

Assessing Climate Impacts through Integration of a Global Computable General Equilibrium Model with Regional and Sector-Specific Damage Functions

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INTRODUCTION

To evaluate the widespread impacts caused by climate change, climate impact models simulate how economies might respond to external shocks such as changes in climate policy or technological advancements. Existing climate impact models can be roughly categorized into one-way or two-way estimation models, depending on whether and how economic and climate modules are integrated together. One-way models treat temperature changes as exogenous shocks and do not reflect the feedback effects between the climate and the economy. Two-way models provide a more dynamic estimation of climate impacts through the linking of economic models and climate modules, but existing two-way models often rely on overly simplistic economic models.

This study aims to contribute to enhancing the robustness and accuracy of climate impact assessments by integrating a global CGE model with a climate module and regional and sector-specific damage functions.

METHODOLOGY

We develop an integrated assessment model, "UNICON-IAM," which fully integrates economic, climate, and damage function components.

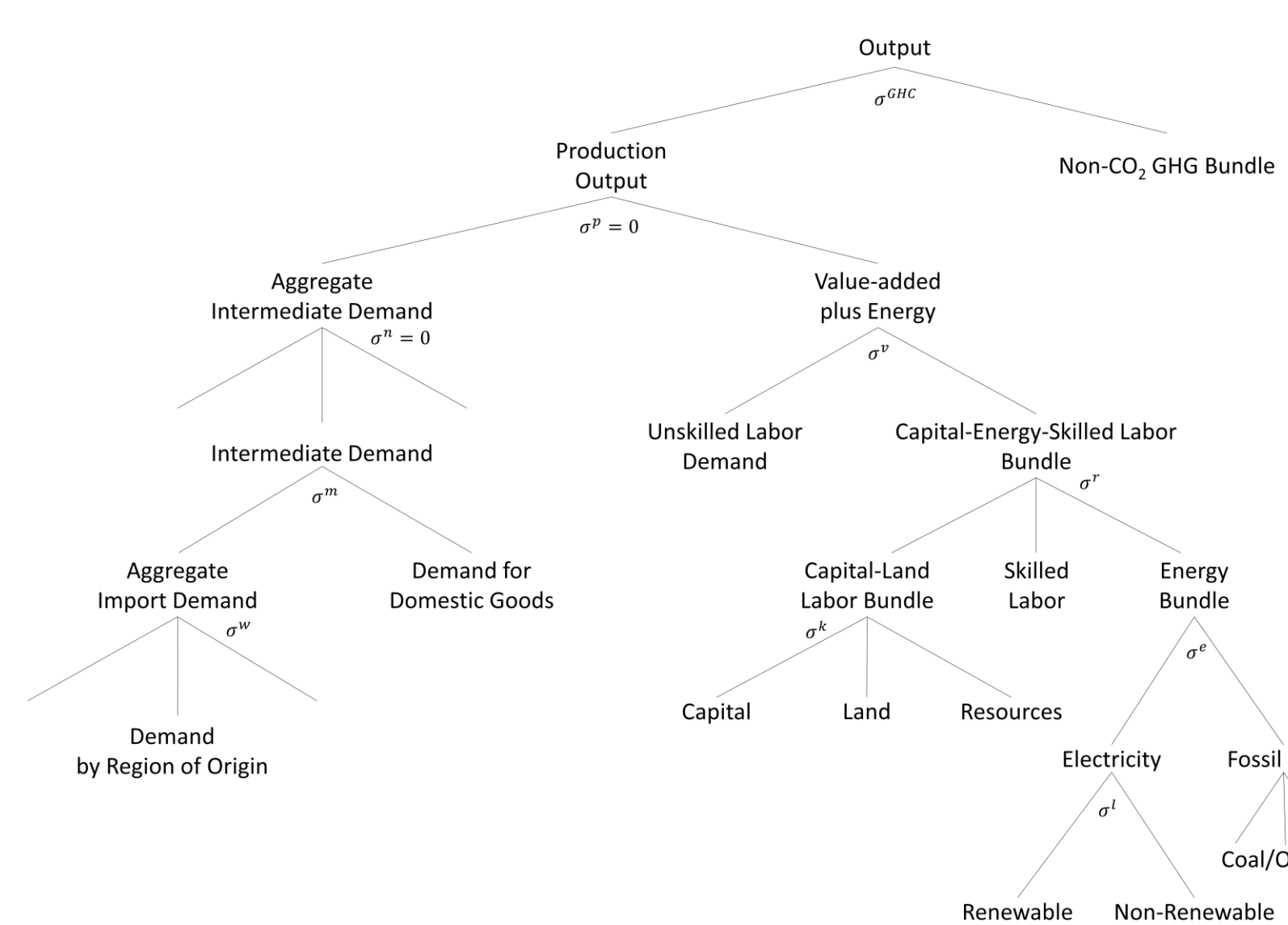
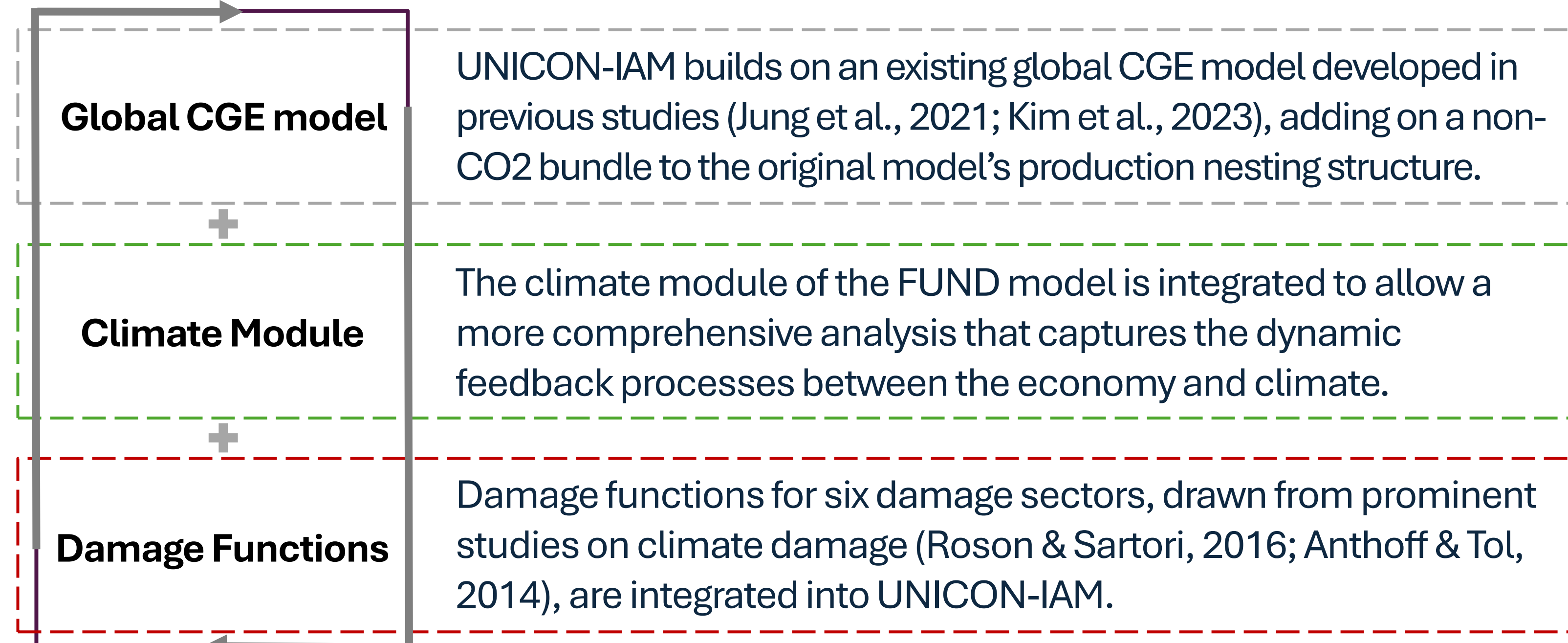


Figure 1. Nesting Structure of CGE model)

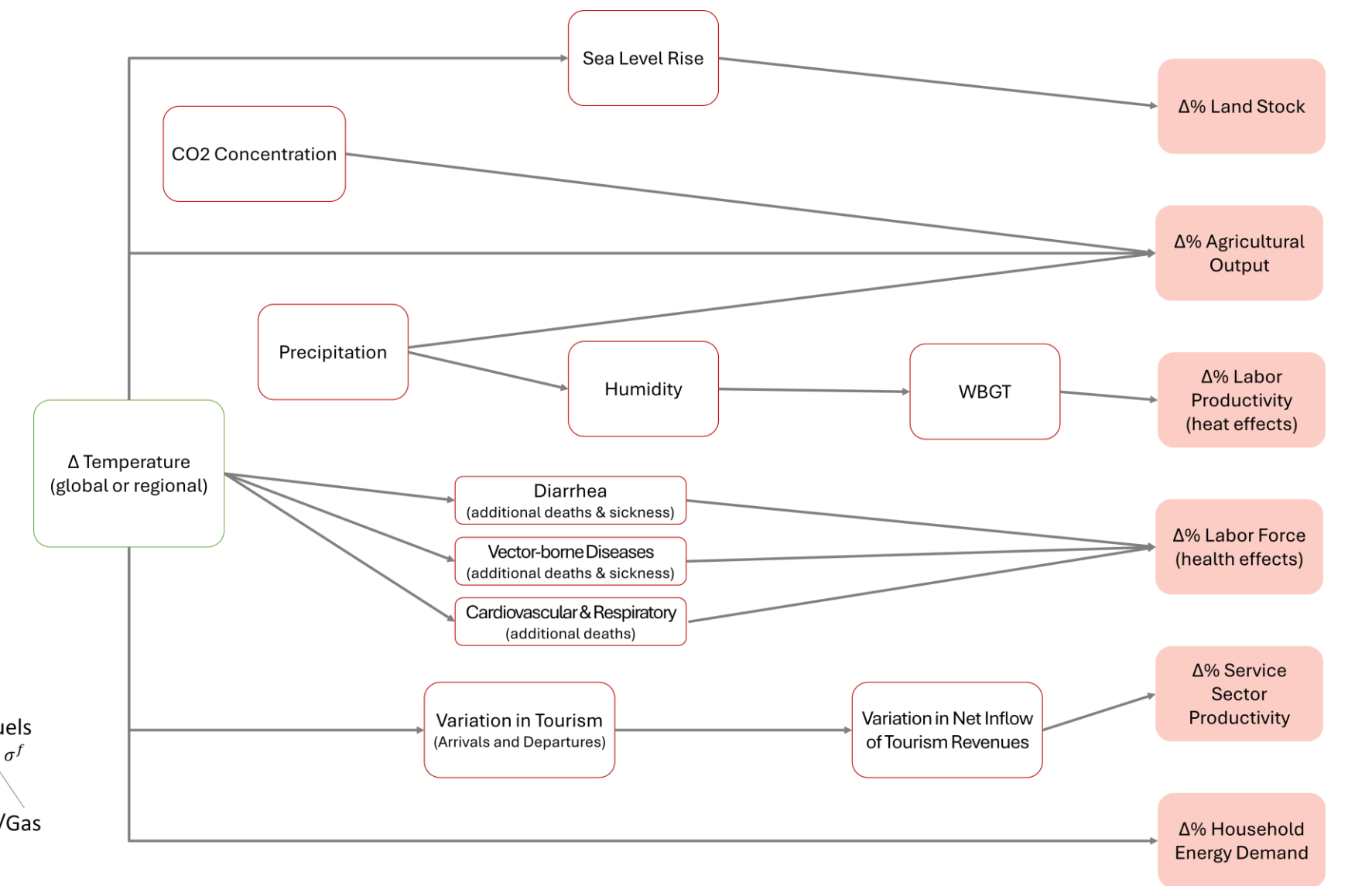


Figure 2. Flow mechanisms of damages reconstructed from damage functions in Rosen & Sartori (2016) and Anthoff & Tol (2014)

- Time period: 2017 to 2100
- Scope of analyses: 16 aggregated regions & 23 aggregated industry sectors
- Scenario: SSP2
- Data sources: GTAP 11 Power, World Development Indicators

RESULTS & DISCUSSION

Impact on Global GDP

The aggregate damage to global GDP from climate change steadily increases over time, with the percentage difference in global GDP from the no-damage BAU baseline reaching approx. - 4.72% in 2100.

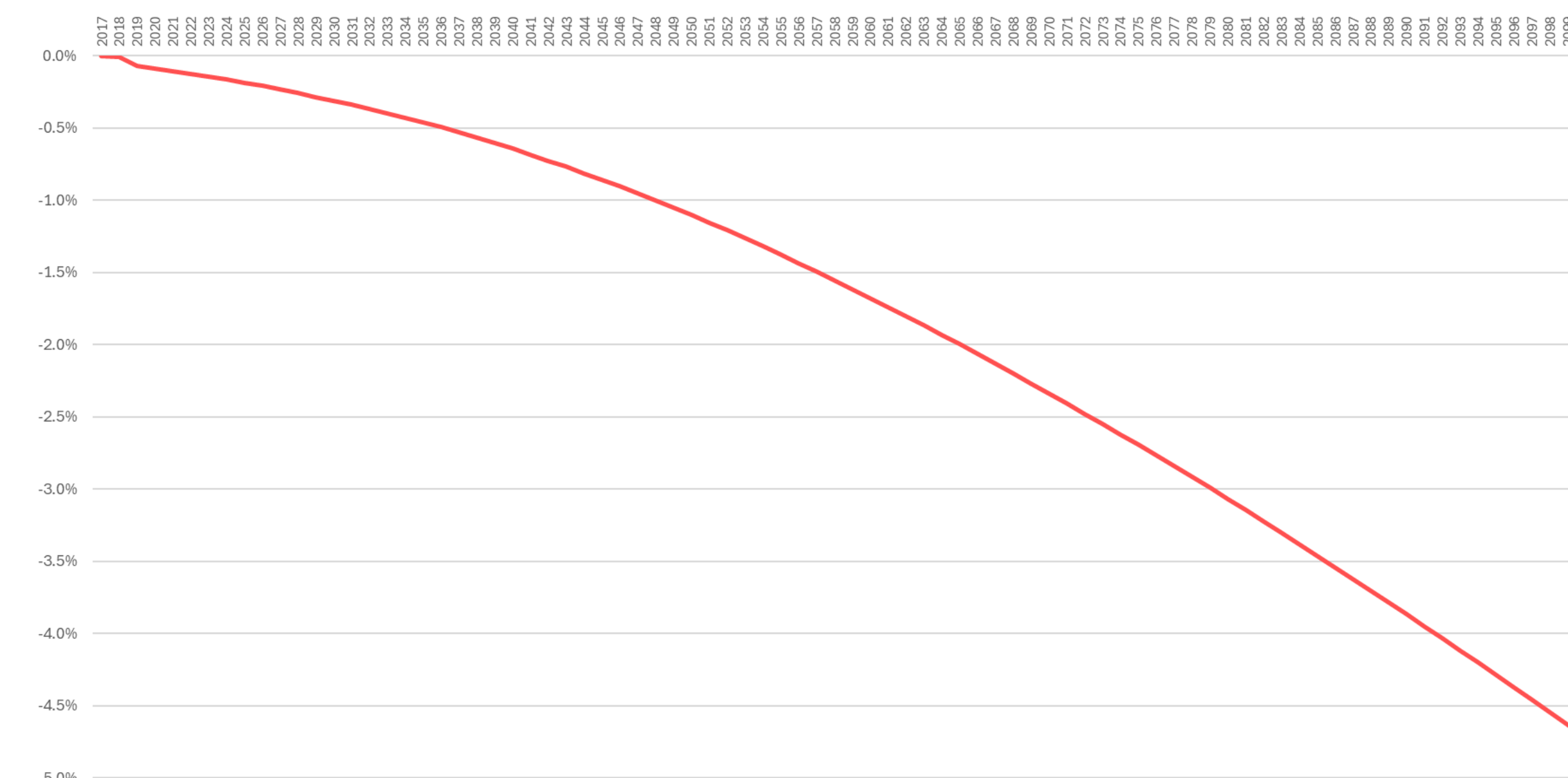


Figure 3. Percentage difference in global GDP from no-damage BAU baseline, 2017-2100

Impacts on Regional GDP (in 2100)

GDP is expected to decline in most regions, with the largest damages in Small Island States and the Middle East. Interestingly, we find positive impacts in regions such as Canada and Central & Eastern Europe.

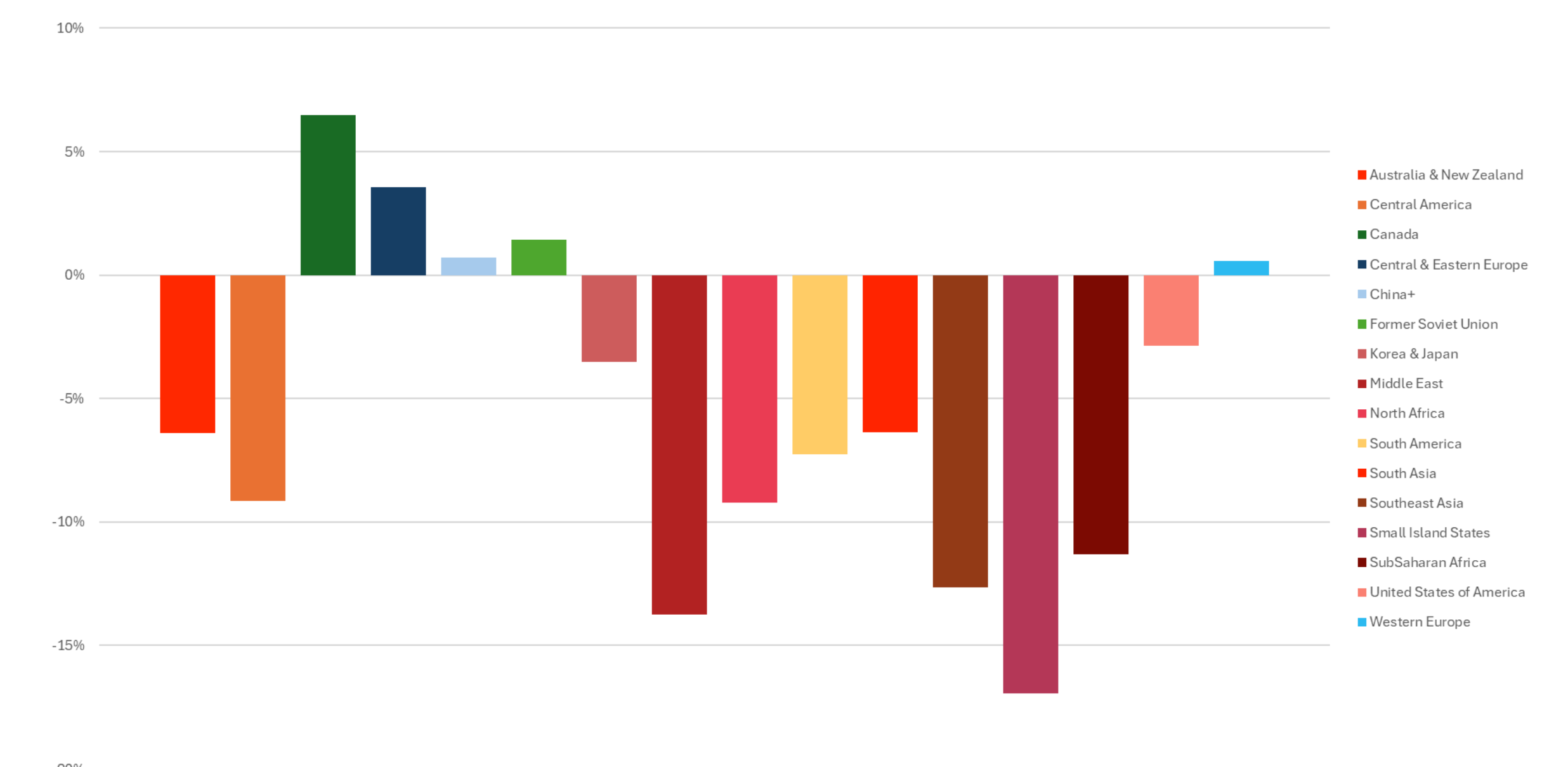


Figure 4. Percentage differences in GDP from no-damage BAU baseline by region, in 2100

Impacts on Sectoral Production (in 2100, as global aggregate & shown by region)

Widespread damages are found for all industry sectors of interest in 2100. Globally, the petroleum-coal products sector is expected to have the largest percentage loss in production relative to the BAU level (- 9.77%). Within each region, the agricultural sector showed notable percentage differences in production compared to BAU in many regions, most significantly in Korea & Japan (- 34.74%), Canada (27.04%), and the Middle East (- 22.15%).

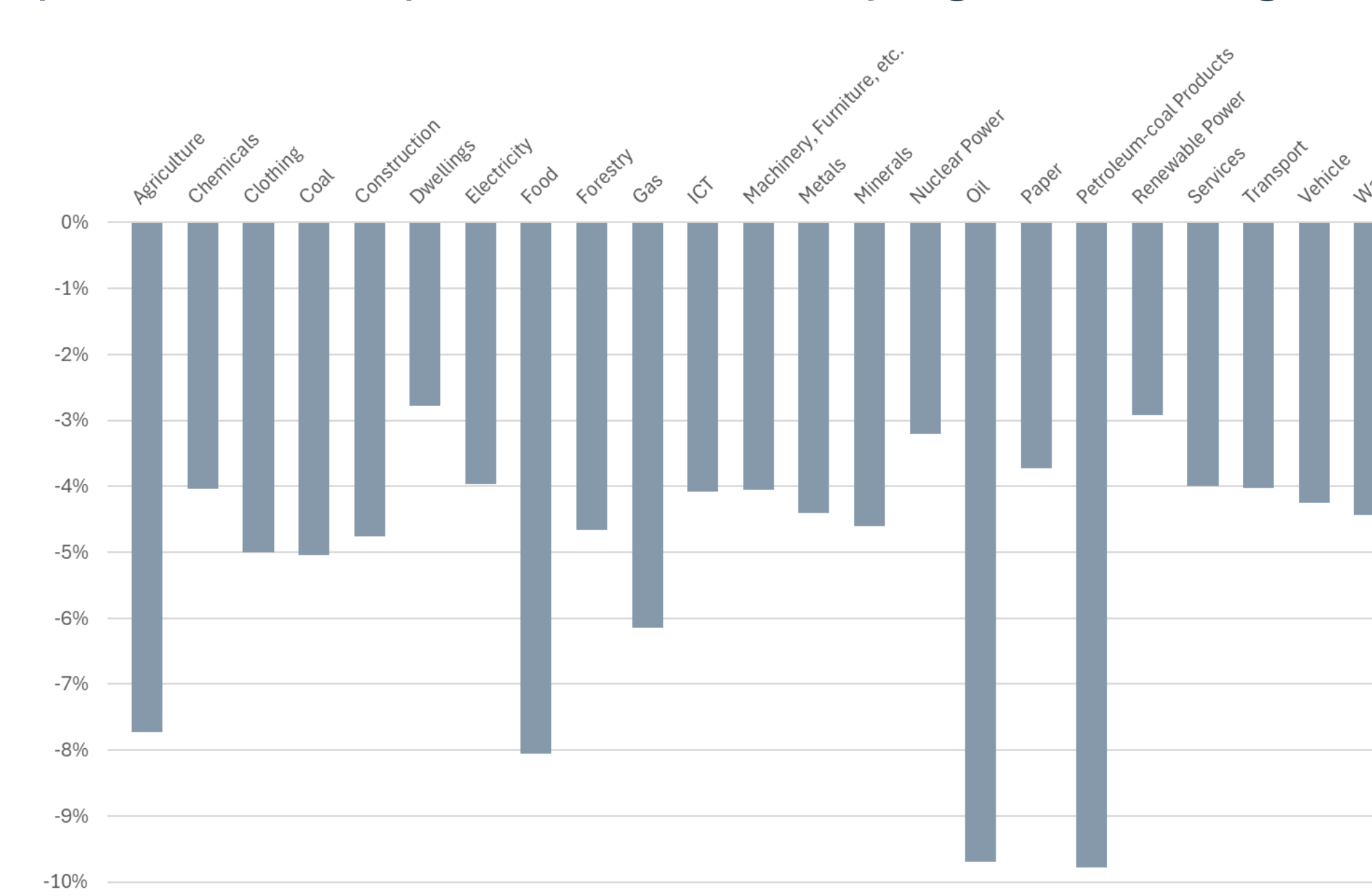


Figure 5. Percentage differences in global sectoral production from no-damage BAU baseline, in 2100

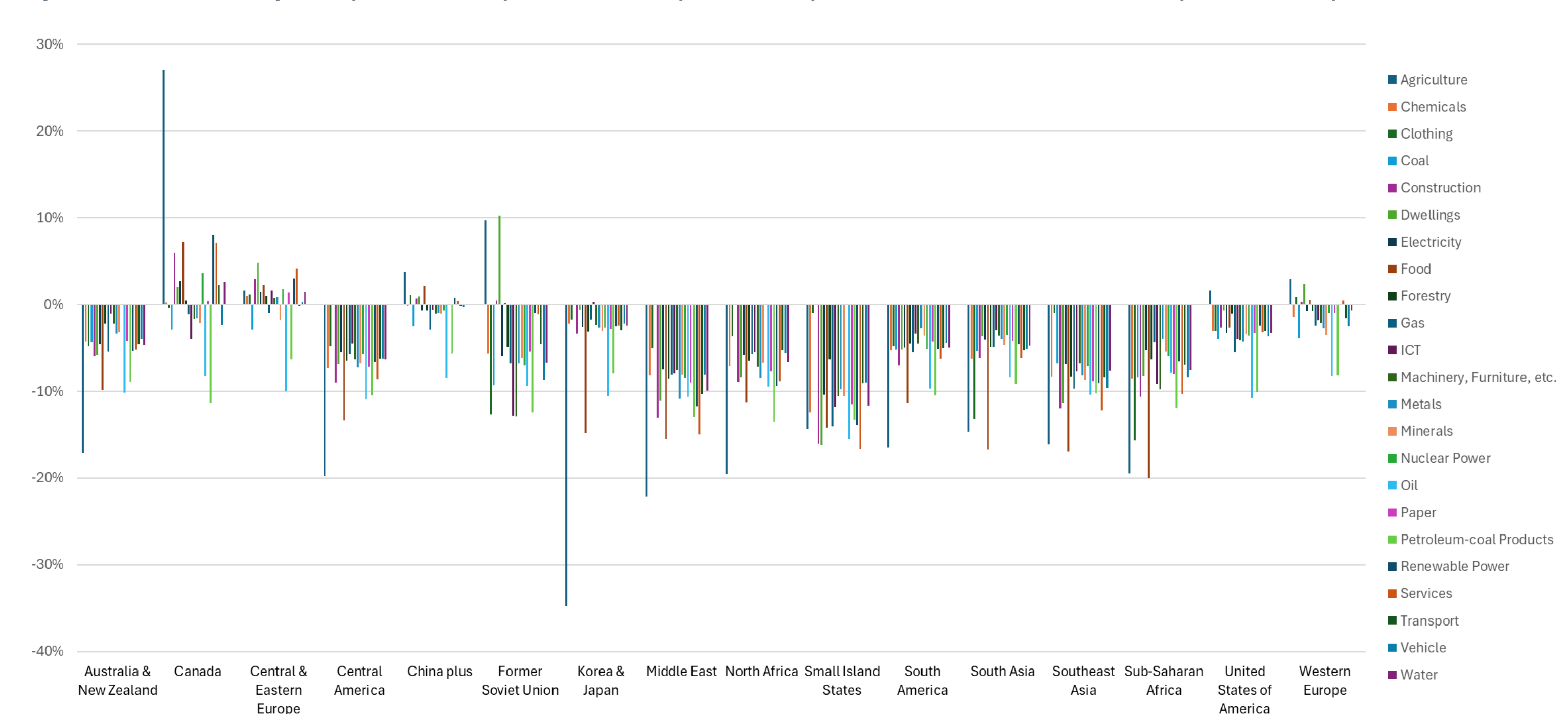


Figure 6. Percentage differences in sectoral production from no-damage BAU baseline by region, in 2100

CONCLUSION

- The economic implications of climate change are far-reaching across various regions and sectors.
- UNICON-IAM enables the comprehensive analysis of regional/sectoral damages, mitigation costs, and adaptation. Our study highlights the importance of integrative modeling and demonstrates the potential to enhance the accuracy of climate change impact assessments.
- Ultimately, we aim to contribute to a better understanding of how climate change affects different regions and sectors, thus facilitating more effective policy responses on multiple levels.