From resource extraction to manufacturing & construction:

Flows of stock-building materials in 177 countries from 1900 to 2016

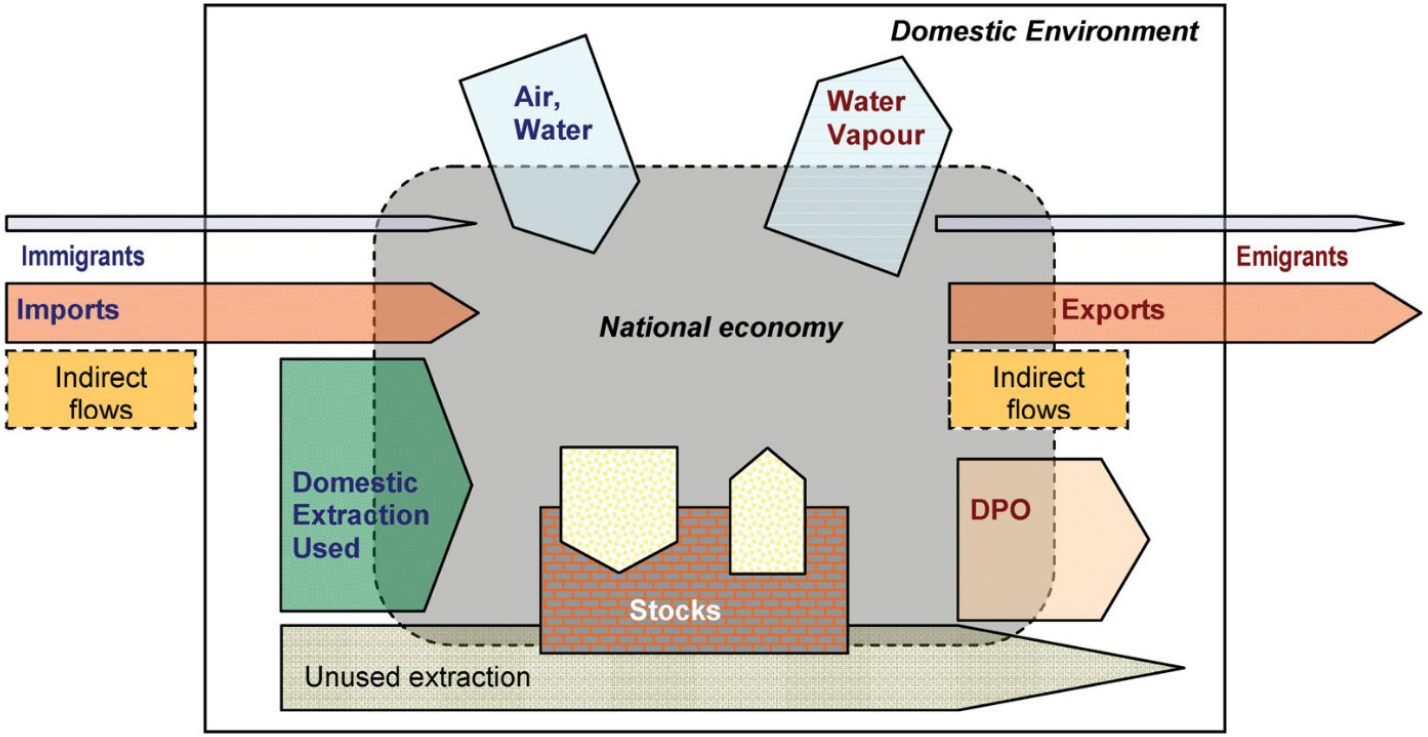
Barbara Plank, MSc

https://boku.ac.at/understanding-the-role-of-material-stock-patterns-for-the-transformation-to-a-sustainable-society-mat-stocks

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme(grant agreement No 741950).

Coal Mine #1, North Rhine, Westphalia, Germany, 2015
Photograph: Edward Burtynsky/Courtesy of Flowers Gallery London

State-of-the-art in economy-wide material flow analysis (ew-MFA)



What about uncertainties?

Further developments for ew-MFA are required!

- more transparent data compilation and uncertainty assessments
- improved representation of socio-economic material cycles
- large spatio-temporal coverage

A centennial country-level ew-MFA database for 14 stock-building materials

- Integrating material flow *accounting* (Krausmann et al., 2017) and *analysis* (Brunner & Rechberger, 2020) principles and methods
- Distinguishing 4 processing steps, from extraction to accumulation in stocks
- In a mass-balanced and transparent way, using a standardized 10-step compilation procedure

Resources, Conservation & Recycling 179 (2022) 106122

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

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From resource extraction to manufacturing and construction: flows of stock-building materials in 177 countries from 1900 to 2016

Barbara Plank *, Jan Streeck, Doris Virág, Fridolin Krausmann, Helmut Haberl, Dominik Wiedenhofer

Institute of Social Ecology, BOKU Vienna; Schottenfeldgasse 29, 1070 Vienna, Austria

ARTICLE INFO

Keywords:
material flow analysis
resource use
long-term analysis
uncertainty assessment
industrial ecology

ABSTRACT

Global material stocks of infrastructure, buildings, machinery and consumer products are growing rapidly, driving emissions and other environmental impacts during materials extraction, processing, construction and waste. However, international data on economy-wide material flows (ew-MFA) currently is limited to national extraction, trade and consumption and does not integrate material processing. Further developments for ew-MFA are required, ranging from more transparent data compilation and uncertainty assessments and improved rep-

MethodsX 9 (2022) 101654

Contents lists available at ScienceDirect

MethodsX

journal homepage: www.elsevier.com/locate/mex

Method Article

Compilation of an economy-wide material flow database for 14 stock-building materials in 177 countries from 1900 to 2016☆

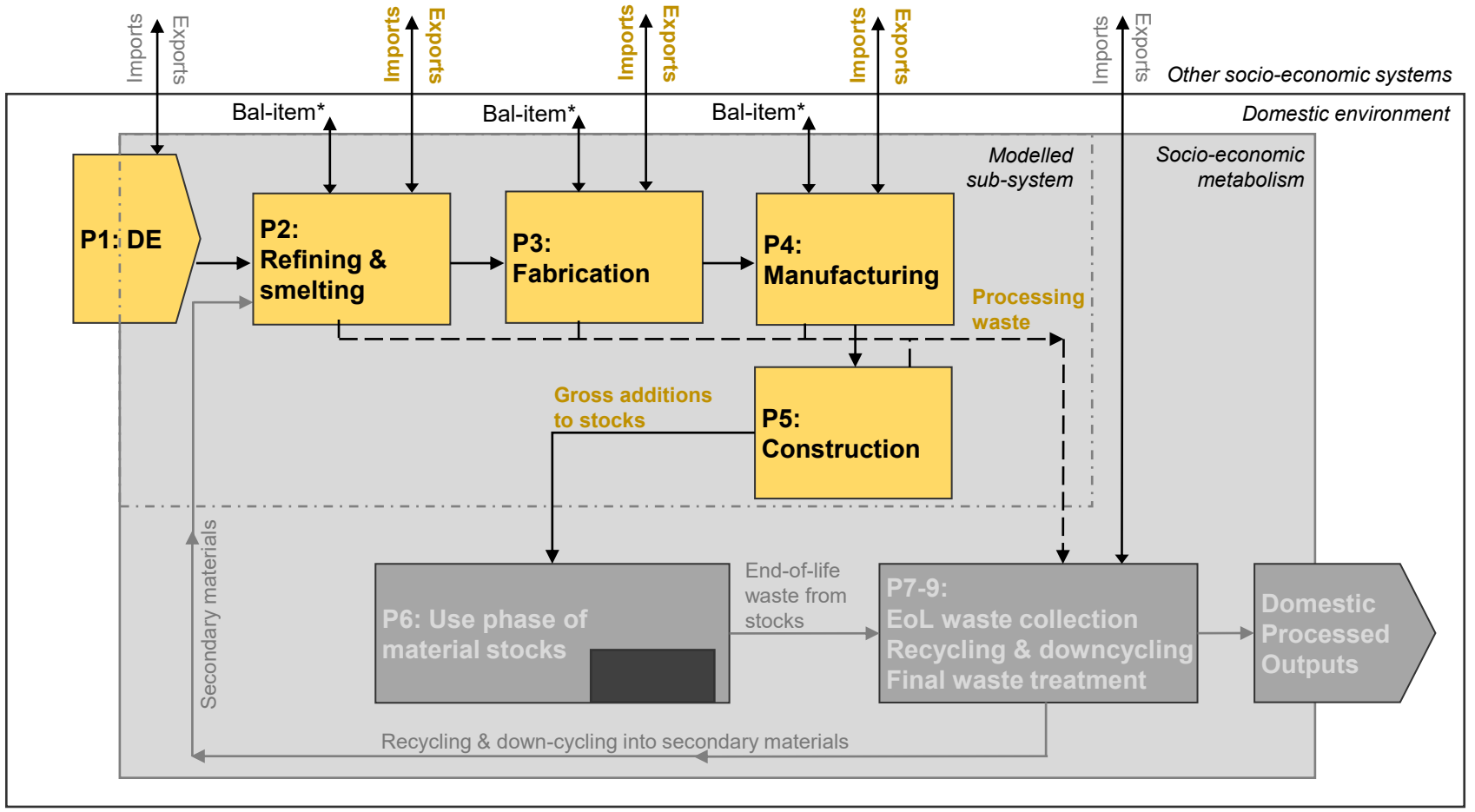
Barbara Plank*, Jan Streeck, Doris Virág, Fridolin Krausmann, Helmut Haberl, Dominik Wiedenhofer

Institute of Social Ecology, BOKU Vienna; Schottenfeldgasse 29, Vienna 1070, Austria

ABSTRACT

International datasets on economy-wide material flows currently fail to comprehensively cover the quantitatively most important materials and countries, to provide centennial coverage and to differentiate between processing stages. These data gaps hamper research and policy on resource use. Herein, we present and document the data processing and compilation procedures applied to develop a novel economy-wide database of primary stock-building material flows systematically covering 177 countries from 1900- 2016. The main methodological

System definition



Scope:

- 177 countries
- 1900-2016
- Uncertainties
- 14 materials:
  - Concrete
  - Asphalt
  - Bricks
  - Wood
  - Paper
  - Iron & steel
  - Aluminum
  - Copper
  - Lead
  - Zinc
  - Other metals
  - Plastics
  - Container glass
  - Flat glass

Uncertainty assessment

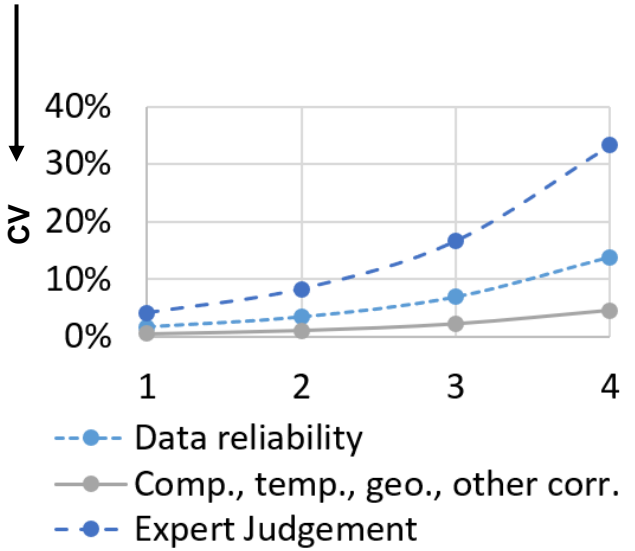
Based on an evaluation framework proposed by Laner et al. (2015)

1. Scoring of the reliability of data sources and estimation methods based on 5 data quality indicators OR an evaluation of our expert judgement

2. Translating data quality scores to normally-distributed standard deviations

3. Uncertainties for production & trade flows and all parameters used aggregated along all processing stages

Criteria	Scores			
Data reliability	based on databases			
Completeness	1	2	3	4
Temporal correlation	1	2	3	4
Geographical correlation	1	2	3	4
Other correlation	1	2	3	4
Expert judgement	1	2	3	4



RESULTS

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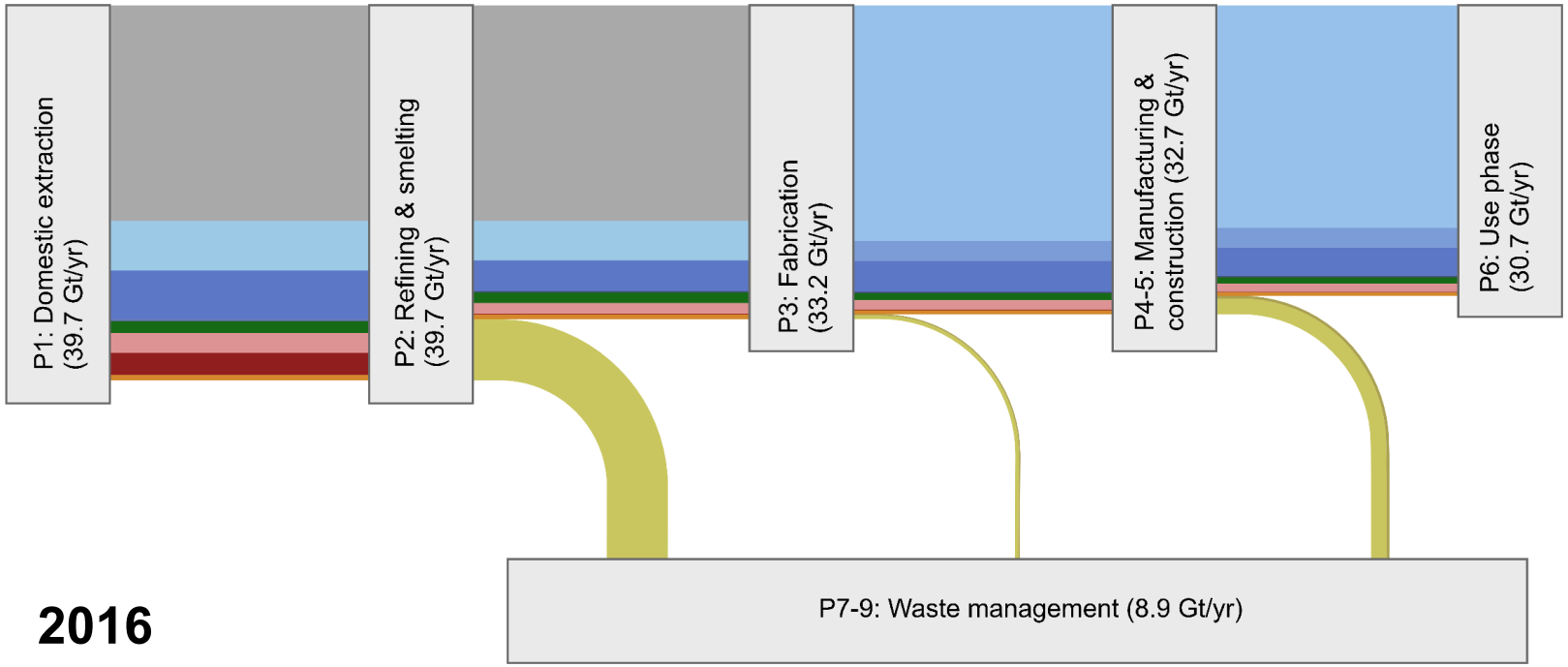
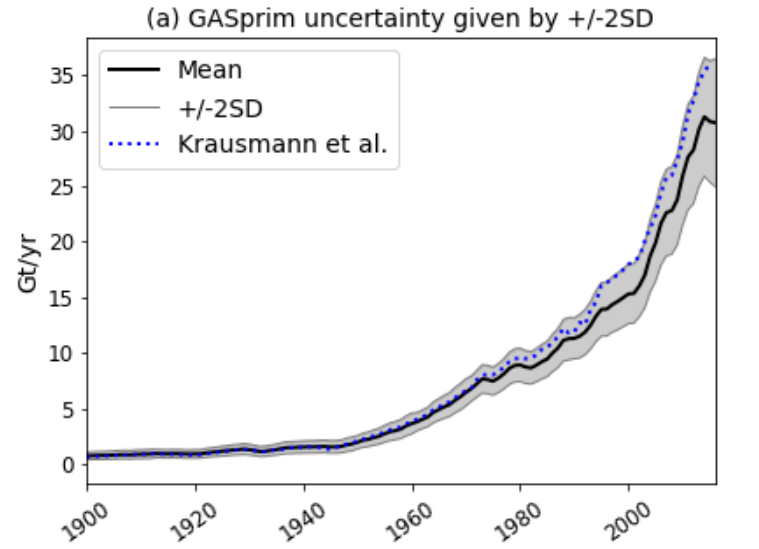
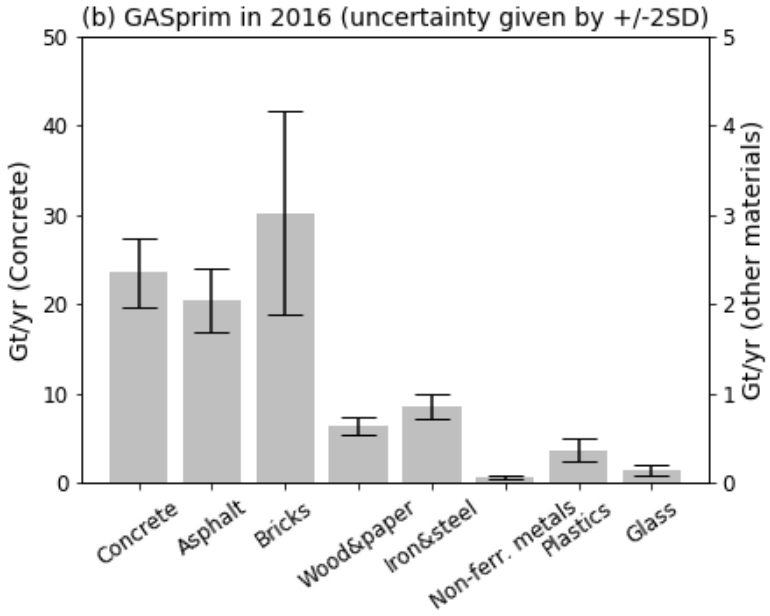
Global processing chain of primary gross-additions-to-stock (GAS_{prim})

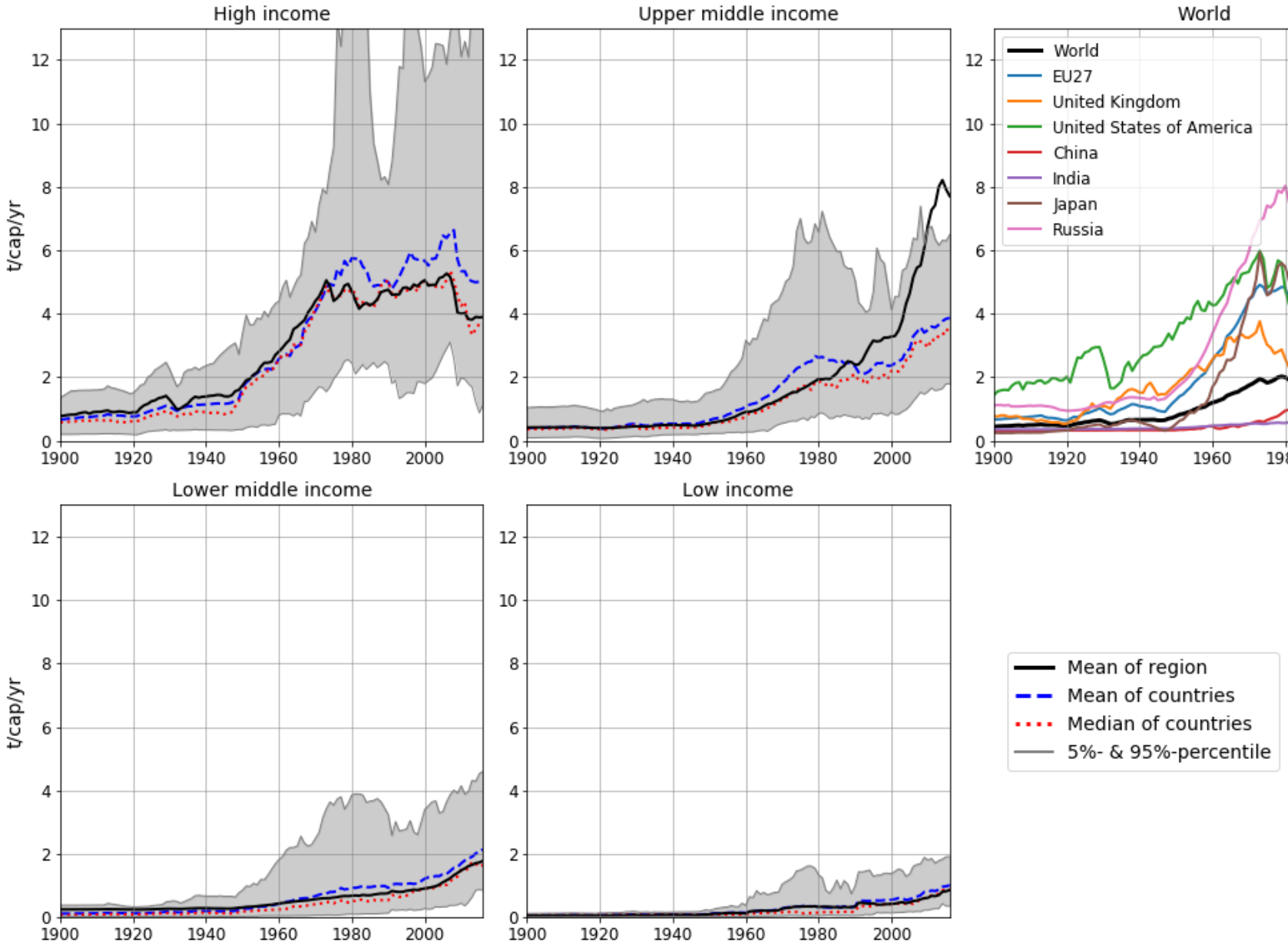


2016

- sand & gravel for concrete & asphalt
- asphalt
- limestone / cement / concrete
- clays / bricks
- other non-met. minerals / glass
- ind. roundwood / wood & paper
- iron ore / iron & steel
- non-ferr. metal ores / non-ferr. metals
- crude oil & natural gas / plastics & bitumen
- unrecoverable waste
- recoverable waste







GAS_{prim} per capita of all countries, grouped by income groups

Conclusions

- Slowdown of growth in GAS_{prim} and more recently even a considerable reduction in high income countries since the 2008 financial crisis
- Absolute and per-capita levels in all other income groups have accelerated drastically since around the year 2000

→ ongoing catch-up and potential future convergence of per-capita GAS_{prim} across countries and income groups

- A first-ever reduction of global GAS_{prim} occurred at the very end of the observed time period
- China plays a dominating role for global stock building and far outpaced high-income countries' stock buildup
- Building-up material stocks to provide essential services for a growing population in large parts of the world is likely to continue to be an important driver for rising global demand in GAS_{prim} in the coming decades
- No indications for novel economic development pathways which are substantially less material-intensive in terms of stock-building than in the past

Thank you for your attention!

barbara.plank@boku.ac.at

Jan Streeck, Doris Virág, Dominik Wiedenhofer, Fridolin Krausmann, Helmut Haberl

Institute of Social Ecology (SEC)
Department of Economic and Social Sciences
University of Natural Resources & Life Sciences, Vienna

MAT_STOCKS: https://short.boku.ac.at/q39w52

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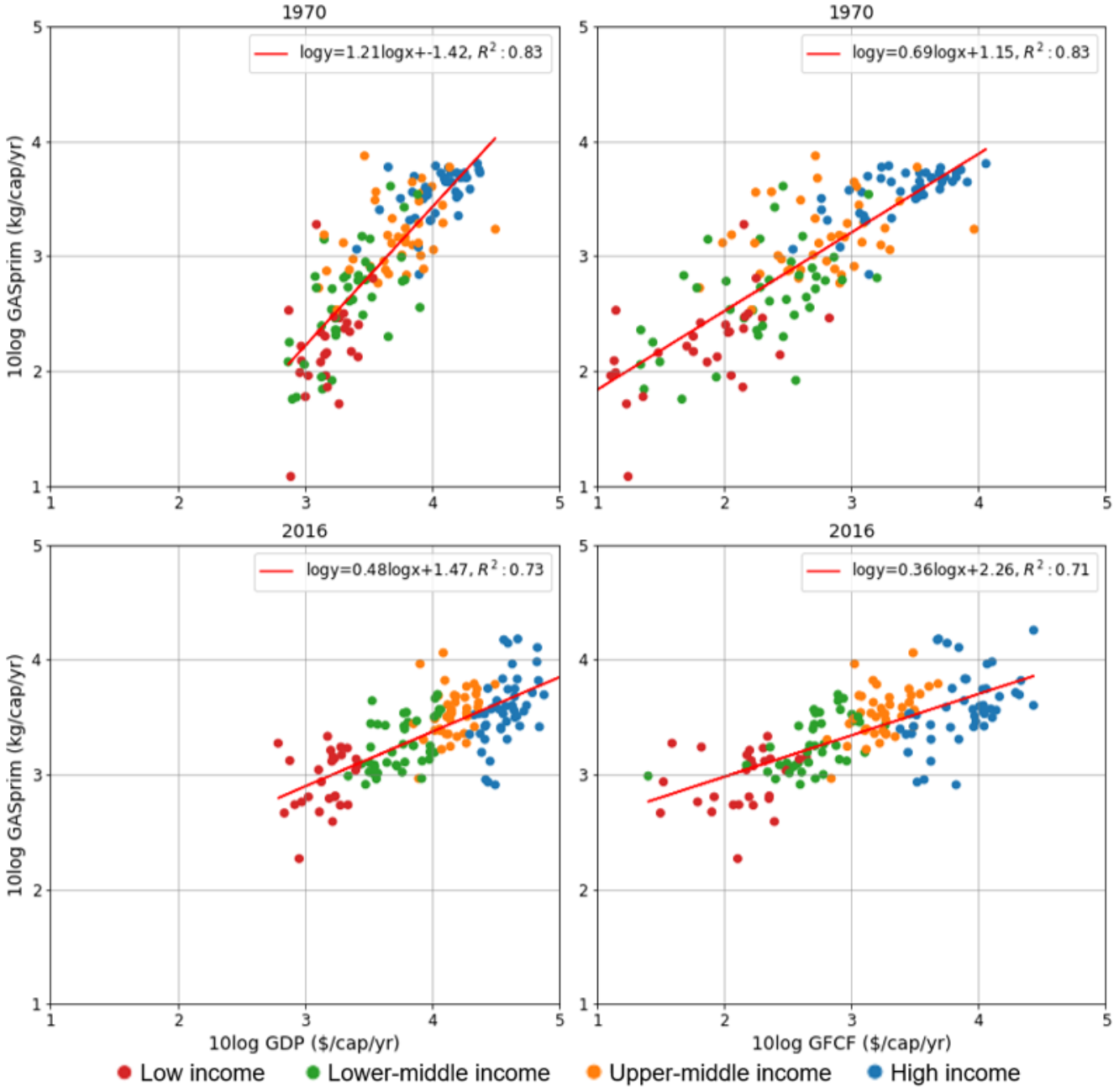
Standardized 10-step compilation procedure

1. Identify, assess and collect relevant data sources
2. Harmonize datasets to the common classifications and units within our database structure
3. Correct major changes of country definitions over the studied time period
4. Outlier removal, interpolating data gaps & plausibility checks
5. Back-casting and extrapolating data for non-available years
6. Estimations applied for materials and countries with very fragmented data
7. Developing uncertainty estimates for each datapoint
8. Deriving production outputs by subtracting processing waste
9. Deriving apparent consumption estimates
10. Creating a balancing item to deal with inconsistencies in the database



Correlations between per-capita GAS_{prim} and per-capita GDP (left) or GFCF (right) for 177 countries, grouped by income groups