Sensitivity of Coastal Adaptation Costs and Decisions to Sea Level and Socioeconomic Uncertainties

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Introduction

- Sea-level rise and coastal flooding pose significant risks to coastal communities
- Efficacy of strategies to manage these risks depends on:
  - uncertainty in future emissions pathways
  - uncertainty in future socioeconomic change
  - uncertainty in geophysical factors (e.g., climate sensitivity)
- Greater model detail can constrain these uncertainties, but also introduces new uncertainties to represent added processes
- So, we use **Galveston, TX** and **New York City** as case studies to ask:
  1. **As we increase model complexity, are we gaining information? Or are we awash in uncertainty?**
  2. **Which uncertain predictions & parameters most strongly influence coastal risk?**

Workflow

Sea-level projections using MimiBRICK[1]

Antarctic & Greenland ice sheets, thermal expansion, glaciers and ice caps, and land water storage contributions to local sea levels

Deep uncertainties

3 model configurations (BRICK, DOECLIM-BRICK, SNEASY-BRICK)
4 SSP-RCP pathways (SSP1-2.6, SSP2-4.5, SSP4-6.0, SSP5-8.5)

Calibration to observational data

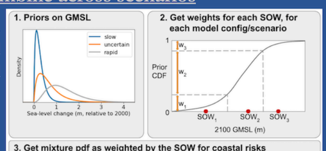
CO_2, temperature, ocean heat uptake, and sea level contributions

Local coastal impacts using MimiCIAM[2]

Mimi Coastal Impact and Adaptation Model to estimate net present value (NPV) of total adaptation costs from **protection** or **retreat**, and damages from **inundation, wetland loss,** and **flooding**

Combine across scenarios[3]

Subjective Bayesian priors on 2100 global mean sea level

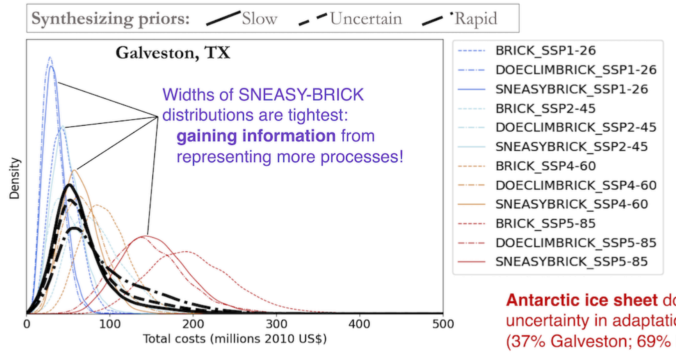


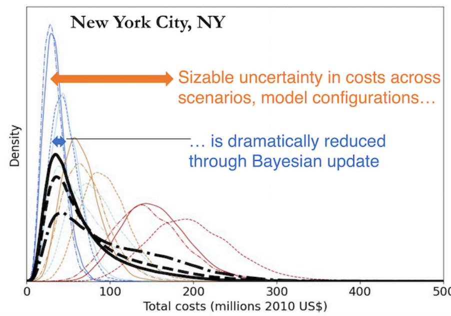
Global sensitivity analysis

- Run model many times, varying uncertain parameters
- How much variance in total adaptation costs is attributable to each uncertainty?

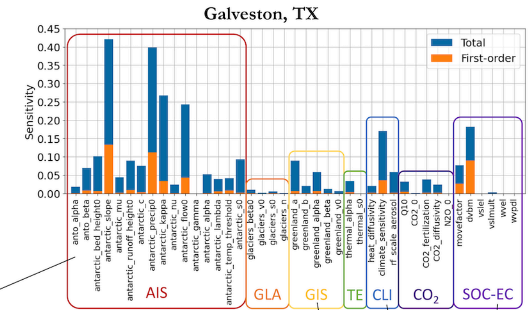
Results

What are probabilistic estimates for NPV of adaptation costs?

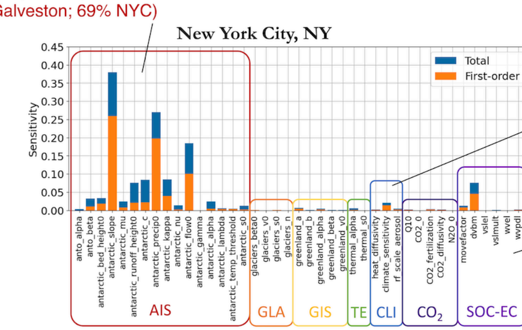




What uncertain factors are adaptation costs most sensitive to?



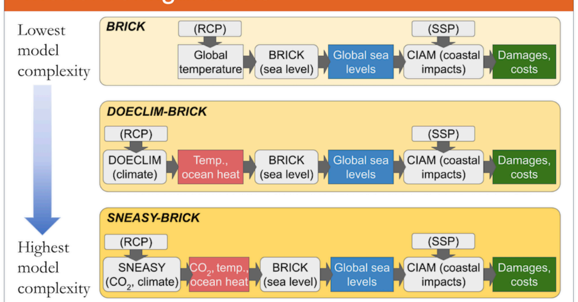
Antarctic ice sheet dominates uncertainty in adaptation costs (37% Galveston; 69% NYC)



Greenland ice loss… …driven by climatic factors (e.g., **climate sensitivity**)

Socioeconomic uncertainties (relocation costs and **abandoned dryland value)** are second-largest driver (12% Galveston; 5% NYC)

Model configurations



Take-aways

- **Distributions tighten as model detail added – information gained!**
- **Predictions/parameters most strongly influencing coastal risk:**
  - Antarctic ice sheet - Socioeconomic (dryland value, relocation costs) - Climate sensitivity
- **Role of major ice sheets varies by proximity to site, gravitational effects**
- **For U.S. Gulf Coast site, CO_2, climatic, and temperature-driven factors important**
- This open source framework is readily incorporated into cost-benefit integrated assessment models to represent deeply uncertain sea-level impacts and adaptation responses in policy relevant metrics such as the social cost of carbon[4]

Model and analysis codes available from: https://github.com/raddleverse

Digital version of this poster:

References

1. Wong *et al.* 2022a, doi: 10.21105/joss.04556
2. Wong *et al.* 2022b, doi: 10.1029/2022EF003061
3. Doss-Gollin & Keller 2022, doi: 10.1002/essoar.10511798.2
4. Rennert *et al.* 2022, doi: 10.1038/s41586-022-05224-9

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