# What do Pension Funds Need to Know About Climate Risk?

Mathijs van Dijk
Erasmus University Rotterdam & Netspar

*10th International Pension Research Association (IPRA) Conference*
*September 9, 2025*

Network for Studies on
**Pensions, Aging and Retirement**

# Motivating quotes

*“Climate change will affect the value of every single financial asset”*

Mark Carney (2019)

Netspar

# Motivating quotes

*"Climate change will affect the value of every single financial asset"*

Mark Carney (2019)

*"Climate change is almost invariably the top issue that clients around the world raise with BlackRock"*

Larry Fink (2020)

Netspar

# Motivating quotes

*"Climate change will affect the value of every single financial asset"*

Mark Carney (2019)

*"Climate change is almost invariably the top issue that clients around the world raise with BlackRock"*

Larry Fink (2020)

*"Combatting climate change requires action from all parts of society […] including the financial sector"*

Christine Lagarde (2021)

Netspar

# Motivating quotes

*"Climate change will affect the value of every single financial asset"*

Mark Carney (2019)

*"Climate change is almost invariably the top issue that clients around the world raise with BlackRock"*

Larry Fink (2020)

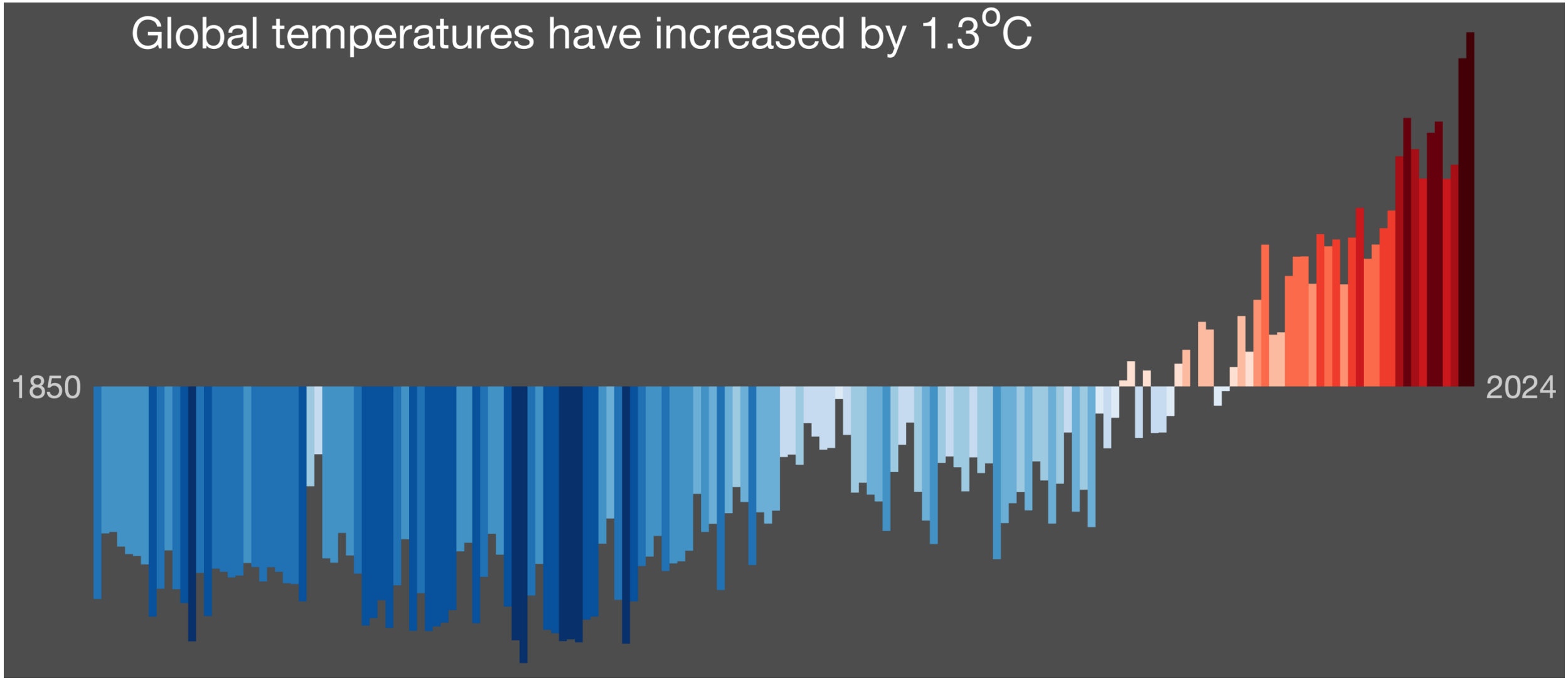
*"Combatting climate change requires action from all parts of society [...] including the financial sector"*

Christine Lagarde (2021)

*"Europe will stay the course, and keep working with all nations that want to protect nature and stop global warming."*

Ursula von der Leyen (2025)

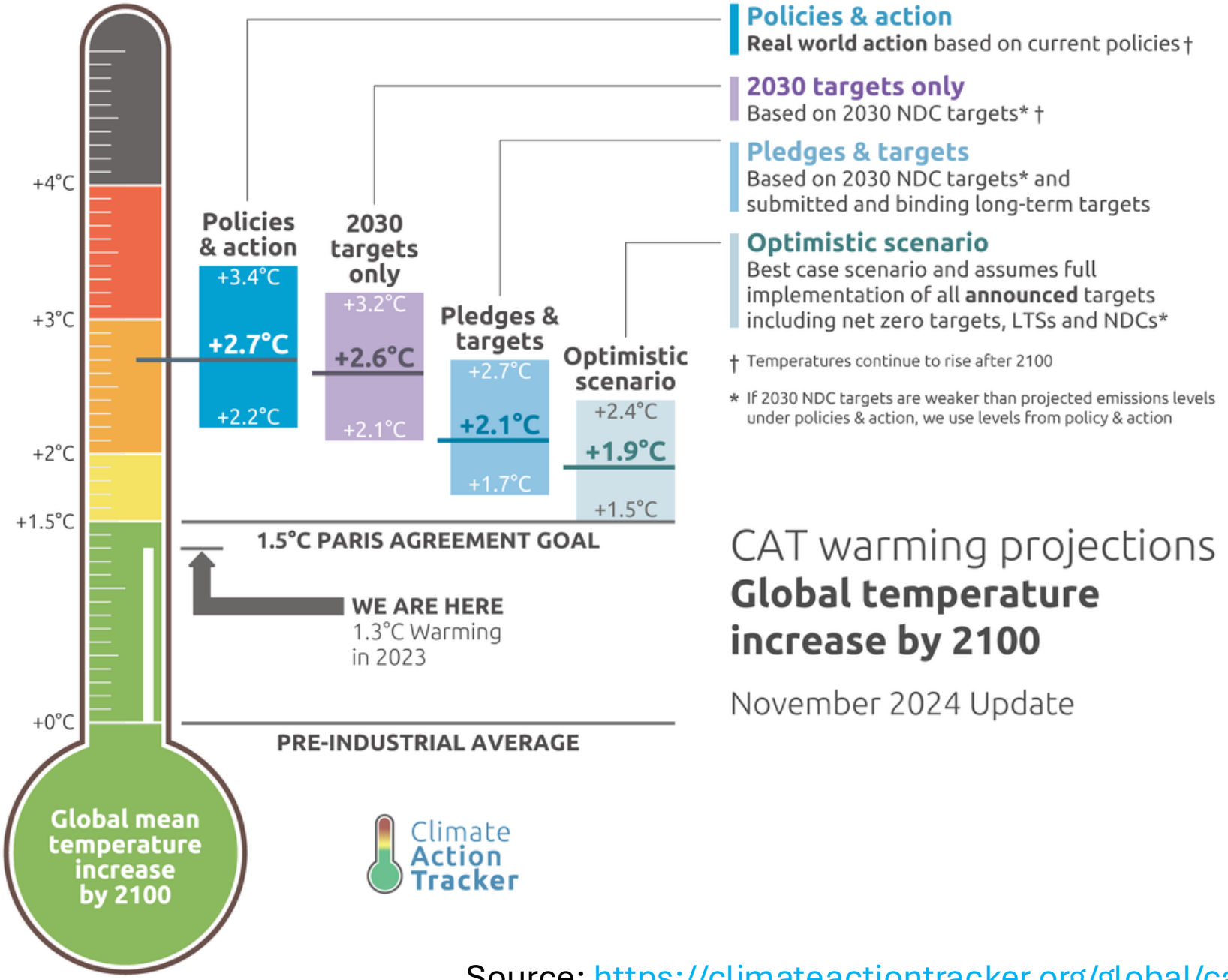
# “Climate stripes”




Source: https://showyourstripes.info/

Netspar

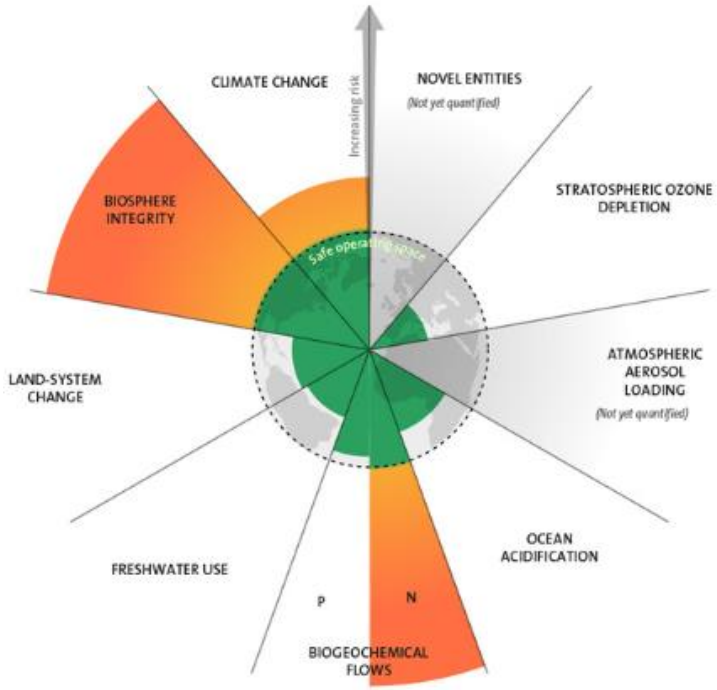
***Video by The Economist on 3° scenario***




Source: https://climateactiontracker.org/global/cat-thermometer/

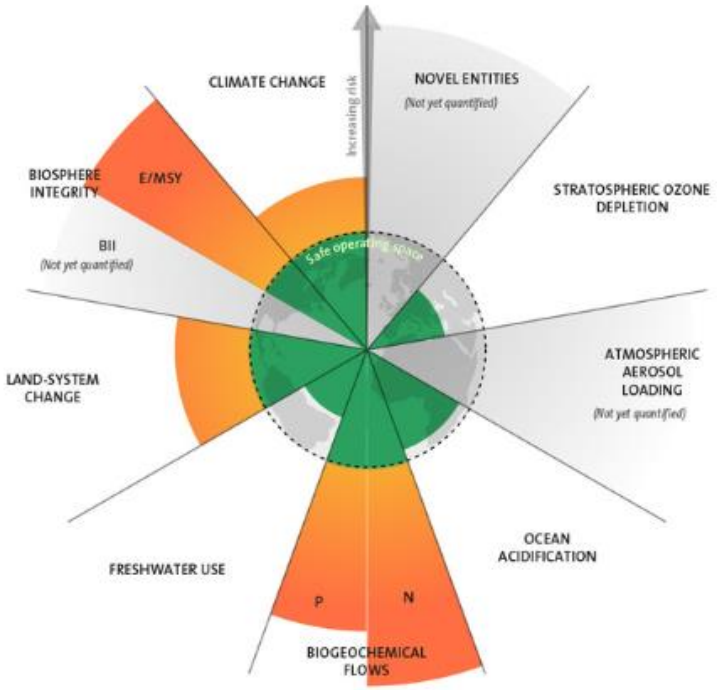
# Planetary boundaries

## 2009



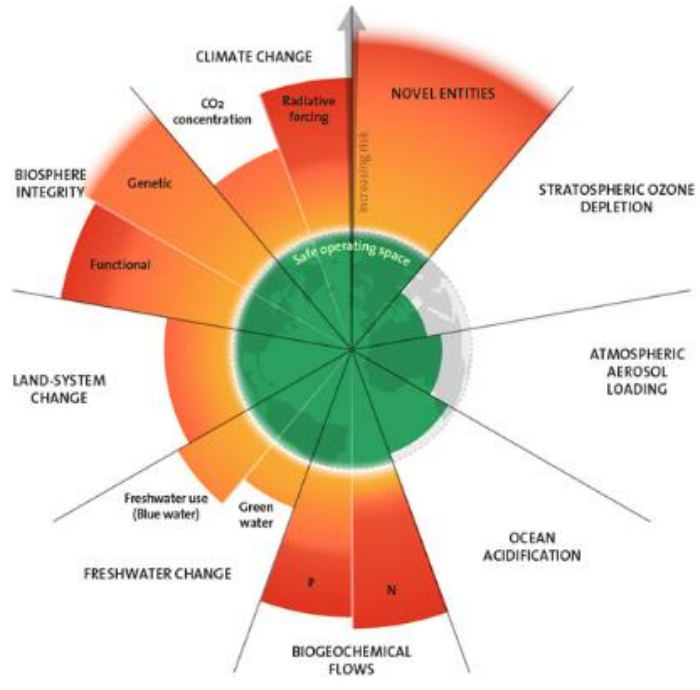

7 boundaries assessed,
3 crossed

## 2015




7 boundaries assessed,
4 crossed

## 2023




9 boundaries assessed,
6 crossed

Source: https://www.stockholmresilience.org/research/planetary-boundaries.html

# Consequences of climate change

- **Chronic hazards**: rising sea levels, water shortage, reduced biodiversity, declining agricultural yields
- **Acute hazards**: increased frequency + intensity of extreme weather events such as storms, floods, periods of drought and wildfires

# Climate risks in investment portfolios

- Effects of climate change are potentially important **source of financial risk** for investors such as pension funds
- **Physical risk**: damage or loss of assets (e.g., floods, droughts, storms, wildfires) and/or impact on supply chain
- **Transition risk**: impact on firms of transition to low-carbon economy – including policy risk (e.g, carbon tax), technological risk, legal/reputation risk; possibly leading to stranded assets
  - Krüger, Sautner & Starks (2020): 50% of global institutional investors say that transition risks have already begun to materialize

Netspar

# Relevant questions for pension funds

1. How to assess climate risk in investment portfolios?
2. What data sources to use?
3. What is the expected impact of climate risks on pension funds?
4. Are climate risks priced on financial markets?

# 1. Assessing climate risk

- Climate risk is considered to be an **important source of financial risk**
- Long-term, **systematic risk** (hard to diversify / hedge)
- **Difficult to measure**:
  - ‘New’ type of risk, huge uncertainty (‘Knightian uncertainty’)
  - Historical data are of little use
  - Physical and transition risk could interact in a myriad of ways
- Institutional investors **required to measure climate risk**
  - IORP II: pension funds must include climate risks in own-risk assessment
  - EIOPA: insurance companies must include “material climate risk exposures” in Own Risk and Solvency Assessment

# 1. Approaches to assessing climate risk

- From my 2020 (2025 update) overview study on measuring climate risk:
  - **a) Top-down ('macro') approaches**
    - Complex models to translate climate scenarios into financial losses
    - Pro: broad analysis; Con: black box
  - **b) Sector ('meso') approaches**
    - Analysis of impact transition risks on specific economic sectors
    - Pro: tractable, facilitates discussion; Con: no macro effects
  - **c) Bottom-up ('micro') approaches**
    - Analysis of impact of transition/physical risk on individual firms
    - Pro: detailed firm-level analysis; Con: no broader analysis; data quality crucial
  - **d) Factor models**

# 2. Brief history of sustainability data *(courtesy of MS co-pilot)*

- 1990s – Early Ethical Investing & SRI
- 2000s – Introduction of ESG in 2004 UN Global Compact report “Who Cares Wins”.
- 2006 – Launch of UN PRI (Principles for Responsible Investment)
- 2010s – Standardization & Data Explosion
  - Major data providers (MSCI, Sustainalytics, Bloomberg) began offering ESG ratings
- 2015 – Paris Agreement & SDGs Influence
  - Rise of impact investing and green bonds
- 2020s – Regulatory Momentum & Mandatory Disclosure
  - E.g., EU’s SFDR and Taxonomy Regulation
- Recent years:
  - Rise of ESG Criticism (e.g., greenwashing, inconsistencies)
  - Emergence of Double Materiality & Climate Risk Stress Testing

# 2. Data sources for assessing climate risk: 3 key issues

- **Limited coverage & data quality:**
  - Often only publicly listed companies; extrapolation
  - Largely self-reported, no clear (international) standard (green washing concerns)
- **Disagreement across data providers**
  - Berg, Koelbel & Rigobon (2022) document correlation of 0.60 across six different ESG data providers
- **What to measure**
  - **Transition risk**: ESG measures like carbon footprint (a) capture only one dimension of transition risk, (b) are not forward-looking, and (c) disregard differences across firms in their ability to adjust
  - **Physical risk**: geographic location of firms measures direct exposure, but neither their ability to adjust nor supply chain effects

# 3. Impact of climate risk on pension funds?

- New working paper (with Allert Jan Dillema & Vivienne Kolman): *"Who's Afraid of Carbon Transition Risk? A Climate Stress Test of Dutch Pension Funds"*
  - Transition to a CO2-neutral economy associated with **significant economic costs** (Acemoglu et al., 2012; Nordhaus, 1992)
  - Higher CO2 price/tax is costly for many different companies (Leaton, 2011), and can lead to **stranded assets**
  - Limiting global warming to 2°C requires a CO2 price of $15-$360 per ton in 2030 and of **$45-$1000 per ton in 2050** (Stiglitz et al., 2017); Compare: current price in EU Emissions Trading System around €77 per ton
- Our paper: compute impact of four scenarios for CO2 tax introduction on equity and corporate bond portfolios of all 180 Dutch pension funds

# 4 scenarios for CO2 tax

- Baseline: €200 per ton of CO2e (Scope 1), variation in two dimensions:
  - *Abrupt* *vs.* *Phased over 10 years*
  - *No pass-through* *vs.* *50% pass-through*
- 4 scenarios ("severe but plausible"):
  - **Scenario I**: abrupt & no pass-through
  - **Scenario II**: phased & no pass-through
  - **Scenario III**: abrupt & 50% pass-through
  - **Scenario IV**: phased & 50% pass-through

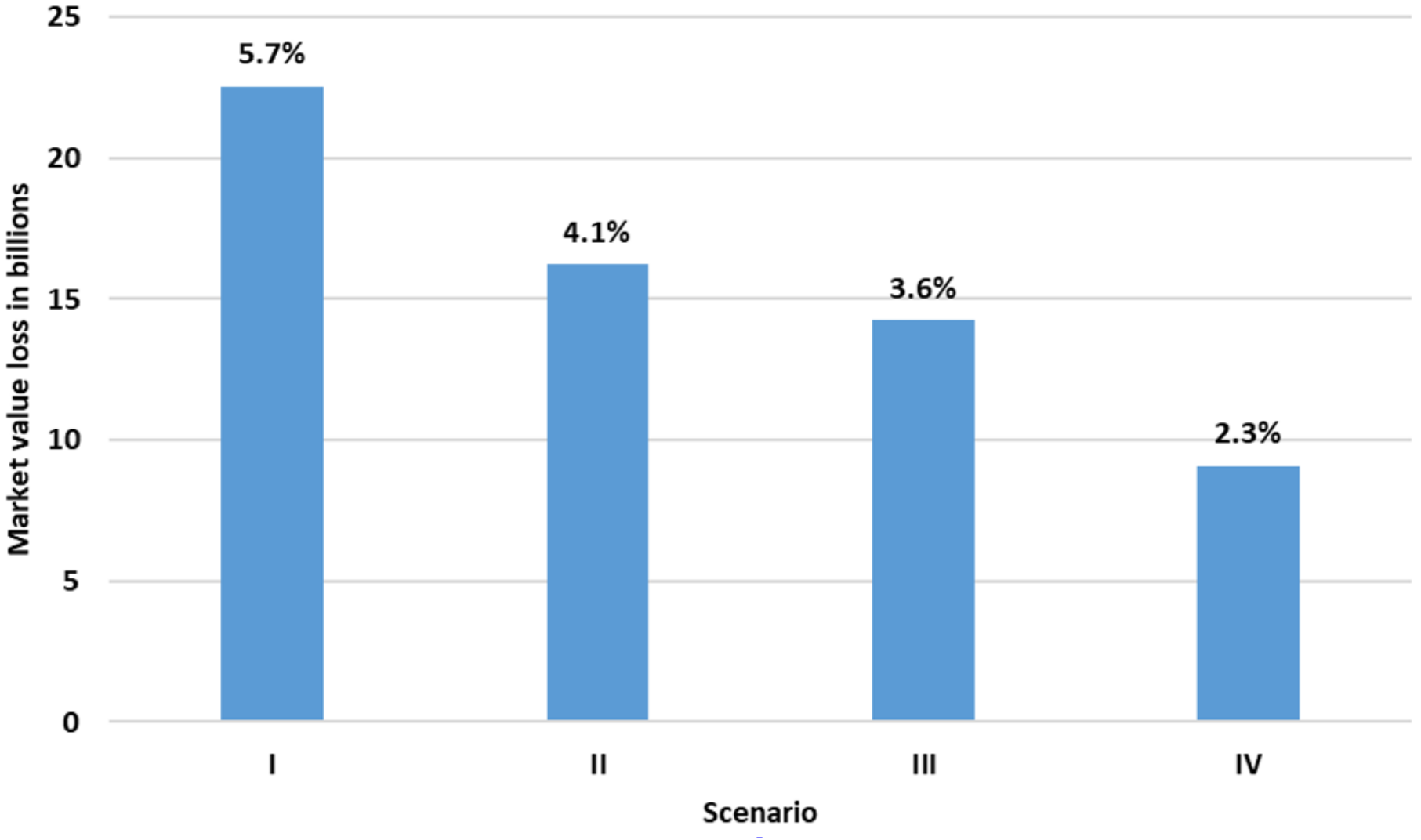
Netspar

# Sectors (top 15/163) with highest value loss [NPV CO2 tax]

| Scenario: | I | II | III | IV | PF Sector % | Max PF % |
|---|---|---|---|---|---|---|
| Independent Power Prod. & Energy Traders | 0.84 | 0.81 | 0.78 | 0.69 | *0.0%* | *0.6%* |
| Aluminum | 0.84 | 0.69 | 0.65 | 0.48 | *0.0%* | *0.4%* |
| Passenger Airlines | 0.81 | 0.57 | 0.49 | 0.30 | *0.1%* | *1.1%* |
| Construction Materials | 0.78 | 0.73 | 0.71 | 0.63 | *0.2%* | *0.9%* |
| Steel | 0.73 | 0.64 | 0.61 | 0.44 | *0.4%* | *3.2%* |
| Marine Transportation | 0.63 | 0.43 | 0.36 | 0.22 | *0.2%* | *1.9%* |
| Oil & Gas Refining & Marketing | 0.59 | 0.42 | 0.35 | 0.23 | *0.5%* | *1.6%* |
| Coal & Consumable Fuels | 0.50 | 0.39 | 0.36 | 0.24 | *0.0%* | *1.8%* |
| Industrial Gases | 0.47 | 0.31 | 0.27 | 0.16 | *0.1%* | *1.7%* |
| Diversified Chemicals | 0.46 | 0.35 | 0.32 | 0.24 | *0.1%* | *1.3%* |
| Integrated Oil & Gas | 0.46 | 0.29 | 0.25 | 0.15 | *0.7%* | *5.1%* |
| Paper Products | 0.46 | 0.34 | 0.29 | 0.18 | *0.1%* | *0.9%* |
| Electric Utilities | 0.43 | 0.36 | 0.31 | 0.22 | *1.4%* | *10.0%* |
| Oil & Gas Storage & Transportation | 0.41 | 0.29 | 0.24 | 0.15 | *0.2%* | *3.8%* |
| Fertilizers & Agricultural Chemicals | 0.40 | 0.32 | 0.29 | 0.19 | *0.3%* | *1.6%* |
| Average across other subindustries | 0.05 | 0.03 | 0.03 | 0.02 | | |
| Average across all firms | 0.09 | 0.06 | 0.06 | 0.04 | | |
| Median across all firms | 0.01 | 0.00 | 0.00 | 0.00 | | |

Netspar

# Total loss of equity market value Dutch pension funds



# Assessment of carbon transition risk

- In baseline Scenario 1, Dutch pension funds face equity losses of 5.7%
  - Up to 16.5% for individual funds
  - In more severe €400 CO2 taks scenario, aggregate (max individual) loss is 9.1% (21.9%)
- How does this compare to other studies?
  - Reinders, Schoenmaker & van Dijk (2023): in similar carbon taks scenarios, market value losses for Dutch banks estimated at 1.5% of their assets and 29% of their Tier 1 capital
  - European Supervisory Authorities and the European Central Bank (ECB) recently published their "Fit-for-55" climate stress test
    - Assesses whether EU financial sector is "fit" to reduce carbon emissions with 55% by 2030
    - Considers two climate risk scenarios in top-down (macro) approach
    - Results: equity market value losses for EU pension funds of 5-15%

# 4. Are climate risks priced in financial markets?

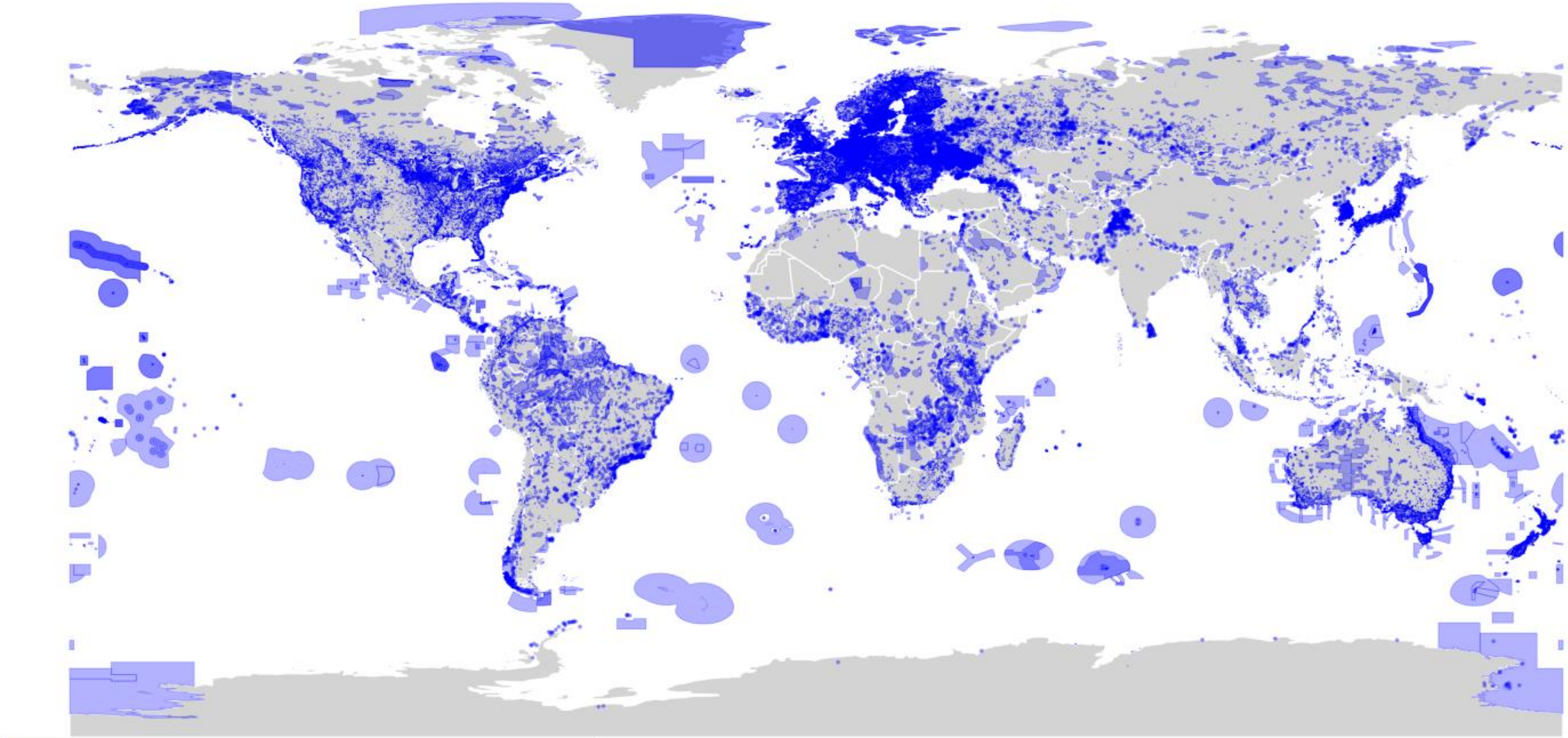
- Some evidence that some climate risks are priced, e.g.:
  - Bolton & Kacperczyk (2021, 2023) : carbon premium in equities
  - Engle et al. (2020): climate change news in equities
  - Murfin & Spiegel (2020): sea level rise in residential real estate
  - Hsu, Li & Tsou (2023): pollution premium in equities
  - Rizzi (2024): extreme weather events in munical bonds
- That said:
  - The evidence is still early stage and often indirect
  - Zhang (2025) undermines Bolton & Kacperczyk results
  - Studying such asset pricing effects is notoriously challenging
  - Stroebel & Wurgler's (2021) survey among academics and practitioners: “by an overwhelming margin [20 to 1], respondents believe that asset prices underestimate climate risks”
- *Plus: even if climate risks carry a risk premium, should pension funds want to run these risks?*

# Is biodiversity risk priced in global stock returns?

- New working paper (with Marloes Hagens): *"Return To Nature: Biodiversity Loss And Global Stock Performance"*
  - We asses biodiversity risk for 12,288 firms from 58 countries over 2009-2022
  - Firm-level data on potential drivers of biodiversity loss (air pollutants, land and water pollutants, waste, GHG, natural resource use, water use) from S&P Global Trucost
  - Asset location data from S&P Global Trucost Physical Risk Asset
  - Geographic data on protected biodiversity areas from World Database on Protected Areas
  - Conclusion (preliminary): *firms with greater exposure of biodiversity (transition) risk tend to have greater stock returns, consistent with a biodiversity risk premium*
    - 1 stdev increase in biodiversity risk associated with 0.5-1.2% greater annual returns
    - 1 stdev increase in "risky assets" associated with 0.55% greater annual returns

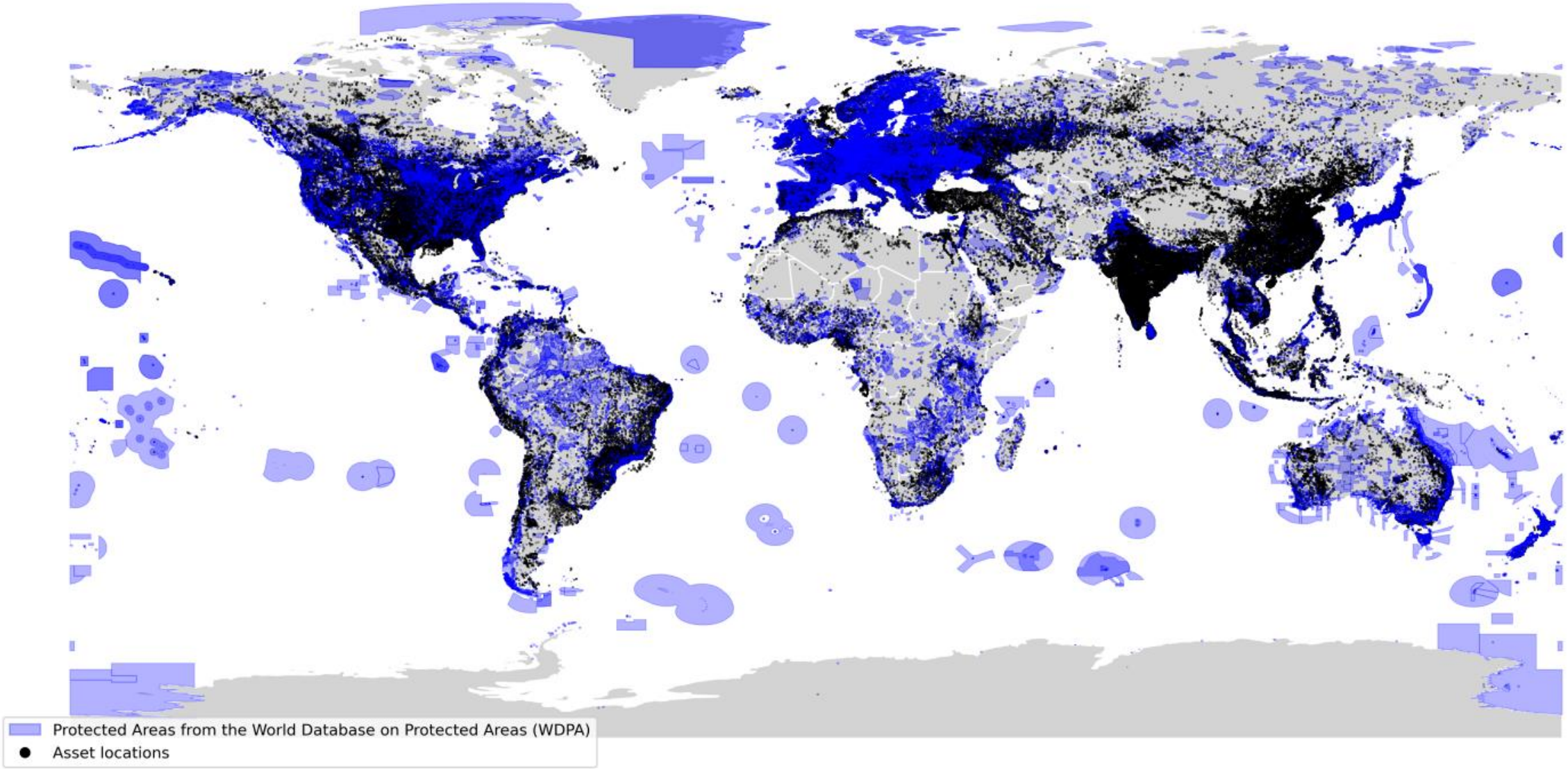
Netspar

# Protected biodiversity areas



Netspar

# Protected biodiversity areas & asset locations



Netspar

# Conclusion

- Climate change will have serious economic consequences and could significantly impact the market value of many financial assets
- Pension funds are required to assess climate risks in their invesment portfolios; initial analyses show non-negligible impact
- Many open questions:
  - Assessment methods
  - Data sources
  - Pricing of climate risks in financial markets

Netspar

# Thank you!