myriad_eu
Reducing risks together

Representation of Indirect Risks

Benjamin Blanz, Davide Ferrario, María García, Elco Koks, Lin Ma, Noemi Padrón, Julius Schlumberger, Nikita Strelkovski, Jana Sillmann

Cross Border Climate Change Impacts Conference
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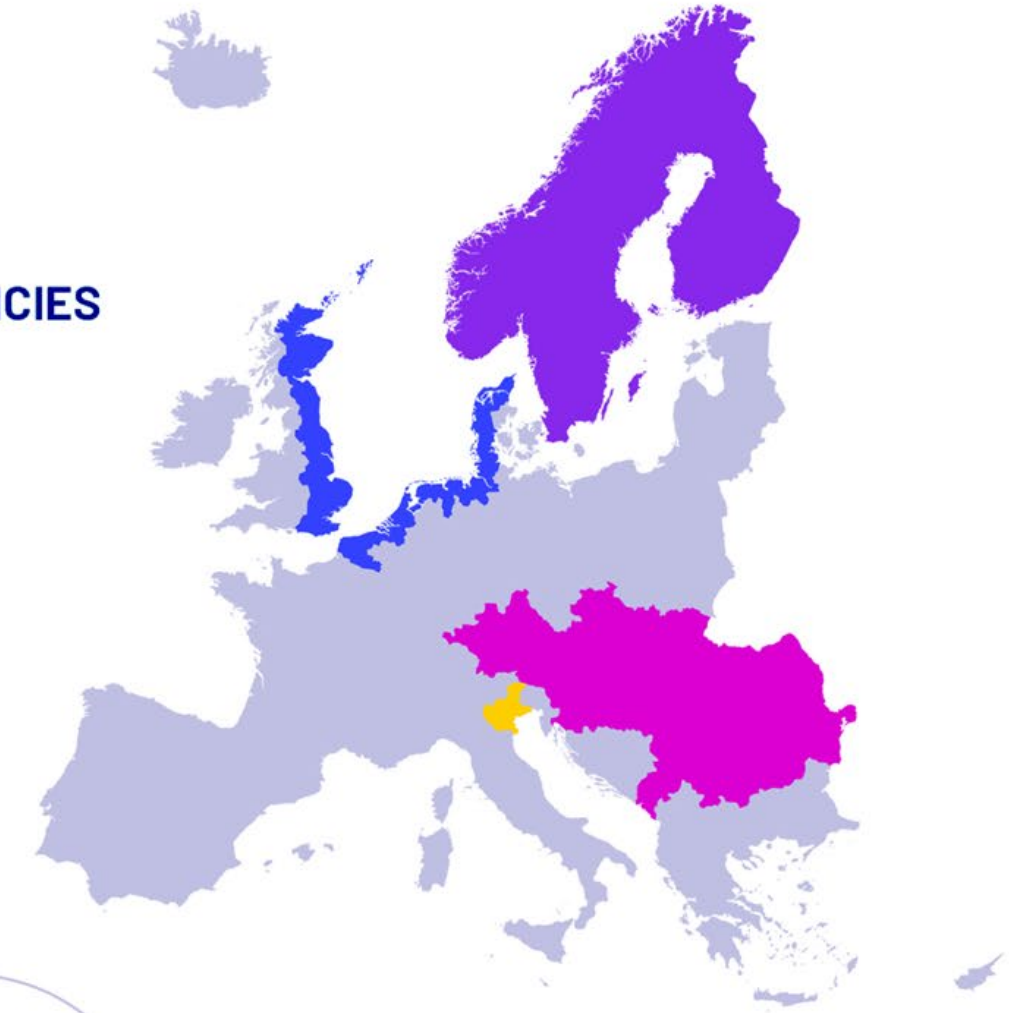
Reducing risks together

SYSTEMIC RISK INTERDEPENDENCIES THROUGHOUT EUROPE



NORTH SEA

SECTOR
- ECOSYSTEMS & FORESTRY
- ENERGY
- INFRASTRUCTURE & TRANSPORT

HAZARDS
- Biological hazard
- Extreme wind
- Flood
- Heat
- Storm
- Thunder and hail

SCANDINAVIA

SECTOR
- ECOSYSTEMS & FORESTRY
- ENERGY
- FOOD & AGRICULTURE

HAZARDS
- Biological hazard
- Drought
- Fire
- Flood
- Heat
- Snow

DANUBE

SECTOR
- FINANCE
- FOOD & AGRICULTURE
- INFRASTRUCTURE & TRANSPORT

HAZARDS
- Drought
- Earthquake
- Flood
- Heat
- Landslide
- Thunder and hail

CANARY ISLANDS

SECTOR
- ENERGY
- FOOD & AGRICULTURE
- TOURISM

HAZARDS
- Earthquake
- Flood
- Landslide
- Storm
- Tsunami
- Volcano

VENETO

SECTOR
- ECOSYSTEMS & FORESTRY
- FINANCE
- TOURISM

HAZARDS
- Biological hazard
- Drought
- Fire
- Flood
- Landslide
- Snow

Effects of Hazards

Total impact of a hazard

- Direct Effects
  - Sectoral, local and immediate impact of a hazard
- Indirect Effects
  - Intersectoral:
    - knock on effects between sectors
  - Interregional:
    - knock on effects between regions
  - Intertemporal:
    - persistence and dynamics of effects

Modelling Methods used in myriad_eu

- Veneto Pilot
  - Empirical and Machine Learning Methods
- Scandinavian Pilot
  - Computational General Equilibrium model GRACE
- Danube Pilot
  - Macroeconomic Agent Based Model
- Canary Islands Pilot
  - Descriptive Impact Assessment
- North Sea Pilot
  - Dynamic Adaptive Policy Pathways – Integrated Assessment Meta Models
- WP5 with VUE
  - Multiregional Impact Assessment Model

Comparing Models

	1	2	3	4	5
Spatial Resolution	Global	National	Coarse Grid / NUTS 2	Fine Grid / NUTS 3	Household
Temporal Resolution	Multiyear timestep	Yearly	Coarse sub year	Monthly	Daily
Sectoral Coverage	Single production function	Single explicit sector others aggregated	2-6 Sectors	Single digit industry identifier 7-20 Sectors	Two digit industry identifier >20 Sectors
Regional Coverage	Single subnational region	national	multinational region	multi continent	whole globe
Time/Prediction Horizon	sub year	single year	decade	century	centuries
Computational Requirements	long on supercomputer	fast on supercomputer		long on laptop	fast on laptop

Comparing Models: Indirect Effects

	1	2	3	4	5
Intersectoral indirect effects	only direct effects		linear sectoral dependencies		non-linear sectoral dependencies
Interregional indirect effects	only local effects		simple trade or physical links between regions		detailed trade and physical feedbacks
Intertemporal indirect effects	only contemporary effects		simple lagged effects		fully dynamics representation of effects

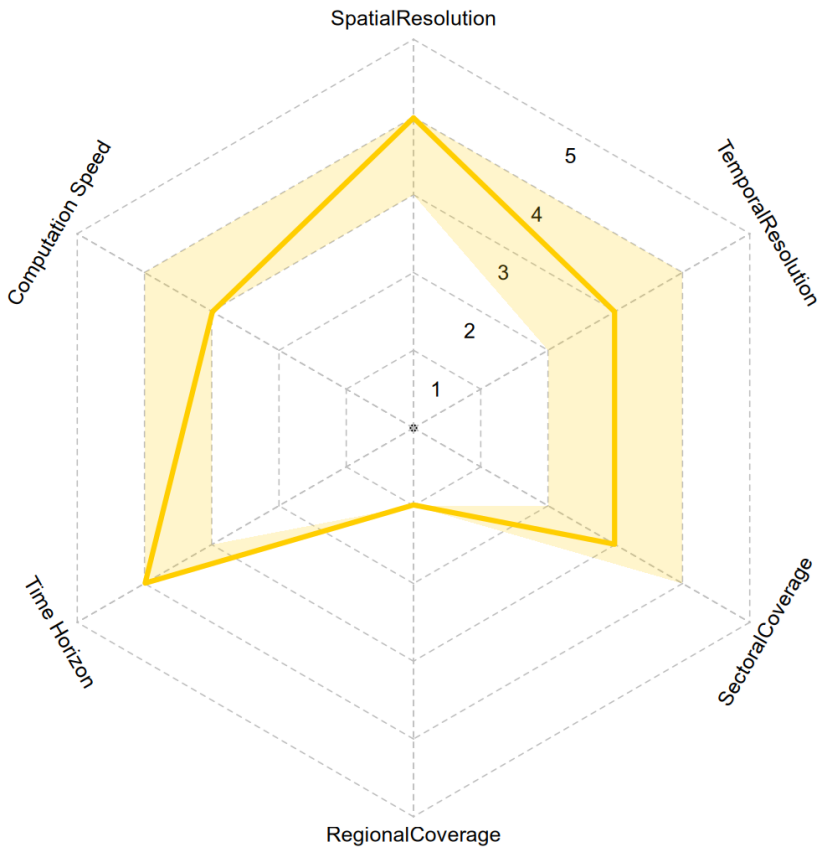
Indirect effect representation is quantified within the bounds of the modelling approach. E.g. it is possible to have a highly detailed representation between two sectors.

Empirical and ML Modelling

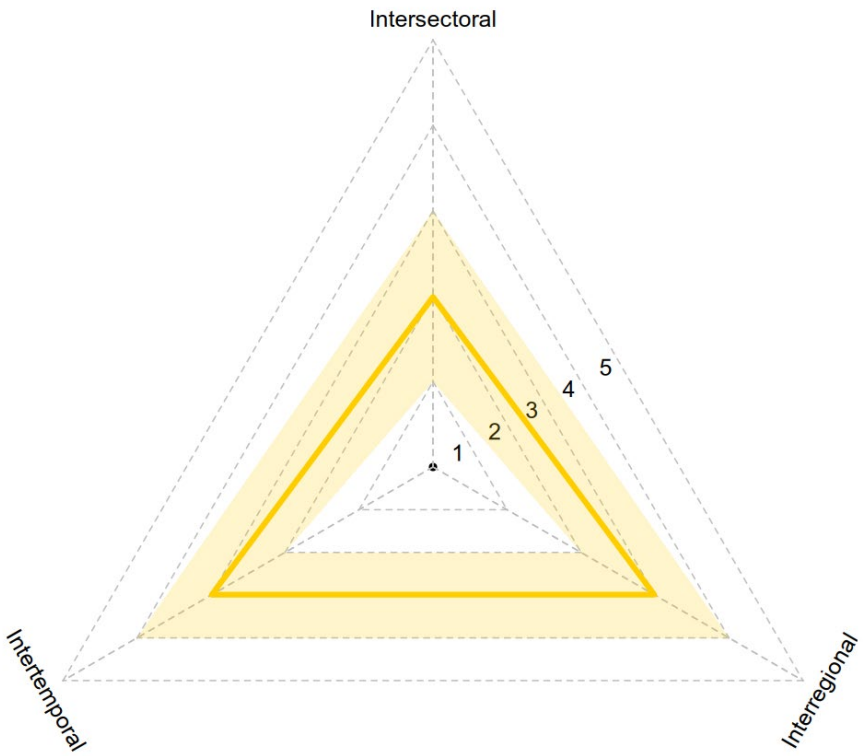
- Neural networks for sector specific endpoints
  - Water quality along river flows
  - Vegetation stress
  - Tourism numbers
- Indirect effects captured by the connectivity within the neural net

Empirical and ML Modelling

General Descriptives



Representation of indirect Effects



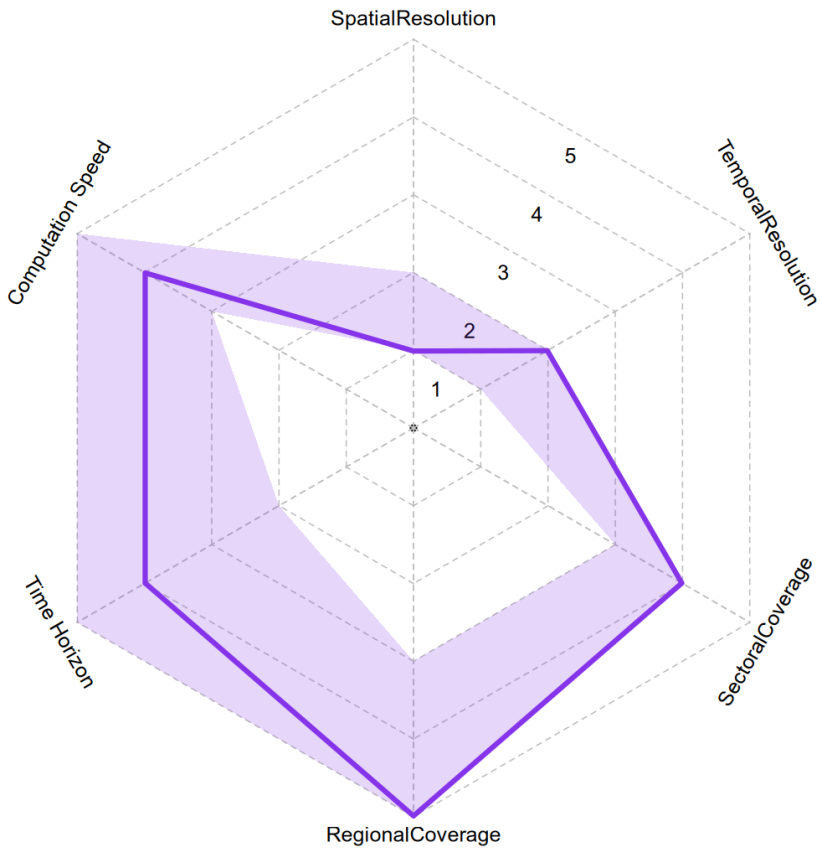
CGE (GRACE)

- Global model: Country level or aggregated regions
- Annual time step
- Regional myopic optimising behaviour
- Detailed interdependent sectoral production
  - Elastic substitution of inputs
- Endogenous international trade

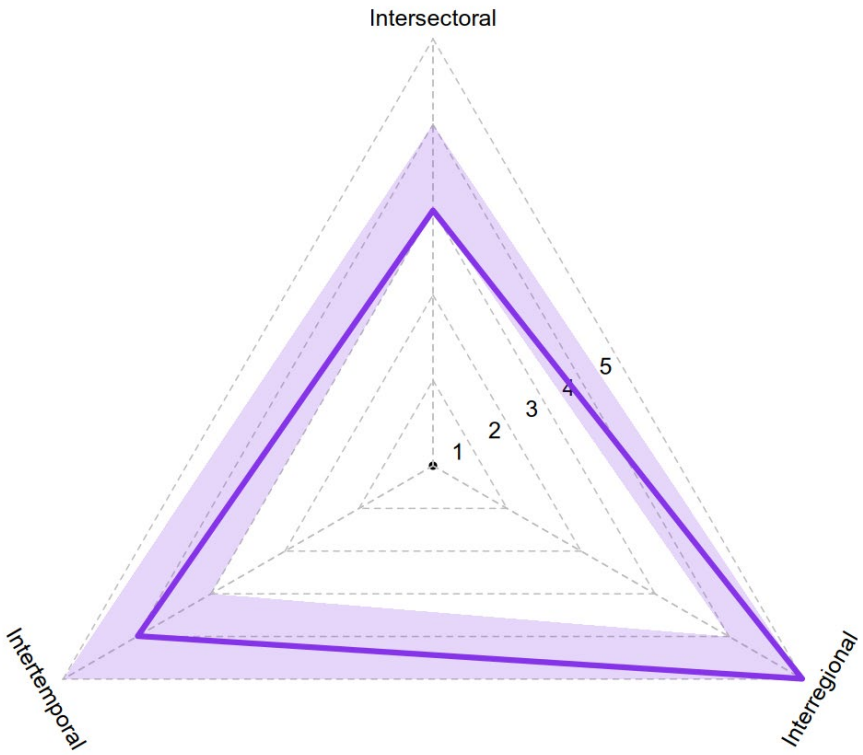
Aaheim, H. A., Orlov, A., Wei, T., & Glomsrød, S. (2018). GRACE model and applications. *CICERO Report*.

CGE (GRACE)

General Descriptives



Representation of indirect Effects



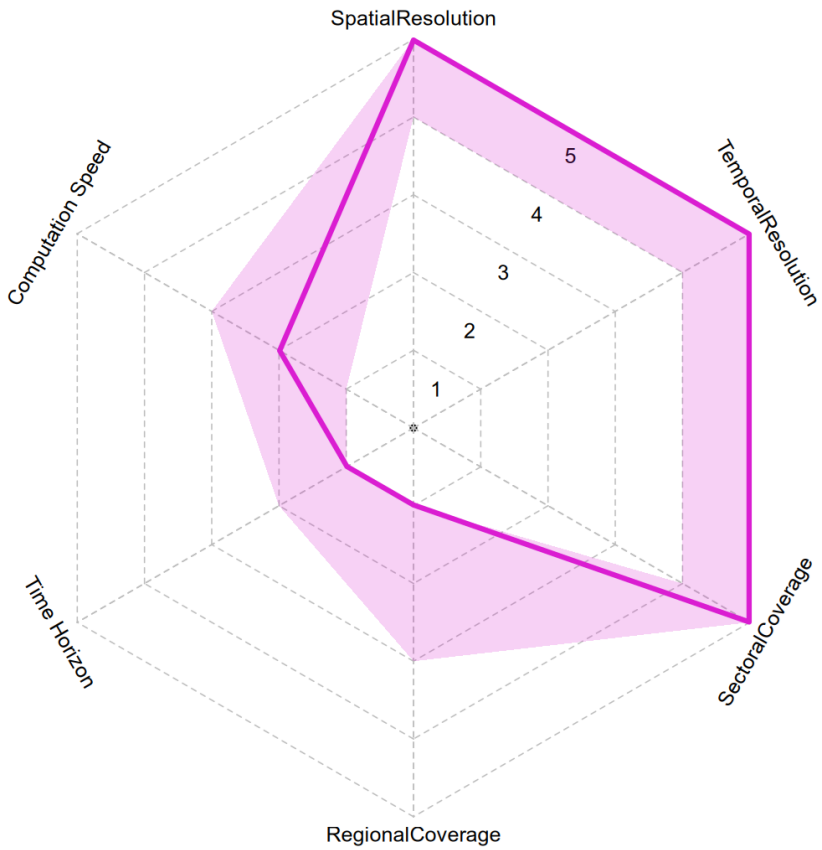
Macroeconomic Agent Based Model

- Regional model: Country level or subnational regions
  - Pan European extension
- Resolves all actors in the economy
  - Individual households and firms, banks, government
- Boundedly rational forward looking behaviour
- Quarterly time step
- Detailed interdependent sectoral production
  - Fixed input ratios
- Exogenous international trade
  - Endogenous within modelled region

Poledna, S., Miess, M. G., Hommes, C., & Rabitsch, K. (2023). Economic forecasting with an agent-based model. *European Economic Review*, *151*, 104306. https://doi.org/10.1016/j.euroecorev.2022.104306

Macroeconomic Agent Based Model

General Descriptives



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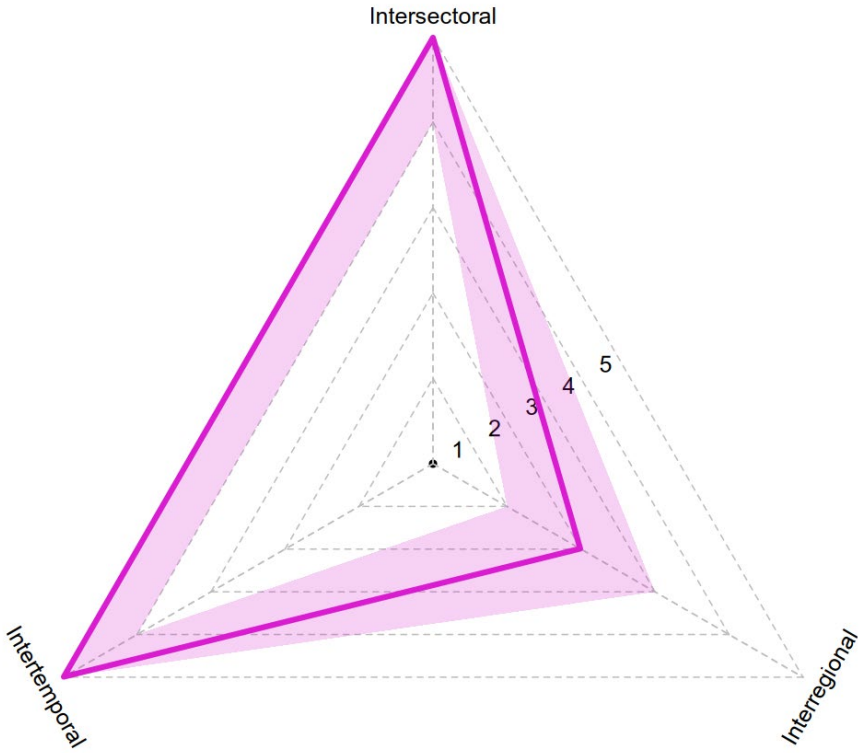
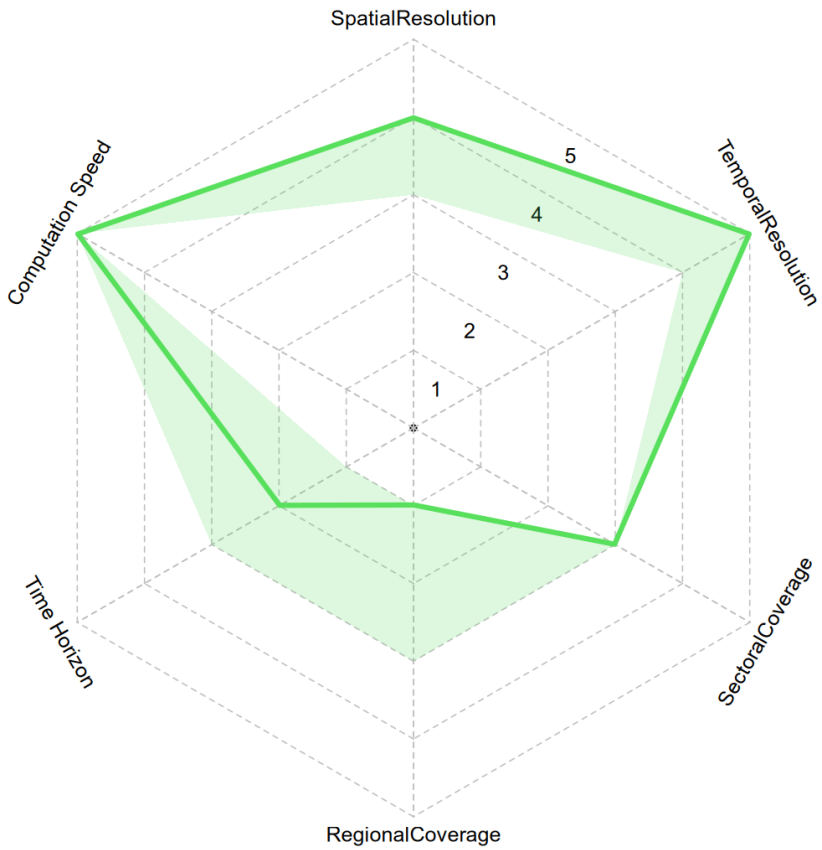


Descriptive Methods

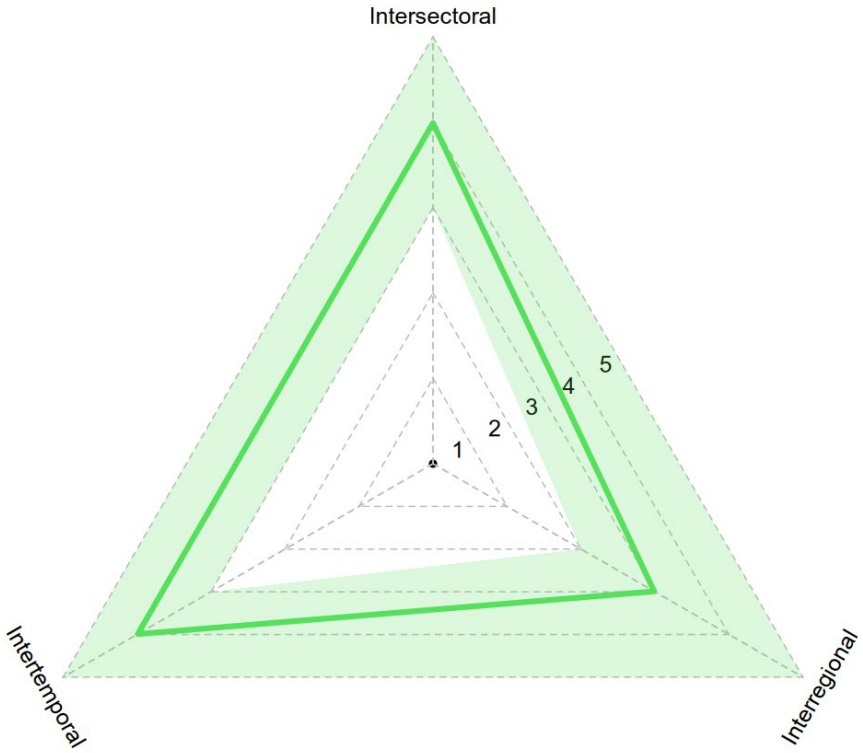
- Detailed description of impact relationships not limited by model structures.
- Natural Hazards are partially independent
  - Geological and meteorological hazards
- Adaptation measures shift multi-risks from one territorial space to another
  - Avoiding geological hazards increases exposure to meteorological hazards
- Two sectors compete for land and water:
  - housing for tourism/residents and agriculture/farming

Descriptive Methods

General Descriptives



Representation of indirect Effects



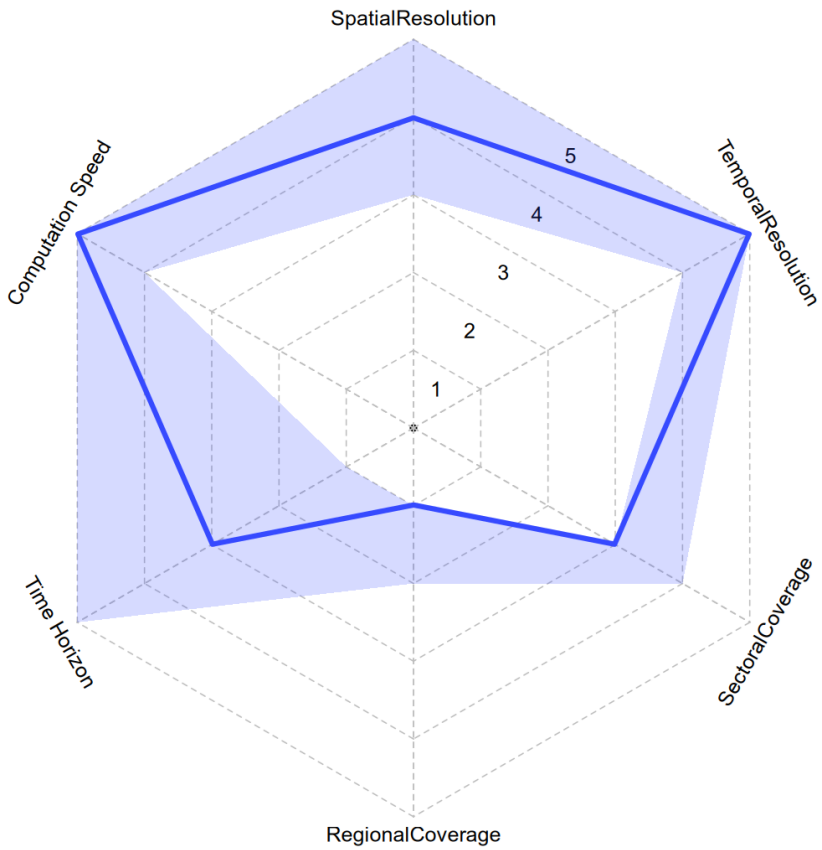
Dynamic Adaptive Policy Pathways – Integrated Assessment Meta Models

- Dynamic Adaptive Policy Pathways
  - Evaluation of multiple policy options over time
- Integrated Assessment Meta Models
  - Emulator of more complex impact assessment models
  - Combines impact assessment of multiple impact types
  - Fast
- Combined in a representative sector agent model
  - Urban
  - Agriculture
  - Shipping

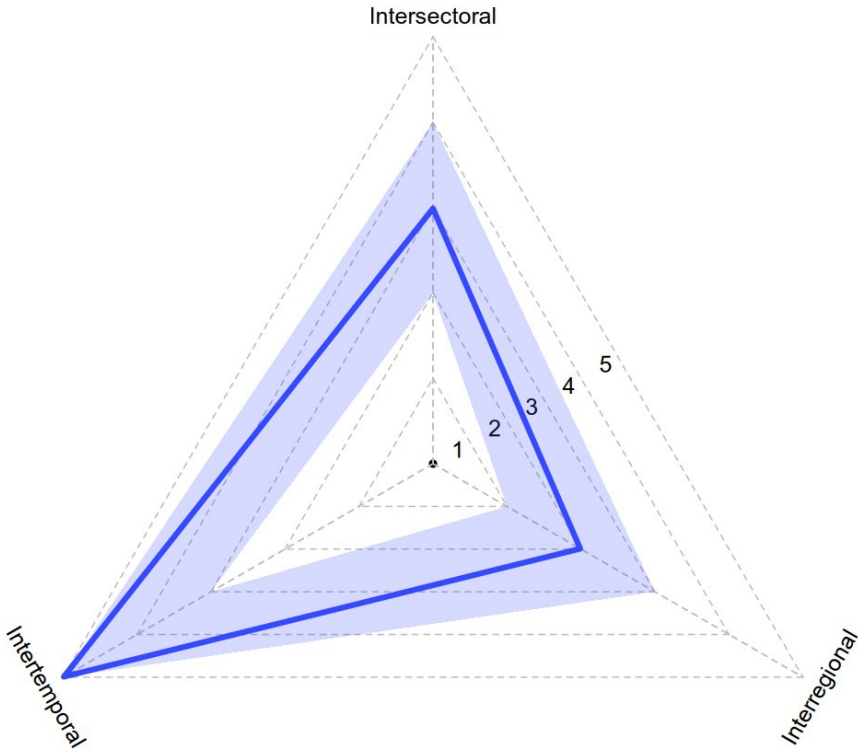
Haasnoot, M., Van Deursen, W. P. A., Guillaume, J. H. A., Kwakkel, J. H., Van Beek, E., & Middelkoop, H. (2014). Fit for purpose? Building and evaluating a fast, integrated model for exploring water policy pathways. *Environmental Modelling & Software*, *60*, 99–120. https://doi.org/10.1016/j.envsoft.2014.05.020

Dynamic Adaptive Policy Pathways – Integrated Assessment Meta Models

General Descriptives



Representation of indirect Effects



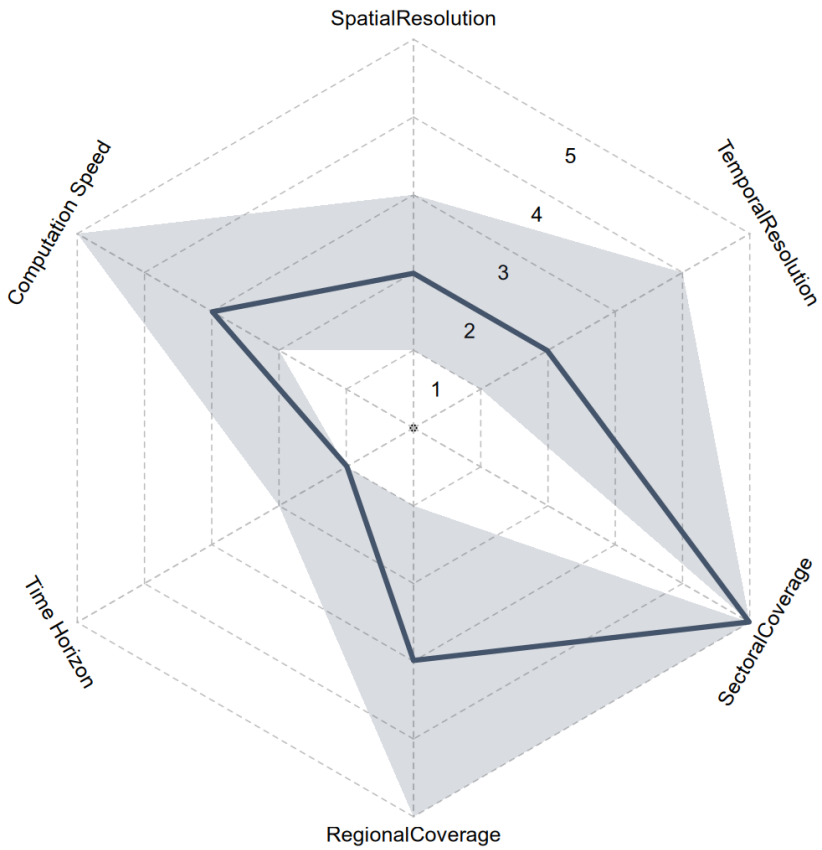
Multiregional Impact Assessment Model (MRIA)

- Pan European model at NUTS 2 level -> built on top of EUREGIO database
- Interregional trade connections
- Input-Output modelling with linear optimization
  - (Multiregional) substitution possibilities
  - Regional production technologies
- Dynamic recursive time dynamics

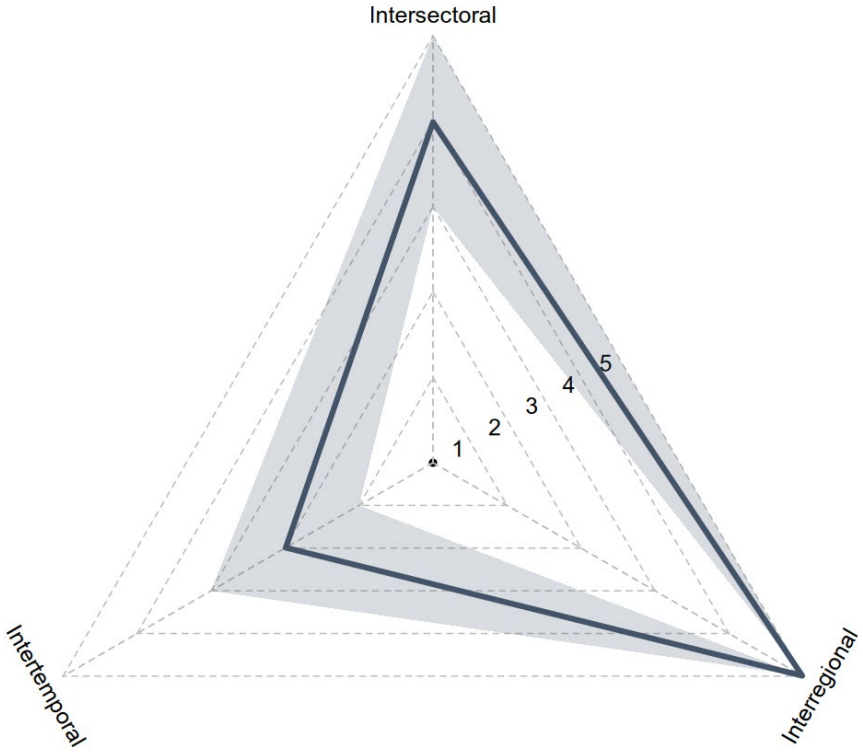
Koks, E. E., & Thissen, M. (2016). A Multiregional Impact Assessment Model for disaster analysis. *Economic Systems Research*, *28*(4), 429–449. https://doi.org/10.1080/09535314.2016.1232701

Multiregional Impact Assessment Model (MRIA)

General Descriptives

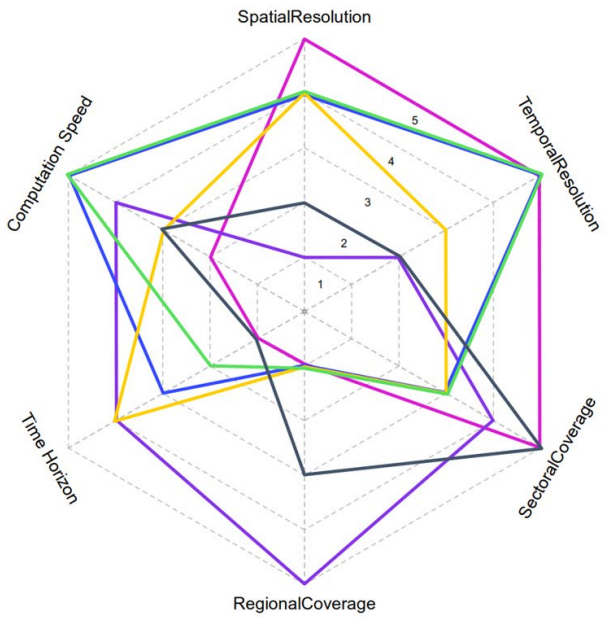


Representation of indirect Effects

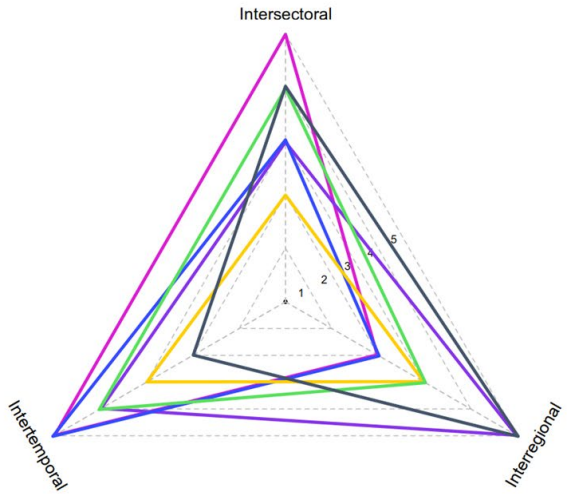


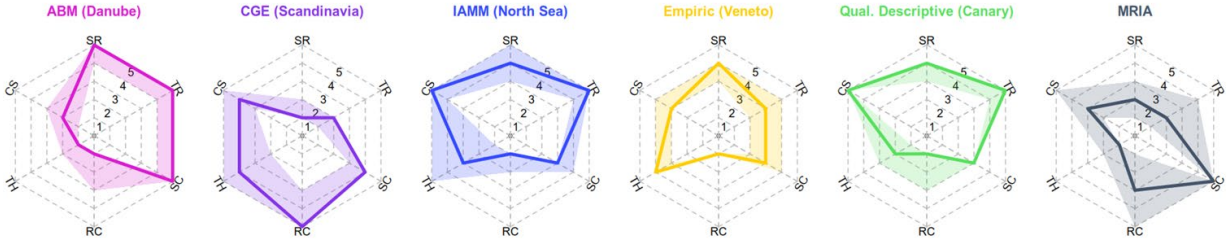
Comparison of Modelling Approaches

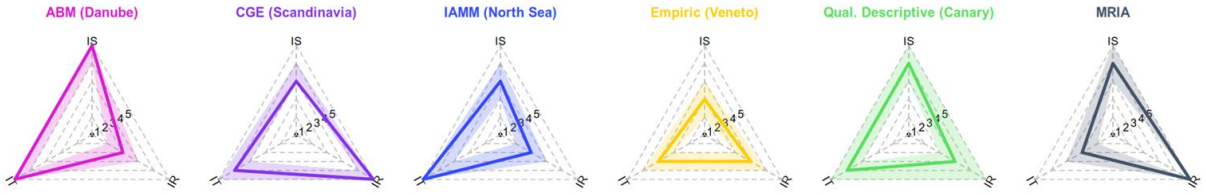
General Descriptives



Representation of indirect Effects







Outlook

- Evaluation of common hazard sets
  - Comparison of magnitude of indirect effects predicted
    - Sectors affected
    - Area affected
    - Persistence of effects
- Hazard sets
  - Floods
  - Earthquakes
  - Heat
  - …

Conclusion

- Indirect effects can make up a large part of the total impact of hazards
- Models are constructed for different research questions
  - Trade off between coverage, resolution and computational requirements
- Quantification of indirect effect magnitude in models with more resolution or coverage could be emulated in more compact models.

Get in touch

www.myriadproject.eu

benjamin.blanz@uni-hamburg.de