Climate justice and equity in integrated assessment models

some reflections

Take home message

- There is a misalignment between the information produced by IAMs and the observed decision needs

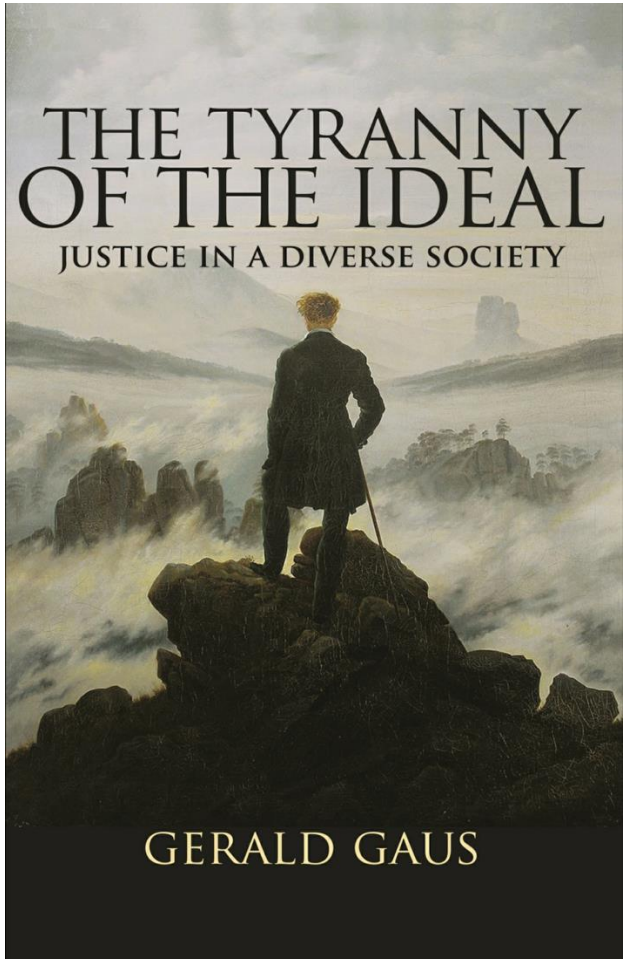
- To address this misalignment
  - Use existing models differently
  - Change what and how we make models
  - Enhance the diversity of modeled perspectives

The lack of attention for climate justice

- Justice, fairness, and equity concerns are central to many urgent social challenges
- Inequality is a threat to state stability and democracy
- IAMs do not consider climate justice and inequality

The need to engage with philosophy

- For questions on behavior, modelers increasingly know to talk with social scientists
- Questions of justice have been debated for over 2500 years
- Recent philosophical work on justice engages with decision-analysis ideas and models
  - Rawls uses game theory
  - Gaus speaks of multidimensional fitness landscapes
  - Sen is an economist and philosopher
  - Social contract arguments based on ABMs



Normative uncertainty

- Situations where there are different partially morally defensible -- but incompatible -- options or courses of action, or ones in which there is no fully morally defensible option. (Taebi et al 2020)

- Complex or ill-structured decision problems cannot be exhaustively captured by a single framing of the problem
- Values are diverse across people and change over time

→ Normative uncertainty is intrinsic to sustainability science

Perspectival diversity

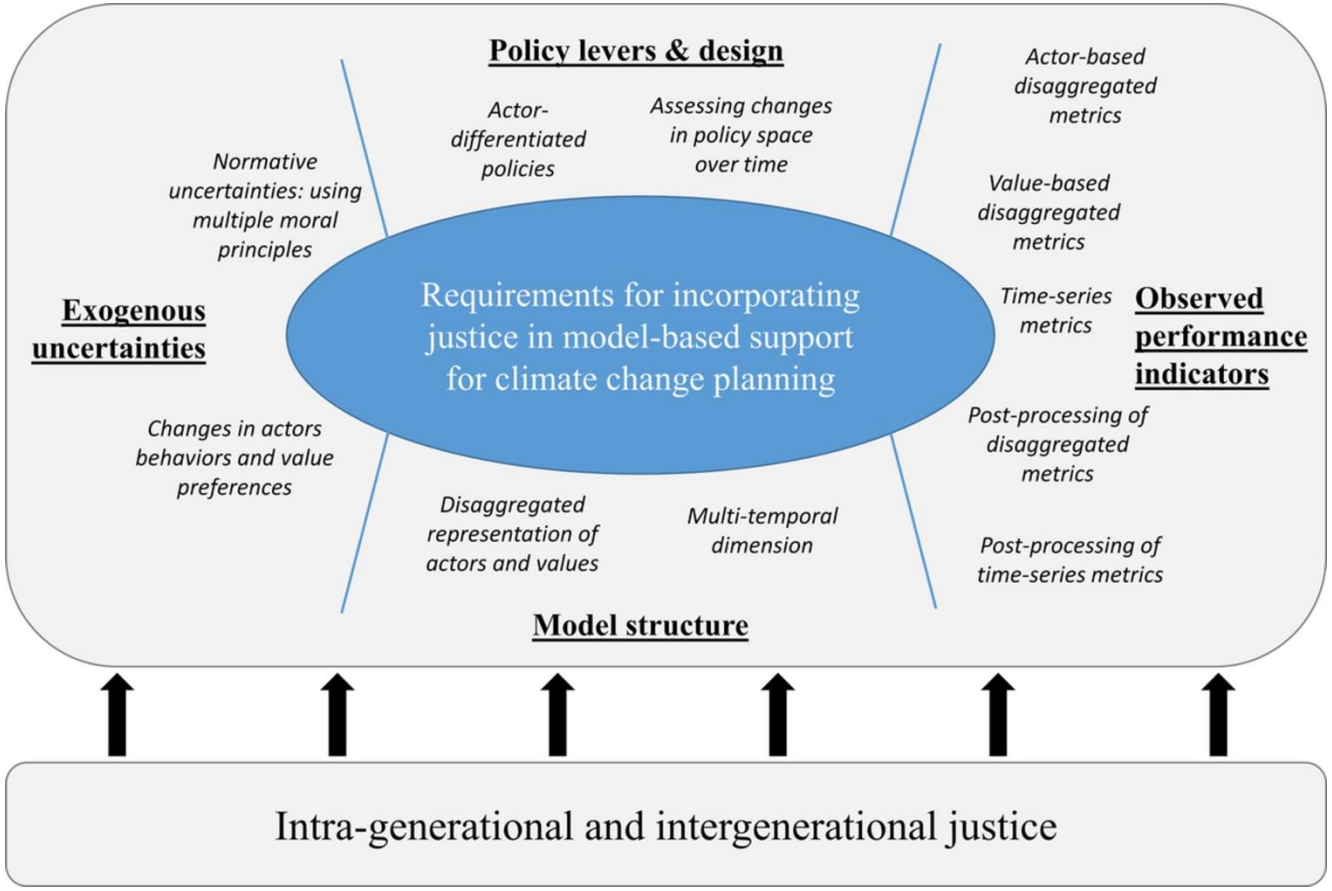
So how to approach questions of justice and equity through models?

1. Use existing models differently

- Existing models have legitimacy and are trusted
- But are often limited in how they are used
- So
  - Shift from single-objective (linear) optimization to multi-objective simulation optimization (Lamontagne et al. 2019)
  - Rival framings (Quinn et al. 2017)
  - Large-scale computational what-if experimentation (i.e., exploratory modeling)

2. Change what and how we model

- Need for disaggregation
- Diversify the outcomes of interest
- Rival theories and conceptualizations;
  - E.g., who has used a model to project future changes in the human well-being index?



Jafino et al. 2021

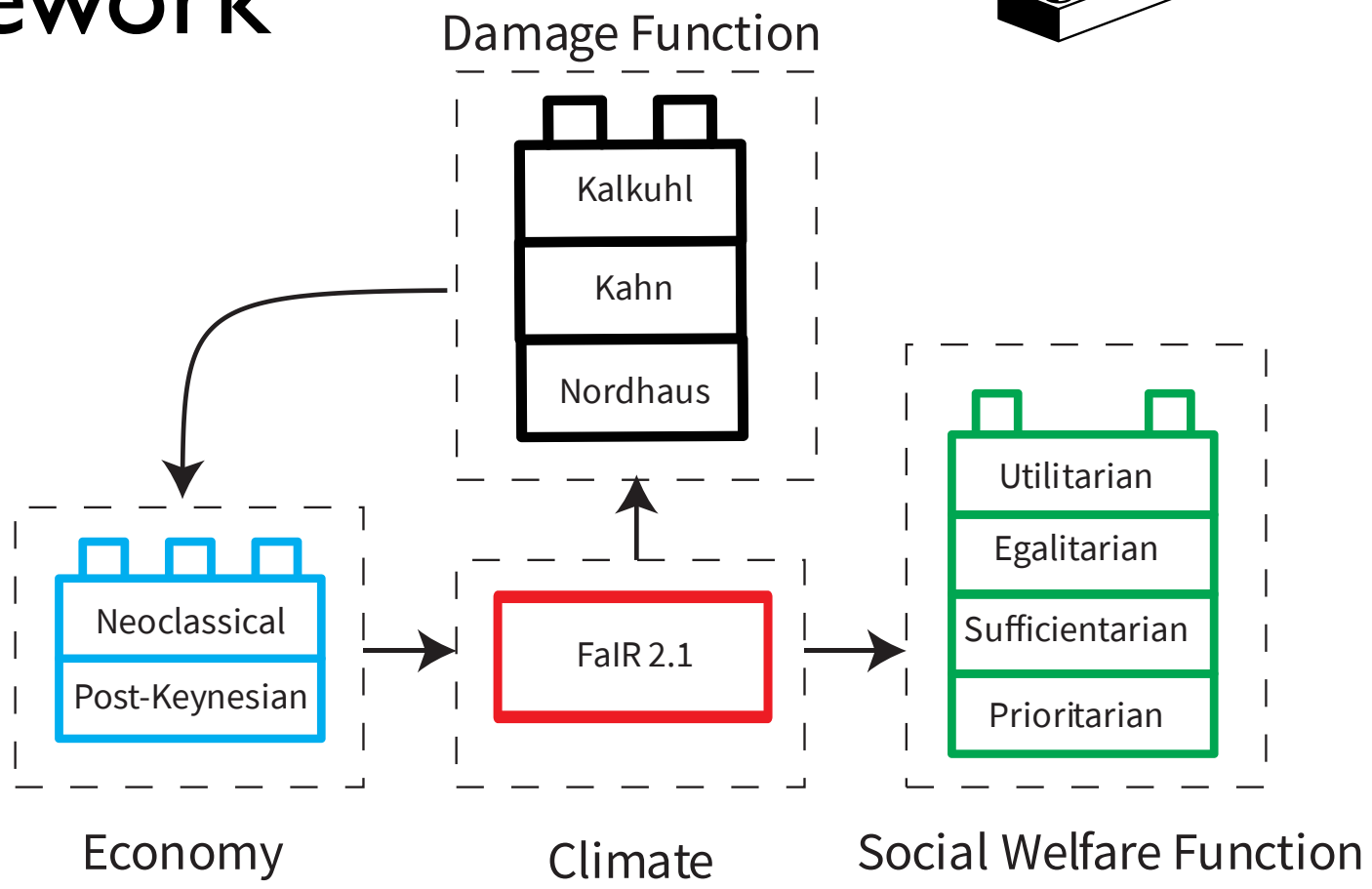
3. Implications of Perspectival diversity

- A single model run is groping in the dark
- An ensemble from a single model is only marginally better
  - e.g., the real value of IAMs comes from the ensemble of IAMs where each IAM is built on different theoretical foundations and intuitions
- Use rival framings (Quinn et al. 2017) to analyze a policy problem from multiple deliberately distinct perspectives
  - e.g., analyze different social welfare functions and see if there are options that rank among the best across all social welfare functions (Ciullo et al 2020)

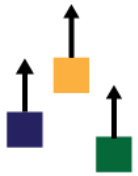
- Identify differences that make a difference

JUSTICE IAM Framework

- *Modular* Simulation-Optimization Model Framework
- *Efficient* Python based computation *for* multi-objective policy optimization under deep uncertainty
- Built-in support for *MOEA and RL* for (solvers)

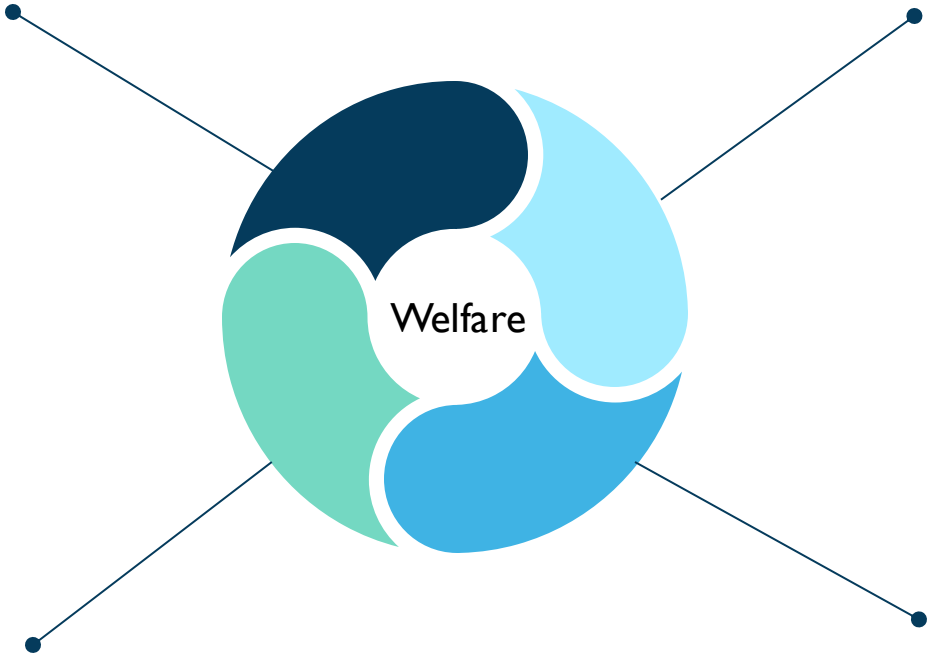


Encoding Equity: Social Welfare Functions



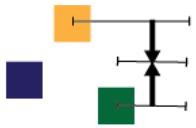
UTILITARIAN

Maximizes the sum of utility without taking distribution into account



SUFFICIENTARIAN

Maximizes the sum of utility above a sufficientarian threshold



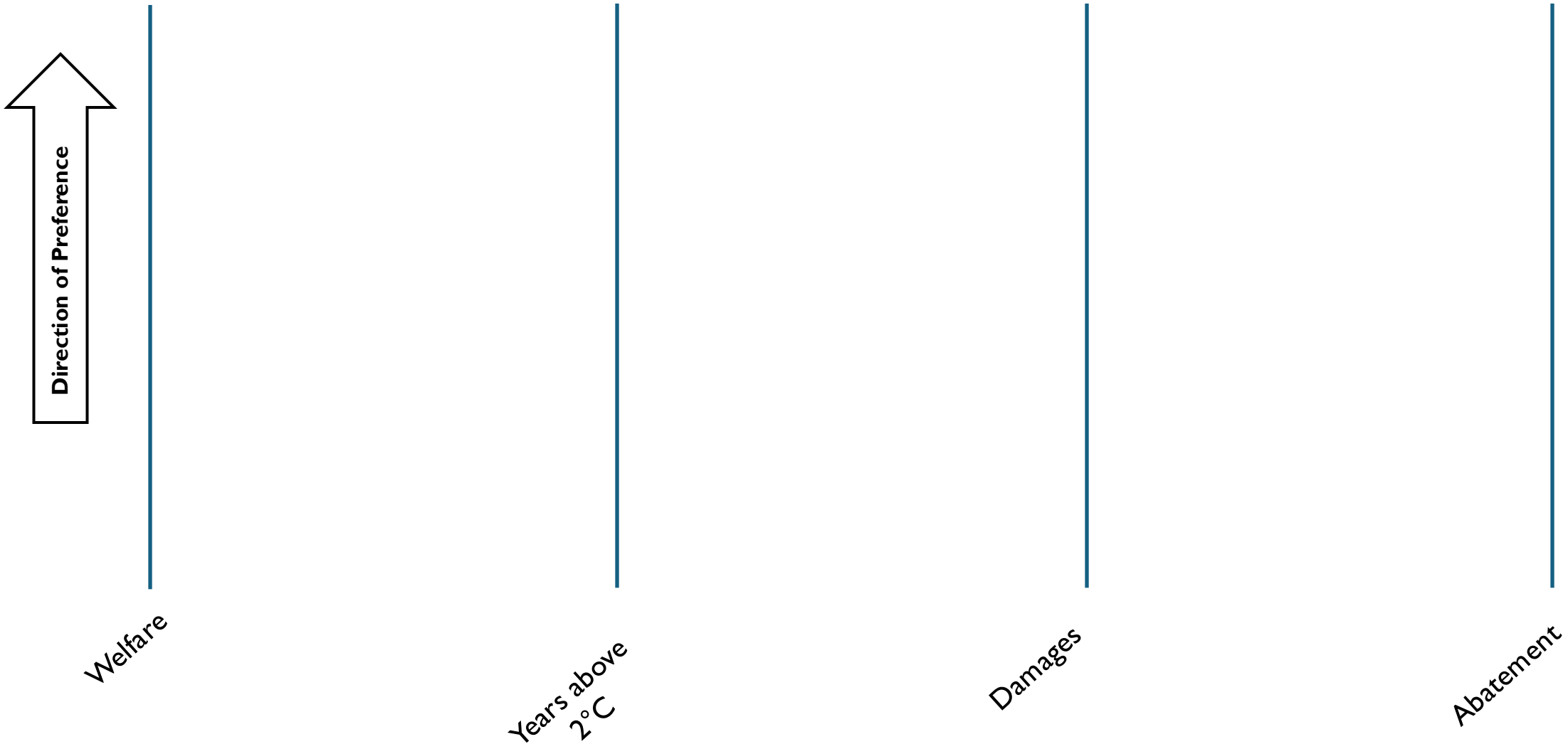
EGALITARIAN

Focuses purely on the distribution of welfare based on inequality index

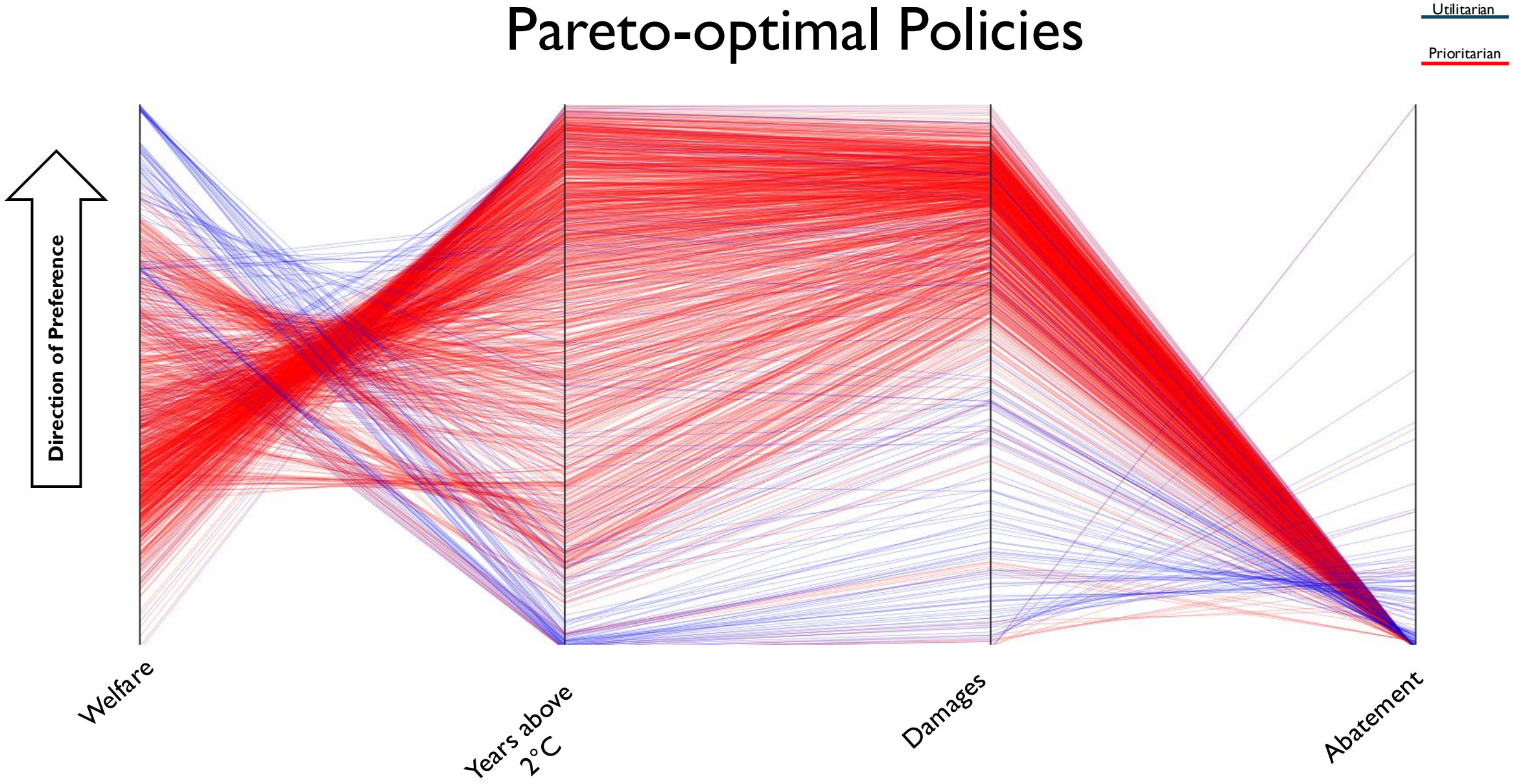
PRIORITARIAN

Prioritizes the welfare of the least well-off

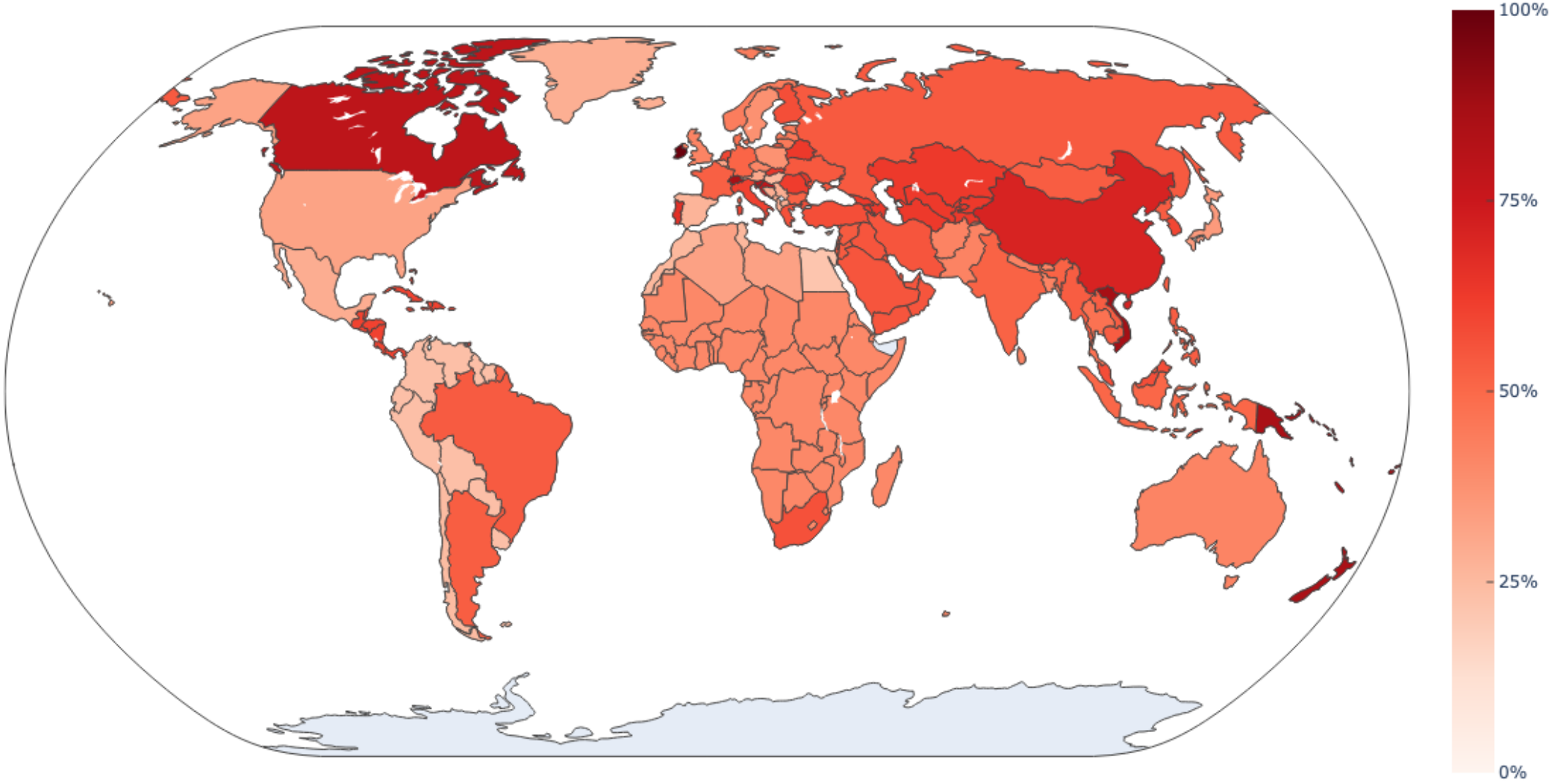
Multi-objective Formulation



Pareto-optimal Policies

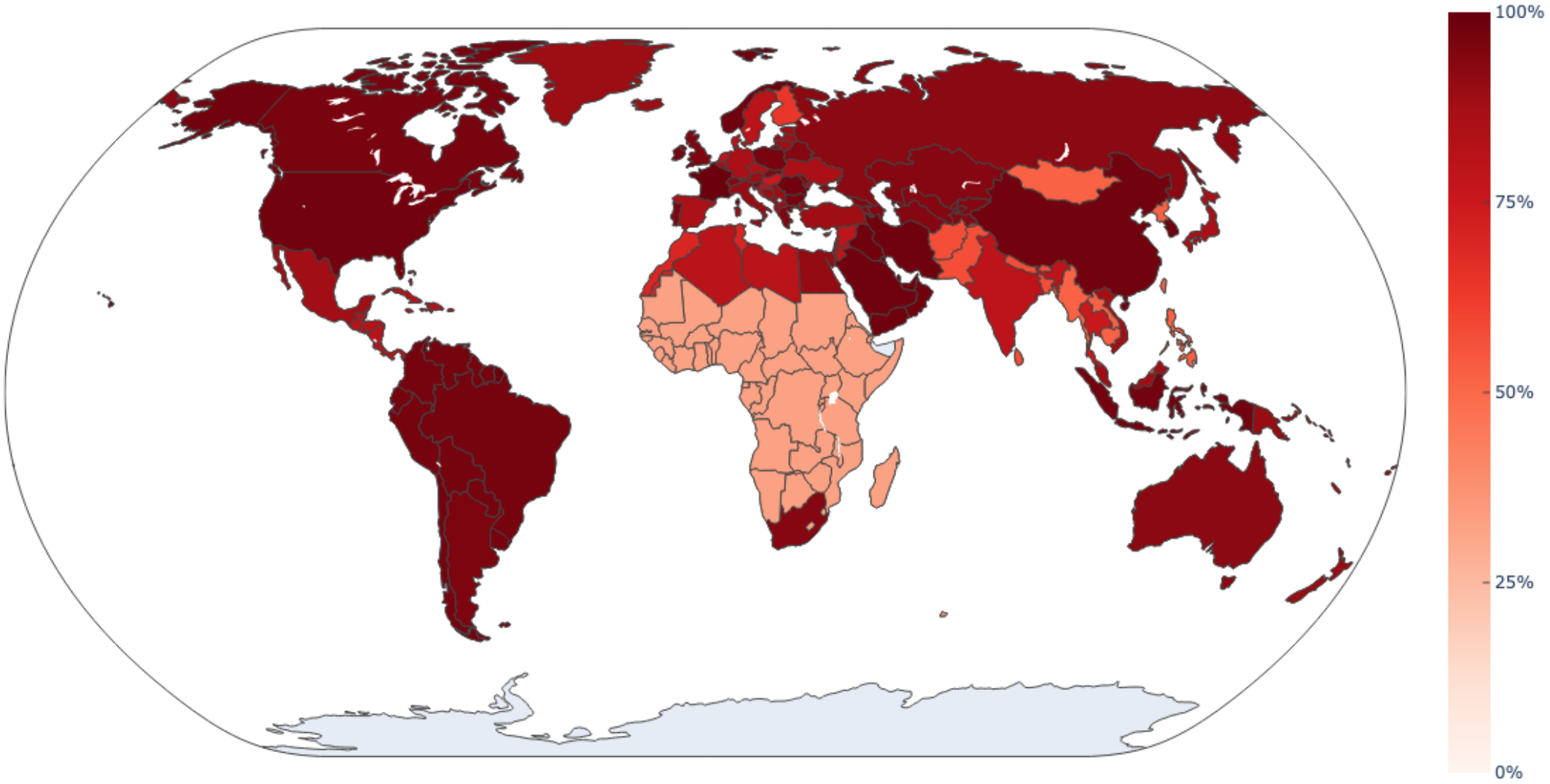


Distribution of Mitigation Burden in 2050 – Utilitarian



SSP2
RCP4.5

Distribution of Mitigation Burden in 2050 – Prioritarian



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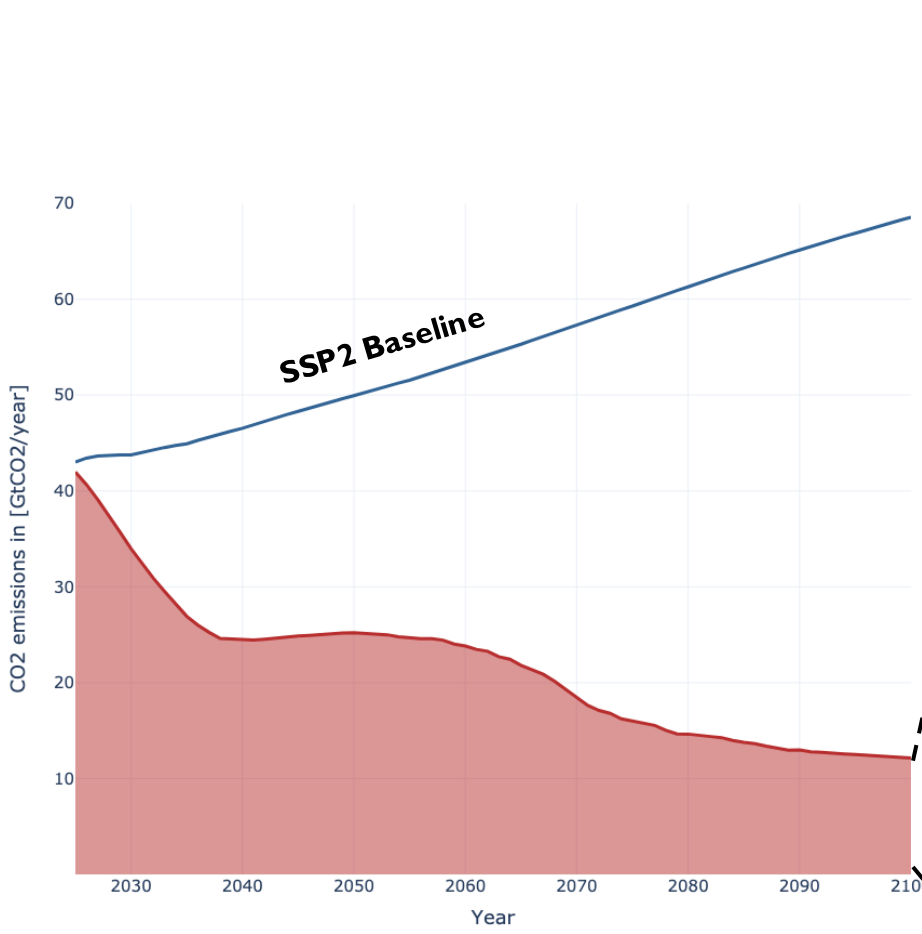
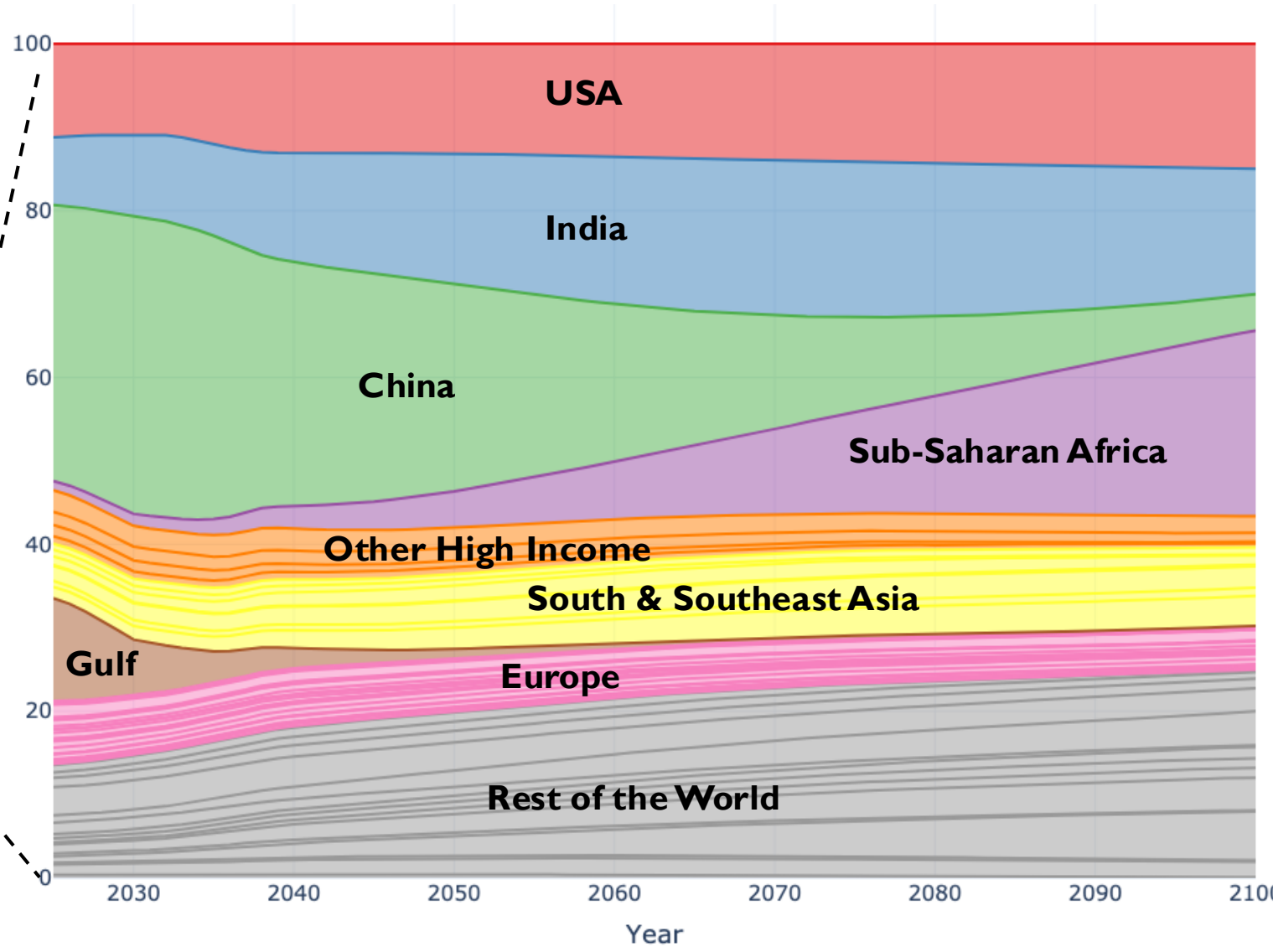
Share of Future Emissions – Utilitarian





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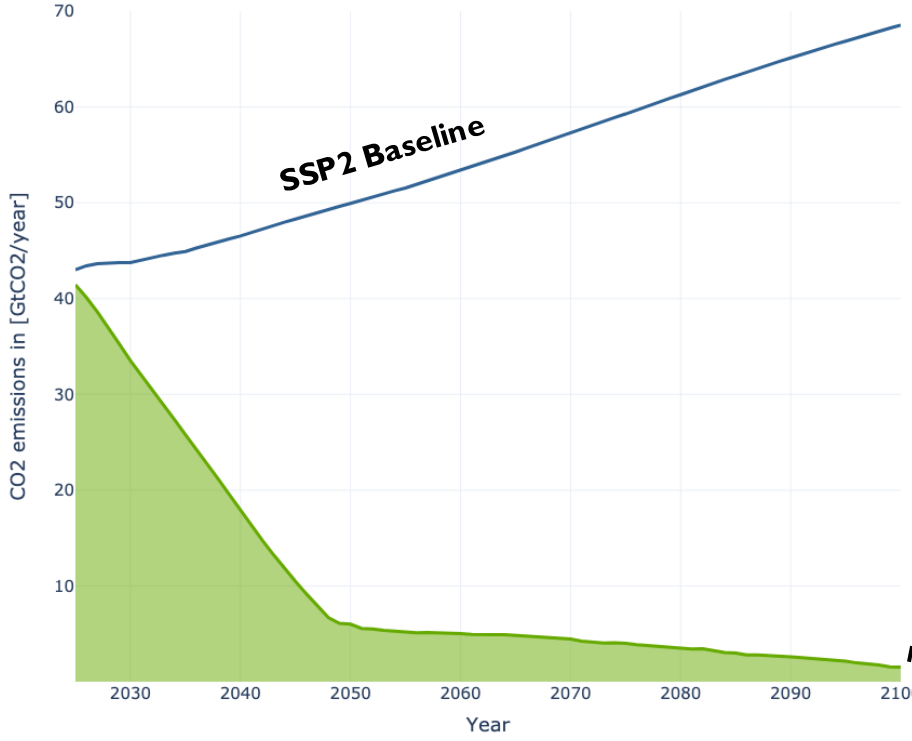

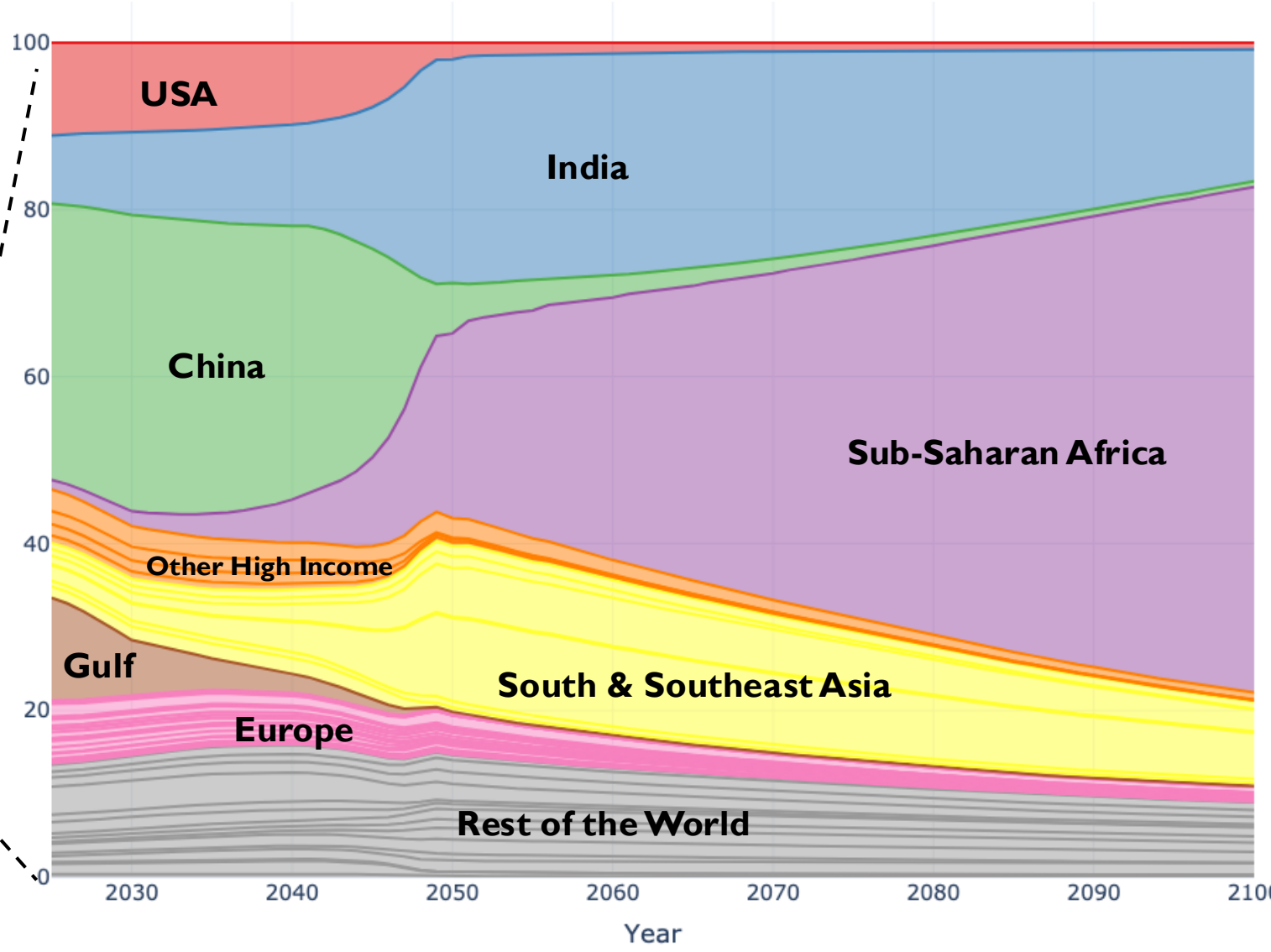

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