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Pricing Climate Risk into Financial Markets

What physical risks are we experiencing which might impact investors?

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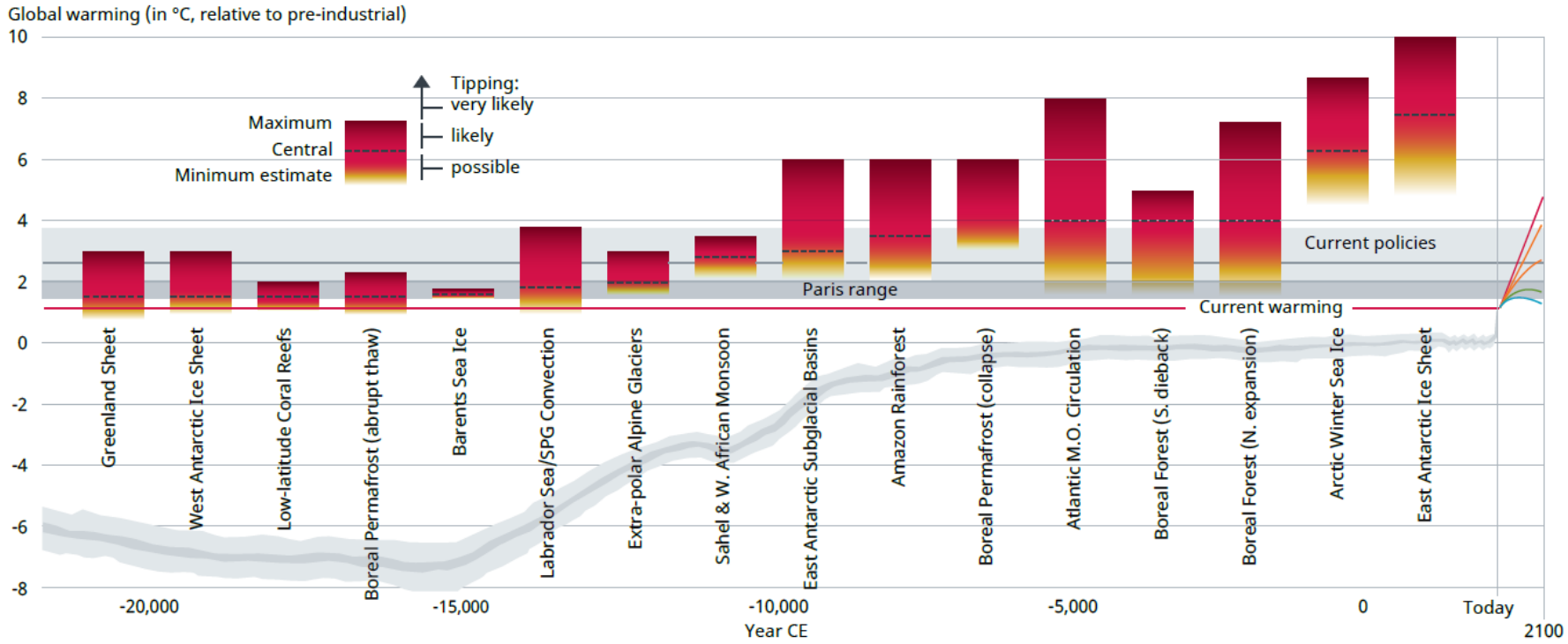
Why is limiting warming to 1.5C the correct global climate target?

The risk of triggering climate tipping points is significantly higher if the earth warms to a long-term temperature average of 1.5C compared to pre-industrial levels.

Likelihood of tipping points being triggered for different global warming temperatures



Source: Armstrong, McKay et al, Science, 2022 and Institute and Faculty of Actuaries, 2023.

Note: There is a higher likelihood of Greenland and West Antarctic icesheet collapse at around 1.5C of global warming

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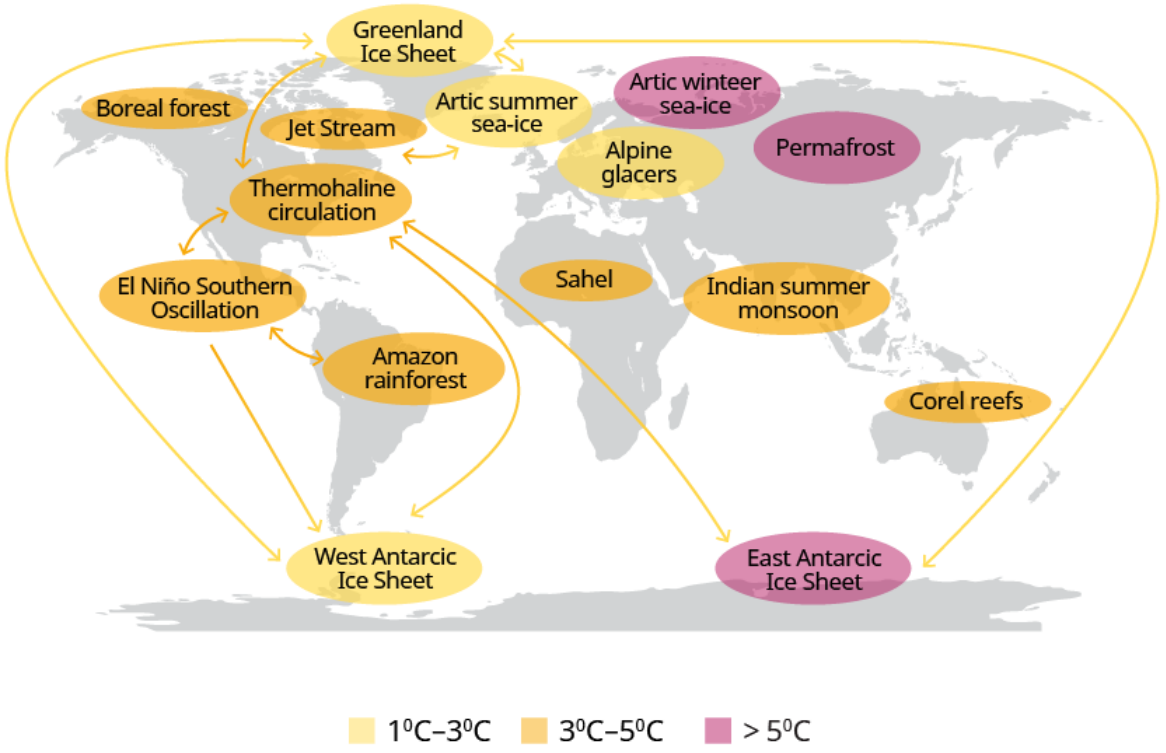
Why is limiting warming to 1.5C the correct global climate target? (continued)

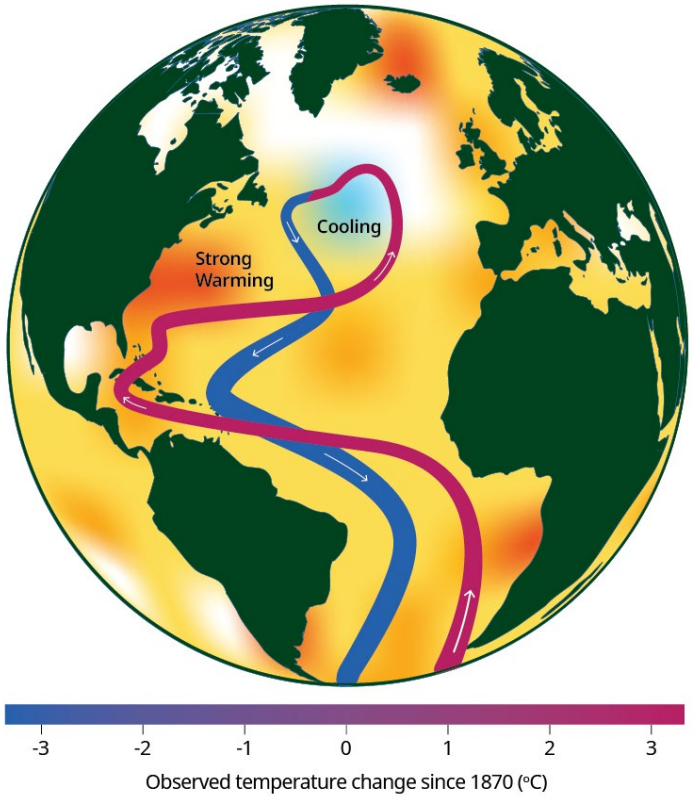
Global map of potential tipping cascades



Note: The diagram shows the interdependence of different climate systems and how triggering a tipping point in one system can lead to a cascade of tipping points emerging.

Source: Trajectories of the Earth System in the Anthropocene.

AMOC[1] running amok: AMOC is the weakest it's been in 1600 years



[1]Atlantic Meridional Overturning Circulation (AMOC) or the Gulf stream

Source: Potsdam Institute for Climate Impact Research.

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How do we assess physical risk?

Trifecta of hazard exposure, socioeconomic sensitivity, and adaptive capacity

- Physical climate risk refers to the damage and financial losses caused by the physical consequences of climate change:
  - **Chronic risk:** driven by long-term shifts in global climate and meteorological patterns, such as temperature and sea level rise
  - **Acute risk:** arising from extreme and fast-onset events, such as floods, droughts, and heatwaves
- The extent of physical risk and its associated negative impacts depend on the interaction of three core components:
  - **Exposure:** the frequency and severity of different physical hazards in a given area
  - **Sensitivity:** the propensity of people and the sectors they depend upon to be negatively affected by climate-related risks, as determined by factors such as demographics, topography, and the stock of assets and infrastructure in hazard-prone areas
  - **Adaptive capacity:** the ability of society and its supporting sectors to adjust to respond to the negative impacts of climate events and reduce potential damage, which depends on factors such as the effectiveness of authorities and quality of basic services

Physical risk				
Exposure		**Sensitivity**	**Adaptive Capacity**	
Acute	**Chronic**	Development	**Institutional**	**Infrastructure**
Flooding and extreme rainfall	Extreme heat	Social inequality	Government effectiveness	Physical infrastructure
Heatwaves and drought	Extreme cold	Economic dependency	Disaster risk reduction	Sanitation, water and healthcare
Wildfires	Sea level rise	Food, water and energy security	Preparedness and response	Access to communications

Source: Schroders, ND-GAIN Index, PreventionWeb.

Physical risk: where are we now?

Losses from physical climate change impacts have increased sevenfold since 1970s

- The climate change-attributed costs of extreme weather over 2000–2019 are estimated to be $2.86 trillion, or $143 billion per year
- 2022 saw: 387 recorded events, $270 billion in overall losses ($150bn insured, $120bn uninsured); 185 million people affected; 8.7 million people displaced; and 56.8 million people living in acute food insecurity driven by weather extremes
- Emerging and developing markets often face the most adverse impacts and losses from climate-related physical risks due to their high sensitivity and low adaptive capacity, which increases the risk of being affected 10-fold relative to high-income countries

Figure 1: GHG emissions, temperature, and physical risk are all increasing

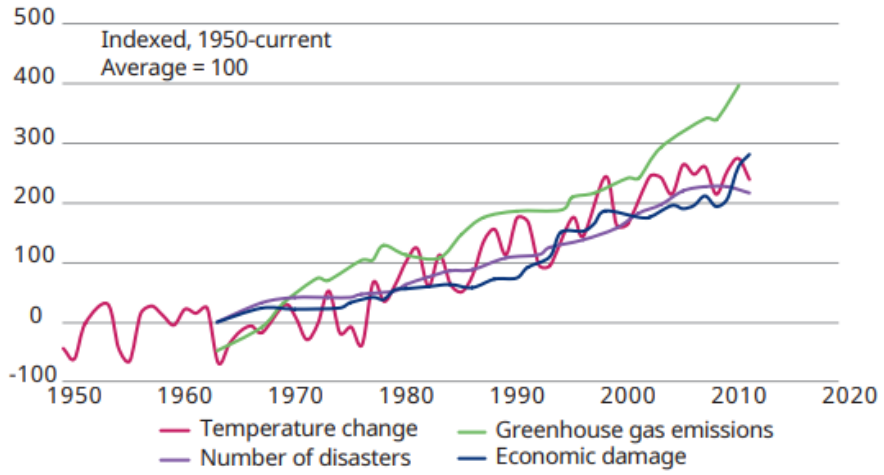
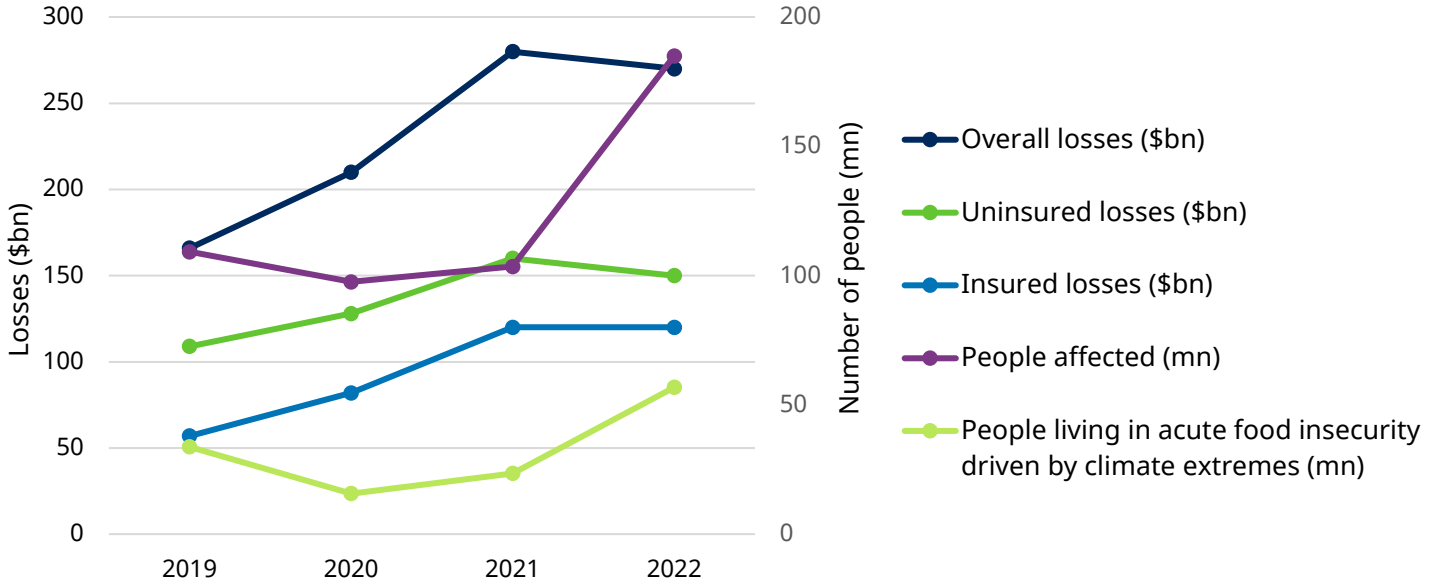


Figure 2: Economic losses and human impacts of climate-related disasters from 2019-2022



Source: Newman and Noy (2023), ND-GAIN, EM-DAT, NASA, Schroders, UNFCCC, Munich Re.

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How does physical risk cause financial losses?

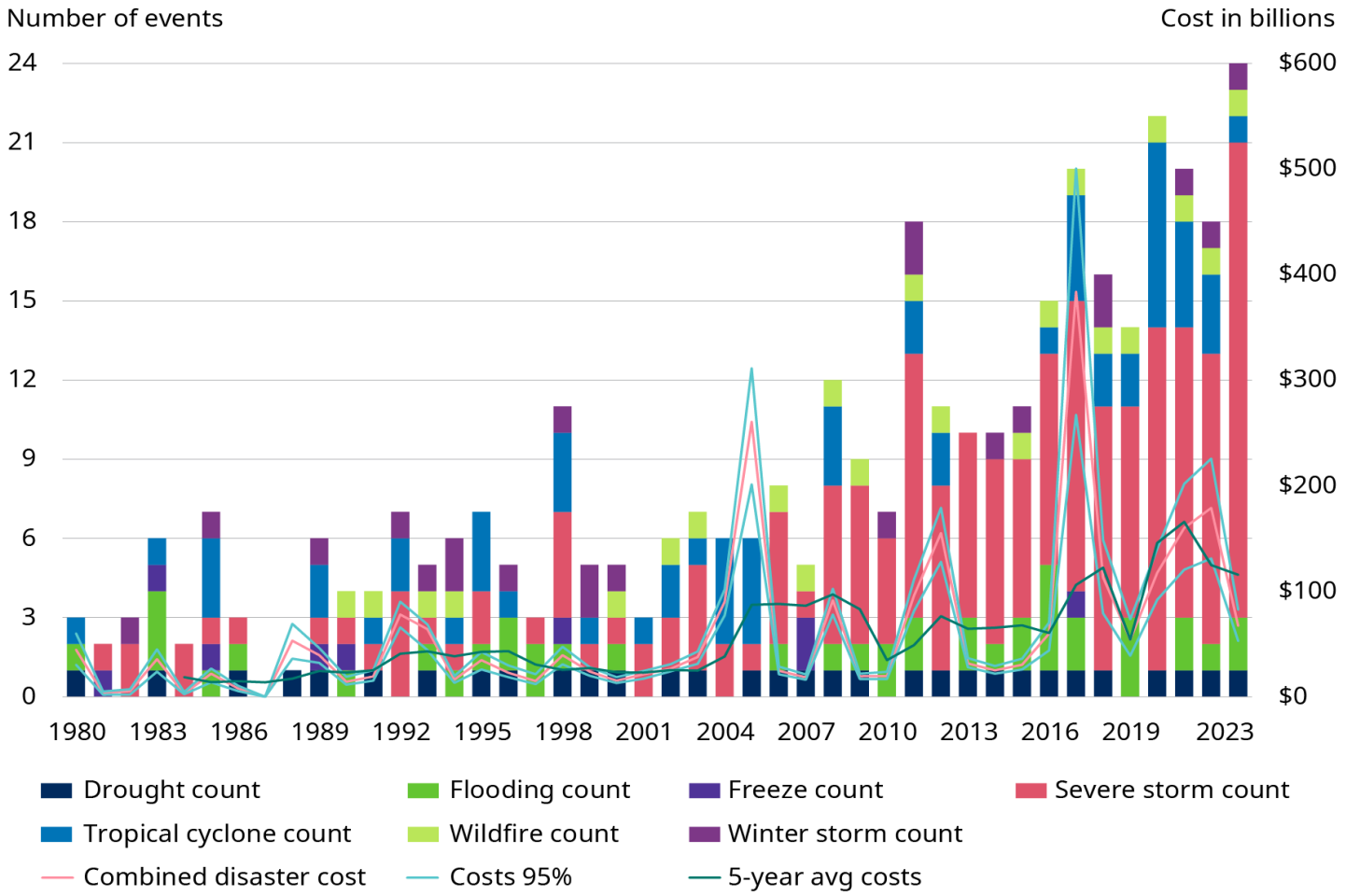
- In addition to the direct and tangible costs of climate-related disasters – such as physical damage to assets and infrastructure, human casualties, and loss of services – there are a number of indirect costs…
  - **Supply chain disruption:** acute risks such as flooded land or wildfires can block transportation routes and cause logistical delays
  - **Labour productivity loss:** long-term temperature increase and acute heatwaves reduce work intensity and lead to productivity loss – our recent research with Cornell University estimated that extreme heat could lead to a 22% shortfall in export earnings by 2030 for apparel manufacturers in some climate vulnerable countries
  - **Product recall and redesign:** certain assets and infrastructure may not be suited to changing climate conditions, meaning they need to be replaced or retrofitted – for example, electricity substations in flood-vulnerable areas need to be equipped with flood defence systems and overhead cables may need to be buried underground
  - **Cascading impacts:** the systemic risks likely to arise when direct risks and impacts compound to affect whole systems, for example…

Source: Schroders. The views shared are those of the Schroders Sustainable Investment team and are subject to change.

Billion-dollar climate disasters are on the rise

The US experienced 28 billion-dollar weather and climate disasters during 2023, the highest on record; with a total cost exceeding $70 bn

United States billion-dollar disaster events 1980–2023 (CPI-adjusted)



Source: National Centers for Environmental Information. Data as of August 2023.

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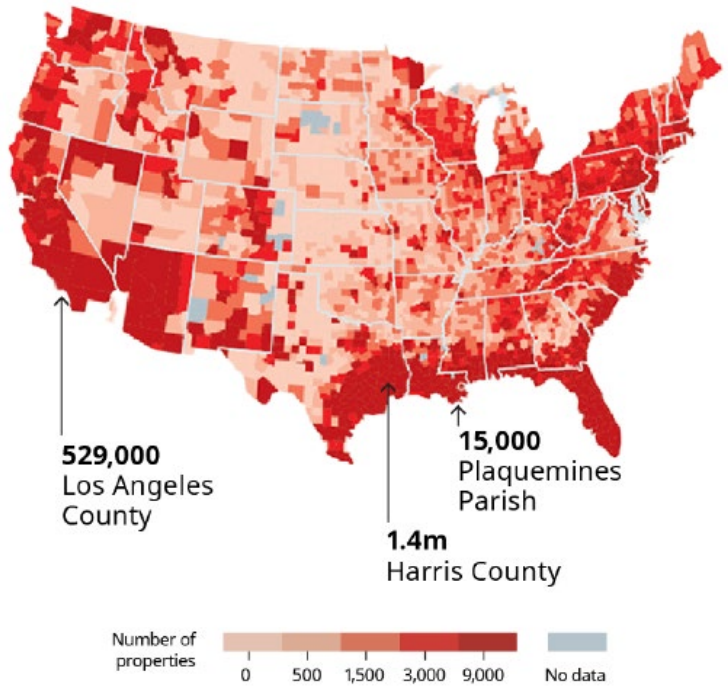
The insurance sector is coming under pressure from rising natural catastrophes

The growing frequency and severity of climate-related disasters in the US has led to ballooning losses, as well as reduced coverage / increasing un-insurability

US: Home insurance premiums are being appraised to reflect growing climate risks

Noah's premium: Risk of an insurance correction due to fire, flood or wind, by county, 2023 estimate



Source: Parts of America are becoming uninsurable – The Economist

Worldwide: Insured losses for natural catastrophes in H1 2023 were 54% higher than the 10-year average.

Total economic and insured losses in H1 2023 and H1 2022 (USD billion in 2023 prices)

	H1 2023	H1 2022	H1 previous 10-y avg	% change vs. 10-y avg
Economic losses	**125**	**129**	**89**	**41%**
Natural catastrophes	120	123	82	46%
Man-made catastrophes	5	6	7	-23%
Insured losses	**54**	**52**	**38**	**42%**
Natural catastrophes	50	48	32	54%
Man-made catastrophes	4	5	6	-28%

Source: Swiss Re and FT; above data relates to natural disasters worldwide

Note: H1 10-yr average refers to the average first-half losses between 2013 and 2022. Preliminary and, due to rounding, some totals may not correspond with the sum of the separate figures

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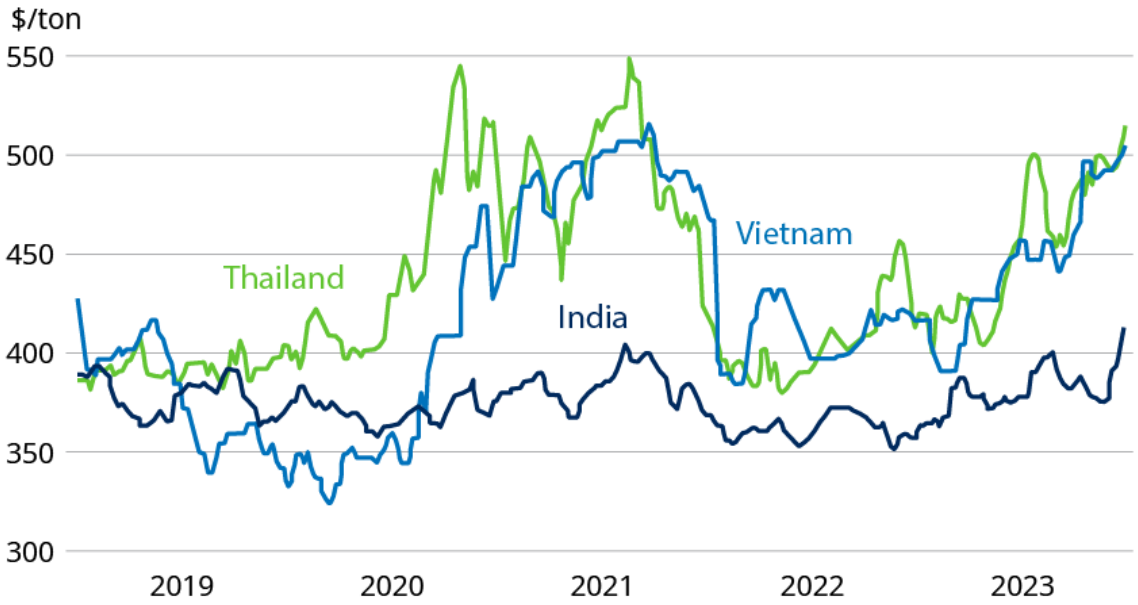
Declining food production

El Nino, droughts impacting crop production and prices

A quarter of the global population experienced drought conditions over 2022/23. Global crop markets are expected to continue being impacted by heat stress over 2024[1] as the El Niño phenomenon continues.

Rice exports prices jump as El Nino develops

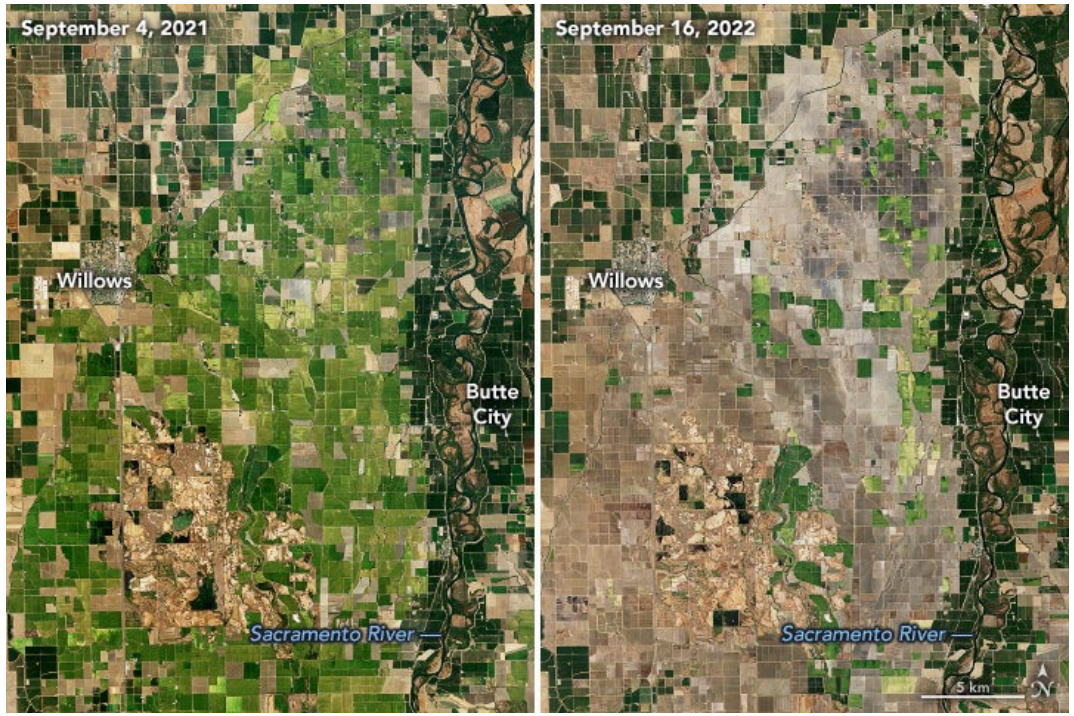
Export prices in India jump to 5-year high; to 2-year high in Thailand and Vietnam



Source: Reuters.

California planted half as much rice as usual due to severe droughts, causing $703 million in losses.

Image of droughts in California impacting crops – 2021 vs 2022



Source: World Economic Forum.

Source: [1]UN, Global Drought Snapshot 2023

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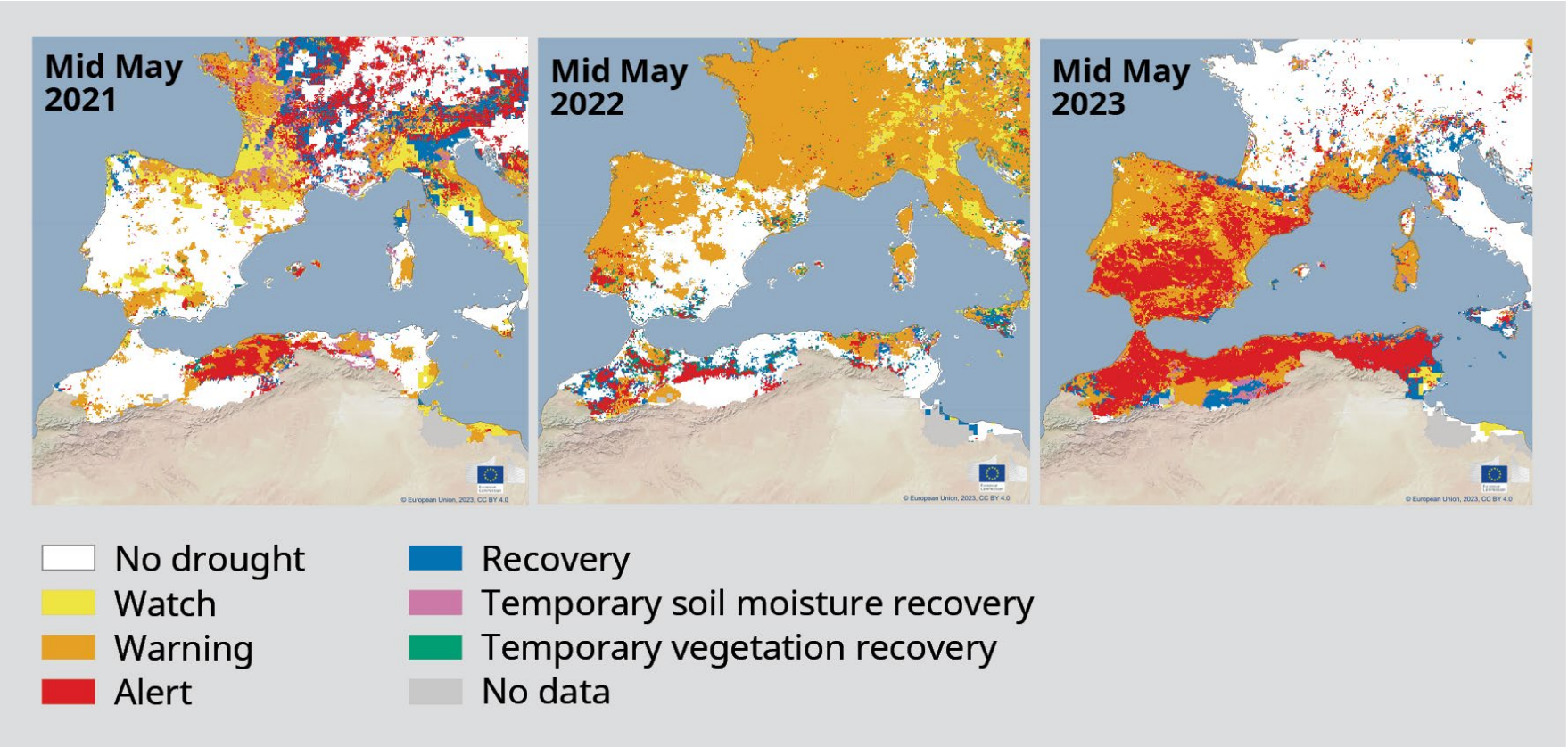
Declining food production (continued)

Intensity of droughts in the Mediterranean rising, leading to lower-than-average yields

The Combined Drought Indicator (CDI)

Based on a combination of indicators of precipitation, soil moisture, and vegetation conditions, mid-May 2021, 2022, and 2023.



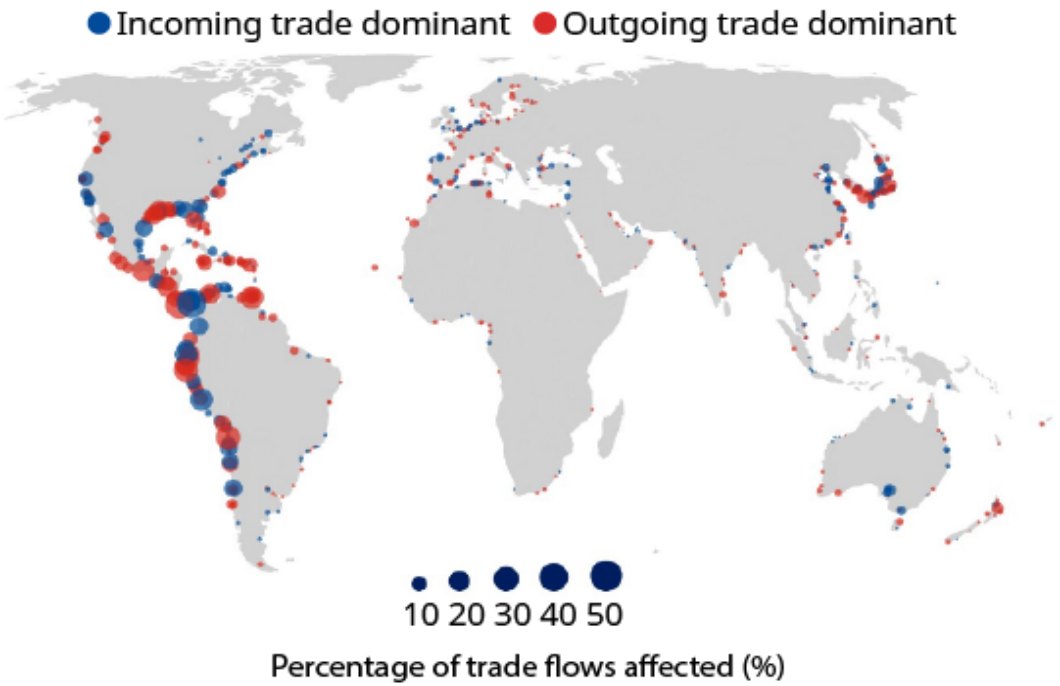
Source: European Commission.

Severe droughts disrupting crucial trade routes

The Panama canal is facing the worst drought in its 140 year period, hindering operations in the waterway responsible for 5% of global maritime trade volume

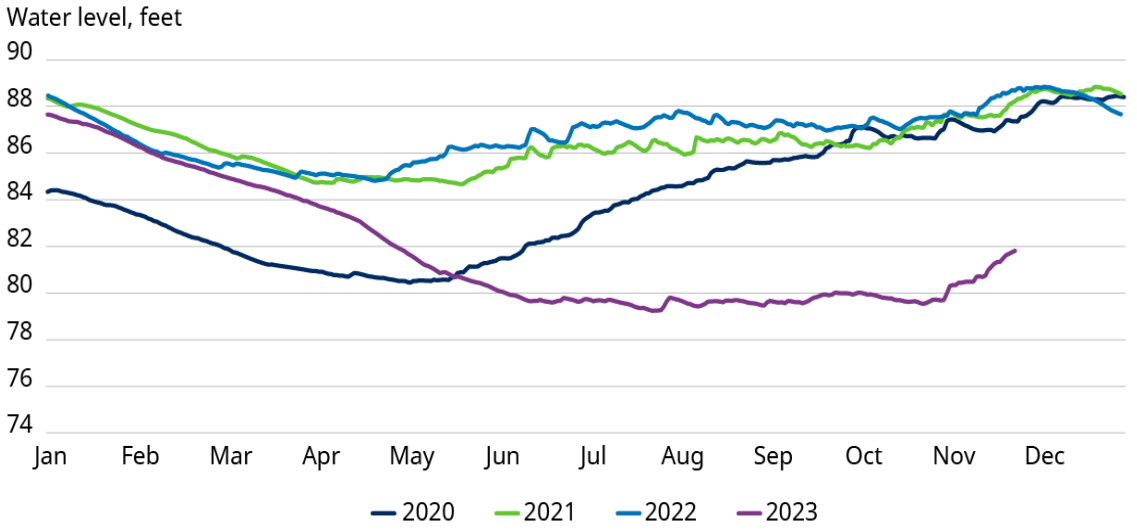
Drought has reduced Panama Canal flows by 5% in 2023, slowing the global trade of goods

Port-level trade flows affected by Panama drought since March 2023



Source: International Monetary Fund; data as of October 13, 2023

Gatun lake in Panama canal is at its lowest level in a decade



Source: Panama Canal Authority

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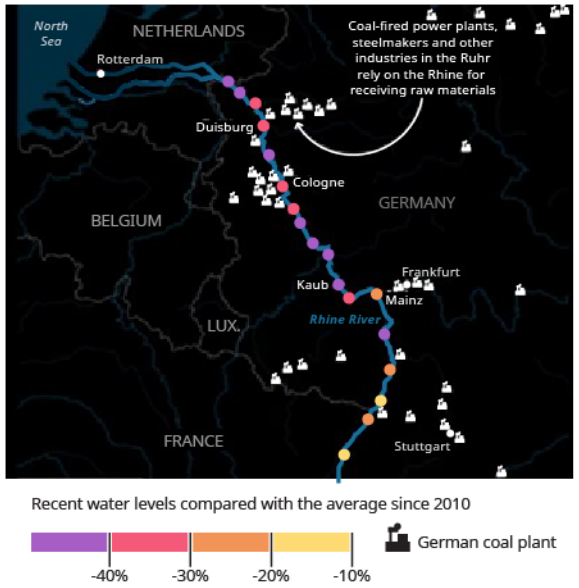
Severe droughts disrupting crucial trade routes (continued)

Germany: The Rhine
Lower water levels have led to a notable reduction in cargo transported

Water levels in some sections of the Rhine are currently > 40% lower than historical average

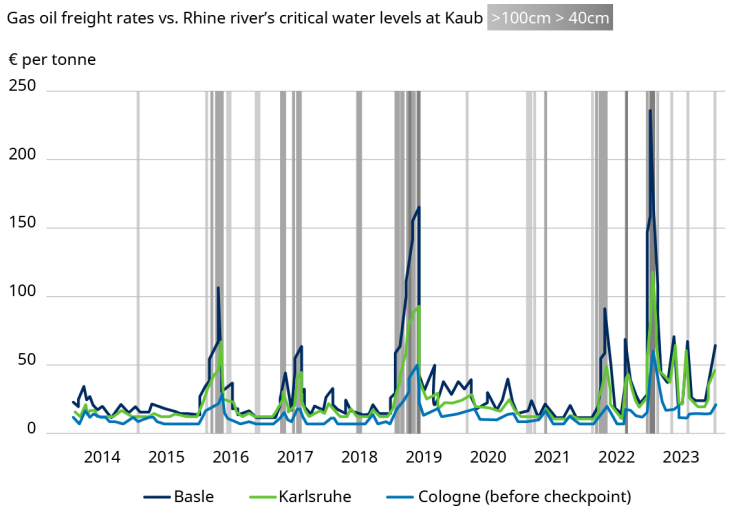
Rhine Water Levels



Source: German Federal Institute of Hydrology

Droughts cause Rhine shipping rates to spike

The cost of transporting goods past the Rhine river's chokepoint at Kaub soars once water levels reach critical thresholds.

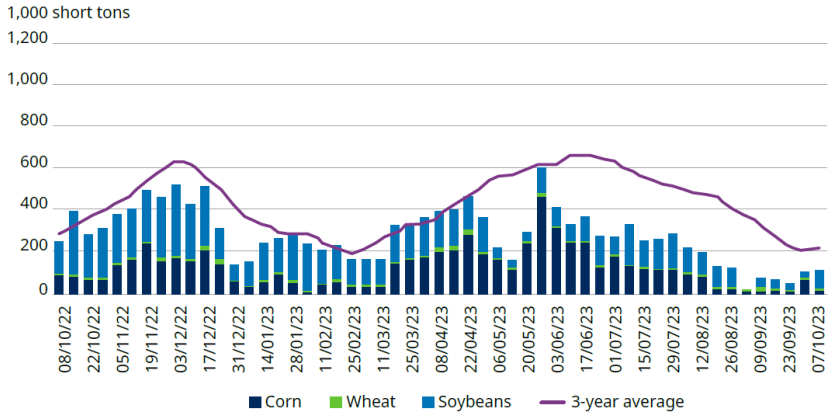


Source: Refinitiv Datastream

US: The Mississippi
Record droughts for two years

Low levels of water in 2022 led to loading capacity being slashed by a third, causing $20bn losses in economic activity

Barge movements on the Mississippi river



Source: US Army Corps of Engineers

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What are the implications for investors?

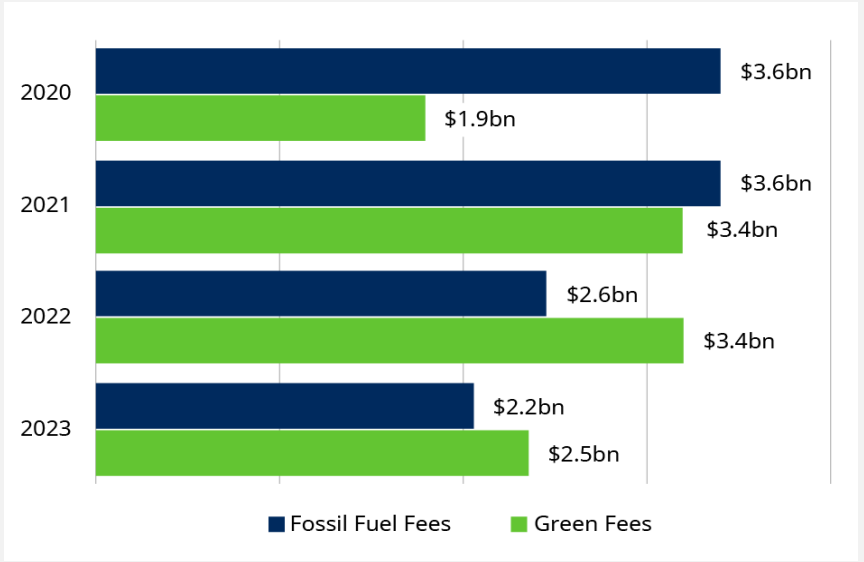
1. **Elevated volatility** for financial markets sooner than expected due to the delayed action on climate change:
    - A disorderly transition - scale and pace of the transition required to limit warming to 1.5C will be disruptive, costly and messy
    - More severe and frequent physical risks, which precipitate abrupt policy change

2. **Preparing for a hotter world** – Adaptation vs. mitigation; implications for risk-return considerations:
    - Mitigation activities (e.g. investing in solar PV, electric vehicles) bring more immediate and certain financial returns vs. adaptation activities.
    - Mitigation's focus on GHG emissions makes it easier to invest in.
    - Adaptation activities focus on building long-term resilience and creating social benefits but may not result in clear financial returns for private investors.

3. **Banks are taking advantage of new revenue streams** from the green transition.
    - Banks have earned revenues of $2.5bn from climate-related projects, compared to $2.2bn from fossil fuel companies.

Banks are earning more from providing green financing

Industry now brings in proportionally less from fossil fuels



Source: Bloomberg

Sources: UNFCCC, World Resources Institute, Bloomberg. The views shared are those of the Schroders Sustainable Investment team and should not be interpreted as investment guidance.

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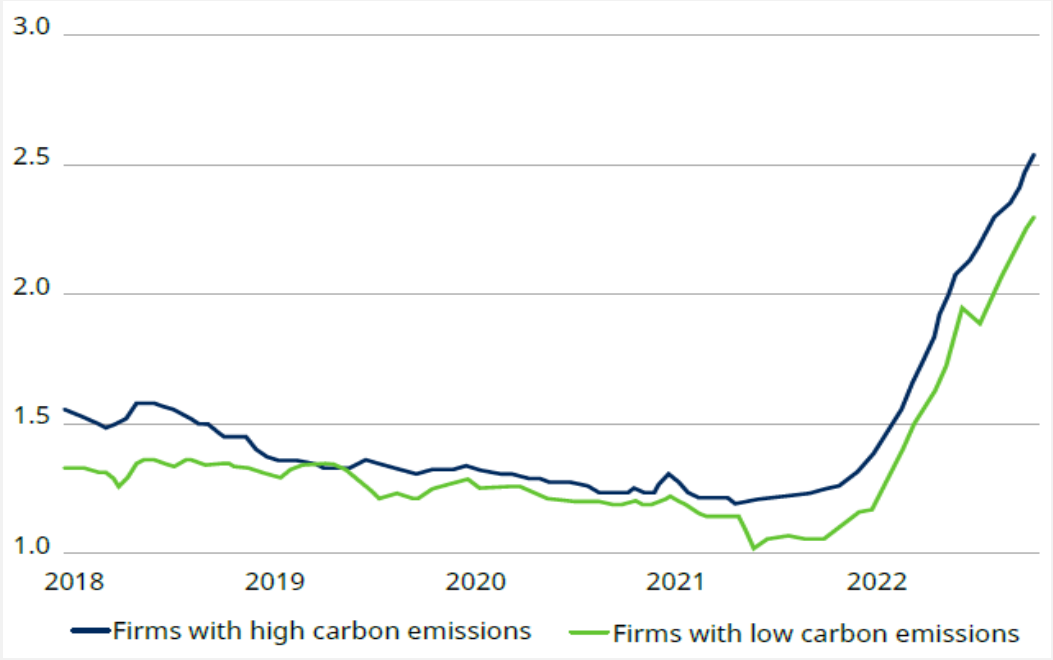
What are the implications for investors? (continued)

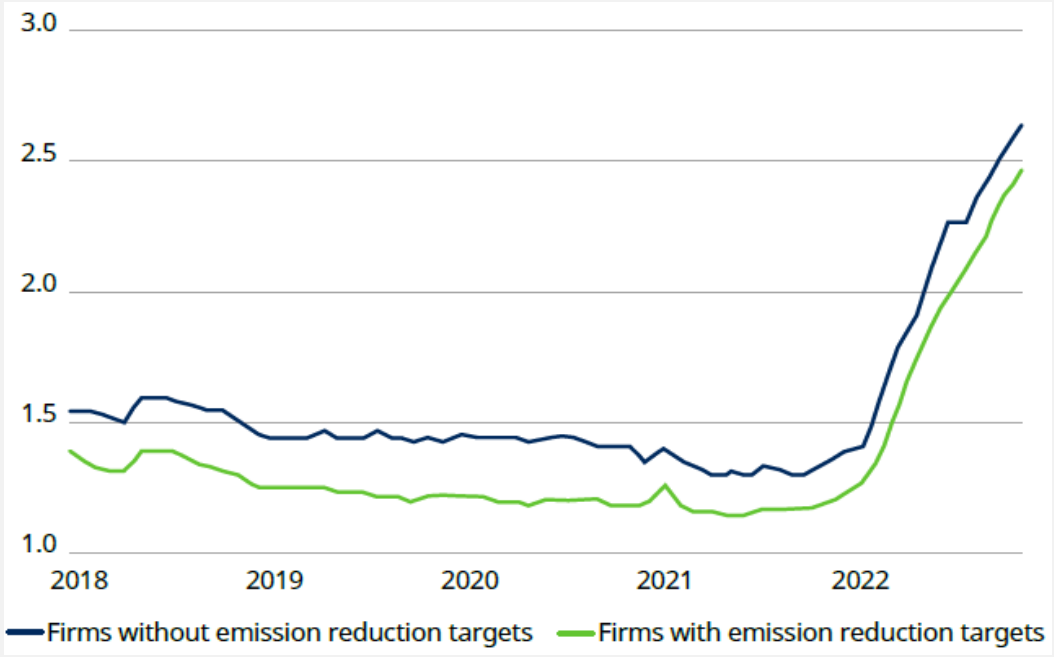
4. Euro area banks are pricing climate risk in their lending policies:

Interest rates charged to green and brown firms

Difference in monthly mean interest rate charged to firms in the top quartile of carbon emissions versus those in the bottom quartile = **15bps**



Difference in rates charged by banks to those who have committed to reducing future emissions versus those which haven't = **20bps**



Source: Centre for Economic Policy Research

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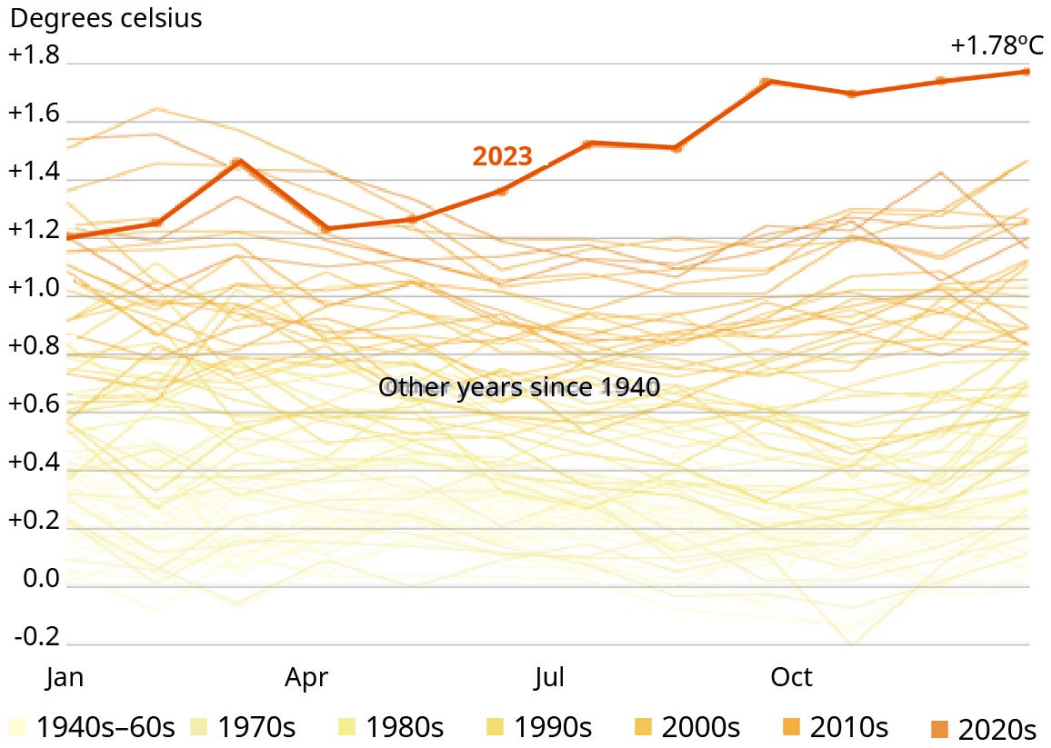
Physical risks: Why we expect them to materialize sooner than expected

1. **Pace of global warming is accelerating** due to record levels of annual emissions

2023 was the warmest year on record globally

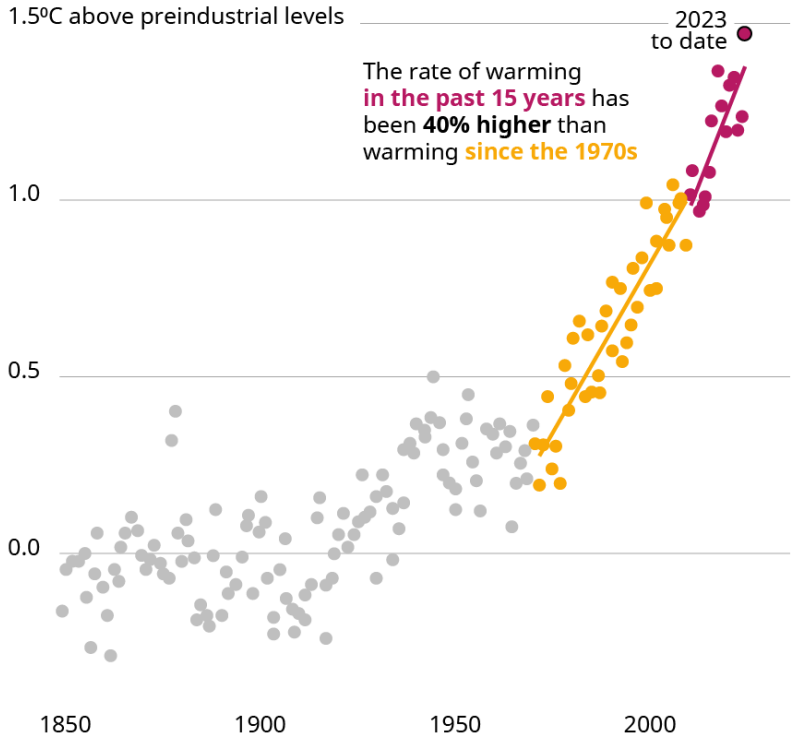
Global temperature above pre-industrial levels, since 1850



Source: Copernicus Climate Change Service and Berkley Earth
Forward looking views may not be realized.

Global warming may have accelerated in the past 15 years

Annual average temperatures since 1850



Source: Berkley Earth

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Physical risks: Why we expect them to materialize sooner than expected (continued)

1. Pace of global warming is accelerating (continued)

- Extreme weather events are occurring at lower levels of warming than scientists initially anticipated.

2. Carbon budget is half of what it should be

- The carbon budget – total amount of carbon dioxide that can be emitted whilst limiting temperature increases to 1.5C by 2030 – is expected to be used up before the end of the decade [1].

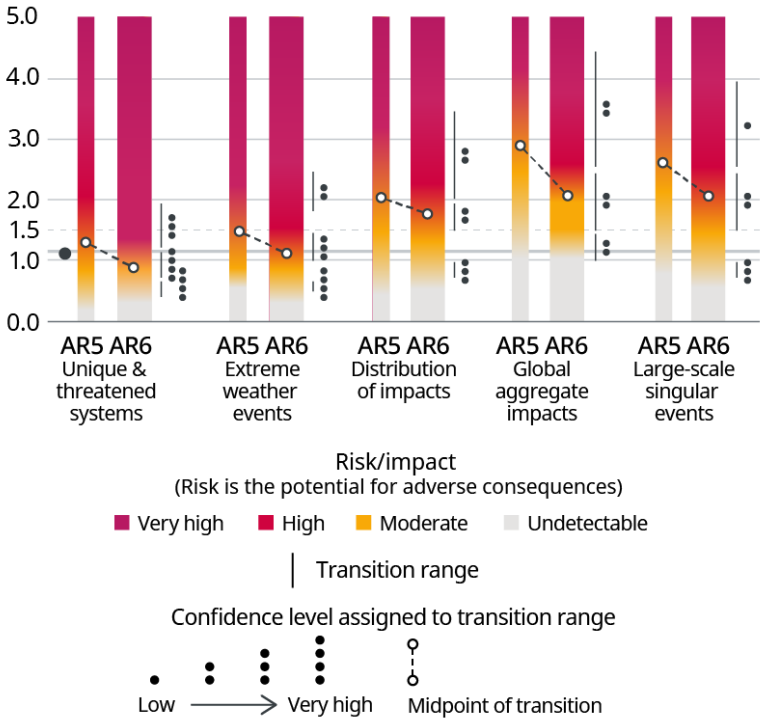
3. Financial models are severely underestimating risk[2]

- Climate-scenario modelling has struggled to incorporate non-linear and exponential impacts of climate risk (such as tipping points and cascades) and second-order impacts (such involuntary mass migration) in their damage functions.
- There is limited relevant past data for climate modelling.
- Economies have never been subject to a transition of this speed and scale, alongside the increasing physical risks.
- Modelling climate-economy models is a complex undertaking involving an integration of different models, leading to compounding errors

Financial institutions have primarily focused on transition risk over physical risk. Less than half of the financial institutions surveyed have reported on physical risk in their climate disclosures[2], creating potential physical risk 'blind spots'.

More severe impacts are being felt at lower temperatures than anticipated

Global reasons for concern (RFCs) in AR5 (2014) Vz AR6 (2022)



Source: The Emperor's New Climate Scenarios

Note: AR5 and AR6 are IPCC's assessment reports released every 7 years.

Source: [1] Lamboll et.al. Oct 2023 [2] The Emperor's New Climate Scenarios [3] World Resources Institute. Forward looking views may not be realized.

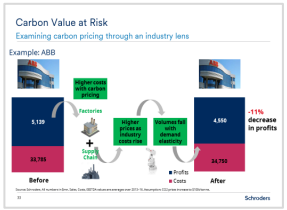
Exposure to climate risks is a key component of our climate toolkit, supporting analysis of unpriced risk and opportunities

① Climate Risk Exposure

Assessing the climate risks and opportunities across portfolios

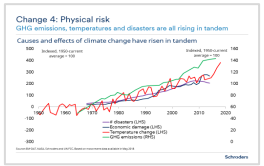
Transition Risk

Carbon VaR



Models how company profits and investor returns could be at risk from tougher climate policies and higher carbon prices

Physical Risk (developing models)



Quantifies the physical impact climate change has on companies

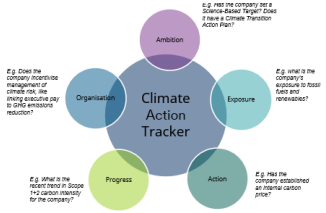
+ Third party data for scenario analysis

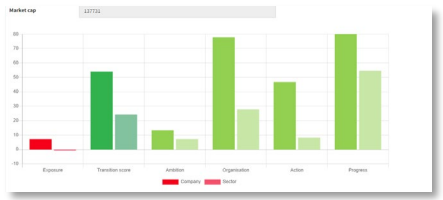
② Climate Mitigation

Analysing company actions to mitigate climate exposures

Climate Action Tracker (BETA)

Tracking the mitigating actions that companies are taking across a range of indicators including actions taken demonstrating ambition, organizational change to decarbonise and actual progress being made.





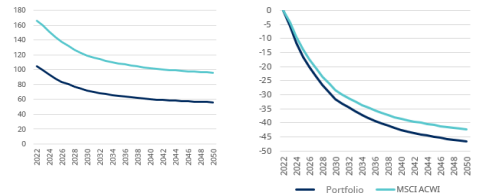
③ Climate Outcomes

Monitoring progress against net zero commitments

Net Zero Dashboard

Measures the commitments companies are making and provides portfolio temperature alignment, as well as financed emissions

Portfolio Decarbonisation Toolkit



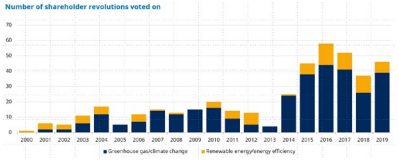
Portfolio Emissions Pathway projects emissions pathway based on company commitments

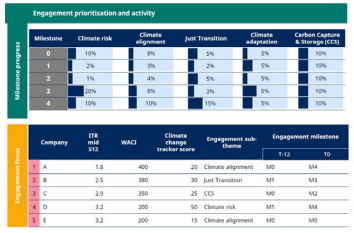
④ Active ownership

Data driven insights inform engagement and voting

Engagement and voting (ActiveIQ)

Various tools and metrics to measure company progress against climate engagement objectives and inform voting decisions





Source: Schroders. For illustrative purposes only.

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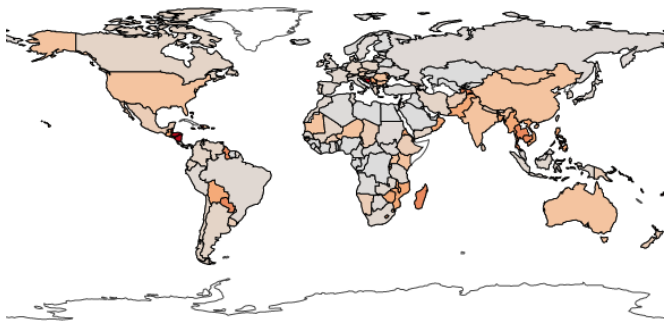
Considering insurance risk and the physical risks of climate change

1

Damage caused by climate change, based on estimated economic costs relative to GDP over the last 20 years.



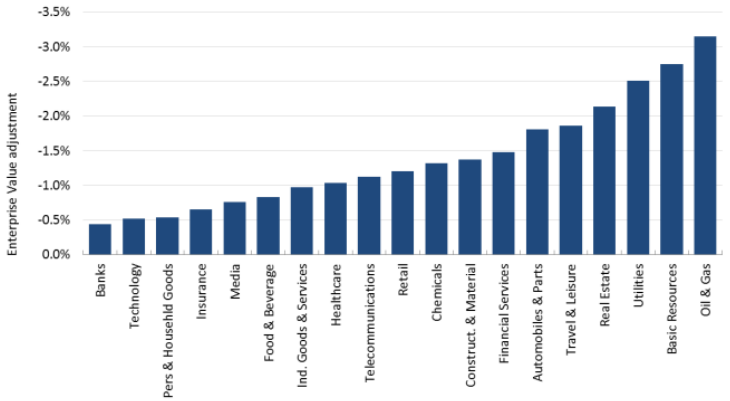
2

Companies' exposure to physical risks calculated by combining country risk analysis with their reported geographic assets.

US$ million	Intangible assets and Property, plant and equipment 2017	2016	Total non-current assets 2017	2016
South Africa	10,818	9,554	11,638	10,488
Botswana	4,536	4,266	4,536	4,266
Other Africa	1,121	1,019	1,127	1,025
Unallocated assets			3,476	3,429
Total non-current assets			39,828	37,700

3

Costs of insurance against physical damage calculated using current exposures, standard global loss ratios and projected damage growth in the short-medium term.



Source: Munich Re, Schroders.

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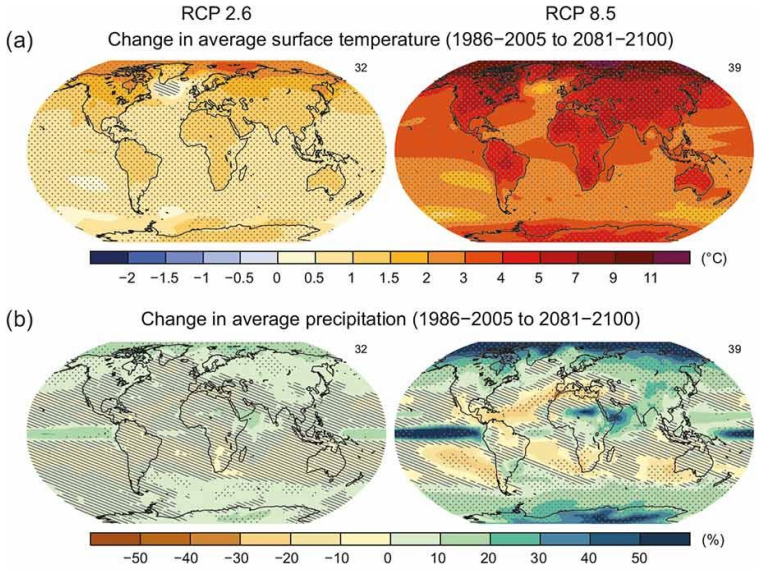
Using scenario analysis to understand the range of uncertainty

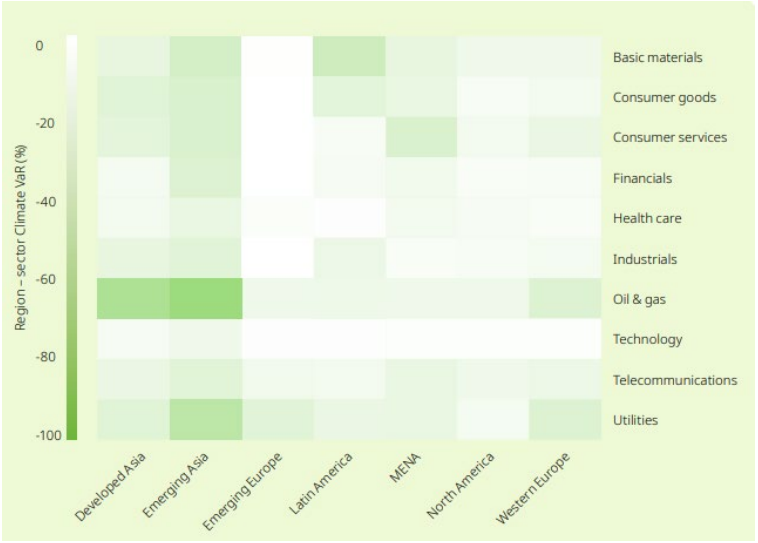
Scenario analysis considers range of scenarios reflecting 1.5°C to 'hot house world'



Models look at chronic and acute physical hazards

Chronic climate risks	• Temperature decrease • Temperature increase • Wind • Snow • precipitation
Acute climate risks	• Tropical cyclones • Coastal flooding events • Fluvial flooding events • River low flow events • Wildfires

Apply to portfolios to understand regional-sector value at risk



Scenario analysis helps to understand potential value at risk in different scenarios and highlights regions and sectors that are more exposed to risks

Source: Schroders sectoral and regional analysis of physical risk using MSCI Climate VaR, Dec 2023. Models are hypothetical and my not account for all risk or actual conditions.

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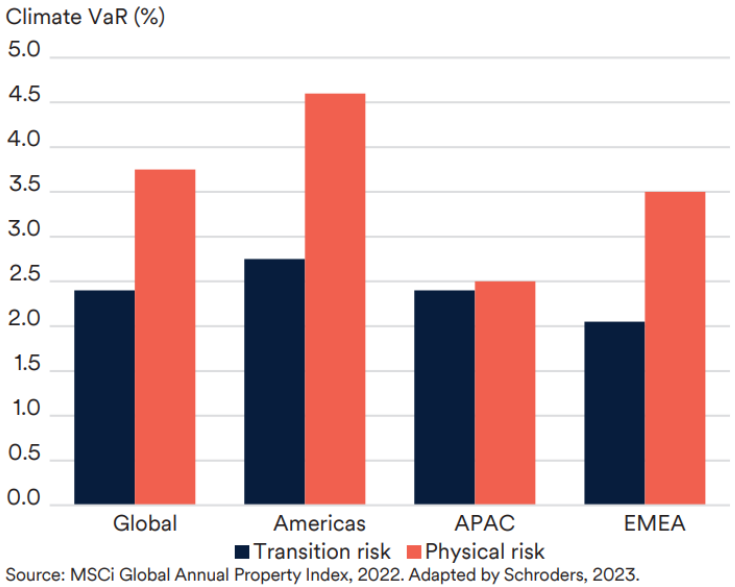
Physical risk assessments in real assets

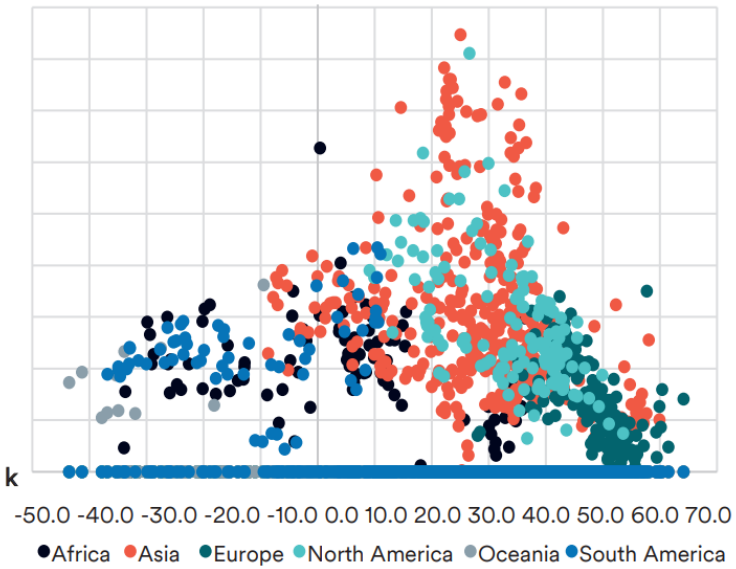
Real Estate faces significant risks from climate change

Real assets are more vulnerable to physical risks from climate change



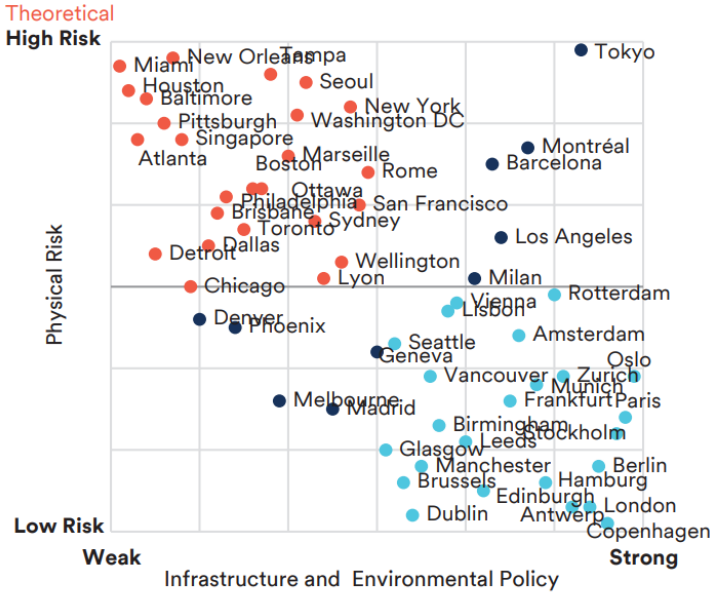
Source: MSCi Global Annual Property Index, 2022. Adapted by Schroders, 2023.

Vulnerability differs by region, with emerging markets potentially more exposed



Source: Verisk Maplecroft, Schroders, 2023.

But strong infrastructure and environmental policies can reduce risks



Source: Arcadis, Schroders, February 2023.

Source: Climate Change and Cities: Adapting Real Estate Investment Decisions (available here). Shown for illustrative purposes only and should not be interpreted as investment guidance.

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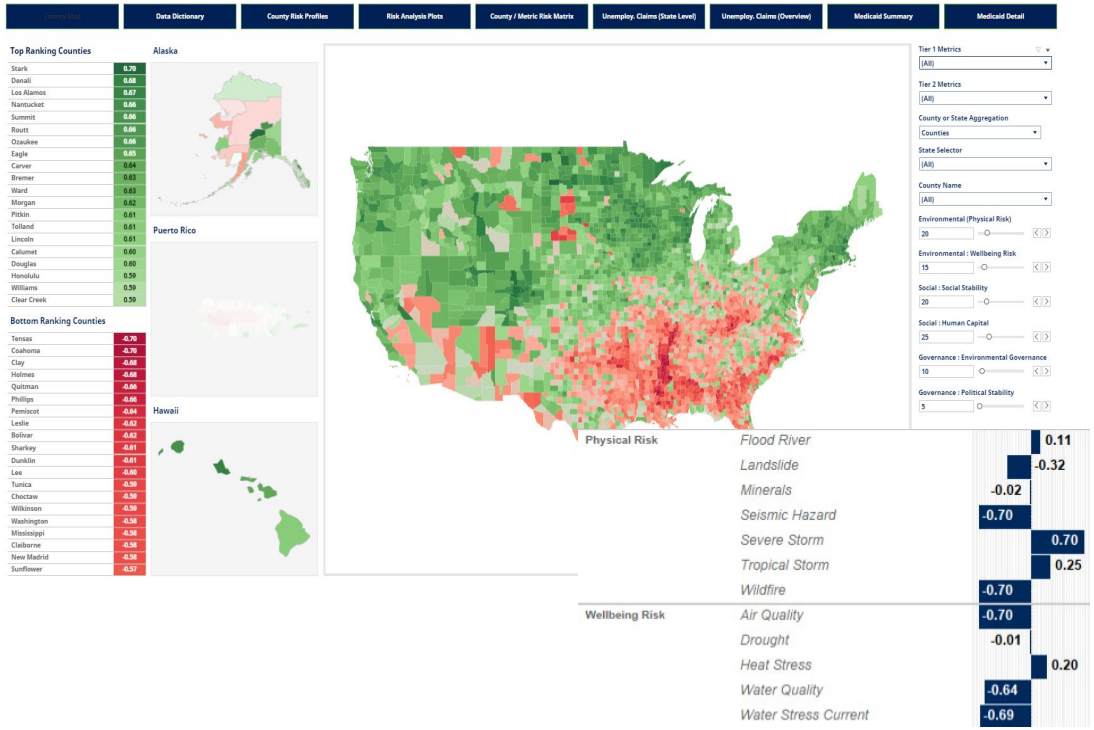
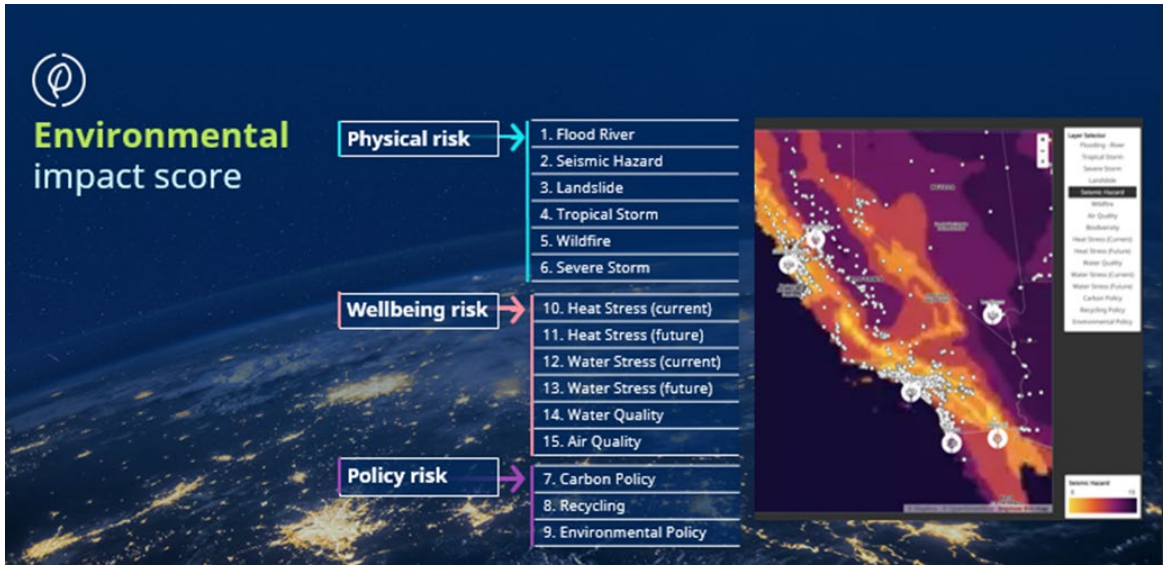
Physical risk assessments in municipalities and cities

Environmental assessment factors into broader sustainability risk assessments

Municipal Bond Environmental Risk Assessment across 40 unique factors including environmental risk data at a granular level to assess long term opportunities and challenges for municipalities



Global Cities use an environmental database scoring and ranking across 10 environmental impact indicators, including using geospatial analysis



Source: Schroders proprietary tools. Illustrative only. Our proprietary tools are designed to enhance the research and evaluation process but do not guarantee favorable investment results.

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Marketing material.

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