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Physical Climate Risk & Cost of Capital

Implications for Corporations, States & Municipalities.

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Source: **G20 CLIMATE RISK ATLAS,** Impacts, policy, economics, CMCC (2022)

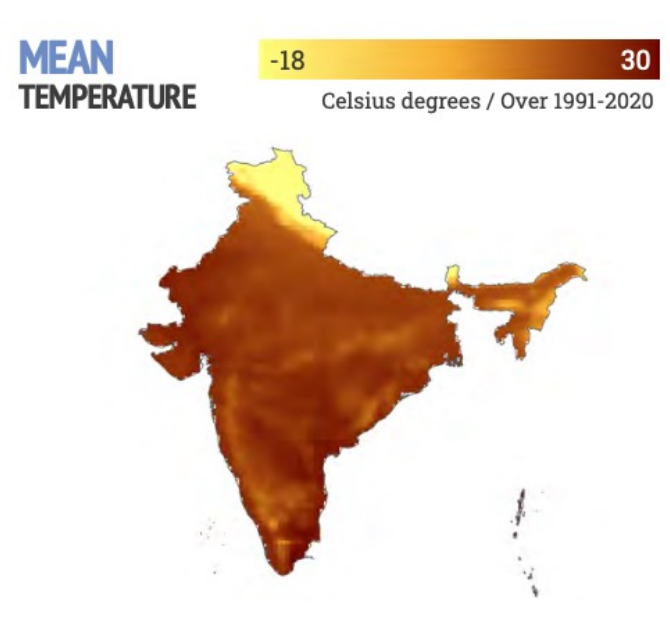
Channels of Physical Climate Risk

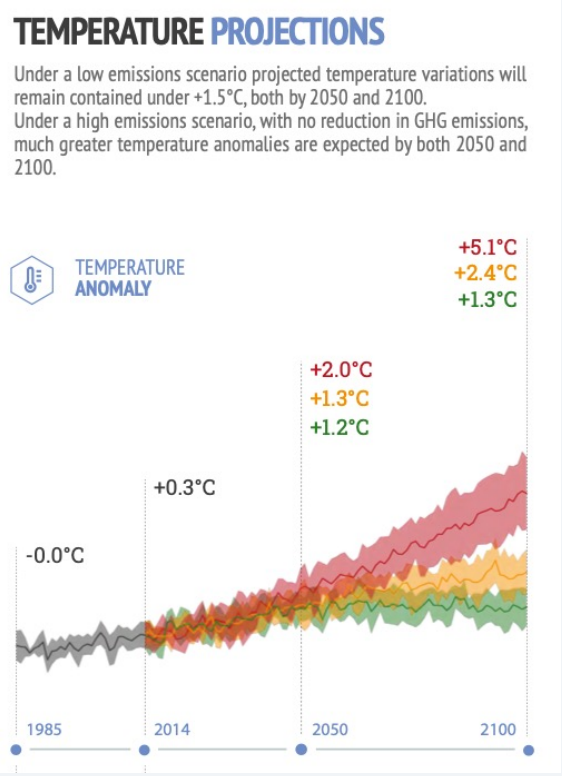
- Heat Stress
  - increases mortality risk, energy expenditures, & GHG emissions, and decreases labor productivity – across the world.
- Sea level rise
  - Coastal areas are more directly affected. Examples: Maldives, New Orleans – storm surges
- Hurricanes
  - Philippines, China, Japan, United States, etc.
- Floods
  - India, Bangladesh, China, etc.
- Droughts
  - Ethiopia, Sudan, Eritrea, etc.

Source: G20 CLIMATE RISK ATLAS, Impacts, policy, economics, CMCC (2022)

Channels of Physical Climate Risk

- Heat Stress





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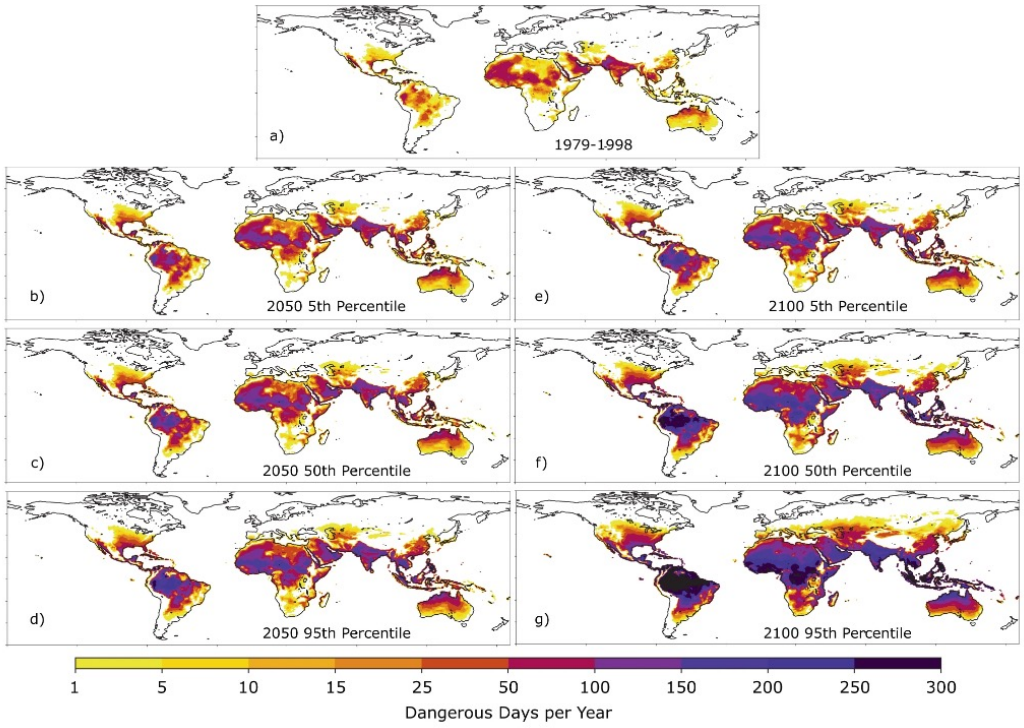
Source: Vargas Zeppetello, L.R., Raftery, A.E. & Battisti, D.S. Probabilistic projections of increased heat stress driven by climate change. *Communications Earth & Environment* **3**, 183 (2022).

Projections of Dangerous Heat Index Values



"In the median projection for 2100, extremely dangerous heat stress will be a regular feature of the climate in sub-Saharan Africa, parts of the Arabian peninsula, and much of the Indian subcontinent."

Highlights from the above research paper.

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Source: Climate Investment Opportunities in India's Cooling Sector, World Bank (2022)

Heat risk is pervasive, not easily diversified and difficult to insure

- By 2030, over 160-200 million people across India could be exposed to lethal heat waves annually.
- Around 34 million people in India will face job losses due to heat stress related productivity decline.
- The current food loss due to heat during transportation is close to $13 billion annually.
- By 2037, the demand for cooling is likely to be eight times more than current levels. ***This means there will be a demand for a new air-conditioner every 15 seconds, leading to an expected rise of 435 percent in annual greenhouse gas emissions over the next two decades.***

Source: **G20 CLIMATE RISK ATLAS,** Impacts, policy, economics, CMCC (2022)

Channels of Physical Climate Risk

- Droughts
  - About 18% of India's total area is drought-prone, and about 50 million people are annually affected by drought. India faces droughts due to poor summer monsoons caused by natural climate variability or climate change. In the Deccan Plateau region of India significant drought conditions occur once in 3 years. The Deccan region sees the highest frequency of severe droughts in all of India.

- Sea level rise
  - Approximately 64 million people live in low elevated coastal areas that are less than 10 meters above sea level. These areas are exposed to both coastal erosion and storm surges, with the highest exposure found on the east coast of India.

Source: **G20 CLIMATE RISK ATLAS,** Impacts, policy, economics, CMCC (2022)

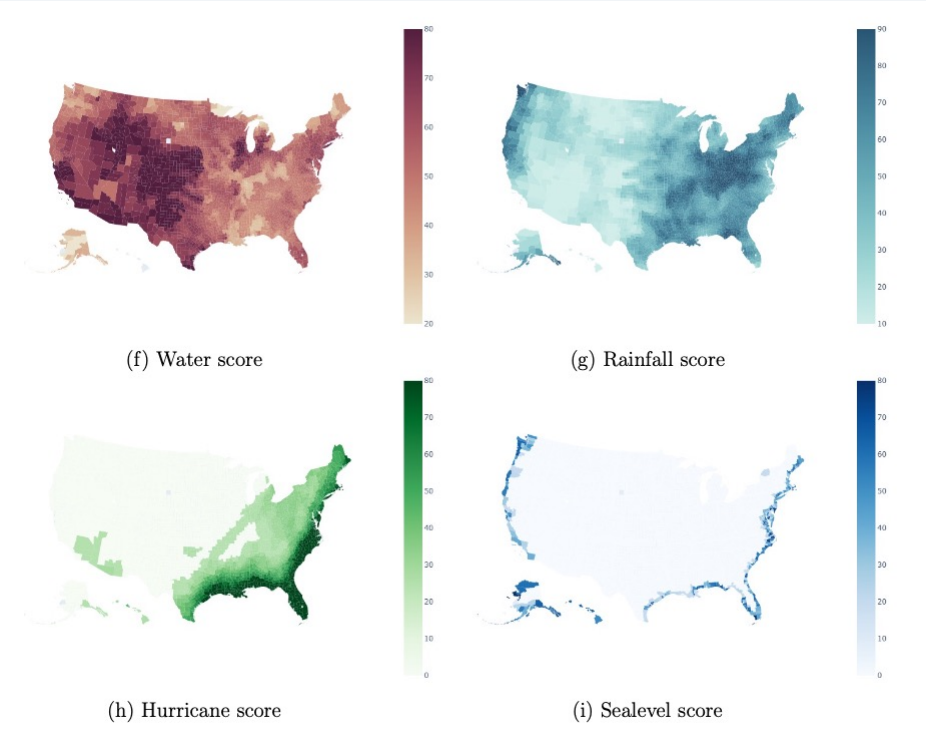
Channels of Physical Climate Risk

- Floods
  - An extreme precipitation (940 mm in 18 hours) event in Mumbai (July 2005) was a disaster that led to flooding that affected 20 million people and caused around 1,200 deaths. Similarly, Mumbai experienced flooding in September 2017 due to extreme precipitation (330 mm in 24 hours), which largely affected road transportation. Furthermore, Chennai received 483 mm of precipitation in 48 hours in November 2015, which had a devastating impact causing widespread damage.

  - Projection of population affected by floods:
    - 2050 about 18 million people.

Source: "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress," by Acharya, Johnson, Sundaresan and Tomunen (2022)

Big Data/Satellite Images – Measures of Physical Risk



- Some of the risks are partially insured.
  - Hurricanes
    - CAT-bonds
    - Insurance
    - Re-insurance
  - Floods
    - FEMA National flood insurance program.
- Coverage is partial.
- Coverage can be expensive.
- Local risks can be diversified by investors, but not by residents/municipalities.

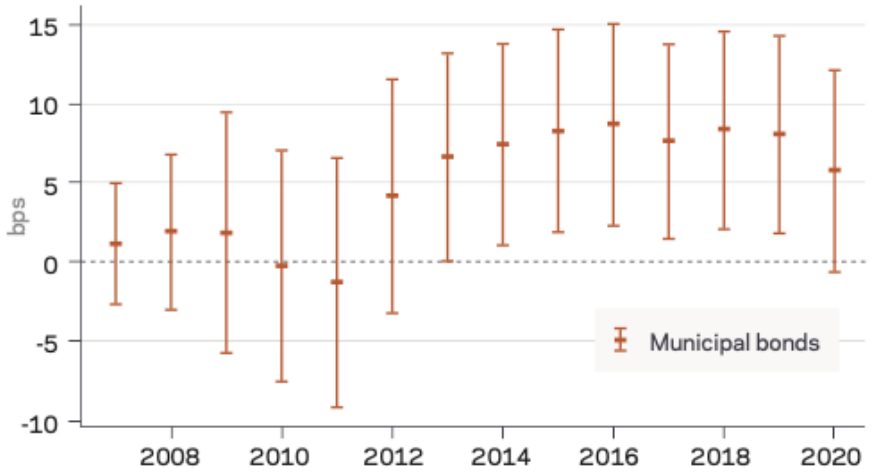
- Swiss Re estimated the Climate related losses in 2019 at about $137 billion. About 51% of that was covered by insurance. The coverage in emerging market is close to just 10%. Uninsured losses pass-through to banks and lenders by default.

Source: "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress," by Acharya, Johnson, Sundaresan and Tomunen (2022)

Heat risk makes Municipal access to capital more expensive

Estimated impact of heat score on municipal bond spreads

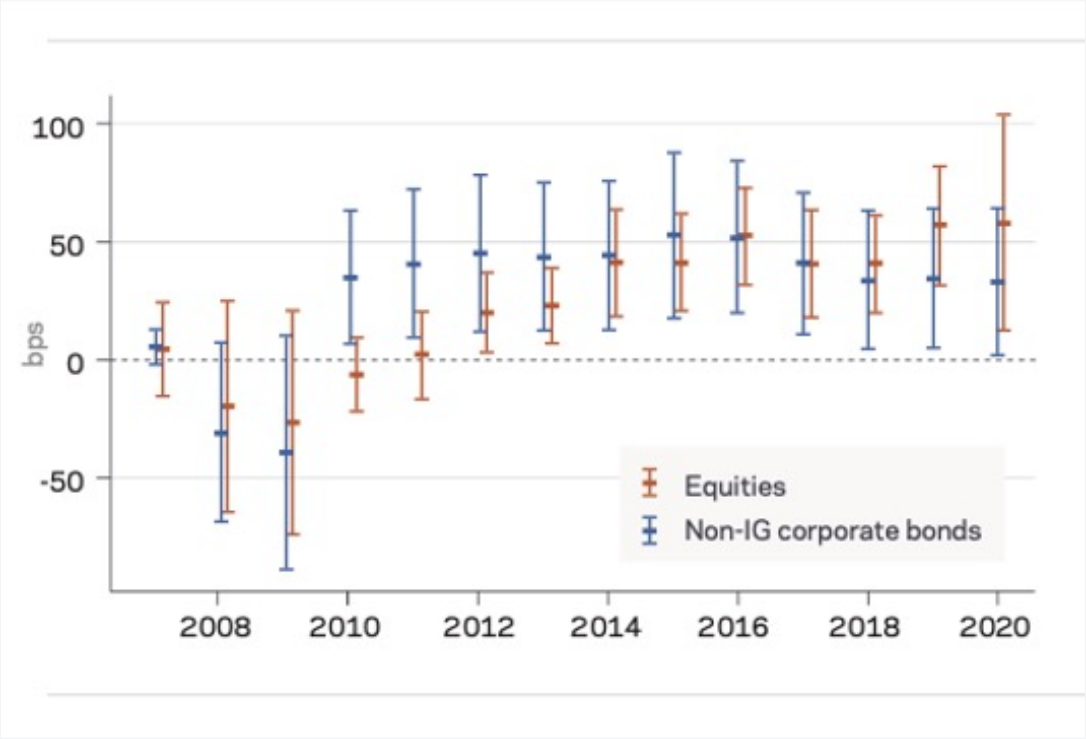
Municipalities in locations with higher heat stress exposure find access to bond markets more expensive. This is important because these municipalities need capital to invest in climate-risk abatement projects.



States and Municipalities cannot easily relocate

Source: "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress," by Acharya, Johnson, Sundaresan and Tomunen (2022)

Heat risk makes Corporate access to capital more expensive



Non-investment grade corporate bond issuers pay a "climate risk premium" when they are exposed to heat risk.

Corporate equity issuances are costlier for companies exposed to more heat risk.

Investment-grade corporate bond issuers are less affected by climate risk.

Source: "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress," by Acharya, Johnson, Sundaresan and Tomunen (2022)

Heat risk affects companies' cash flows and default risk

Extreme heat can cause damage to the local economy through several different channels, including:

- increased energy demand
- decreased efficiency of electricity production
- decreased labor productivity

Heat stress stands out in terms of its consistent asset-pricing impact relative to other physical risks and is priced in municipal credit spreads, corporate credit spreads, and equity markets.

The effects of heat stress are substantial, ranging from 15 bps (municipal bonds) to 45 bps (equity).

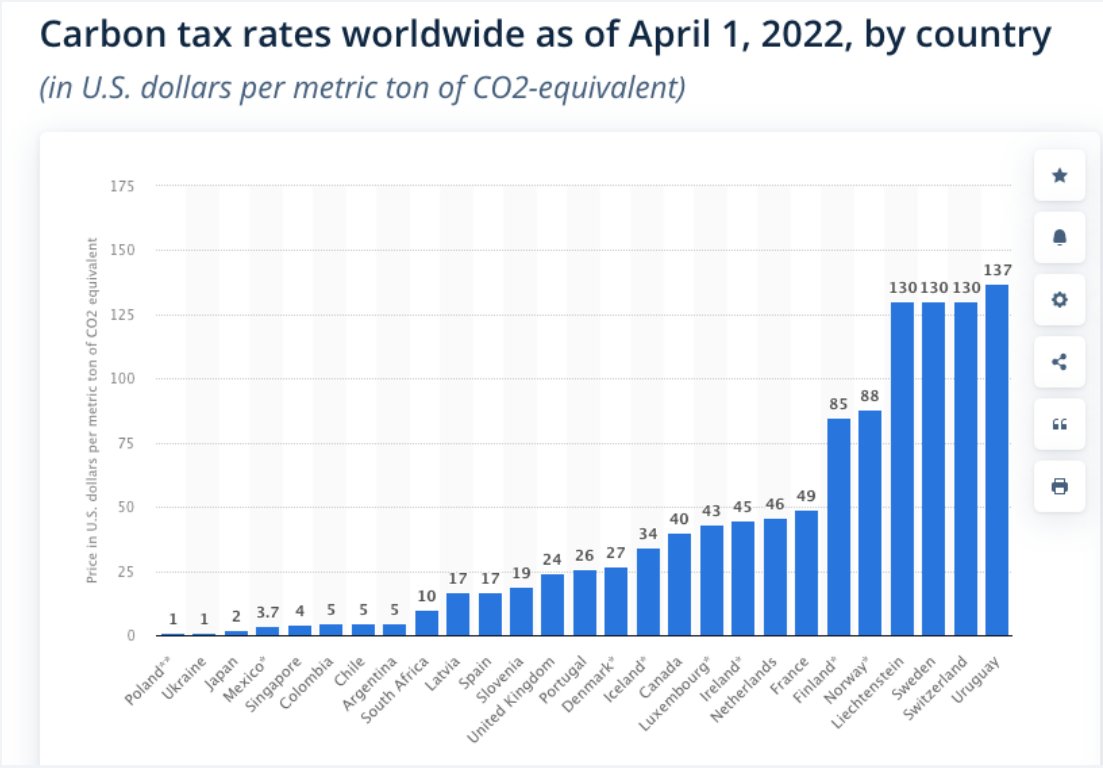
Source: "Is Physical Climate Risk Priced? Evidence from Regional Variation in Exposure to Heat Stress," by Acharya, Johnson, Sundaresan and Tomunen (2022)

Heat risk affects companies' cash flows and default risk

- California's largest utility, Pacific Gas and Electric (PG&E) filed for Chapter 11 bankruptcy in January 2019 on a total of about $30 billion of liabilities after the wildfires across the state. The stock price of PG&E fell precipitously following the financial distress.
- The Wall Street Journal called it the "first climate change bankruptcy" (PG&E: The First Climate-Change Bankruptcy, Probably Not the Last, WSJ, January 18, 2019).
- The bankruptcy also imposed costs, by way of reduced utility services and increased costs, on families residing in affected areas as well as on municipal bondholders who invested in the debt issued by PG&E.
- In addition, tax-payers also were affected as assistance was provided by Federal Emergency Management Agency (FEMA) and other federal agencies.

Source: Statista, Energy and Environment and
"Do investors care about carbon risk?" by Patrick Bolton and Marcin Kacperczyk, Journal of Financial Economics (2021)

Corporations face external pressures (Governments & Markets)
"cap and trade", carbon taxes & risk premium



Stocks of firms with higher total carbon dioxide emissions (and changes in emissions) earn higher expected returns, controlling for size, book-to-market, and other return predictors.

Institutional investors implement exclusionary screening based on direct emission intensity (the ratio of total emissions to sales) in a few salient industries.

Overall, investors are already demanding compensation for their exposure to carbon emission risk.

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Source: The Securities and Exchange Commission,
March 21, 2022

Corporations face external pressures (Regulators)

SEC requires Climate risk disclosures

- The Securities and Exchange Commission today proposed ***rule changes that would require registrants to include certain climate-related disclosures in their registration statements and periodic reports, including information about climate-related risks that are reasonably likely to have a material impact on their business***, results of operations, or financial condition, and certain climate-related financial statement metrics in a note to their audited financial statements.

- ***The required information about climate-related risks also would include disclosure of a registrant's greenhouse gas emissions***, which have become a commonly used metric to assess a registrant's exposure to such risks.

Source: Electrek, Fossil fuels, divestment movement

Corporations face external pressures (Banks & Shadow banks)
HSBC December 14, 2022

- HSBC will no longer provide new lending or capital markets finance for the specific purpose of projects pertaining to new oil and gas fields and related infrastructure when the primary use is in conjunction with new fields.

- Given the parallel urgency of today's global energy crisis, HSBC plans to accelerate activities in renewable energy and clean infrastructure, aligned with our previously announced ambition to provide $750 billion to $1 trillion in sustainable finance and investment by 2030.

- HSBC has previously announced an ambition to provide up to $1 trillion in "sustainable finance and investment" by 2030, targeting net zero emissions across its customer base by 2050 at the latest. It also wants its own operations to be net zero by 2030.

How should corporations manage climate risk?

- Senior management oversight and action plans on climate related risk and opportunities. Is there a process in place?
    - Supply chain vulnerability to physical climate risk.
    - Shifts in demand from consumers to “greener products and services”
    - Pressure from credit rating agencies – requiring mitigation strategies and stress testing.
    - Climate related disclosure requirements.
    - Technological innovations: battery, EVs, storage, Clean-Hydrogen, etc.
- Transition strategy, stranded assets, and carbon emission commitments.
- Is there a timeline and strategy in place to achieve net zero carbon emissions?

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Thank you!