



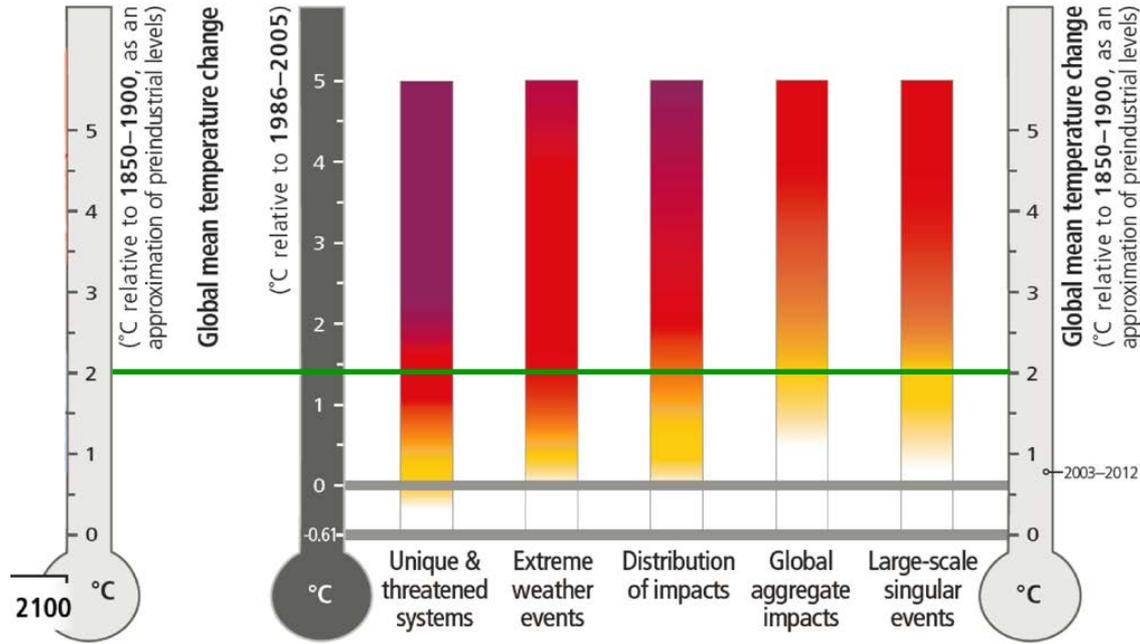
POTSDAM INSTITUTE FOR
CLIMATE IMPACT RESEARCH

Climate Change in Oceania

Prof. Dr. Ottmar Edenhofer

**FCBCO - Federation of Catholic Bishops Conferences of Oceania
Assembly
12 April 2018, Port Moresby**

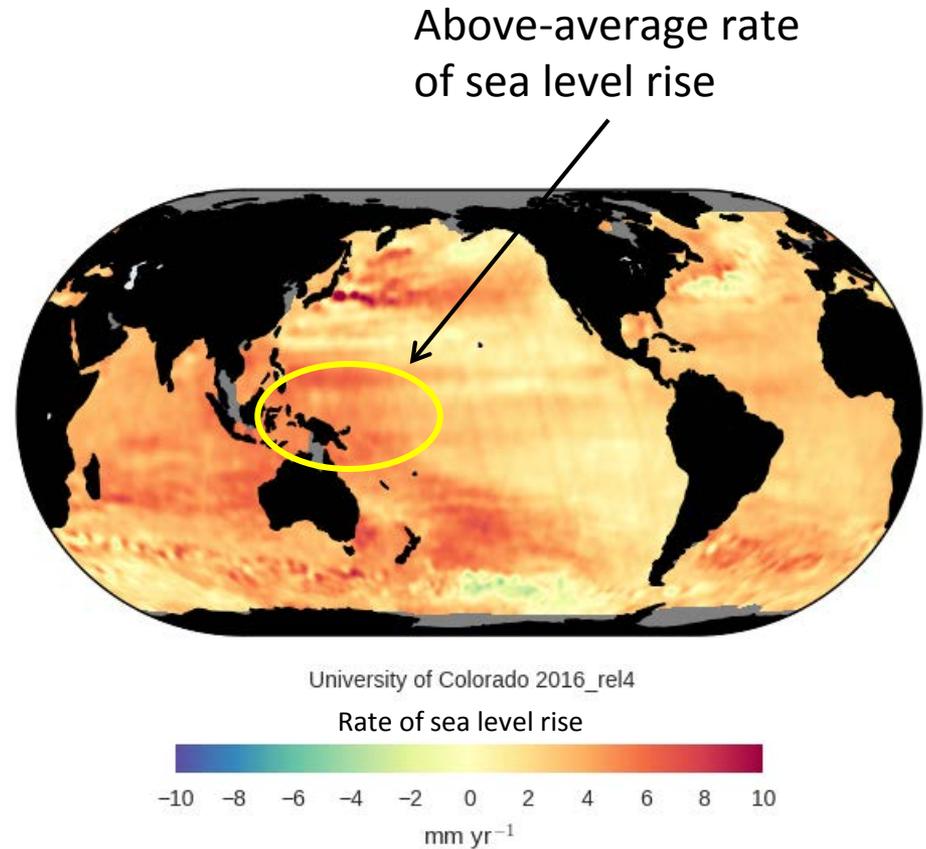
Climate Projections and Associated Risks



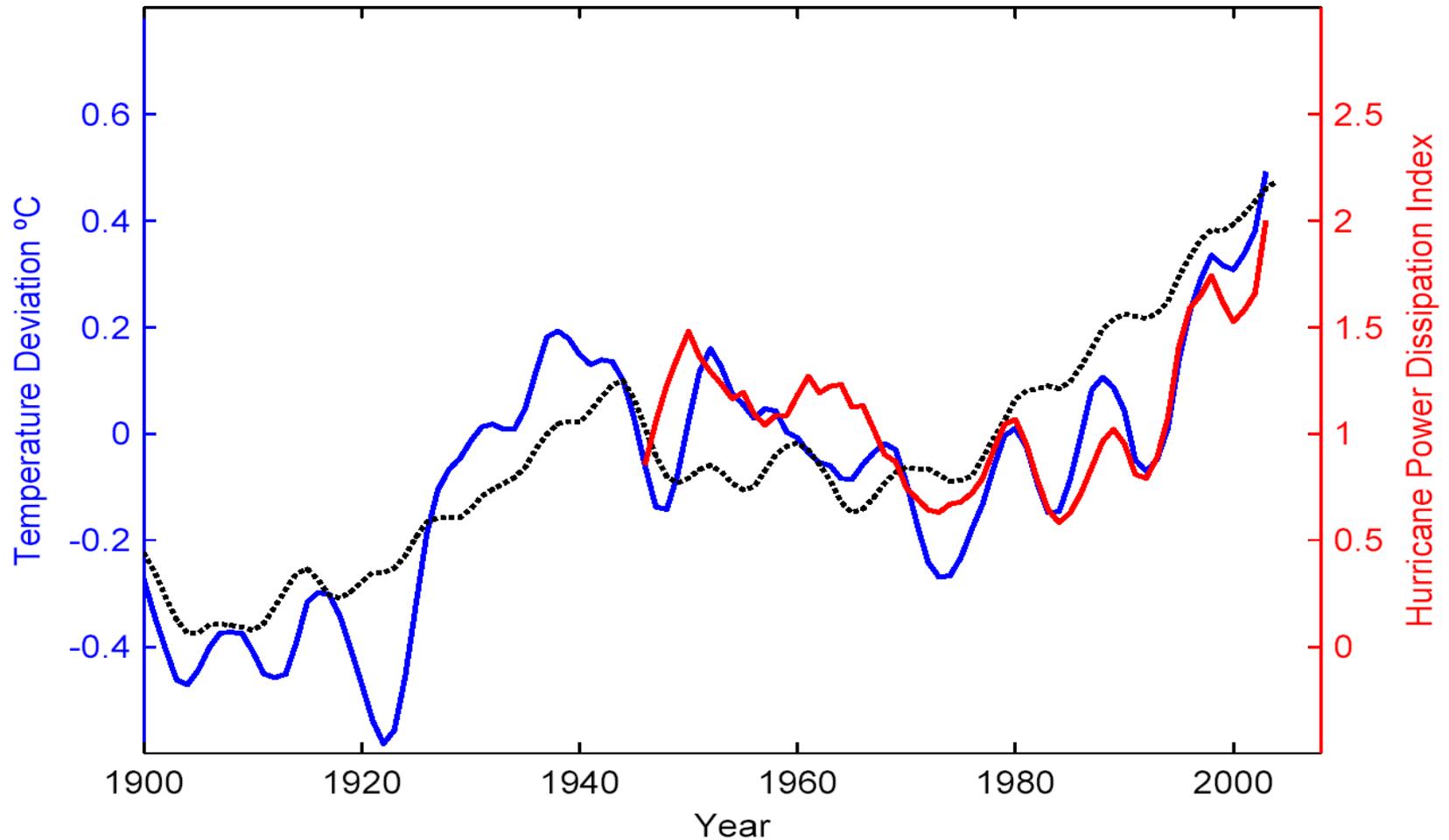
Source: Slide by H. J. Schellhuber

Unequally Distributed Sea-Level Rise Increase

- Melting ice sheets and thermal expansion lead to rising sea levels
- Sea level rise in the West Pacific occurs faster, affecting islands like Kiribati or Fiji
- Impacts of sea-level rise:
 - Shrinking land mass
 - Salinization of ground water lenses and soil
 - Storm tides strongly intensified by sea level rise



Warming Sea Surface increases Cyclone Intensity



Severe Tropical Cyclone Gita



Cyclone Gita: Tonga devastated by worst storm in 60 years

Winds of more than 230km/h recorded as parliament building flattened and power lines brought down



Photograph: Social Media/Reuters

Impacts of tropical storms:

- Higher risks of storm surges
- Damage of infrastructure and diseases
- Salinization

Severe Tropical Cyclone Pam

Pam hit Vanuatu with a wind speed up to 320 km/h in March 2015, leaving 16 people dead and several with severe injuries.

"After all the development we have done for the last couple of years and this big cyclone came and just destroyed... all the infrastructure the government has... built. Completely destroyed."

- President of Vanuatu, Baldwin Lonsdale

"There are more than 100,000 people likely homeless, every school destroyed, full evacuation centres, damage to health facilities and the morgue."

- Prime Minister of Vanuatu, Joe Natuman

Surrounded by water, impacted by drought

- Societal impacts:
 - High vulnerability caused by reliance on local fruits due to widespread subsistence-farming
 - Heating of surrounding water leads to temporary loss or migration of marine food stock
 - Health problems (e.g. diabetes) due to drought-related reliance on imported food
 - Fire hazards

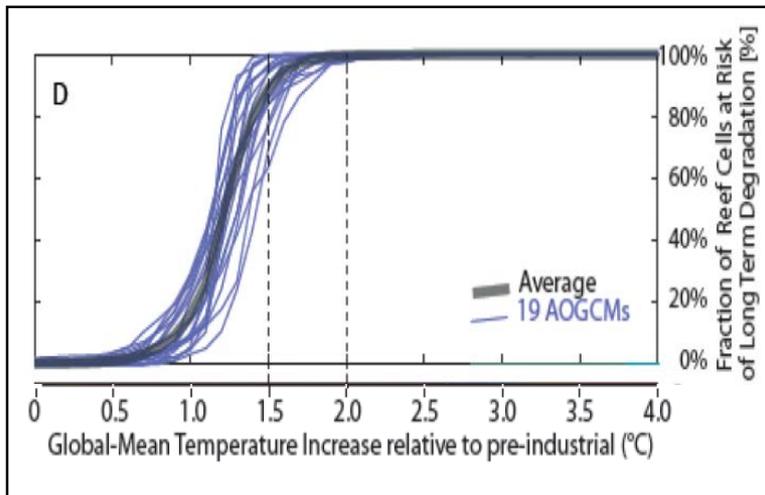


Photograph: The Pacific Adaptation to Climate Change Project

2013 drought on Ailuk Atoll, Marshall Islands

Coral Bleaching: A Hazard beyond Biodiversity Loss

- Acidification and increasing sea surface temperatures lead to coral bleaching and coral death
- Societal impacts:
 - Protective function of coral reefs against storm surges is lost
 - (Traditional) fishing becomes difficult as shallow water fish move further out
 - Fish stocks will decrease in reaction to habitat losses

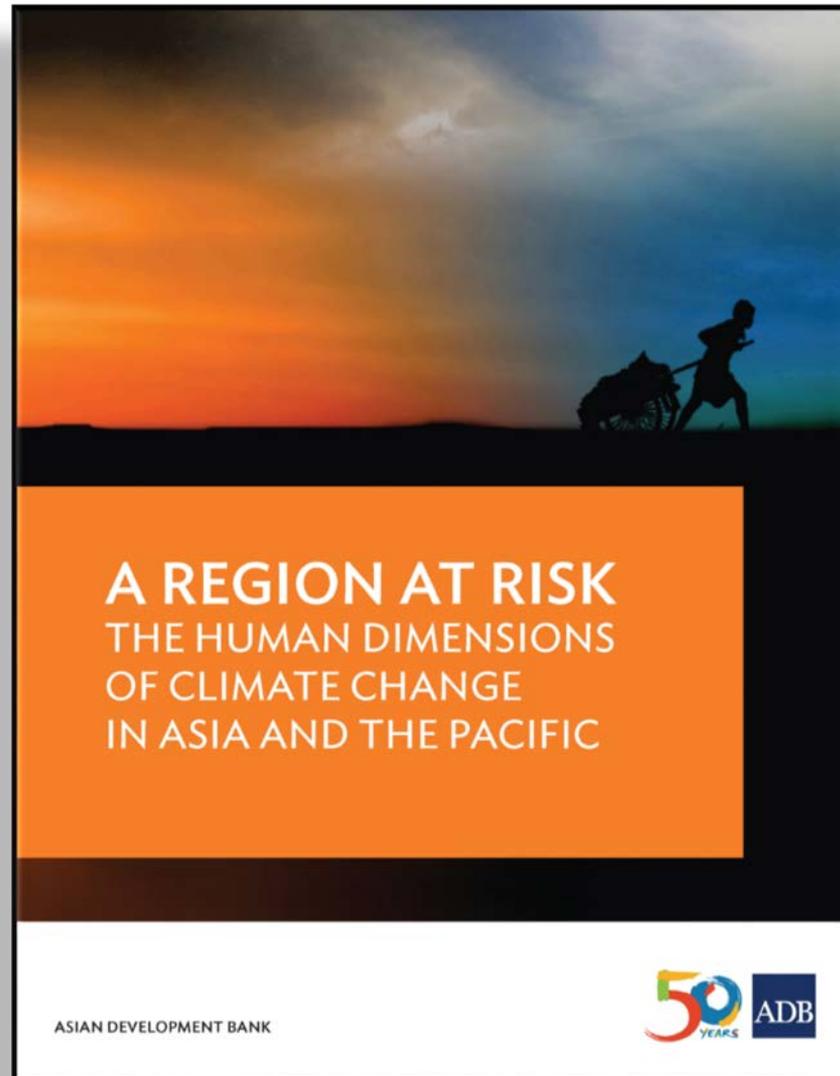


Frieler et al.
(2012):

Preserving >10% of
coral reefs
worldwide would
require limiting
warming to *below*
1.5 °C

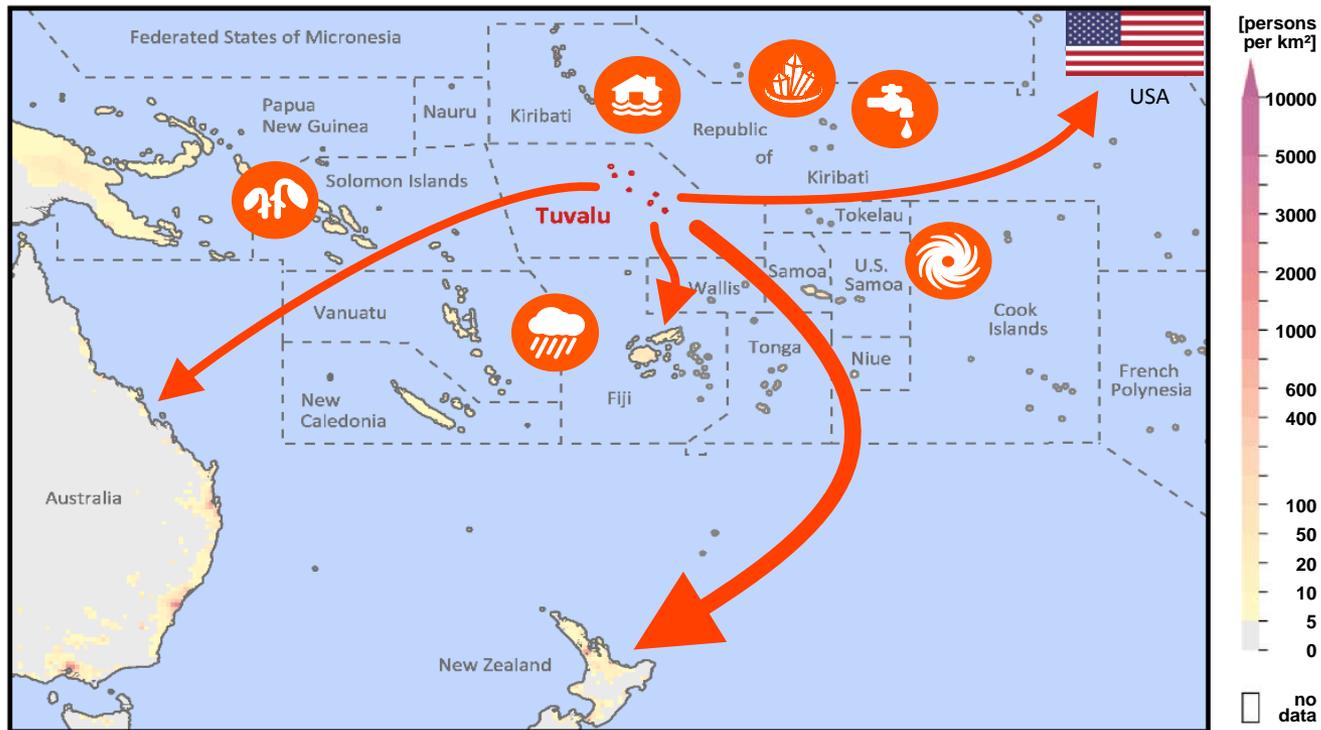


PIK – ADB Report



Vinke, K.; Schellnhuber, H.-J.; Laplante, B.; Coumou, D.; Geiger, T.; Glanemann, N.; Huber, V.; Kropp, J.; Kriewald, S.; Lehmann, J.; Levermann, A.; Lobanova, A.; Lu, X.; Knaus, M.; Otto, C.; Reyer, C.; Robinson, A.; Rodgers, C.; Rybski, D.; Schewe, J.; Willner, S.; Wortmann, M.; Zhao, F.; Zhou, B. (2017)

Climate Change & Migration: Possible Routes from Tuvalu

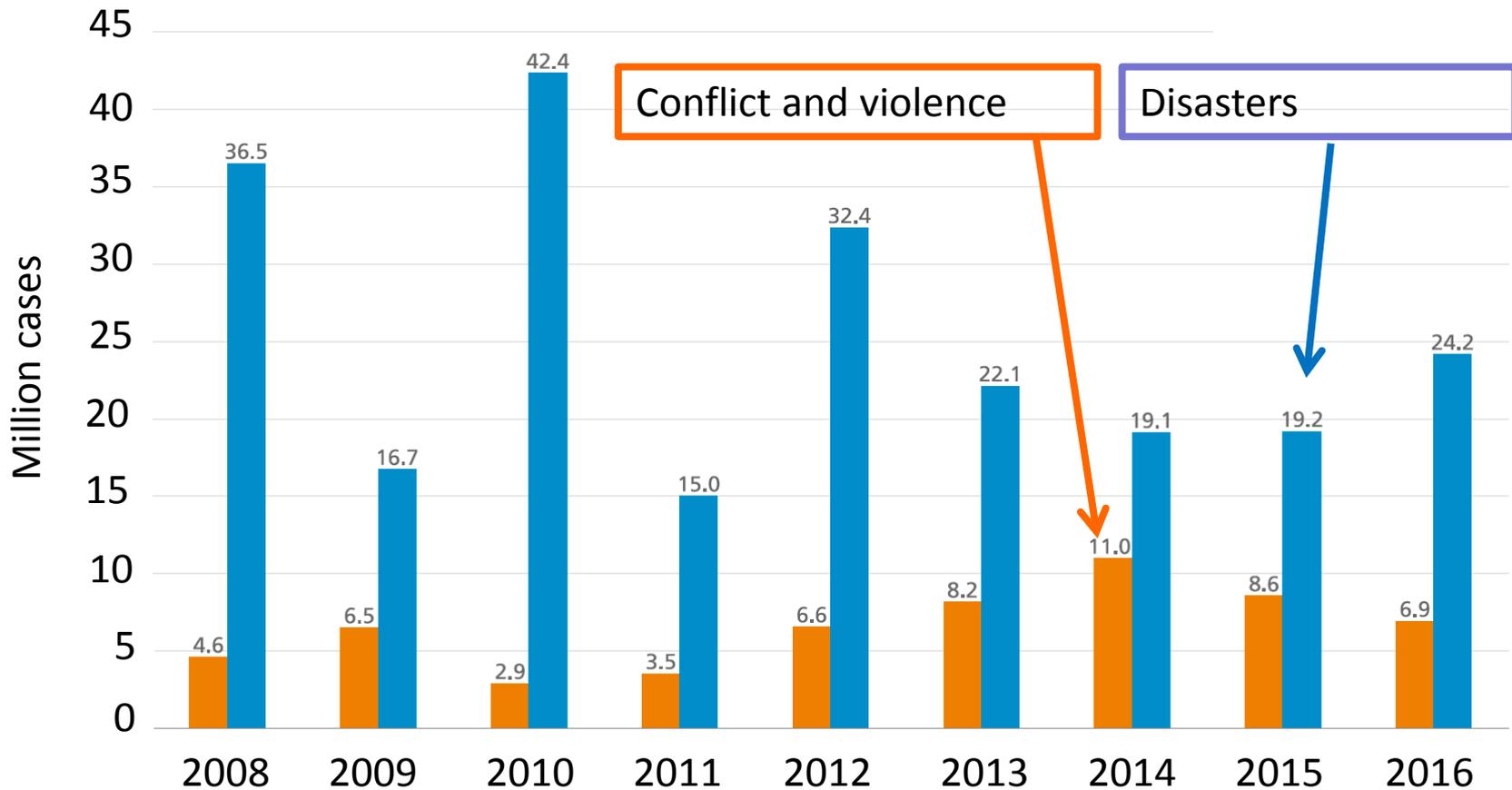


- 
Salinisation
- 
River Flooding
- 
Sea Level Rise
- 
Extreme Heat
- 
Drought / Water Scarcity
- 
River Bank Erosion
- 
Extreme Precipitation
- 
Crop Yield Decrease
- 
Tropical Storm

Vinke, Schellnhuber, Laplante et al. (2017)

Climate Effects on Migration

Internal Displacement Monitoring Centre, Norwegian Refugee Council, 2017



Weather-related disasters displace millions every year!

Climate Change and Conflicts – State of the Art in Three Quotes

“There is evidence that **the 2007–2010 drought contributed to the conflict in Syria**. It was the worst drought in the instrumental record, causing **widespread crop failure and a mass migration** of farming families to urban centers. “ (Kelley, 2014).

“(…) risk of armed-conflict outbreak is enhanced by climate-related disaster occurrence in **ethnically fractionalized countries**“ (Schleussner & Donges et al., 2016).”

“(…) drought can contribute to sustaining conflict, especially for **agriculturally dependent** groups and **politically excluded groups** in very poor countries“ (Uexkull, 2016).

Photo: Tigray, Ethiopia, Source: Silas Koch

Climate Change is an international Security Issue

"Climate change will be one of the major threats to the **stability** of states and societies in the decades to come" – *Report commissioned by the G7, 2015.*

Fragility hotspots

Ranking of countries with high levels of instability, disaster risk, poverty, and climate change vulnerability.

Rüttinger et al., G7 report, 2015



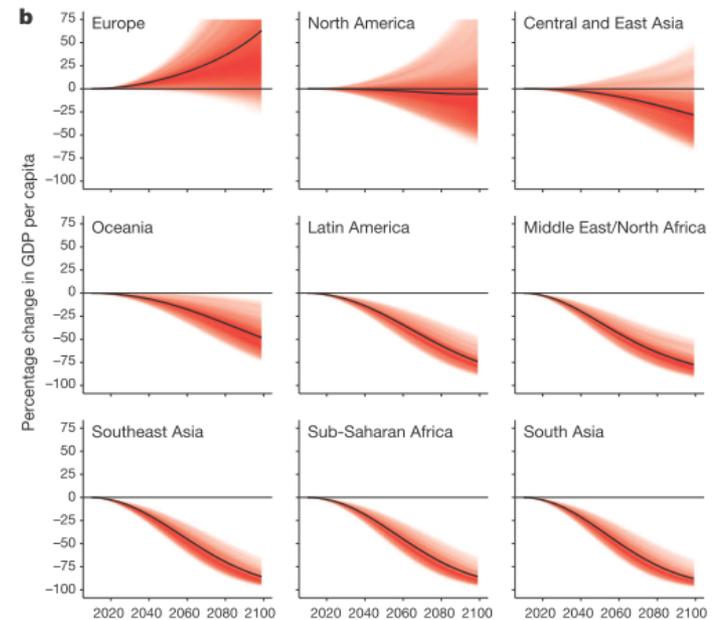
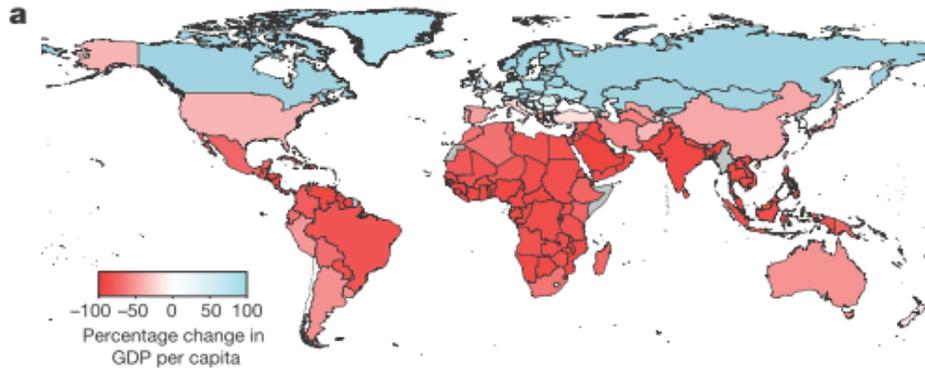
Climate events or trends are rarely the sole cause of conflict, migration, or social instability. However, there is mounting evidence that they have **exacerbated** existing social risks or inequalities, or acted as triggers, in past conflicts and migration. Future climate change will lead to extreme weather events and adverse climatic conditions far **beyond past experiences**.

LETTER

Global non-linear effect of temperature on economic production

Marshall Burke^{1,2*}, Solomon M. Hsiang^{3,4*} & Edward Miguel^{4,5}

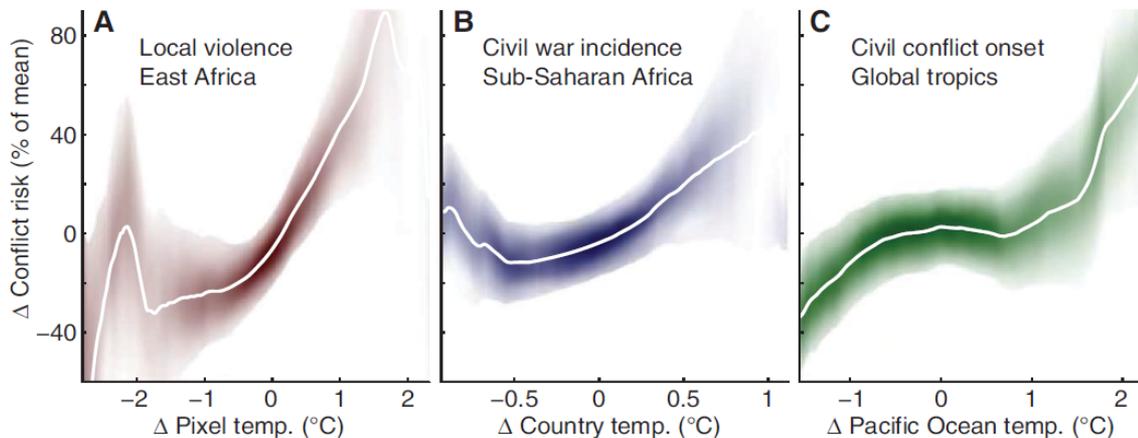
nature



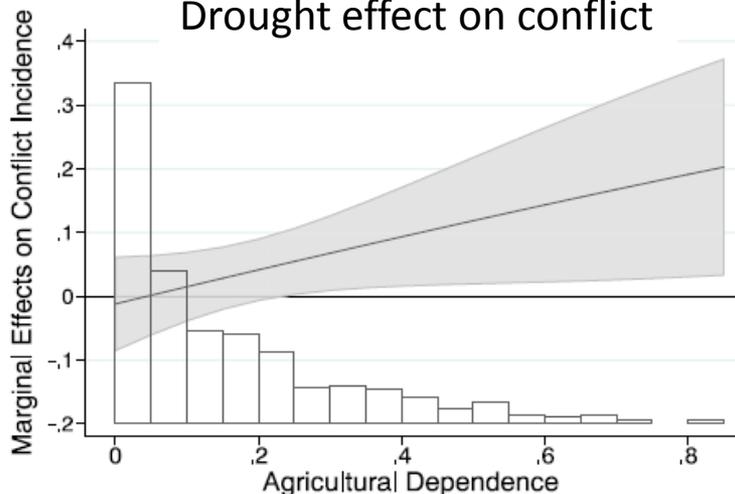
Climate Effects on Conflict Risk

Multiple lines of evidence suggest that under certain conditions, adverse climatic events (often proxied by temperature) can enhance the risk of violence and conflict.

In the past, higher temperatures have been associated with higher rates of conflict, at different spatial scales from local crime to civil war onset (Meta-study by Hsiang et al., 2013, Science).



Drought effect on conflict

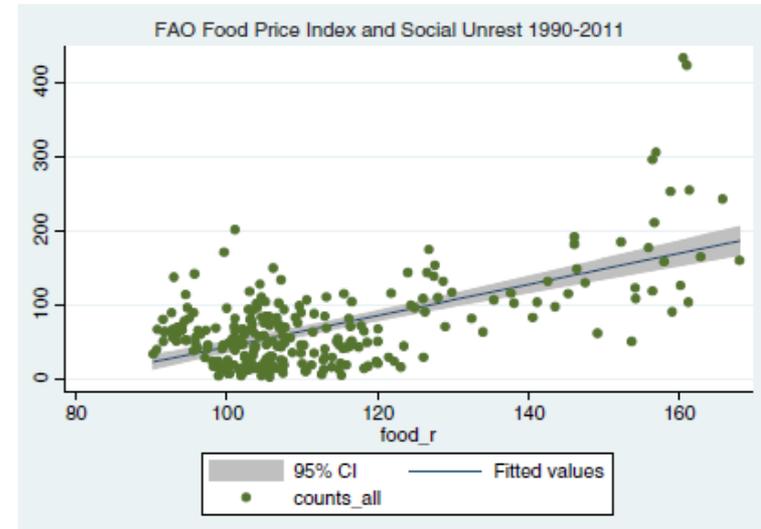


Climate-related disasters have been associated with higher risk of armed conflict in ethnically fractionalized countries (Schleussner et al., 2016, PNAS). Droughts have increased the likelihood of armed violence for agriculture-dependent, and politically excluded ethnic groups in poor countries (von Uexkull et al., 2016, PNAS).

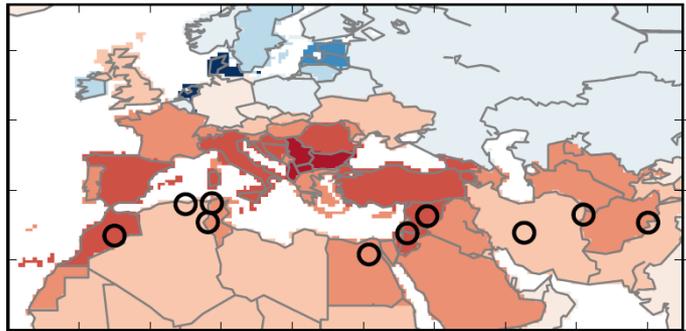
Climate Effects on Conflict Risk

Bellemare, 2014, AJAE

Food price spikes in 2007 and 2010 were associated with **social unrest** in developing and emerging countries around the world – and were triggered by weather-related crop failures. (Bellemare, 2014; Schewe et al., 2017)

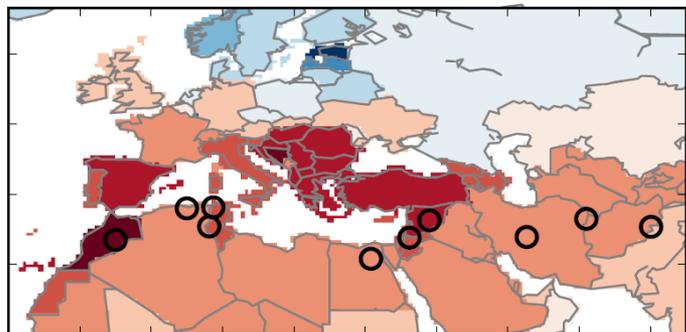


1°C historical warming



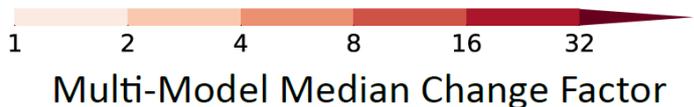
○ Water scarcity related conflicts 2010 – present, pacinst.org

2°C future warming

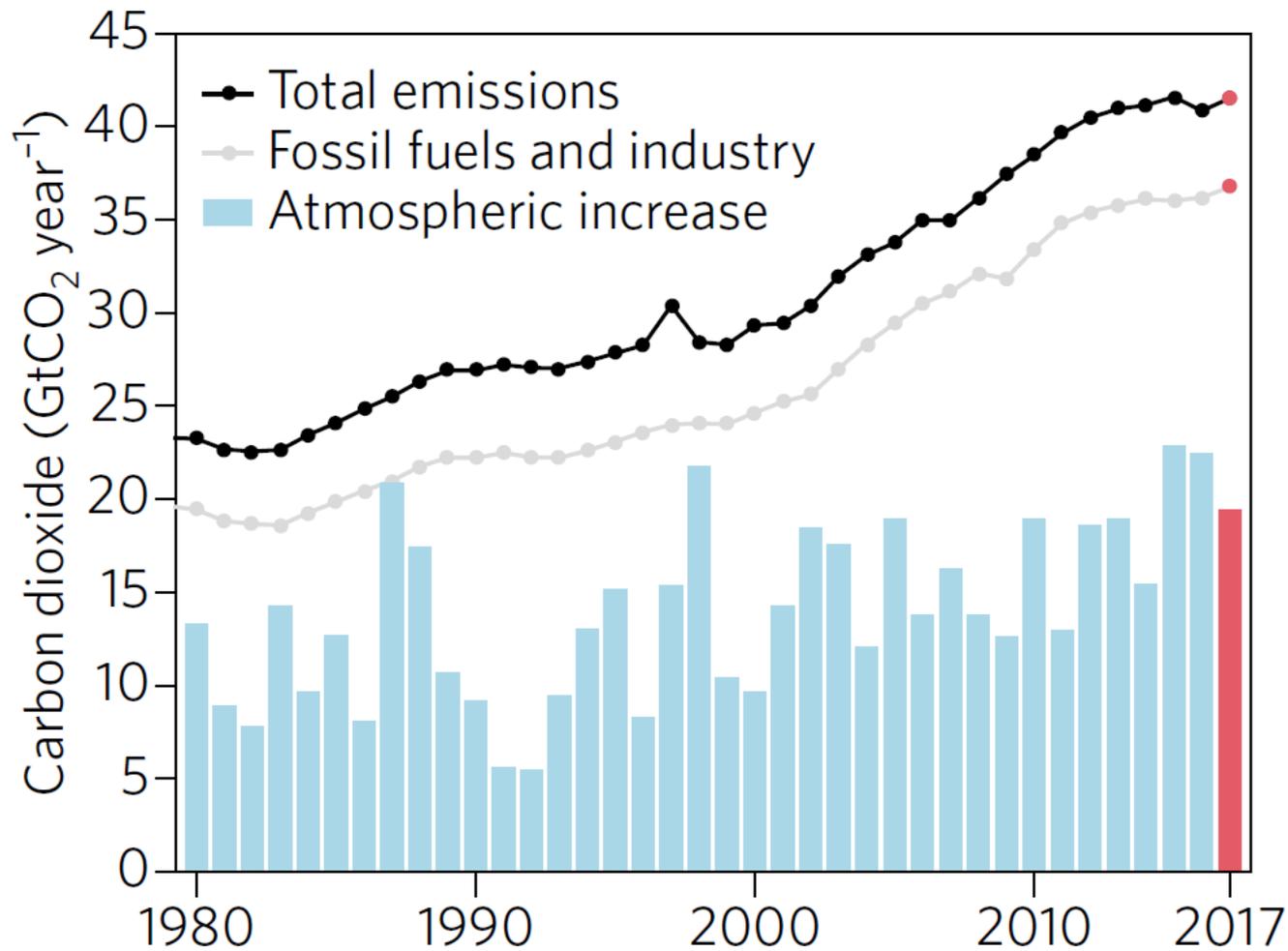


The **Mediterranean** region has seen conflicts over water in the past. It has seen substantial drying due to historical climate change, and will become even drier in the future.

Lange et al., to be submitted

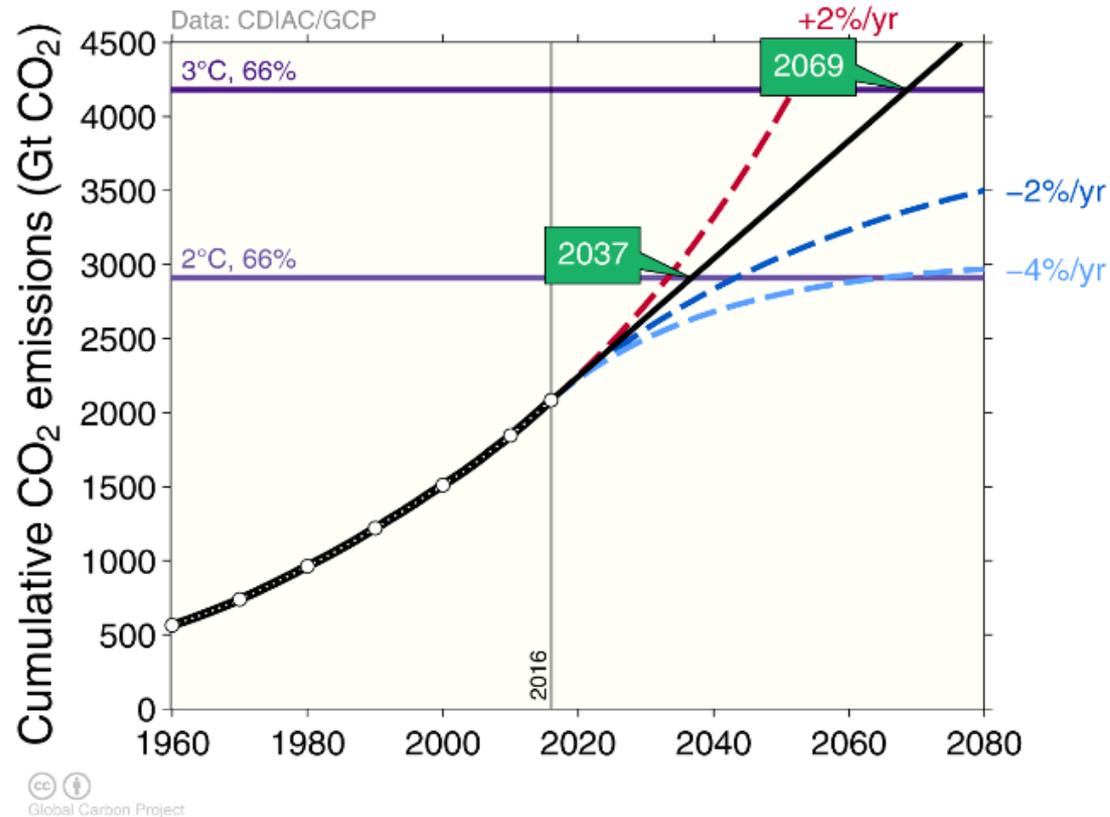


Emissions are rising.

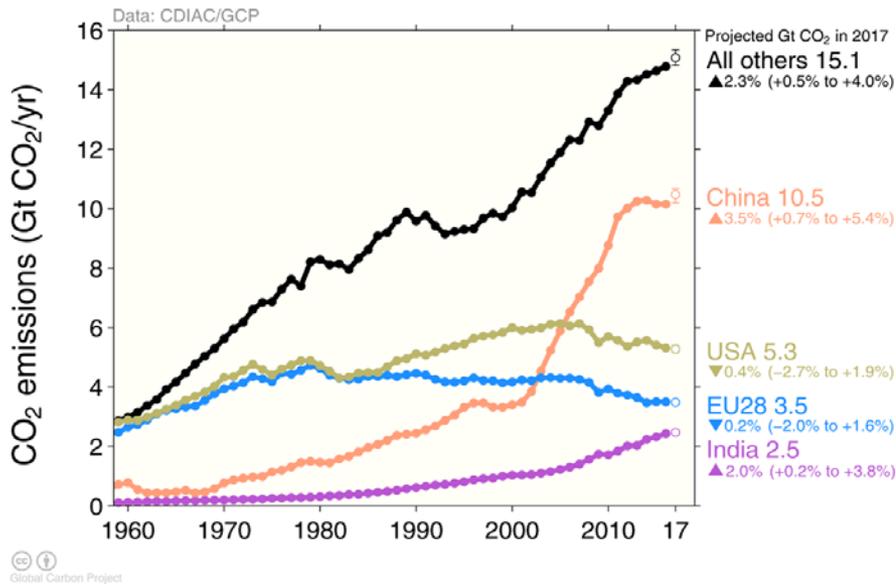


Source: Peters et al. (2017)

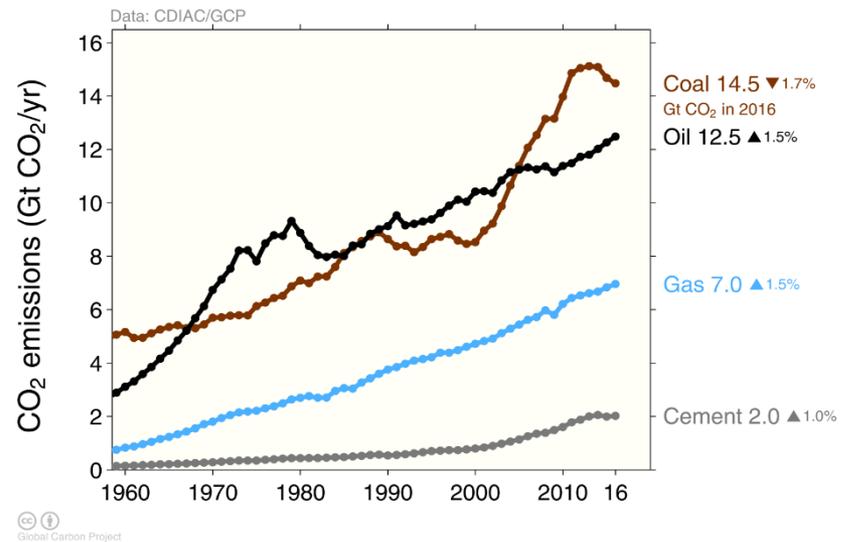
We are not on track.



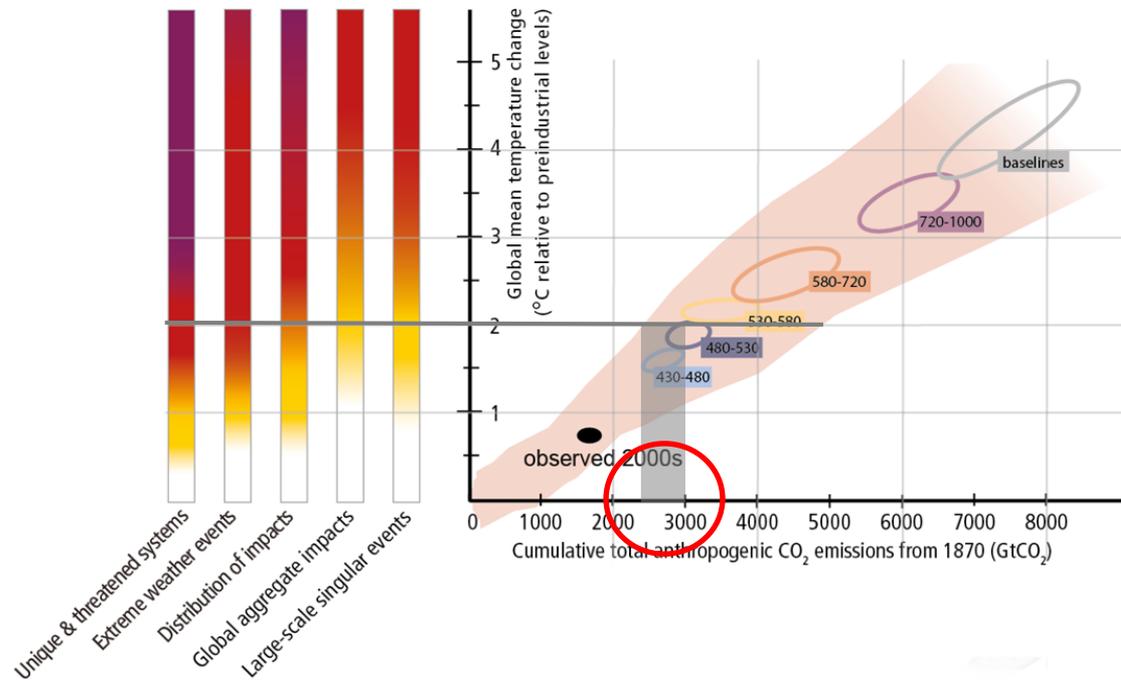
Does Climate Policy already show effects?



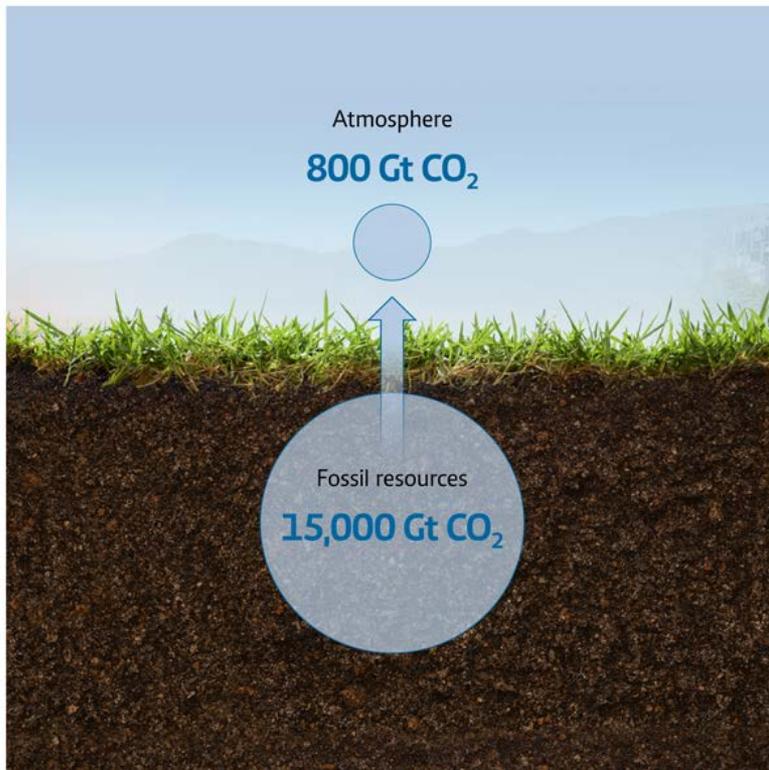
Quelle: Global Carbon Project 2017



Risks from climate change depend on cumulative CO₂ emissions...



The climate problem at a glance



Resources and reserves to remain underground until 2100 (median values compared to BAU, AR5 Database)

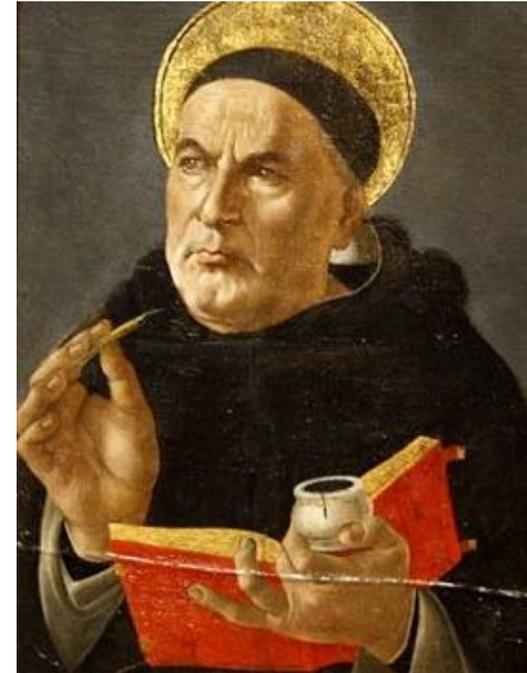
Until 2100	With CCS [%]	No CCS [%]
Coal	70	89
Oil	35	63
Gas	32	64

Source: Bauer et al. (2014); Jakob, Hilaire (2015)

The Common Destination of Goods

“The principle of the subordination of private property to the universal destination of goods, and thus the right of everyone to their use, is a golden rule of social conduct and ‘the first principle of the whole ethical and social order’⁷¹”

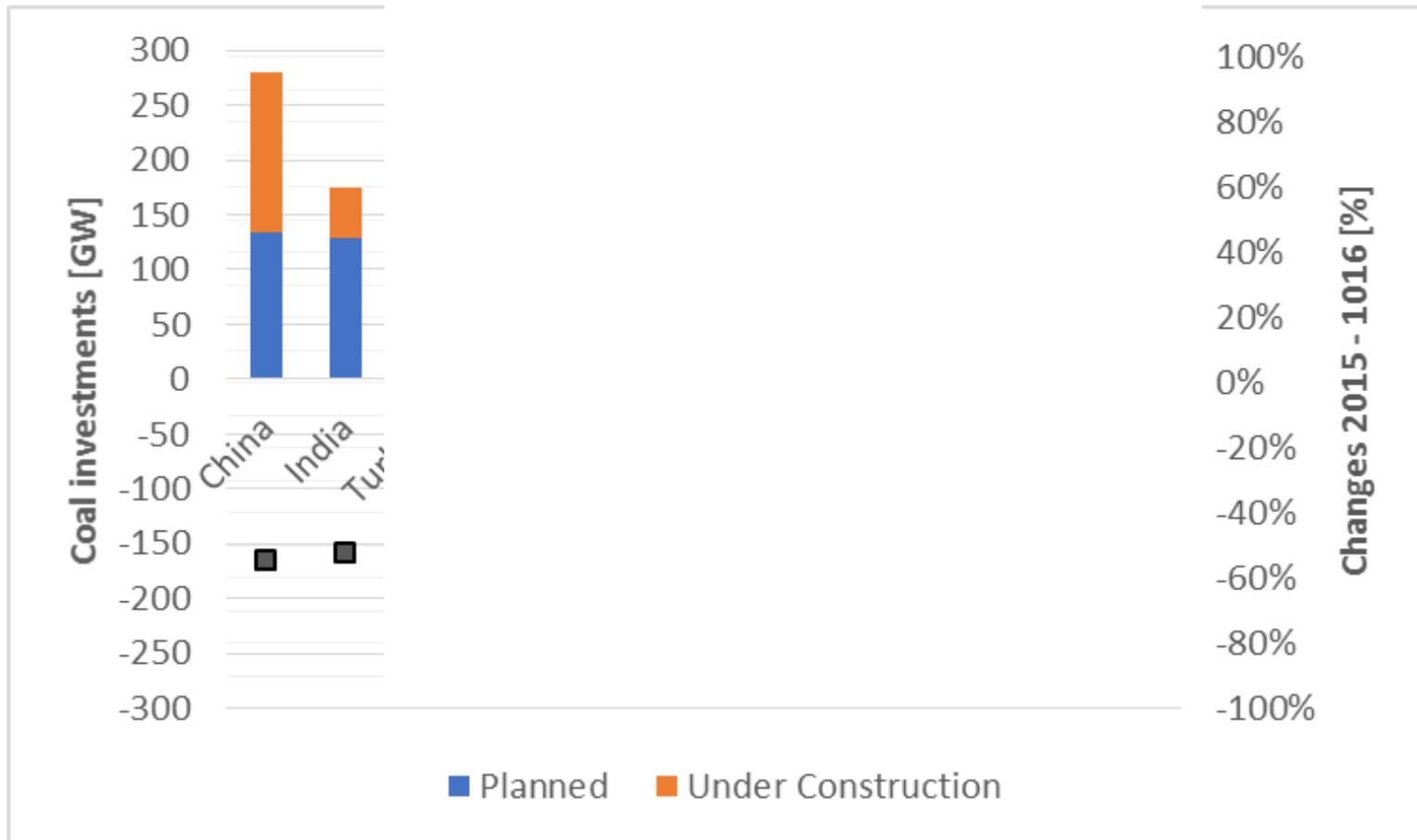
71 John Paul II, encyclical letter *Laborem Exercens*,
in Pope Francis, encyclical letter *Laudato Si* [93]



St. Thomas Aquinas
(1225-1274)

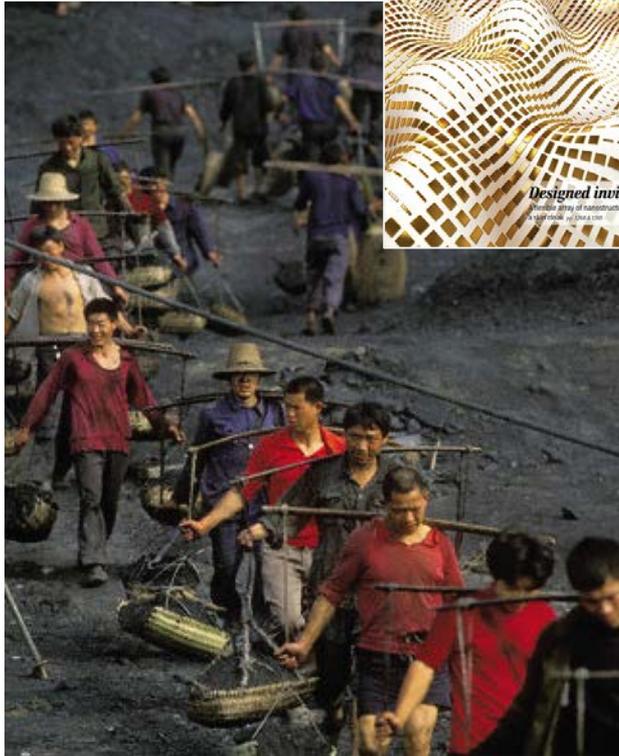
Summa Theologiae II/II q. 66, a. 2.

The Coal Pipeline in 2016



Renaissance of Coal

Social Costs vs subsidies



ENERGY

King Coal and the Queen of Subsidies

The window for fossil fuel subsidy reform is closing fast

By Ottmar Edenhofer

Coal is the most important energy source for the Chinese economy (see the photo). Other rapidly growing economies in Asia and Africa also increasingly rely on coal to satisfy their growing appetite for energy. This renaissance of coal is expected to continue in the coming years (1) and is one of the reasons that global greenhouse gas (GHG) emissions are increasing despite the undisputed worldwide technological progress and expansion of

wide emissions are expected to continue to rise. After all, a reduction in coal demand in one region reduces world market prices, incentivizing an increasing demand in other regions (6).

What explains this renaissance of coal? The short answer is the relative price of coal. The price of coal-based electricity generation remains much lower than that of renewable power when the costs of renewable intermittency are taken into account.

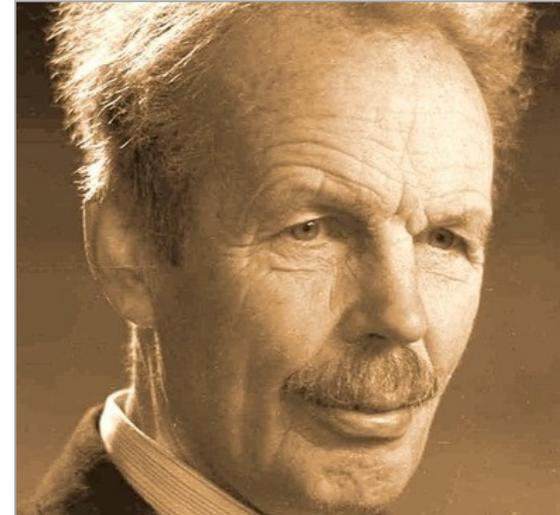
As a result of technological progress and economies of scale, the costs of generating

“one ton of CO₂ receives, on average, more than 150 US\$ in subsidies”

The Polluter Pay Principle and the Social Costs

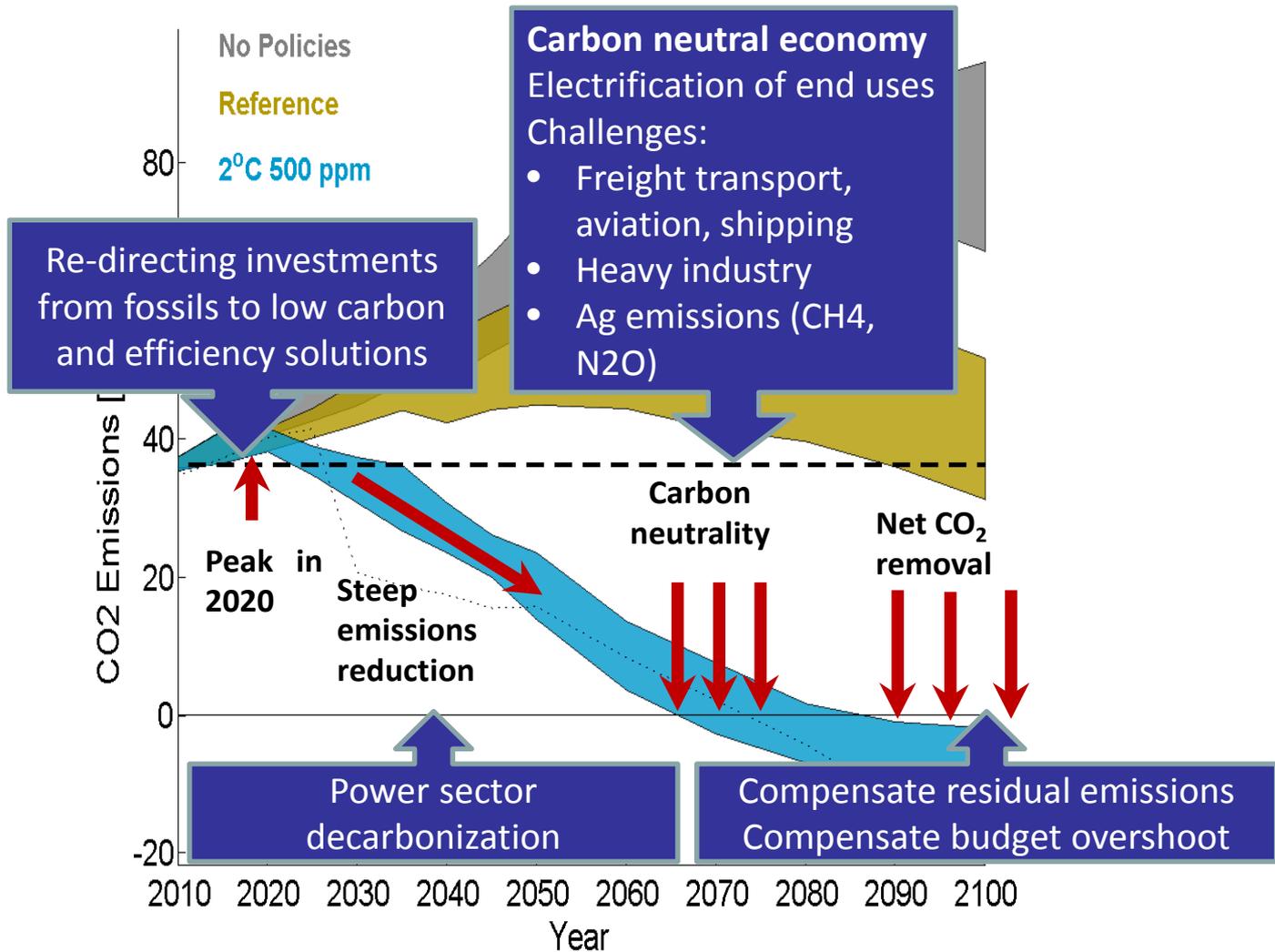
“Yet only when ‘the economic and social costs of using up shared environmental resources are recognized with transparency and fully borne by those who incur them, not by other peoples or future generations’¹³⁸, can those actions be considered ethical.”

138 Pope Benedict XVI, encyclical letter *Caritas in Veritate*,
in Pope Francis, encyclical letter *Laudato Si* [195]



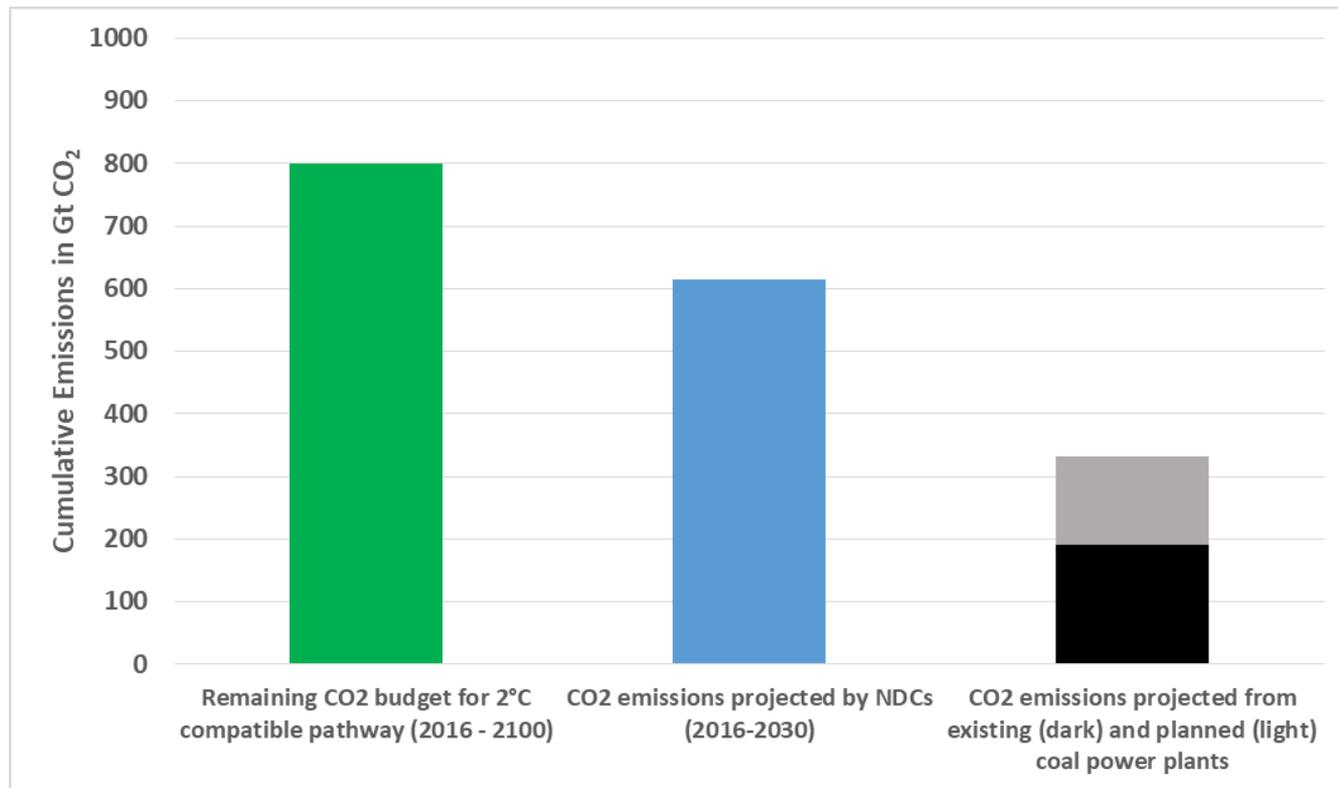
Arthur Cecil Pigou
(1877-1959)

General structure of mitigation pathways



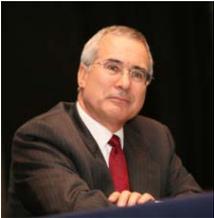
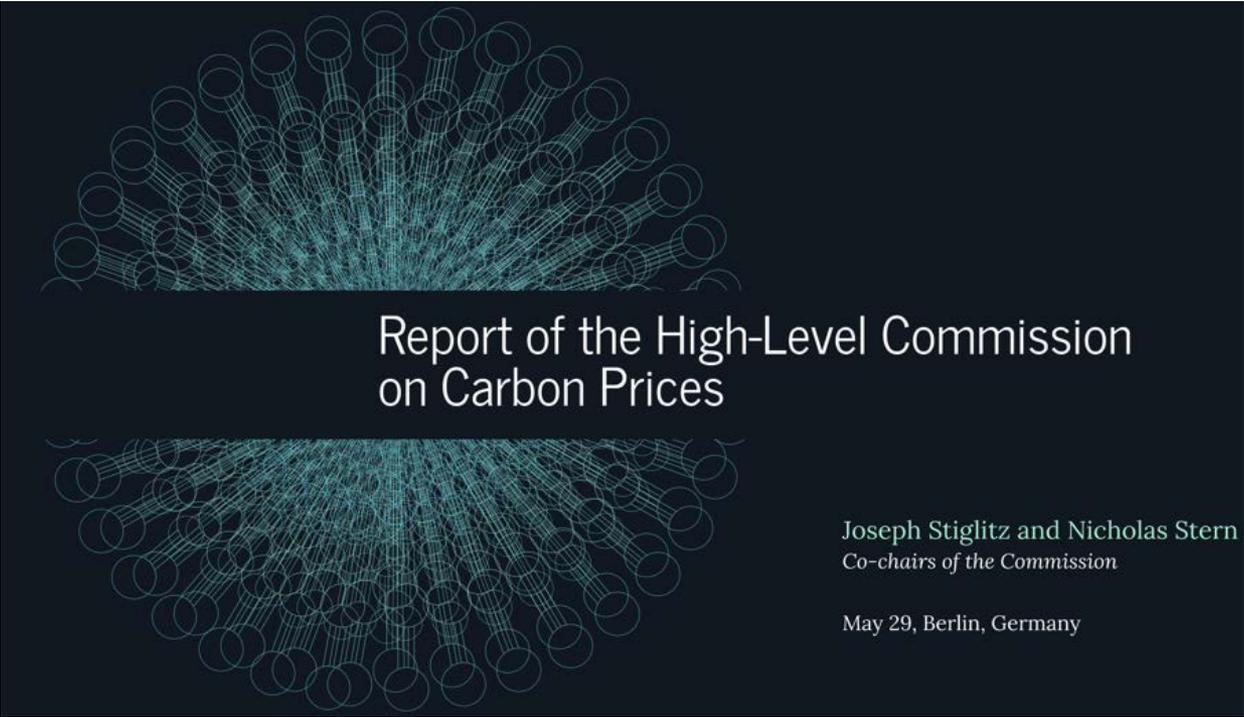
The 2°C Budget does not leave any leeway

Cheap and abundant coal is the driver of a „re-carbonisation“ of the energy system in some parts of the world



*All budgets are subject to considerable uncertainty, see Edenhofer et al. (2017)

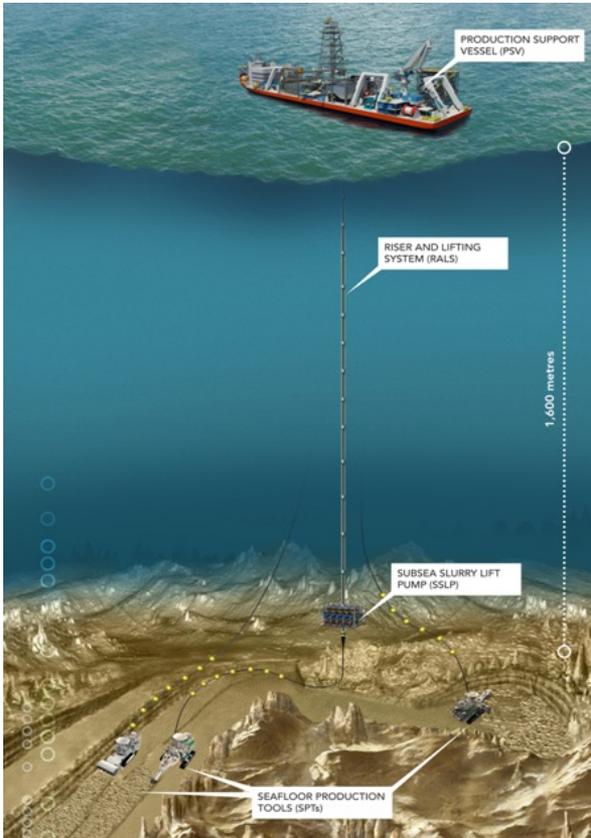
Report of the High-Level Commission on Carbon Prices



Results obtained by Stiglitz-Stern-Commission

- Based on the analysis of three approaches:
technical roadmaps, national roadmaps, global models
- Necessary carbon price for implementing the Paris Agreement:
40-80 \$/t CO₂ until 2020 and 50-100 \$/t CO₂ until 2030
- This assumes that carbon pricing will be complemented by activities and policies such as efficiency standards, R&D, urban development, healthy climate for investments, etc.
- Stress on the relevance of the income side. Put to use in order to reduce other taxes, invest in clean infrastructure, etc.

Resource Curse in the Pacific: Deep Sea Mining



Nautilus Minerals Deep Sea Mining System

- Objects of interests:
 - Valuable metals like gold or rare metals for modern technologies
 - i.e. manganese nodules and metals deposit at hydrothermal vents
- Legal situation:
 - Exclusive exploitation rights of states within a 370-km-zone
 - Mineral exploitation in the high-sea-zone is organized and controlled by the International Seabed Authority (ISA)
 - E.g. Sale of 29 licenses to Clarion Clipperton Fracture Zone (CCZ)
- Political Agents:
 - Companies (e.g. Nautilus Minerals)
 - Increased state-driven activity in the recent years

Effects of Deep Sea Mining similar to Terrestrial Mining?



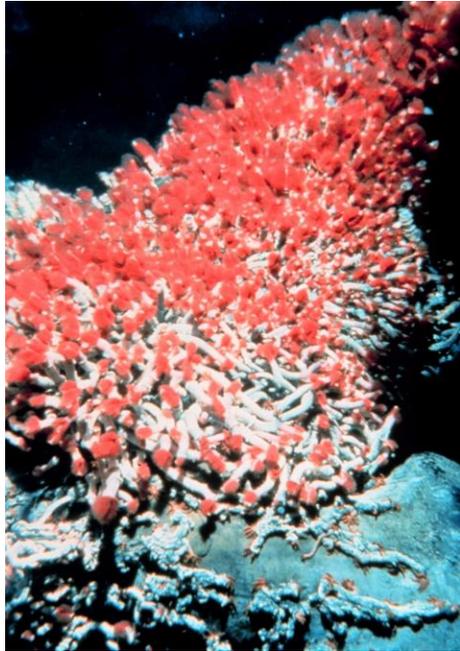
Effects of Deep Sea Mining similar to Terrestrial Mining?



Nautilus Minerals Seafloor Production Tools

... or maybe worse?

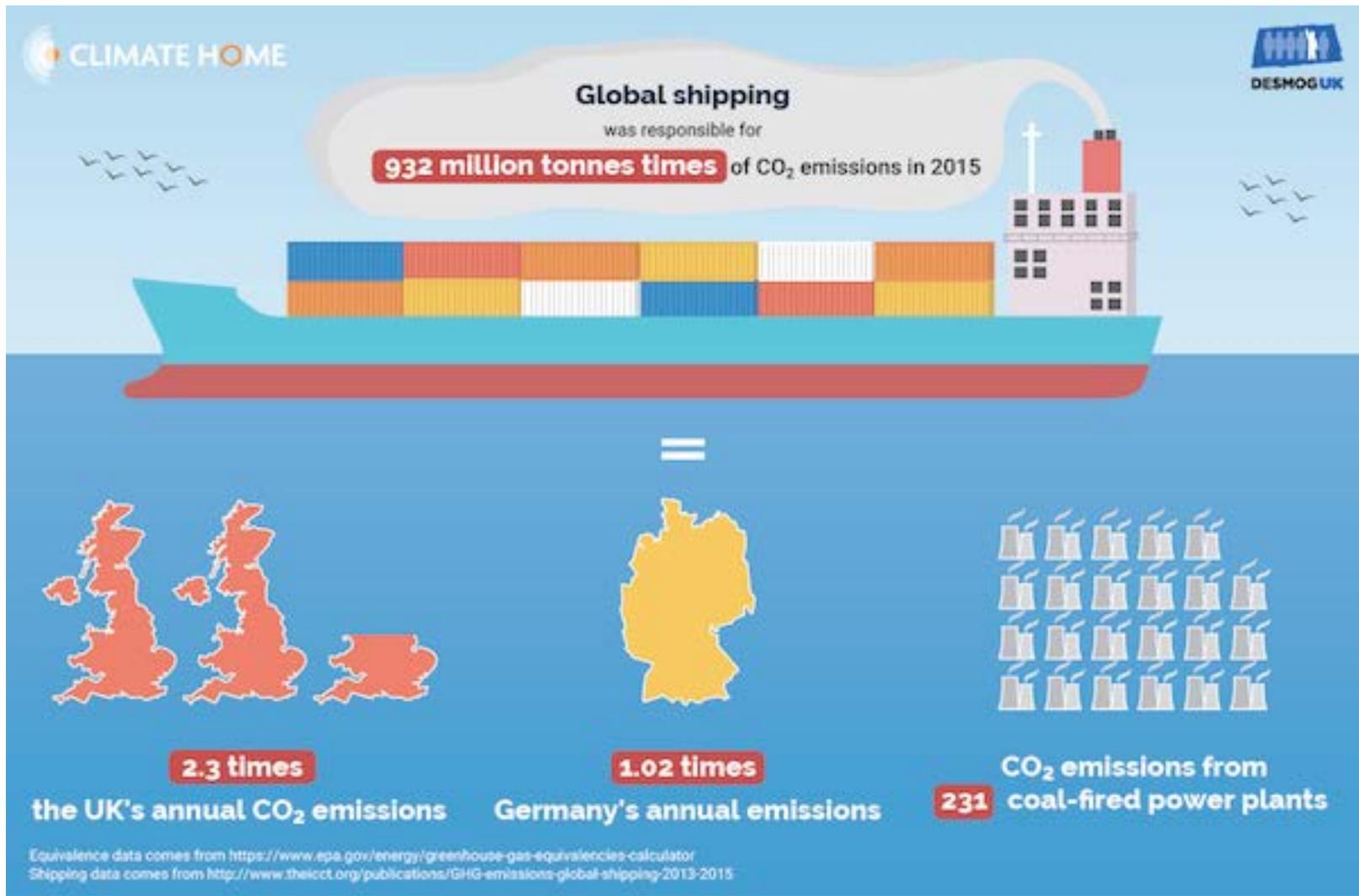
Extinguishing unknown and irretrievable Ecosystems for economic interests?



Tube worms feeding at base of a black smoker chimney hydrothermal vent.

- World's first operator of deep sea mining in PNG
 - Environmental Impact Statement (EIS) is scientifically weakly modeled and analyzed
 - Risks for deep sea mining are not yet fully explored
 - Public concerns in PNG
 - Unequal distribution of profits
- Long-term impacts of deep sea mining:
 - Nodule ecosystems consist of a highly diverse fauna of sessile and mobile species
 - Faunal communities show high variability on small spatial scales

High Emissions from Shipping



Alternative Development Pathway: Sustainable Sea Transport

- Revival of Pacific Sailing Culture
- Solar and Coconut Oil Powered Sailing Vessels
- Increasing Inter-Island Transport & Improving Livelihoods
- Comparative Advantage in possible future export market



Hokule'a



Vaka Motu,
Okeanos Foundation for the Sea

Apocalyptic rationality?

“Although the post-industrial period may well be remembered as one of the most irresponsible in history, nonetheless there is reason to hope that humanity at the dawn of the twenty-first century will be remembered for having generously shouldered its grave responsibilities.”

Papst Franziskus, Enzyklika *Laudato Si* [165]

