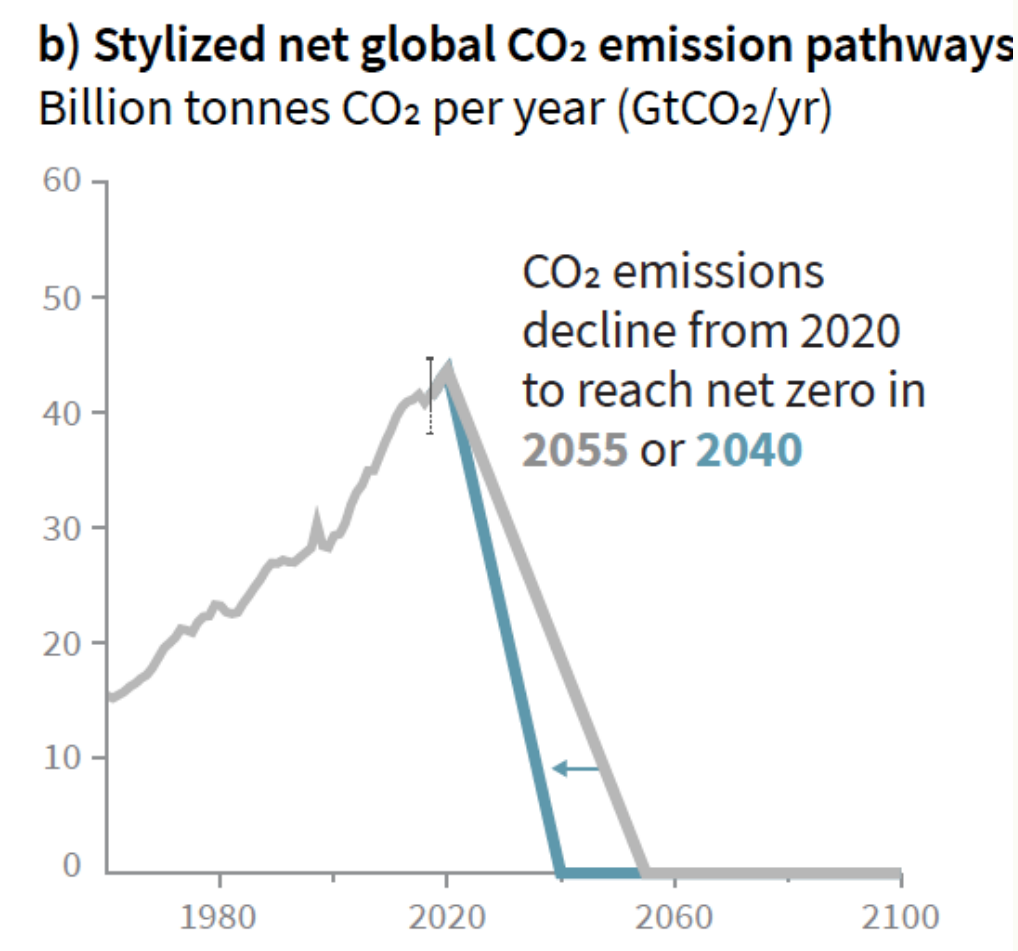
The latest climate science: Implications for accelerating the material transition

Paul Behrens, Leiden University

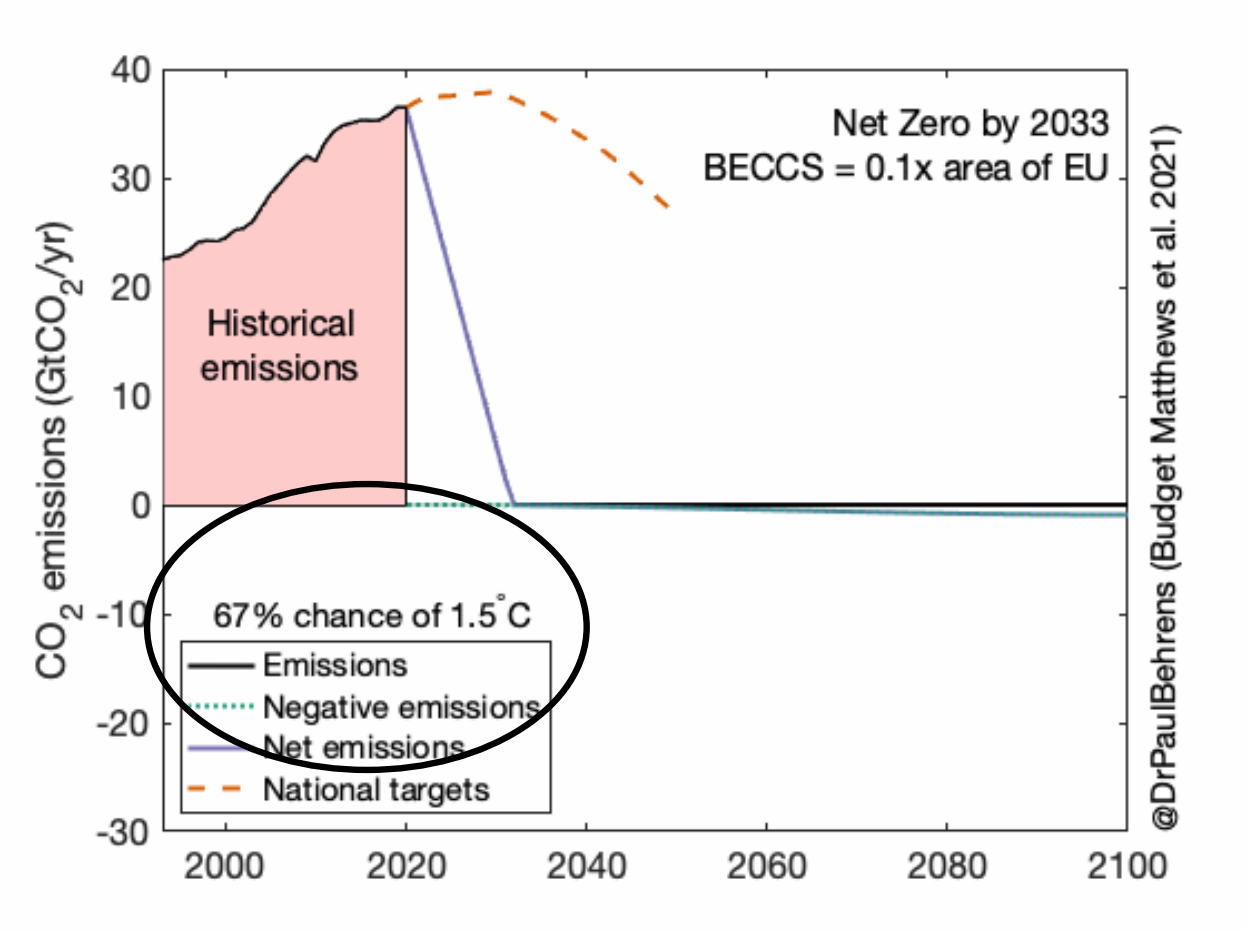
05/04/2022

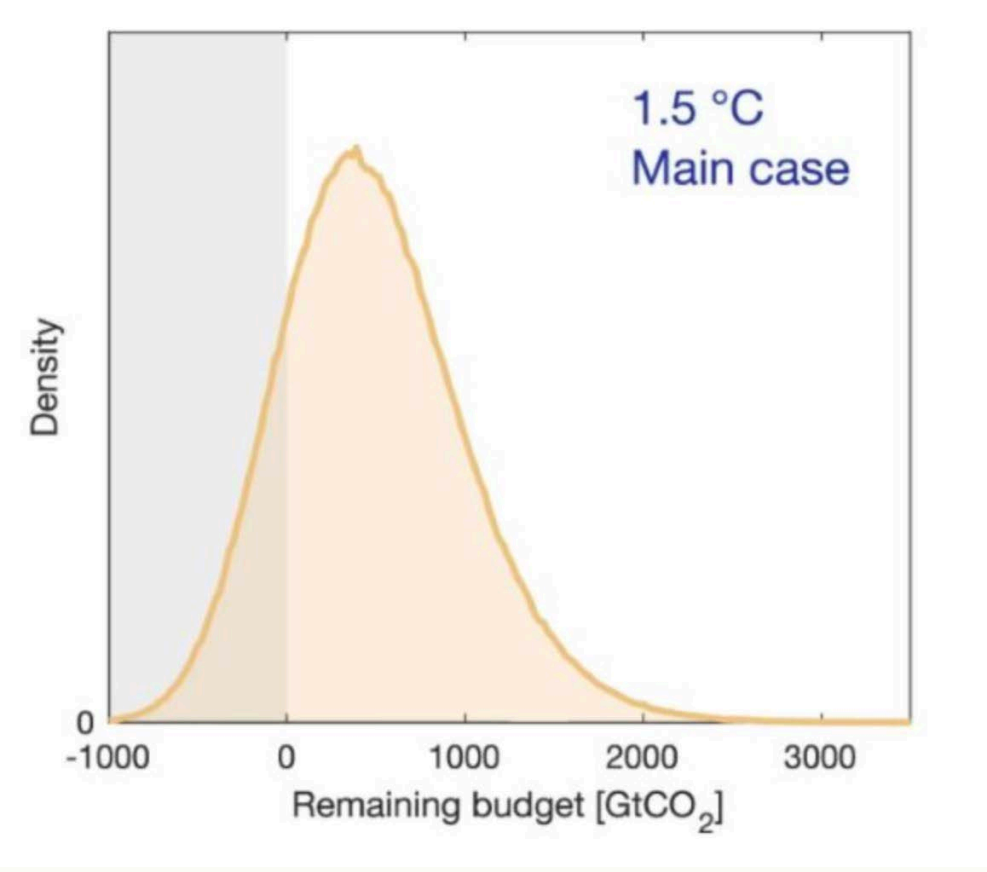
Universiteit Leiden

A reminder of the trajectory



A reminder of an uncertain future





H. D. Matthews *et al.*, An integrated approach to quantifying uncertainties in the remaining carbon budget. *Commun. Earth Environ.*, 1–11 (2020).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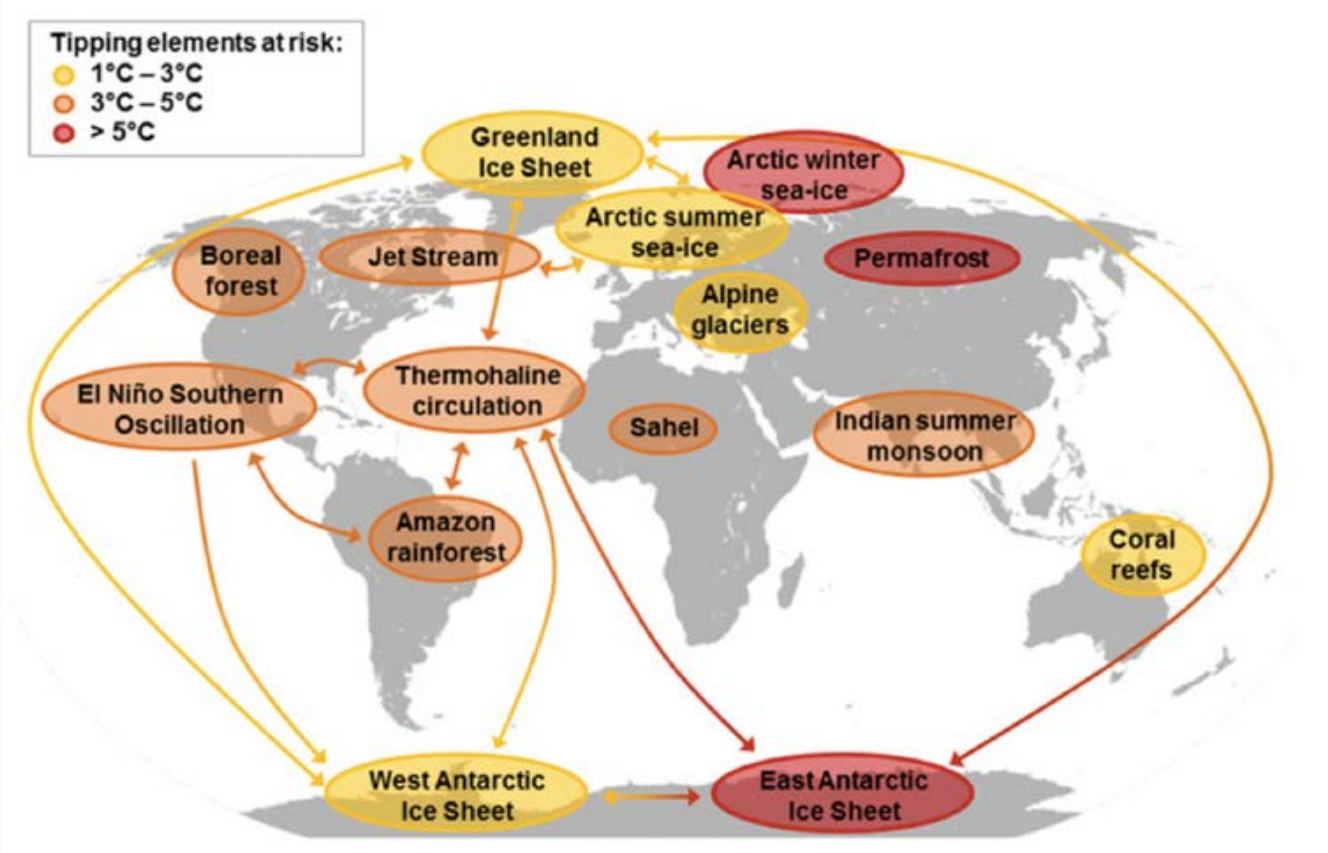
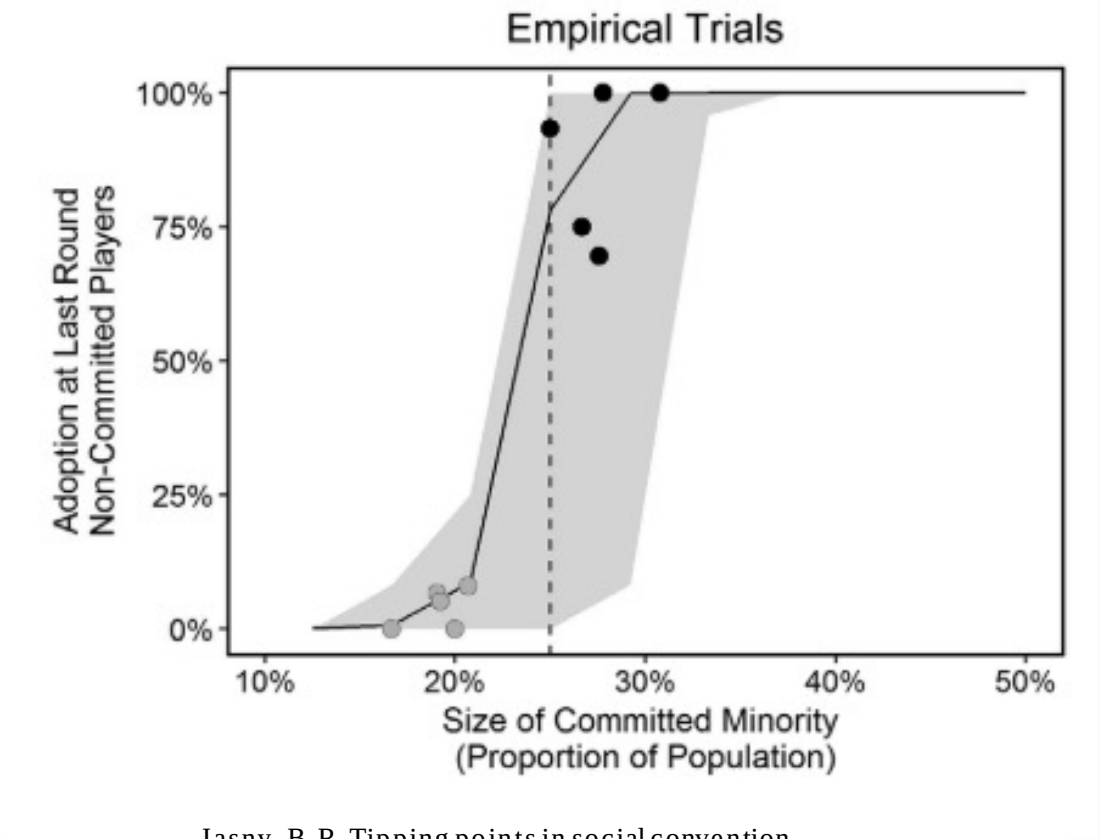
A reminder of an uncertain planet & society

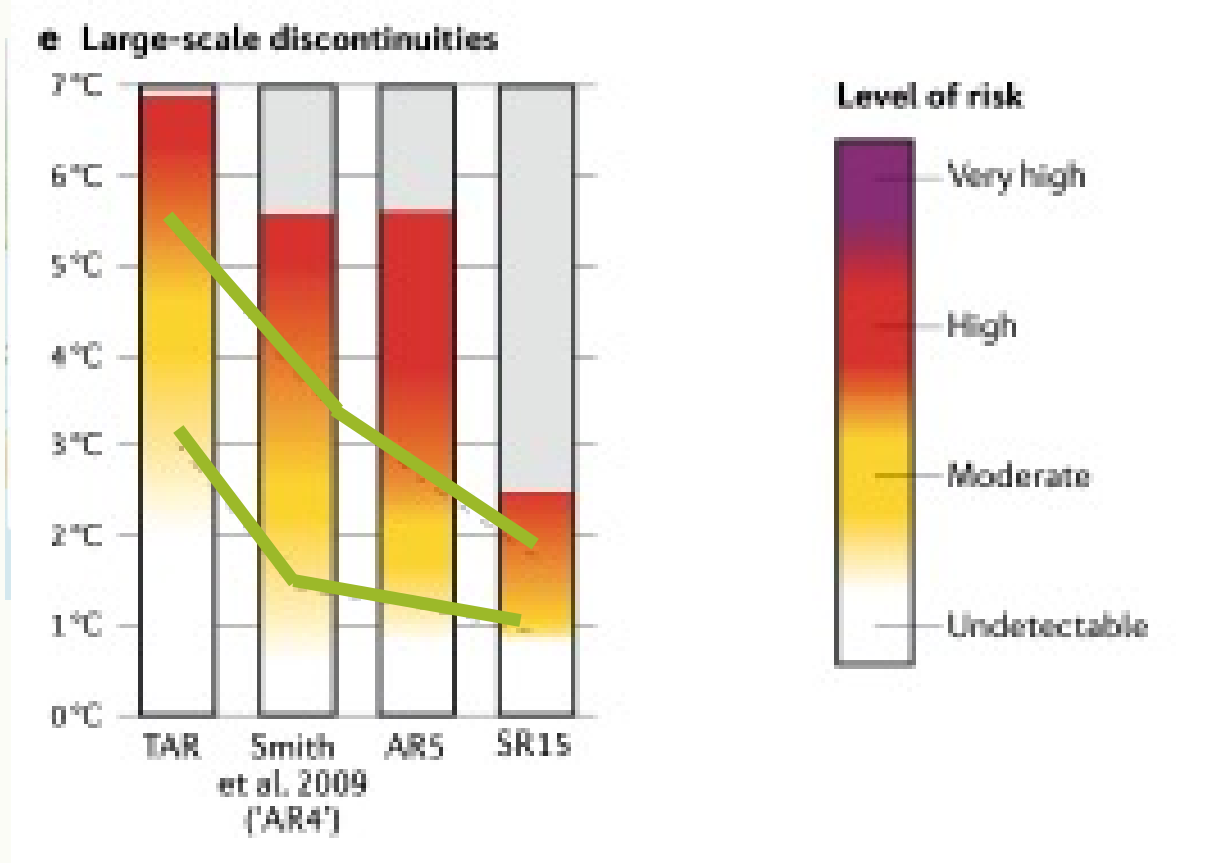


Steffen, W. *et al.* Trajectories of the Earth System in the Anthropocene. *Proc. Natl. Acad. Sci.* **115**, 8252–8259 (2018).



Jasny, B. R. Tipping points in social convention. *Science (80-.)*. **360**, 1082.4-1082 (2018).

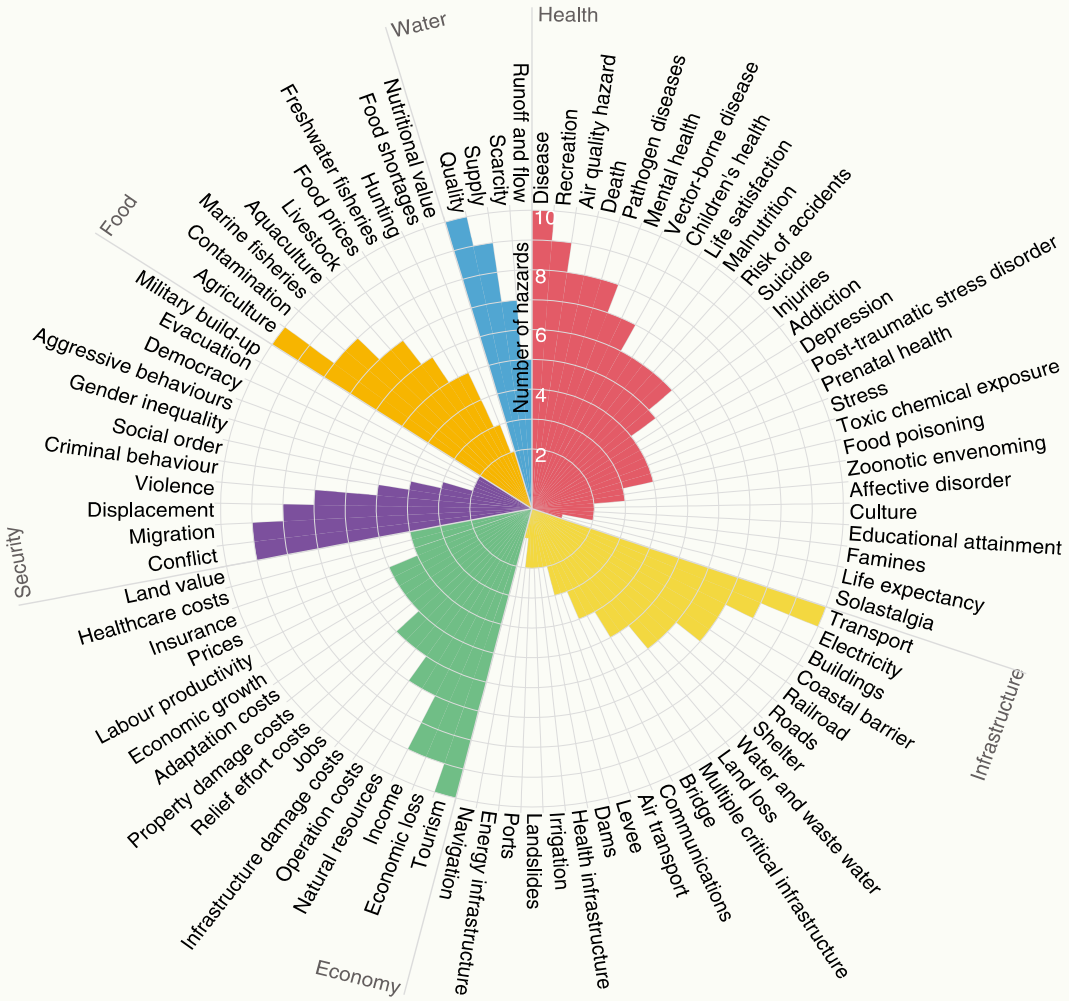
Impacts – brace yourself



P. Marbaix *et al.*, Burning embers: towards more transparent and robust climate-change risk assessments. *Nat. Rev. Earth Environ.* **1** (2020), doi:10.1038/s43017-020-0088-0.

C. Mora *et al.*, Broad threat to humanity from cumulative climate hazards intensified by greenhouse gas emissions. *Nat. Clim. Chang.* **8**, 1062–1071 (2018).

Uncertainty of social impacts are larger



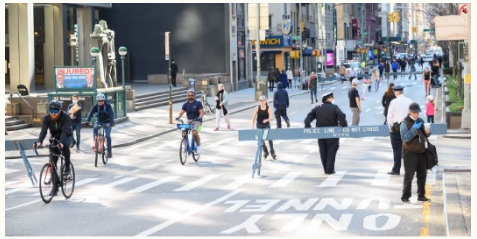
C. Mora *et al.*, Broad threat to humanity from cumulative climate hazards intensified by greenhouse gas emissions. *Nat. Clim. Chang.* **8**, 1062–1071 (2018).

"Evidence of observed impacts, projected risks [etc] demonstrate that worldwide climate resilient development action is more urgent than previously assessed in AR5."

"Beyond 2040 and depending on the level… numerous risks to natural and human systems (*high confidence*). For 127 identified key risks, assessed mid- and long- term impacts are up to multiple times higher than currently observed (*high confidence*)."

It is late in the day…
rapid transitions and priorities

Energy transition

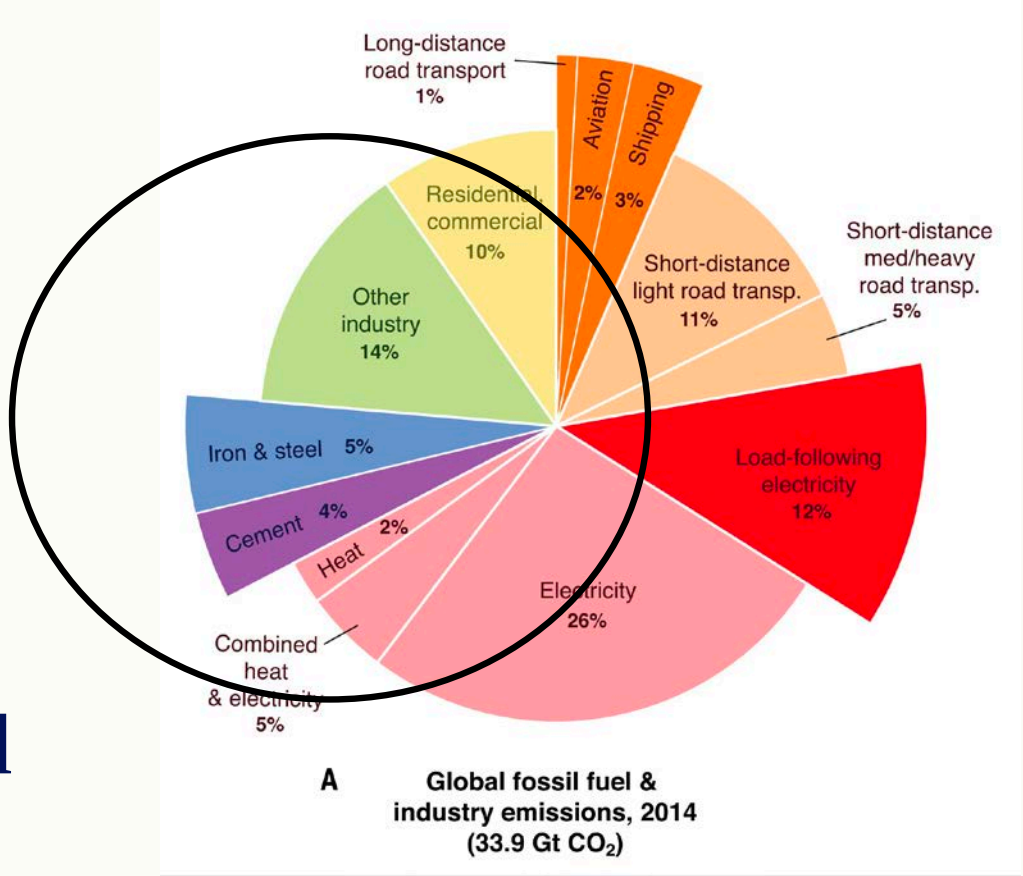


Food transition

Economic transition

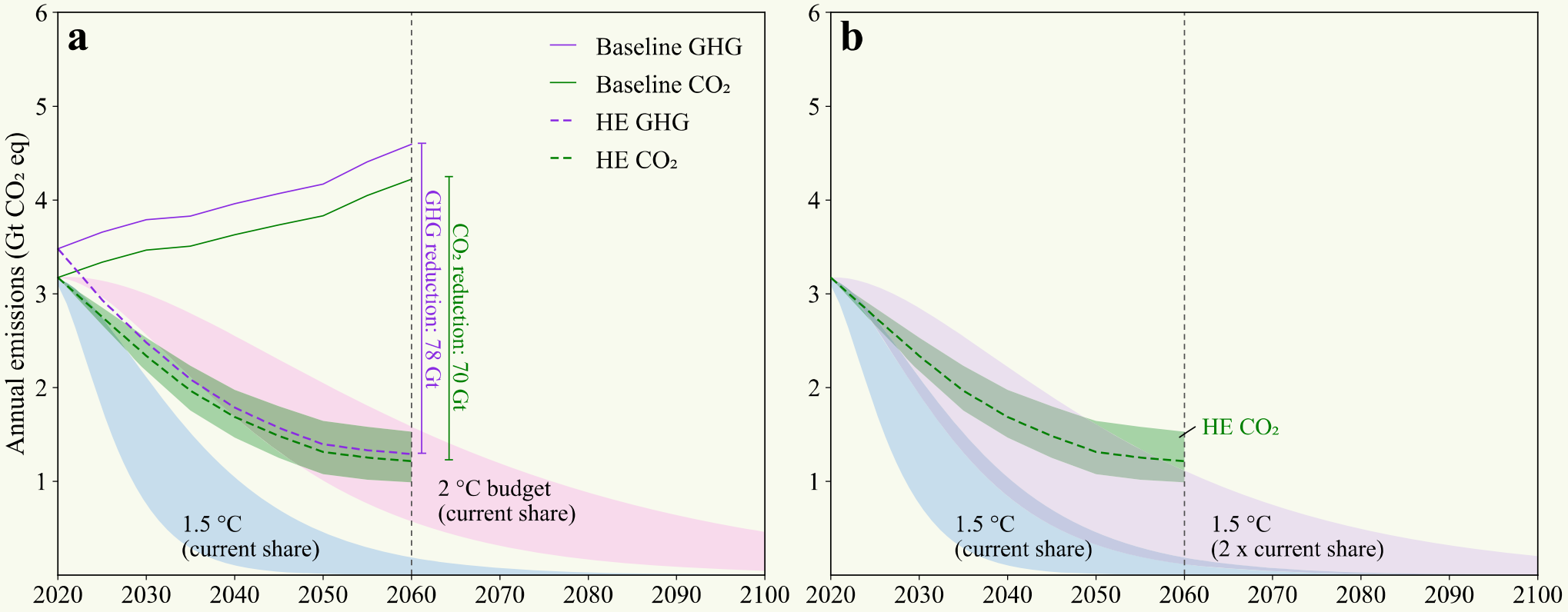
Energy Transition

- Electrify almost everything (with mostly Wind & Solar)
- Can already electrify ~70% cheaply
- Deep decarbonization is harder and materials based - but start now and it will become easier.



S. J. Davis *et al.*, Net-zero emissions energy systems. *Science (80-.).* **9793** (2018), doi:10.1126/science.aas9793.

A significant development challenge



X. Zhong *et al.*, Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060. *Nat. Commun.*, 1–10 (2021).

Possible interventions

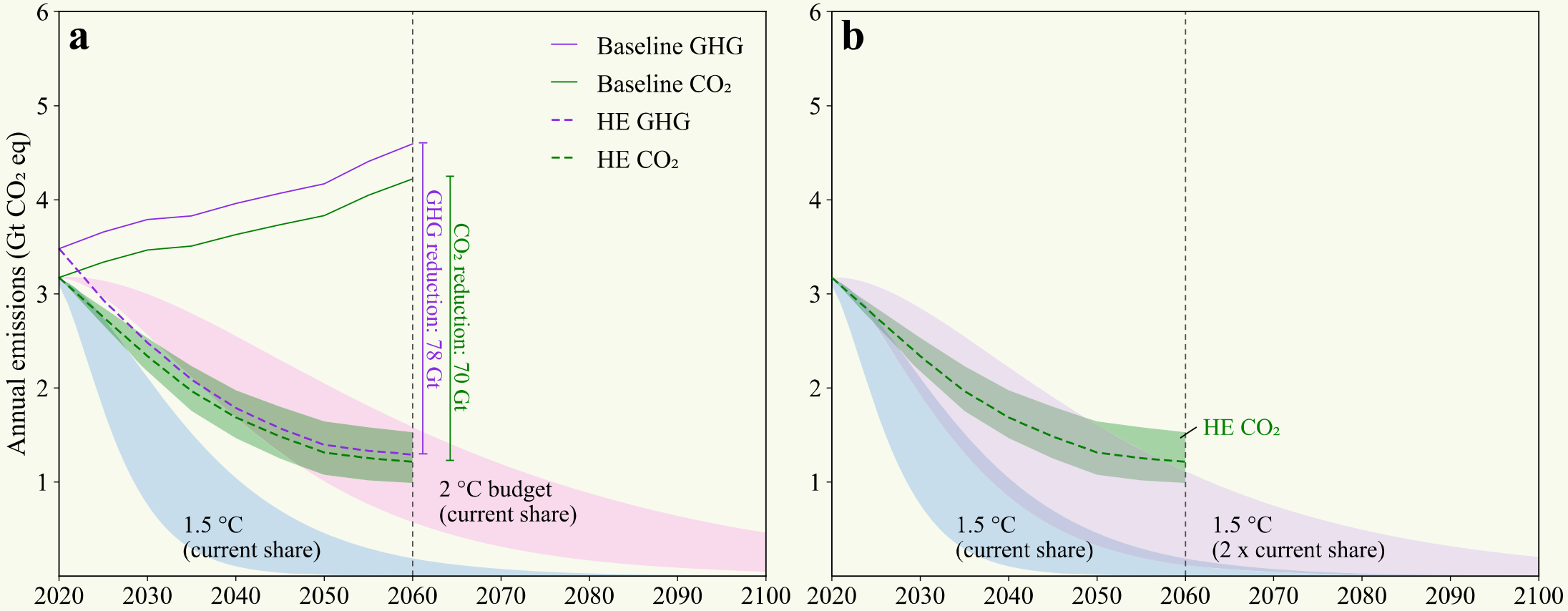
Table 1 Mitigation strategies for reducing emissions from materials required for buildings construction.

Strategies	Description
M1—More intensive use	20% lower area per person compared to 2050 baseline[29]
M2—Lifetime extension	Up to 90% lifetime extension (depending on the region and average lifetime) by 2050[29]
M3—Lightweight design	19% reduction in aluminum and steel, 10% in concrete by 2050[6, 16, 29]
M4—Material substitution	10% more timber buildings by 2050[29,37]
M5—More recovery	Maximum recycling and reuse rates estimated by 2050(recycling: 90% steel[38], 95% aluminum[26], 93% copper[39]; reuse: 15% steel and concrete[6,29])
M6—Energy transition	An energy transition consistent with the SSP2-RCP2.6[35]
M7—Production efficiency increase	Efficiency increases of material production via manufacturing improvements and process-switching (for example switching from hydrometallurgy to pyrometallurgy processes for copper production)[28,40–42]

Strategies are drawn from the literature as feasible targets (see the second column for specific references). Please see the Supplementary Information for further information.

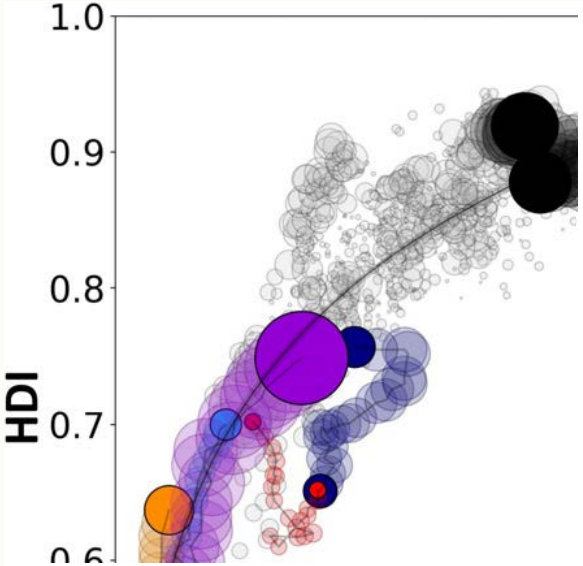
X. Zhong *et al.*, Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060. *Nat. Commun.*, 1–10 (2021).

Impact of interventions



X. Zhong *et al.*, Global greenhouse gas emissions from residential and commercial building materials and mitigation strategies to 2060. *Nat. Commun.*, 1–10 (2021).

Development models



M. Jiang *et al.*, Different Material Footprint Trends between China and the World in 2007-2012 Explained by Construction- and Manufacturing-associated Investment. *One Earth*. **5**, 109–119 (2022).

Not only a climate change challenge

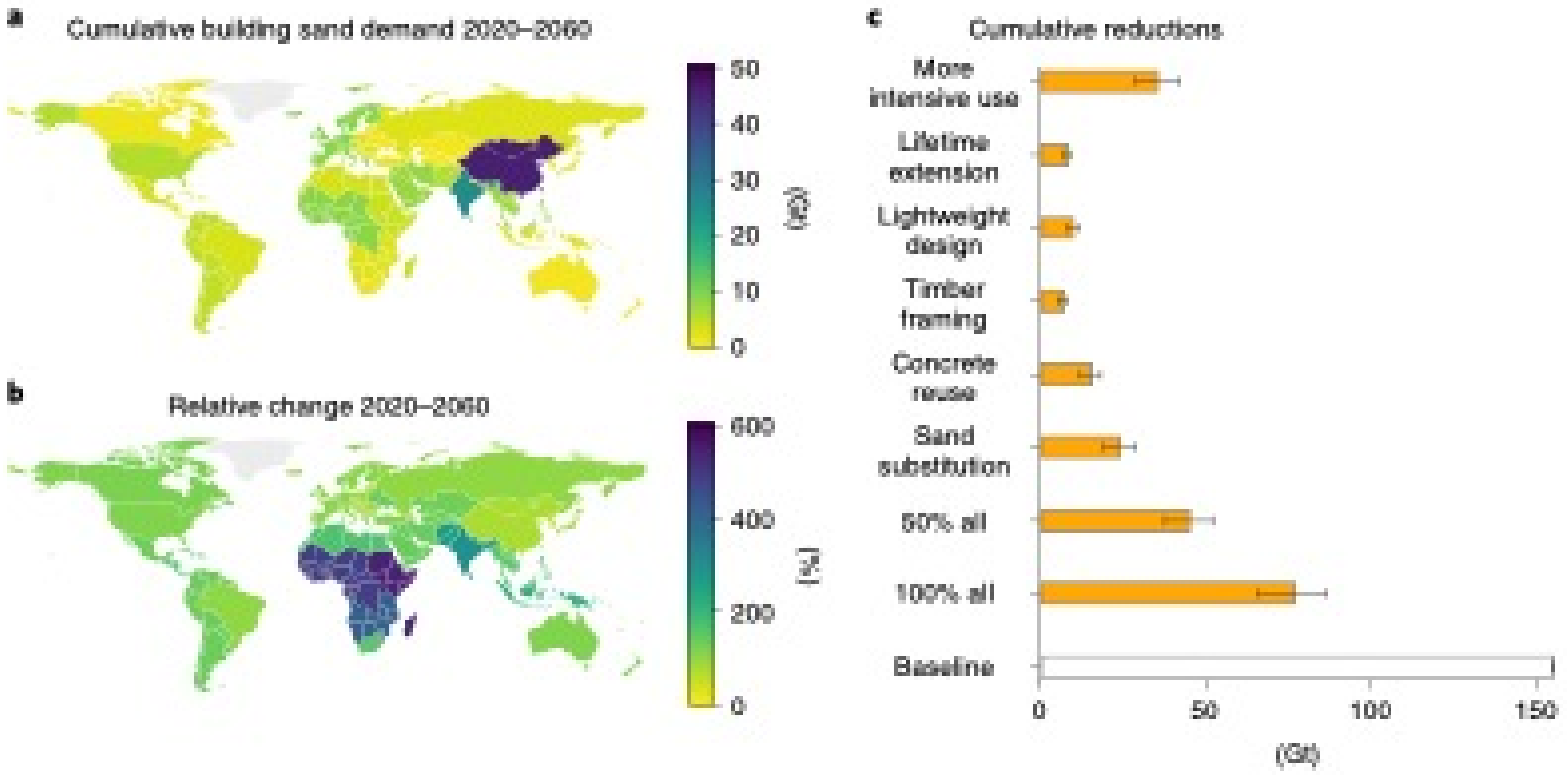
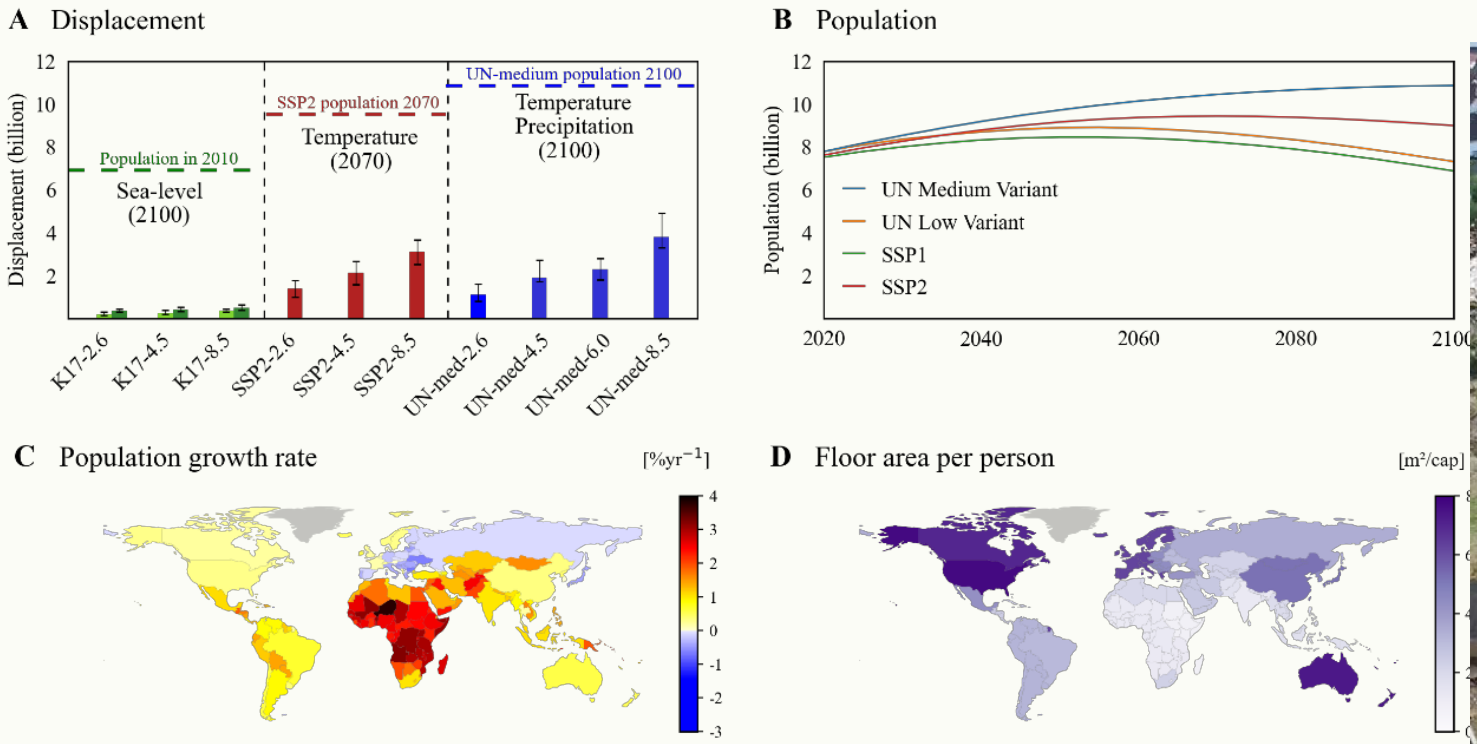


Fig. 1 | Building sand use and reduction scenarios in world regions. a, Cumulative building sand use during 2020–2060 under the baseline scenario. **b**, Baseline building sand use in 2060 relative to 2020. **c**, Cumulative sand reductions from material efficiency interventions. The whiskers represent the sensitivity intervals given by 20 percentage point variations for each strategy.

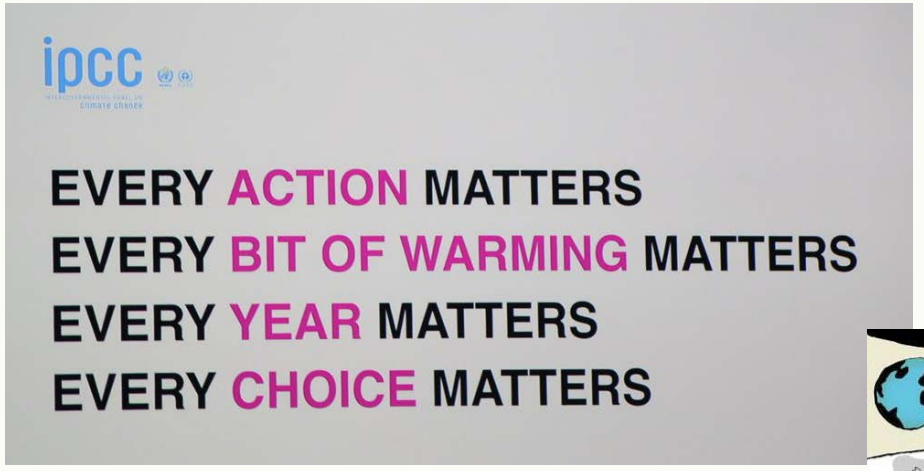
X. Zhong, S. Deetman, A. Tukker, P. Behrens, Increasing material efficiencies of buildings to address the global sand crisis. *Nat. Sustain.* (2022), doi:10.1038/s41893-022-00857-0.

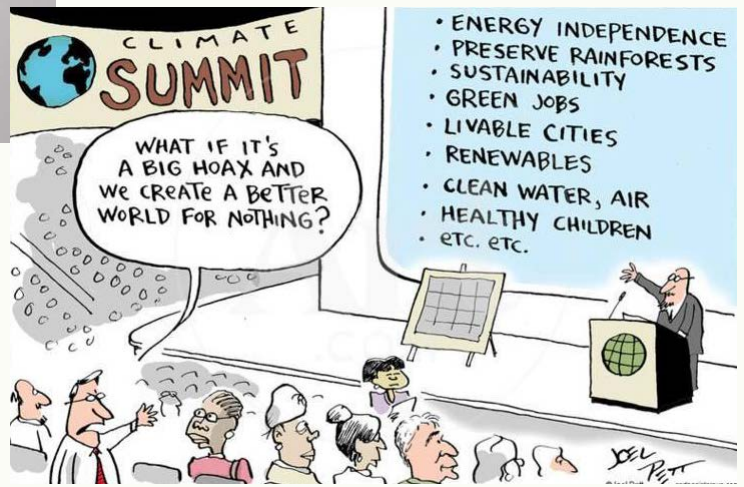
Thinking big picture

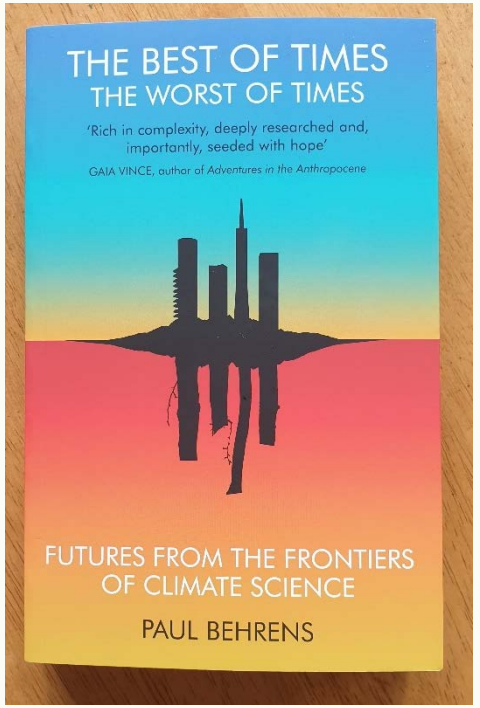


Communication at this unique time in history

Be honest, alarm people, give solutions, act, build hope







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