Integrating impacts in mitigation pathways analysis reinforces need for ambitious climate action

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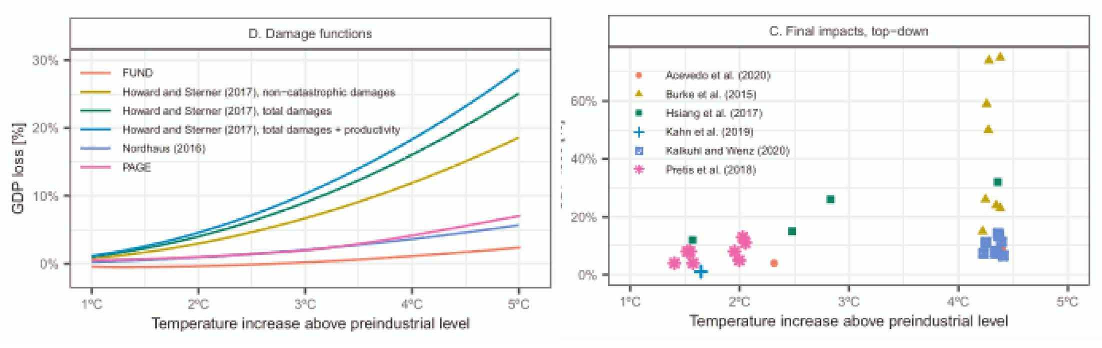
Economic impacts of climate change are …

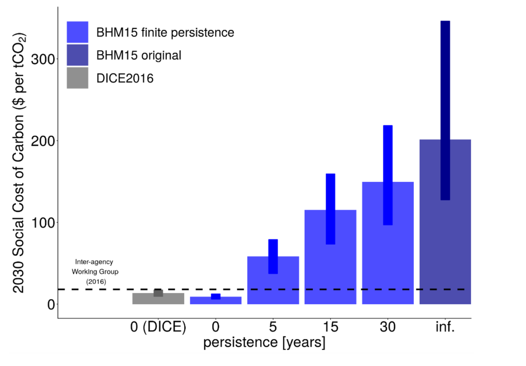
… likely higher than previously assumed, and more uncertain

Recent state-of-the art damage estimates have increased compared to previously applied damage functions as for example in the widely used DICE model. This is driven by two main advances:

- Detailed bottom-up process-based modeling
- Assessing the persistence of damages over longer periods of time, e.g. through effects on the growth rate of output rather than the level



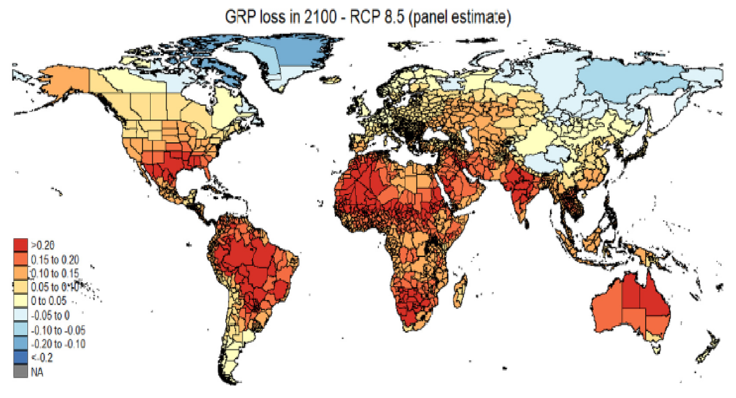
Standard damage functions (top panel) compared to recent empirical estimates taking into account growth-rate effects (bottom panel). (Piontek et al. 2021)



The persistence of damage increases strongly the social cost of carbon on cost-benefit modeling. (Schultes et al. 2020)

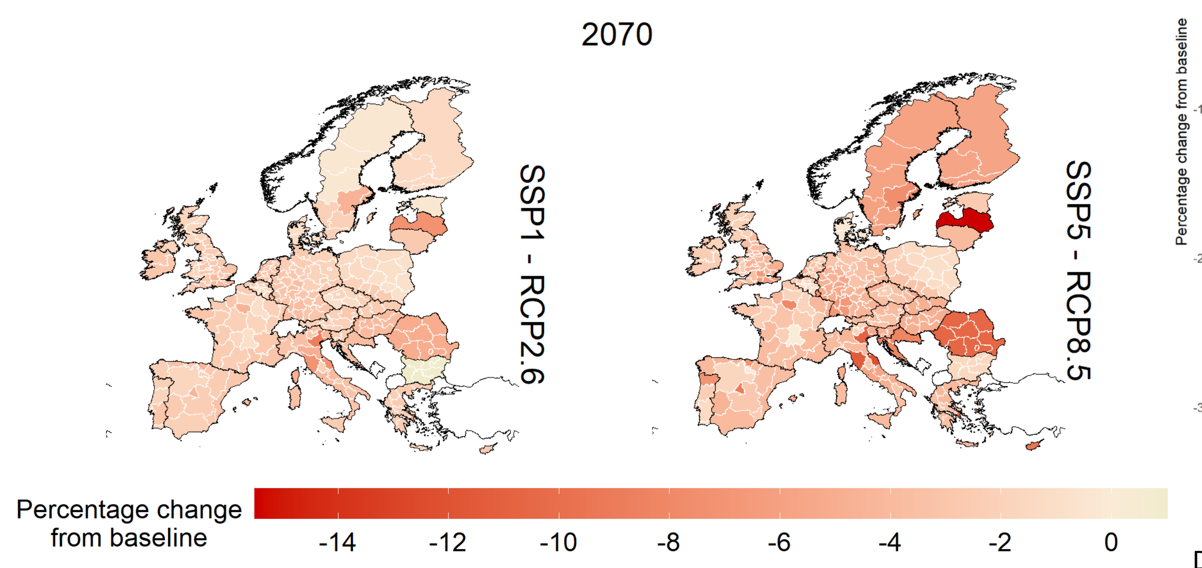
… very heterogeneous

- Warming levels vary strongly across the world, driving heterogeneity of impacts
- In-between country inequality is increased as cooler regions might experience lower or even positive effects
- Estimates based on top-down empirical assessments only include productivity effects of temperature

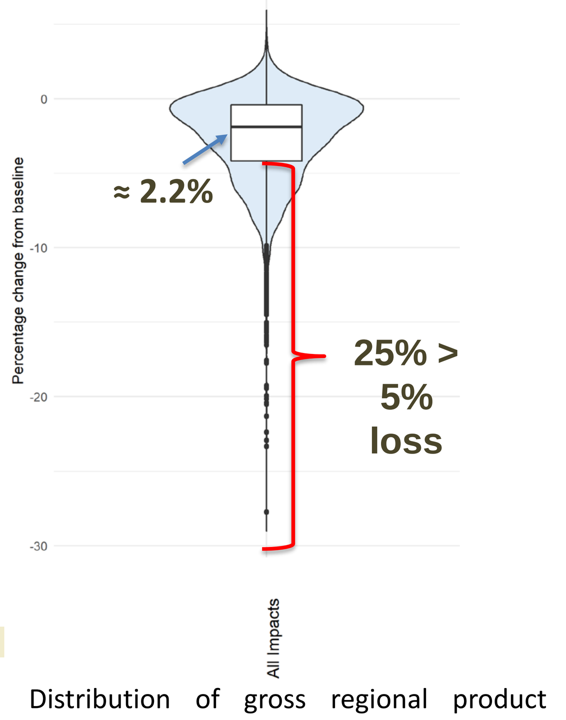


Output loss in 2100 under RCP8.5 warming compared to present day (Kalkuhl & Wenz 2020).

In addition to the more evident "between country" heterogeneity, recent research emphasizes important "within country" heterogeneity, pointing to the likelihood of high losses in gross regional product also in more moderate warming scenarios and in developed areas.



Gross regional product losses due to climate change in the EU in 2070 in SSP1-RCP2.6 (left) and SSP5-RCP8.5 (right). Impacts implemented jointly: agriculture, fishery, forestry, infrastructure and transportation (river & sea-level rise flooding), energy supply and demand, labour supply. Source: H2020 COACCH project



Distribution of gross regional product losses due to climate change in the EU in 2070. Full range of uncertainty: Results pool 9 different combinations of SSP1,2,3,5 and RCP2.6,4.5,6.0,8.5, "climate" and "model uncertainty". Note that the 2.2 average value hides losses >5% for 25% of EU regions. Source: H2020 COACCH project

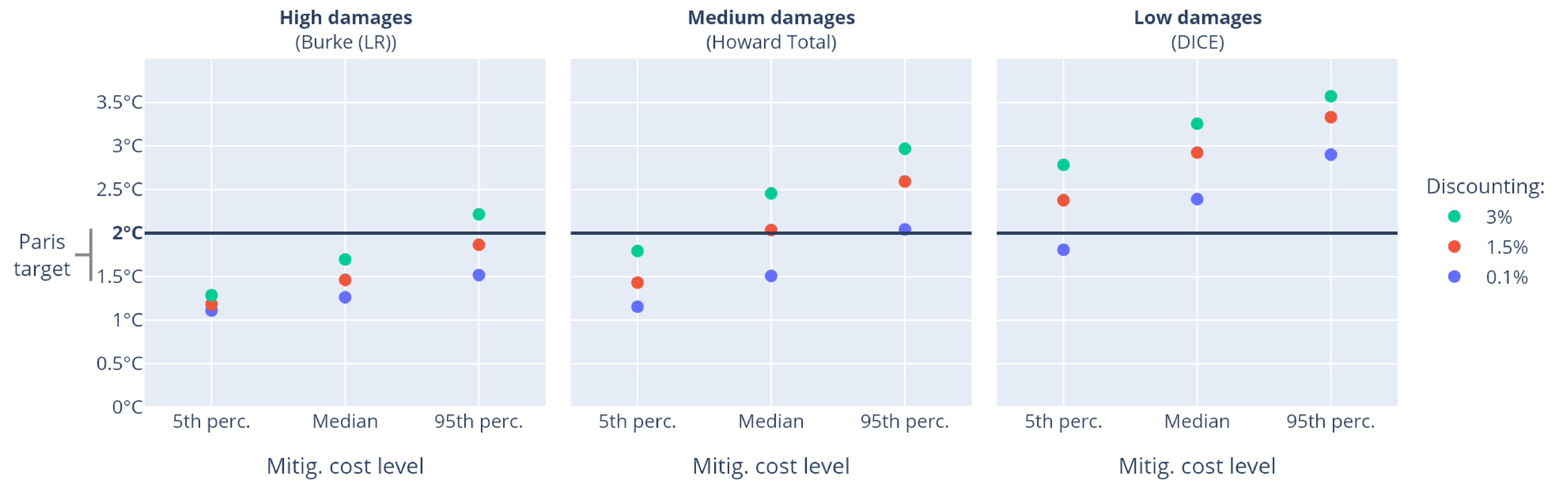
Accounting for impacts leads to more stringent mitigation

➢ Cost-benefit optimal temperature in line with Paris Agreement

- Benefits (reduced residual damage costs) significantly larger than the related mitigation costs when limiting global temperature increase to 2°C, for nearly all uncertain parameter combinations.
- Cost-benefit optimal temperature target in line with the Paris Agreement for all parameter combinations except the very low damage estimations.
- 1.5˚ C is preferred over 2˚ C, from an economic point of view, when using a low discount rate (except when the climate damages are assumed to be very low).

These results are calculated using a recent simple cost-benefit model that allows to disentangle the high degree of uncertainty in key aspects for climate policy, such as climate damages, mitigation costs and socio-economic assumptions.

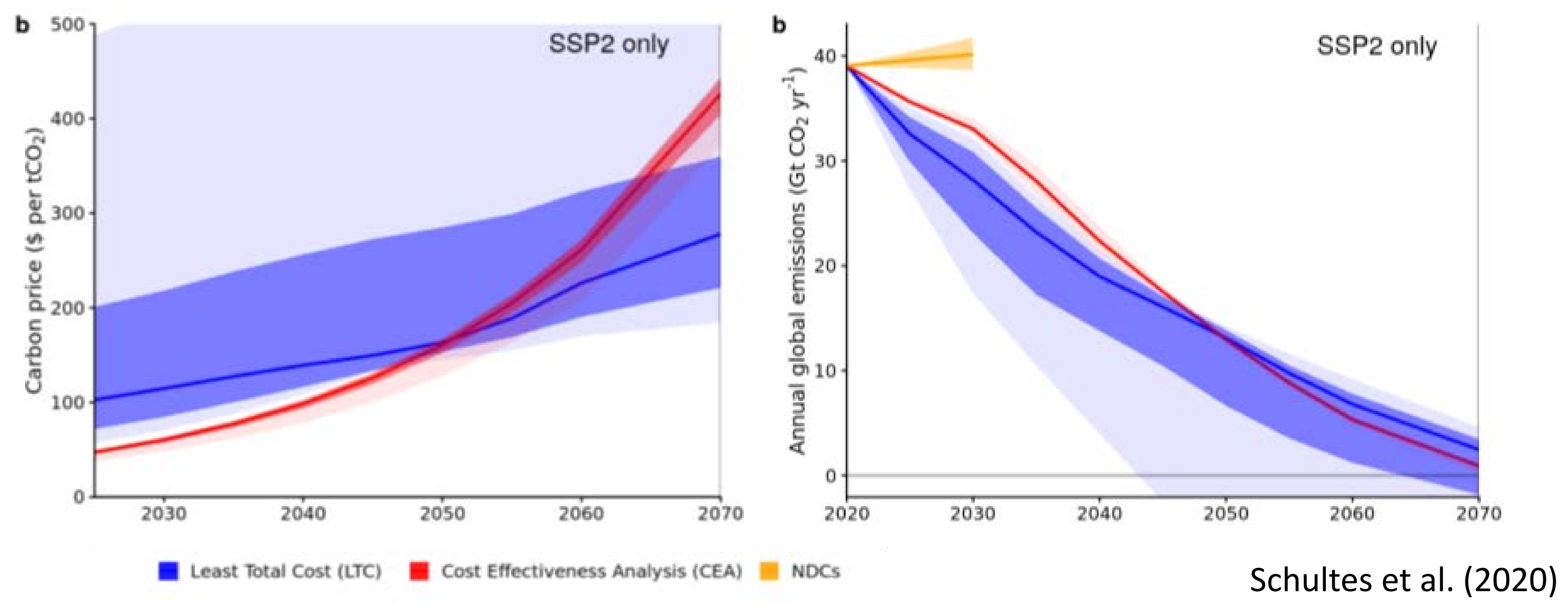
Cost-optimal temperature target in 2100



Results for SSP2 and medium climate sensitivity. *van der Wijst et al. (2021)*

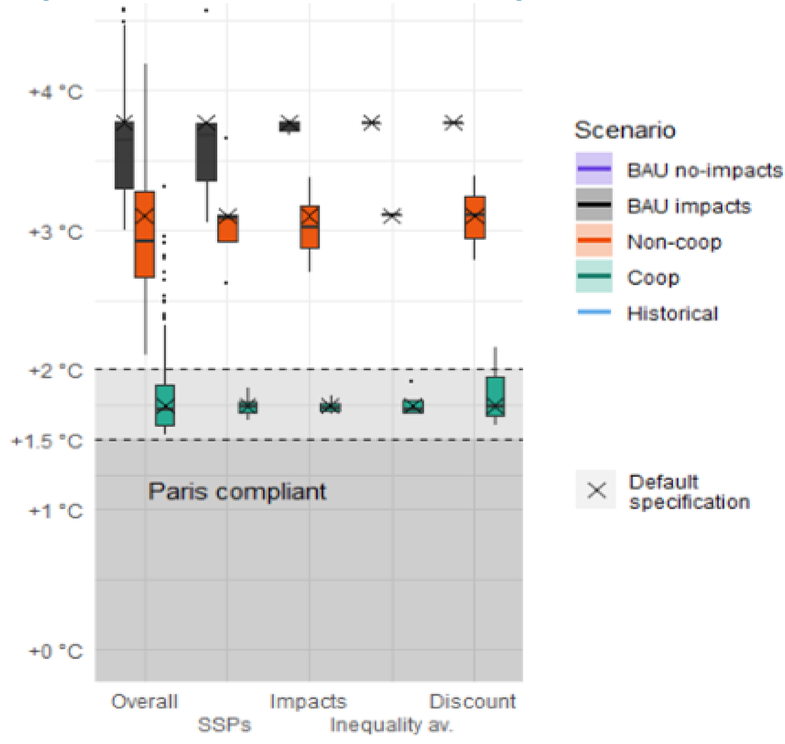
➢ Accounting for damages occurring below given temperature target increases near-term mitigation ambition

- Optimal temperatures from cost-benefit analysis are strongly determined by highly uncertain damage functions which typically do not include large-scale, irreversible disruptions or tipping points.
- Cost-effective mitigation pathways hedge against such effects through a given temperature guardrail but ignore any damages occurring below this guardrail.
- Both approaches can be reconciled in a least-total cost approach.
- Combining guardrail and damages leads to more ambitious near-term mitigation action driven by higher carbon prices.
- The gap between 2030 emissions projected under the currently pledged nationally determined contributions and the optimal pathway in a least-total cost framework is two thirds larger than when damages are not accounted for.
- Long-term carbon prices increase more gradually as less mitigation is needed in later periods to stay below the guardrail.



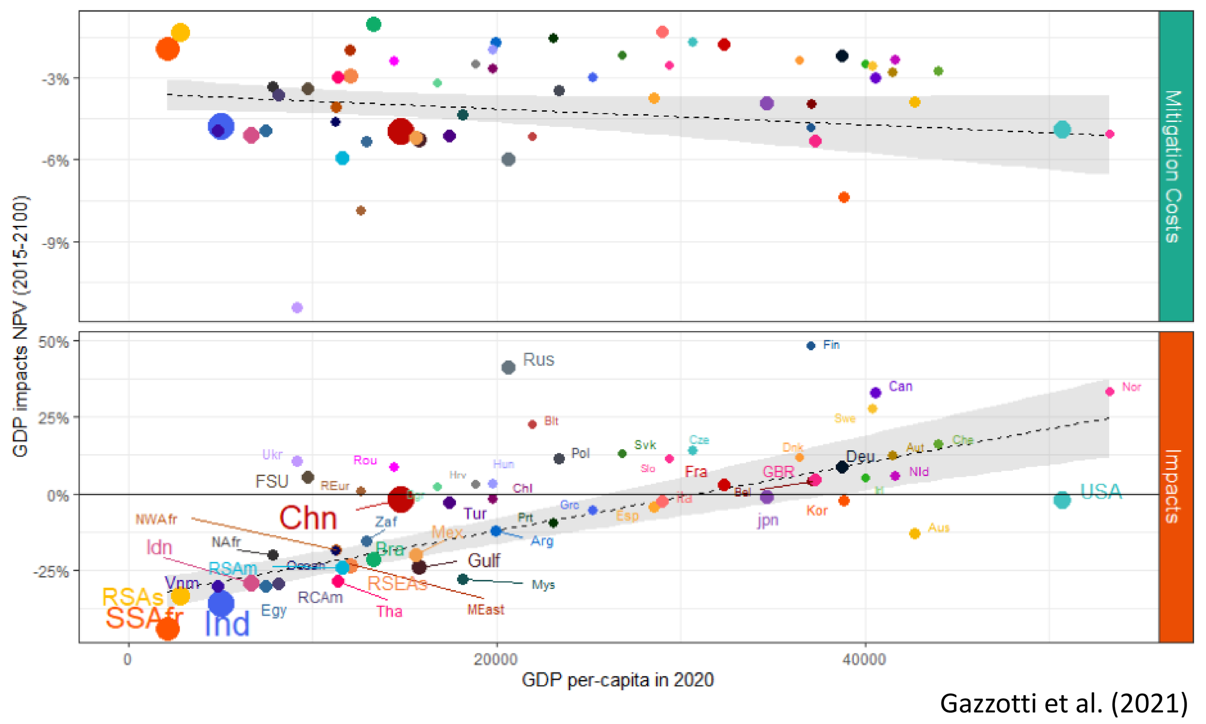
Schultes et al. (2020)

International cooperation finds achieving the Paris Agreement targets economically optimal, but climate impacts still lead to an increase of inequality between countries



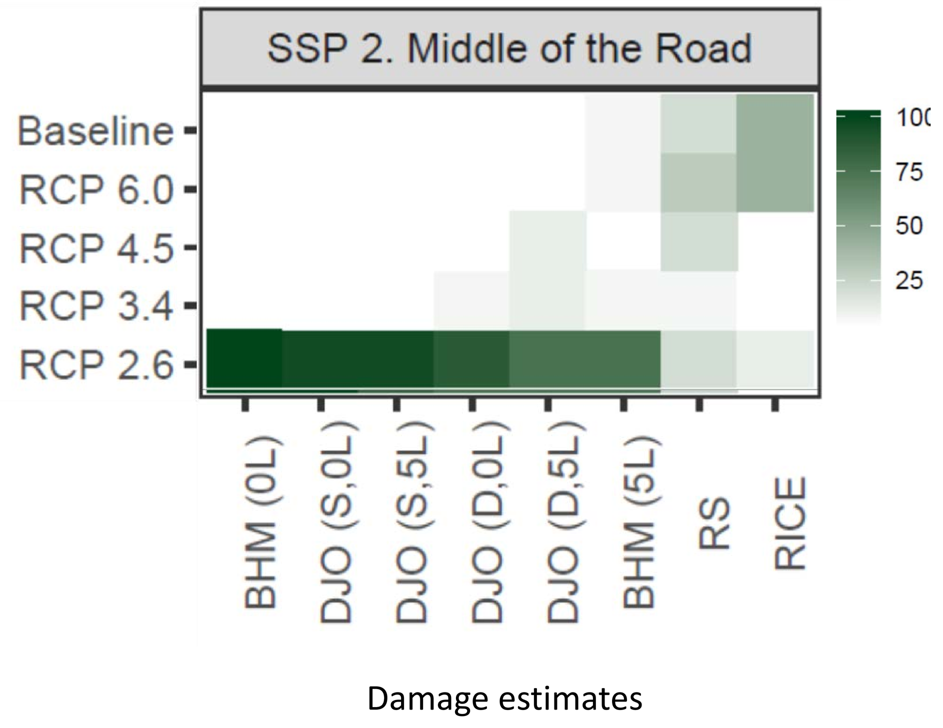
- With an almost country level version of the DICE model including impacts based on the Burke et al. (2015) specification, we compute the global optimal and self-interested non-cooperative climate outcomes.
- Cooperation stabilizes temperature within the Paris goals (about 1.80˚ C in 2100).
- If all countries act unilaterally, GMT increase is only reduced to about 3˚ C by the end of the century.
- Across countries, heterogeneity in particular of impacts is substantial, with higher damages in poorer countries.

- Nevertheless, economic inequality persists due to climate change impacts.
- The ratio between top and bottom income deciles more than doubles in 2100.
- Resilient socioeconomic development and adaptation planning and financing are crucial.
- In particular for compensating the worst affected countries.



Gazzotti et al. (2021)

More ambitious mitigation decreases inequality between countries



% of scenarios in which a given RCP is the emission pathway with the lowest inequality level (Taconet et al. 2020)

- Income convergence between countries in the 21st century will be slowed by impacts of climate change falling primarily on the poorest countries.
- Uncertainty about the magnitude of climate impacts and socioeconomic development drives heterogeneous results on the effect of climate on future inequality.
- If the economic damages from climate change are in line with the highest estimates, then warming would reverse gains in declining inequality over the past few decades. Instead, there would be a rise in inequality between countries in the course of the 21st century.
- A statistical analysis allows to identify robust results across a large range of uncertainties. In particular, emission pathways compatible with the 2˚ C target from the Paris Agreement (RCP 2.6) would limit the increase in inequality, and display the lowest inequality levels (see figure). This does not occur in scenarios combining low climate damage levels with regressively distributed mitigation costs.
- This suggests that climate change mitigation is key to limiting future inequality, provided that mitigation costs do not fall too heavily on the poorest countries.

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