

Climate Change: Mitigation, Adaptation, and Resilience

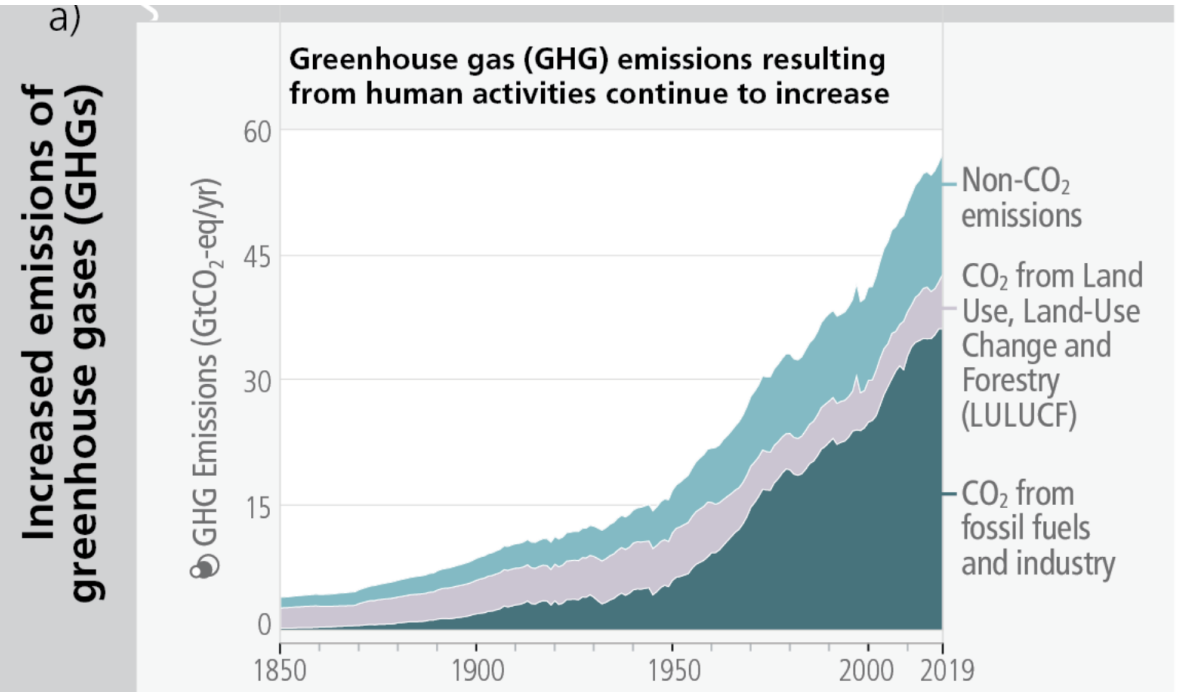
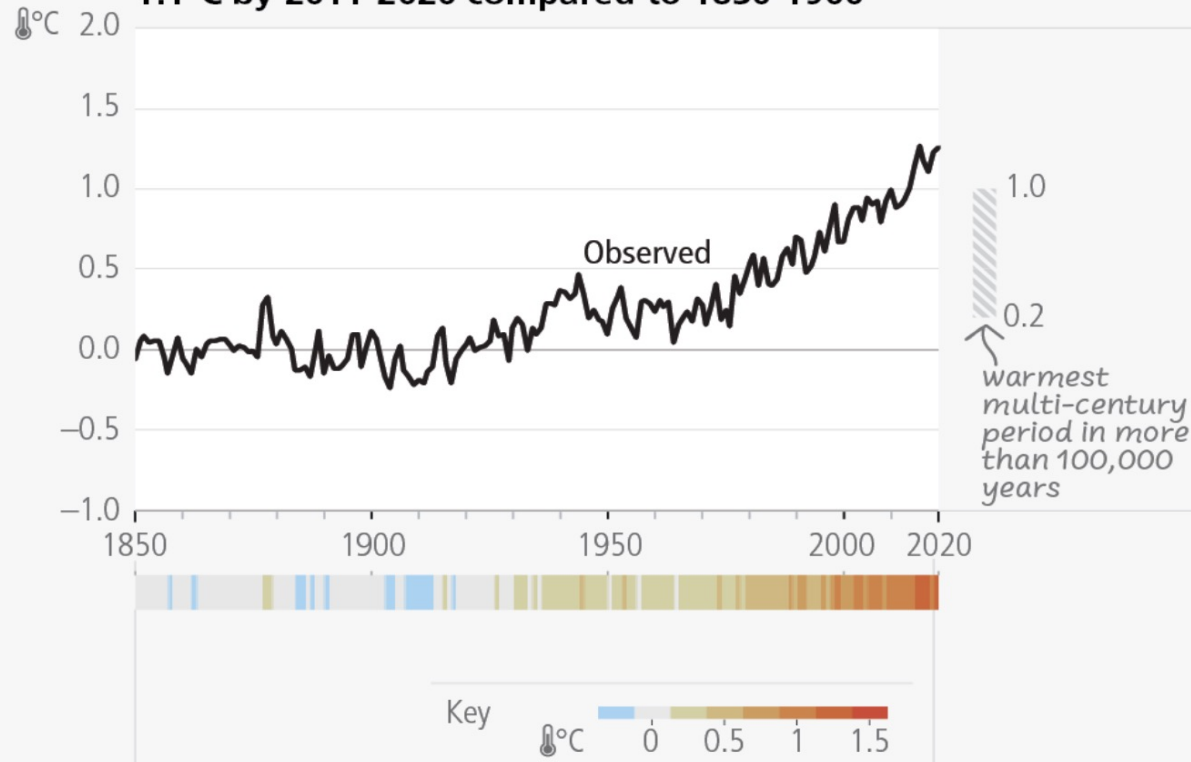
IFAC 2023
Yokohama, Japan

Pramod P. Khargonekar
University of California, Irvine



What Has Already Happened?

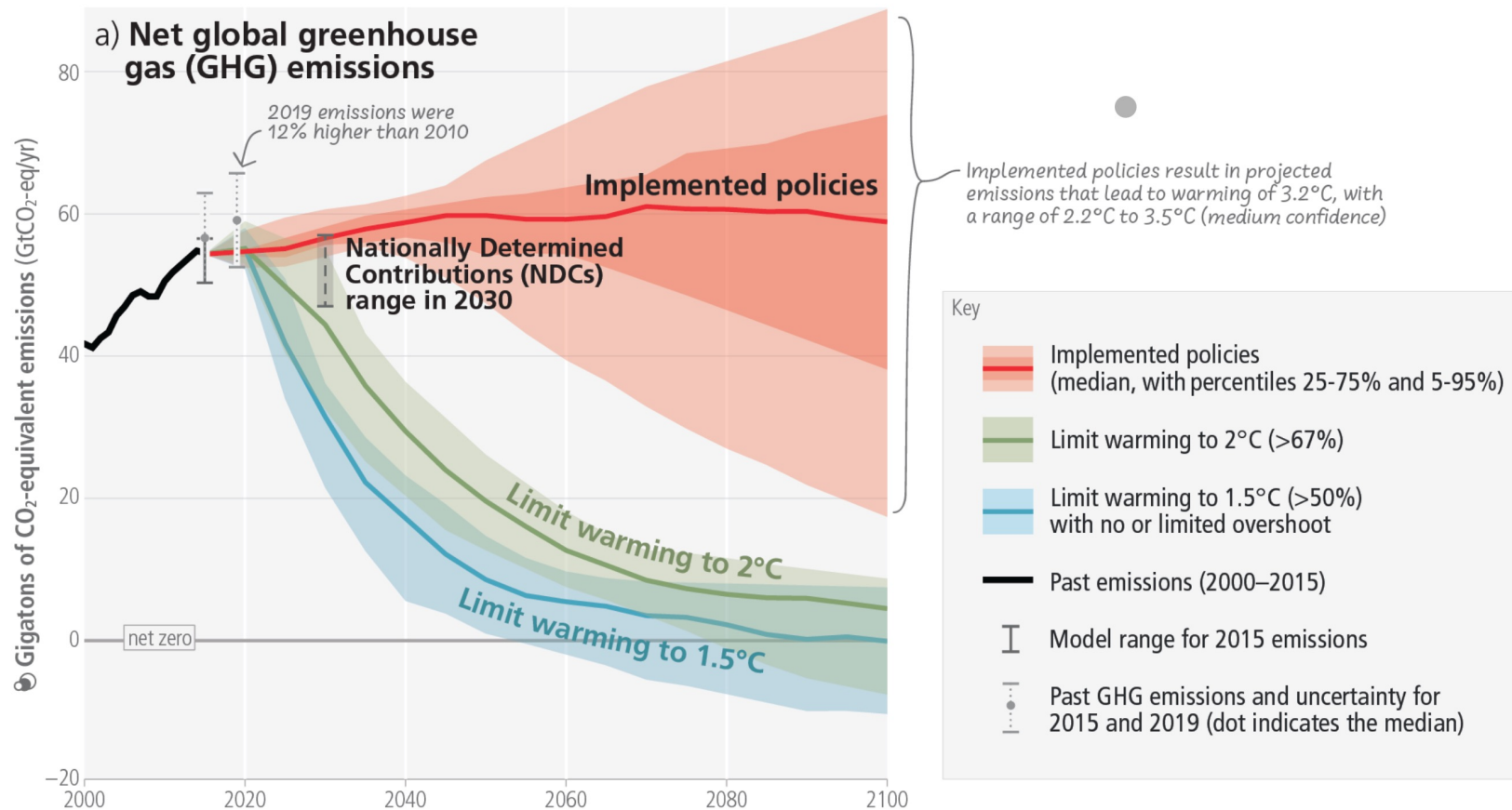
Global surface temperature has increased by 1.1°C by 2011-2020 compared to 1850-1900



What May Happen?

Limiting warming to 1.5°C and 2°C involves rapid, deep and in most cases immediate greenhouse gas emission reductions

Net zero CO₂ and net zero GHG emissions can be achieved through strong reductions across all sectors

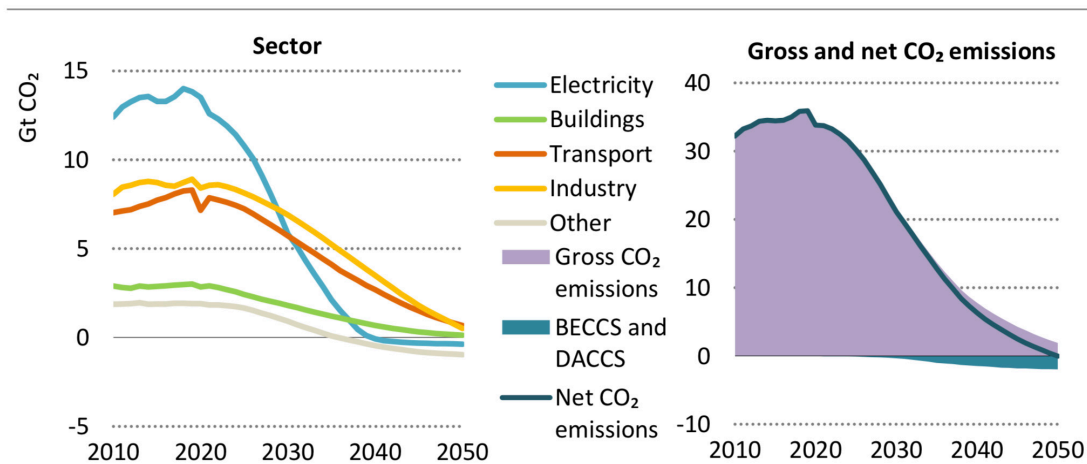


Substantial global warming is going to occur.

Source: IPCC AR6, 2023

Mitigation: IEA Net Zero

Figure 2.3 ▶ Global net- CO_2 emissions by sector, and gross and net CO_2 emissions in the NZE

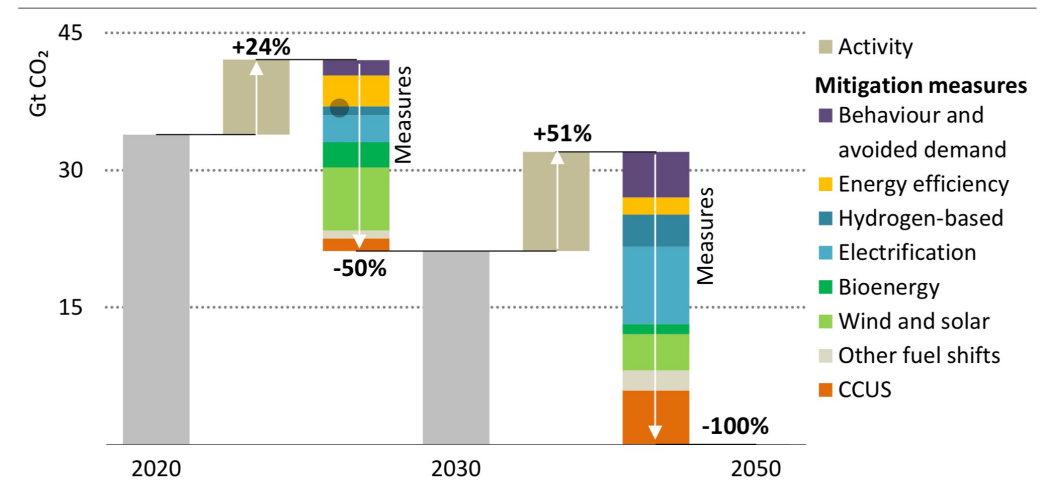


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Emissions from electricity fall fastest, with declines in industry and transport accelerating in the 2030s. Around 1.9 Gt CO_2 are removed in 2050 via BECCS and DACCS.

Notes: Other = agriculture, fuel production, transformation and related process emissions, and direct air capture. BECCS = bioenergy with carbon capture and storage; DACCS = direct air capture with carbon capture and storage. BECCS and DACCS includes CO_2 emissions captured and permanently stored.

Figure 2.12 ▶ Emissions reductions by mitigation measure in the NZE, 2020-2050



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Solar, wind and energy efficiency deliver around half of emissions reductions to 2030 in the NZE, while electrification, CCUS and hydrogen ramp up thereafter

Notes: Activity = energy service demand changes from economic and population growth. Behaviour = energy service demand changes from user decisions, e.g. changing heating temperatures. Avoided demand = energy service demand changes from technology developments, e.g. digitalisation. Other fuel shifts = switching from coal and oil to natural gas, nuclear, hydropower, geothermal, concentrating solar power or marine.

Impacts of Climate Change

a) Observed widespread and substantial impacts and related losses and damages attributed to climate change

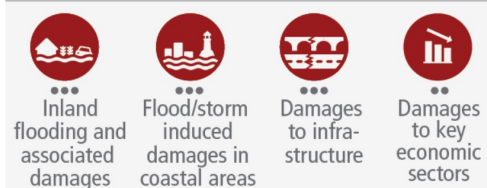
Water availability and food production



Health and well-being



Cities, settlements and infrastructure



Biodiversity and ecosystems



Key

Observed increase in climate impacts to human systems and ecosystems assessed at **global level**

- Adverse impacts
- Adverse and positive impacts
- Climate-driven changes observed, no global assessment of impact direction

Confidence in attribution to climate change

- High or very high confidence
- Medium confidence
- Low confidence

Adaptation and resilience are crucial

b) Impacts are driven by changes in multiple physical climate conditions, which are increasingly attributed to human influence

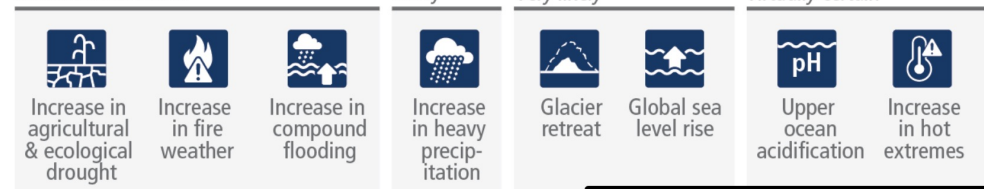
Attribution of observed physical climate changes to human influence:

Medium confidence

Likely

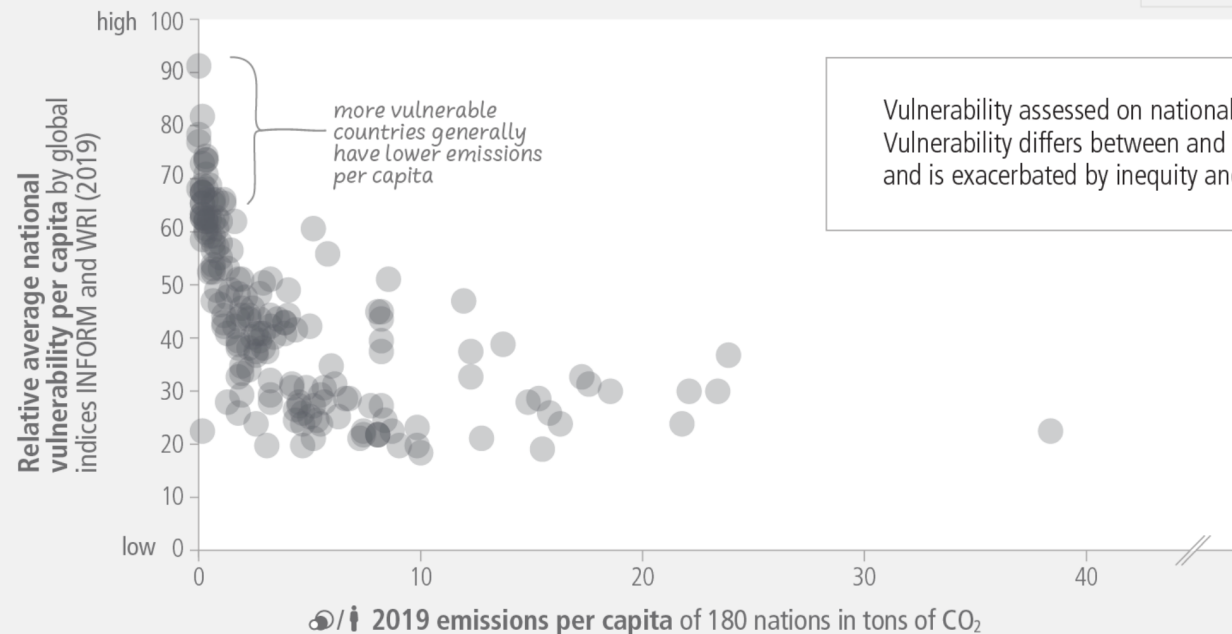
Very likely

Virtually certain



Equity and Justice Issues are Central

b) Vulnerability of population & per capita emissions per country in 2019



Dimension of Risk:



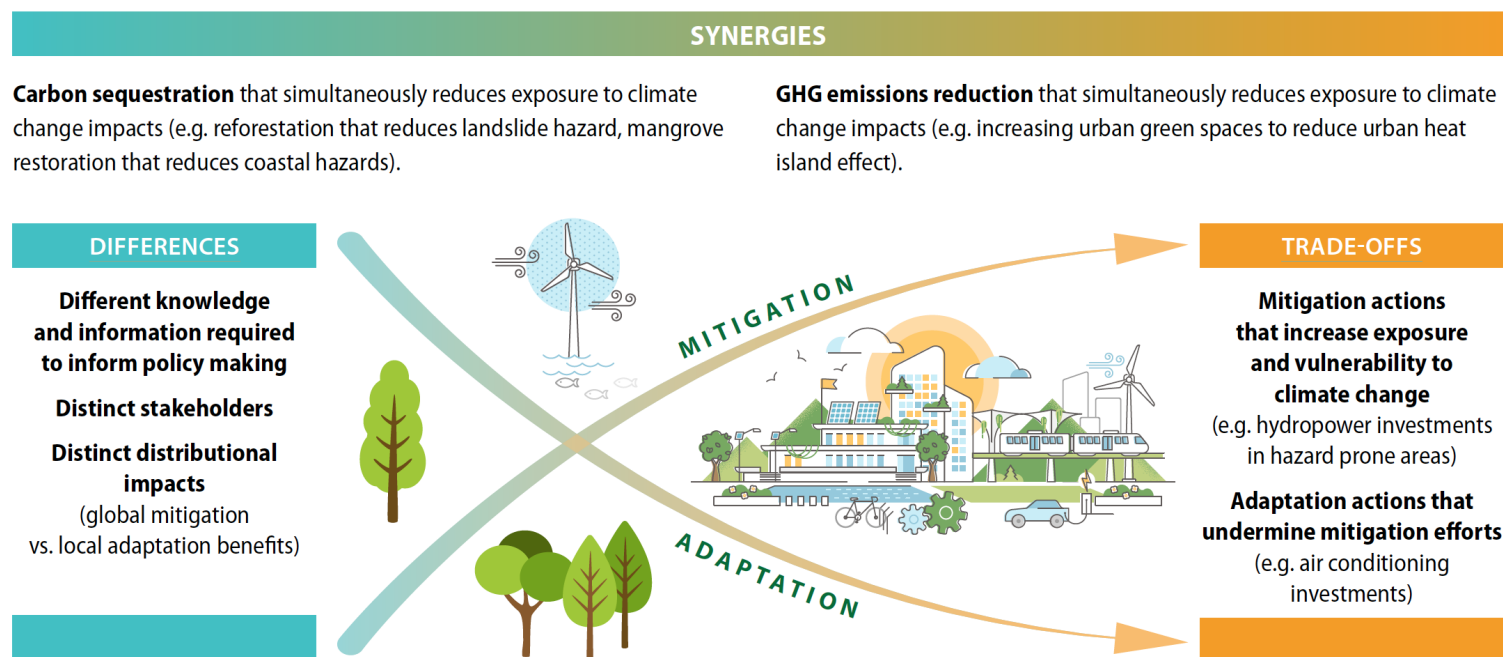
Vulnerability

c) Observed impacts and related losses and damages of climate change

		Global	Africa	Asia	Australasia	Central & South America	Europe	North America	Small Islands
HUMAN SYSTEMS	Water availability and food production								
	Physical water availability								
	Agriculture/crop production								
	Animal and livestock health and productivity								
	Fisheries yields and aquaculture production								
HUMAN SYSTEMS	Health and wellbeing								
	Infectious diseases								
	Heat, malnutrition and harm from wildfire								
	Mental health								
HUMAN SYSTEMS	Cities, settlements and infrastructure								
	Displacement								
	Inland flooding and associated damages								
	Flood/storm induced damages in coastal areas								
	Damages to infrastructure								
	Damages to key economic sectors								

Adaptation, Resilience, and Mitigation Can Be Synergistic

FIGURE 2. Aligning climate change mitigation and adaptation policies: differences, synergies and trade-offs



- Distributed energy systems can enable greater renewable integration as well as resilience to extreme events
- Resource optimization in agriculture can be better adapted to future arid climate and higher temperatures
- Electrification of transportation can yield better public health outcomes with cleaner air

What Can We Do?



- Numerous opportunities in mitigation, adaptation, and resilience
- Most problems require multidisciplinary collaboration including sciences, engineering, social sciences, humanities, business, and law
- Research to innovation to implementation is critical
- Scaling of solutions is relatively well understood for mitigation but in infancy for adaptation and resilience
- Solutions should be implementable in the developing countries