

Knowledge for Climate Change

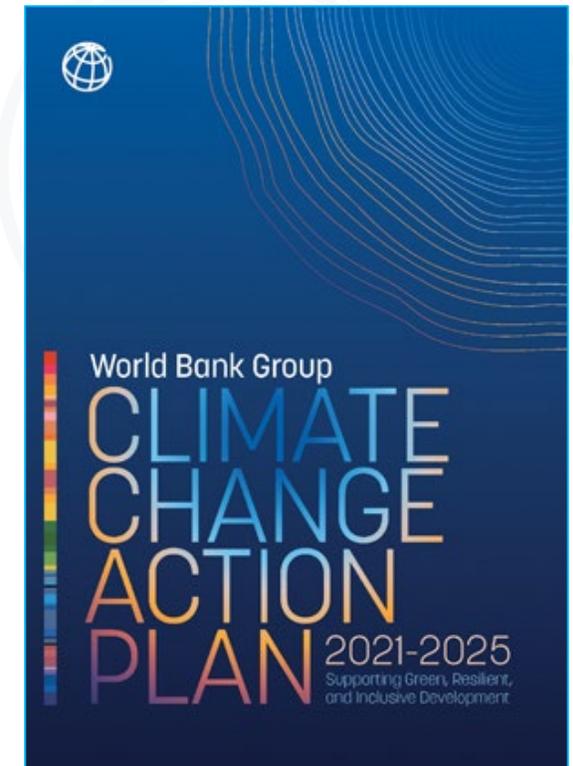
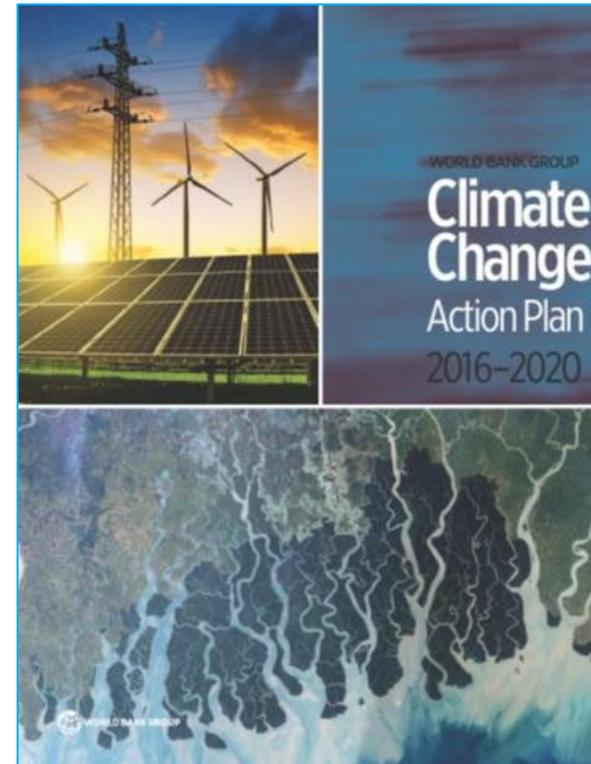
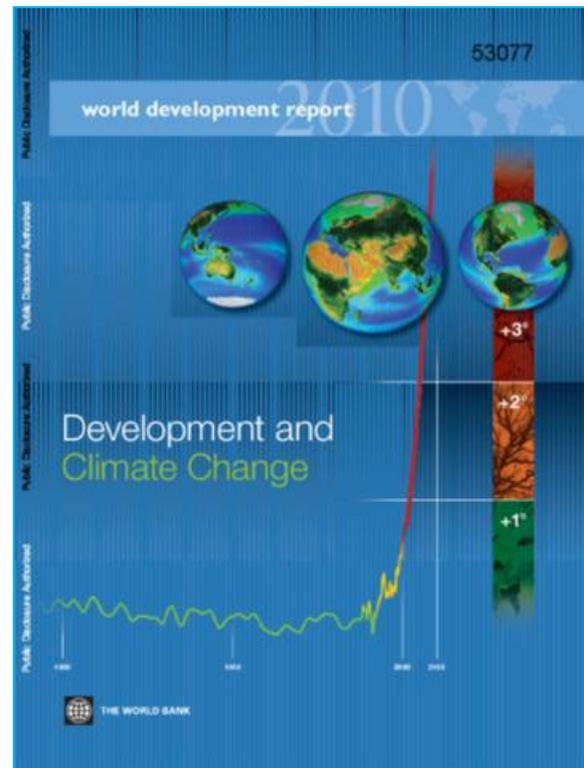
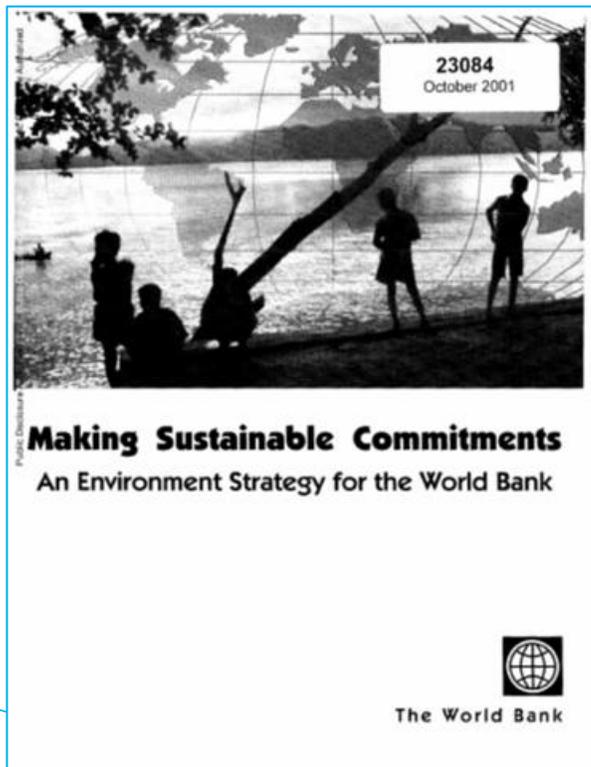
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Research Manager, Development Impact Evaluation Department (DIME), Infrastructure and Climate Change

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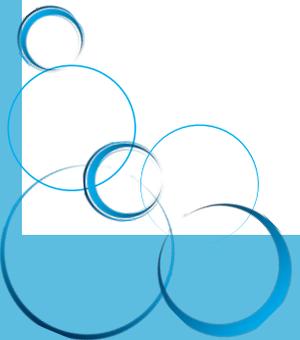
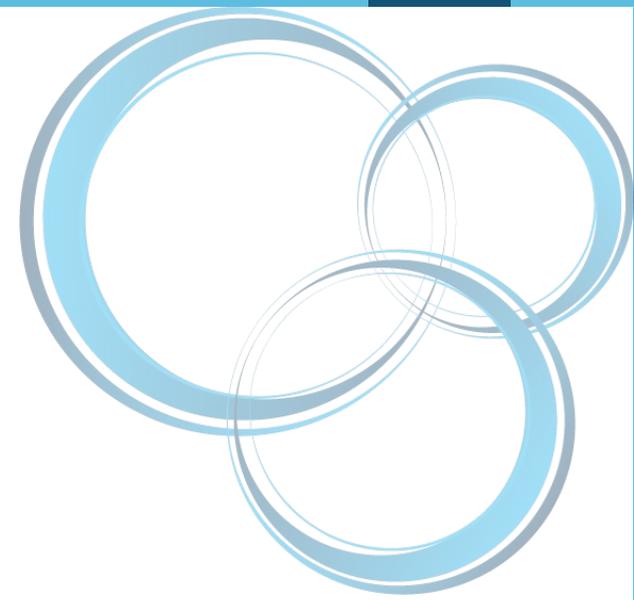
Research Manager, Development Research Group, Sustainability and Infrastructure (DECSI)

Addressing climate change has grown as a development priority



... supported by a growing body of research

Mitigation and low-carbon growth



The concept of the Social Cost of Carbon (SCC)

- Nordhaus (1982) asks “How Fast Should We Graze the Global Commons?”
- Goes on to develop Integrated Assessment Models (IAMs), famously the Dynamic Integrated Climate-Economy model (DICE) and RICE models (1992, 1994)
 - Similar growth-theoretic framework to Manne and Manne-Richels (1990)
- Many more IAMs today
 - AIM, PACE, IMAGE, MRN-NEEM, GTEM, MiniCAM, SGM, IGSM, WITCH, ADAGE, GEMINI, POLES, IGEM, MESSAGE, FUND, ETSAP-TIAM, MERGE, DART...



AEA PAPERS AND PROCEEDINGS

MAY 1982

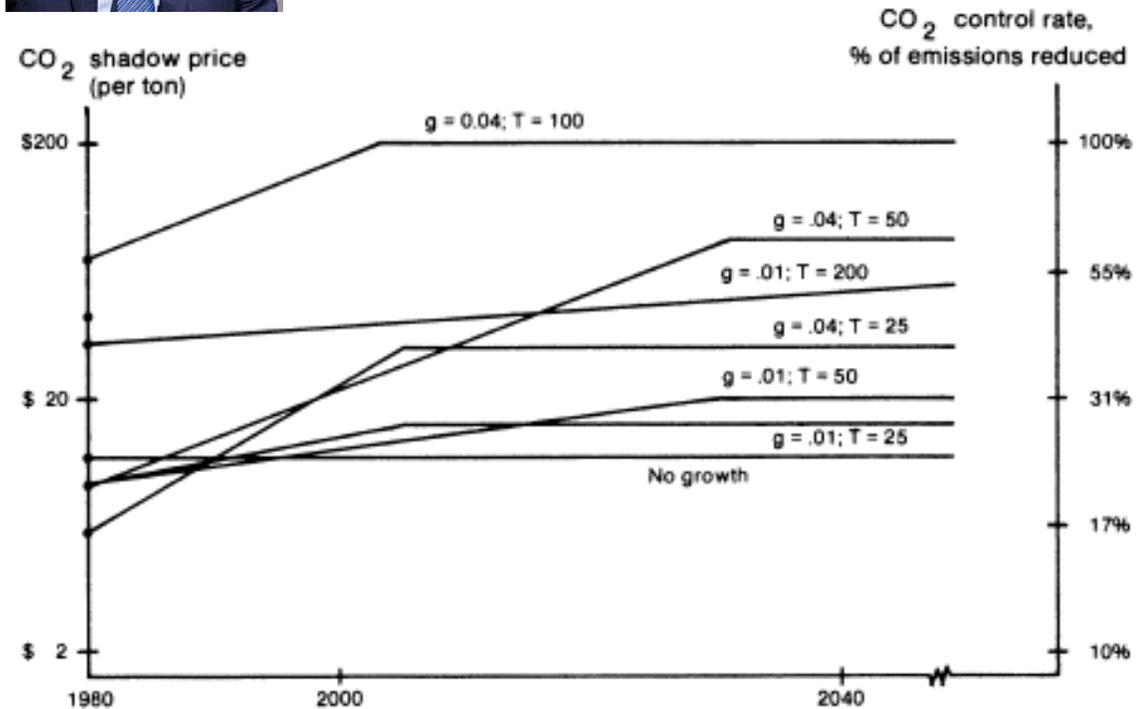


FIGURE 1. CALCULATED TRAJECTORY OF OPTIMAL CARBON SHADOW PRICE (LEFT SCALE) AND CONTROL RATE (RIGHT SCALE) FOR DIFFERENT ECONOMIC GROWTH PATTERNS

Evolution of the SCC

IAMs have evolved over time, including and improving assumptions regarding many variables

- Damage functions, potential tipping points, population, technical progress, carbon cycle, radiative forcing, inequity aversion, uncertainties, risk aversion, and discounting

Growing criticisms push for new approaches

- E.g. Stern, Stiglitz, and Taylor (2022) “The economics of immense risk, urgent action and radical change”

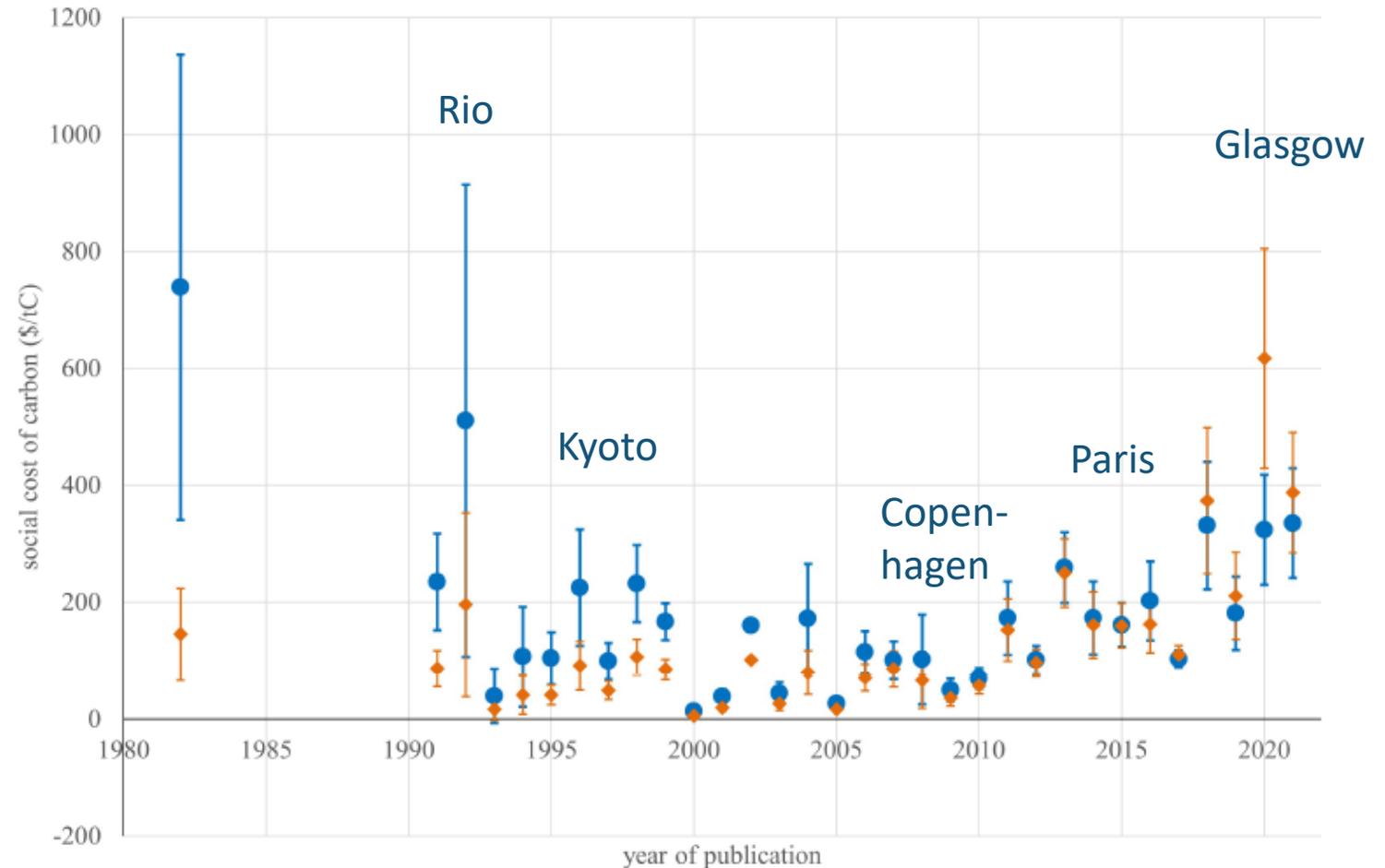
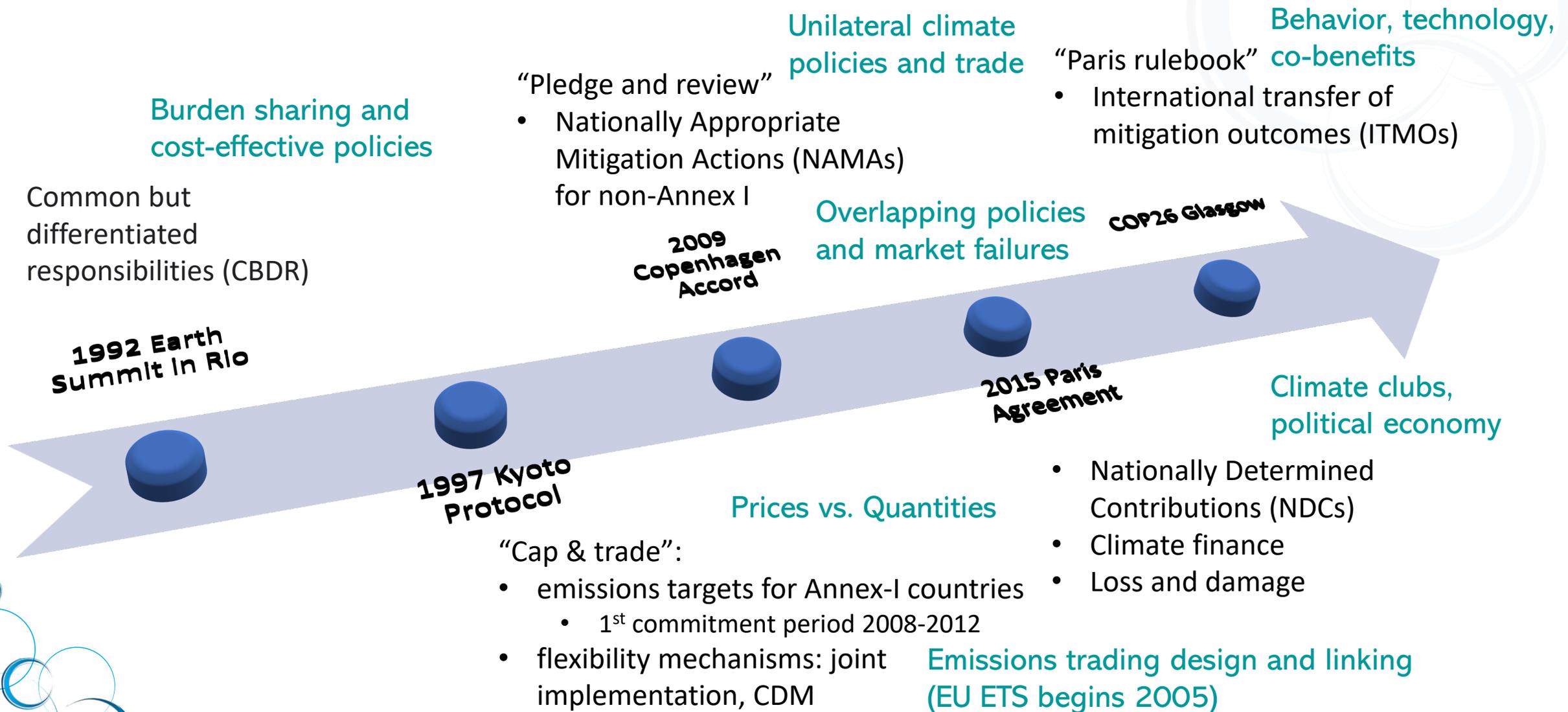


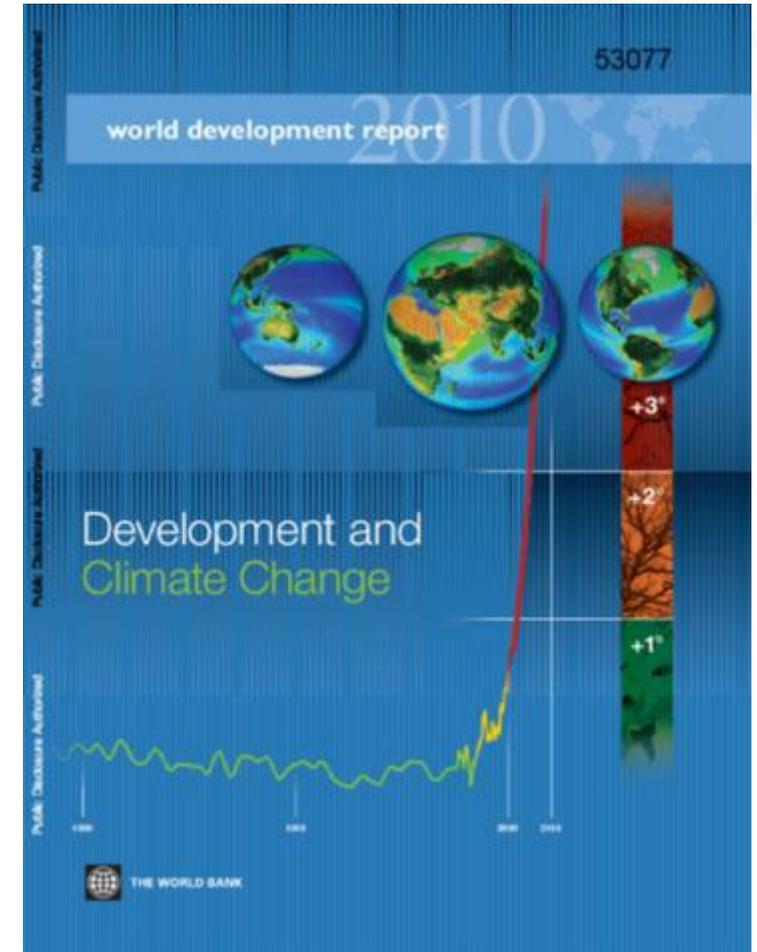
Figure 1: Average social cost of carbon by publication year. Orange diamonds are as reported, blue dots are corrected for inflation and year of emission. Error bars are plus and minus the standard deviation of the published estimates. Estimates are quality weighted and censored. Source: Tol (2022)

30 years of climate negotiations (and research)



KCP research on the road to Copenhagen (selected mitigation-related)

- Mitigating climate change by avoiding lock-ins to high carbon energy systems
- Options for cleaner energy in developing countries and overcoming barriers to their adoption and sustainability
- Global warming and developing countries: an economy-wide perspective
- Biofuels and sustainable development
- WDR 2010 Development and Climate Change



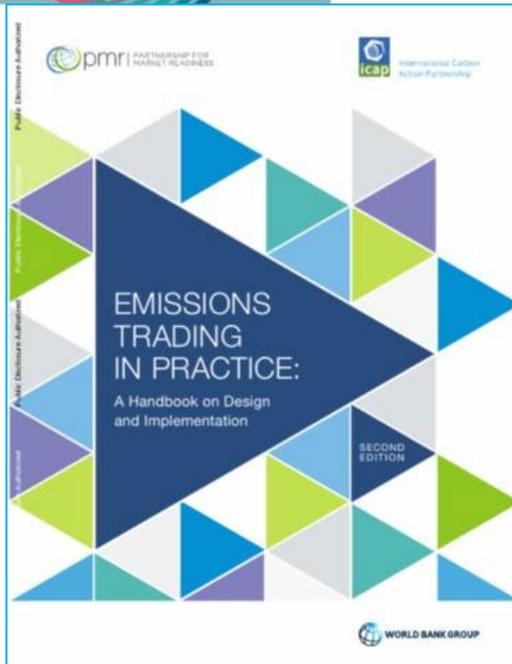
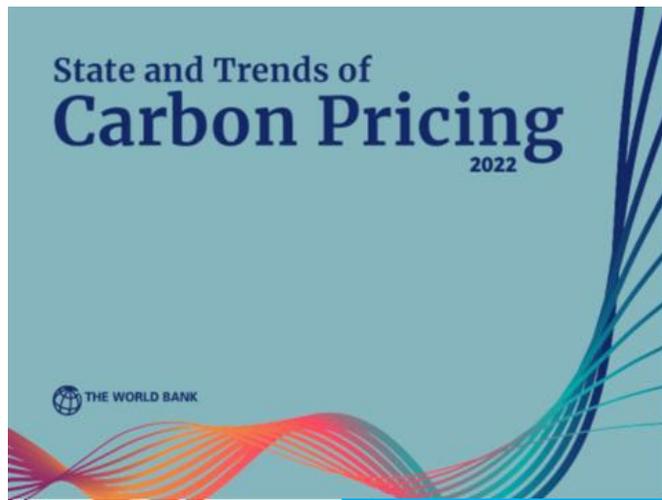
<https://openknowledge.worldbank.org/handle/10986/4387>

KCP research after Copenhagen (selected mitigation-related)

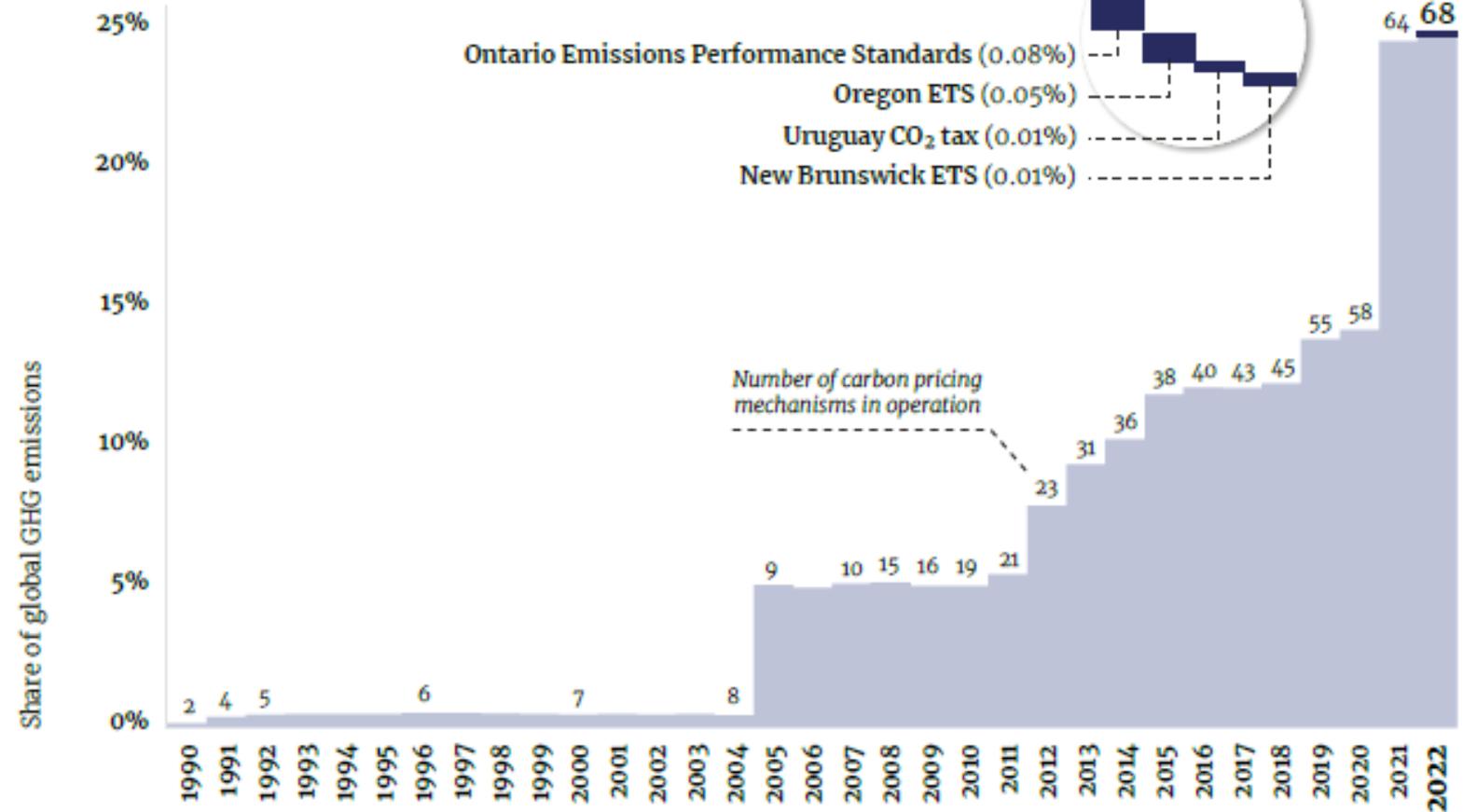
- Nuances in low-carbon technologies and development
 - Biofuels and biodiversity
 - Electricity market competition and low-carbon generation
 - Community forestry and pro-poor carbon sequestration
 - Transaction costs of energy efficiency measures to reduce GHGs
 - Supporting Ethiopia's Push for 9 Million Improved Cooking Stoves
- Assessing green growth opportunities in developing countries
 - Economic impacts of low-carbon growth scenarios
 - Linking bottom-up and top-down models for assessing economy-wide impacts of discrete climate change mitigation measures
 - Sustainable poverty reduction and shared prosperity under a changing climate



30 years of carbon pricing

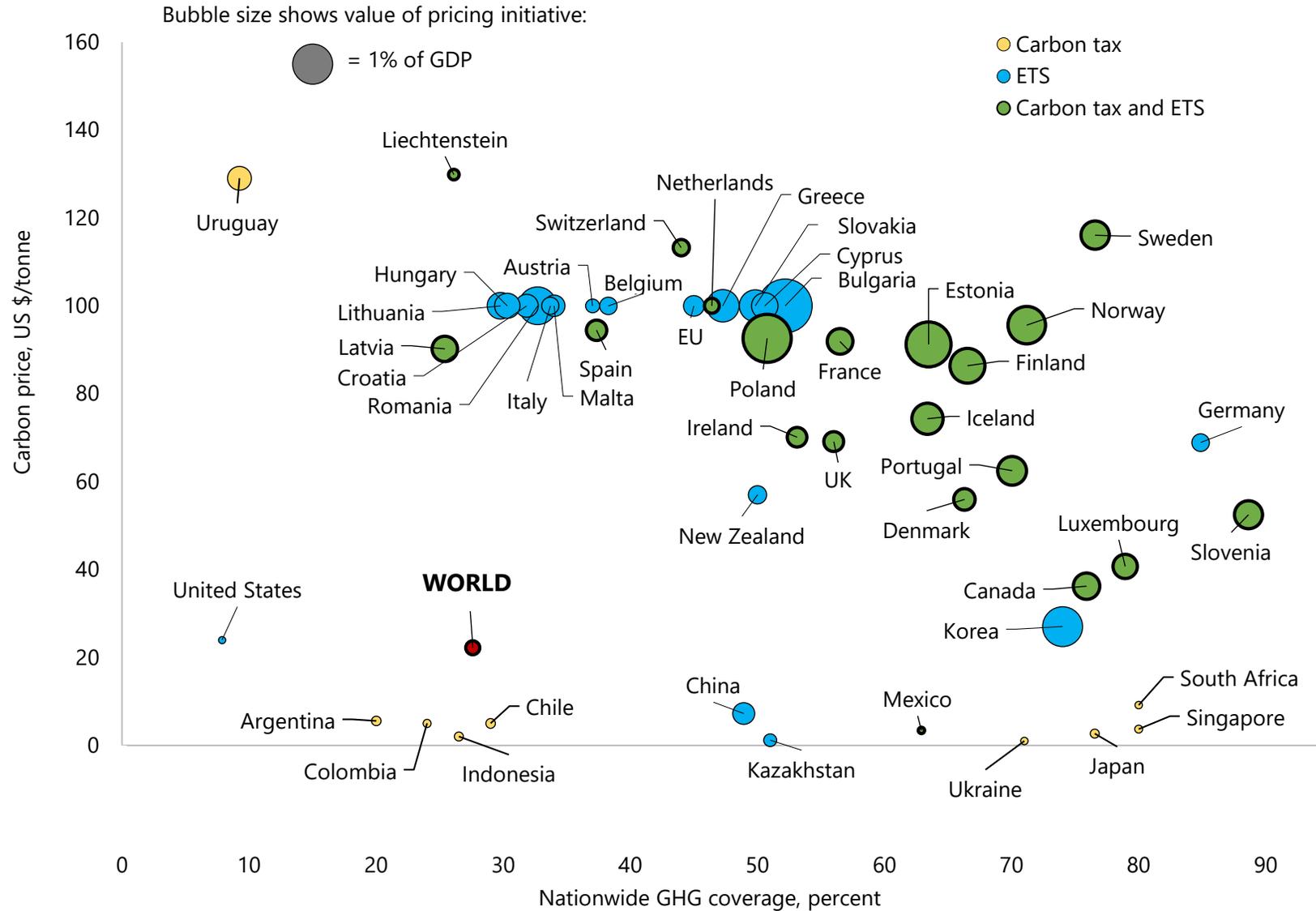


Share of global GHG emissions covered by carbon pricing instruments



Source: [WBG \(2022\)](#)

National and Regional Carbon Pricing Schemes



Carbon tax under consideration:

- Botswana
- Senegal

ETS under consideration:

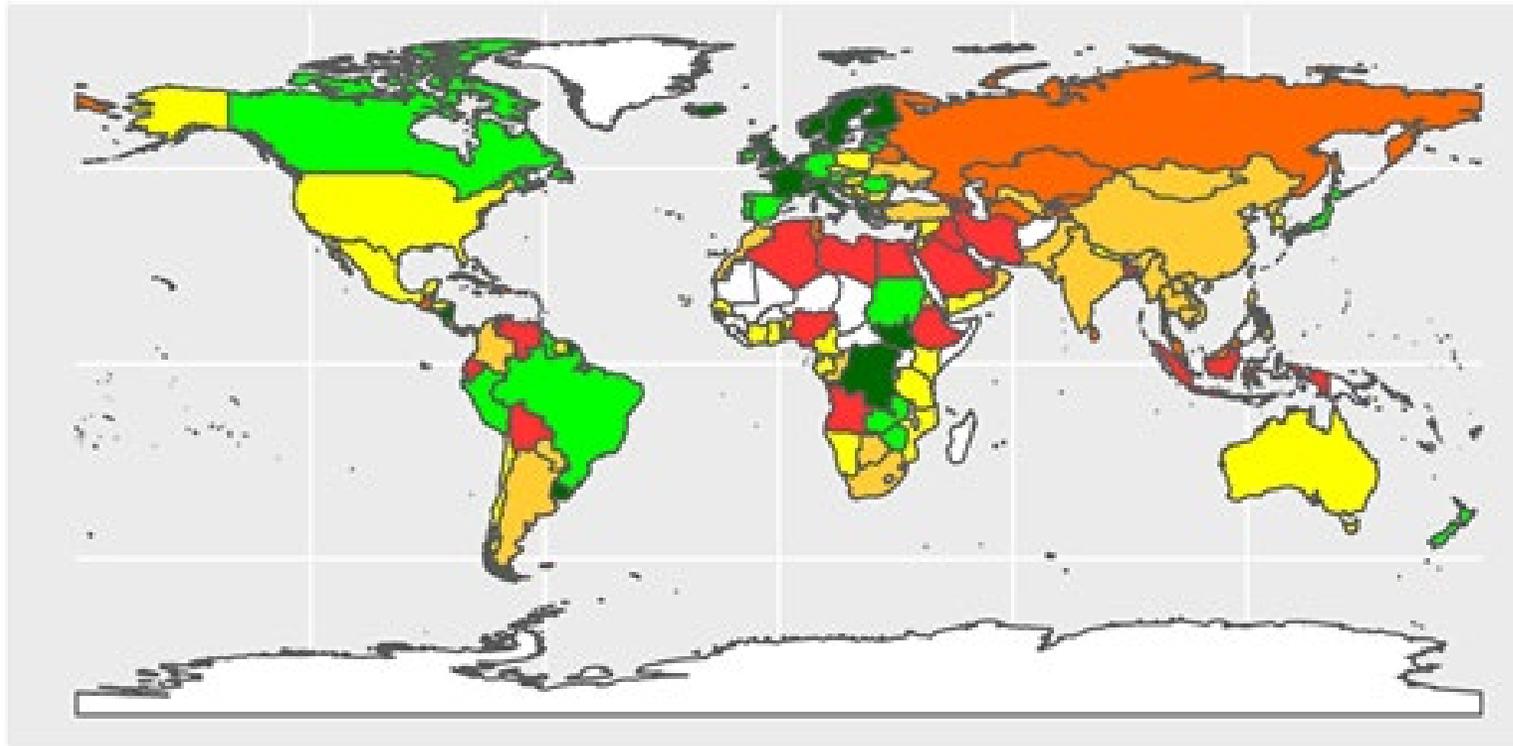
- Malaysia
- Vietnam
- Thailand
- Philippines

Sources: [WBG \(2022\)](#), IMF staff calculations, government websites. Notes: Prices are emissions weighted averages between schemes at national, sub-national and, if applicable, EU level. Value of pricing is the carbon price times emissions covered divided by GDP

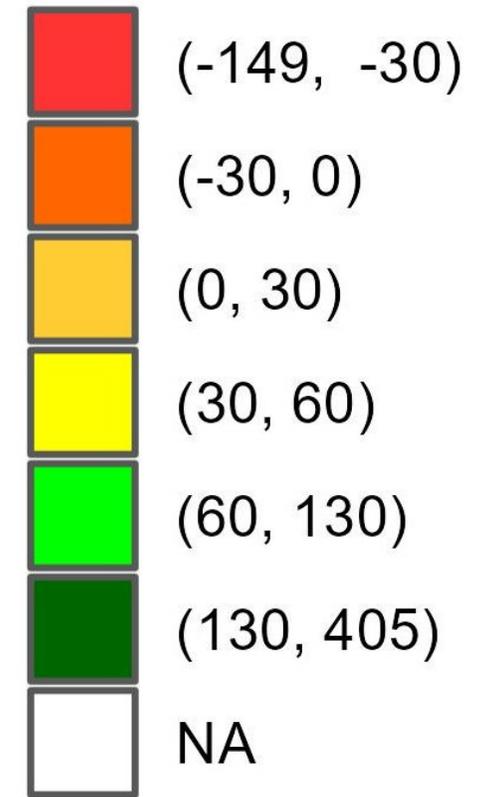
Direct carbon pricing only part of the story

- Indirect taxes on fossil fuels (net of subsidies) also contribute to total carbon pricing

Total carbon prices in 2021

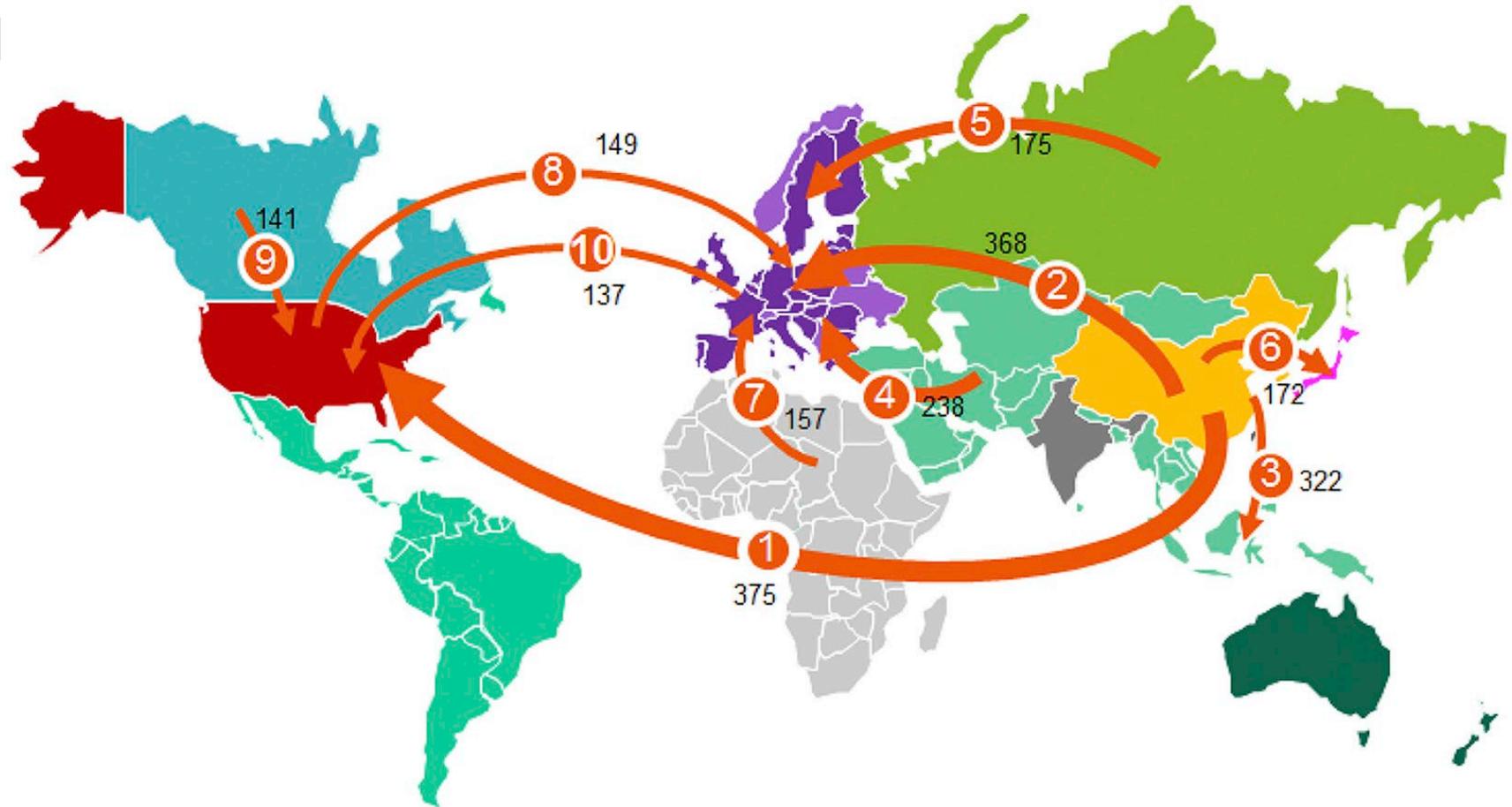


USD/tCO₂



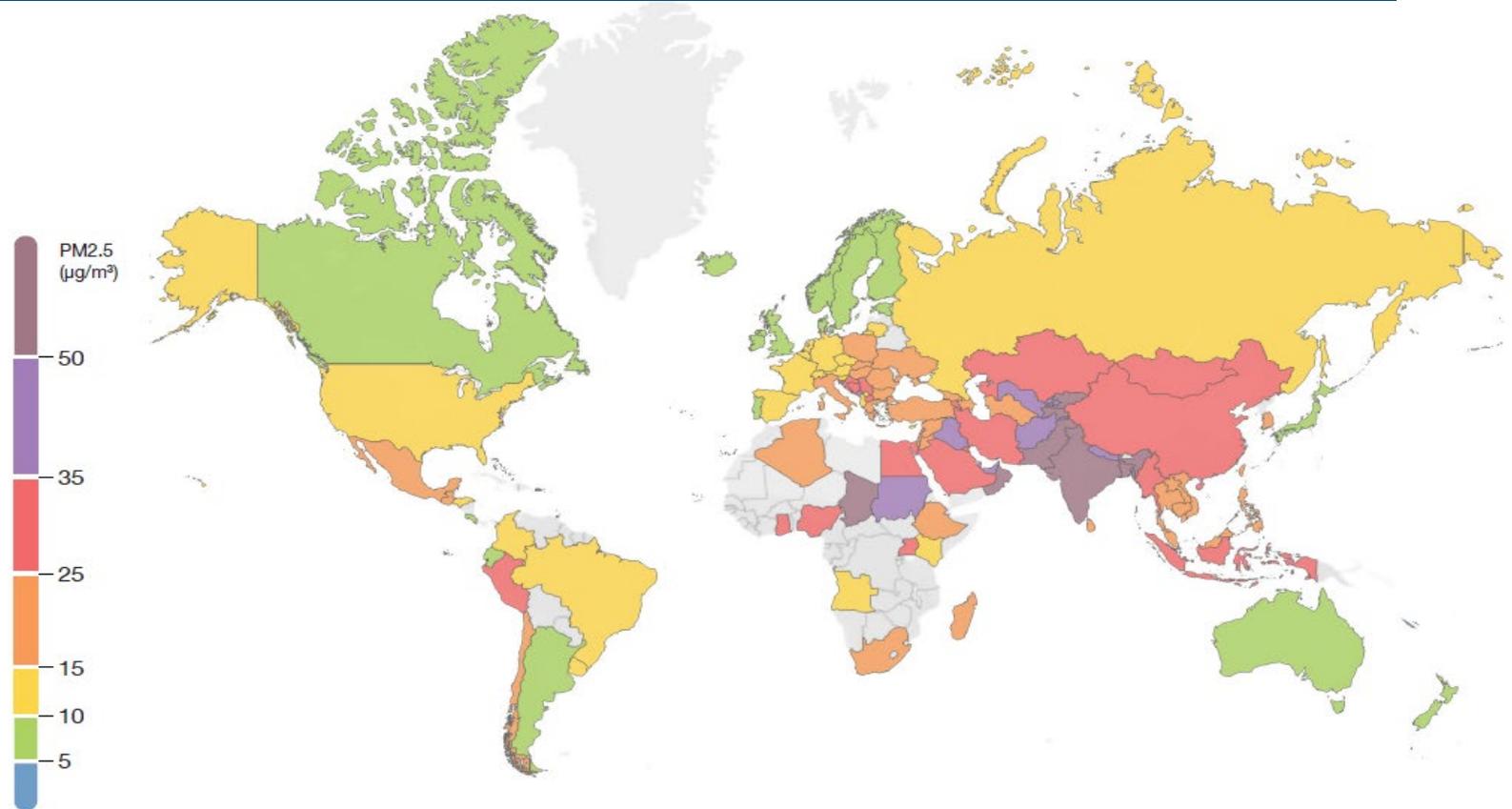
Research priorities: a broader view of carbon cost alignment

- Carbon embodied in trade



Research priorities: a broader view of carbon cost alignment

- Carbon embodied in trade
- **Co-benefits**



2021 global map color coded by annual average PM2.5 concentration

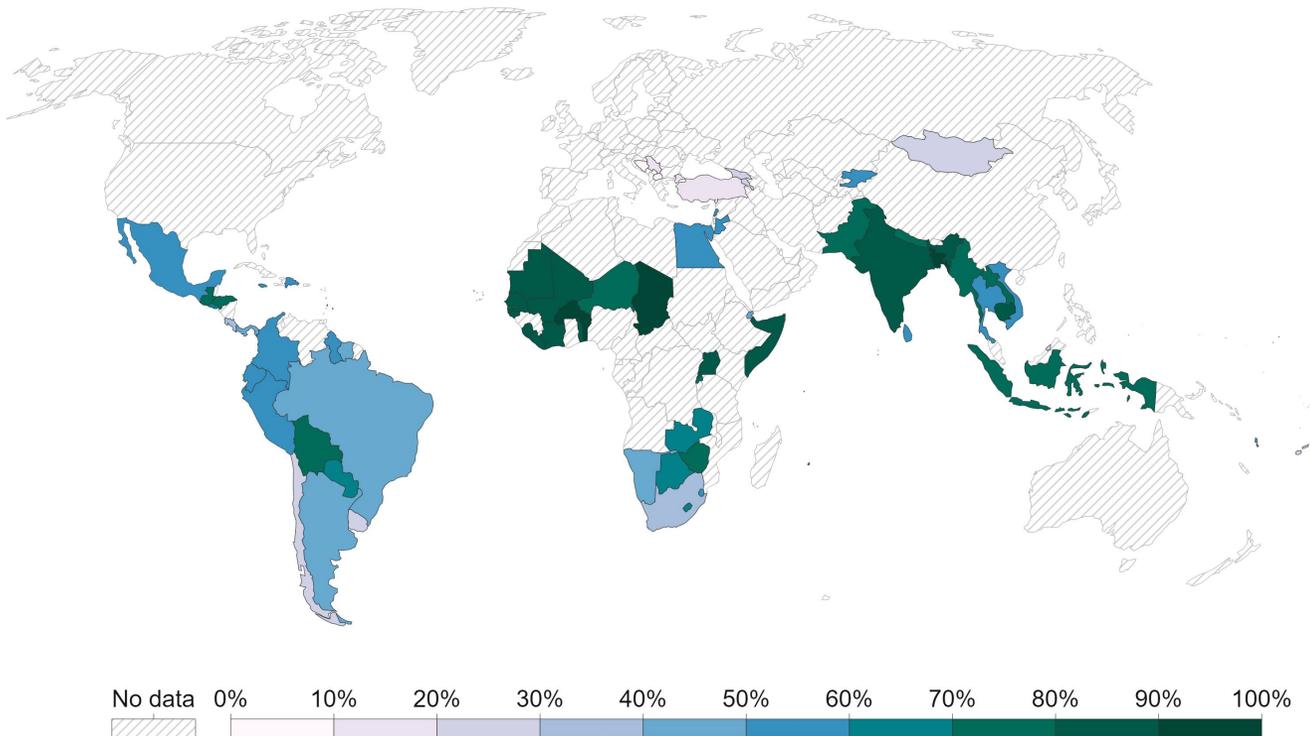
Research priorities: a broader view of carbon cost alignment

- Carbon embodied in trade
- Co-benefits
- Informality

Informal employment, 2021

Employment in the informal economy as a percentage of total non-agricultural employment. This includes all jobs in unregistered and/or small-scale private unincorporated enterprises that produce goods or services meant for sale or barter. Self-employed street vendors, taxi drivers and home-base workers, regardless of size, are all considered enterprises.

Our World
in Data

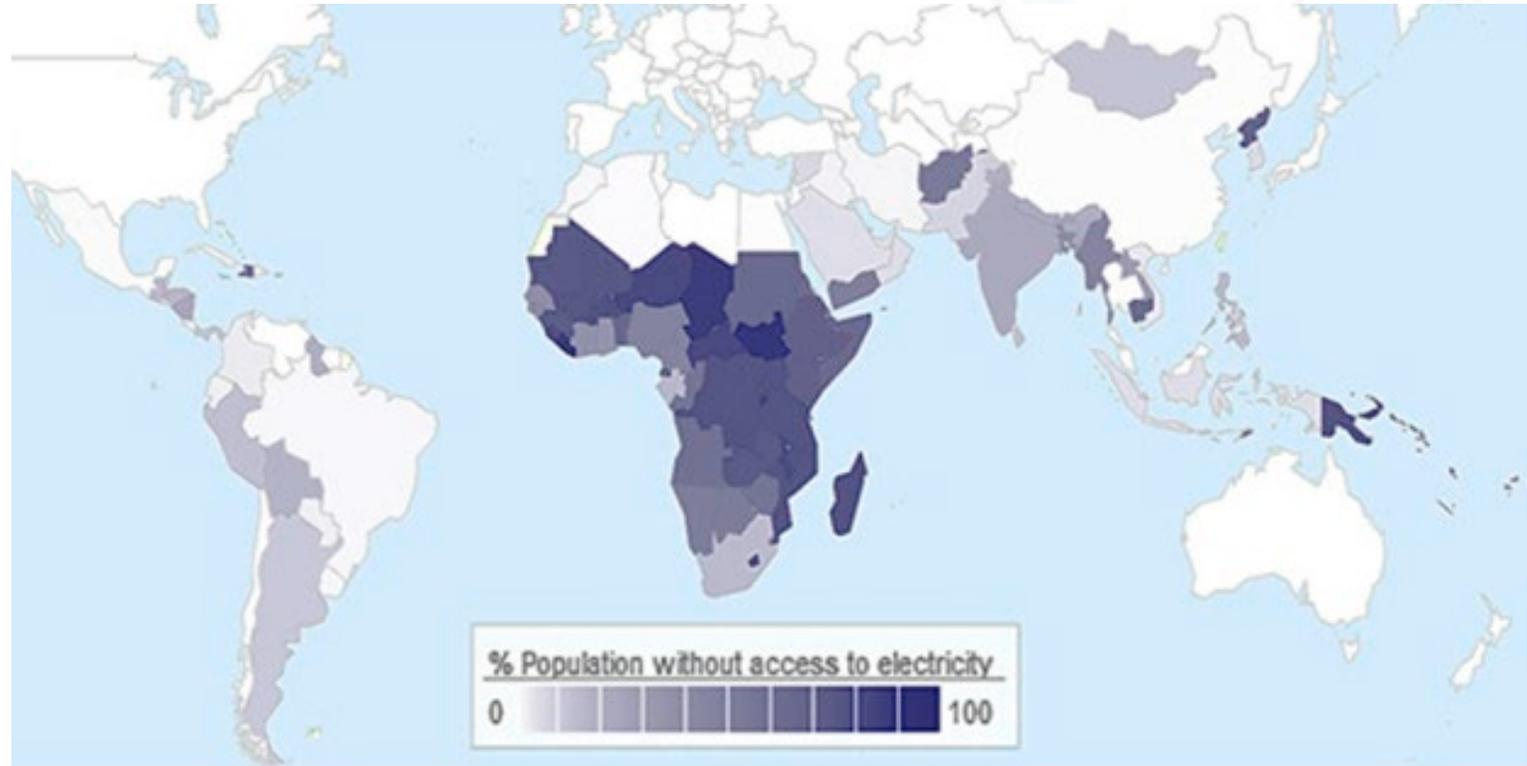


Source: Data from multiple sources compiled by the UN

CC BY

Research priorities: a broader view of carbon cost alignment

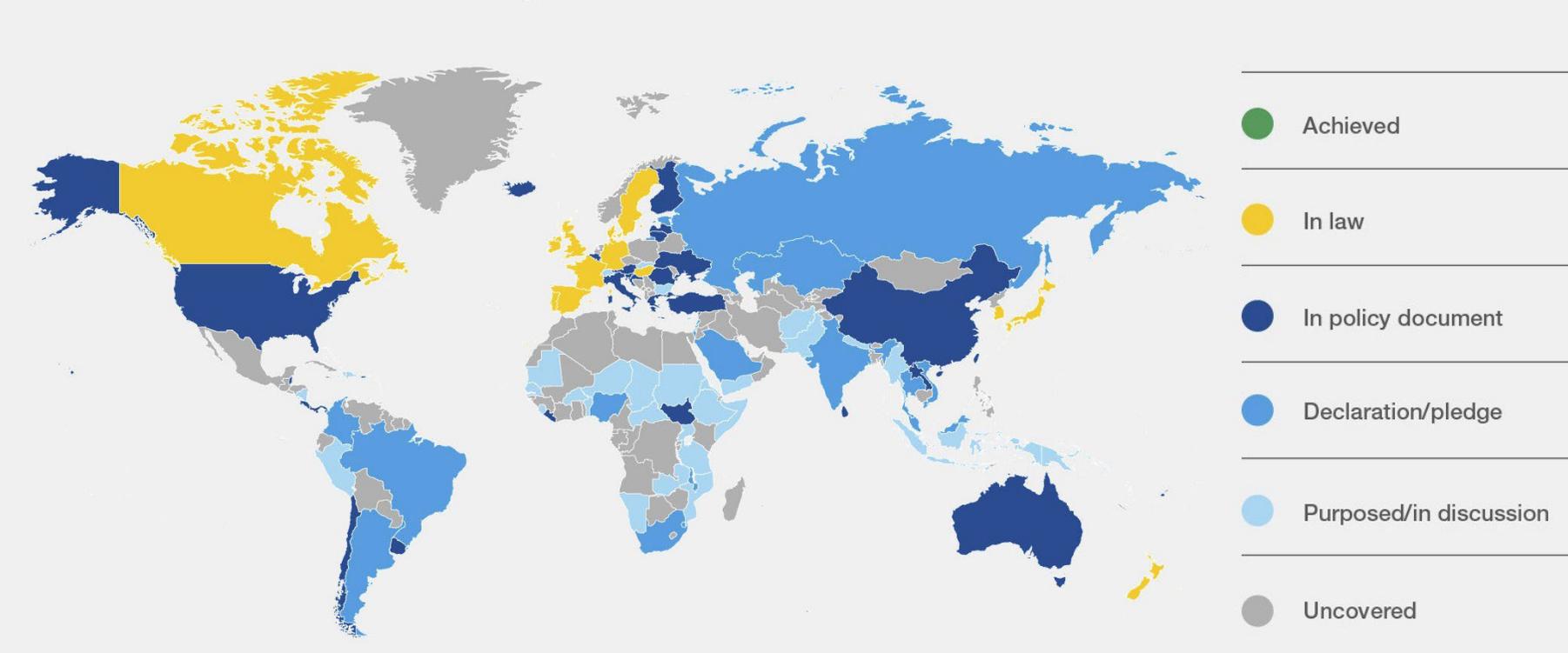
- Carbon embodied in trade
- Co-benefits
- Informality
- **Energy access**

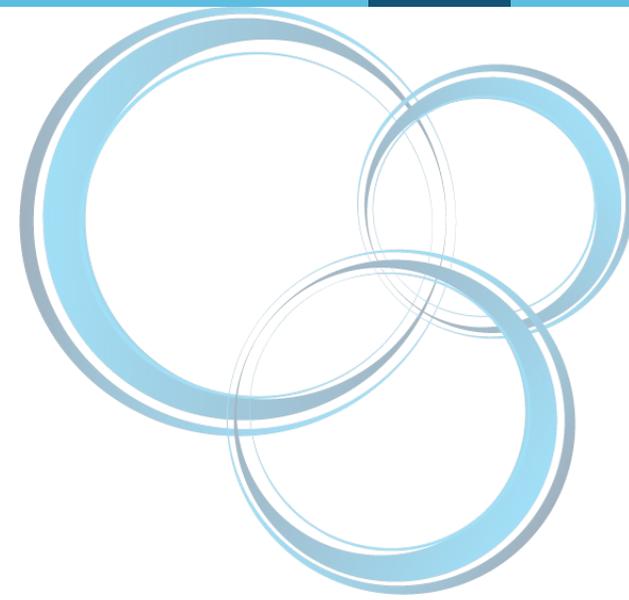


Research priorities: a broader view of carbon cost alignment

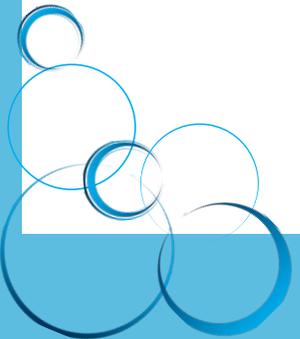
- Carbon embodied in trade
- Co-benefits
- Informality
- Energy access
- **NDCs and just transition**

Status of countries' net-zero targets, 2021



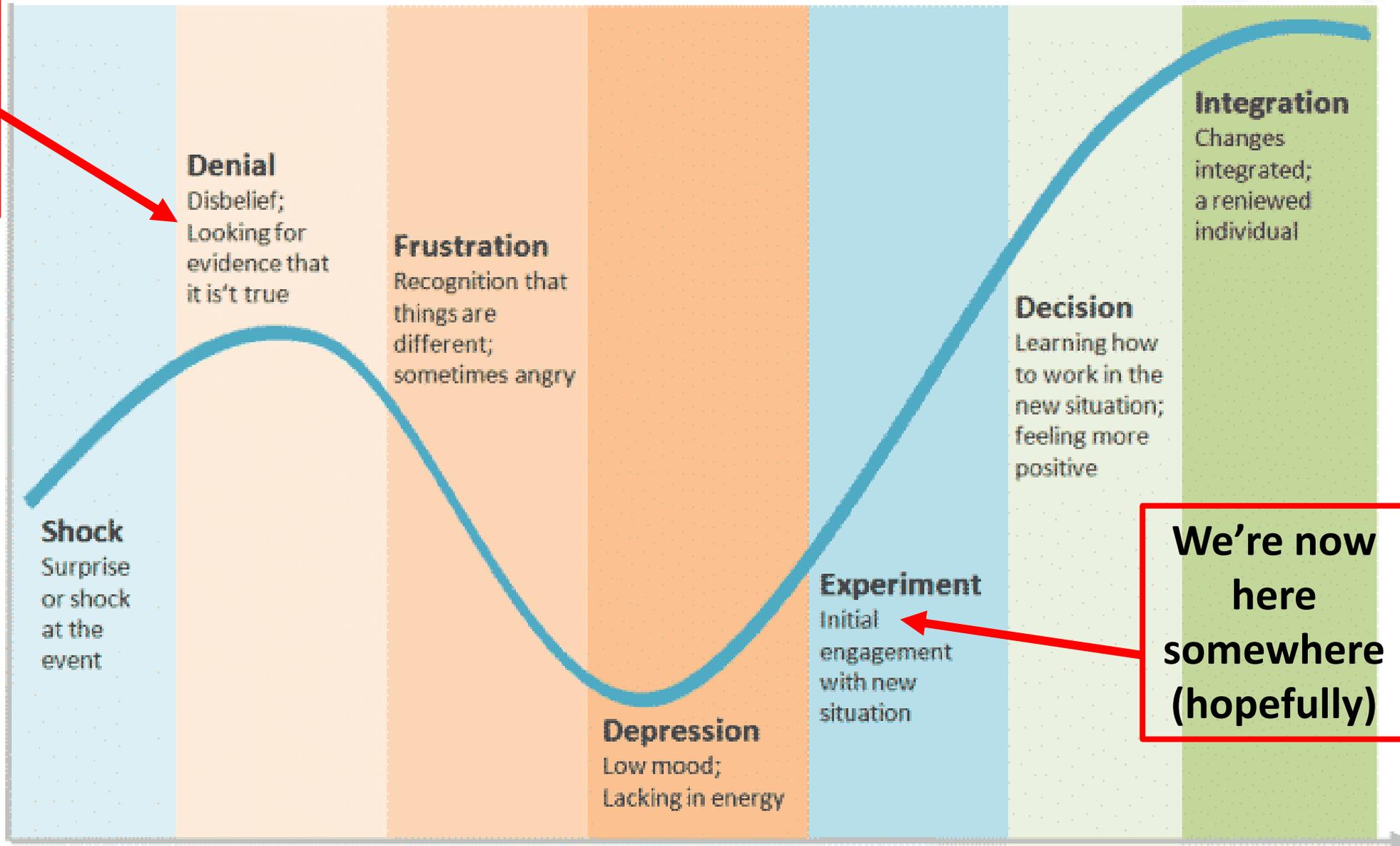


Resilience and adaptation



CC
research
starts
here

MORAL & COMPETENCE



We're now
here
somewhere
(hopefully)

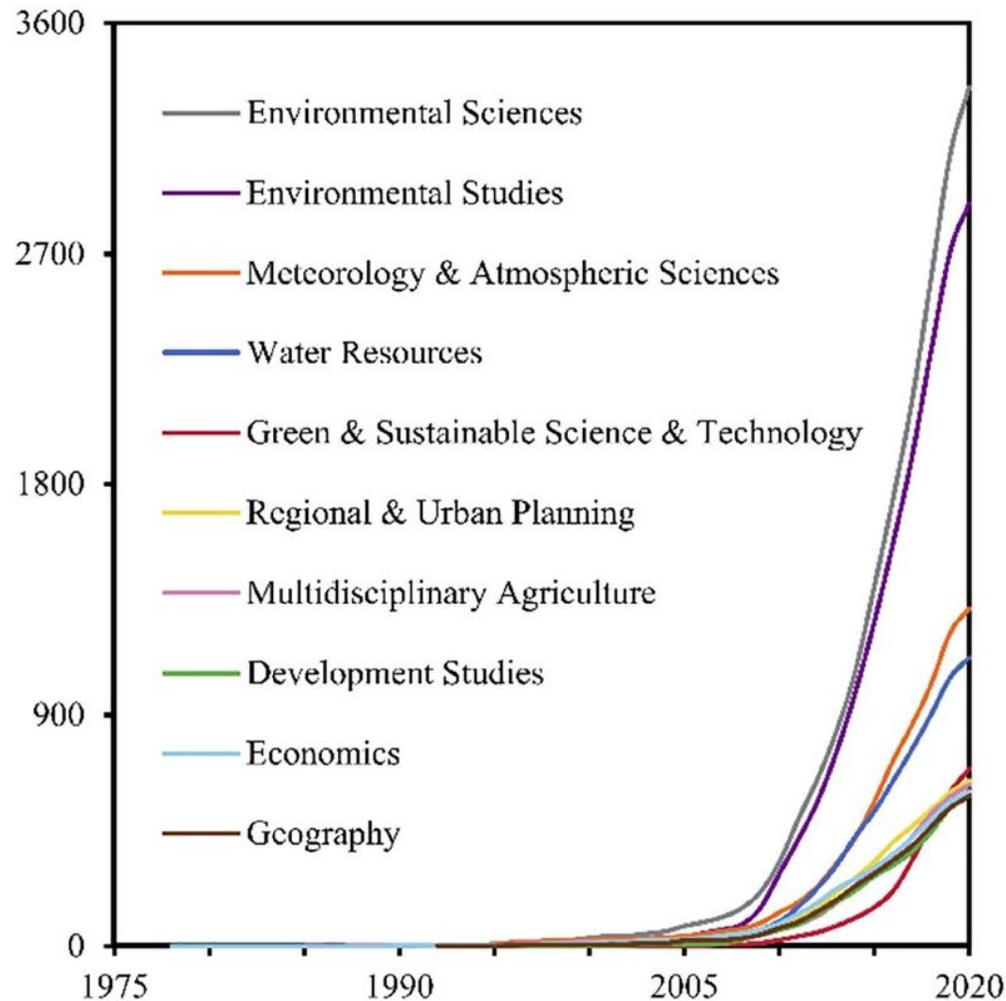
TIME

First empirical confirmation of climate-induced migration...

“This suite of analyses generates ‘very high confidence’ (as laid down by the IPCC) that climate change is already affecting living systems.”

Parmesan & Yohe (Nature, 2003)

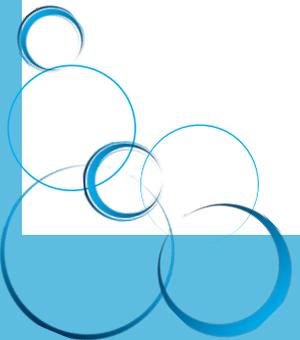
Exponential growth in climate adaptation research



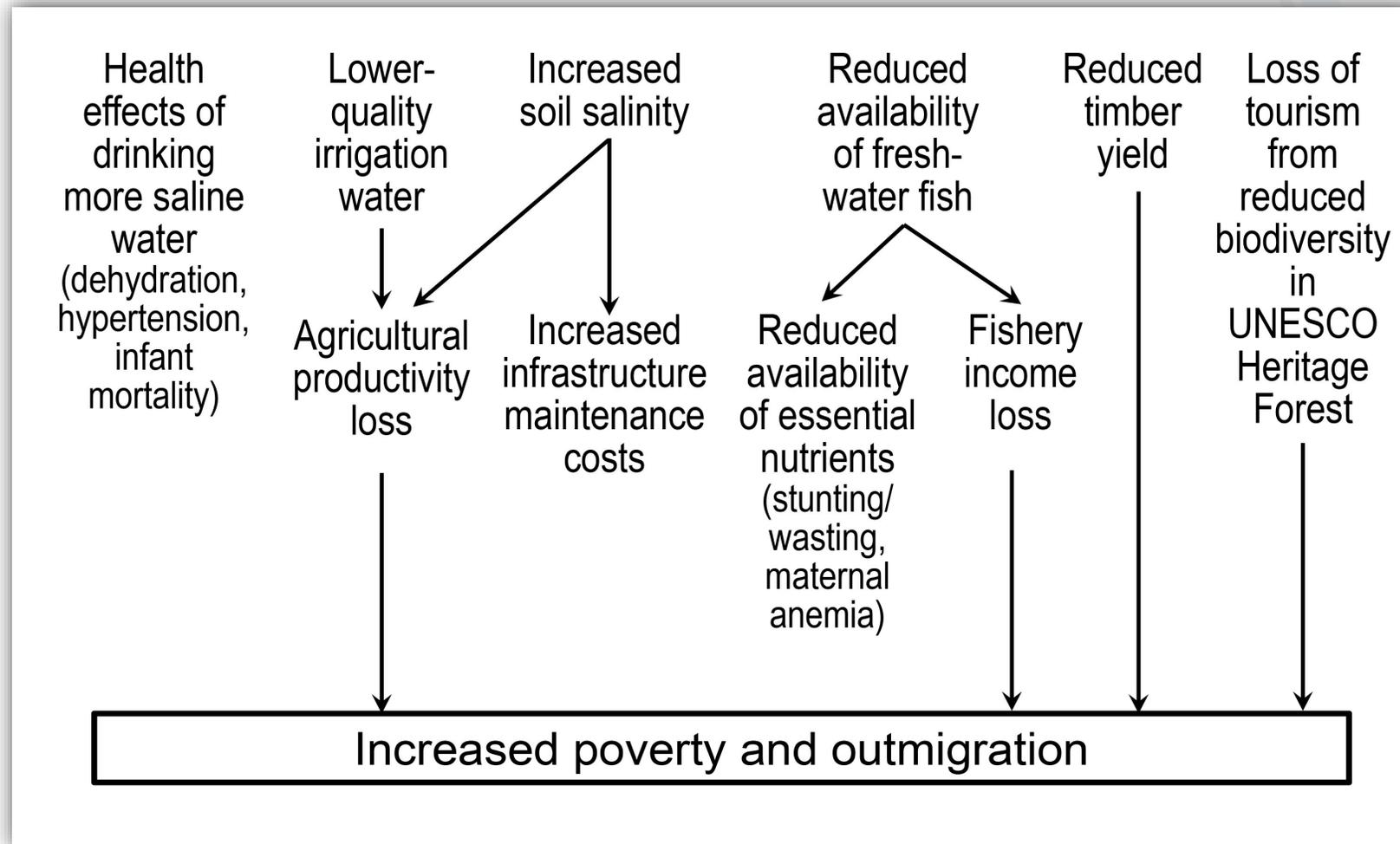
Leading to advances in:

- Data
- Impacts of climate change
- Effectiveness of adaptation approaches

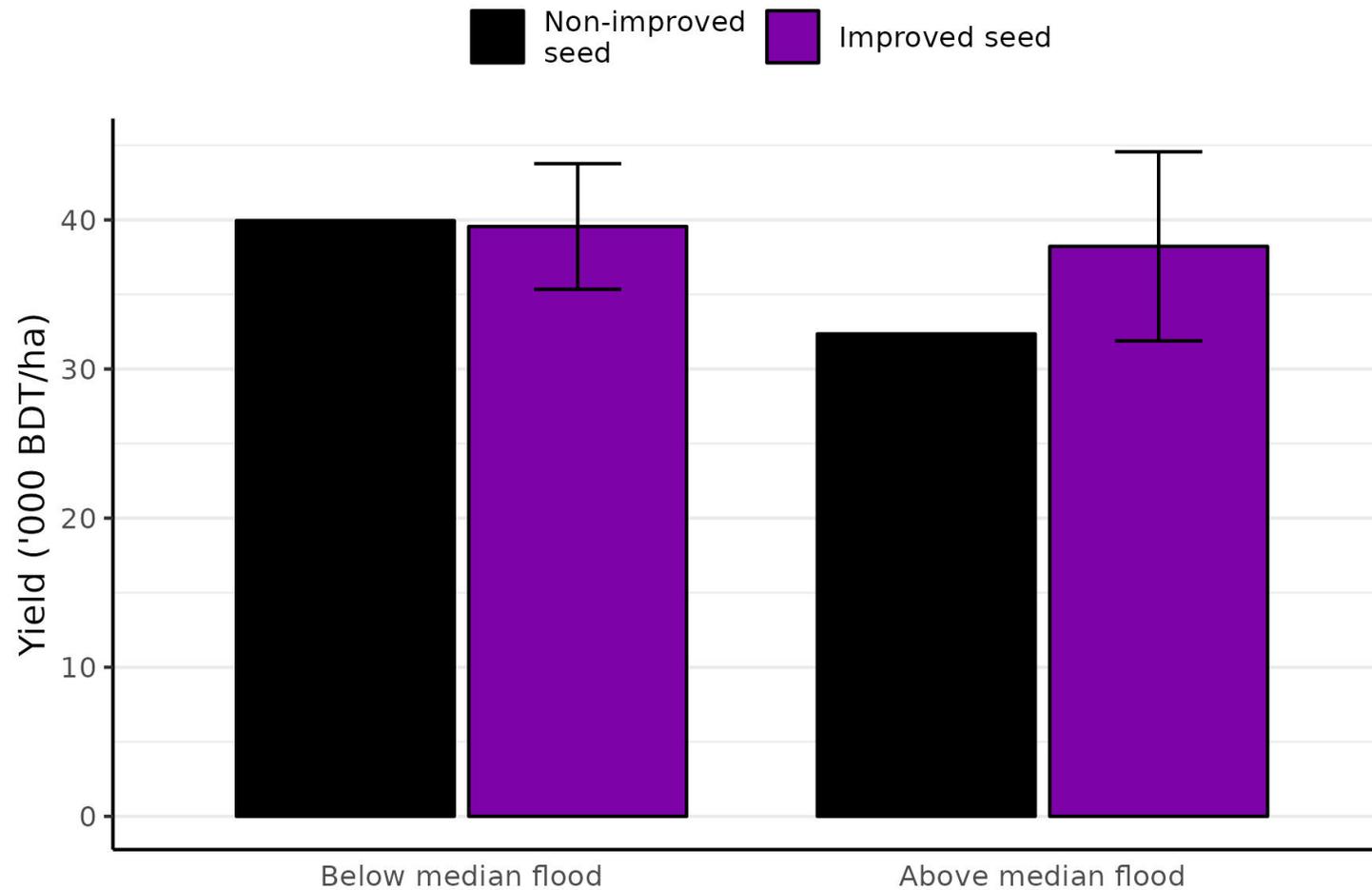
Zooming In



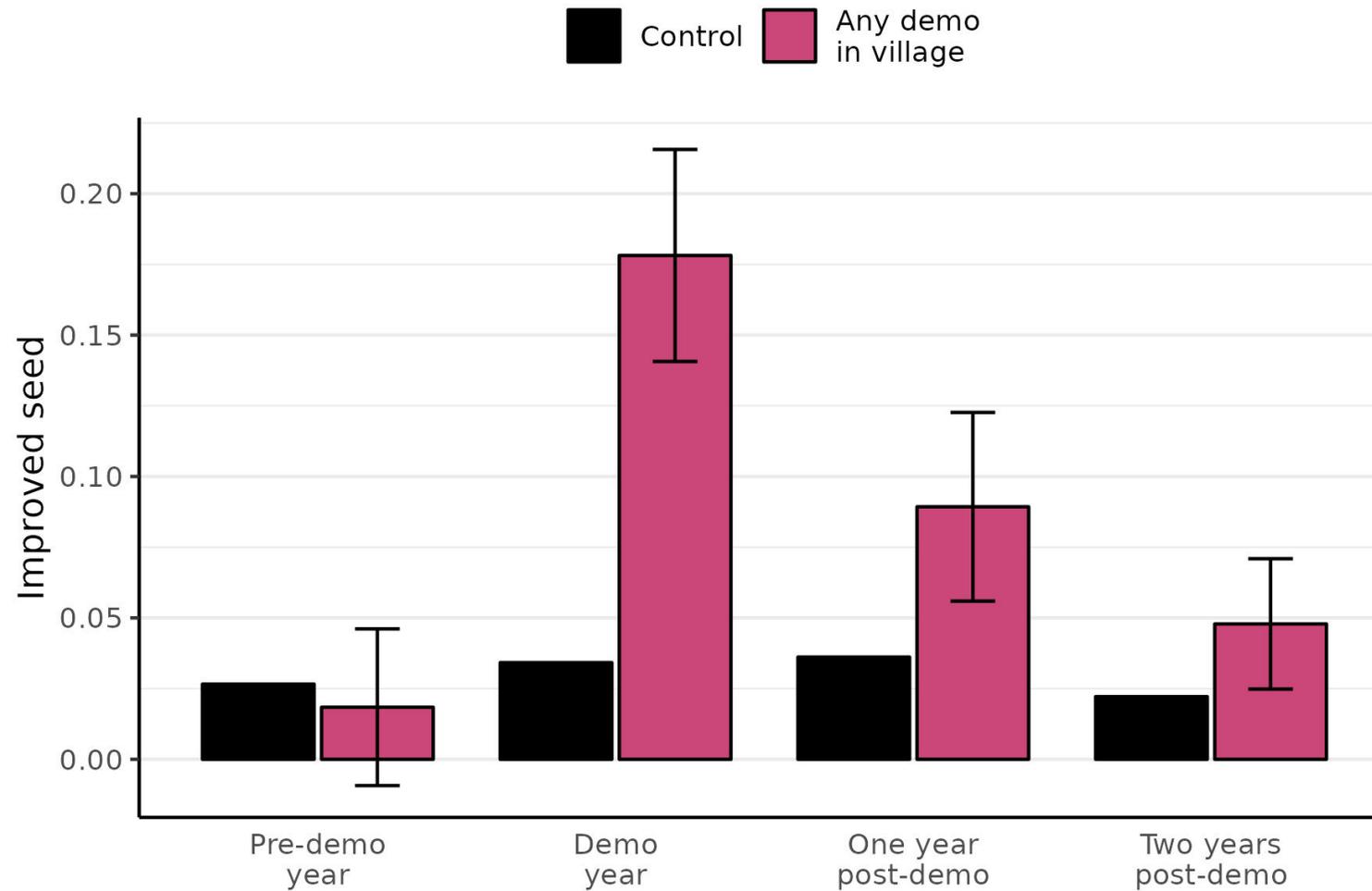
Progressive Salinization in Bangladesh



New seeds increase productive resilience



Demonstration increases adoption, but effects fade



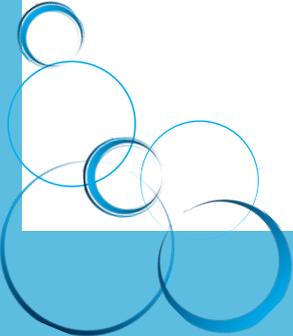


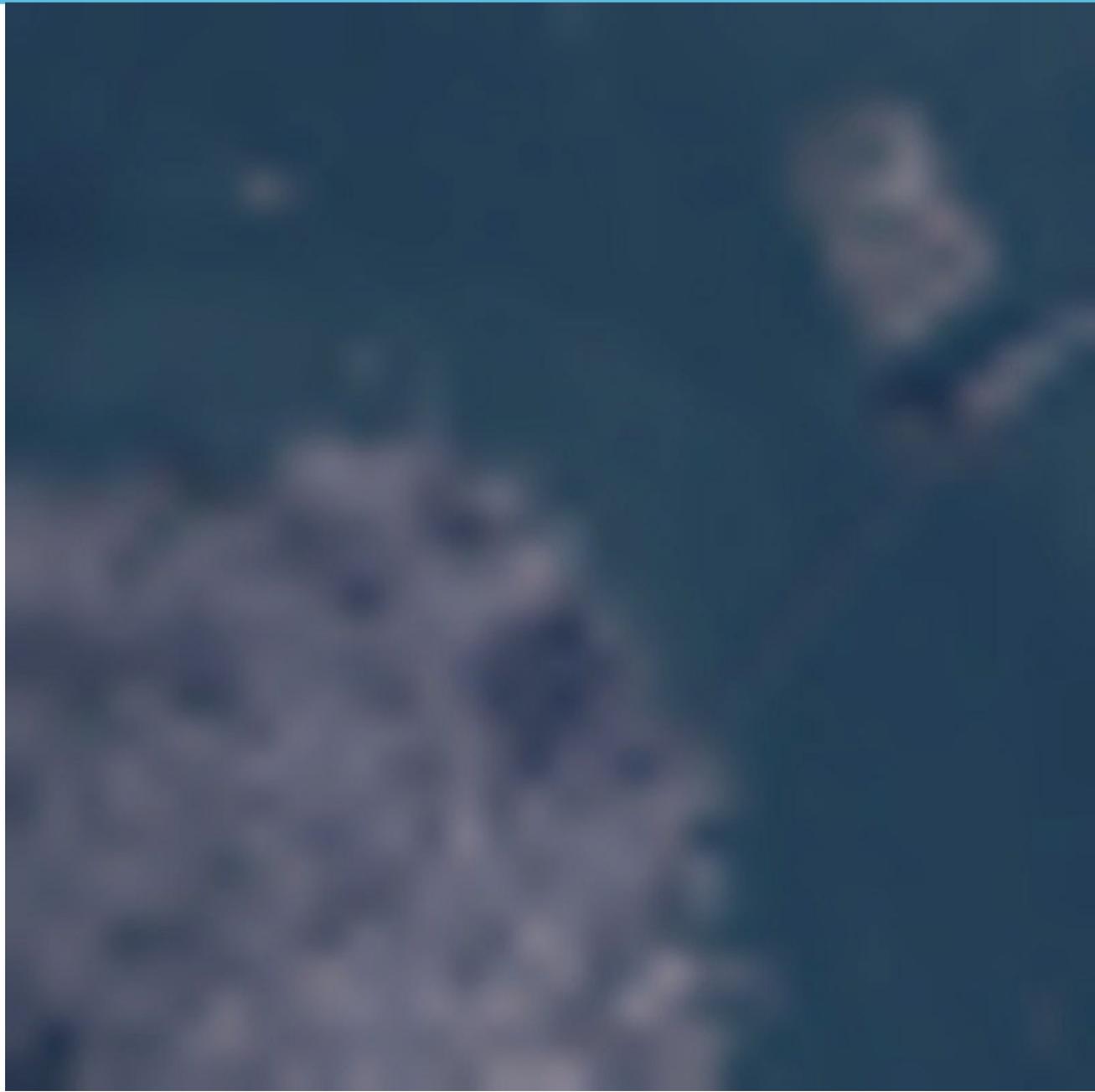
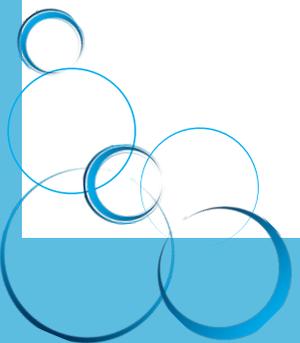
Zooming Out

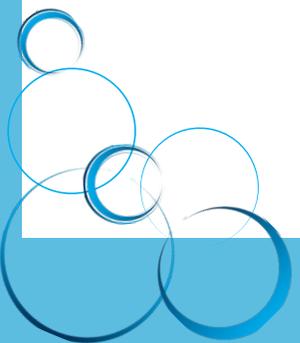
Advances in ...Data

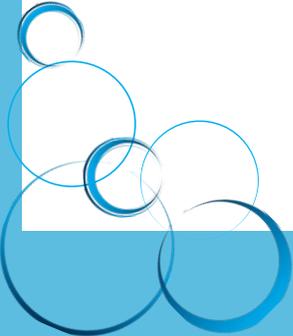
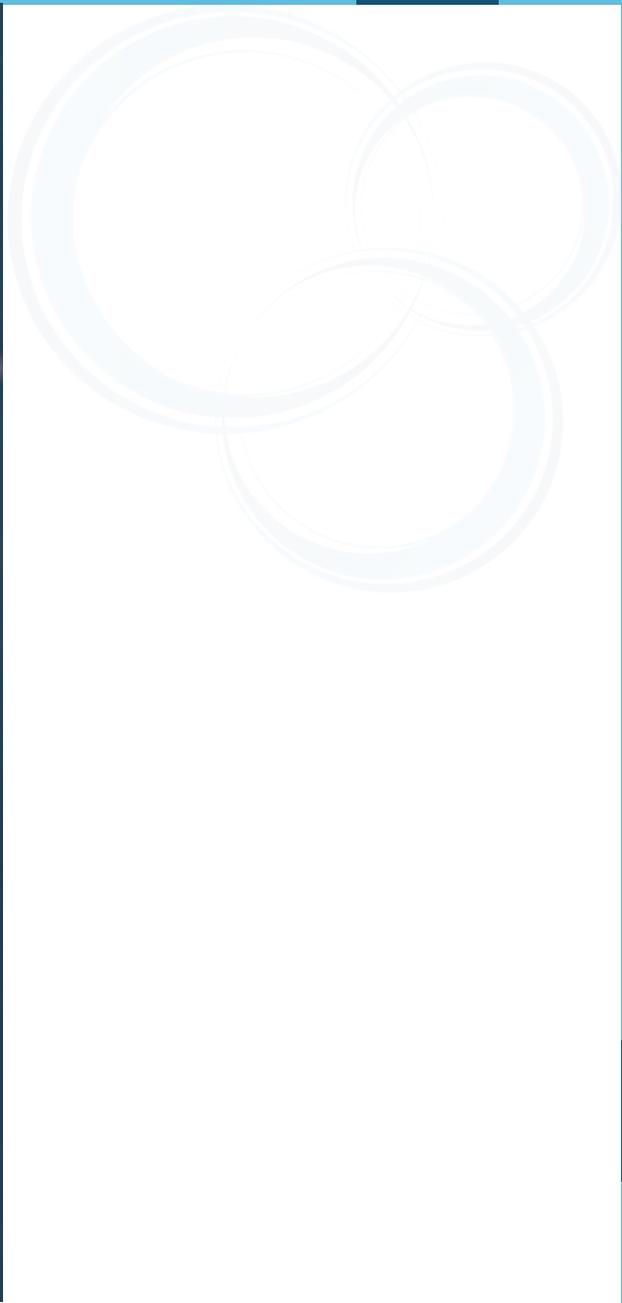
...Measuring climate impacts

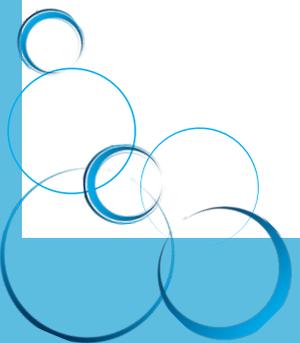
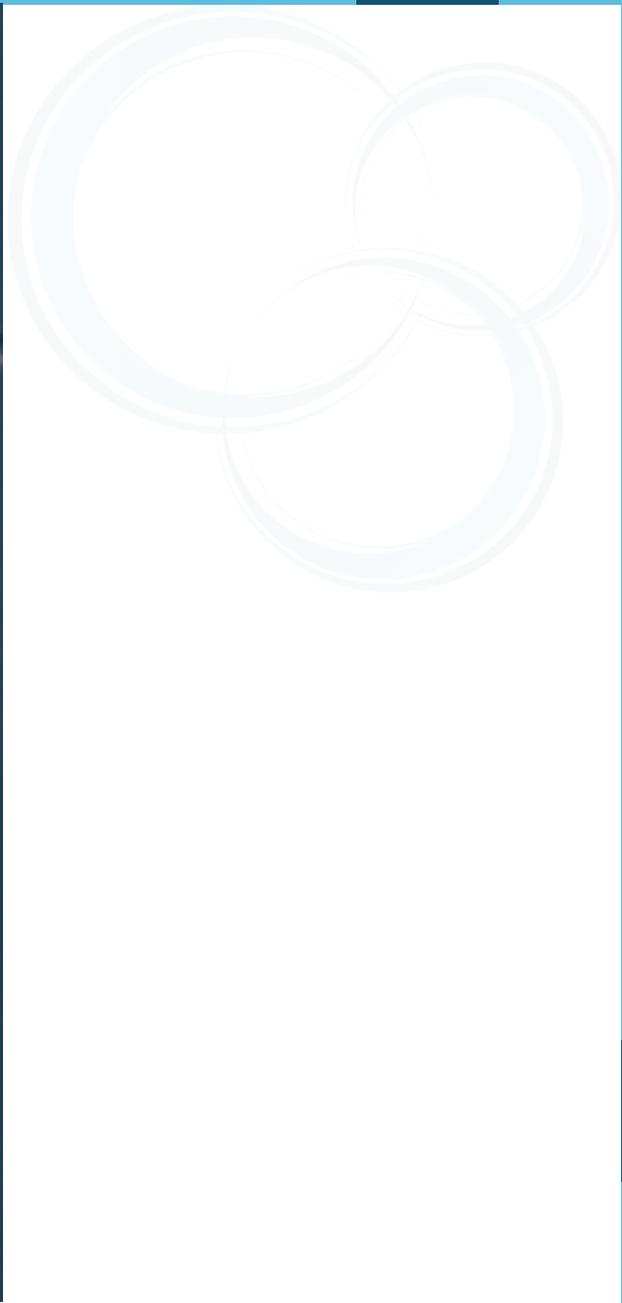
...Measuring effectiveness of adaptation strategies

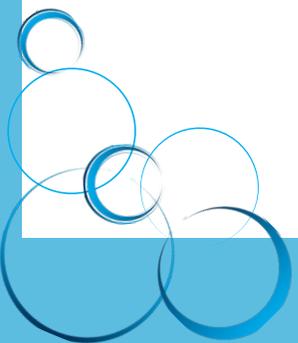
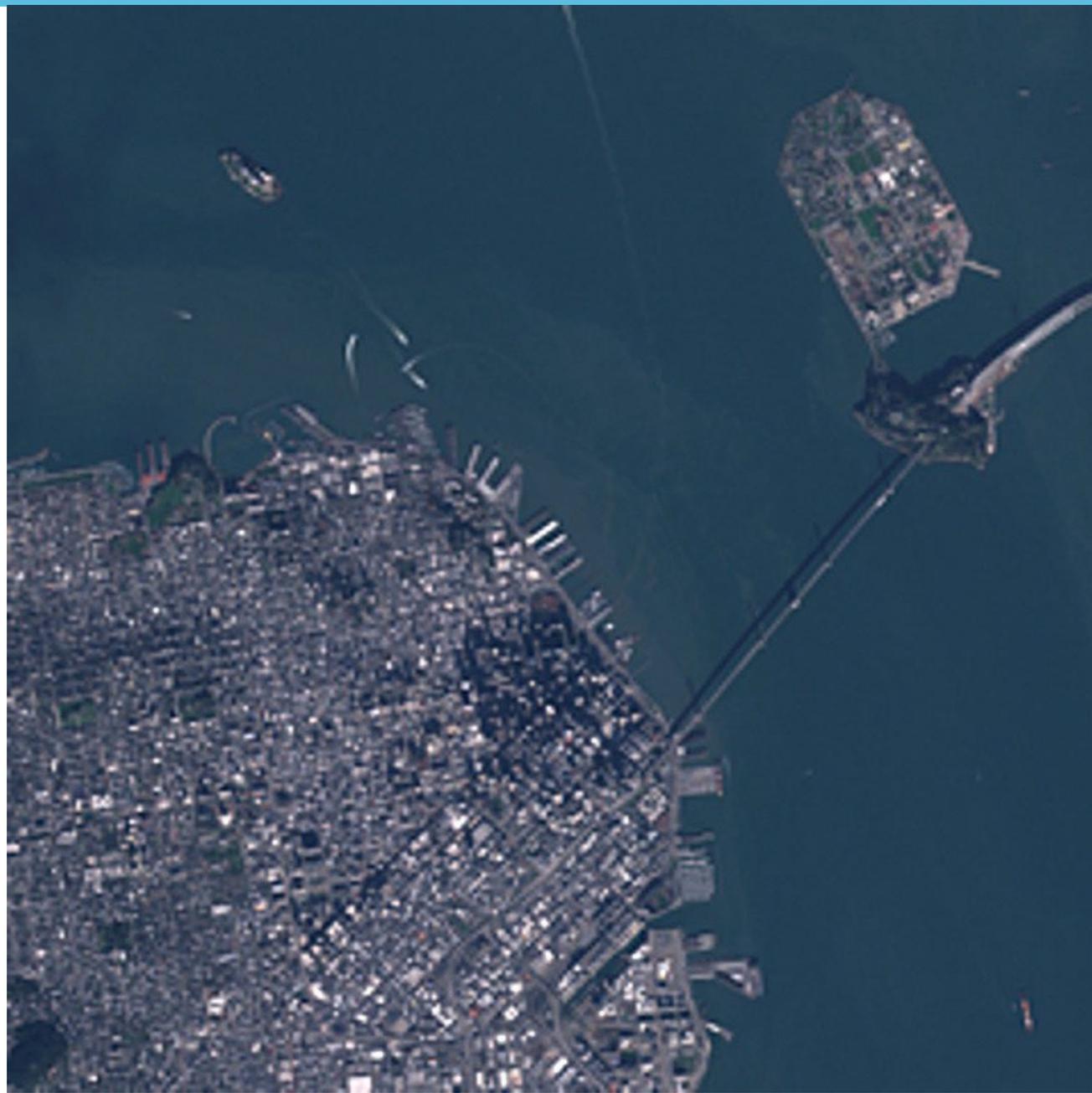


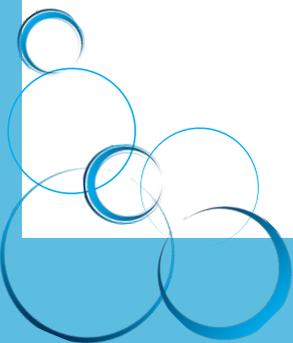
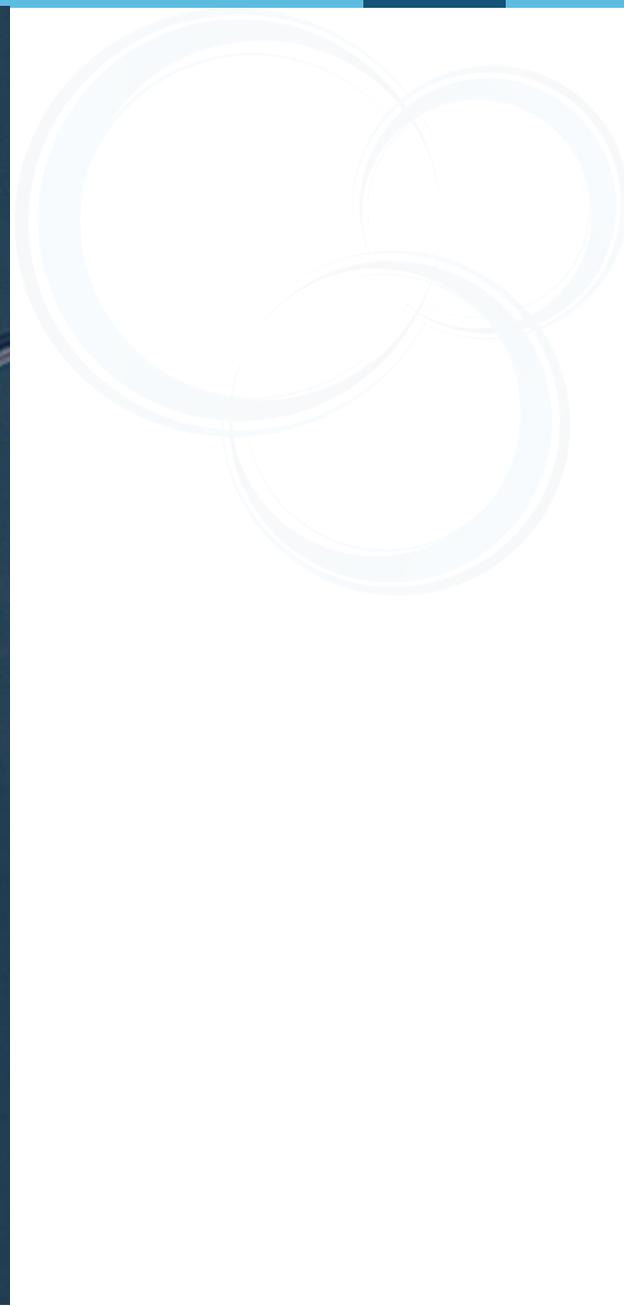
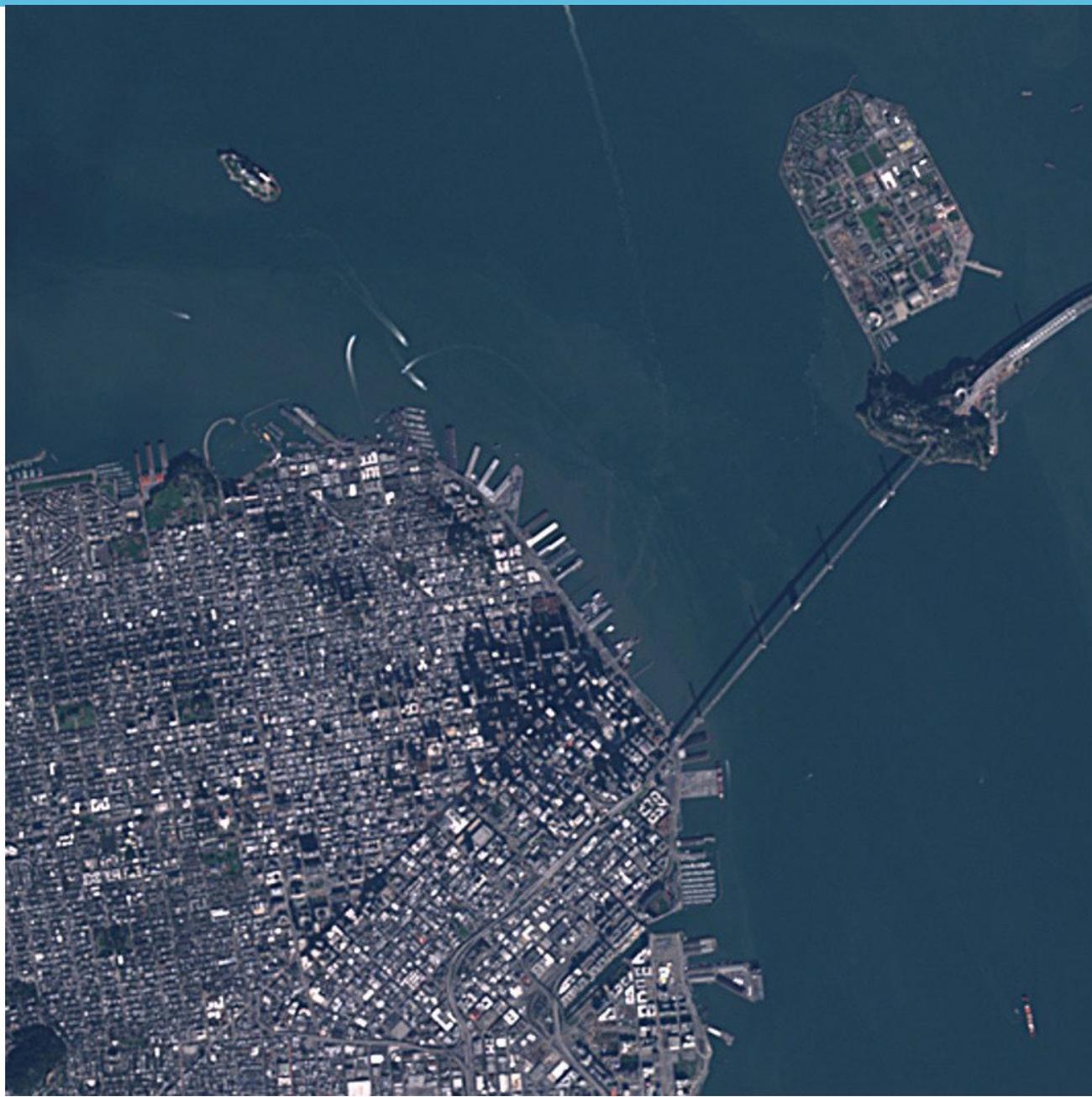


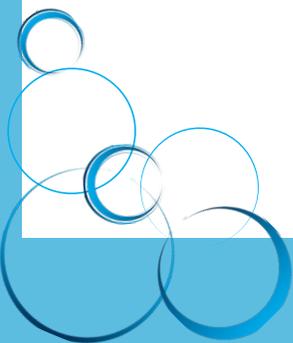
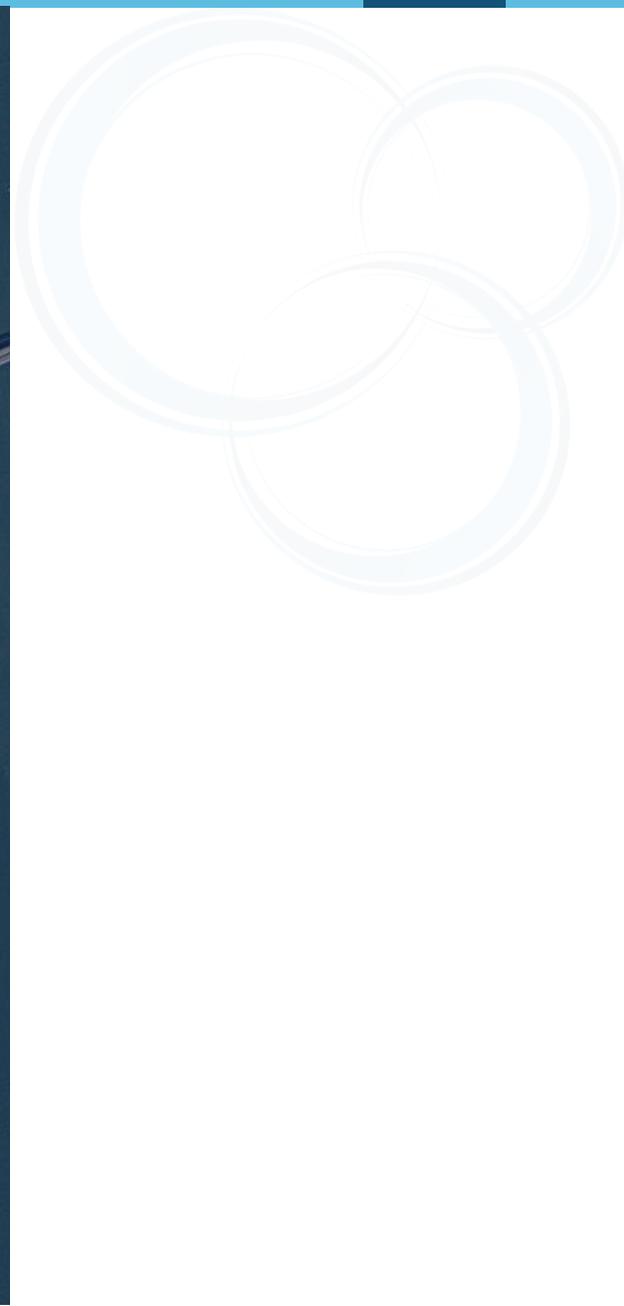
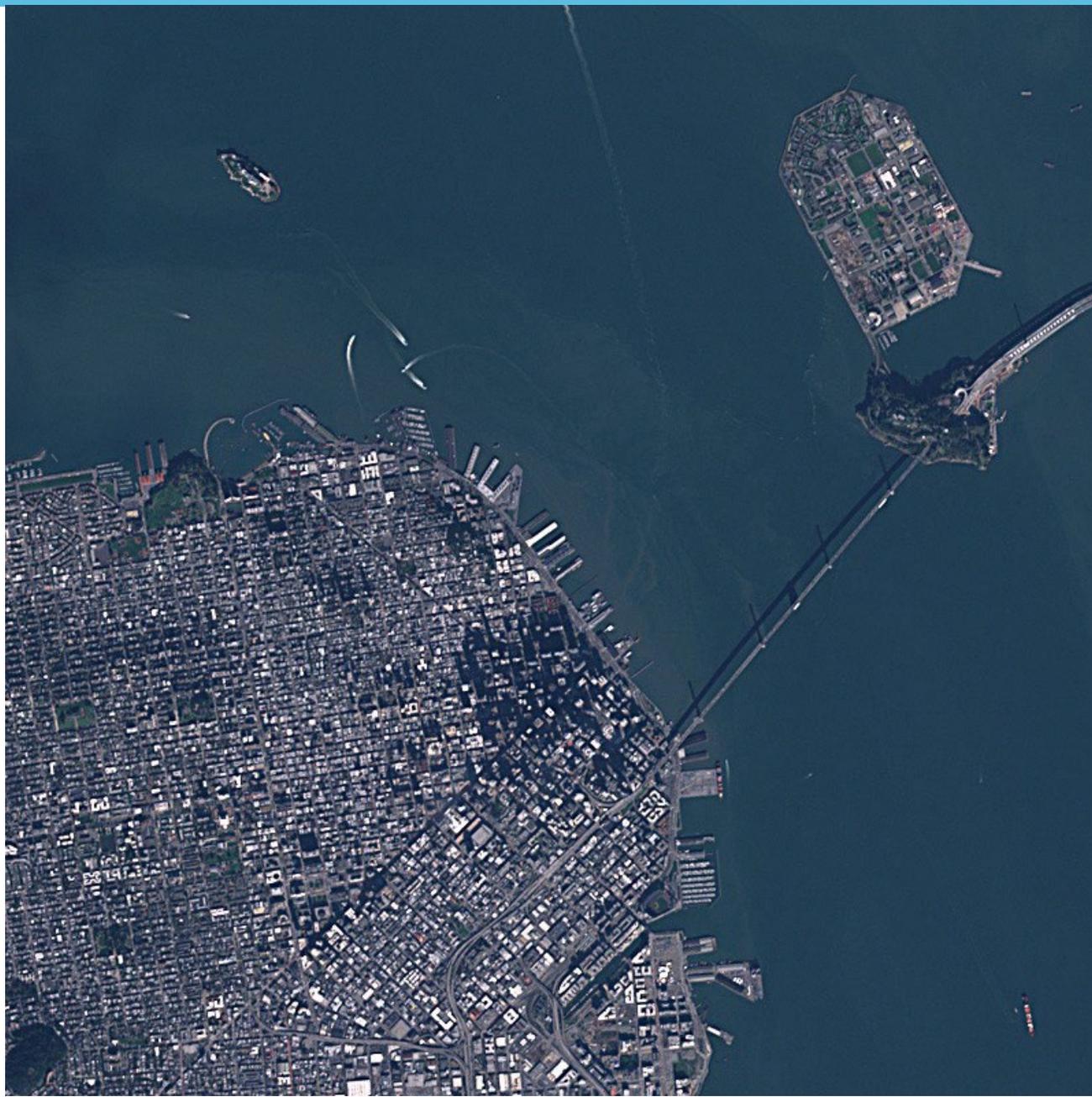


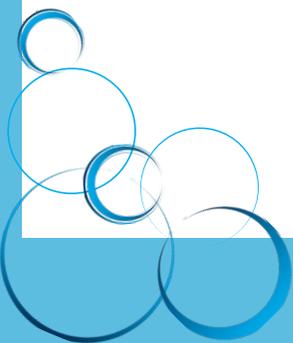
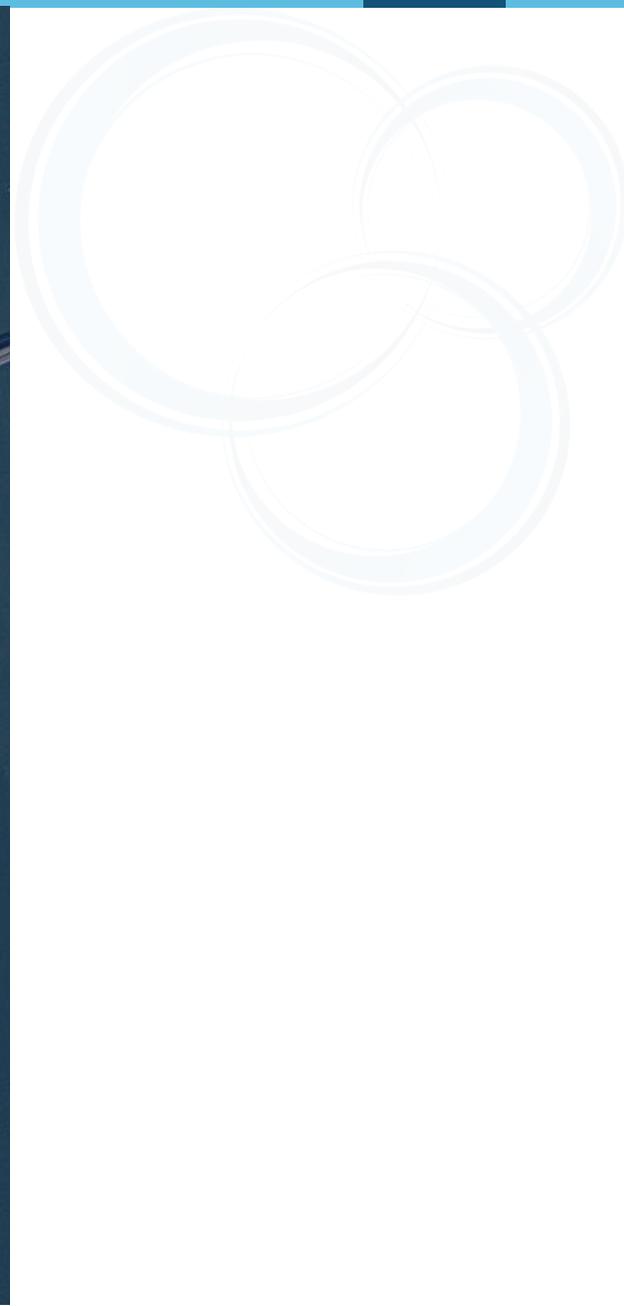
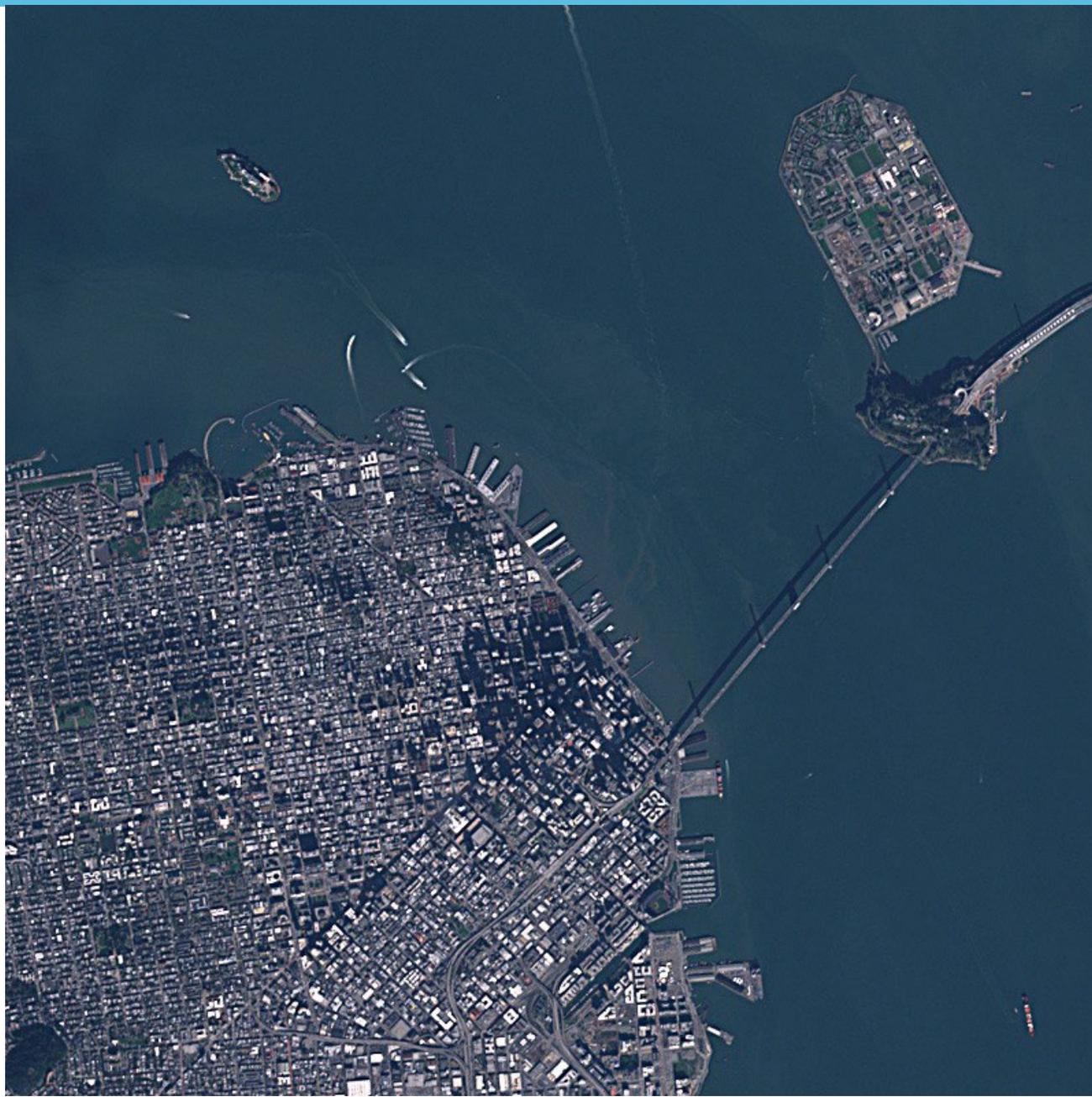












Advances in...data

True color satellite imagery

1972 (Landsat)

Nighttime lights

1992 (DMSP-OLS)

Very high resolution sat. imagery

2000 (Ikonos)

Pollution sat. data

2004 (NASA)

Smartphone tracking

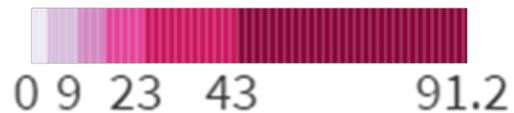
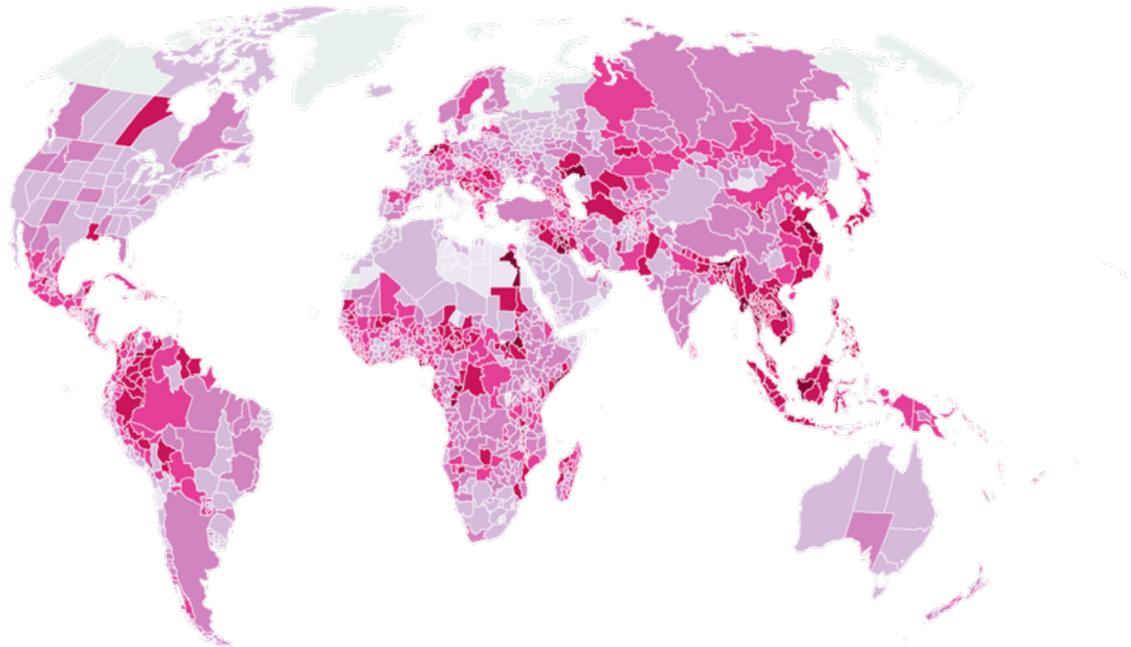
2007 (iPhone)

Computing power and AI tools

2010 (Earth Engine)

Advances in...data

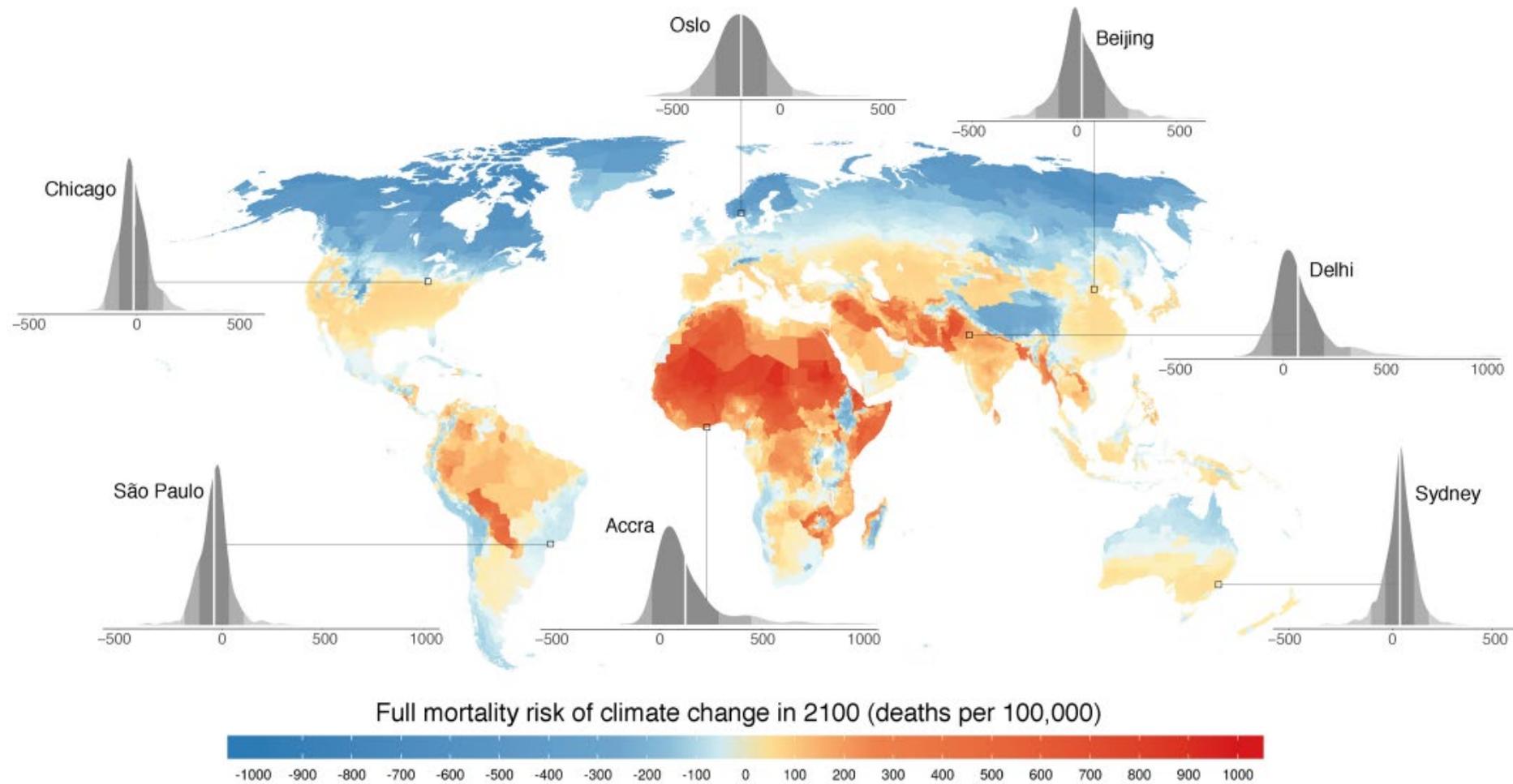
Flood exposed people (%)



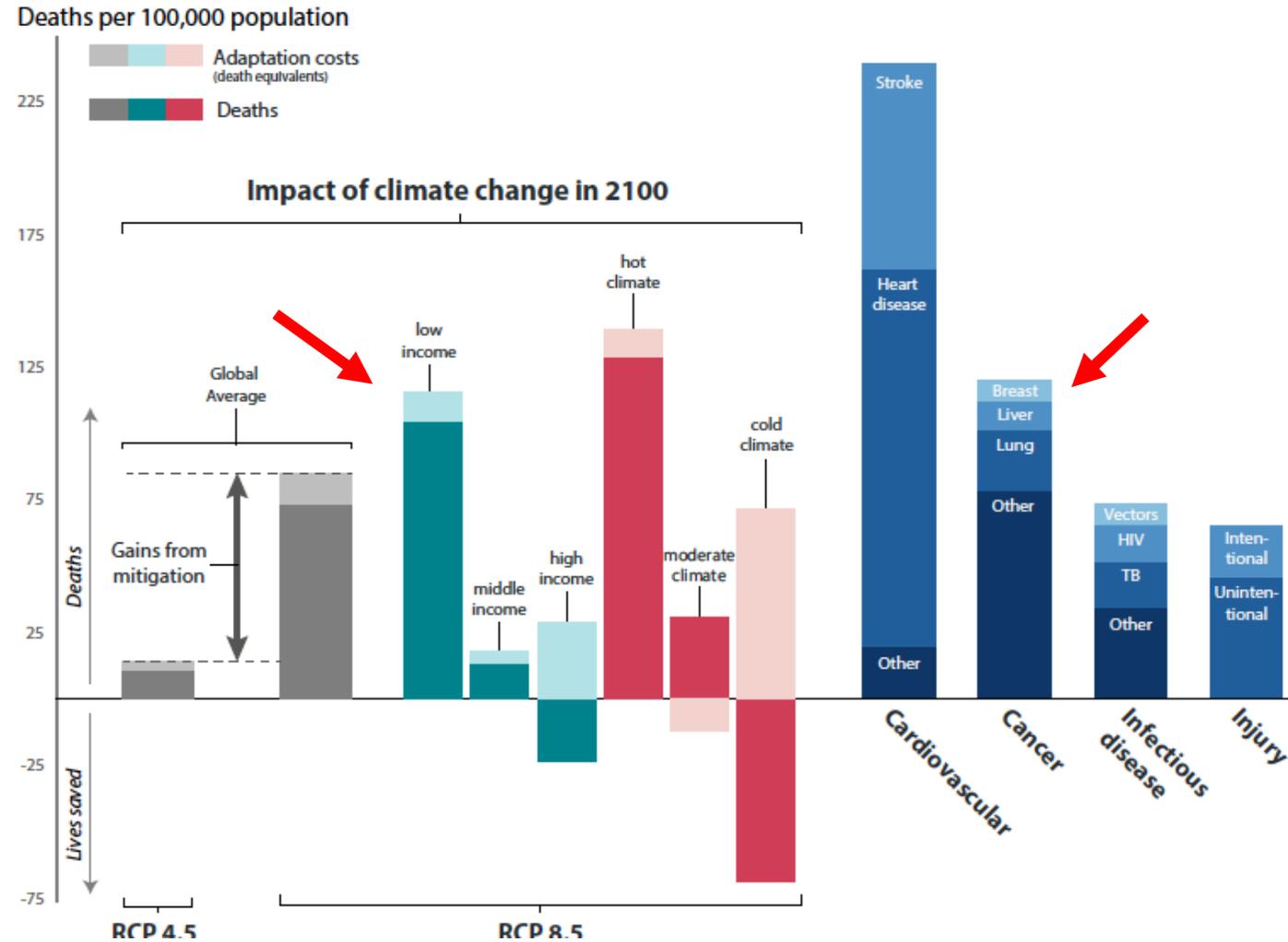
Source: [Global flood risk study](#)

1.47 billion people globally are directly exposed to the risk of intense flooding - almost 600 million are poor

Advances in...measuring climate impacts



Advances in...measuring climate impacts



Advances in...understanding effectiveness of adaptation

- “Credibility revolution” in economics helps identify precise causal estimates of adaptation effectiveness (Angrist & Pischke, JEP, 2010)
- But...Review of 1,682 articles describing human adaptation to climate change – 30 (1.4%) present primary evidence of risk reduction (Berrang-Ford et al., Nature Climate Change, 2021)

Advances in...understanding effectiveness of adaptation

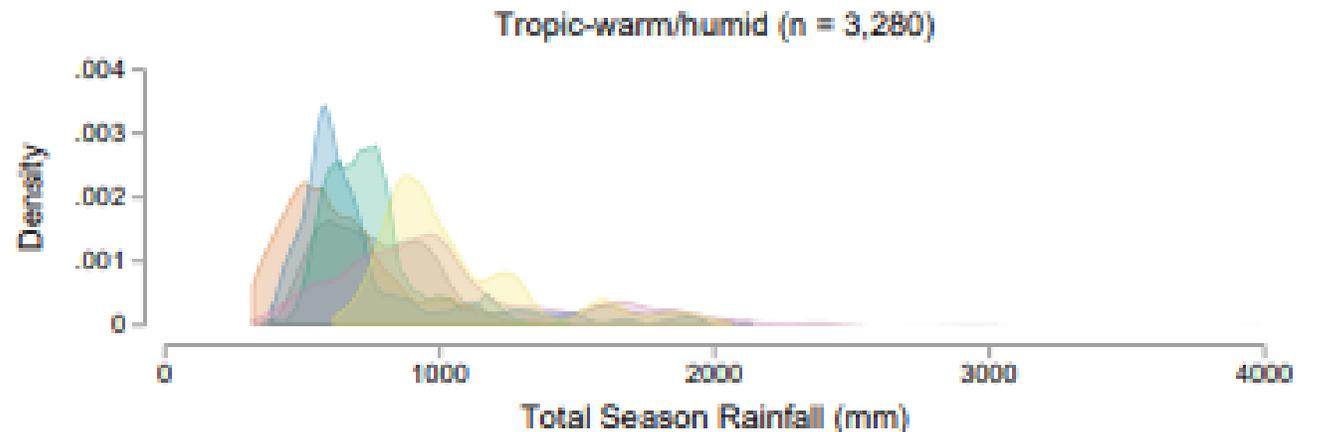
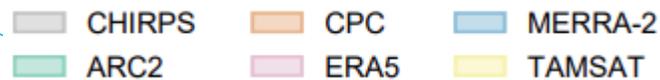
Non-exhaustive, but for example:

- **Income/cash transfers:** Household cash transfers can protect against shocks (de Janvry et al., JDE, 2006); at macro level, income is key factor affecting adaptation options (Carleton et al., QJE, 2022).
- **Insurance:** Systemic low take up limiting effectiveness (Cole et al., AEJ Applied, 2013, Carter et al., ARRE, 2017). When taken up, boosts investment (Stoeffler et al., WBER, 2022).
- **Tech adoption:** Knowledge/norms constraints (e.g. BenYishay et al., JDE, 2020), but also factor market constraints (e.g. Jones et al., AER, 2022).
- **Nature-based solutions:** Concerns of “greenwashing”, but potential for both mitigation and adaptation (e.g. mangroves to improve coastline resilience) Seddon (Science, 2022); Blankespoor et al. (Ambio, 2016).
- **Migration:** Climate change may spur migration, but most vulnerable can’t afford to move (Hoffmann et al., Nature CC, 2020). Limited evidence on promoting migration is positive (Bryan et al., Econometrica, 2014)

Research priorities (1): Expanding data access, retaining privacy

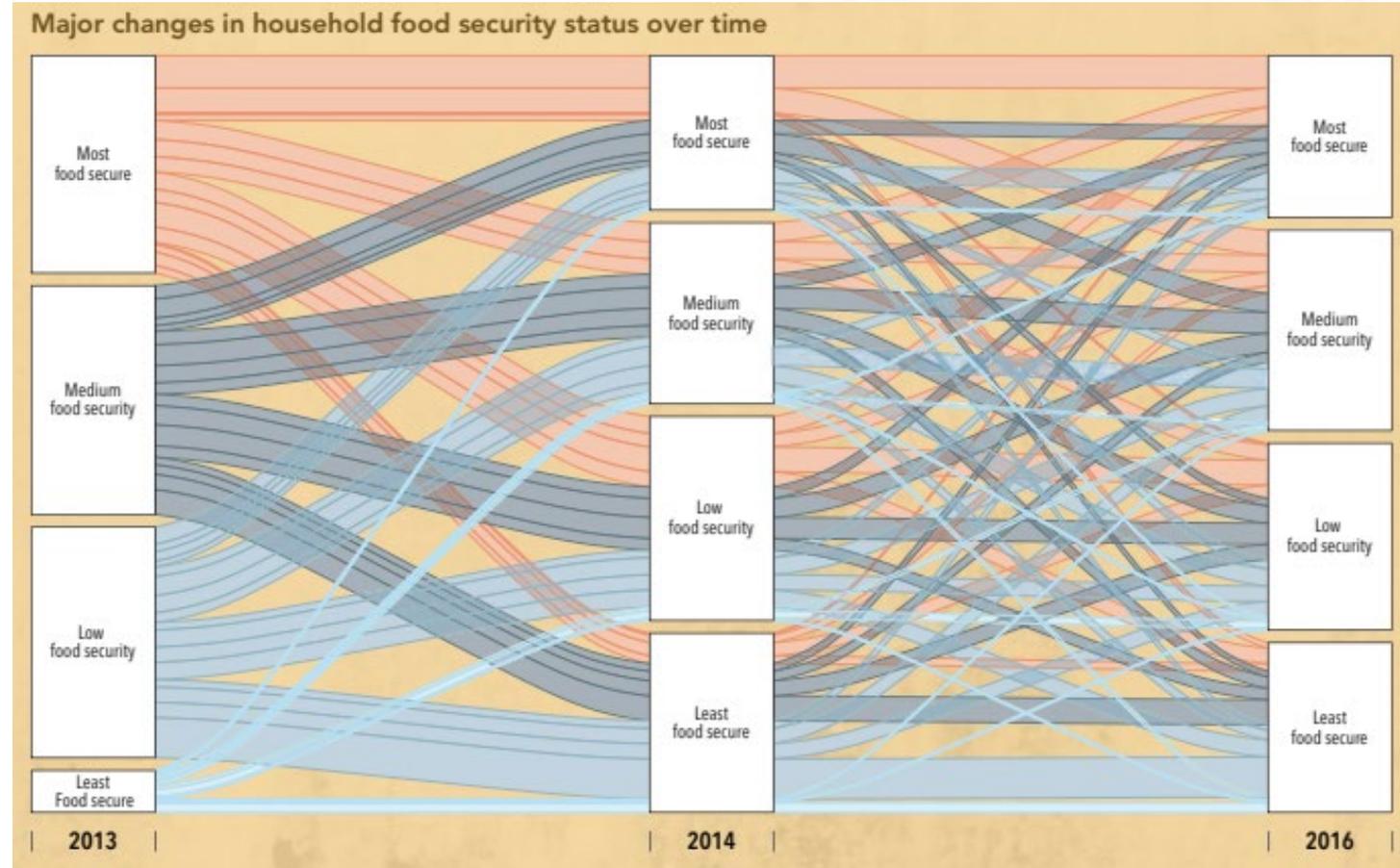
- Combining remote and survey data is foundation for empirical research in adaptation.
- Michler et al. (JDE, 2022) shows spatial anonymization is less problematic than choice of remote sensing tool for weather – ag productivity relationship. But where are limits (think: Mobility data)

Rainfall variability by remote sensing source



Research priorities (2): Understand vulnerability dynamics

- Vulnerability is a moving target: need to capture variance, not just levels (e.g. Macours et al., EJ, 2022)
- How to think from a timing perspective? (ongoing work with WFP)
- How to think about this from welfare perspective? (Ligon & Schechter, EJ, 2003; Lybbert et al., EJ, 2004)



Research priorities (3): Causal estimates of effective adaptation

- Go beyond conceptual to measuring actual effectiveness of adaptation strategies, especially slow onset climate change impacts
 - including documenting maladaptation and co-benefits (Magnan et al., Science, 2022)
 - Incremental vs. transformative adaptation (think: new seeds vs. migration)
- Adaptation funding gap and adaptation limits means we need to test technology/policies to understand behavioral response and **scale / cost effectiveness**

Research priorities (4): Unpacking indirect channels

Most salient:

- ***Climate:*** Slow onset (e.g. temp change) and extreme events (e.g. floods/hurricanes)

Don't forget:

- ***Uncertainty:*** Risk dampens growth, and much of this is driven by ex ante behavioral responses (Elbers et al., WBER 2007). How to think about protective vs. responsive support (Macours et al., EJ, 2022); insurance vs. self-protection (Gill & Ilahi, 2000)?
- ***Adapting to mitigation policies:*** Significant potential distributional implications of mitigation policies – what works to help adapt to ensuing economic/labor transitions? (think: just transition)

Thank you!

