



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

Dr. Stefan Giljum

# Content

---

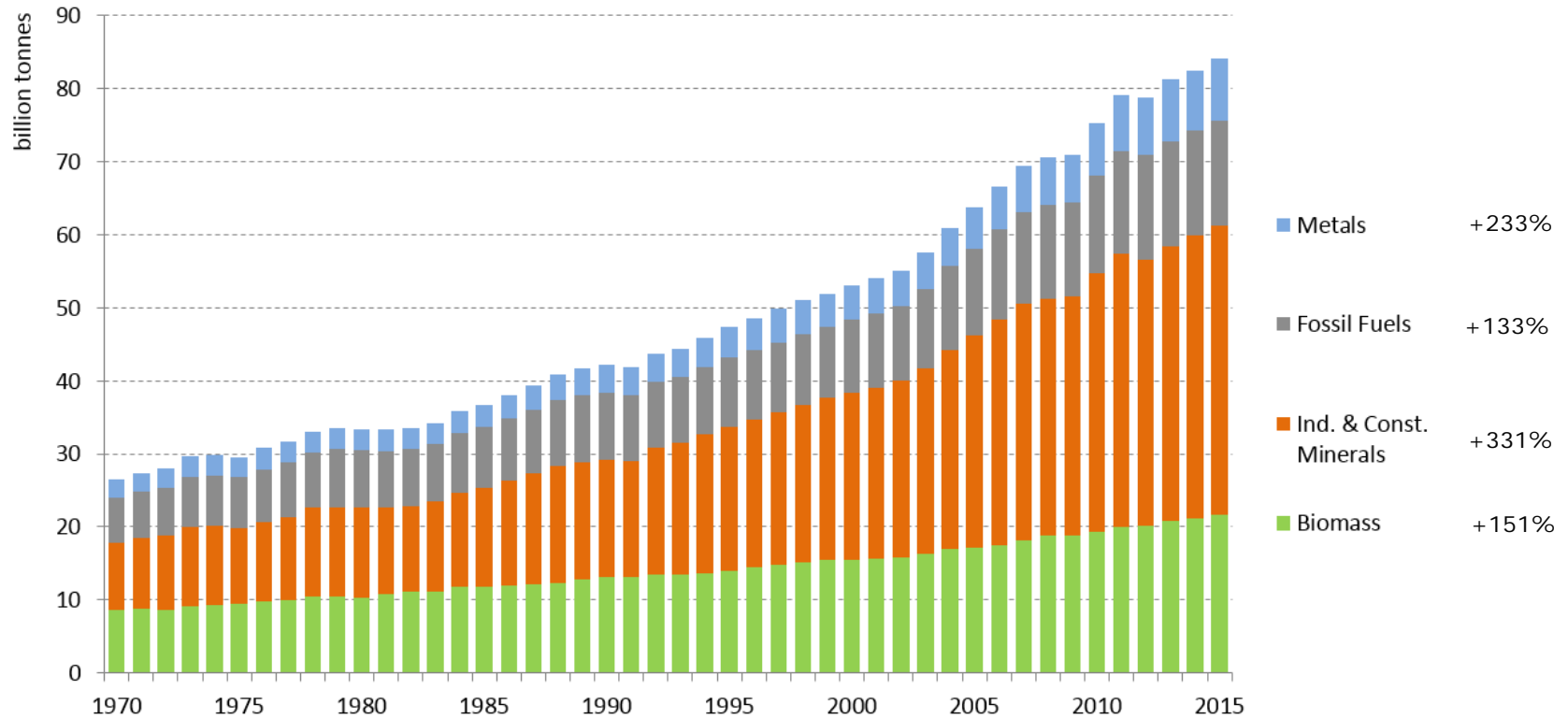
1. Economy-wide material flow accounting on the global level
2. Multi-regional input-output (MRIO) models of material flows
3. Future research directions
  - i. Global physical input-output models
  - ii. Spatially-explicit MRIO models to assess impacts

# Content

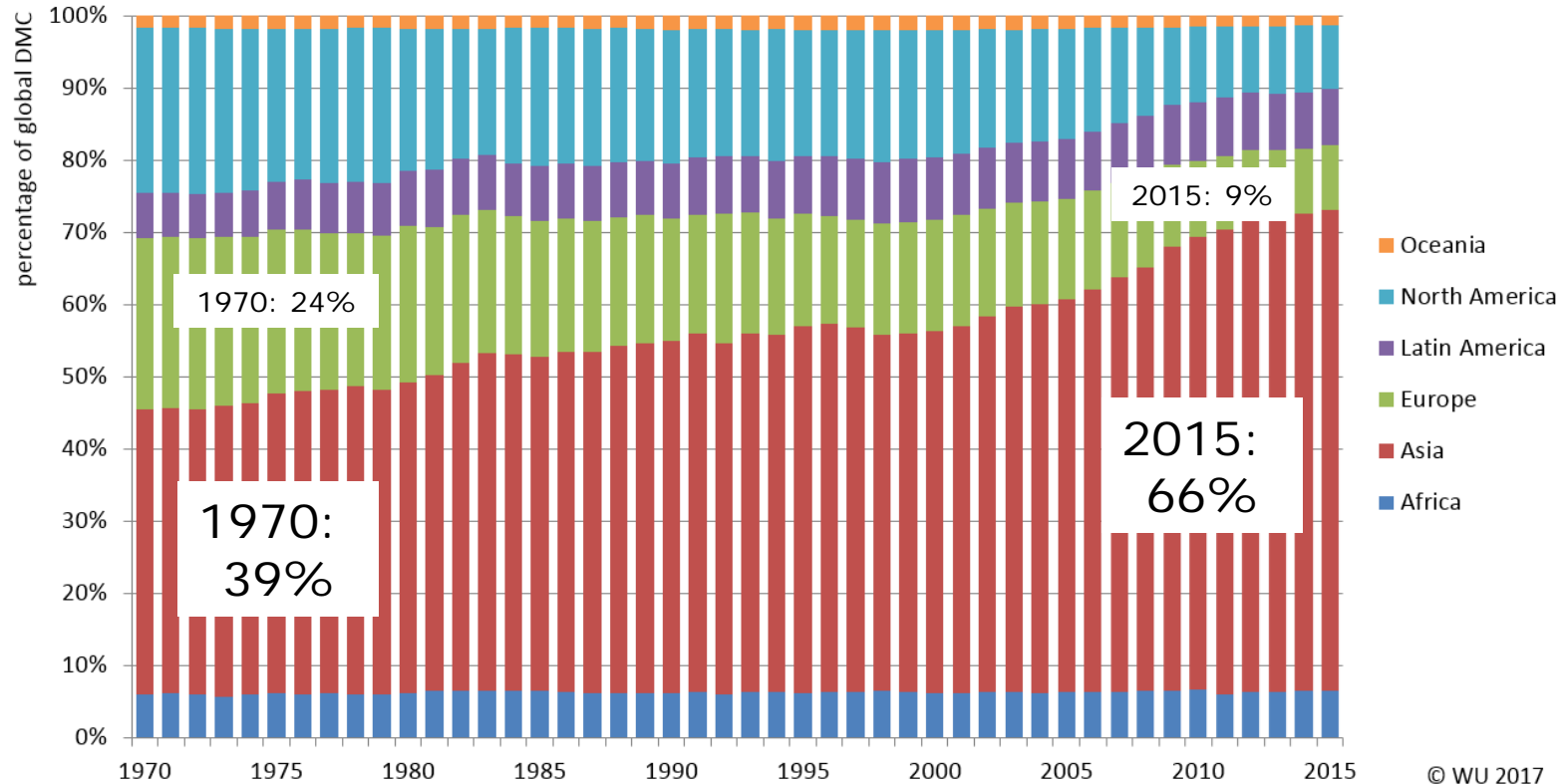
---

- 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

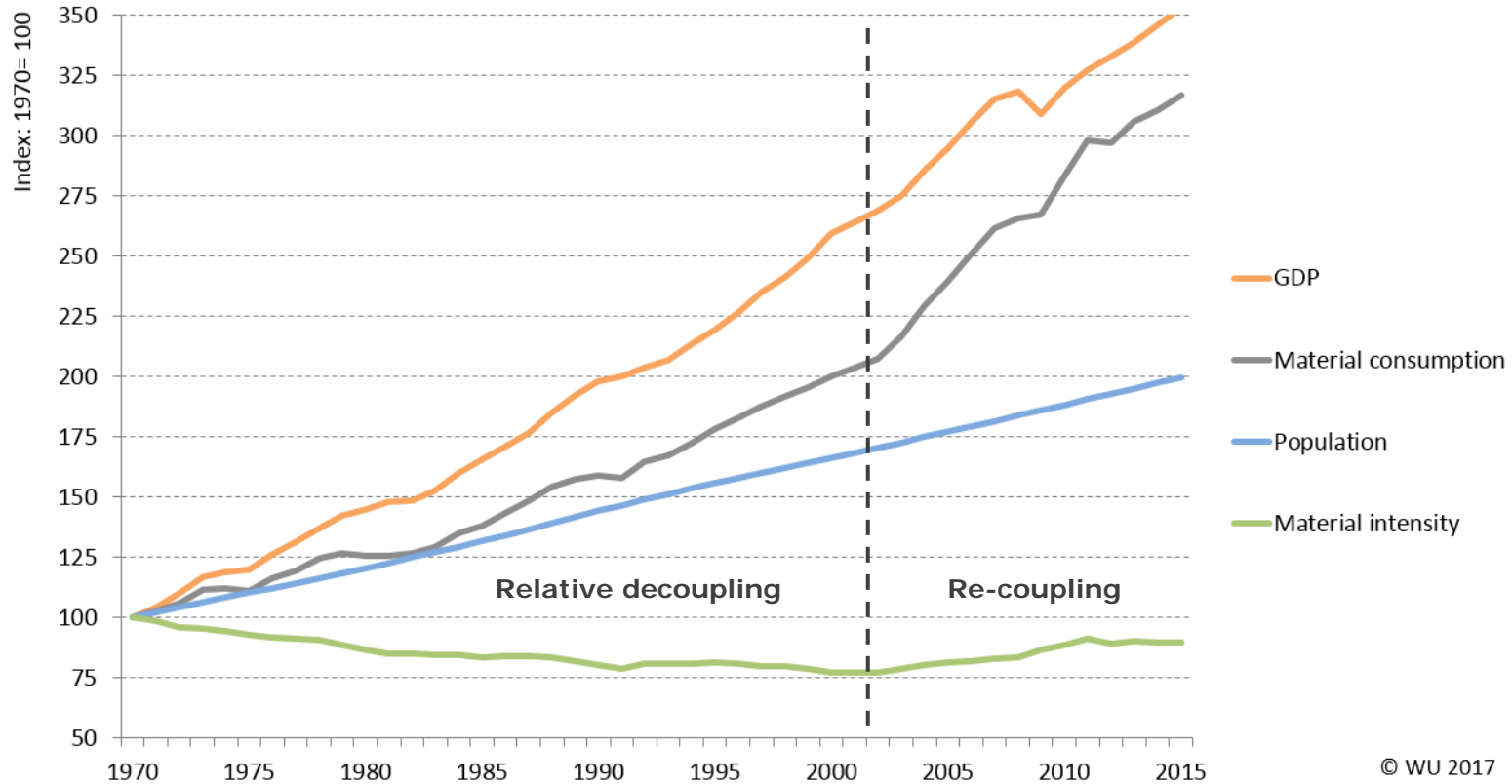
# Increasing global material consumption



# Growing role of emerging economies



# Re-coupling of material consumption and economic growth

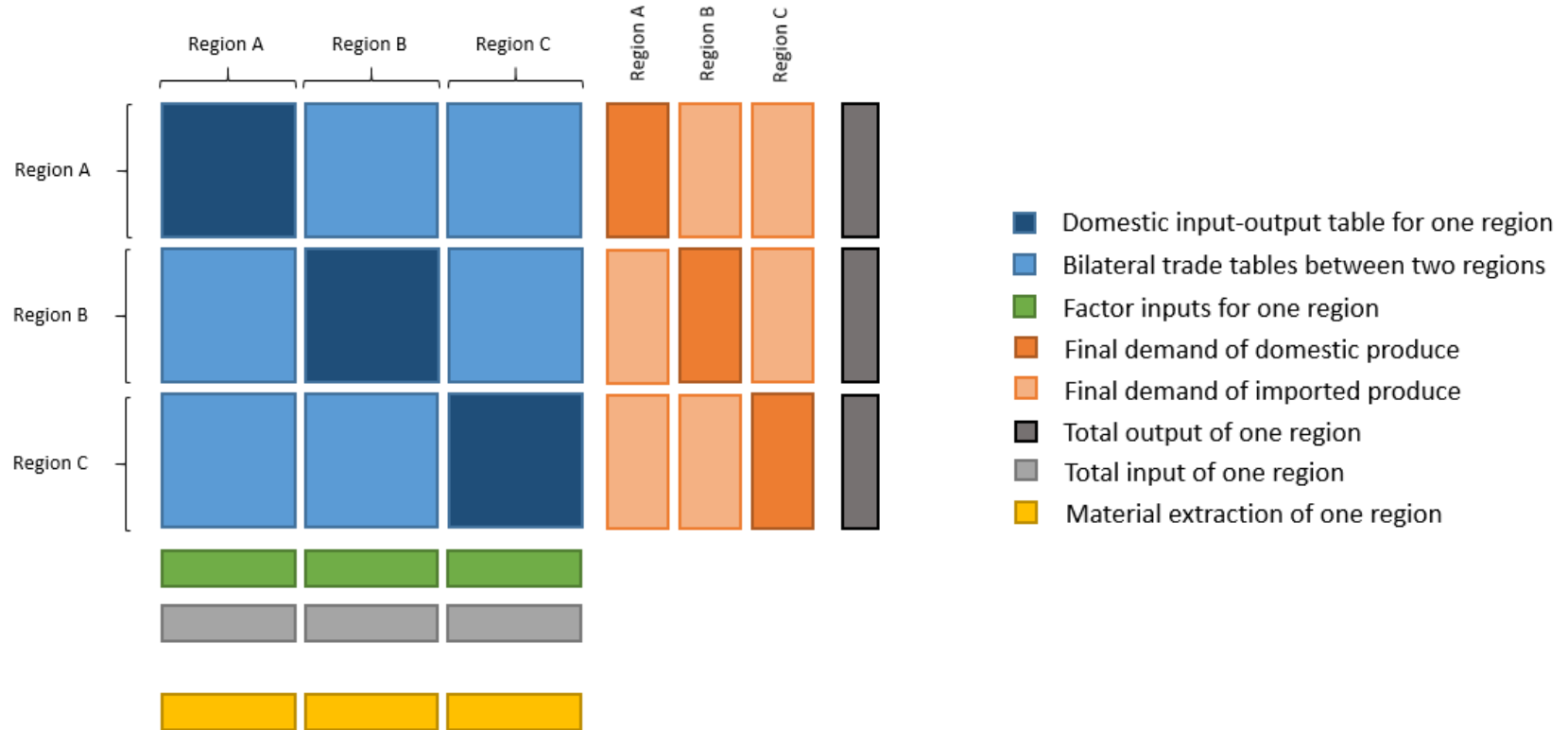


# Content

---

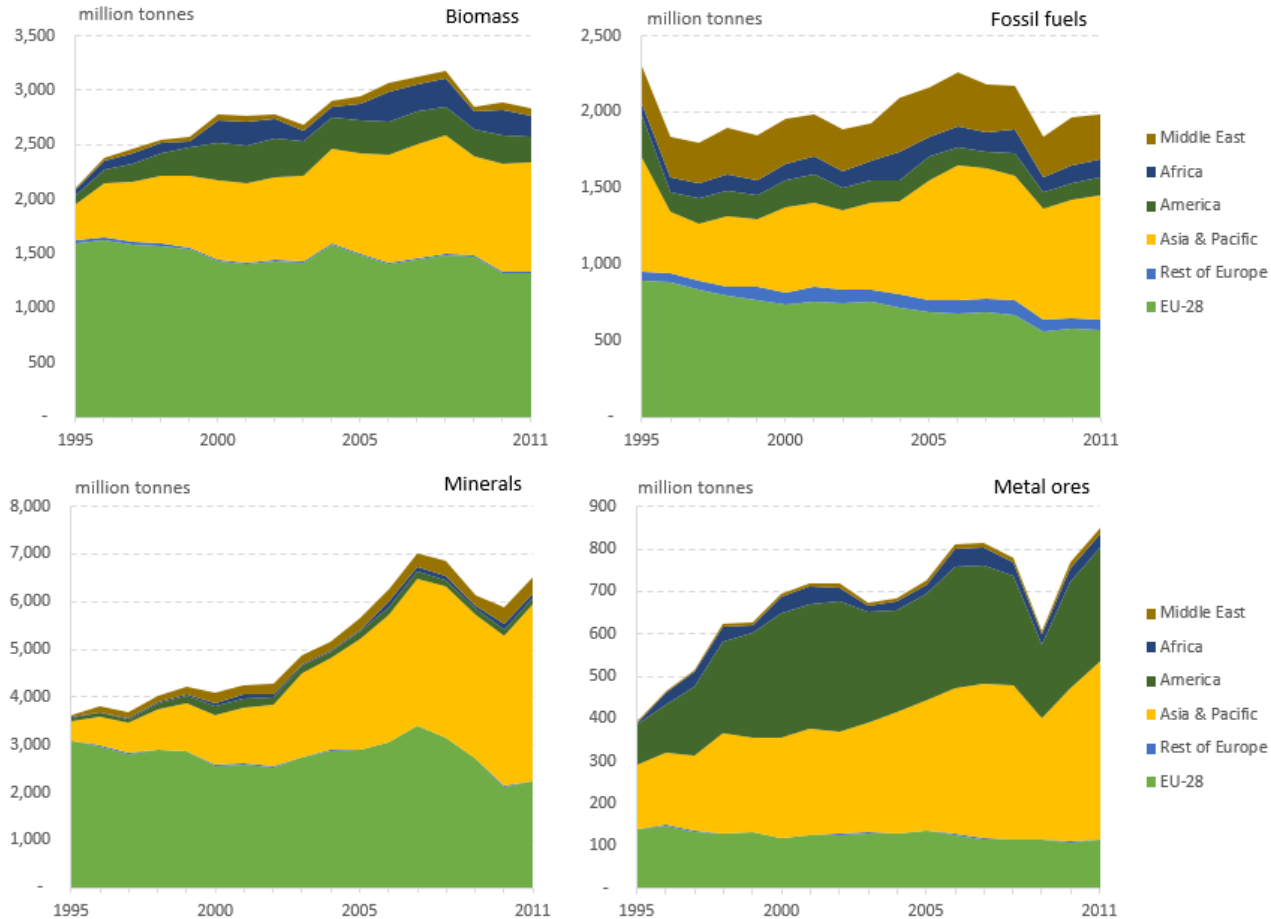
1. Economy-wide material flow accounting on the global level
2. **Multi-regional input-output (MRIO) models of material flows**
3. Future research directions
  - i. Global physical input-output models
  - ii. Spatially-explicit MRIO models to assess impacts

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

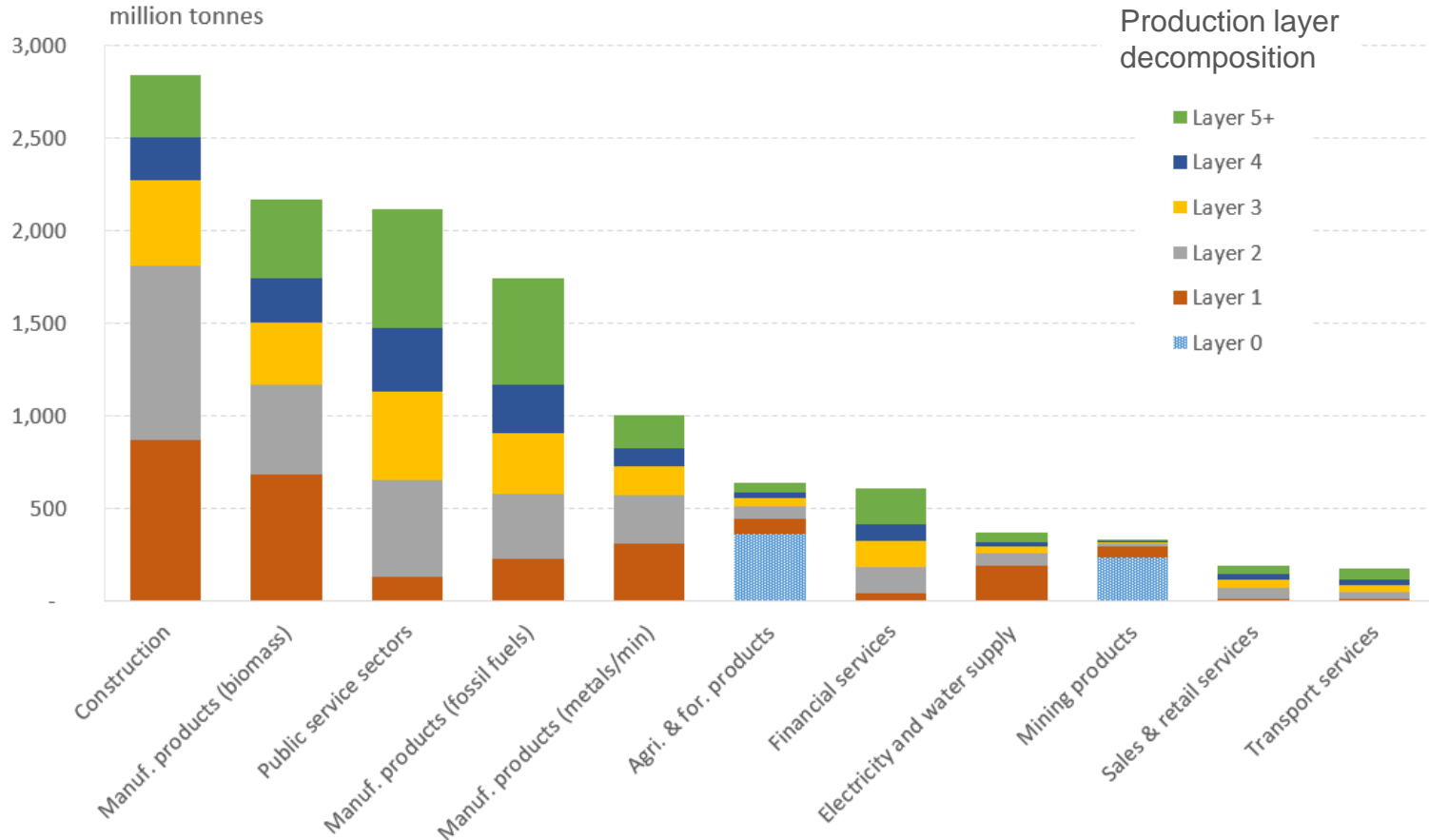




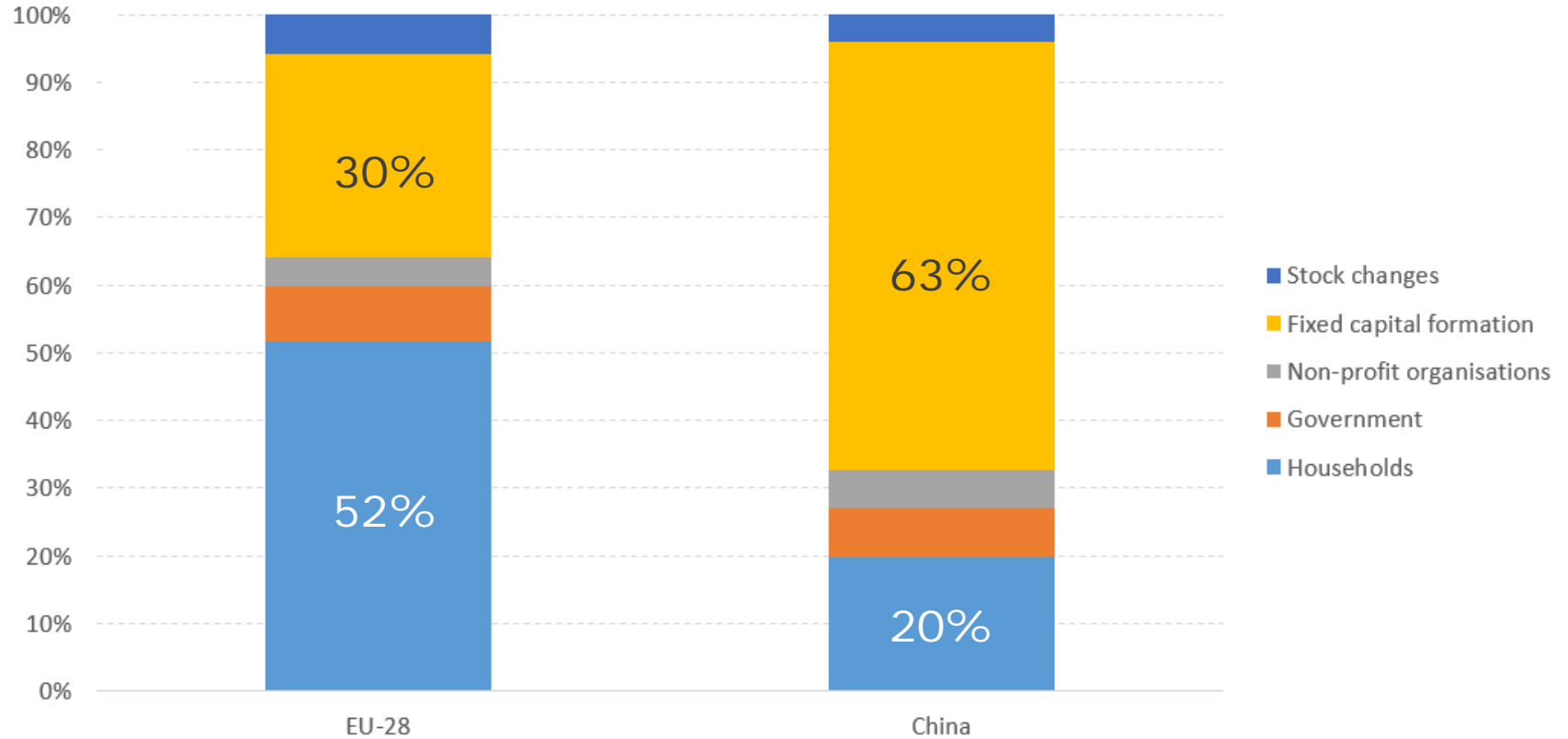
# Geographical origin of EU-28 material footprint (MF)



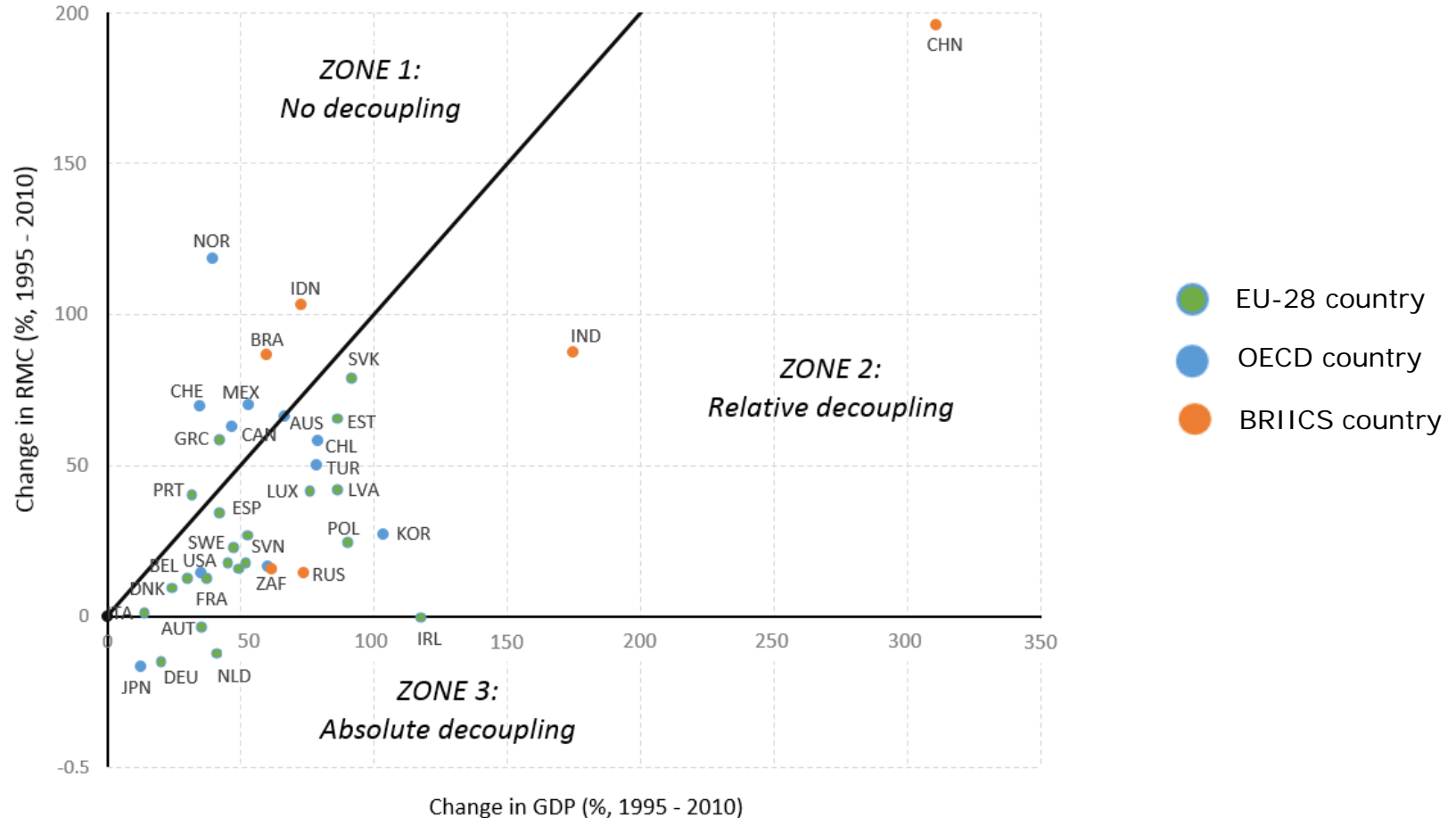
# Material footprint of EU-28 by product groups, 2011



# Composition of MF by final demand categories, 2011



# Decoupling of material footprint from economic growth



# Content

---

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

# 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

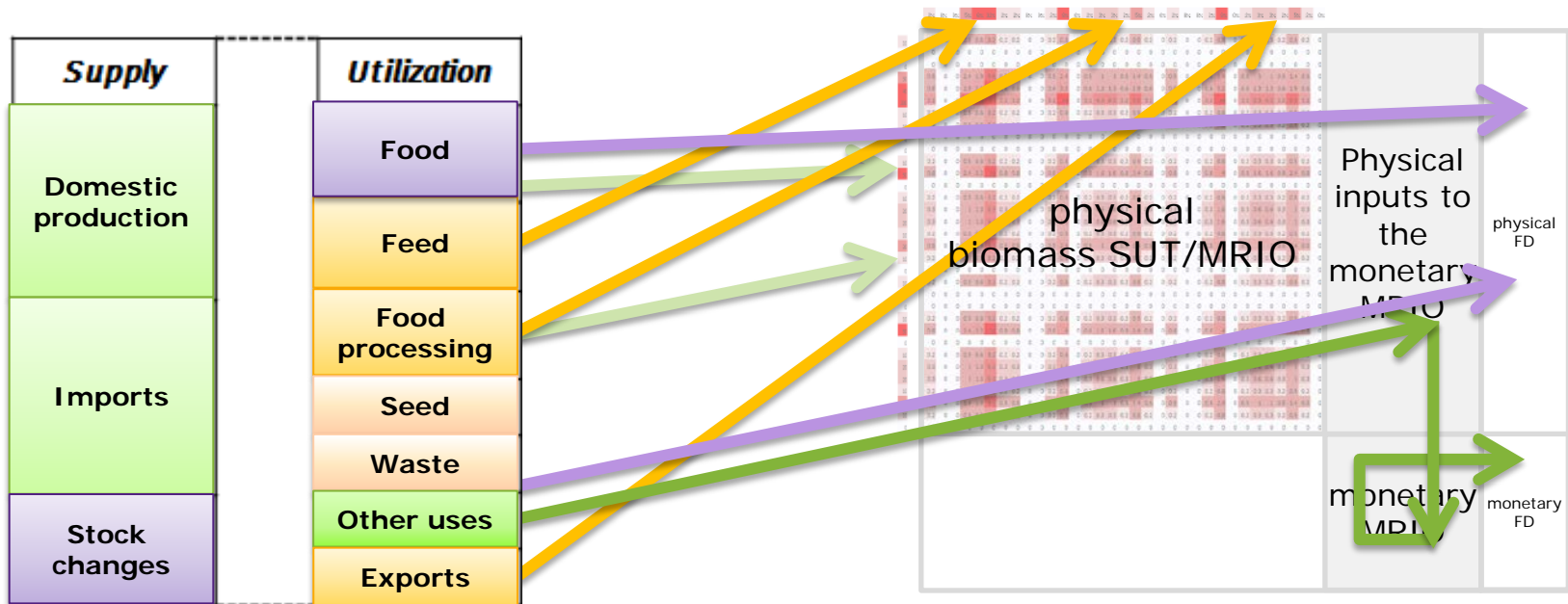
---

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

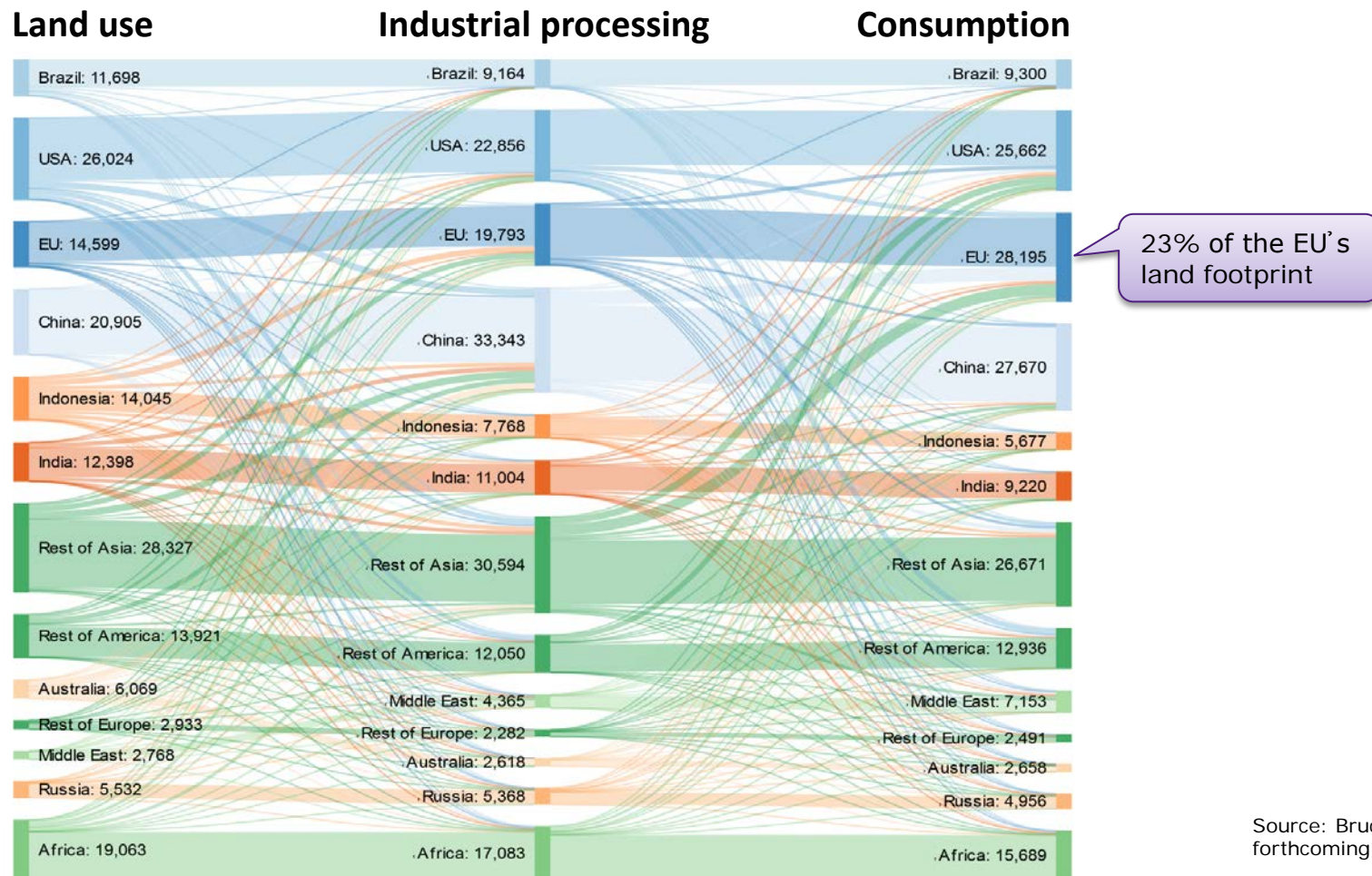
# Hybrid MRIO of the global bioeconomy (FAOSTAT data)

- 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”



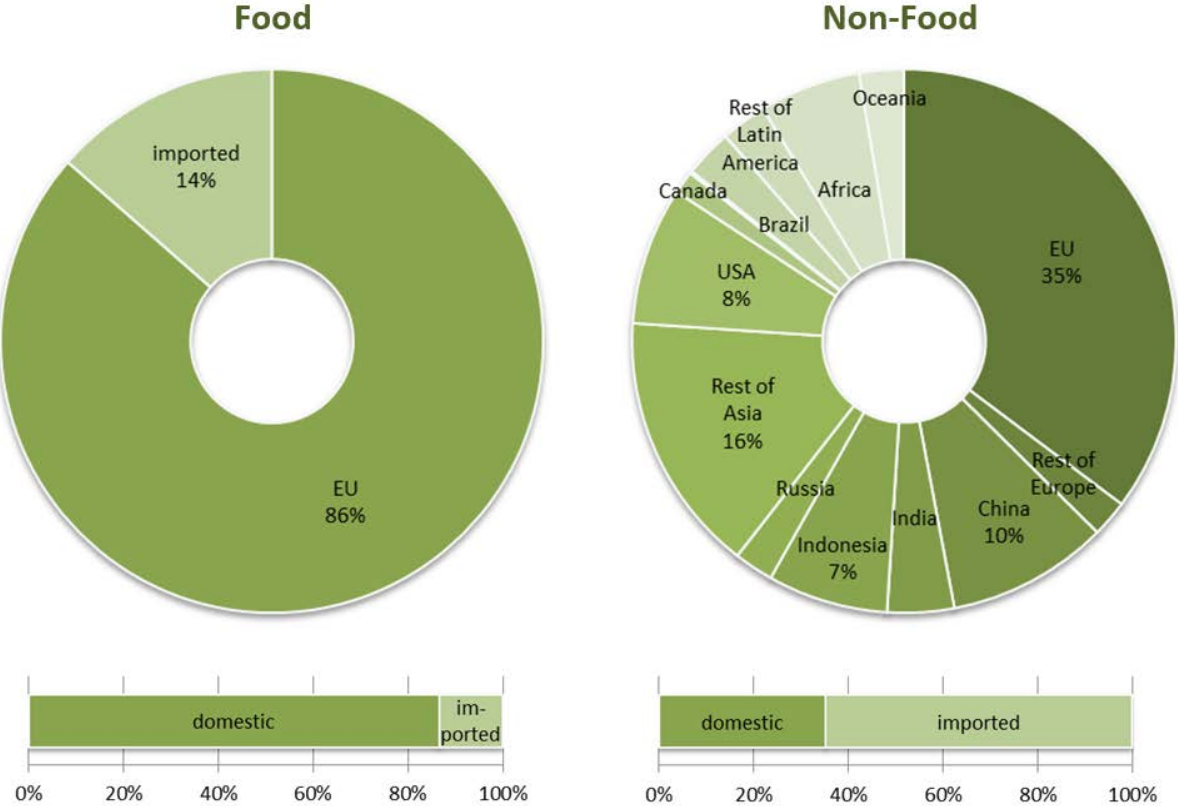


# Global flows of embodied land associated with non-food products, 2010, in thousand hectares



Source: Bruckner et al., forthcoming

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



Source: Bruckner et al., forthcoming

# Content

---

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**

## 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**

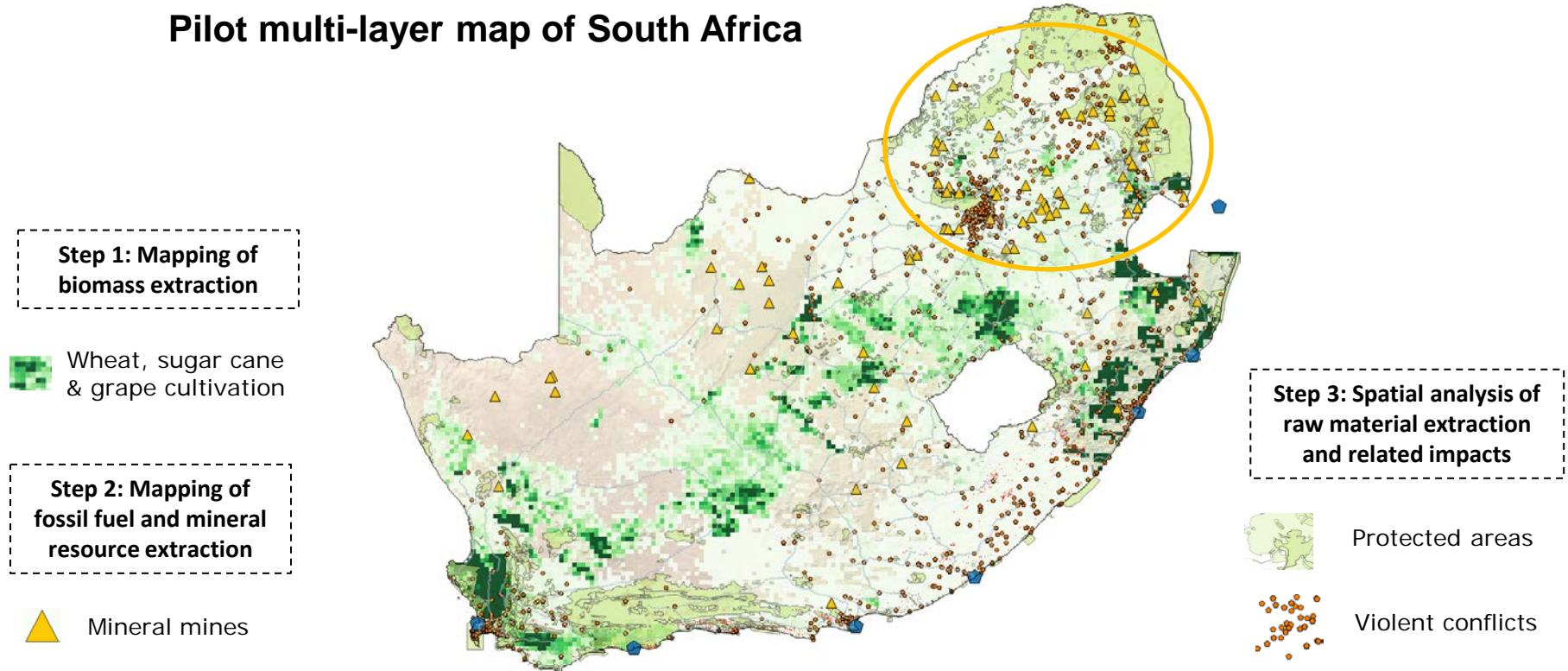




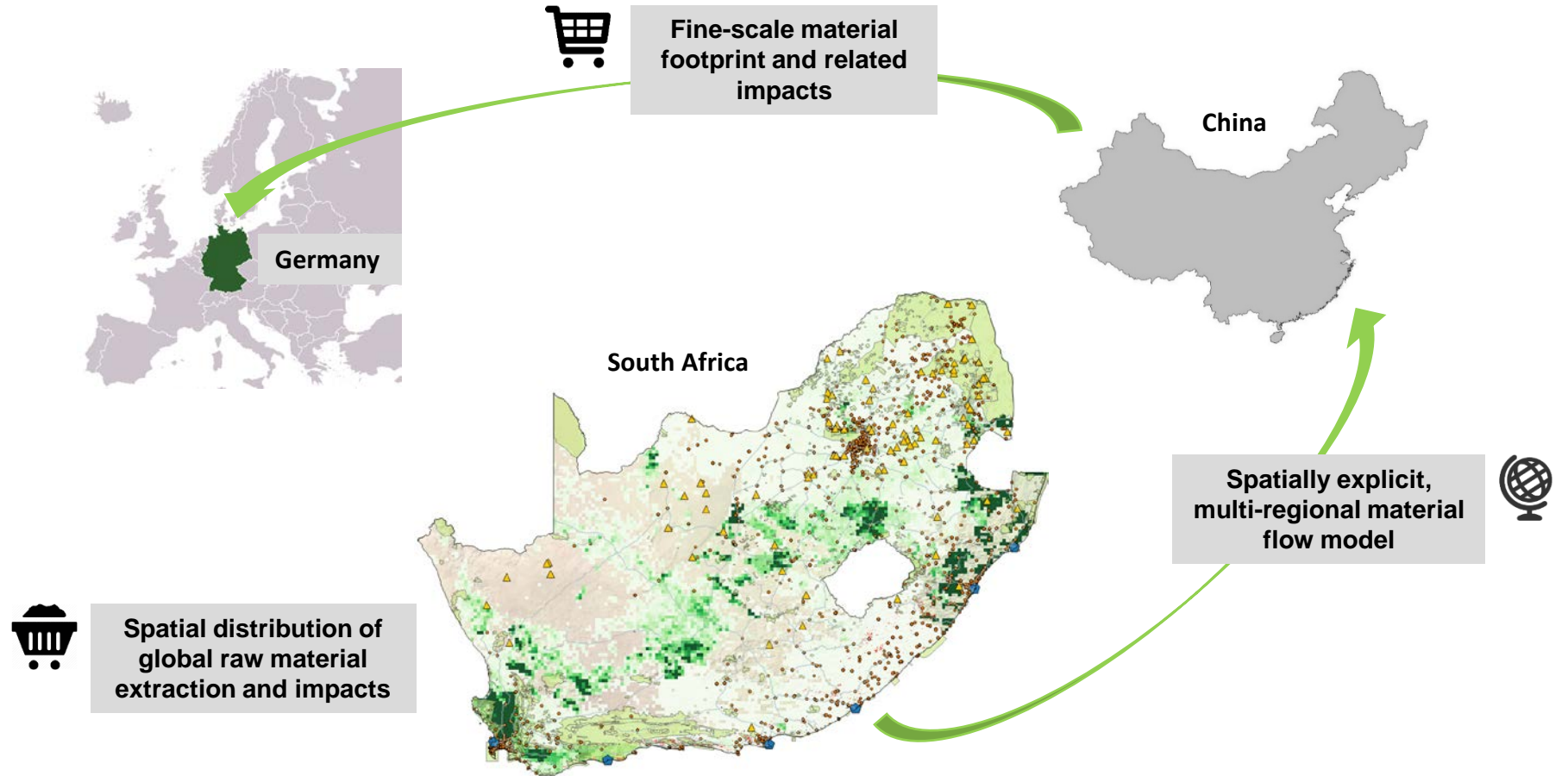
# Spatial distribution of material extraction



## 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