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Effect on climate change impacts and mitigation costs on inequality

Nicolas Taconet

Joint work with Céline Guivarch (ENPC, CIRED) and
Aurélie Méjean (CNRS, CIRED)

About this work

Climatic Change
https://doi.org/10.1007/s10584-019-02637-w

Influence of climate change impacts and mitigation costs on inequality between countries

Nicolas Taconet[1] · Aurélie Méjean[2] · Céline Guivarch[1]

https://rdcu.be/b2d1Z

Outlines

1. Climate change and inequality
2. Method: exploring future inequality
3. Results
4. Limitation and discussion

Introduction

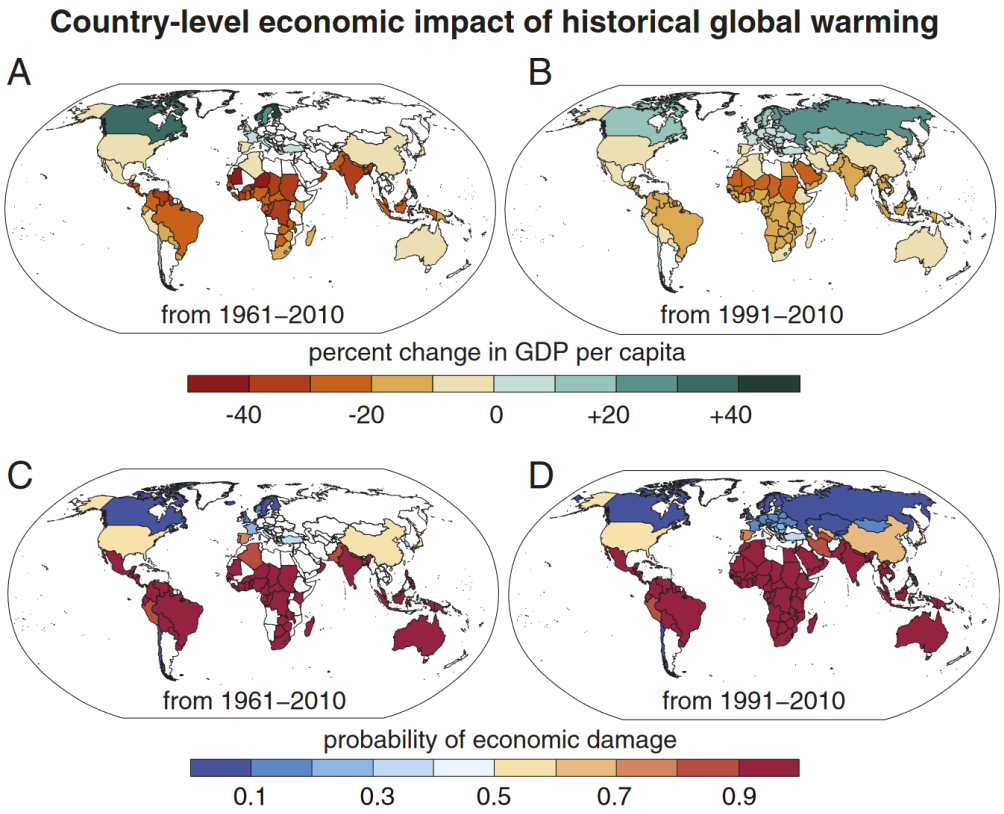
Climate change **will affect poorest primarily**

- Exposure:
  - Water stress, drought intensity, heat waves, yields (Byers et al. 2018)

- Sensitivity and ability to adapt
  - Rely more heavily on exposed sectors.
  - Lower-quality infrastructures
  - Indirect impacts via food price
  - Insurance mechanisms, access to health services

  => Both between and within countries.

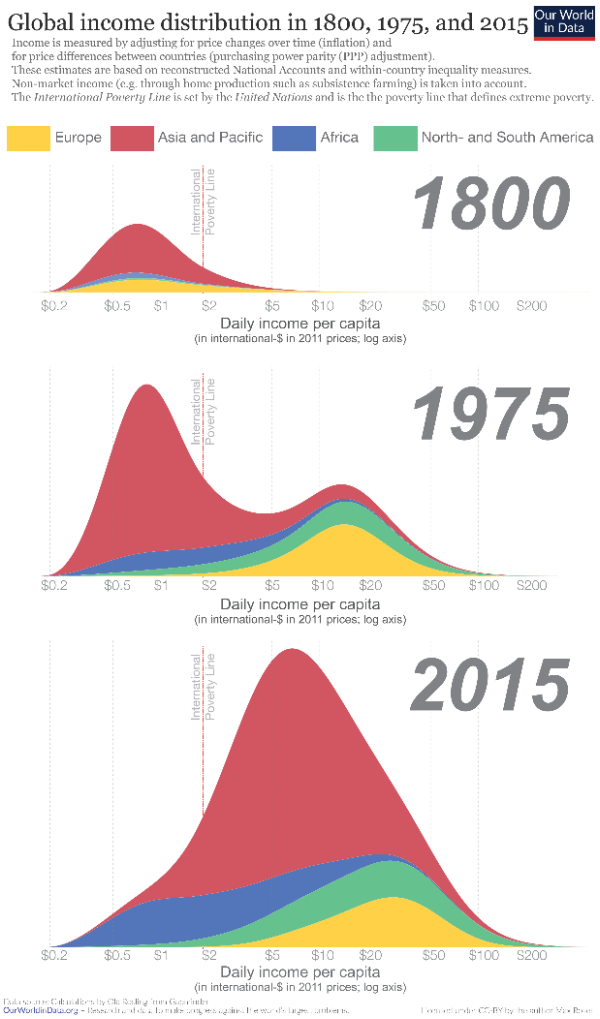
Introduction

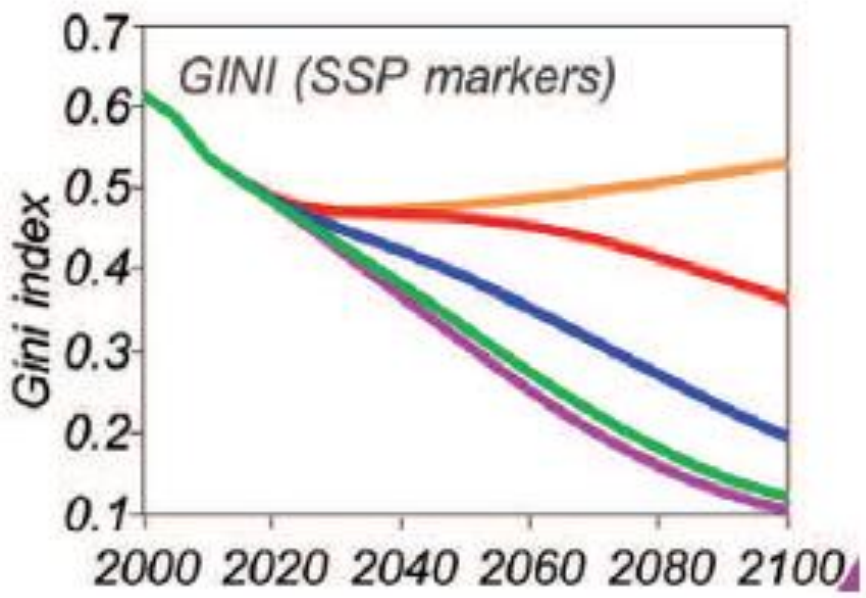


Lower inequality without climate change

$\Rightarrow$ 25% difference in top/bottom decile (Diffenbaugh and Burke, 2019):

Introduction





- **Uncertain future convergence.**
- **How much will climate change affect future inequality?**

Introduction

Research questions

- How much will climate change affect future inequality between countries?
  - Compared to non climatic drivers?

- To what extent does mitigation reduce climate-induced inequalities?
  - The cost of mitigation are also unequally distributed
  - Poor countries: energy.
  - Comparative burden of avoided damages vs mitigation costs.

Method

• Quantitative projections in different mitigation pathways, building on the SSPs

• Uncertainty in socioecon and climate dimensions

$\Rightarrow$ Statistical tools to analyse the outcomes.

Outlines

1. Climate change and inequality
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2. Methods

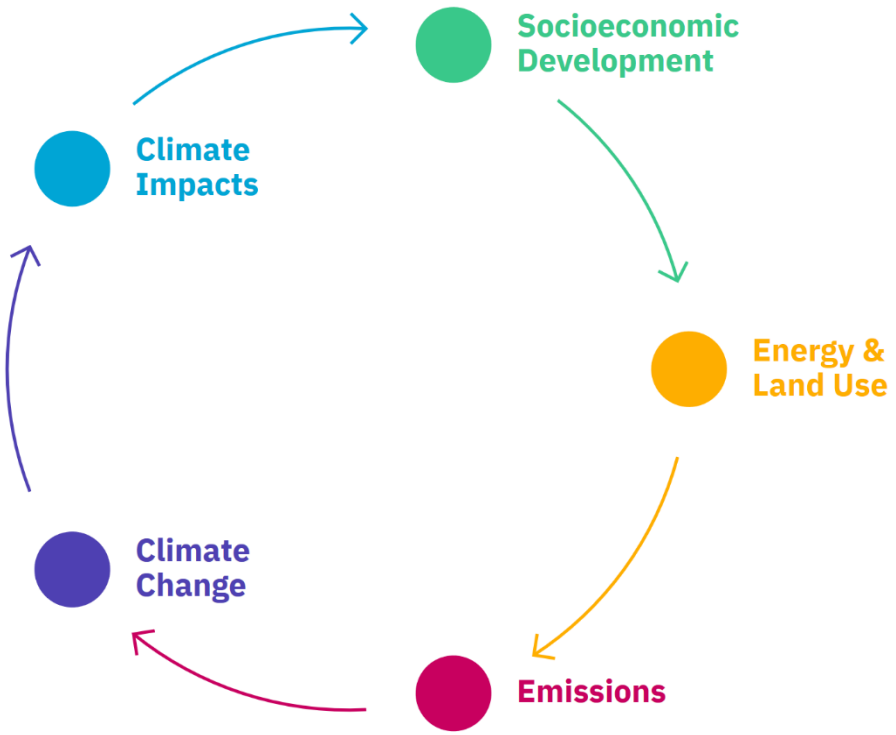
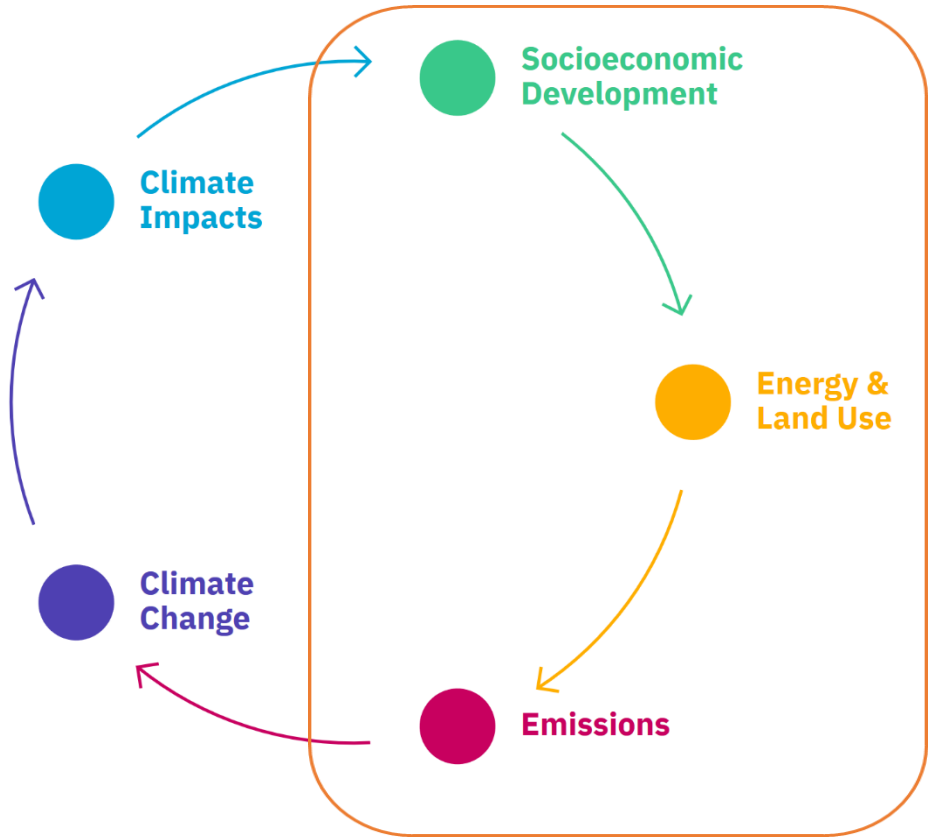


Chart from SENSES project, Scenario Primer
https://climatescenario.org/primer/

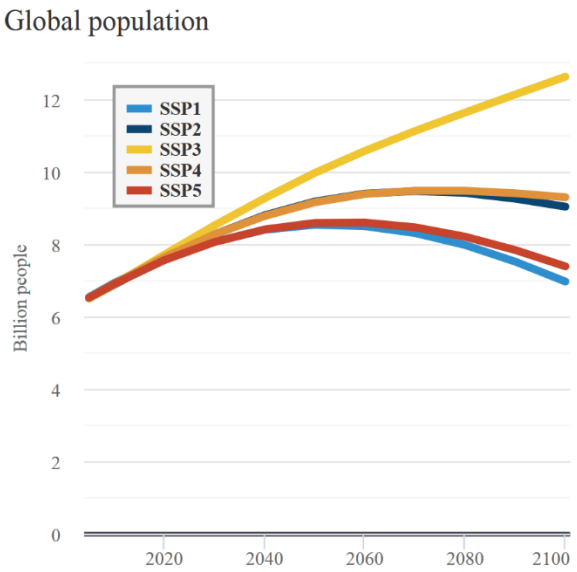
2. Methods

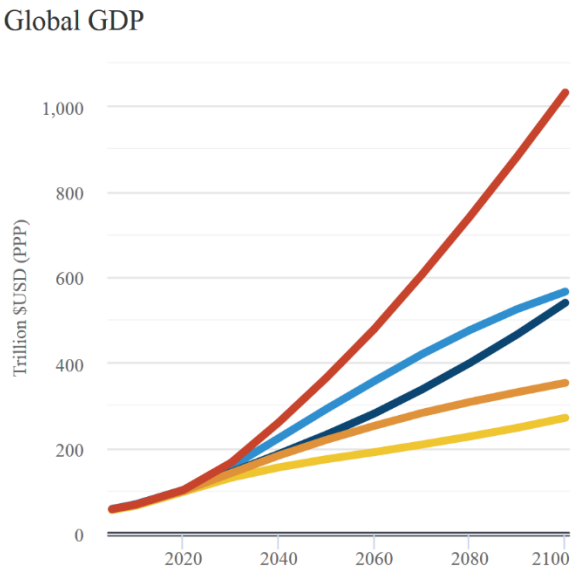
SSPs and IAMs

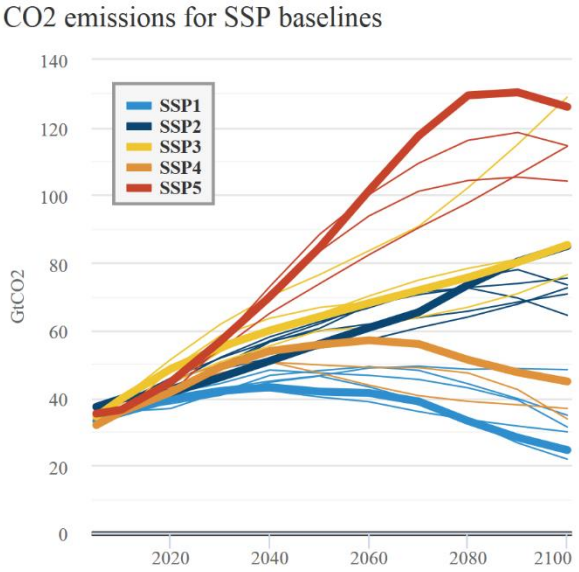


2. Methods

- 5 Contrasted socioeconomic futures (Riahi et al. 2017)







CB

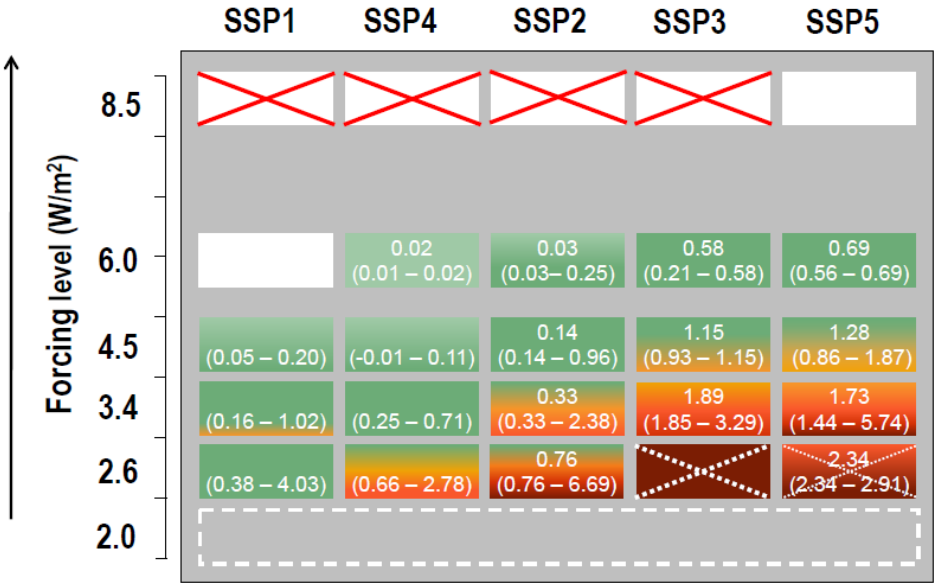
Charts by Carbon Brief, data from IIASA SSP database

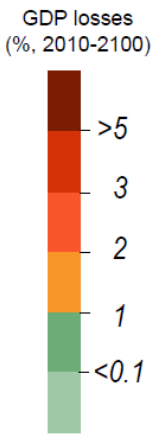
SSPs	Name
1	Sustainability
2	Middle of the road
3	Regional rivalry
4	Inequality
5	Fossil-fueled development

- Country-by-country projections in « baseline » scenarios

2. Methods

- **Different mitigation pathways (3 to 4 RCPs):**
  - **Mitigation costs** (SSP Database).



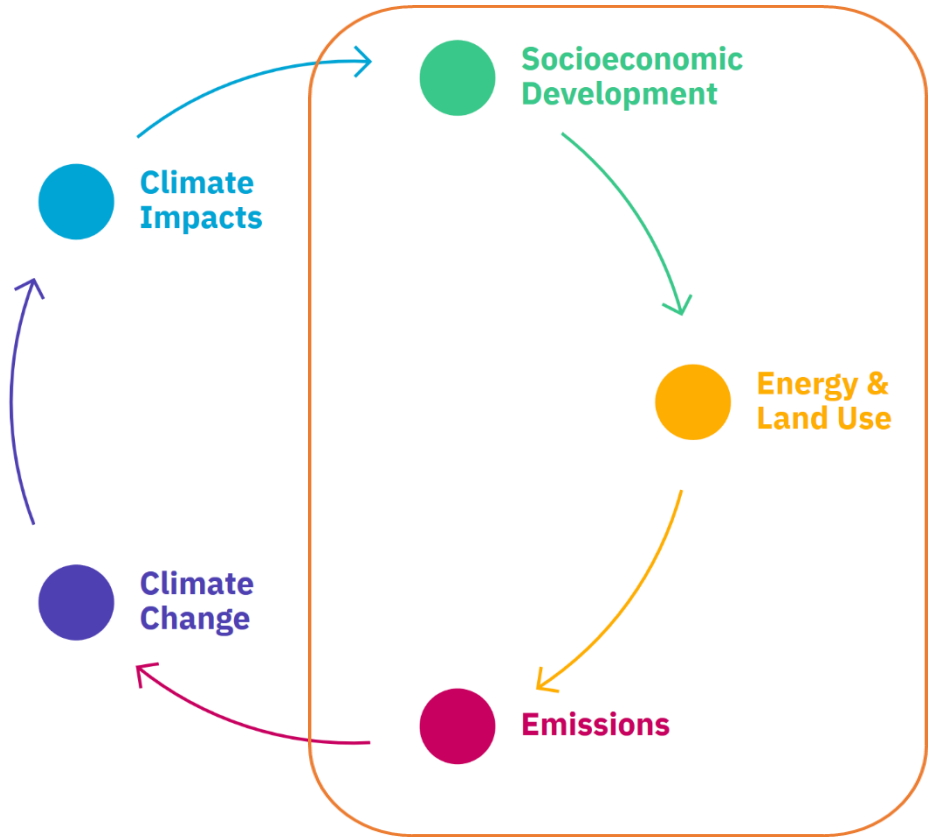


2 to 4 estimates
- Consistent with SSPs
- Least-cost
- 2 ways to downscale regional costs to country-level (equal vs proportional)

Source: Riahi et al. (2017)

2. Methods

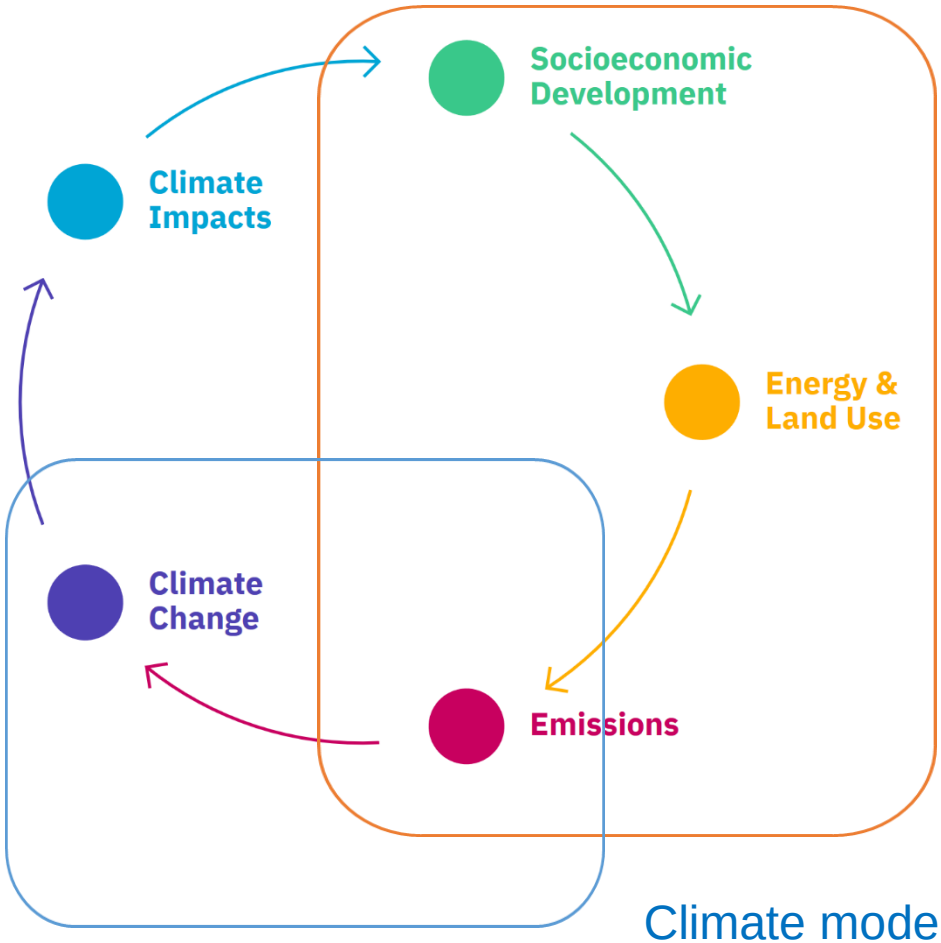
SSPs and IAMs



SSP x RCP matrix

2. Methods

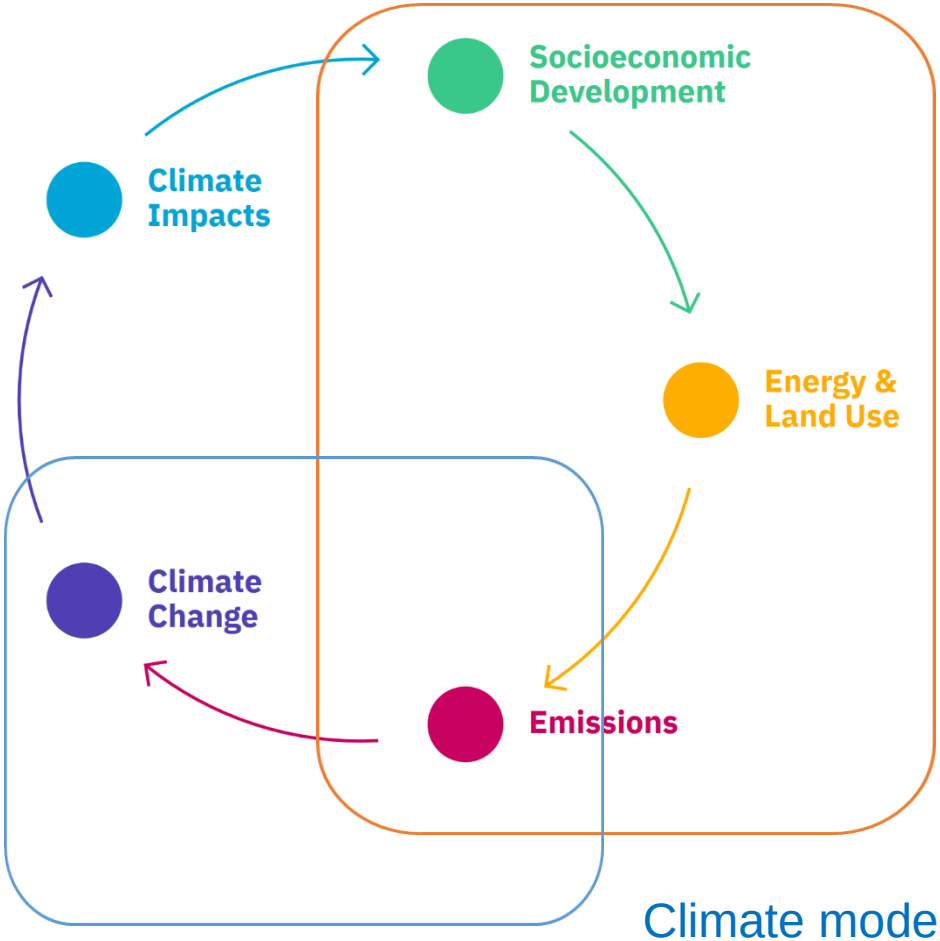
SSPs and IAMs

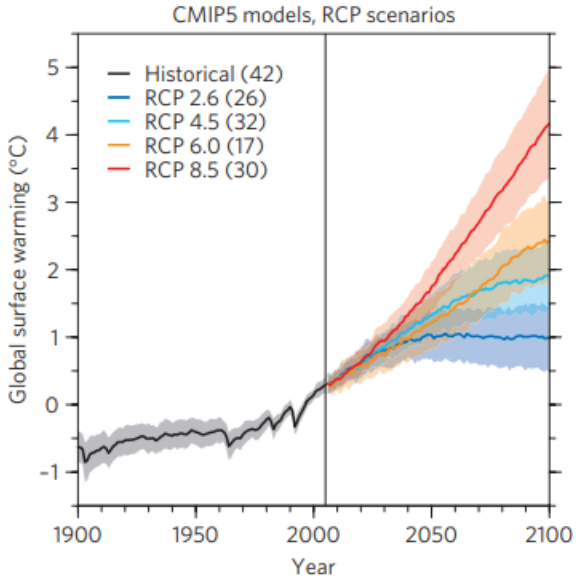


Climate models (CMIP 5)

2. Methods

SSPs and IAMs





Knutti and Sedlàcek, 2012

Global and country-level temperature change

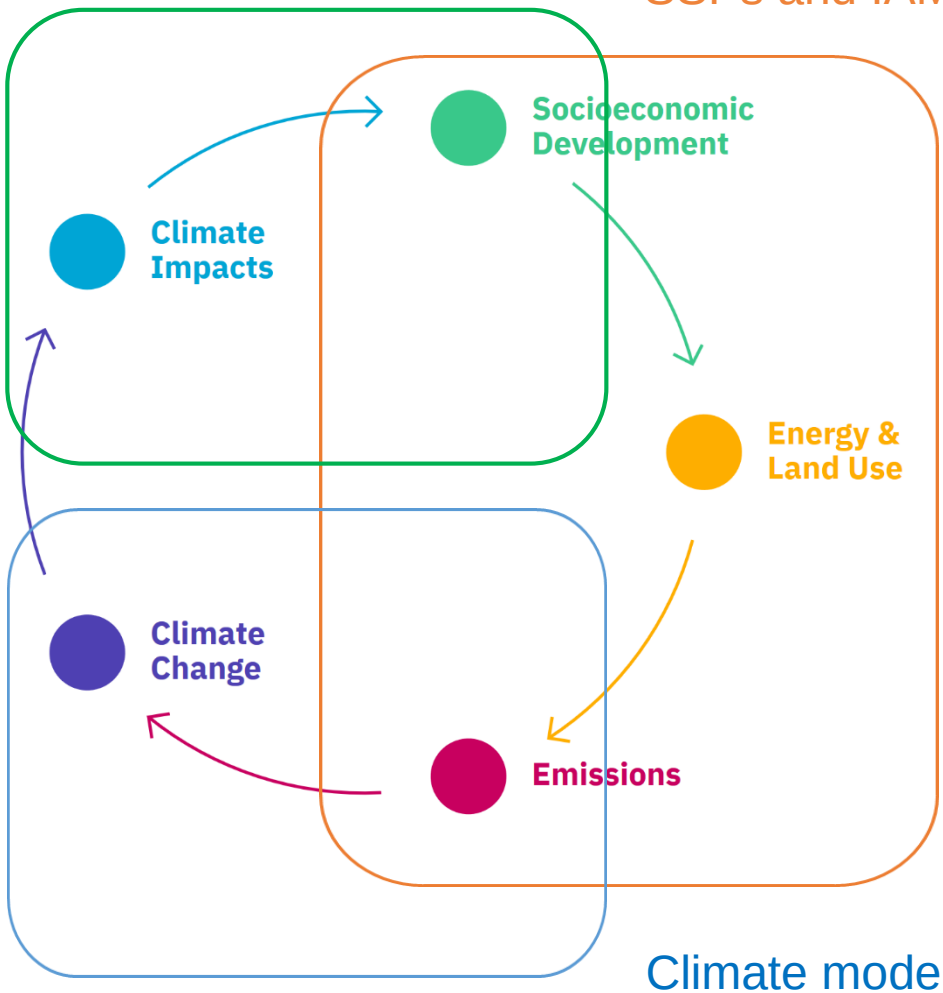
•10th percentile, mean, 90th percentile

Climate models (CMIP 5)

2. Methods

Climate damage

SSPs and IAMs



Climate models (CMIP 5)

2. Methods

- **Country-level damage functions**

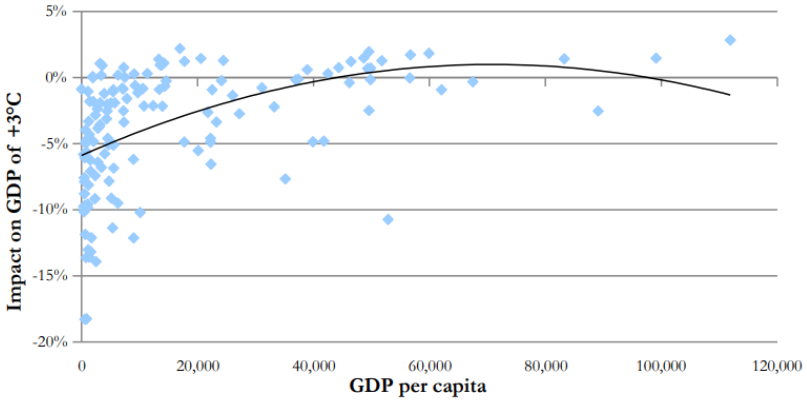
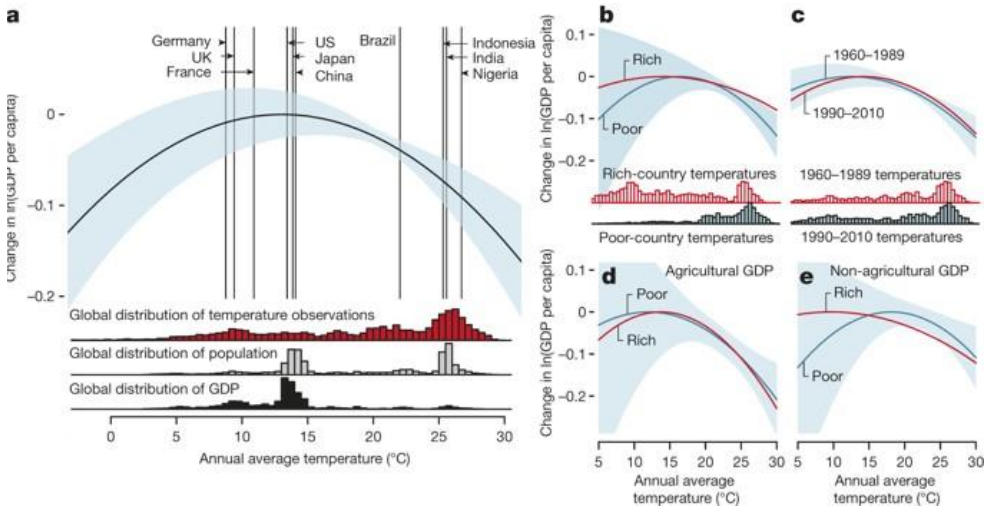


Figure 7. Percentage variation of GDP against per capita income level



- Enumerative:
  - downscaled RICE
  - country-level (Roson and Sartori, 2016)
- Statistical: (Burke et al. 2015, Dell et al. 2012)
  - In one specification ~ ‘vulnerability’

2. Methods

- **Summary of the uncertainties**

Table 2 Uncertain factors considered in the study

Dimension	Levels	Source
Socioeconomic	5 growth pathways	SSP database
Emissions	baseline and lower pathways among RCPs 2.6, 3.4, 4.5, 6.0	SSP database
Mitigation costs	regional costs from 2 to 4 models	SSP database
Distribution of mitigation costs	Equal distribution or proportional to income within regions	
Temperature	10th percentile, mean, 90th percentile	CMIP5
Damages	8 damage functions (IAM- and econometrics-based)	RICE2010, Roson and Sartori (2016), Dell et al. (2012), Burke et al. (2015)

- Projections of countries GDP and GDP per capita up to 2100
- 3408 scenarios
- Gini coefficient (pop-weighted)

Outlines

1. Climate change and inequality
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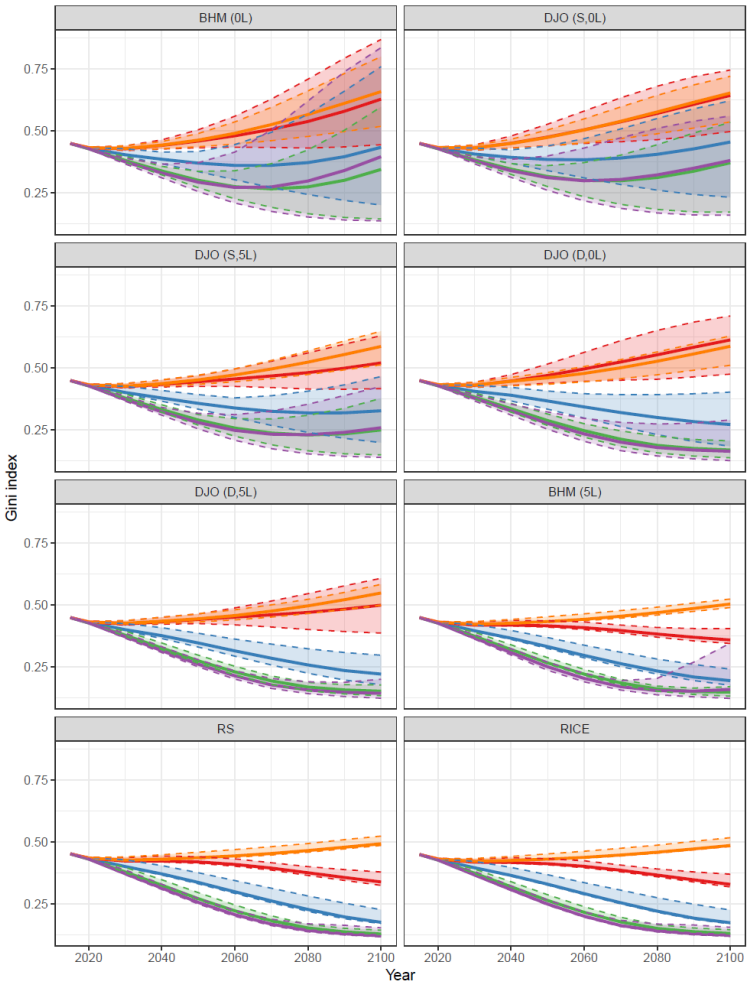
4. Limitation and discussion

3. Results

- **Evolution of Gini** (panel=damage function)



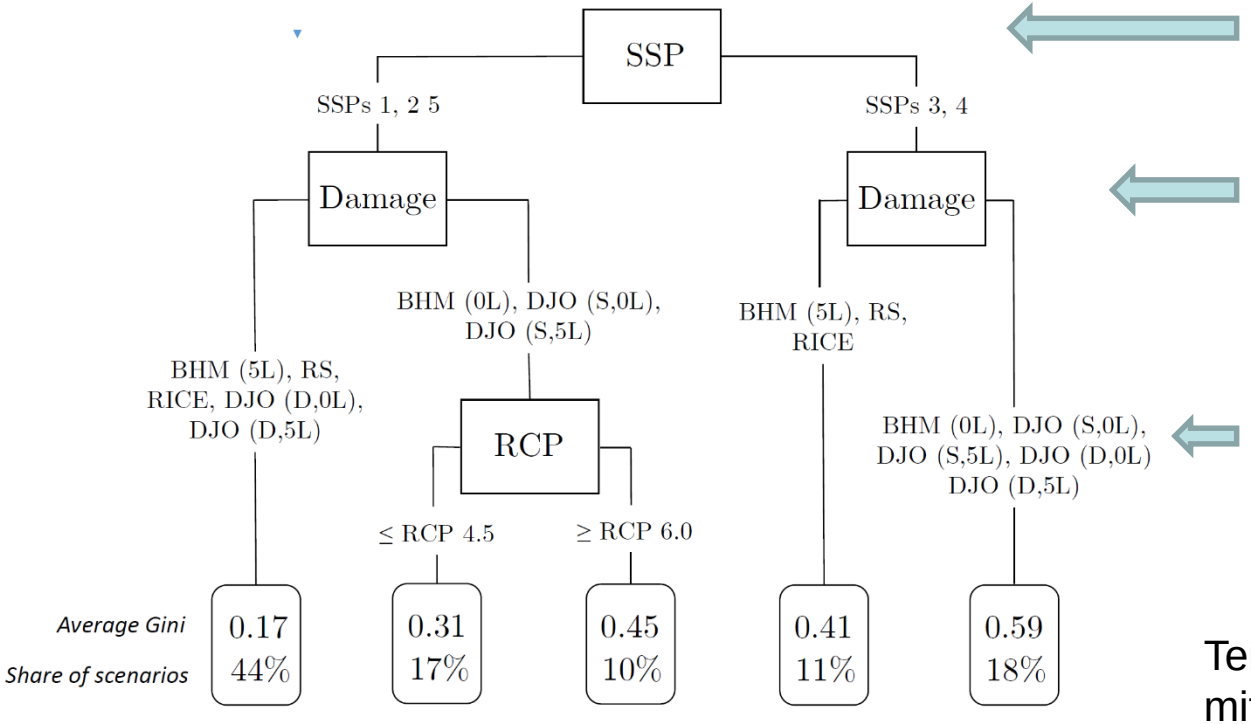
Socioeconomic pathway (SSP)

1. Sustainability
2. Middle of the Road
3. Regional Rivalry
4. Inequality
5. Fossil−fueled Development

- Divergence across damage functions
- Regressive damage:
  - dispersion of potential values
  - Overlap of SSPs

3. Results

- **Regression tree to predict Gini in 2100**



Low inequality vs high inequality SSPs

Regressivity of damage (*SSP-dependent when vulnerability accounted for*)

Emission scenario

Temperature response, mitigation costs
⇒ Less influence

3. Results

Reversal in inequality? A PRIM analysis

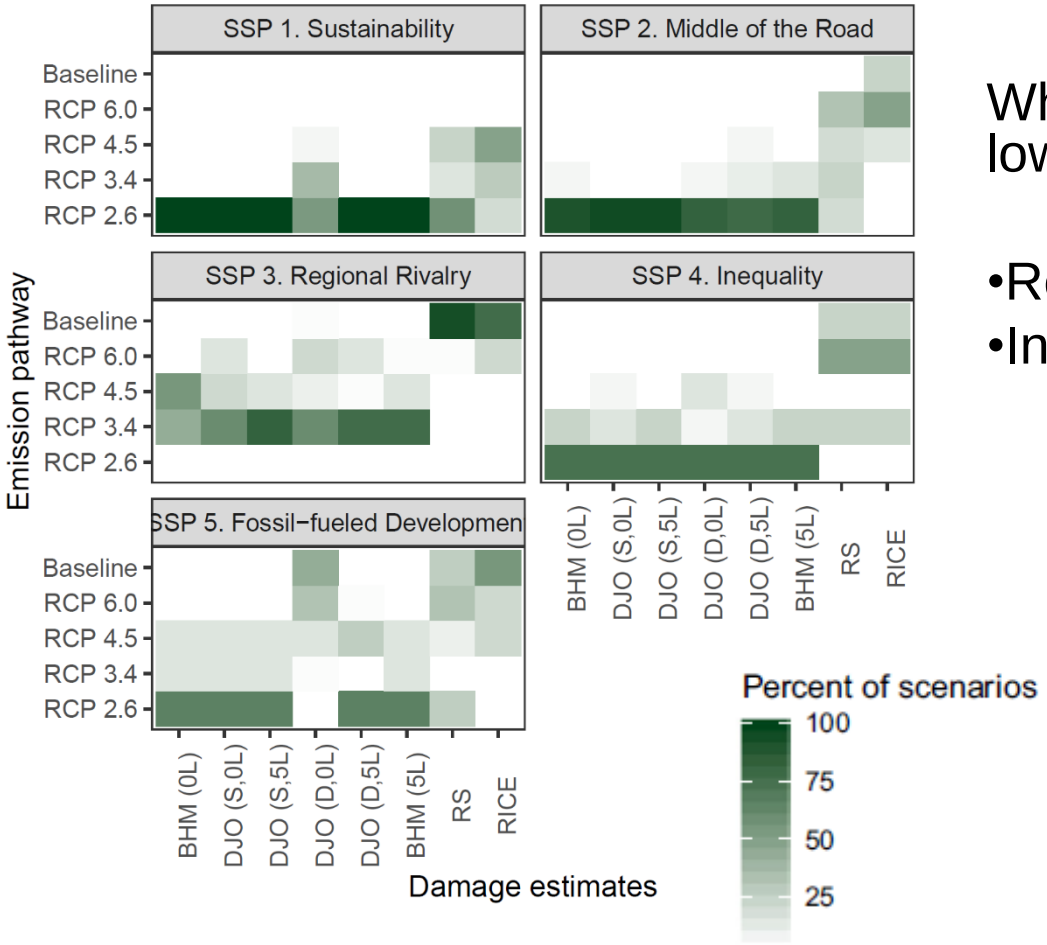
SSP	Damage	RCP	Temperature response
SSP 1	BHM (0L)	$\geq$ RCP 3.4	All
	DJO (S,5L)	All	Medium, High
	DJO (S,0L)	$\geq$ RCP 3.4	All
SSP2	BHM (0L)	$\geq$ RCP 3.4	Medium, High
	DJO (S,5L)	$\geq$ RCP 3.4	Medium, High
	DJO (S,0L)	$\geq$ RCP 3.4	All
SSP3	BHM (0L)	All	All
	DJO (S,5L)		
	DJO (S,0L)		
	DJO (D,0L)		
	DJO (D,5L)		
SSP4	All	All	All
SSP5	BHM (0L)	$\geq$ RCP 3.4	All
	DJO (S,5L)	$\geq$ RCP 3.4	
	DJO (S,0L)	$\geq$ RCP 3.4	

Combination of inputs leading to trend reversal in Gini?

- Occurs in all SSPs, but…
- Only for regressive damages, a high RCP or a high temperature response.
- Variability in how soon this occurs.

3. Results

To what extent does mitigation allow to reduce?



Which emission pathway has the lowest inequality?

- Regressivity of damage
- Influence of SSP

Outlines

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4. Limitation

Key limitations and perspective

- On damages:
  - Validity of the underlying damage estimates
  - Accounting for vulnerability: structure of the economy, adaptation

- On mitigation:
  - Least-cost
    => Equity? Compensation, financial transfers
    => Real-world? NDCs,…

- Considering within country inequality (Rao et al. 2019)
  - Poor households vulnerable to climate change impacts

Conclusion

Main message

- Climate change has an effect on inequality between countries
  - Mitigation costs vs climate damages.

- Main uncertainties are **socioeconomic assumptions** and **damage estimates**.

- Mitigation **can reduce inequality**.
  - Most of the time for regressive damage estimates
  - Uncertain for low damages => how to distribute?

- More quantitative studies needed to design fair mitigation pathways.
  - NAVIGATE: develop inequality dimension in IAMs

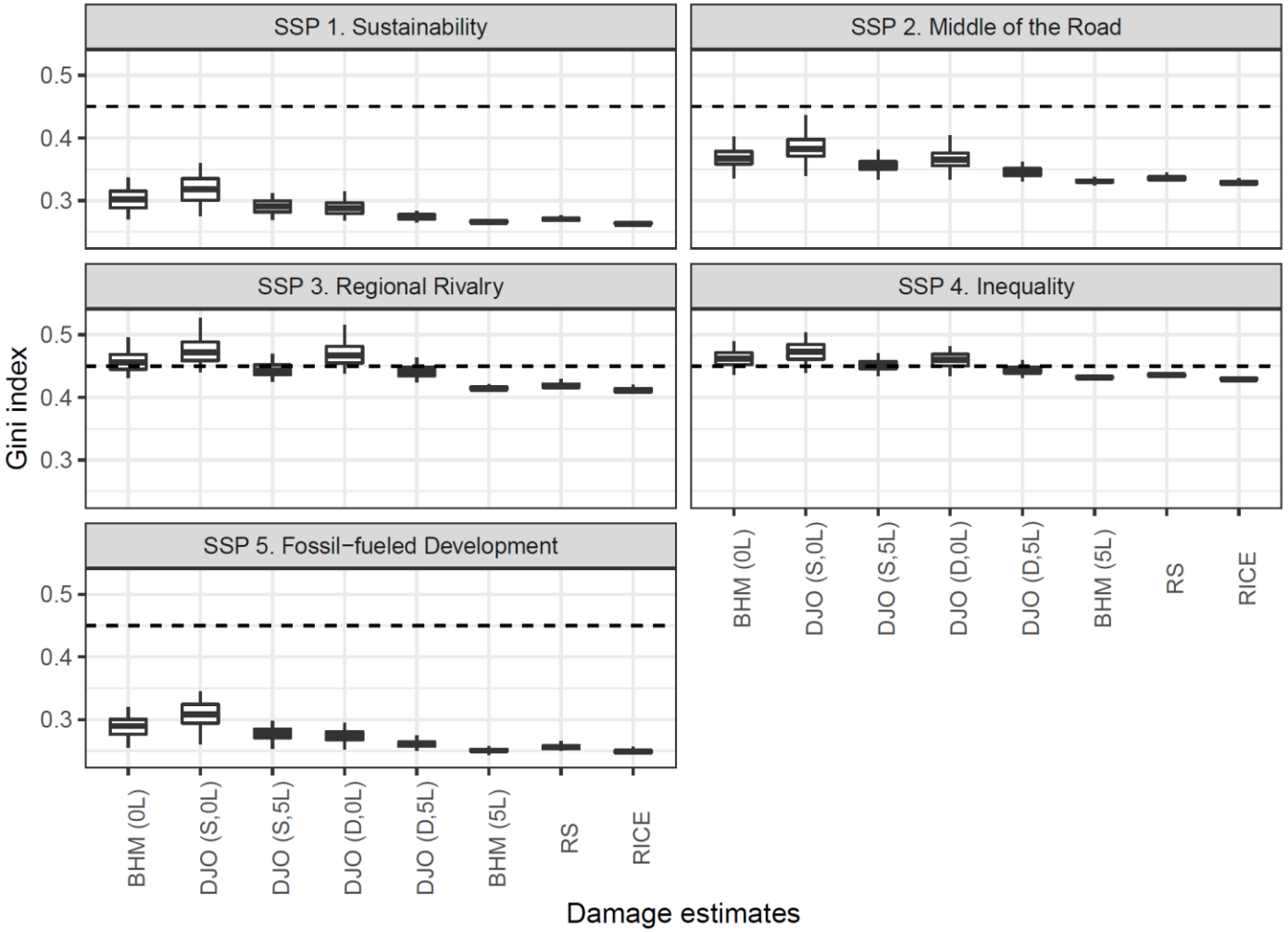
Conclusion

Thank you for your attention

Additional Slides

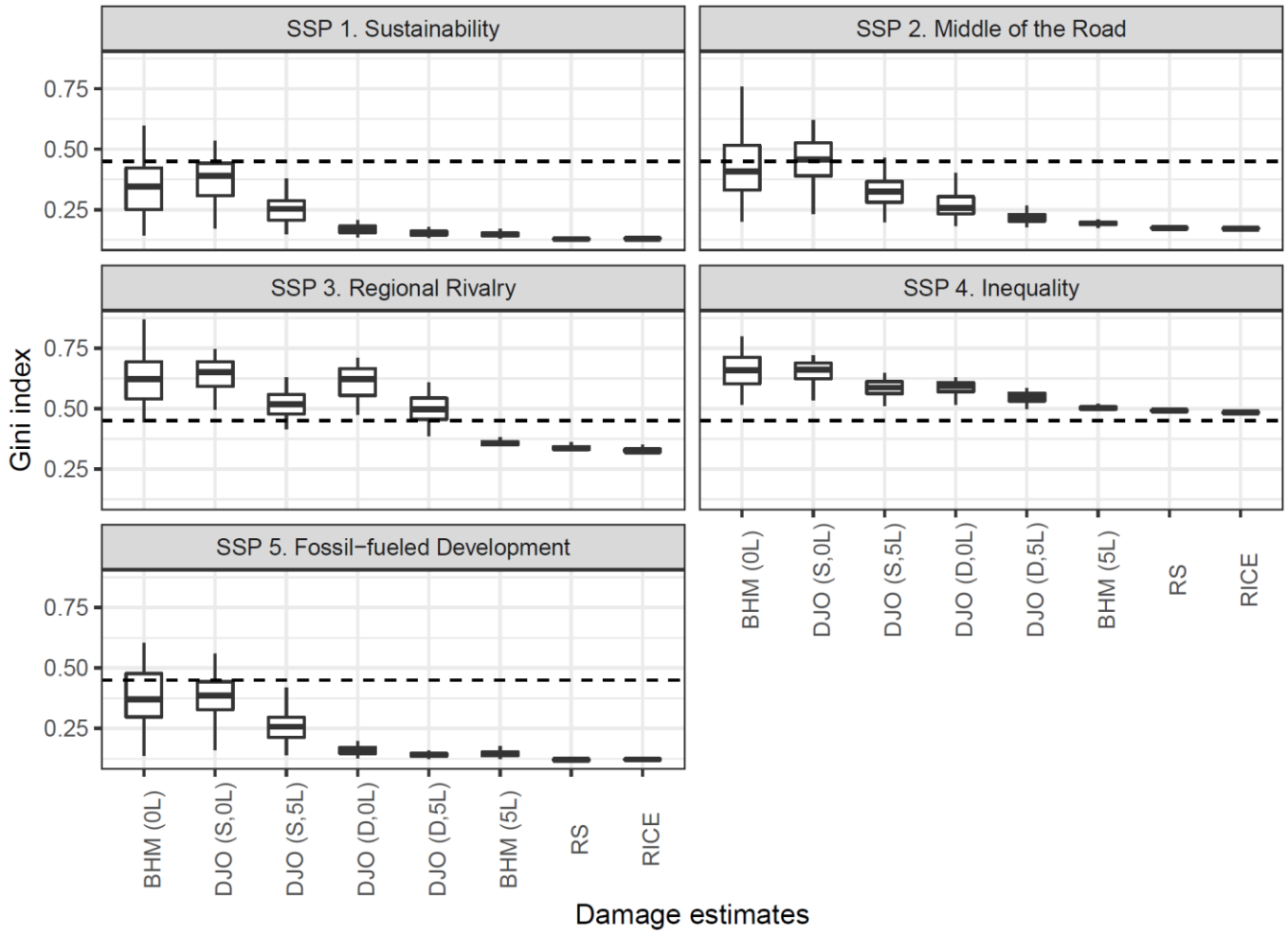
Results

- **Gini in 2050**



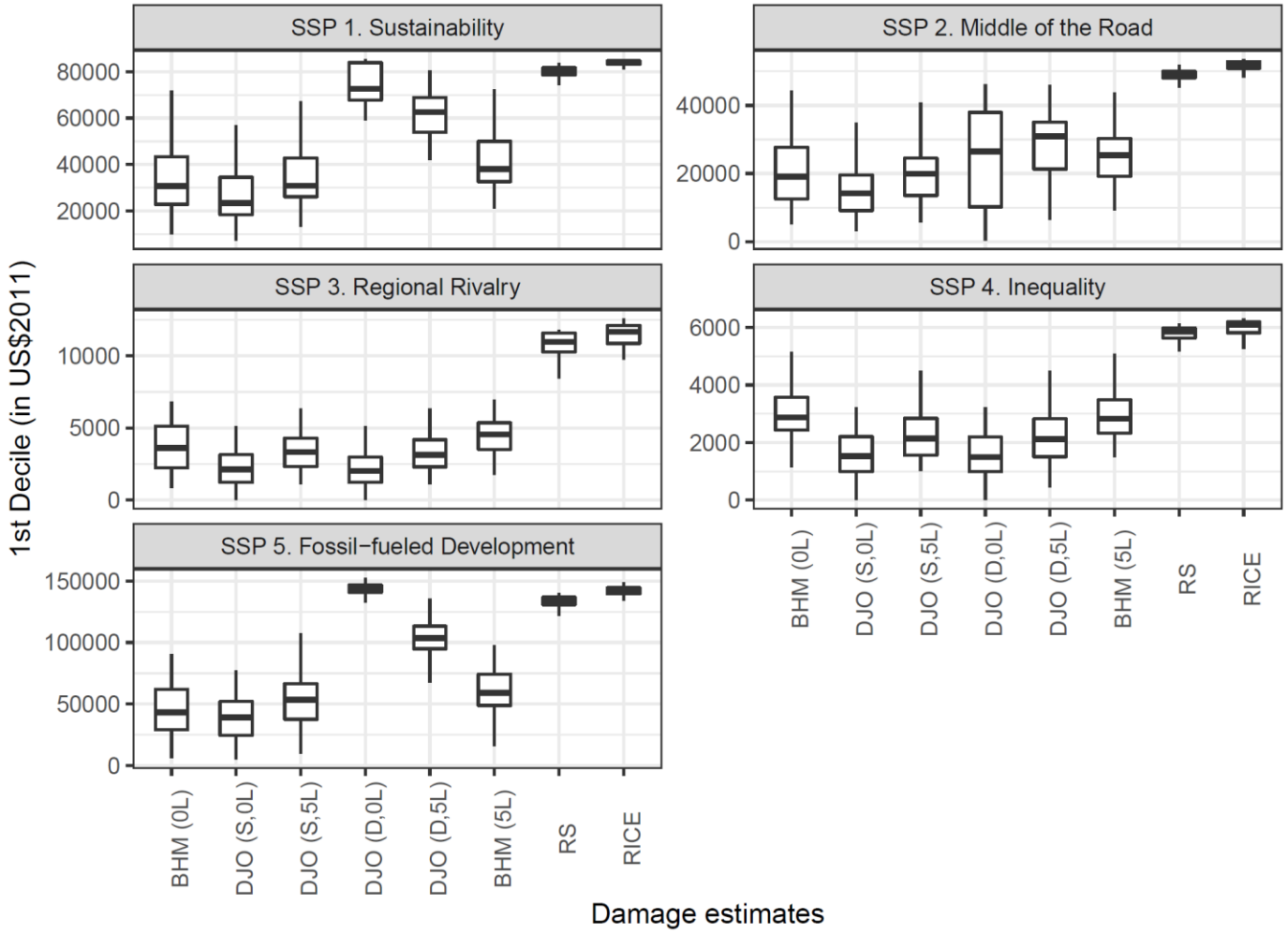
Results

- **Gini in 2100**

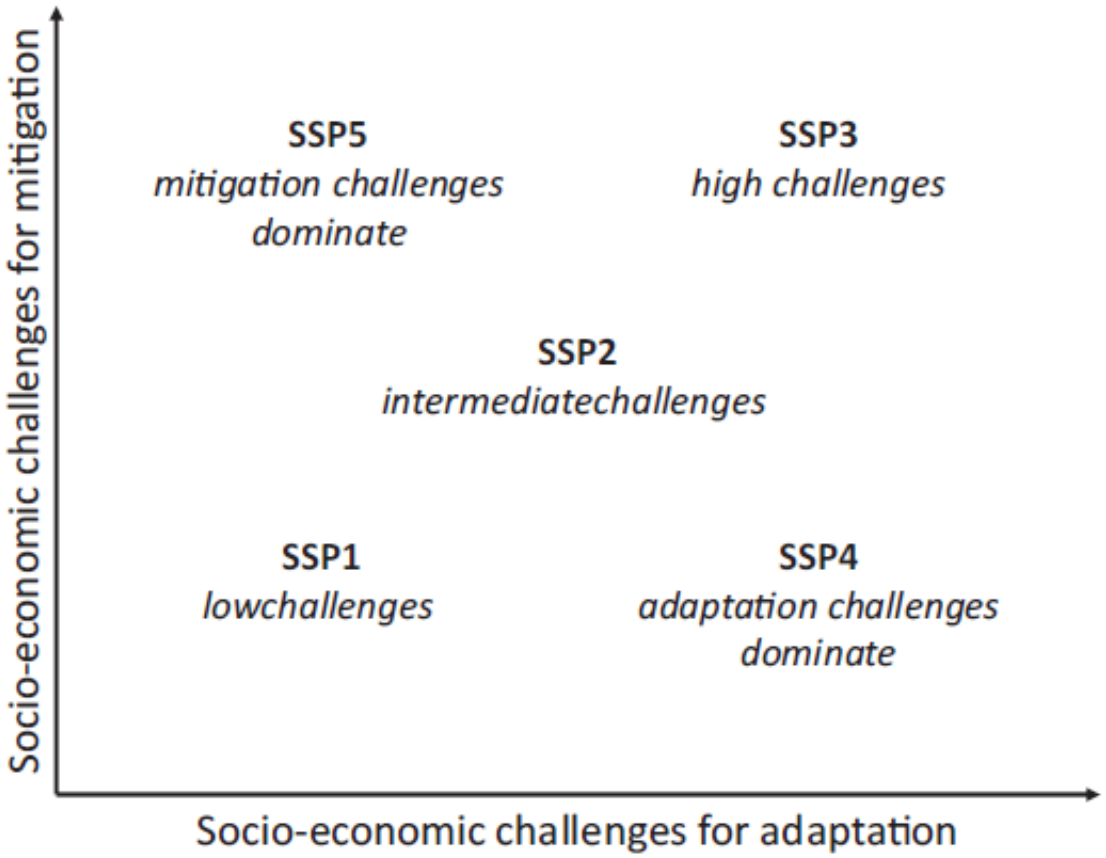


Results

- **First decile, 2100**

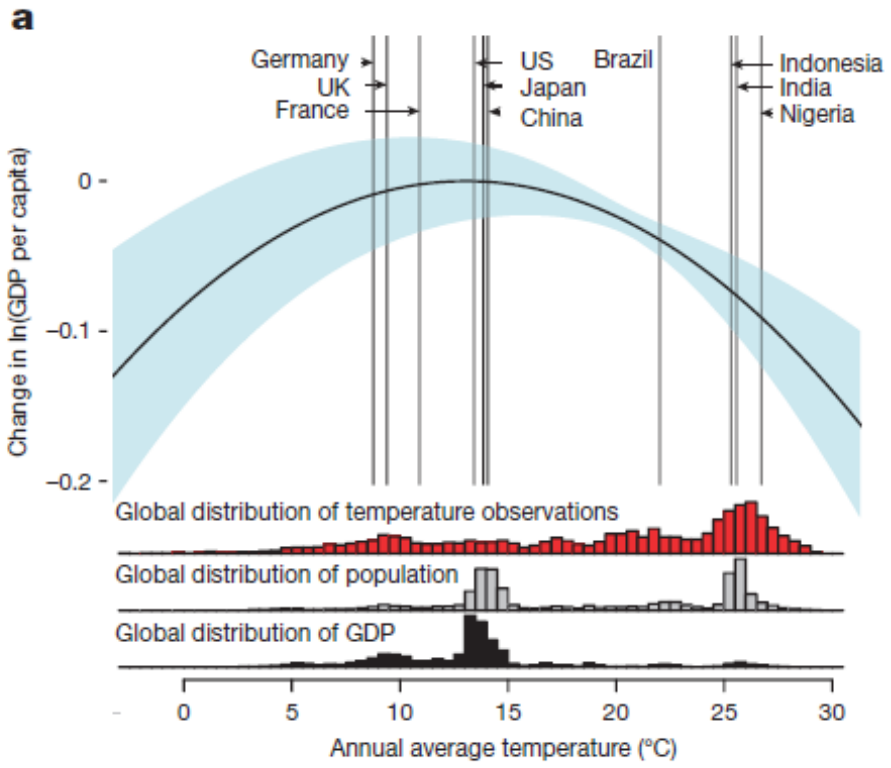


Shared Socioeconomic Pathways



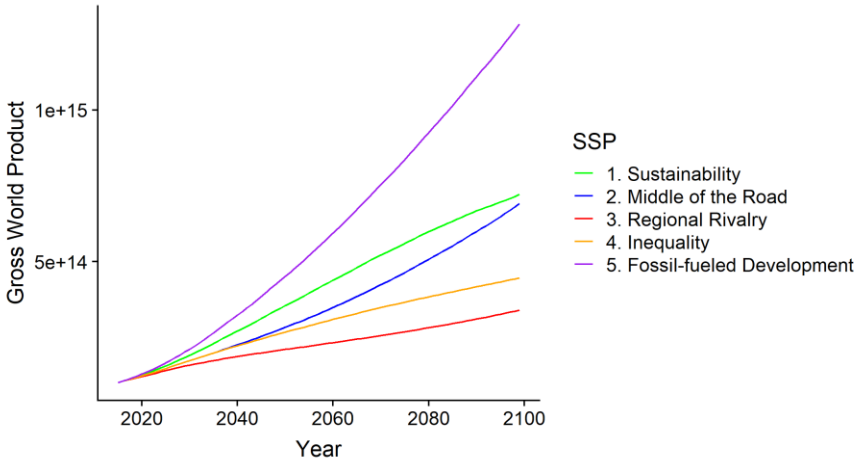
Burke et al. damage estimates

- **Econometric regression leads to a Bell-shaped curve between growth and temperature**

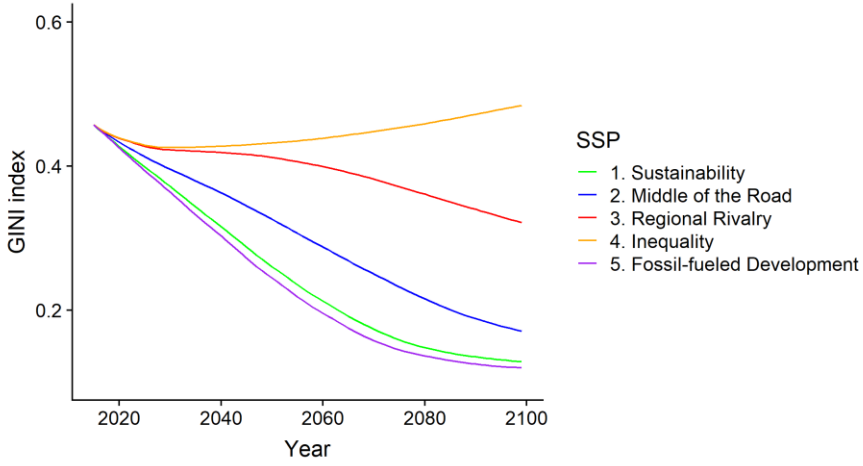


Methodology

- **National growth** (SSP Database):
  - Population
  - Human capital
  - Technology
  - Resource availability



Global Growth



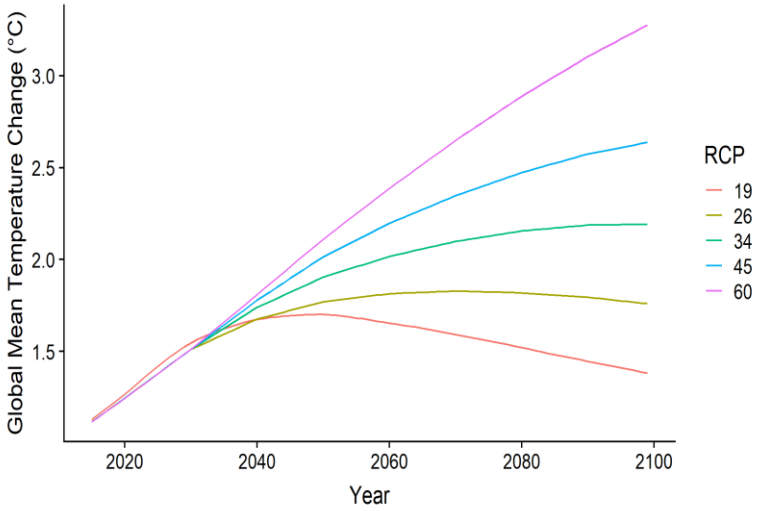
Inequality

Methodology

National growth (Baseline no CC)

⇒ Shared Socioeconomic Pathways (SSP)

Emission pathways: RCP 6.0, 4.5, 3.4, 2.6 and 1.9



Mitigation costs

⇒ SSP Database (mean)

+

Economic damages