Assessing multisector near-term transition and longer-term physical climate risks of greenhouse gas emissions pathways

Financial institutions' investment and lending portfolios could be affected by both physical climate risks stemming from impacts related to increasing temperatures, and from transition climate risks stemming from the economic consequences of the shift to a low-carbon economy. Here we present a consistent framework to explore near term (to 2030) transition risks and longer term (to 2050) physical risks, globally and in specific regions, for a range of plausible greenhouse gas emissions and associated temperature pathways, spanning 1.5-4^{o}C levels of long-term warming. We draw on a technology-rich, regionally disaggregated Integrated Assessment Model representing energy system, agricultural and land-based greenhouse gas emissions, a reduced complexity climate model to simulate probabilistic global temperature changes over the 21st century, and a suite of impacts models to estimate regional climate-related physical hazards and impacts deriving from the temperature change pathways and their underlying socio-economics. We consider 11 scenarios to explore the dependence of risks on both temperature pathways, as well as socio-economic, technology and policy choices. This builds and expands on existing exercises such as the Network for Greening the Financial System (NGFS).

By 2050, physical risks deriving from major heatwaves, agricultural drought, heat stress and crop duration reductions depend greatly on the temperature pathway. By 2030, transition risks most sensitive to temperature pathways stem from economy-wide mitigation costs, carbon price increases, fossil fuel demand reductions and potential stranding of carbon-intensive assets such as coal-fired power stations.

The more stringent the mitigation action, the higher the abatement costs and sector-specific transition risks. However, such scenarios result in lower physical climate hazards throughout the century.

Our study also explores multiple 2 deg C pathways which demonstrate that scenarios with similar longer-term physical risks could have very different near-term transition risks depending on technological, policy and socio-economic factors. As such, "a single scenario will not answer all questions".

No.	Name	Details
1	No Policy	No new policies from 2010
2	NDC Pledges	NDCs to 2030
3	2C Central	Paris Agreement compliant transition from 2025. Socio-economics based on second shared socio-economic pathway (SSP2[19]). Full technology portfolio.
4	2C NDCs	NDCs to 2030, then rapid mitigation towards a 2°C target
5	2C Fragmented	Different start dates of 2°C-consistent action, with some countries going early e.g. EU, US, and others going later e.g. China Russia, Brazil, India.
6	2C SSP1	Alternative underlying socio-economics to 2C Central scenario, focusing on greater resource efficiency & energy efficiency, utilising the SSP1[20] dynamics
7	2C SSP3	Underlying socio-economics (the third shared socio-economic pathway – SSP3[21]) consistent with a more challenging mitigation scenario that may require greater disruption and transition risk.
8	2C RES	As 3, but with higher renewables (wind and solar)
9	2C NUC CCS	As 3, but with higher nuclear and CCS
10	2.5C	As 2C Central (i.e. scenario 3), but orderly, coordinated transition to higher temperature outcome (2.5°C)
11	1.5C	As 2C Central (i.e. scenario 3), but orderly though ambitious coordinated transition to lower long-term temperature (1.5°C)

(a)

(b)

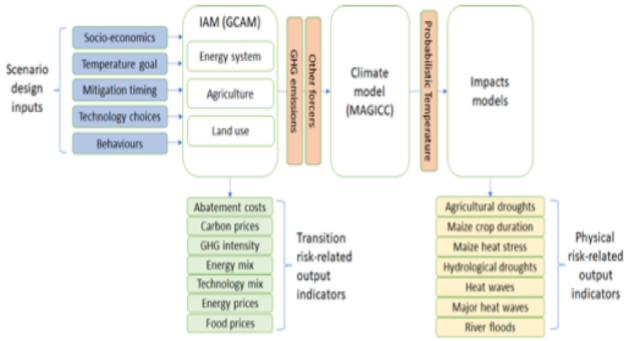
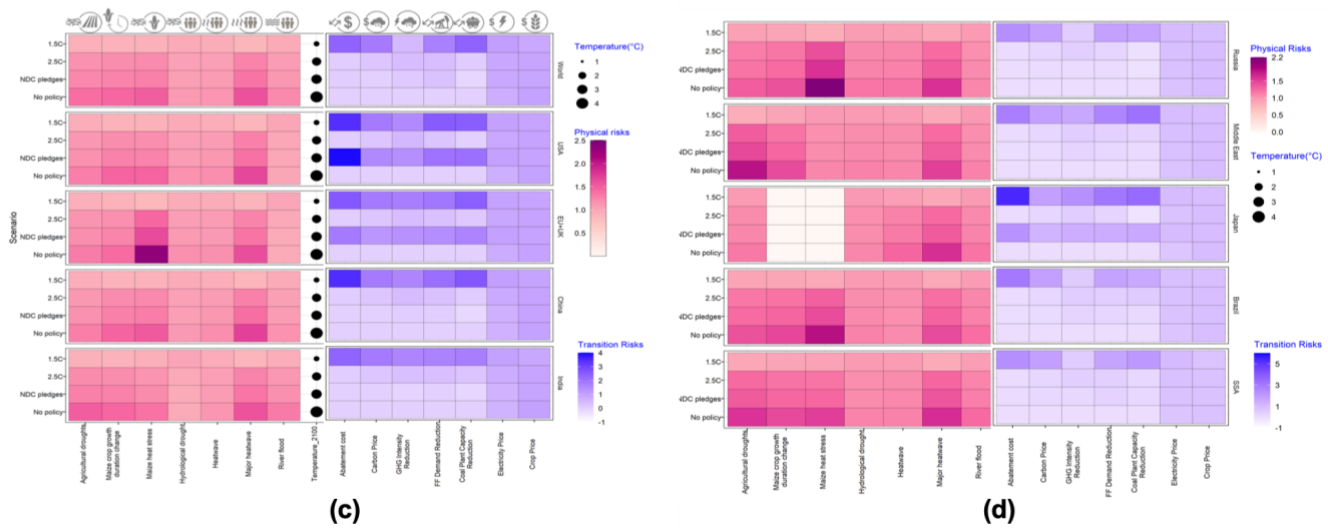


Fig. (a) Scenarios and pathways modelled in our study and (b) the model set-up to produce physical and transition risk-related output indicators for each scenario



(c) (d)

(c) Physical and transition risk metrics for world and four major regions (d) and for 5 additional major regions *. Each heat map shows 7 physical hazard metrics on the left-hand panel and 7 transition risk metrics on the right-hand panel. The physical hazard metrics are produced in a distribution and medians are shown here. The metrics (for both physical and transition risk metrics) are expressed as a ratio of each scenario's value and the value for the 2C Central scenario. Each transition risk metric is for the year 2030, whereas each physical risk metric is for the year 2050. Circle size indicates 2100 median temperature increase on pre-industrial (1850-1900) levels in each temperature scenario*