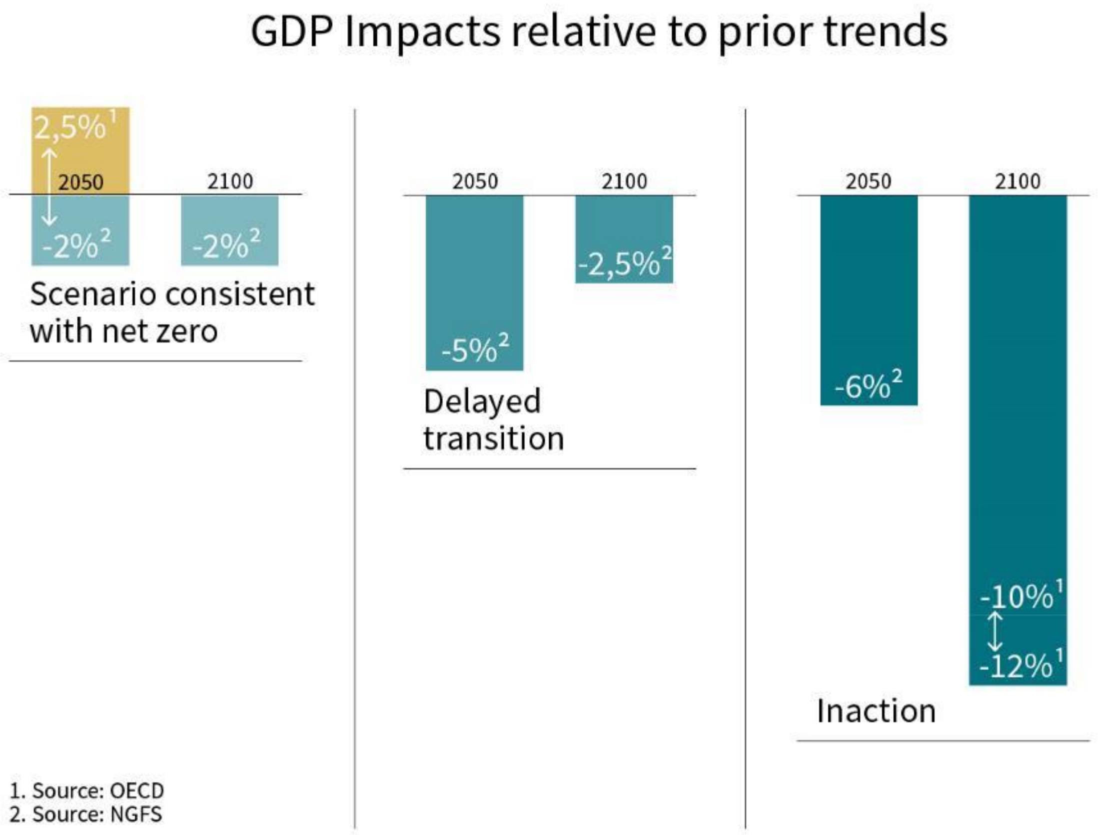
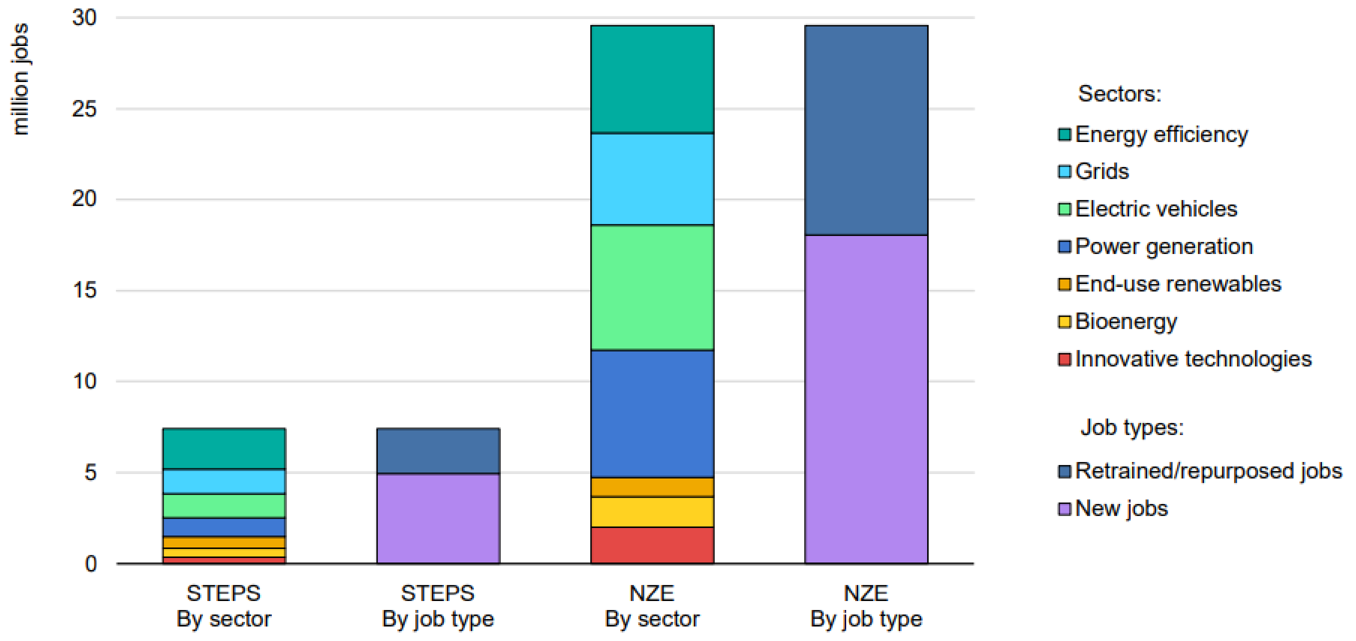


- Achieving the required GHG emission reductions will require immense investments.
- However, investment will also deliver a positive boost to economic activity, directly bolstering demand and delivering additional benefits.
- Assessing the cost of inaction is highly uncertain, but existing estimates suggests that the effects on global GDP would be much higher than those for rapid and ambitious action.
- Costs will differ across different economies and geographies.

Mitigation: creating jobs through enhanced action

New workers in clean energy and related sectors and shares by sector and job type in the Net Zero Emissions by 2050 Scenario (NZE) and the Stated Policies Scenario (STEPS) in 2030



In the IEA Net Zero Emissions by 2050 Scenario, an early policy focus on energy efficiency would triple the number of jobs created by 2030 through increased spending on building retrofits, more efficient appliances and other measures.

Adaptation: working towards a global goal

The Paris Agreement established a global goal on adaptation:

- Enhancing adaptive capacity
- Strengthening resilience to climate change
- Reducing vulnerability to climate change

With a view to ensuring that adaptation and mitigation efforts contribute to sustainable development, an adequate adaptation response and low GHG development without threatening food production.

The two-year 'Glasgow–Sharm el-Sheikh work programme on the global goal on adaptation' aims to support the implementation, operationalisation and tracking of progress towards this goal.

Adaptation: most difficult for those who need it most

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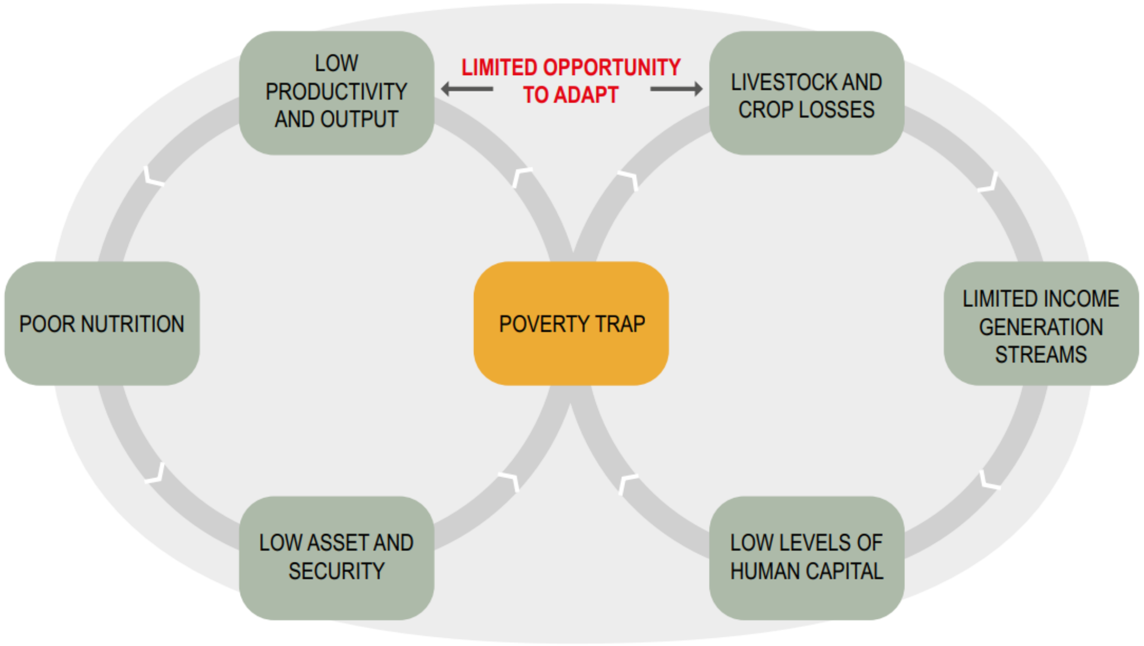
Adaptation is defined, in human systems, as the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities.

Adaptation is a social process that evolves over time, includes multiple decision-points, and requires dynamic adjustments in response to new information about climate risk, socioeconomic conditions, and the value of potential adaptation responses.

Impacts of climate change together with non-climatic drivers can create poverty-environment traps that may increase the probability of long-term and chronic poverty.



The IPCC discusses a wide range of adaptation measures, their feasibility and the state of implementation.

Inter-relations between gender equality and adaptation

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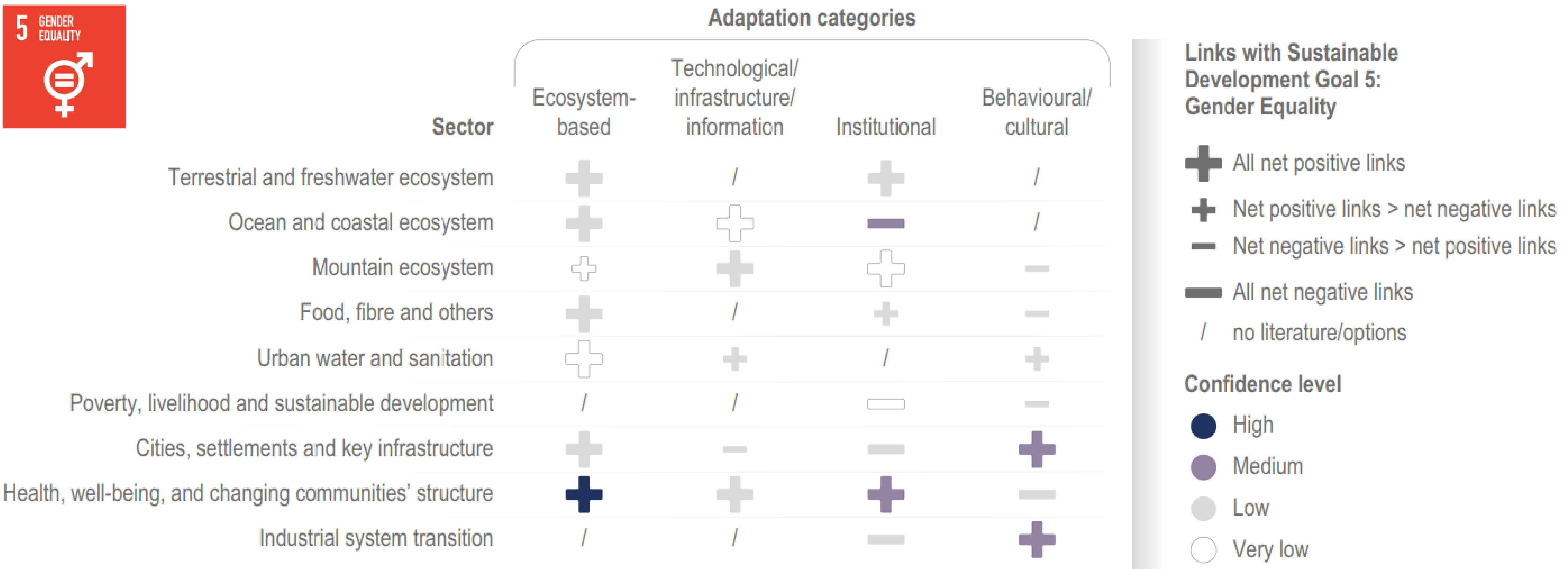
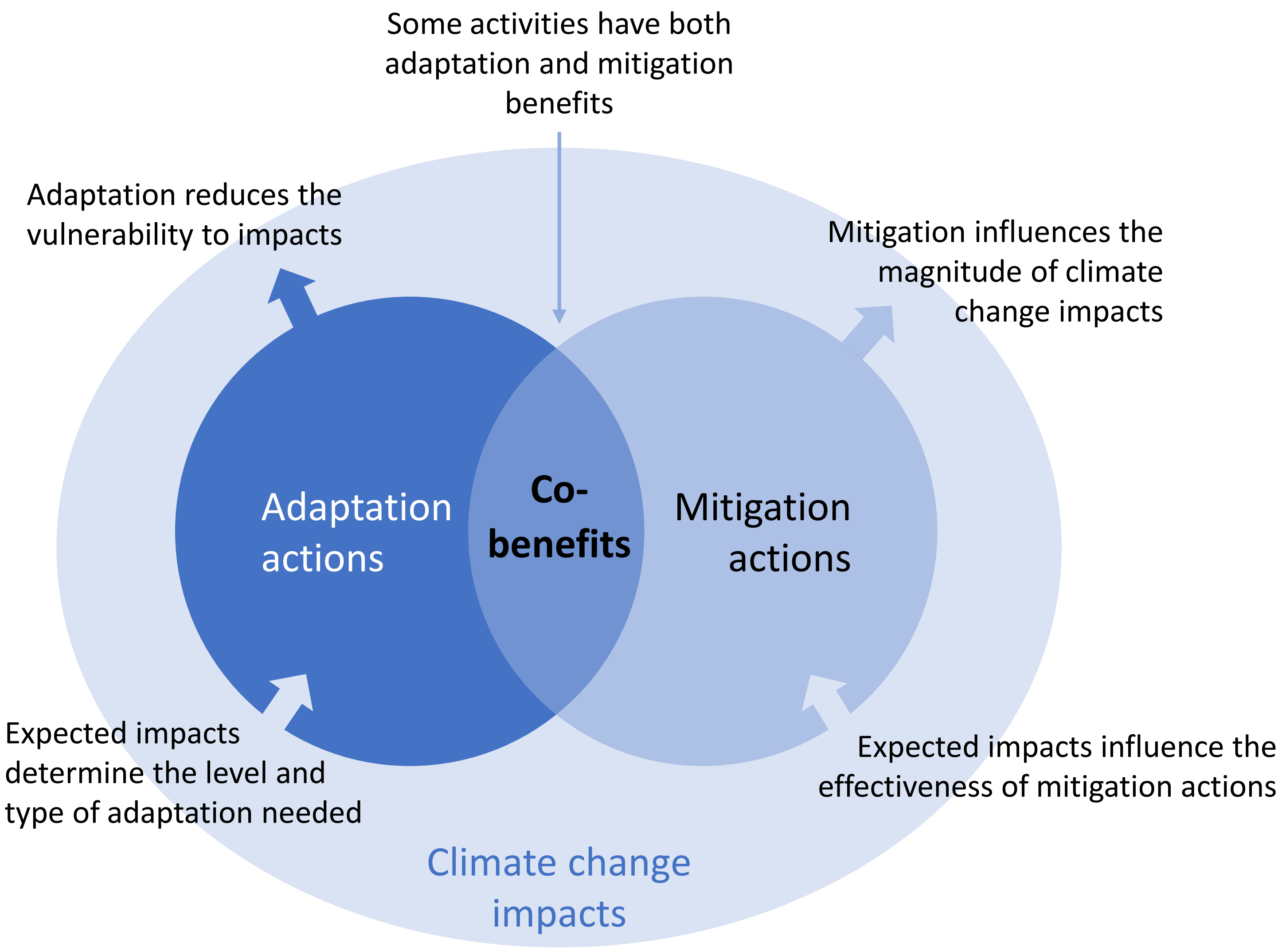


Adaptation and mitigation in the context of a changing climate

Both adaptation and **mitigation** activities need to be designed in the light of the expected climate change impacts!



Adaptation – mitigation synergies and trade-offs

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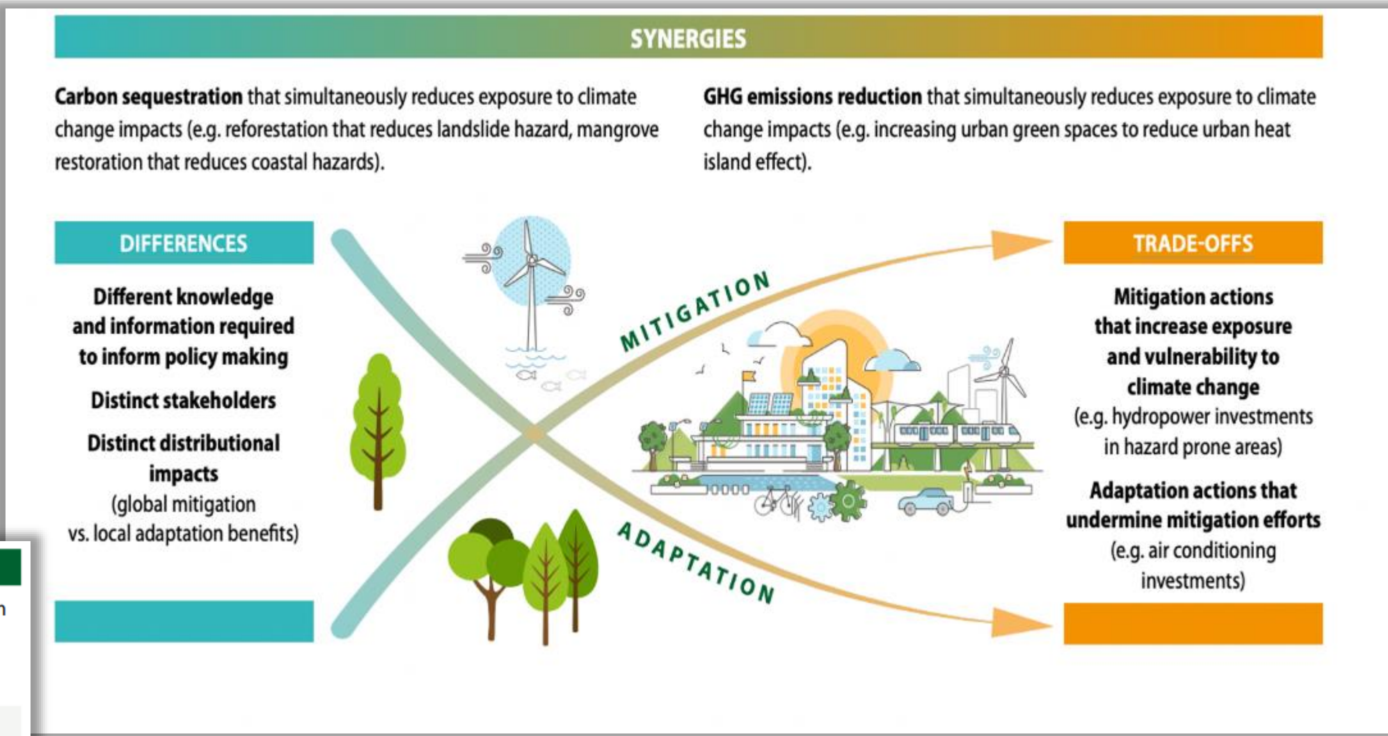
Actions that have synergies can help achieve climate goals more effectively.



Sector	Climate action	Mitigation benefit	Adaptation benefit	Trade-offs
Forestry	Forest conservation and rehabilitation	Carbon sequestration	Increase resilience to water-related risks (floods, landslides, mudslides, torrents)	Monoculture plantations can be susceptible to fire
Agriculture and land management	Use of crop varieties with higher drought and pest resistance; Sustainable land management practices (efficient nitrogen use and soil management)	GHG emissions savings from reduced energy consumption for irrigation and improved soil quality	Increase resilience to droughts and floods	Biofuel production in some context
Water management	Protect and restore marine ecosystems such as seagrass beds, mangroves, saltmarsh, coastal wetland; storm water management	Carbon sequestration	Enhance resilience to water-related risks (coastal floods and storms; droughts)	Solar water pumps in arid zones
Urban planning	Urban green space expansion (parks, green roofs)	Carbon sequestration, GHG emissions savings from reduced energy consumption for cooling	Increase resilience to extreme heat and urban floods (by decreasing urban heat island effect and increasing water absorption capacity)	Building less dense areas; use of air-conditioning

Trade-offs between adaptation and mitigation, need to be recognised and managed to avoid undermining policy objectives.

The Sustainable Development Goals (SDGs)

The Sustainable Development Goals are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere.

The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals.

Mitigation and SDGs: Synergies and trade-offs

Interactions between individual mitigation measures and sustainable development will depend on:

- The specific local context
- The scale of implementation
- The design of the measure, especially activities to minimise adverse effects
- Other mitigation measures in place or planned
- Adaptation measures in place and planned

Depending on the type of measure, the impact will be different for each of the dimensions of sustainable development and may vary for different population groups, depending on age, gender, socio-economic class, ethnicity and race.

➡ The IPCC provides an overview of some of the most common synergies and trade-offs between mitigation measures and the SDGs.

Mitigation and SDGs: Energy

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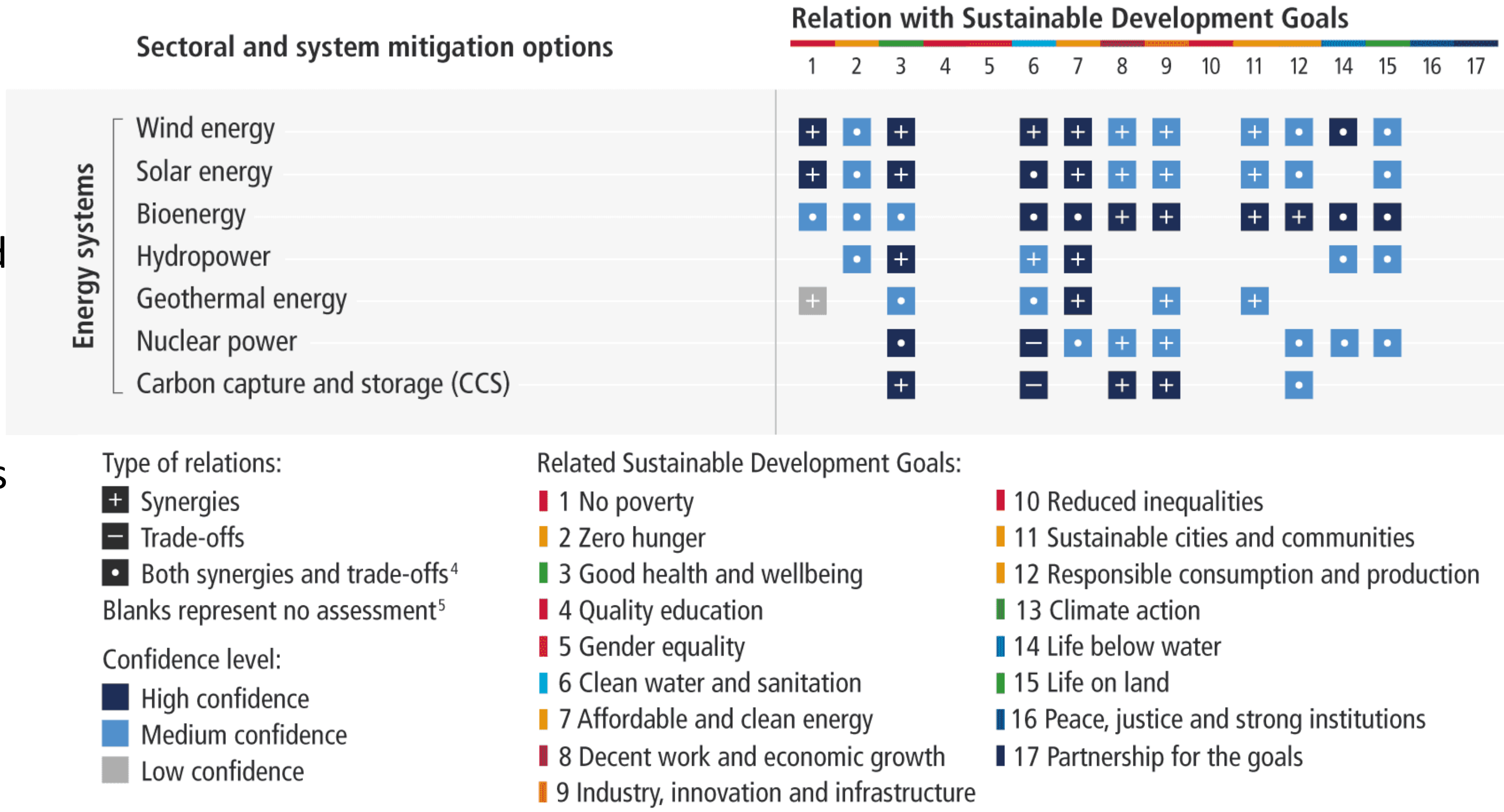
There are many co-benefits of decarbonising the energy system:

- Job creation
- Improvement of air quality (indoor and outside)
- Enhancing energy security

But there are also considerable trade-offs for some measures:

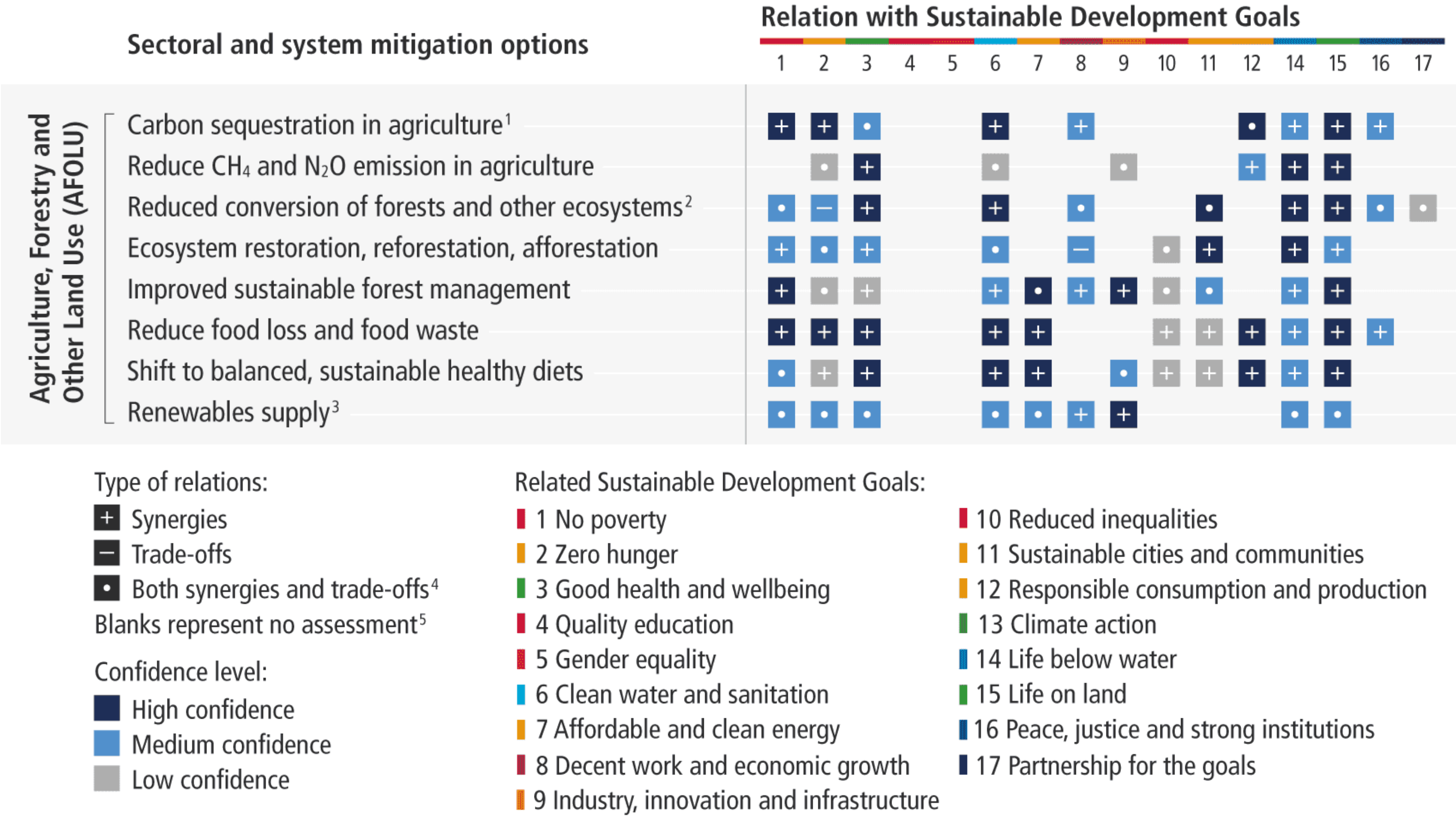
- Unemployment for specific types of workers or regions
- Food security

Some measures also require the achievement of specific SDGs to be successful.



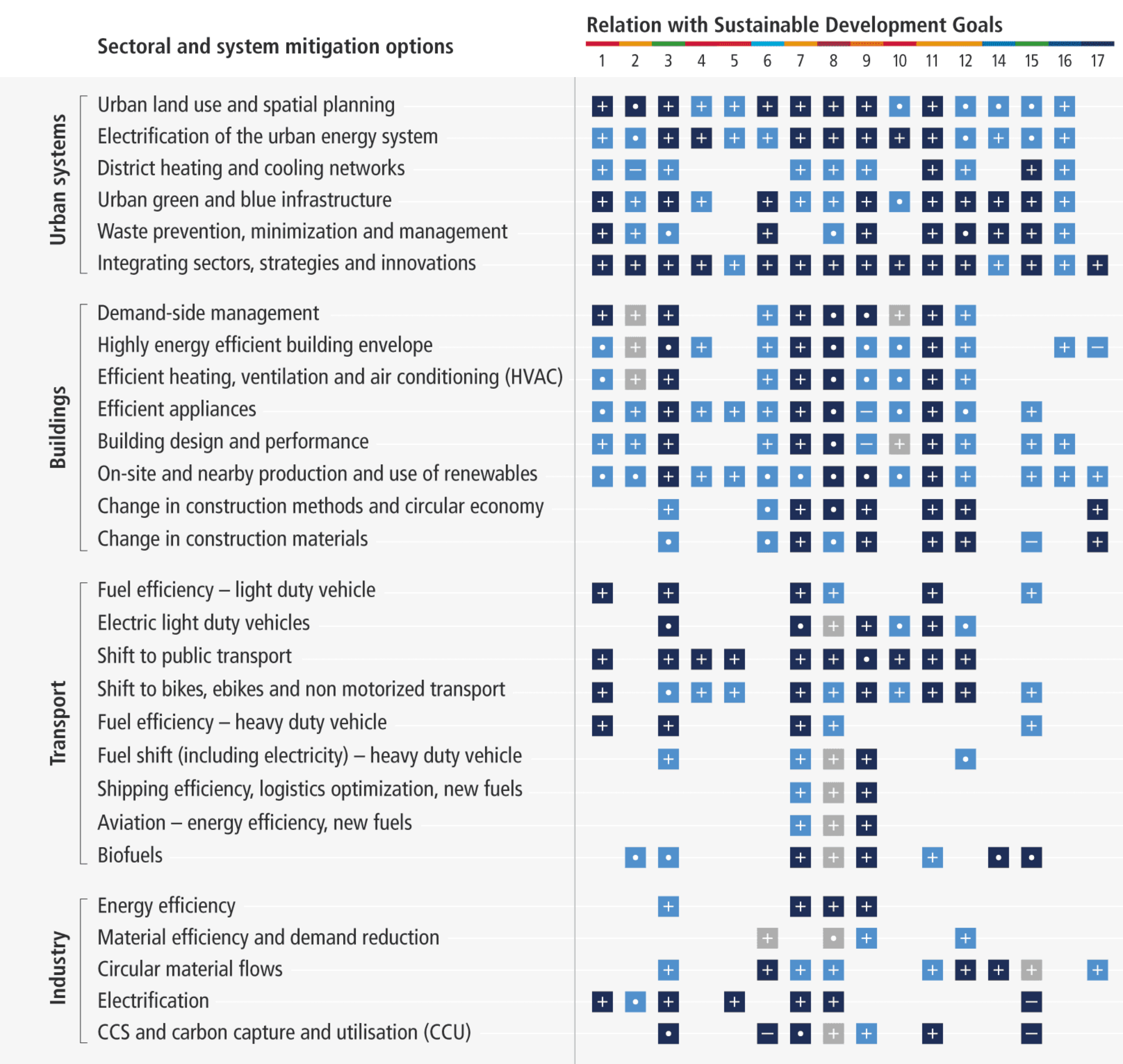
Mitigation and SDGs: AFOLU

- Conservation of biodiversity and ecosystem services is critical to sustaining the well-being and livelihoods of poor and marginalised people, and indigenous communities who depend on natural resources.
- Combined land-based mitigation and adaptation can have several co-benefits as well as help promote development and conservation goals.



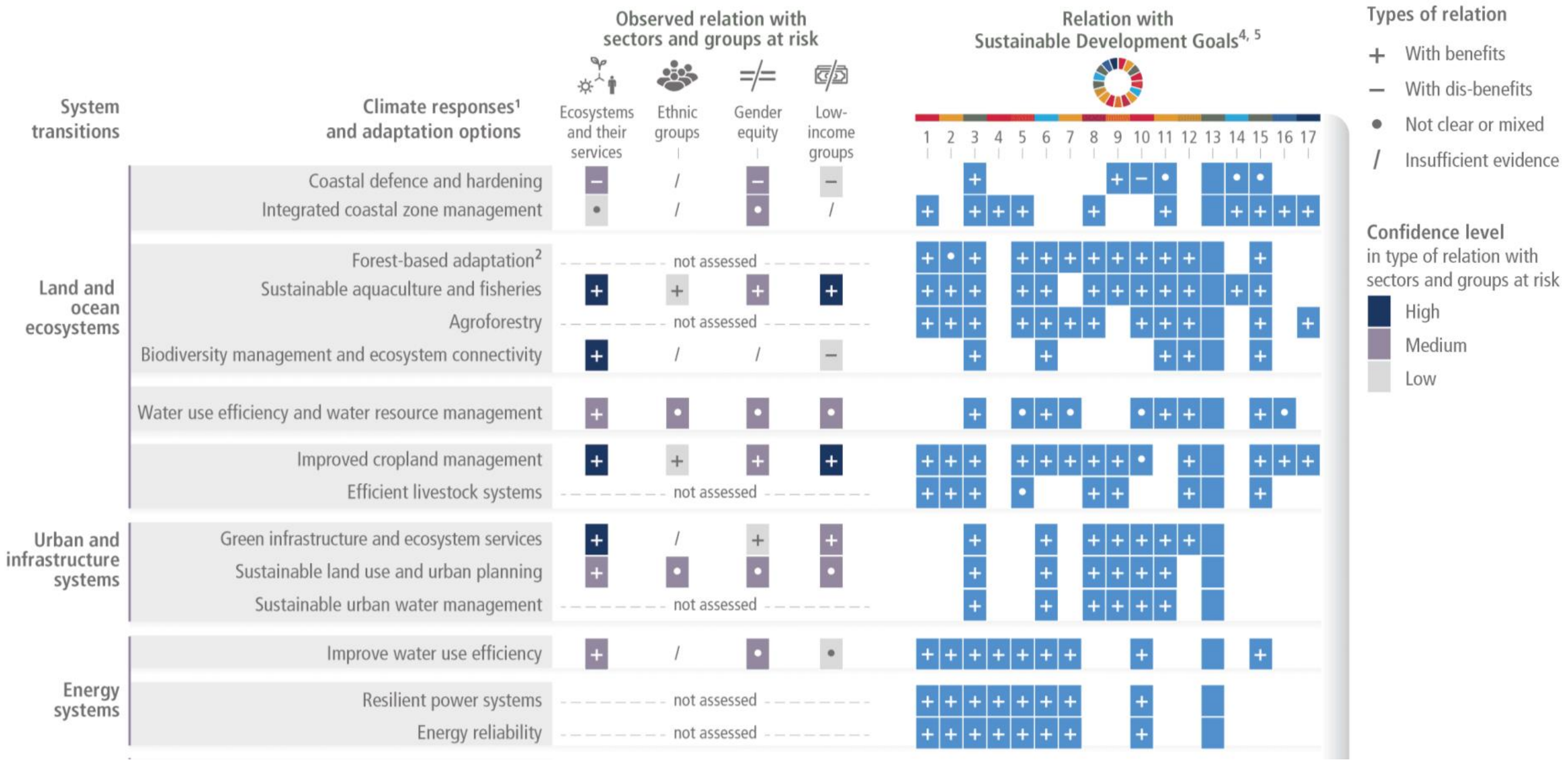
Mitigation and SDGs: other sectors

- The knowledge base varies strongly by sector.
- Information on the linkages in the transport and industry sectors is still limited.
- Overall, there appear to be more synergies than trade-offs.



Adaptation and SDGs: Synergies and trade-offs

- Most adaptation options have clear synergies with the SDGs.
- Some, however, may have negative effects on low income groups or on gender equality.
- Measures should be designed to minimise such negative impacts.



Rapidly narrowing window of opportunity to enable climate resilient development

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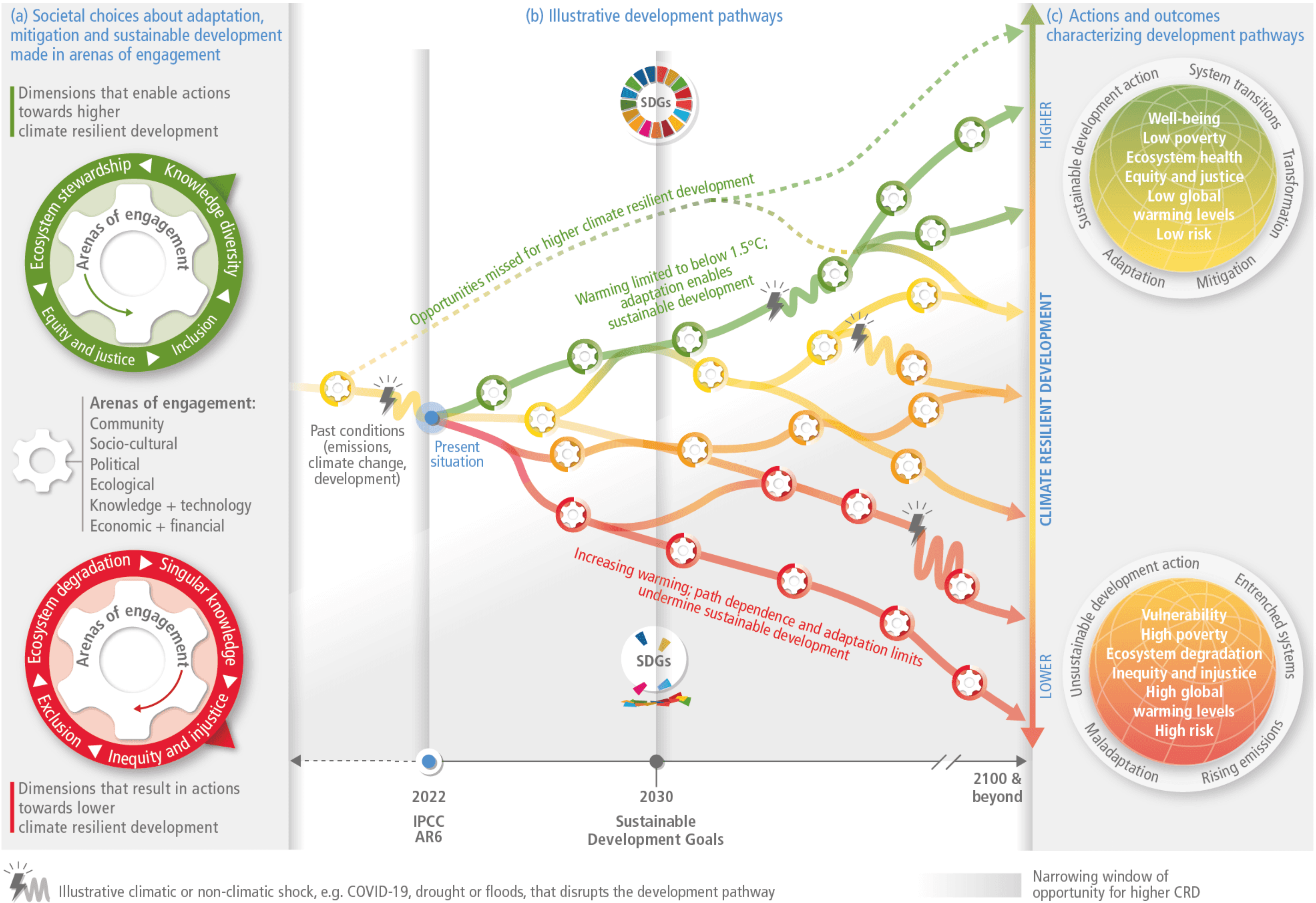
Without decisive action, development will be undermined by climate change



Topics for discussion

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- Where are there opportunities to integrate climate change mitigation and adaptation to address sustainable development priorities in your country in a holistic way?

- What are the key challenges in deciding on and implementing climate change mitigation actions and adaptation responses in your country?

- How can decision-making process be better informed through data and information especially with regards to policies and measures?

THANK YOU FOR YOUR ATTENTION.

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