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The Financial Risks of Climate Change

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Presentation

1. Introduction
2. Scientific facts and economic impacts
3. Climate change and investments
4. Climate change and the financial system
5. Further research

1 Introduction

Climate change and sustainability

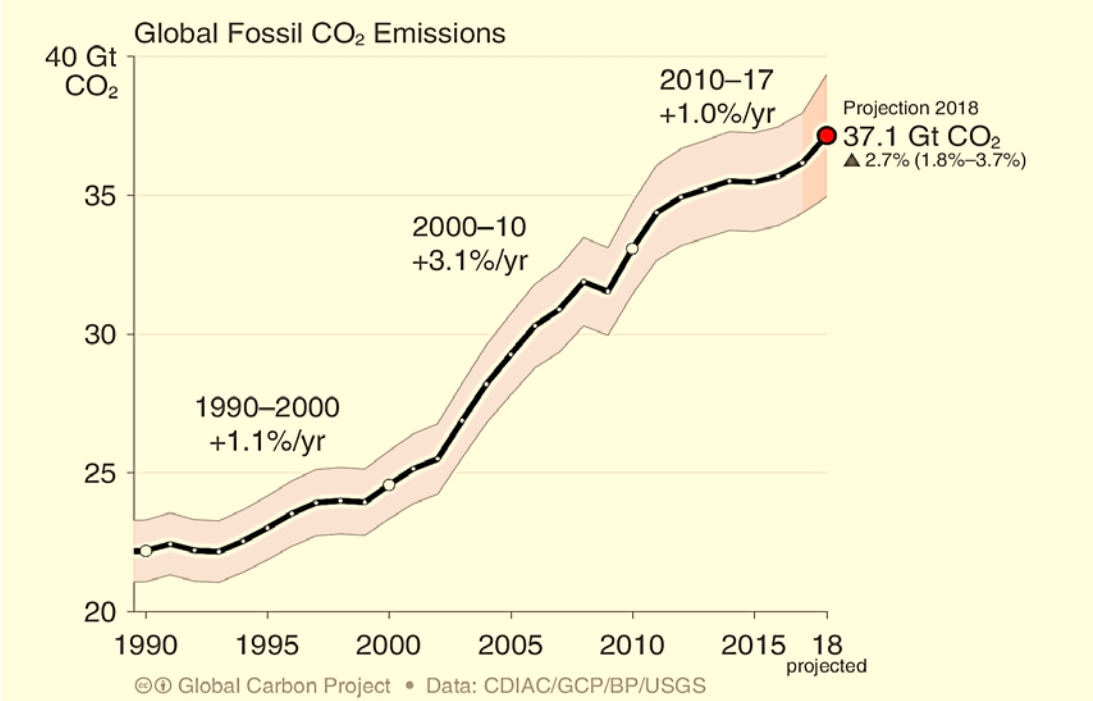
Climate change and the economy

- Climate change is regarded as one of the ultimate challenges for economics.
- The challenge is to understand the interactions between climate and the economy and to design policies which will slow down climate change and address its negative impacts.
- Climate change is an externality – the most important of all externalities.
- Economic theory states that the correction of externalities requires the use of fiscal measures.
- The use of fiscal measures – e.g. carbon taxes, tradable emission permits – requires pricing of the externality.

2 Scientific Facts and Economic Impacts

Global fossil CO_2 emissions: 36.2 ± 2 $GtCO_2$ in 2017, 63% over 1990

Projection for 2018: 37.1 ± 2 $GtCO_2$, 2.7% higher than 2017 (range 1.8% to 3.7%)

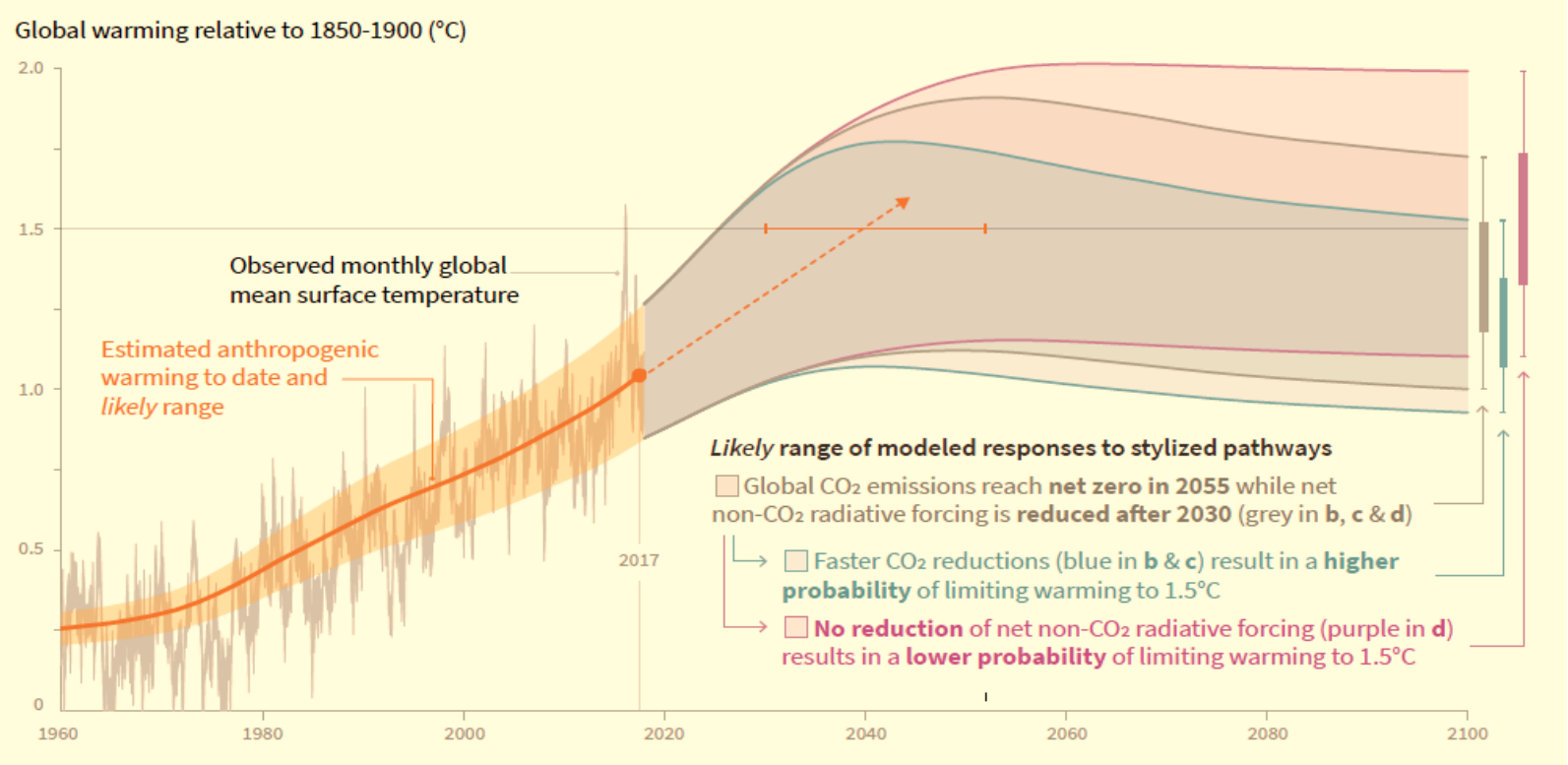


Uncertainty is ±5% for one standard deviation (IPCC "likely" range)

Estimates for 2015, 2016 and 2017 are preliminary; 2018 is a projection based on partial data.

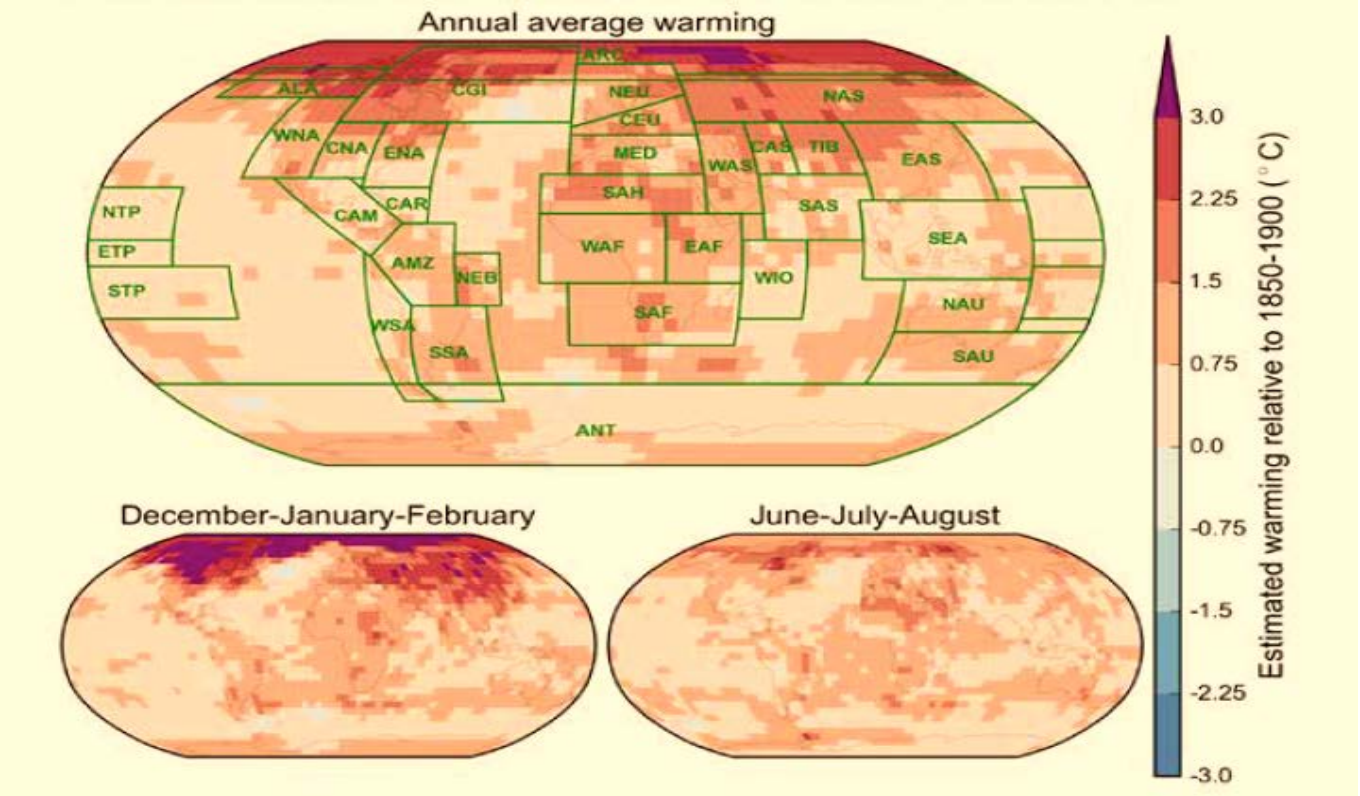
Source: CDIAC; Le Quéré et al 2018; Global Carbon Budget 2018

Observed global temperature change and modeled responses to stylized anthropogenic emission and forcing pathways



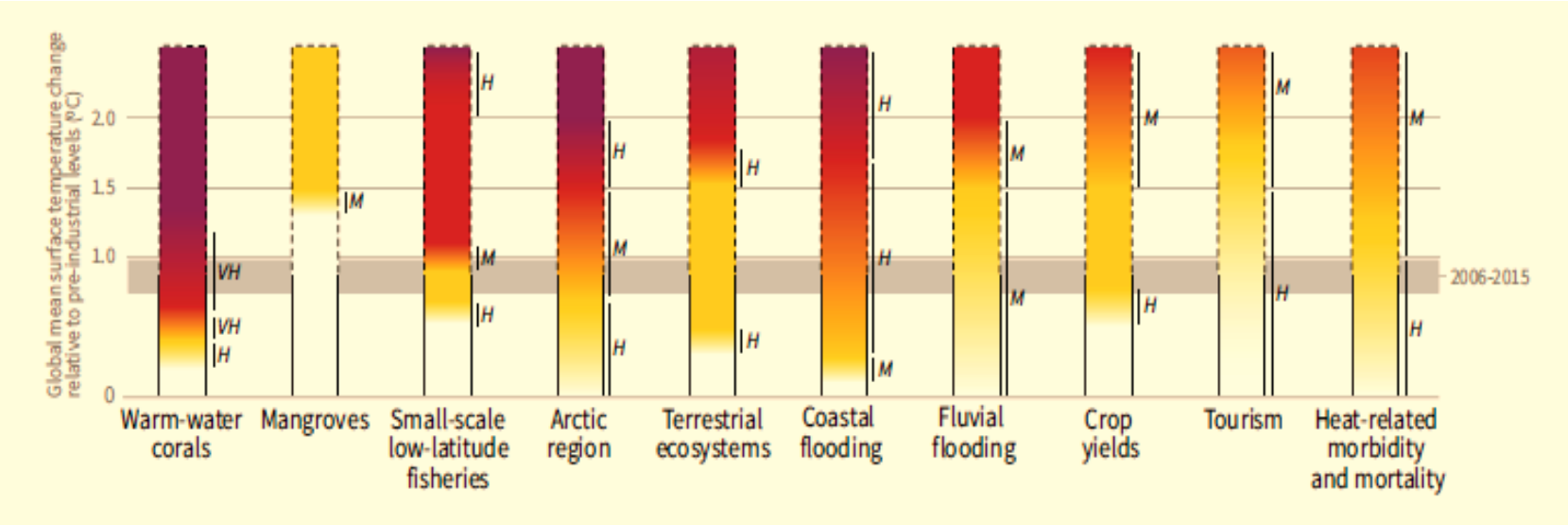
Source: IPCC Special Report, “Global Warming of 1.5°C”, October 2018

Regional warming in the decade 2006-2015 relative to preindustrial time



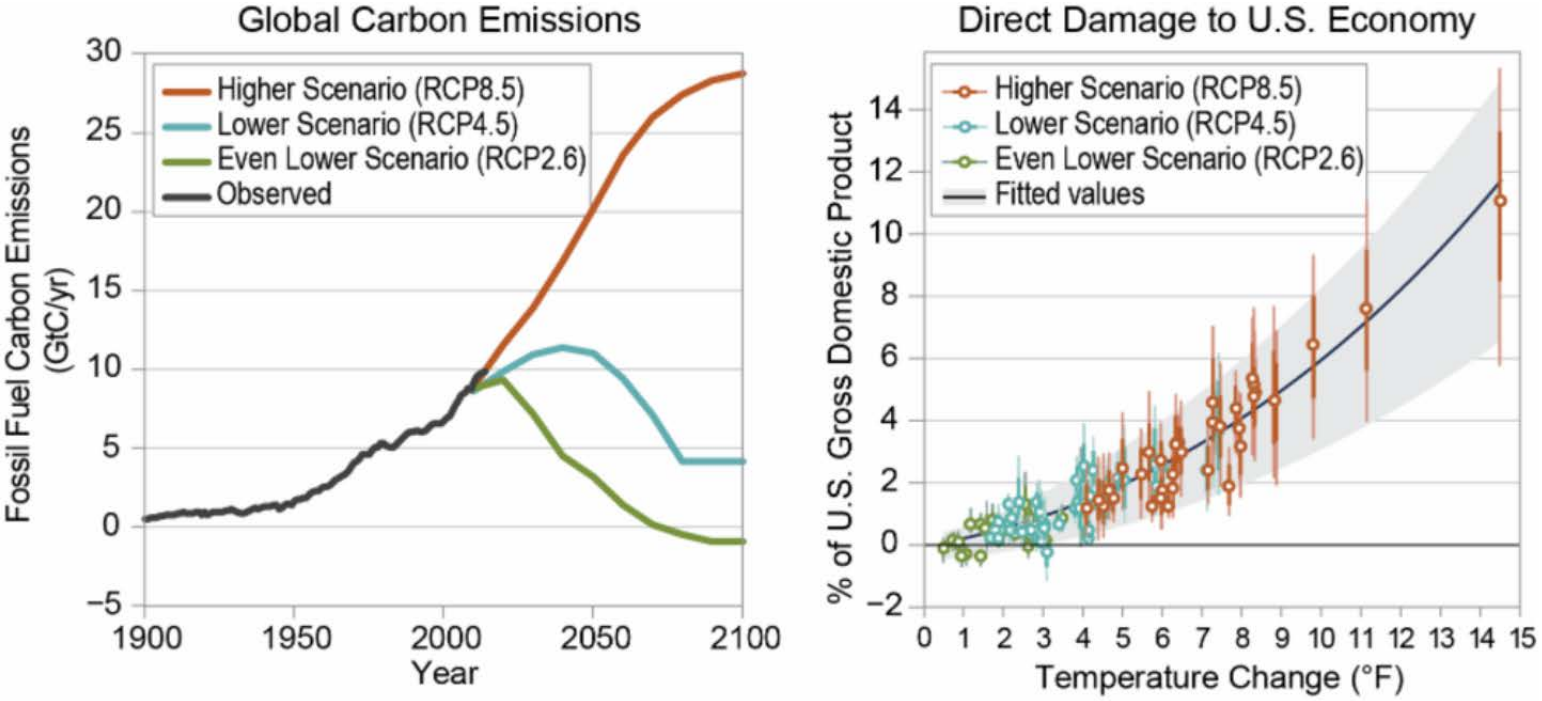
Source: IPCC Special Report, “Global Warming of 1.5°C”, October 2018

Impacts and risks for selected natural, managed and human systems



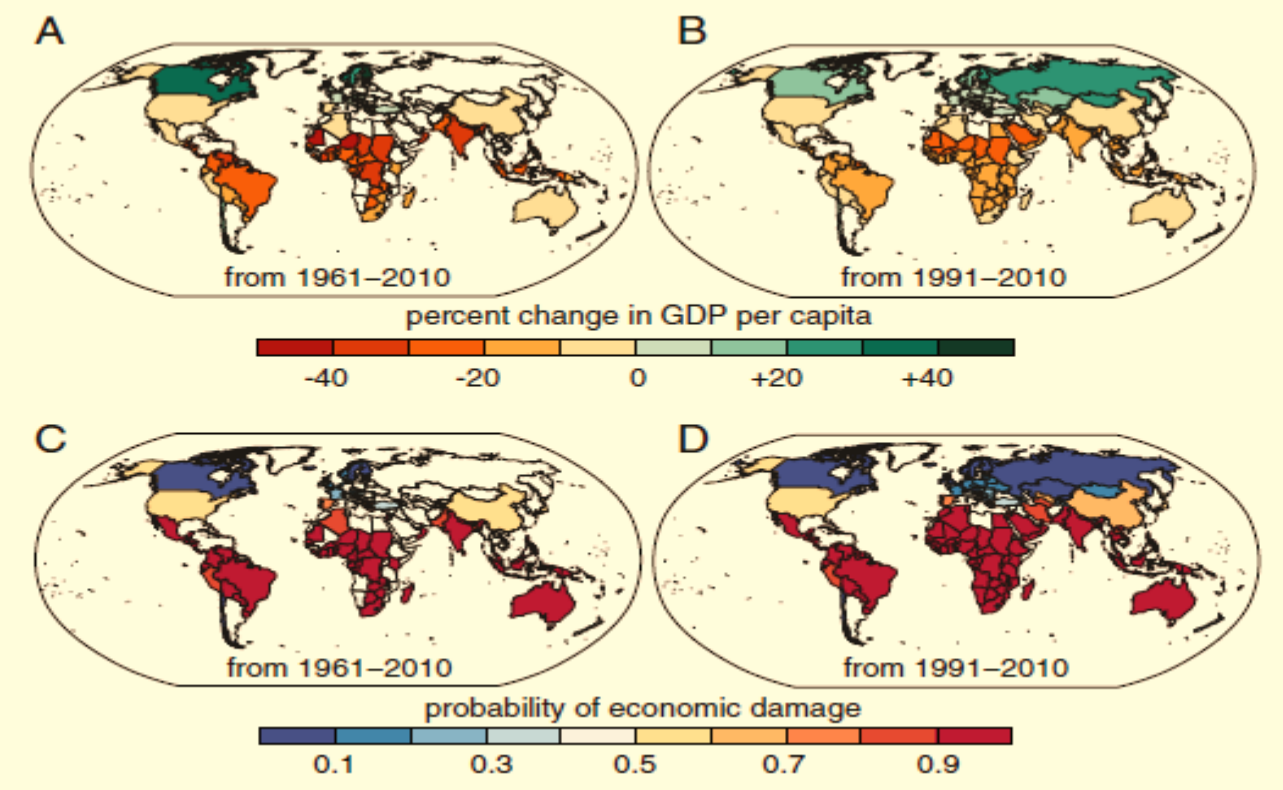
Source: IPCC Special Report, “Global Warming of 1.5°C”, October 2018

Damages from climate change



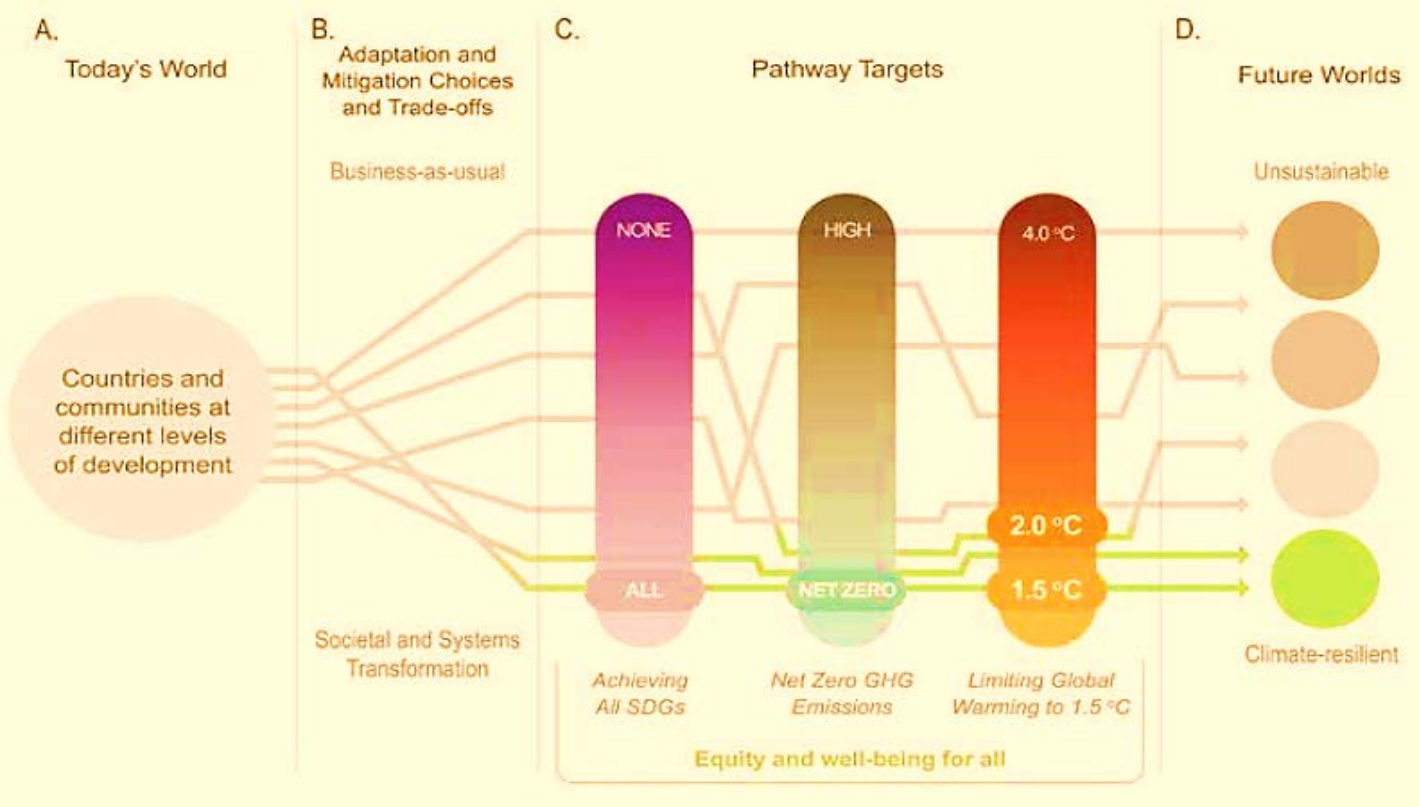
Source: The Fourth US National Climate Assessment, 2018

Country-level economic impact of historical global warming



Source: Diffenbaugh, N. and M. Burke, Global warming has increased global economic inequality, PNAS, 2019

Sustainability



Source: IPCC Special Report, "Global Warming of 1.5°C", October 2018

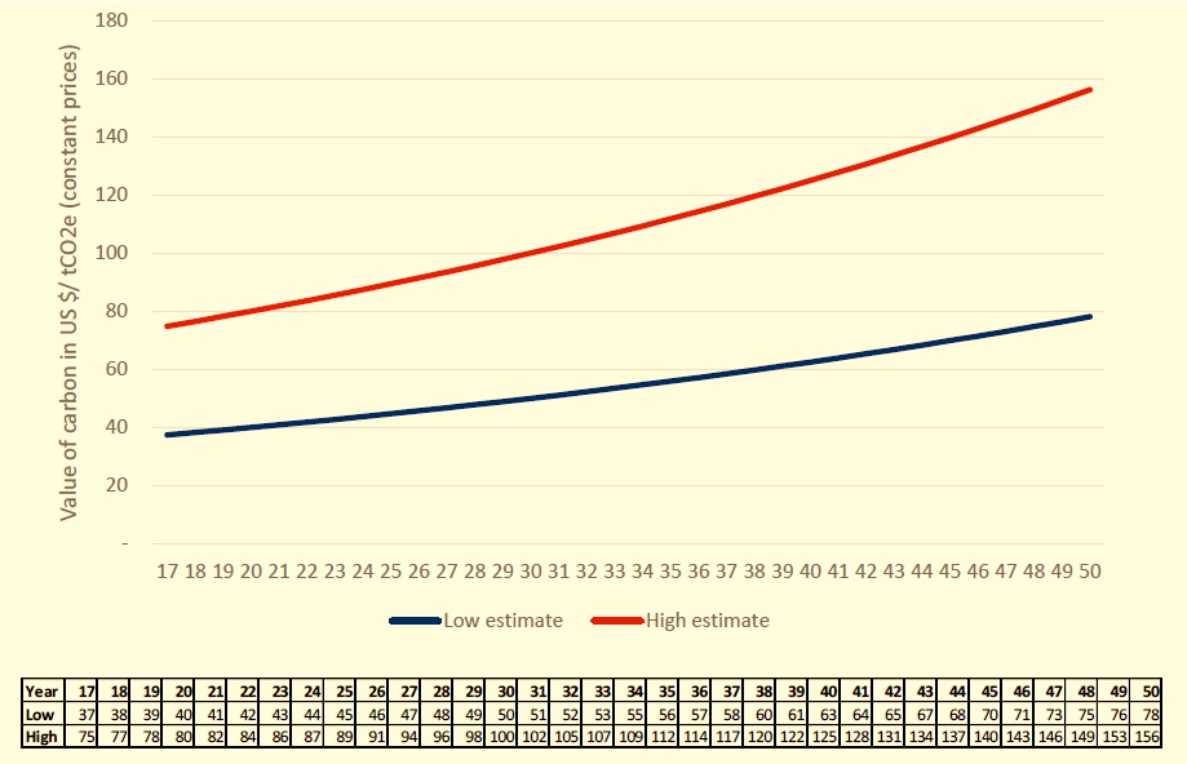
3 Climate Change and Investments

- How do we take into account changes (+/-) in greenhouse gasses in project appraisal ?
- Is there a price of carbon to be used in project appraisal?

The price of carbon

- **The social cost of carbon (SCC)** is the full effect on social welfare from emitting 1 ton of carbon as CO_2 or (GHGs) over the lifetime of that ton in the atmosphere. This the marginal damage cost of carbon.
- Many projects generate global social benefits from reduced GHG emissions or costs from increased emissions. The SCC or the **shadow price of carbon (SPC)** should be used to evaluate these benefits/costs.
- $$\mathbf{NPV} = -\mathbf{fixed\ costs} + \sum_{t=1}^{T} \frac{\mathbf{benefits}(t) - \mathbf{costs}(t) - \left(\mathbf{SPC}(t) \times \mathbf{\Delta GHG\ emissions}(t)\right)}{(1 + \mathbf{social\ discount\ rate})^{t}}.$$
- GHG emissions are calculated as the difference between gross/absolute GHG emissions of the project and the gross GHG emissions of a baseline scenario.

Recommended shadow price of carbon in USD per metric ton of CO_2 equivalent (constant prices)



Year	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Low	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	55	56	57	58	60	61	63	64	65	67	68	70	71	73	75	76	78
High	75	77	78	80	82	84	86	87	89	91	94	96	98	100	102	105	107	109	112	114	117	120	122	125	128	131	134	137	140	143	146	149	153	156

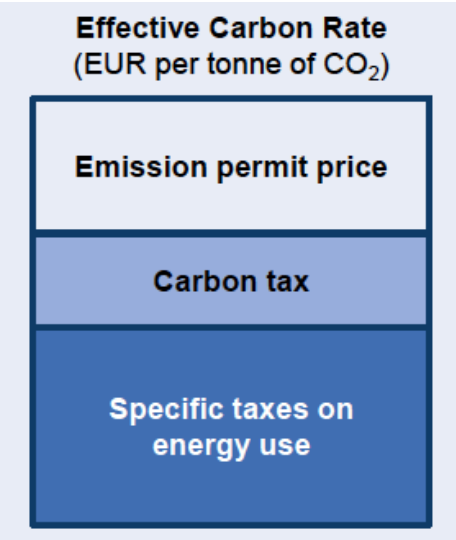
Source: Guidance note on the shadow price of carbon in economic analysis, The World Bank, 2017

EU Emission Trading System

Source: Sandbag, Smarter climate policy

The effective carbon rate

The effective carbon rate is the total price that applies to CO_2 emissions from energy use as a result of market-based policy instruments.

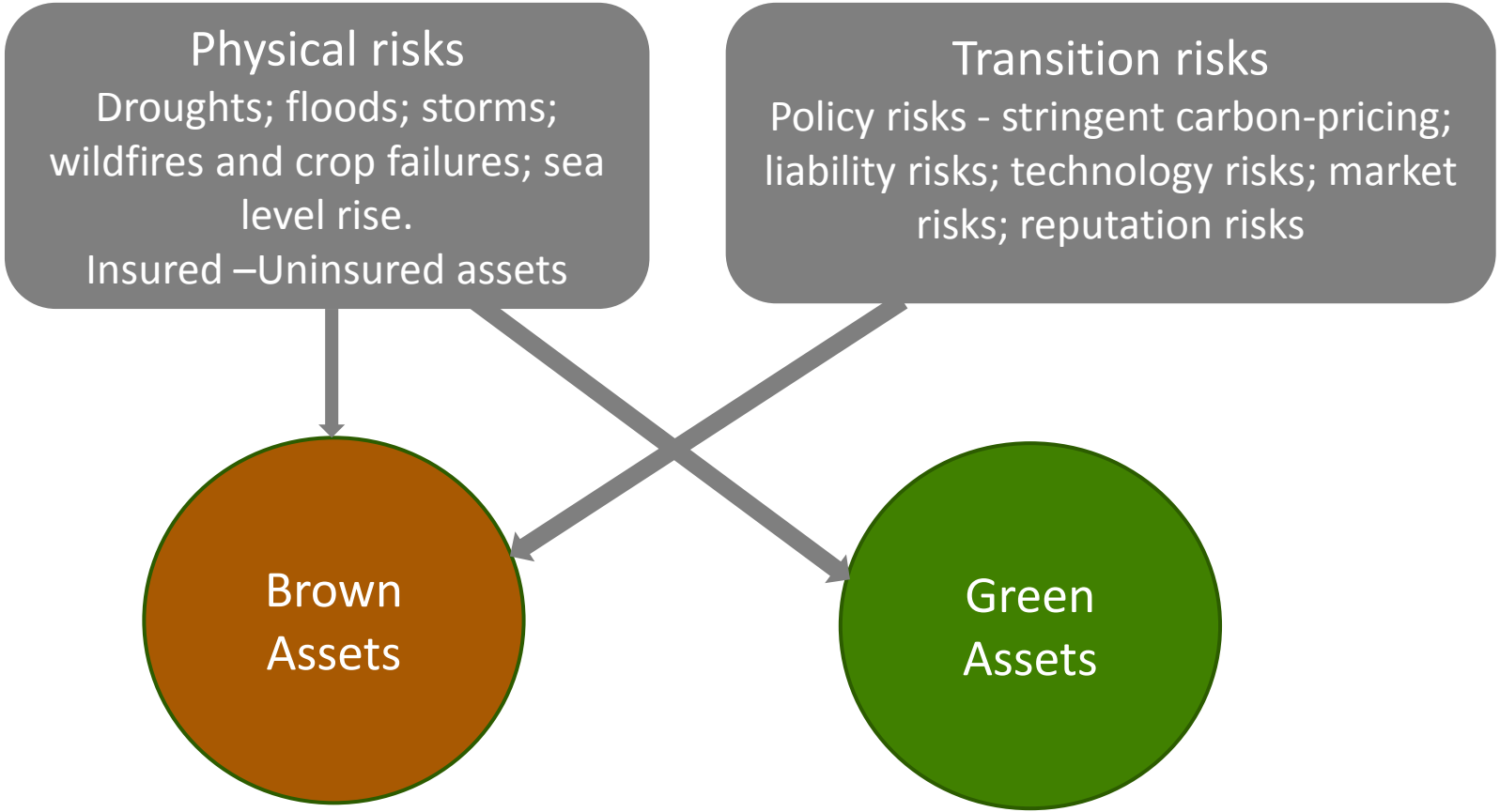


Source: OECD, 2016

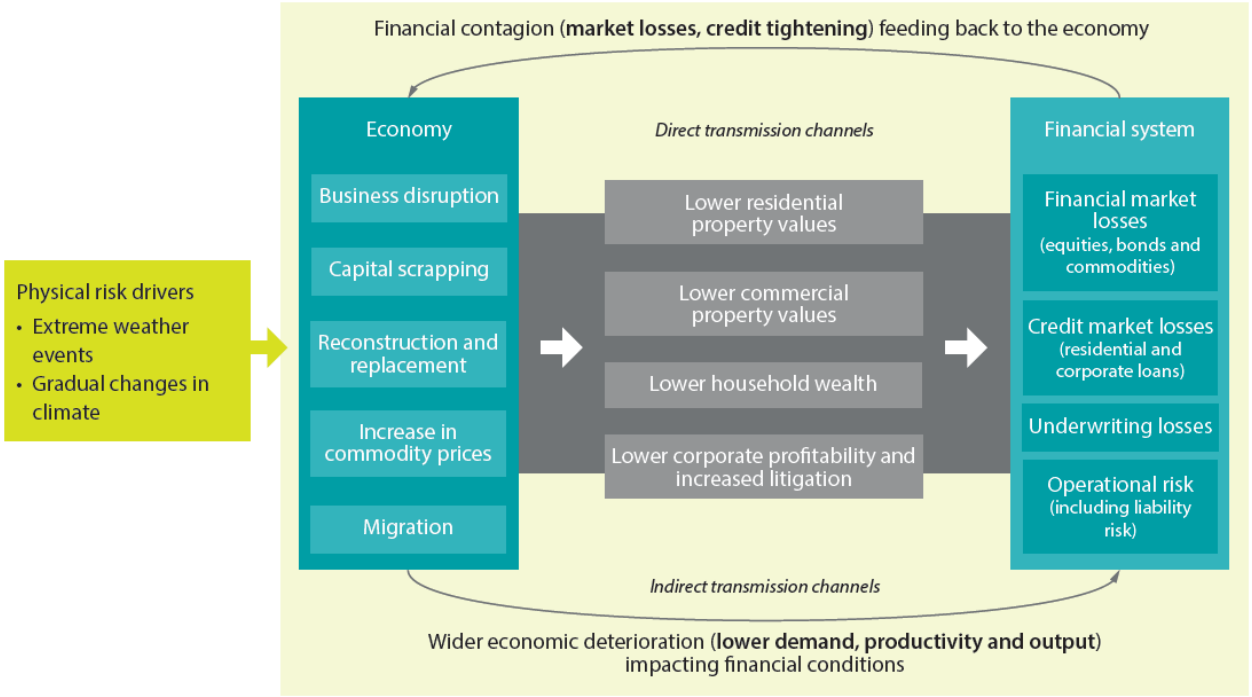
- The carbon pricing gap measures the extent to which current prices fall short of a benchmark value, as a percentage.
- The results show that the carbon pricing gap is large, but that it falls over time.
- Using €30 per ton of CO_2 as the benchmark, there is a drop from 83% in 2012 to 79.5% in 2015 and to 76.5% in 2018. This amounts to a decline of about 1 percentage point per year.

4 Climate Change and the Financial System

- The Governor of the Bank of England, Mark Carney, was the first to highlight the threat of climate change for the stability of the financial system and to identify the risks involved (“Breaking the tragedy of the horizon”, 2015).
- Are climate-related risks properly reflected in asset pricing?


Physical risks
Droughts; floods; storms; wildfires and crop failures; sea level rise.
Insured –Uninsured assets
Transition risks
Policy risks - stringent carbon-pricing; liability risks; technology risks; market risks; reputation risks
Brown Assets
Green Assets

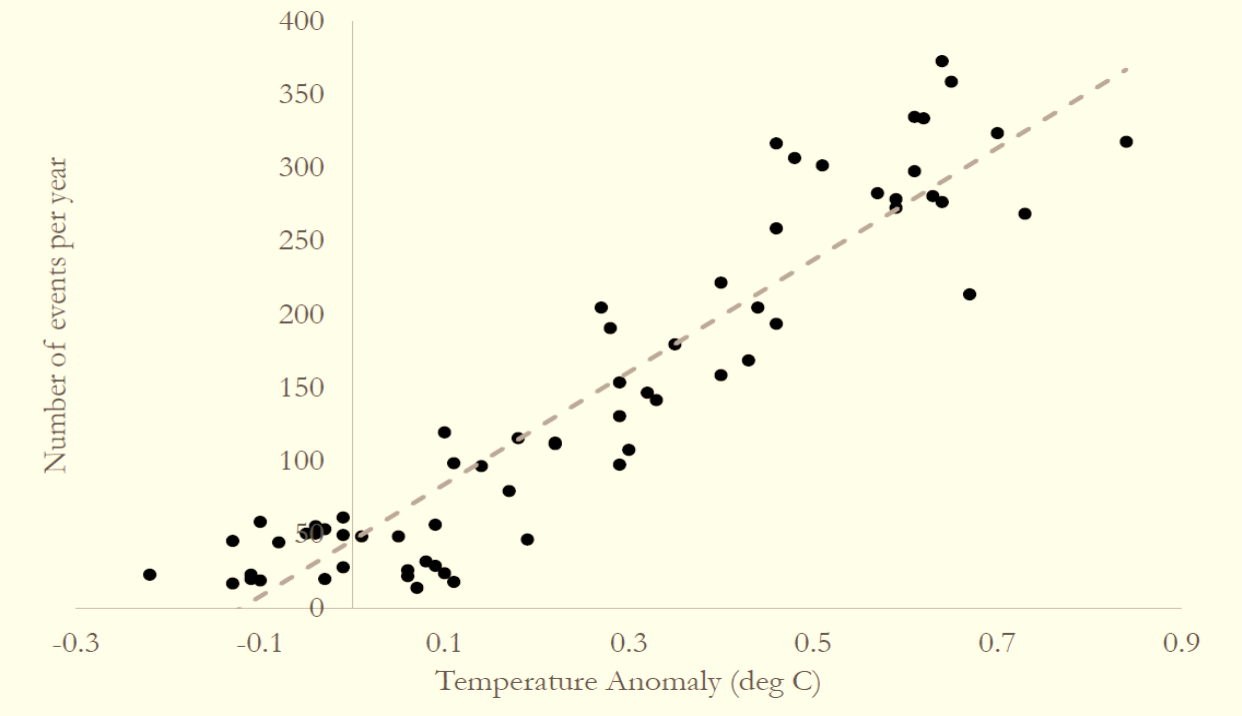
From physical risk to financial stability risks



Source: Network for Greening the Financial System, "A call for action: Climate change as a source of financial risk", 2019

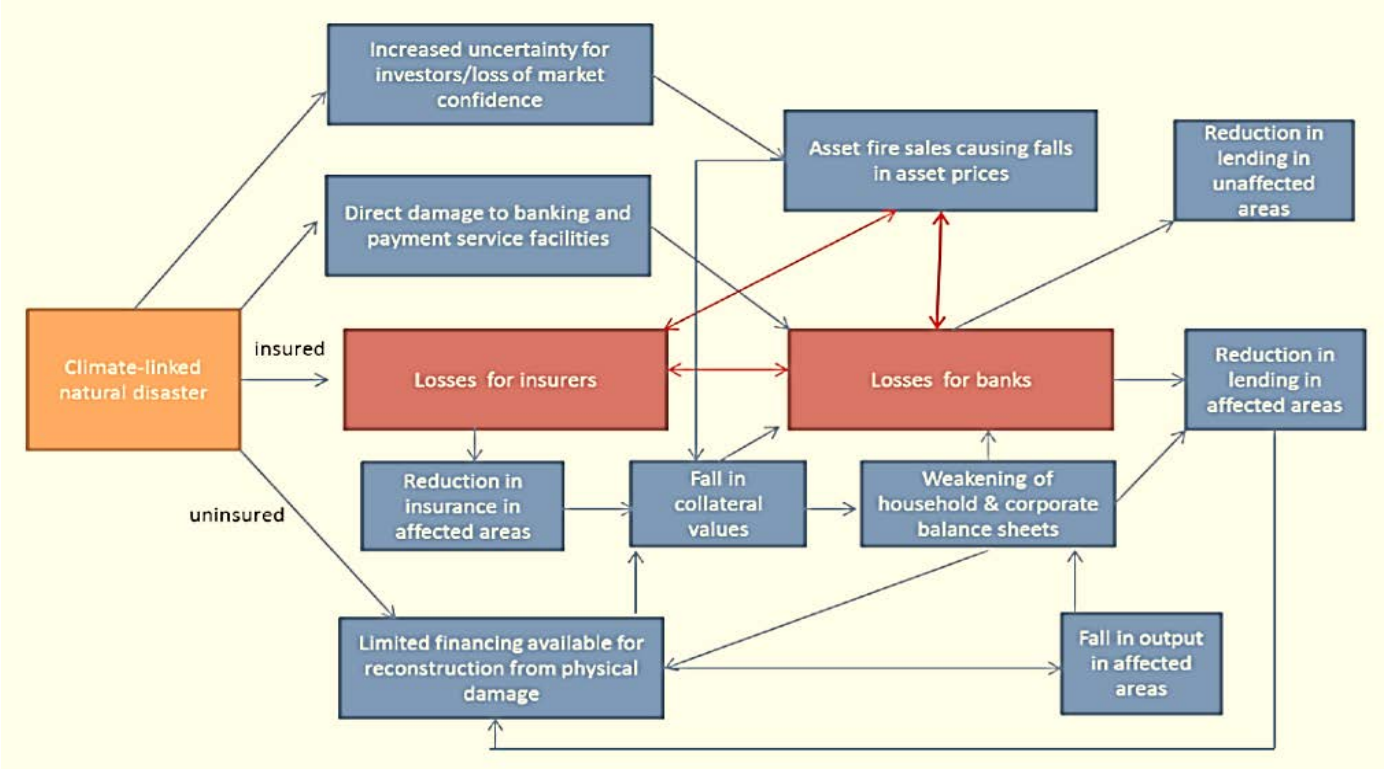
One study found that almost 2% of the world's financial assets are at risk if the global mean surface temperature rises by 2.5°C compared to pre-industrial levels (Dietz et al., "Climate value at risk of global financial assets", *Nature Climate Change*, 2016). Warming of 5°C could result in losses equal to 5% of the global stock of manageable assets ("The cost of inaction: Recognising the value at risk from climate change, *The Economist Intelligence Unit*, 2015).

Number of climate-related disasters p.a. 1955-2015 vs temperature anomaly from the mean of the 20th century



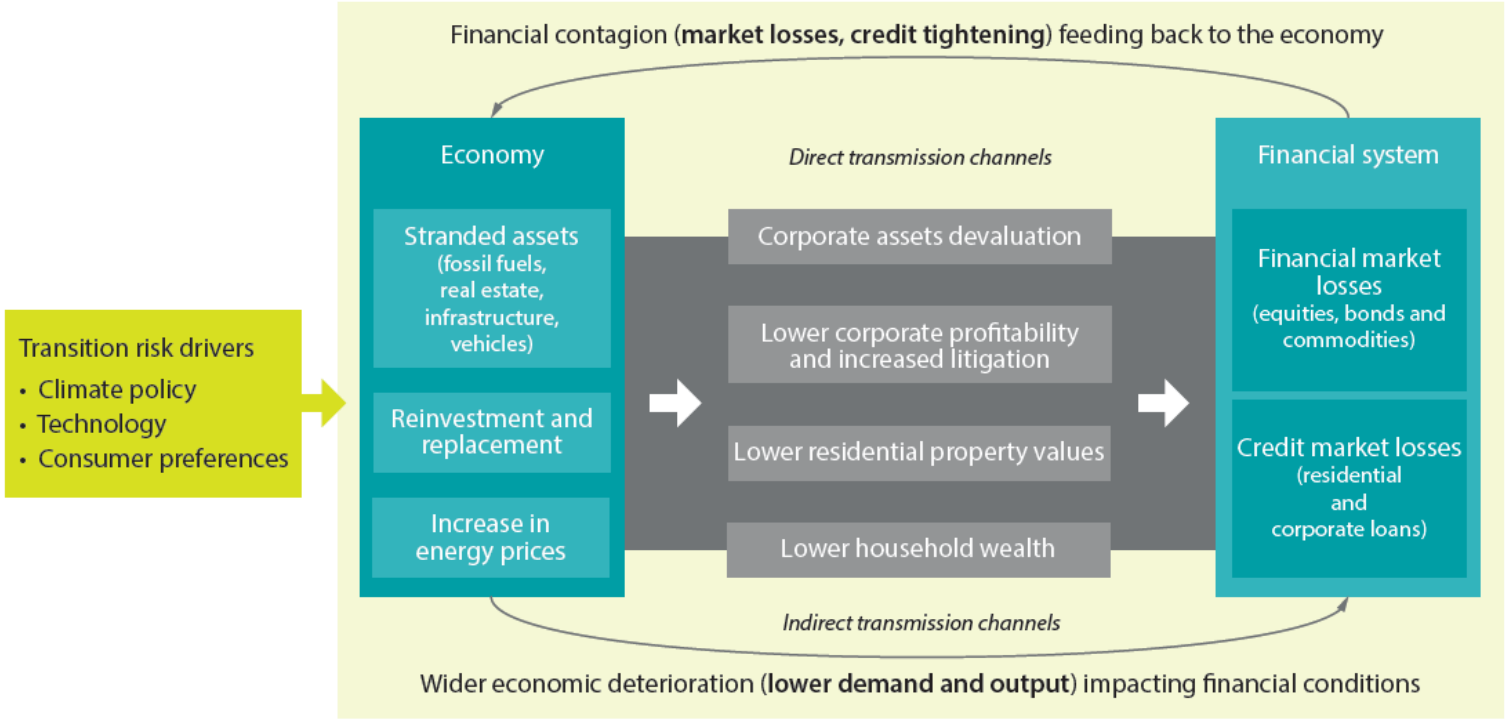
Source: Karydas, C. and A. Xepapadeas, Pricing climate change risks: CAPM with rare disasters and stochastic probabilities, ETH Zurich, WP 2019-1, 2019

Natural disaster risks from climate change



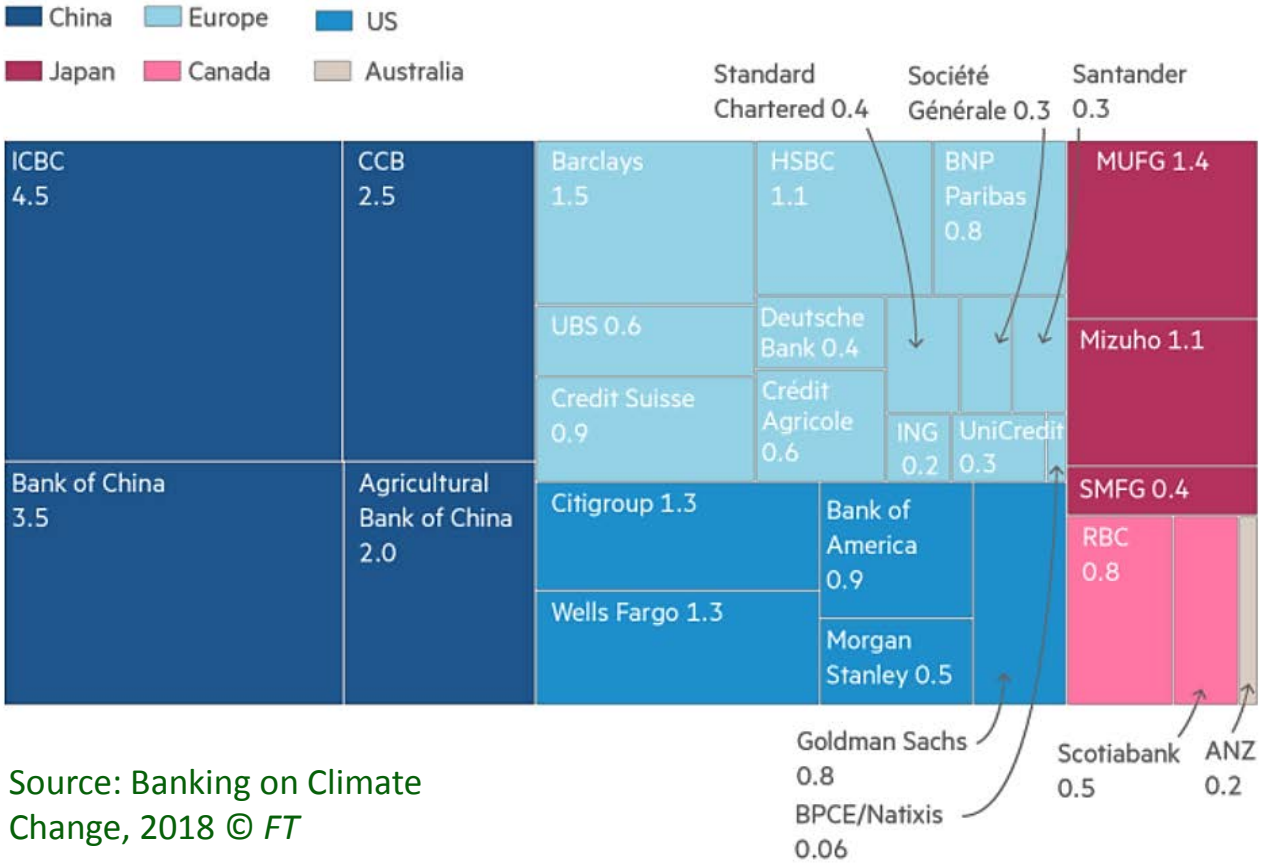
Batten S., R. Sowerbutts and M. Tanaka, “Let's talk about the weather: the impact of climate change on central banks”, Bank of England, London, Staff Working Paper No. 603, 2016

From transition risk to financial stability risks



Source: Network for Greening the Financial System, "A call for action: Climate change as a source of financial risk", April 2019

Loans to coal power companies, 2017 (USD bn)



Source: Banking on Climate Change, 2018 © *FT*

Transition risks and stranded assets

Stranded assets refer to those investments which have already been made but which, at some time prior to the end of their economic life (as assumed at the investment decision point), are no longer able to earn an economic return" (IEA, 2013, p. 98). The Carbon Tracker Initiative uses this definition and links the economic losses to those that are "a result of changes associated with the transition to a low-carbon economy" (Carbon Tracker Initiative, 2017).

Carbon bubble

- Carbon bubble: “A hypothesized overvaluation of fossil fuel reserves and related assets due to neglecting the possibility of those assets becoming unusable or ‘unburnable’ ” (Carbon Tracker Initiative, 2011)
- Limiting the rise in global warming to 2°C compared to pre-industrial levels will leave the majority of fossil fuel reserves as stranded assets. (Carbon Tracker Initiative, 2011, 2013; McGlade and Ekins, 2015)
- Nevertheless, listed oil, gas, and coal companies still largely invest in locating and developing new fossil fuel reserves (Carbon Tracker Initiative, 2013)
- Financial markets might carry a carbon bubble
- Are climate risks properly valued?
- Recommendation n°1 NFGS: Integrate climate-related risks into financial stability monitoring and micro-supervision.

Pricing

There is some evidence that after 2015 some kind of stranded asset risk is priced, especially for firms holding more fossil fuel reserves. There is some further evidence that “green banks” charge marginally higher loan rates to fossil fuel firms (Delis et al., “Being Stranded with Fossil Fuel Reserves? Climate Policy Risk and the Pricing of Bank Loans”, 2019).

Green bonds

- “Green bonds” are debt instruments used to finance green projects that deliver environmental benefits. A green bond is differentiated from a regular bond by its commitment to use the funds raised to finance or refinance "green" projects, assets or business activities” (OECD, 2016).
- The main categories include renewable energy and energy efficiency, pollution prevention and control, sustainable land use, biodiversity conservation, clean transportation and also climate adaptation.
  - It is important that the environmental benefits of green projects be clearly presented by the issuer and if possible quantified as well, so that they can be verified by independent evaluators.

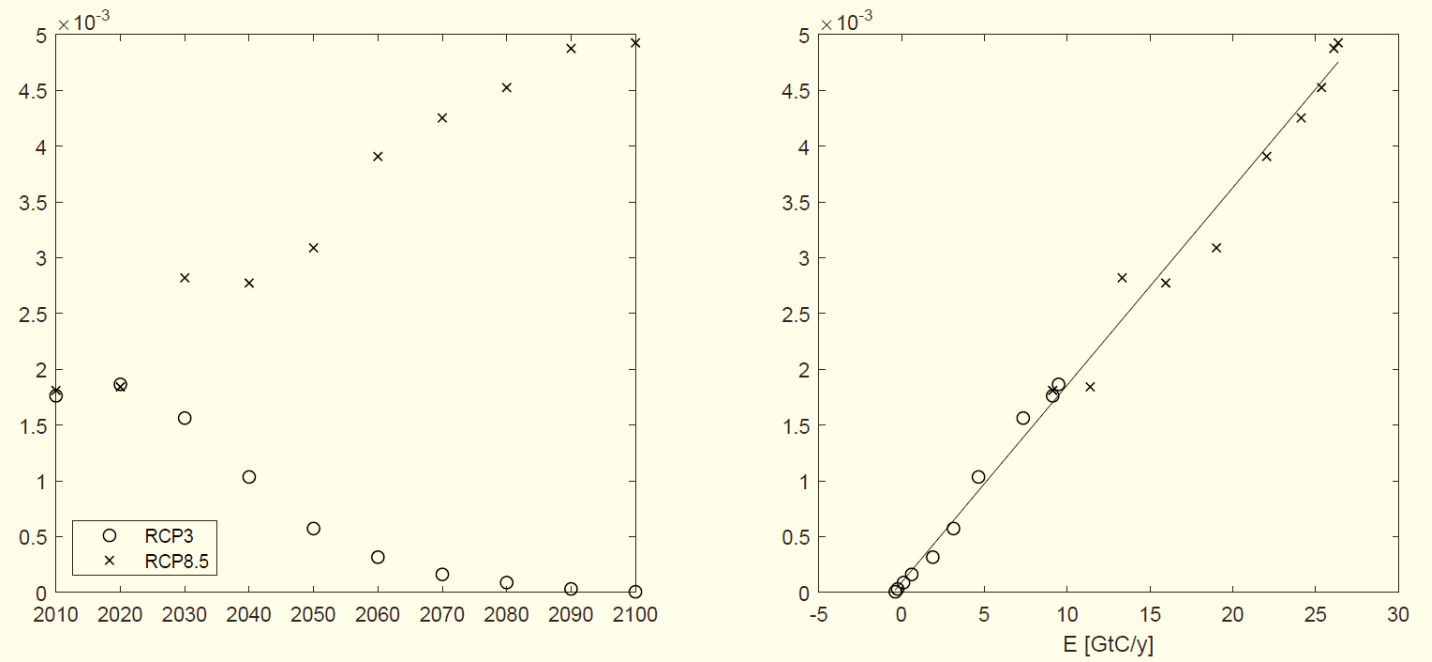
The green bond premium

- The “greenium” is defined as the difference in yield between a green bond and an equivalent synthetic conventional bond. Is a green bond yield lower than that of a completely equivalent non-green bond?
- There is evidence that the average green bond premium is found to be negative from the green bonds’ issuance date to 30 December 2016, especially in several segments such as EUR and USD bonds where the issued amount is greater than USD 100 (Zerbib, “The Green Bond Premium”, 2017).

The green bond premium

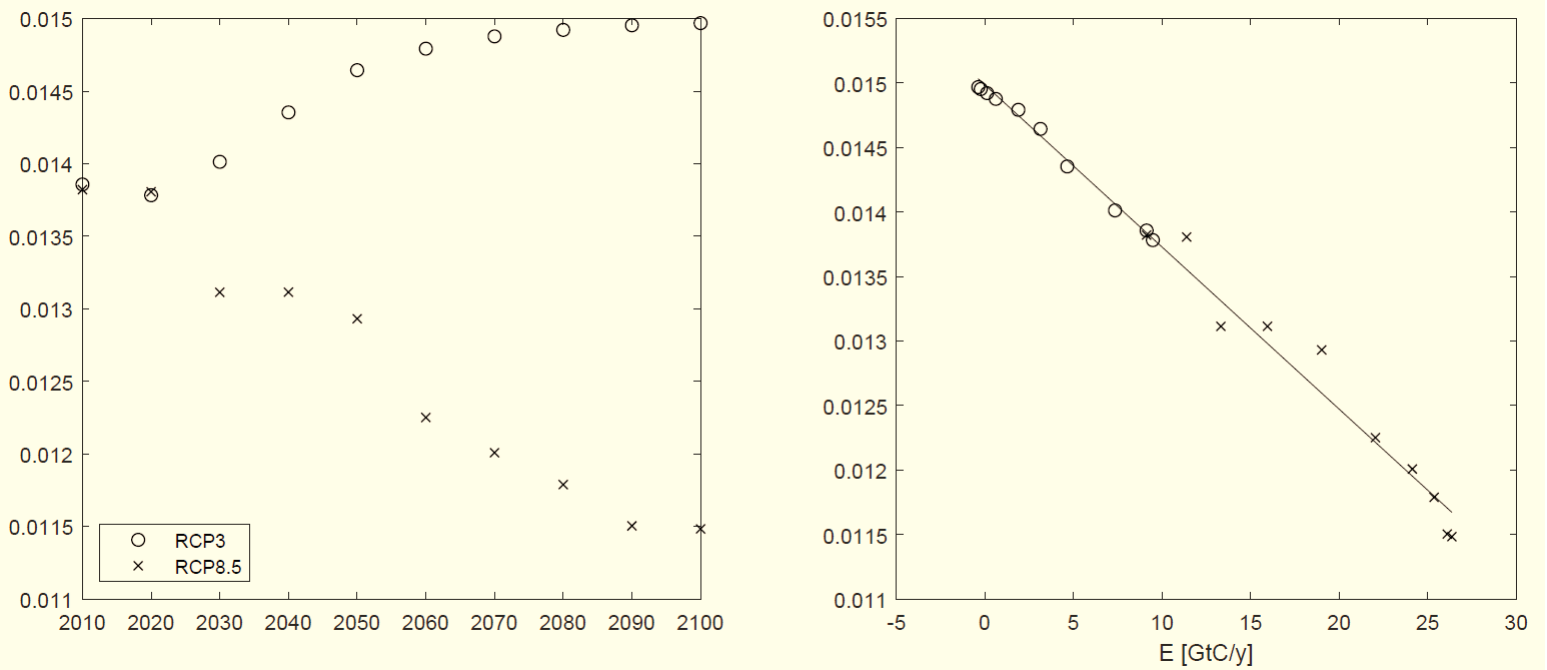
- Agliardi, E. and R. Agliardi ("Financing environmentally-sustainable projects with green bonds", EDE, 2019) suggest that in order to accelerate the green bond market:
  - green bonds should have some kind of tax exemption.
  - policy-makers should invest in environmentally responsible education and information provision to encourage consumers-investors' demand for green bonds.
  - transparency should be increased on green projects, so as to improve the issuer's credibility.
  - the cost of obtaining and monitoring the green label should be reduced.

The premium of climate change risk



Source: Karydas, C. and A. Xepapadeas, Pricing climate change risks: CAPM with rare disasters and stochastic probabilities, ETH Zurich, WP 2019-1, 2019

Climate change and government bond yield



Source: Karydas, C. and A. Xepapadeas, Pricing climate change risks: CAPM with rare disasters and stochastic probabilities, ETH Zurich, WP 2019-1, 2019

5 Further Research

Further research

- The exposure of the financial system to carbon intensive assets and the possible financial risks from the emergence of stranded brown assets
- The liabilities of the insurance system to physical climate change risks
- The extent to which assets are uninsured with respect to climate change risks
- The structure of a potential green macroprudential policy which will facilitate the introduction of green technologies
- Green bonds policies which will facilitate the transition to a low carbon economy and support programs of adaptation to climate change

Further research

- Green bonds policies which will facilitate the transition to a low carbon economy and support programs of adaptation to climate change
- The appropriate discount rate and the price of carbon to be used in cost benefit analysis of projects associated with transition to a low-carbon economy and adaptation to climate change.