



Physical and hybrid multi-regional models to assess material flows and related impacts

Dr. Stefan Giljum

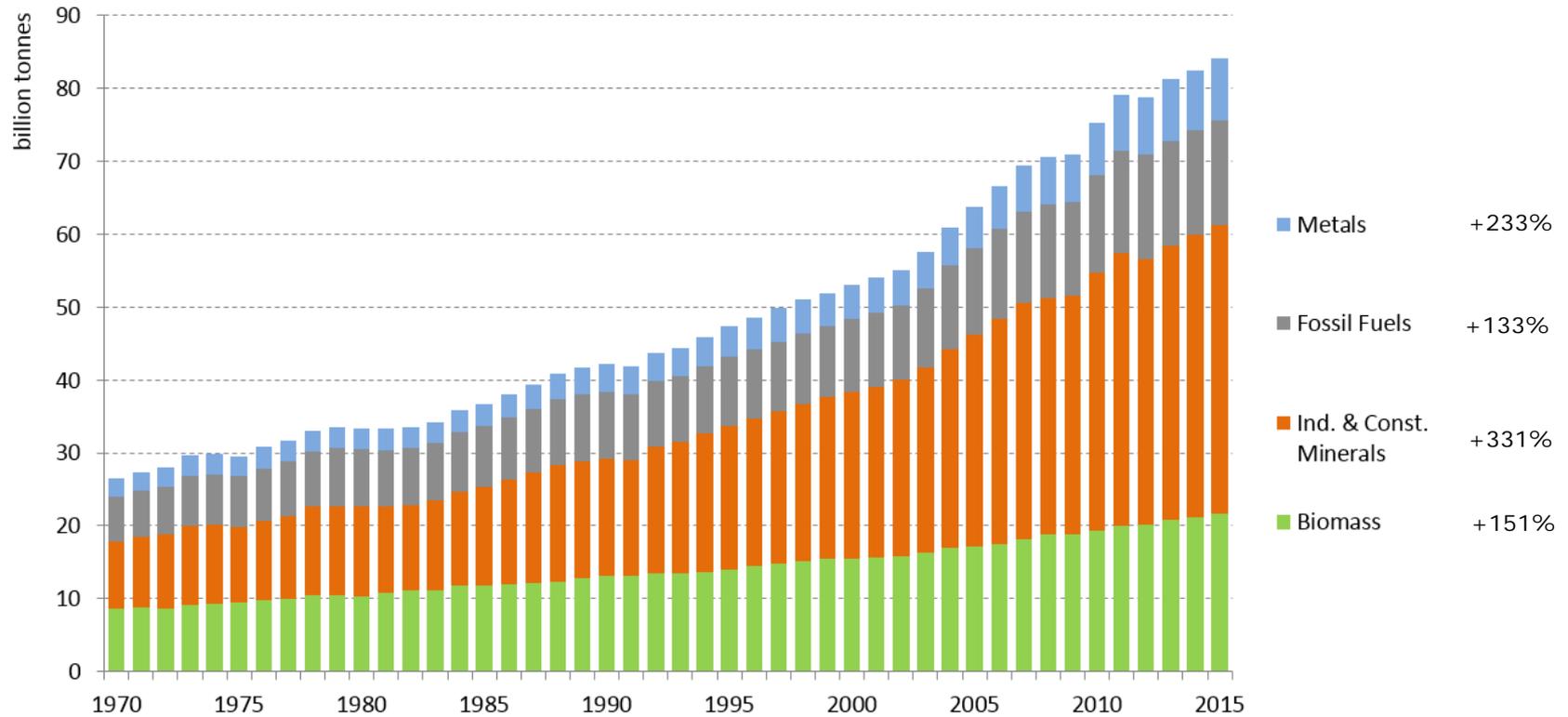
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1. Economy-wide material flow accounting on the global level
2. Multi-regional input-output (MRIO) models of material flows
3. Future research directions
 - i. Global physical input-output models
 - ii. Spatially-explicit MRIO models to assess impacts

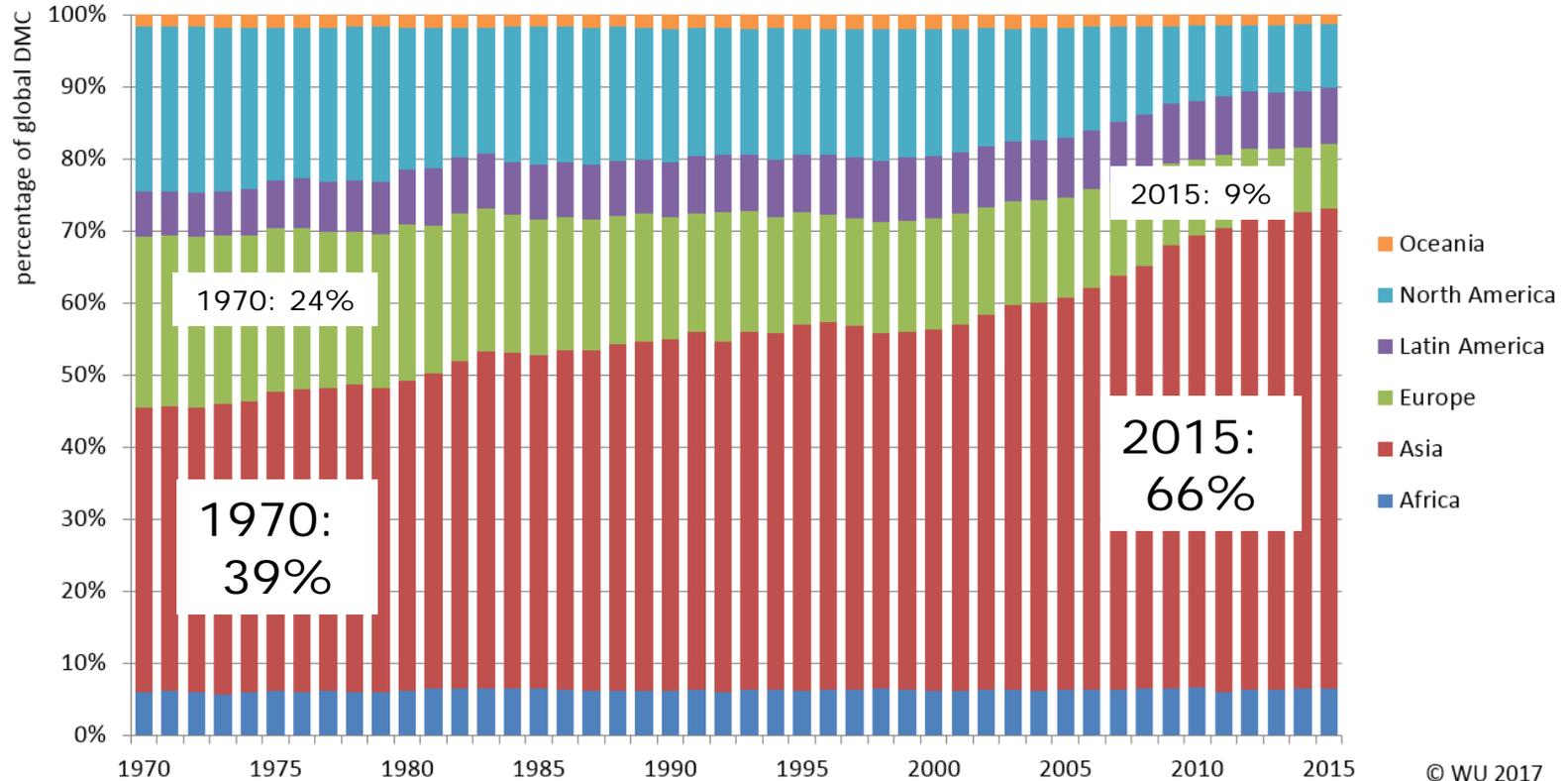
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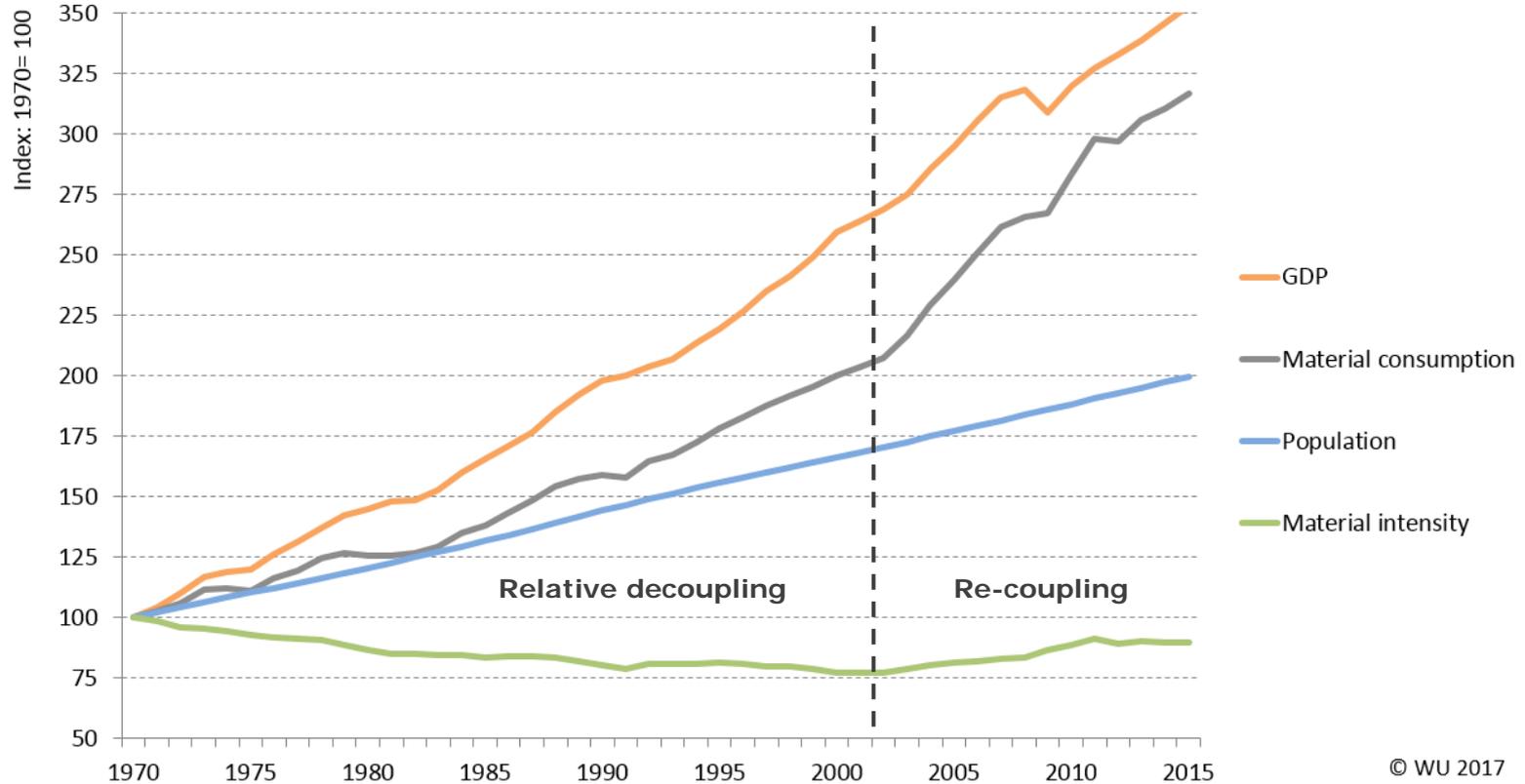
Increasing global material consumption



Growing role of emerging economies



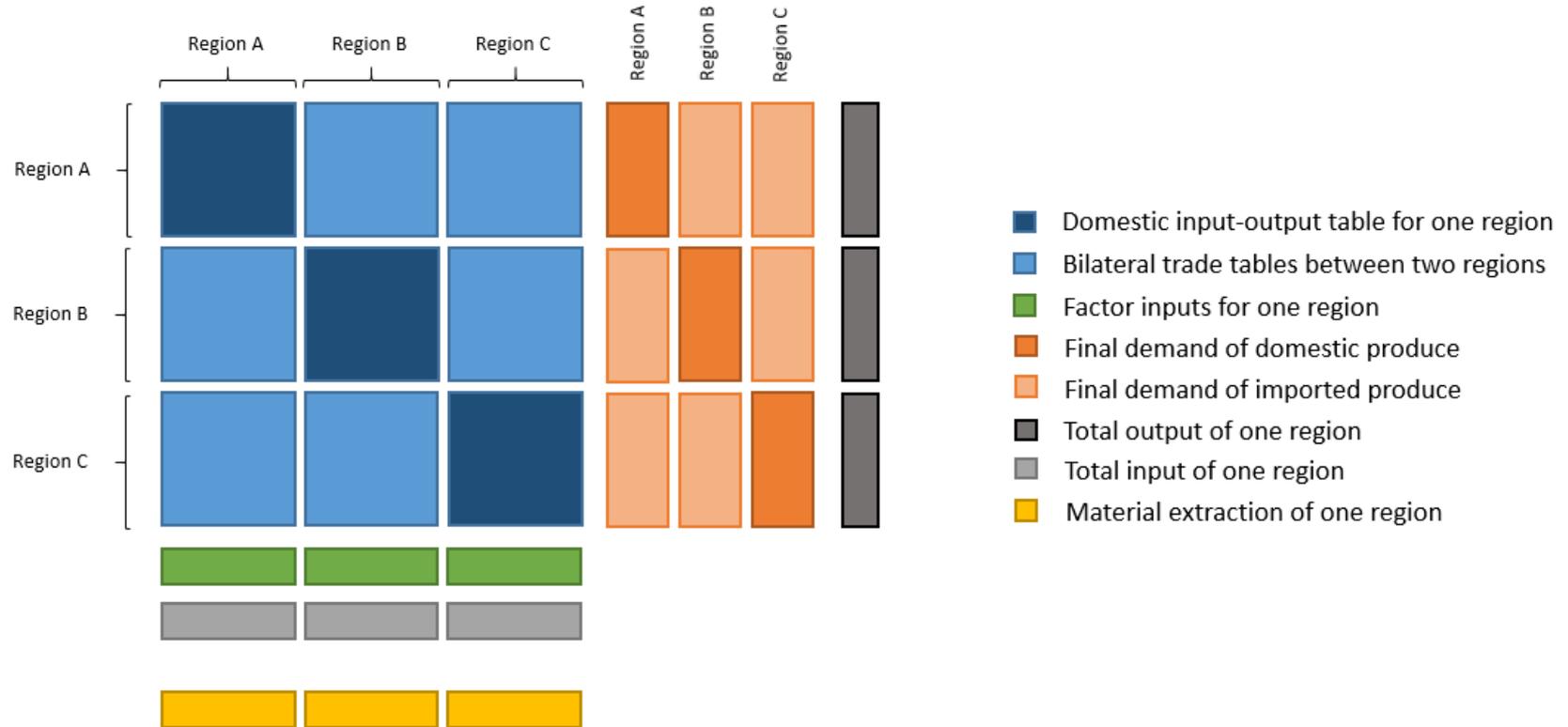
Re-coupling of material consumption and economic growth



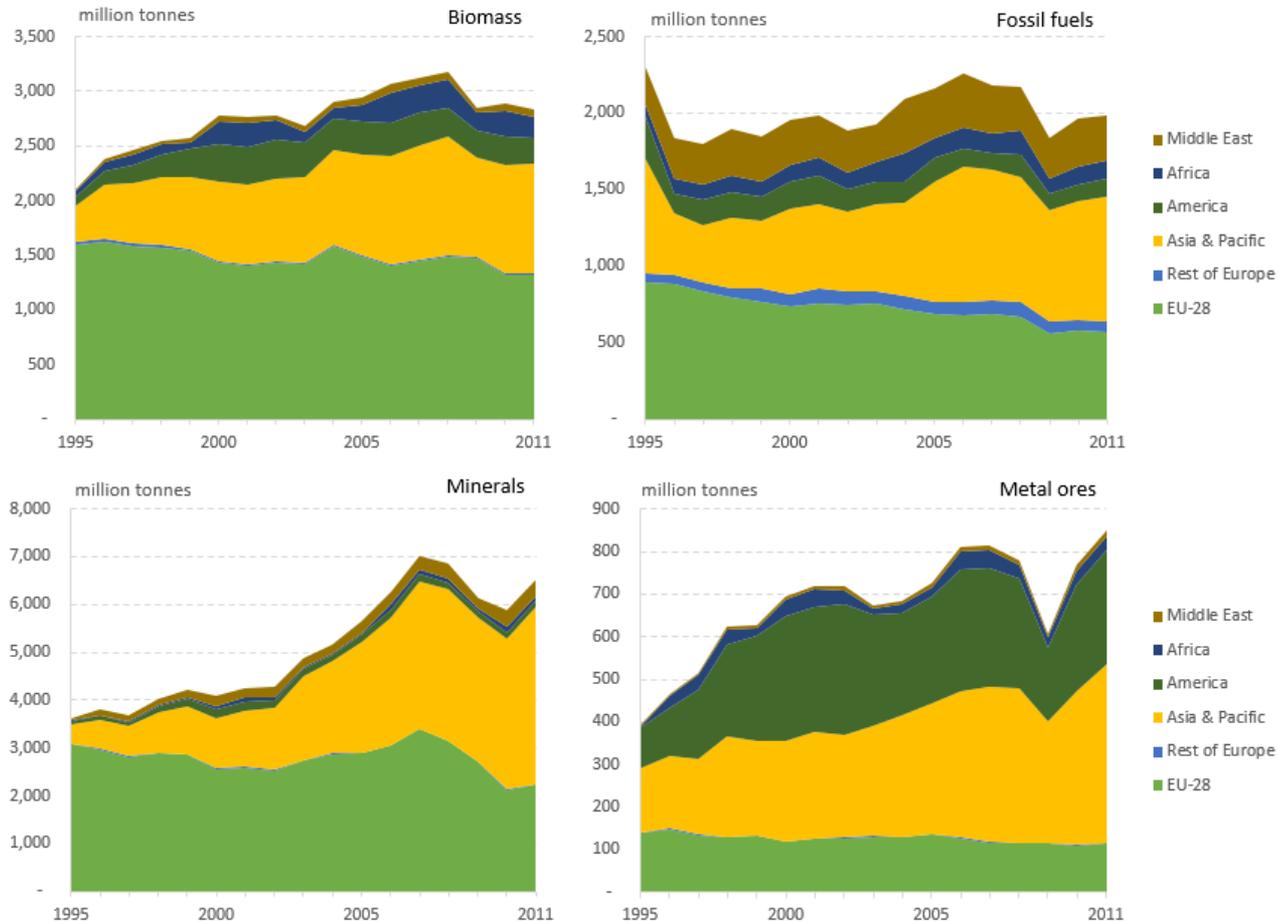
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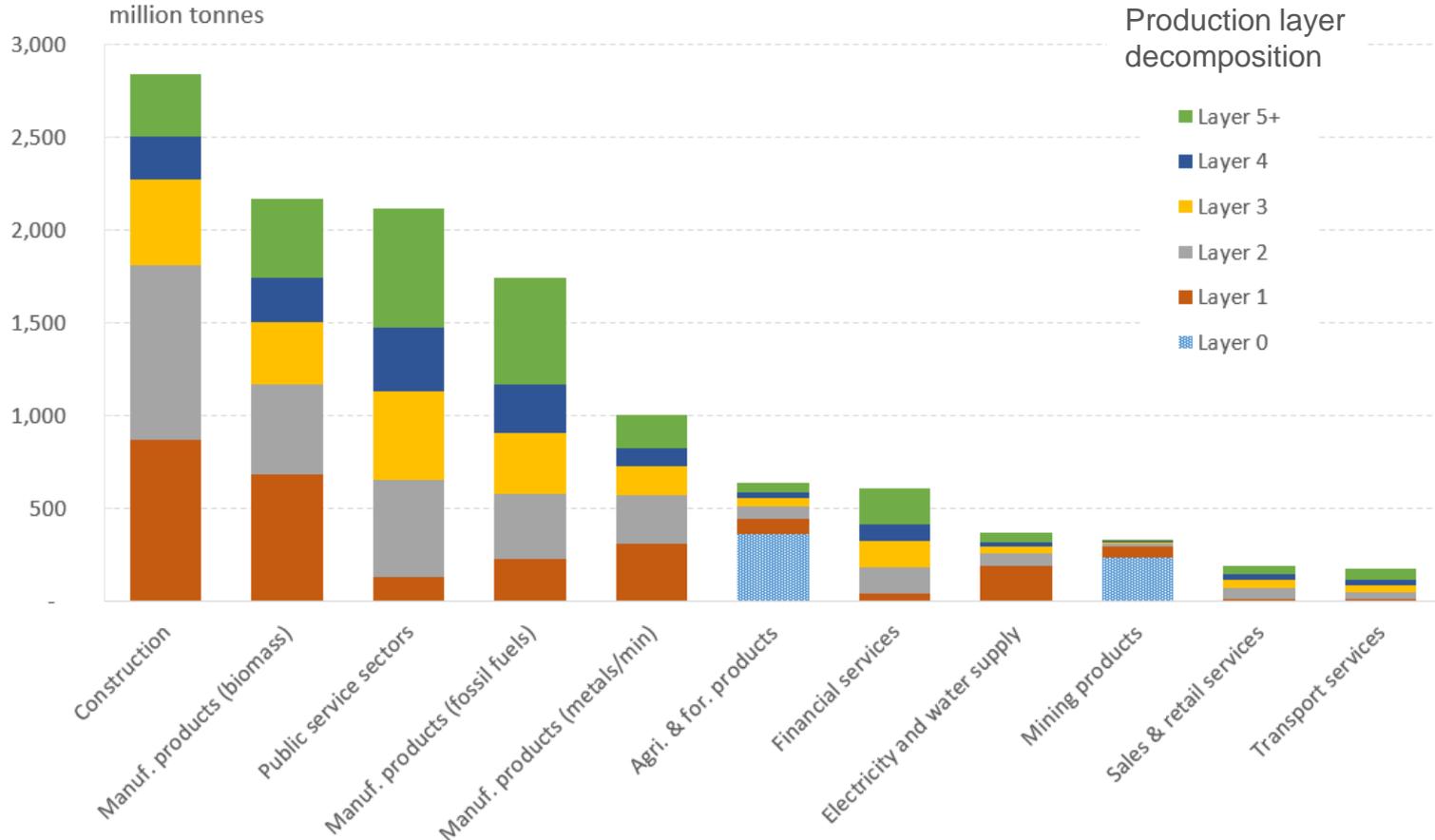
Environmental, multi-regional input-output (MRIO) models



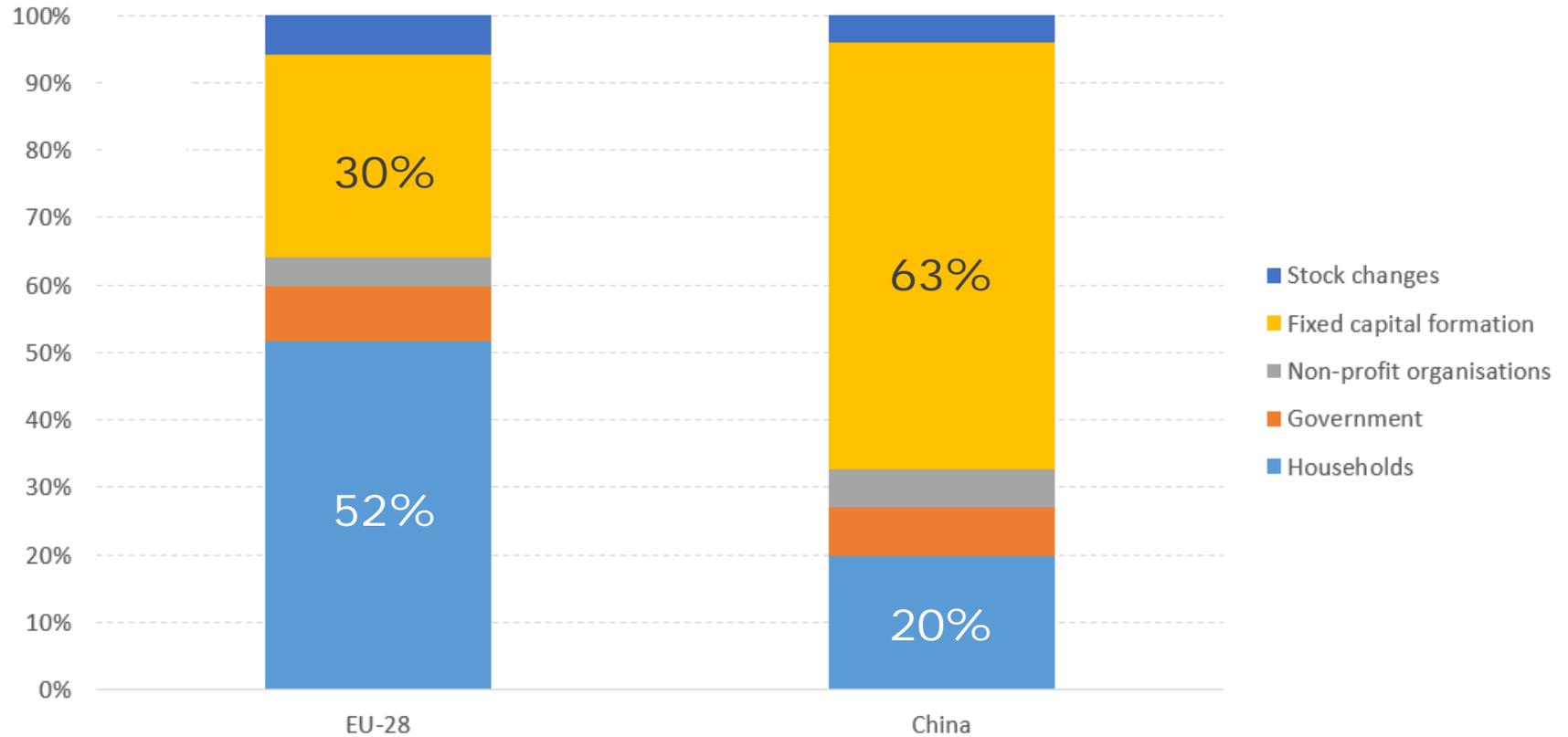
Geographical origin of EU-28 material footprint (MF)



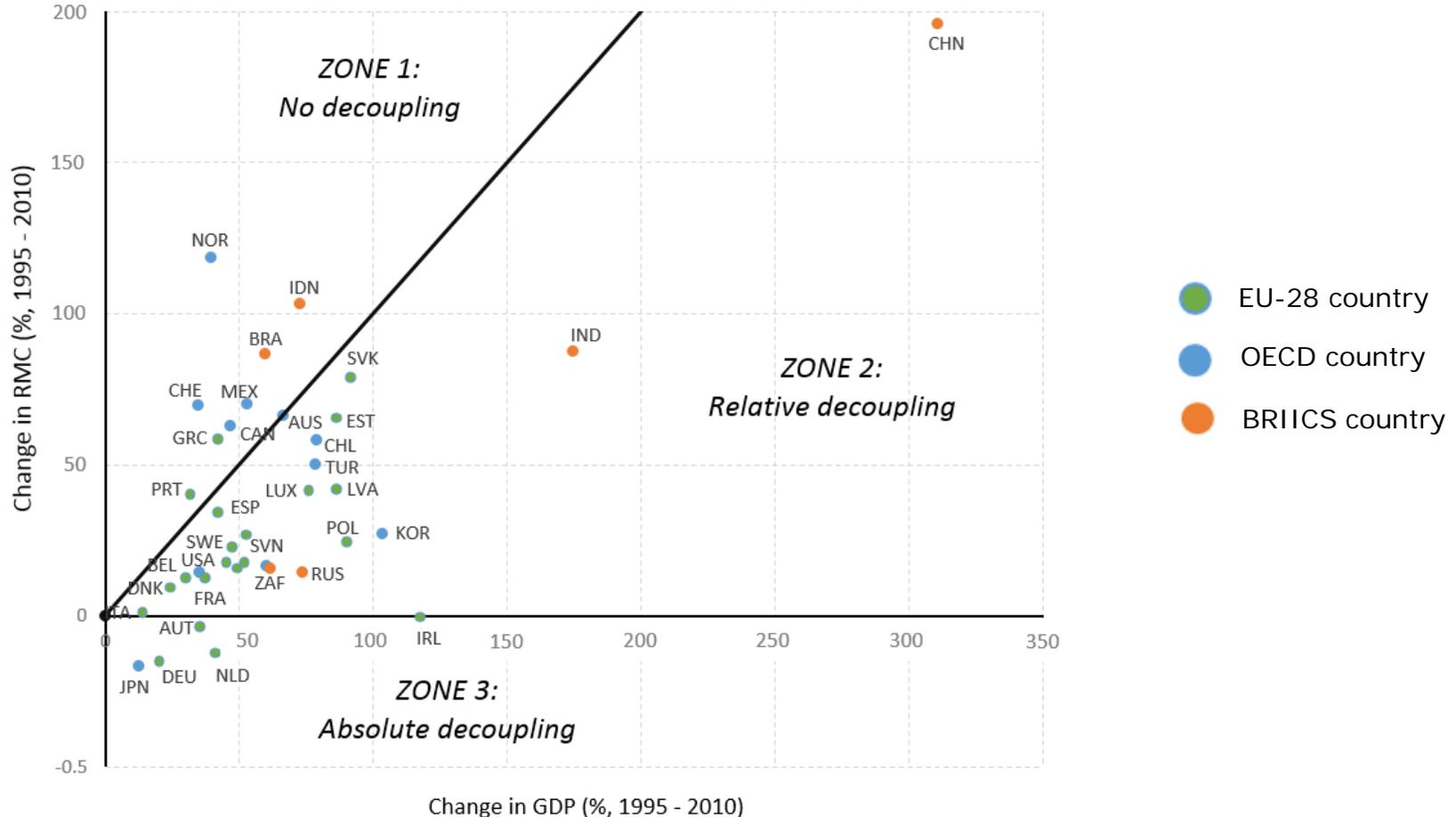
Material footprint of EU-28 by product groups, 2011



Composition of MF by final demand categories, 2011



Decoupling of material footprint from economic growth



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Challenges in MFA-MRIO

Material extraction concentrated in a few sectors (in contrast to other environmental factors, e.g. carbon emissions):

1. Resolution in extraction sectors is key, otherwise **aggregation errors** due to different use structures of different raw materials
2. Allocation based on monetary data in IOTs often problematic (different value-to-weight ratios) → **proportionality errors**
3. Mismatch between material flow data in physical units and the monetary data in the IOTs → **consistency errors**

From monetary to physical MFA-MRIO systems

Advantages of using physical data:

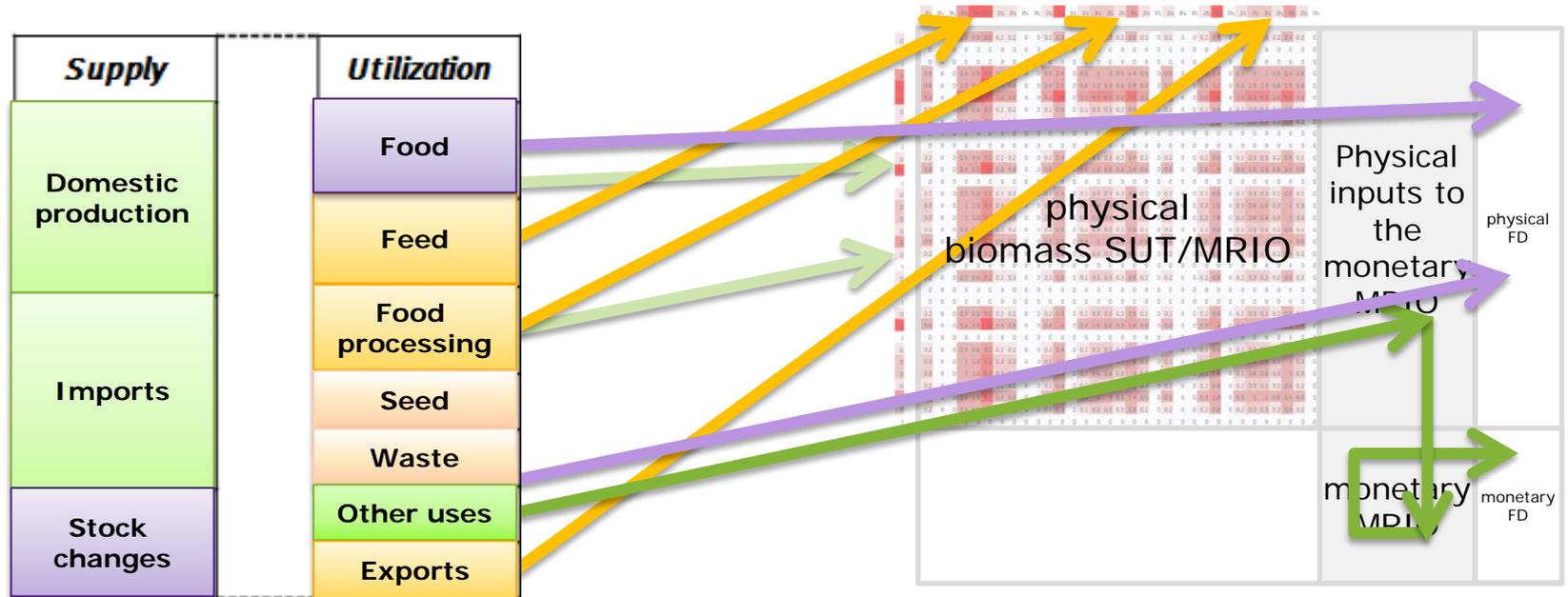
- Keep high product detail (avoid aggregation errors)
- Keep physical perspective and allocation logic (avoid proportionality and consistency errors)

- Step 1: “Use extensions”, i.e. model first processing stages in physical units and allocate to using sector
- Step 2: Full physical MFA-MRIO models from extraction to final demand

- Ongoing: biomass
- Upcoming: energy, metals

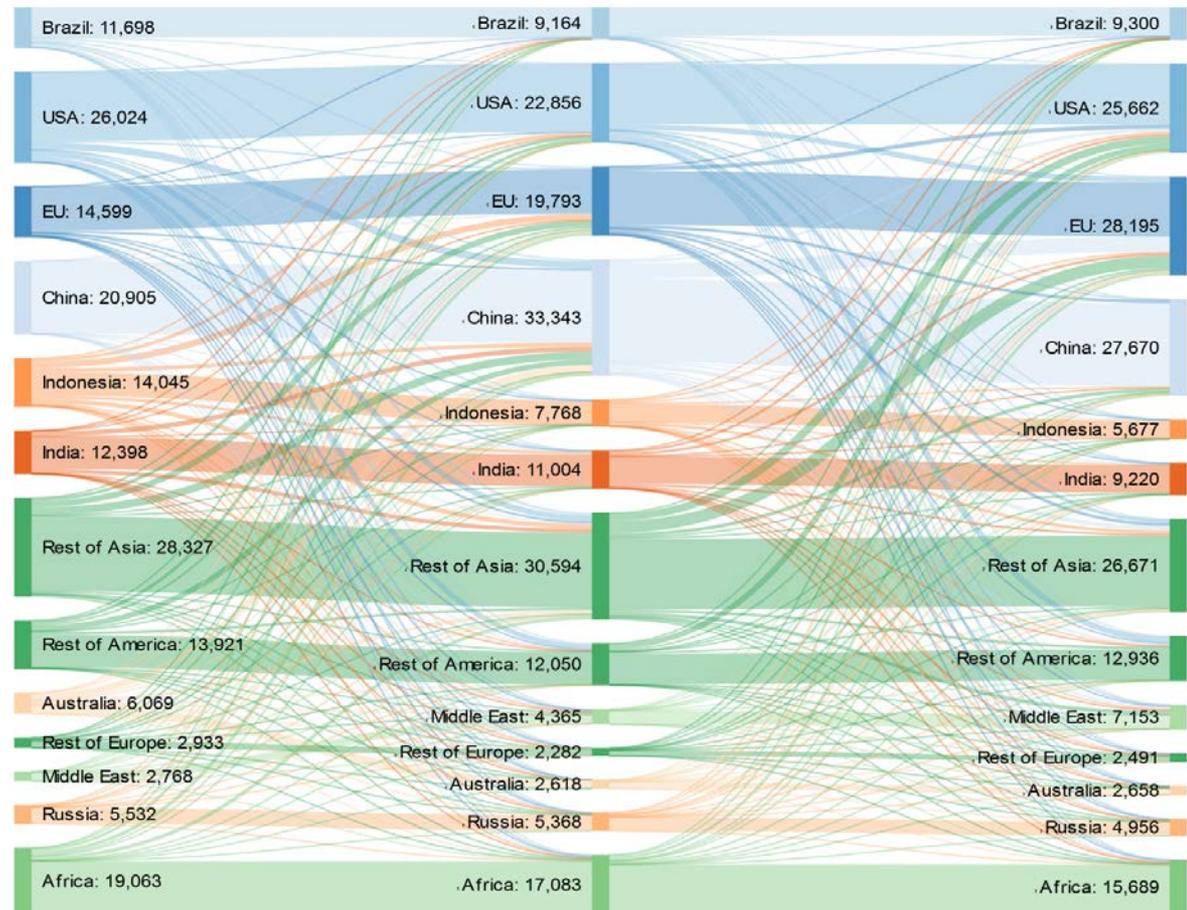
Hybrid MRIO of the global bioeconomy (FAOSTAT data)

- Physical Supply-Use and Input-Output Tables for 1986–2013
- Covering global agriculture and forestry
- 117 activities → 132 commodities
- Coupled with a monetary MRIO model to trace “other uses”



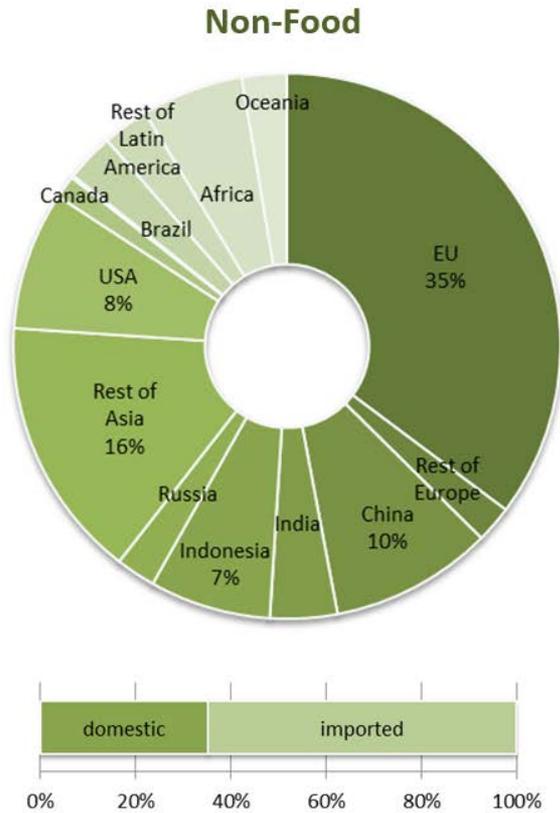
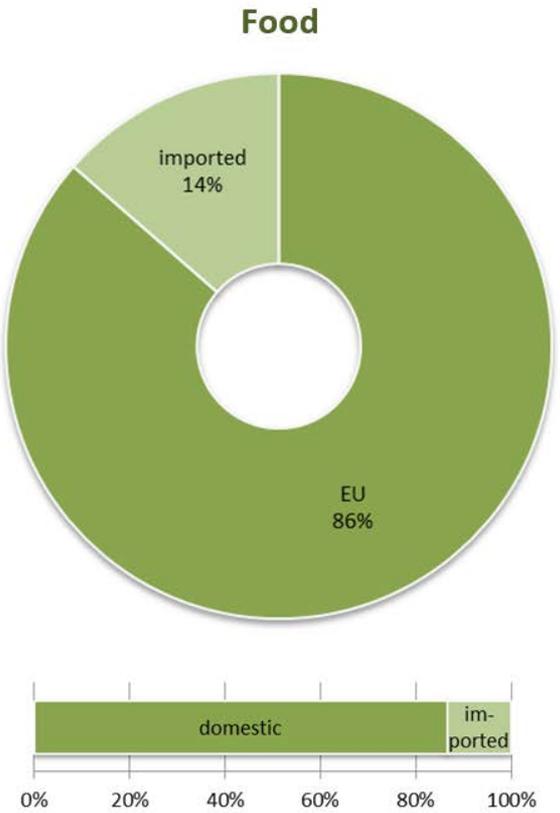
Global flows of embodied land associated with non-food products, 2010, in thousand hectares

Land use Industrial processing Consumption



23% of the EU's land footprint

Origin of the EU's cropland footprint for food and non-food products, 2010



Source: Bruckner et al., forthcoming

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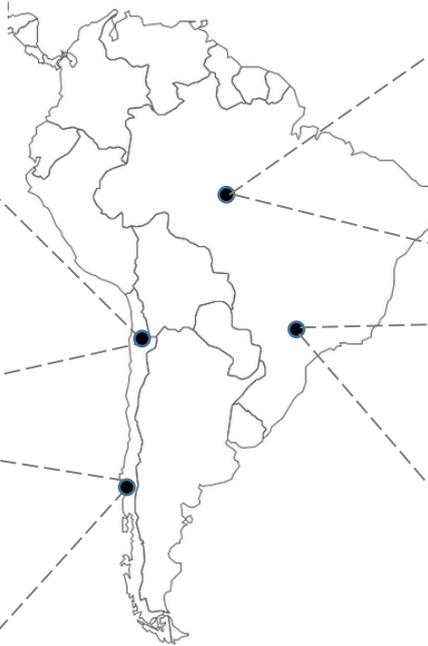
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ERC Consolidator Grant: 'FINEPRINT'

- Spatially explicit material footprints: fine-scale assessment of Europe's global environmental and social impacts
- July 2017 – June 2022
- Team of 7-8 researchers
- Budget of 2 million Euro

Impacts depend on specific location

Chile:
Copper mining



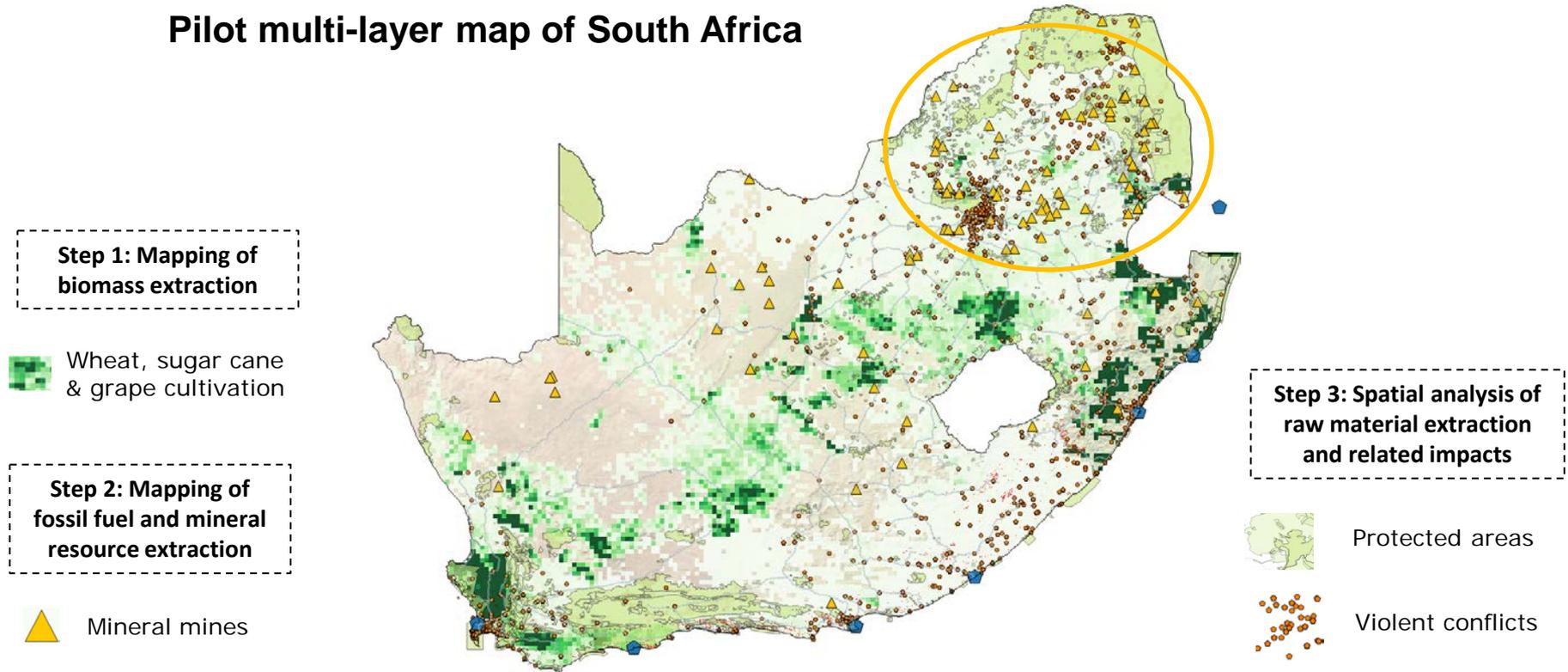
Brazil:
Soybean production



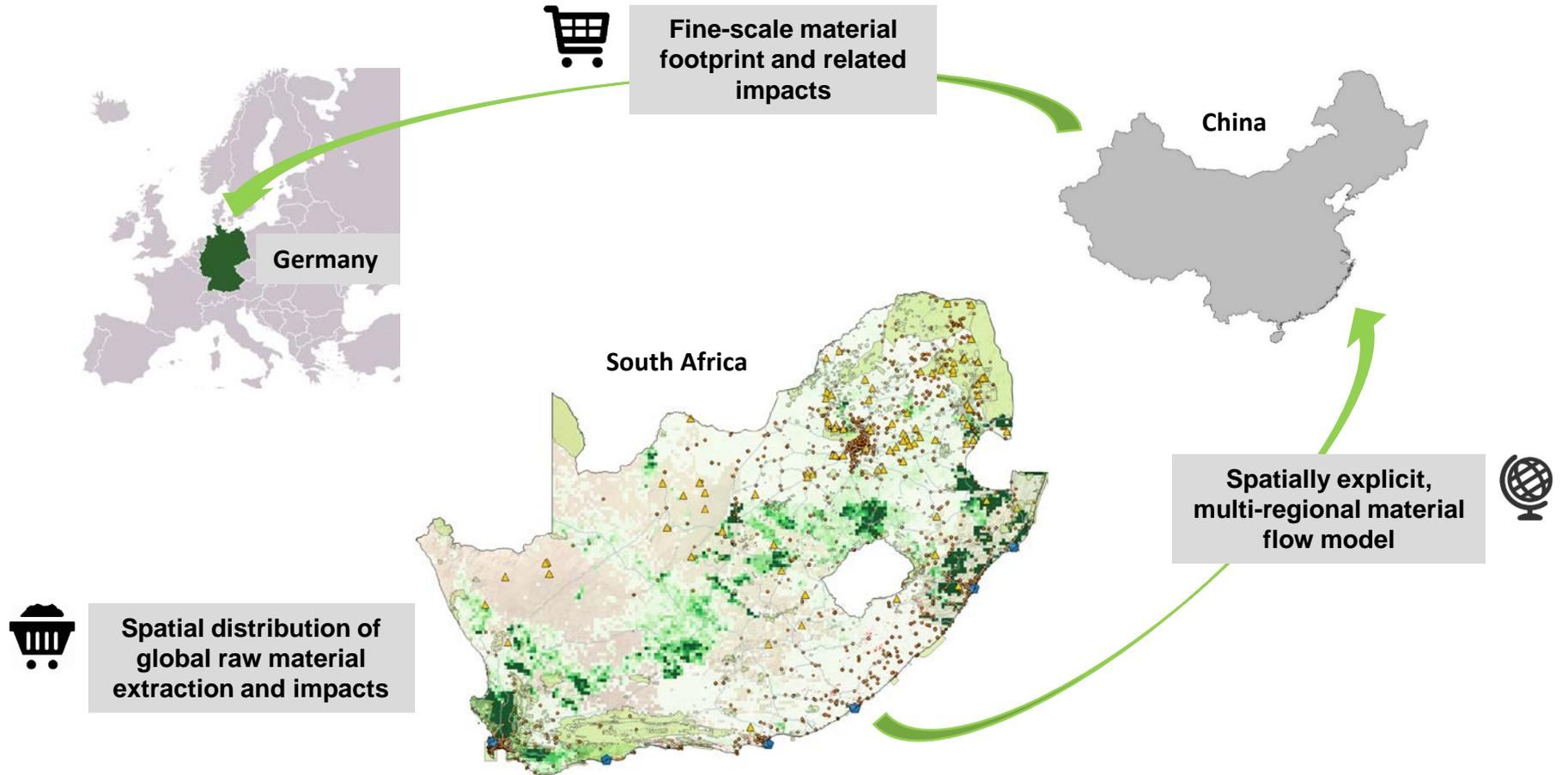
Spatial distribution of material extraction



Pilot multi-layer map of South Africa



Spatially-explicit, multi-regional material flow model



Fine-scale footprints and related impacts



Conclusions

- Growing interest in solid indicators on material use and material footprints (e.g. SDGs, OECD, EU Circular Economy, ...)
- MRIO models to assess global material flows are a rapidly evolving field → hot-spot sectors and supply chains, decoupling, import dependencies, etc.
- Huge potential to integrate existing environmental and social data sets with material flows to move from environmental pressures to impacts

Thank you very much for your attention!



VIENNA UNIVERSITY OF
ECONOMICS AND BUSINESS

DEPARTMENT SOCIOECONOMICS

Institute for Ecological Economics
Welthandelsplatz 1, 1020 Vienna, Austria

DR. STEFAN GILJUM

T +43-1-313 36-5755

stefan.giljum@wu.ac.at
www.wu.ac.at