Creating EXIOBASE in the Global Industrial Ecology Virtual Laboratory

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EXIOBASE is ...
- It has been successful in ...
- Many researchers use it for...
- However in order to update it ... is required every ... years
- In order to ensure consistency for users, a more streamlined, routine compilation process would be desirable.
- However the workload is high.
- Here is where the Virtual Lab idea comes to bear
- In this work we demonstrate an EXIOBASE update using the collaborative Global MRIO Lab

2) Methods
2.1) EXIOBASE
2.2) The Global MRIO Lab
- overview – main paper
2.3) Modifications
- to EXIOBASE required to enable lab-based compilation and update (eg sigmas)
- and their theoretical impact on MRIO table features
2.4) Implementation
- data, machines

3) Results
3.1) Heat map
3.2) Uncertainty heat map (novel !!!)
3.3) Differences to published EXIOBASE (Matrix difference metrics - see Arne)
3.4) Differences in multipliers (eg imports or value added)
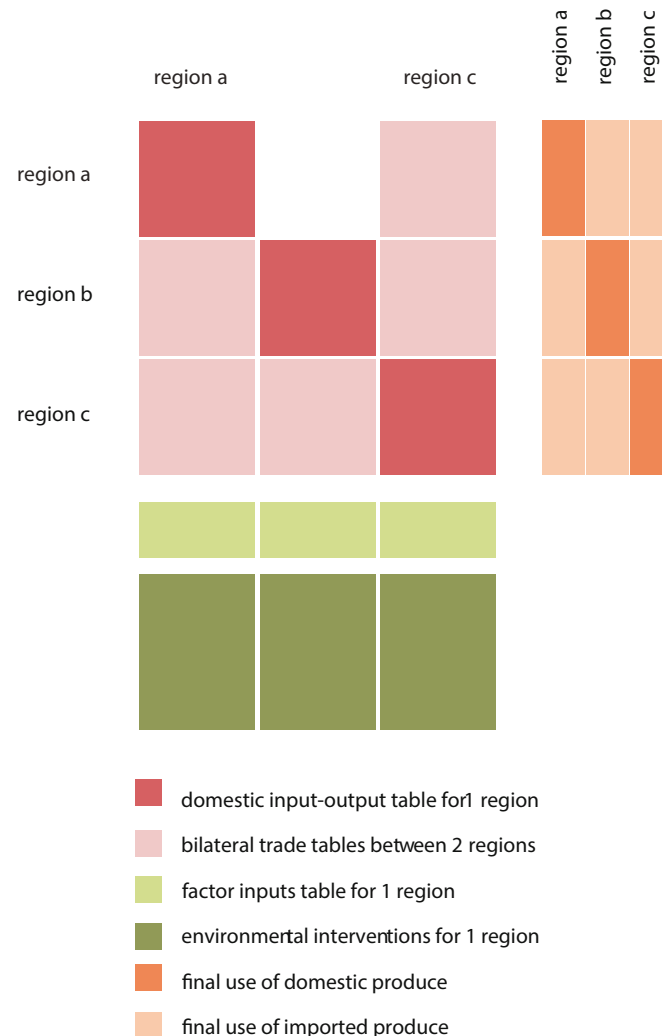
4) Discussion and conclusions

EXIOBASE

Building an MR EE IOT is time consuming, and thus far, only a handful of such databases are available. EXIOBASE was developed with support from the EU's Sixth and Seventh Framework Programmes, with economic-environmental analyses in mind. The database provides data at an unprecedented level of consistent detail in terms of sectors, products, emissions and resources for all the countries covered.

EXIOBASE has the following characteristics:
- Covers 43 countries (95 % of the global GDP) with over 150 smaller countries combined in 5 'Rest of the World' groups by continent.
- Full trade matrices with insights on which product from which country is exported by which sector to which industry sector in another country.
- Base year 2007.
- Distinguishes over 160 industry sectors and 200 product categories by country.
- Covers the relations between industries and countries, not only in monetary value, but also in physical terms.
- Covers 40 emitted substances, land use, water use and 80 resources by industry.

Figure: Example of a MR EE IOT with three countries

- domestic input-output table for 1 region
- bilateral trade tables between 2 regions
- factor inputs table for 1 region
- environmental interventions for 1 region
- final use of domestic produce
- final use of imported produce

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Arnold Tukker, Tatyana Bulavskaya, Stefan Giljum, Arjan de Koning, Stephan Lutter, Moana Simas, Konstantin Stadler, Richard Wood

The Global Resource Footprint of Nations

Carbon, water, land and materials embodied in trade and final consumption
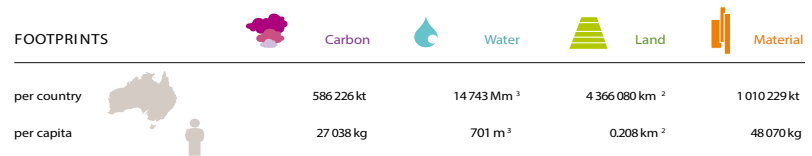
Australia

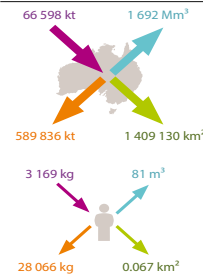Population: 21 015 900 | Land area: 7 741 220 km² | GDP: 625 361 Mil. €

Australia has the highest per capita carbon, water and land footprint in the world, and ranks second only after Ireland, in terms of material footprint. Australia's land footprint is particularly high compared to the world average, reflecting the country's low population density. Australia is a net exporter of water, land and materials embodied in trade but a net importer of embodied carbon. Although Australia also has a high GDP per capita, the carbon footprint per unit of GDP is high.
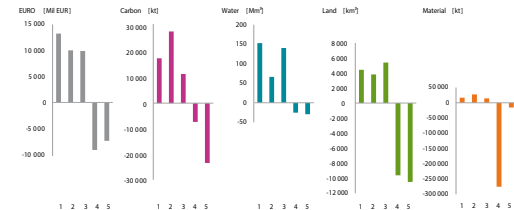
FOOTPRINTS	Carbon	Water	Land	Material
per country	586 226 kt	14 743 Mm³	4 366 080 km²	1 010 229 kt
per capita	27 038 kg	701 m³	0.208 km²	48 070 kg

NET TRADE

66 598 kt | 1 692 Mm³
589 836 kt | 1 409 130 km²

3 169 kg | 81 m³
28 066 kg | 0.067 km²

TRADE FLOWS BY PRODUCT

Shown below are the net trade of products imported/exported to/from a country (imports minus exports) – the products include products for both further processing into more advanced goods/services (that may be later exported) and for final consumption. Environmental impacts are shown for the complete up-stream international supply chain of each product.

EURO [Mil EUR] | Carbon [kt] | Water [Mm³] | Land [km²] | Material [kt]

1 Machinery and equipment n.e.c.
2 Gas/Diesel Oil
3 Radio, television and communication equipment and apparatus
4 Iron ores
5 Other Bituminous Coal

RANKING

World average per capita

Carbon	Water	Land	Material
1 Australia	1 Australia	1 Australia	1 Ireland
2 Luxembourg	2 Luxembourg	2 Canada	2 Australia
		topped0.21/a	3 Luxembourg

KEY INDICATORS

	Carbon	Water	Land	Material	GDP	Population
Resource footprints per € GDP	0.909 kt/Mil €	0.024 Mm³/Mil €	6.982 km²/Mil €	1.615 kt/Mil €		
Per capita footprints relative to world average	4.73	2.80	15.67	4.86		
Contribution to global total	1.50 %	0.89 %	4.96 %	1.54 %	1.53 %	0.32 %
World total	37.97 Gt	1 660 560 Mm³	88 031 435 km²	65 627 314 kt	40 744 556 Mil €	6 638 184 044
World average per capita	5 721 kg/cap	250 m³	0.013 km²	9 886 kg		
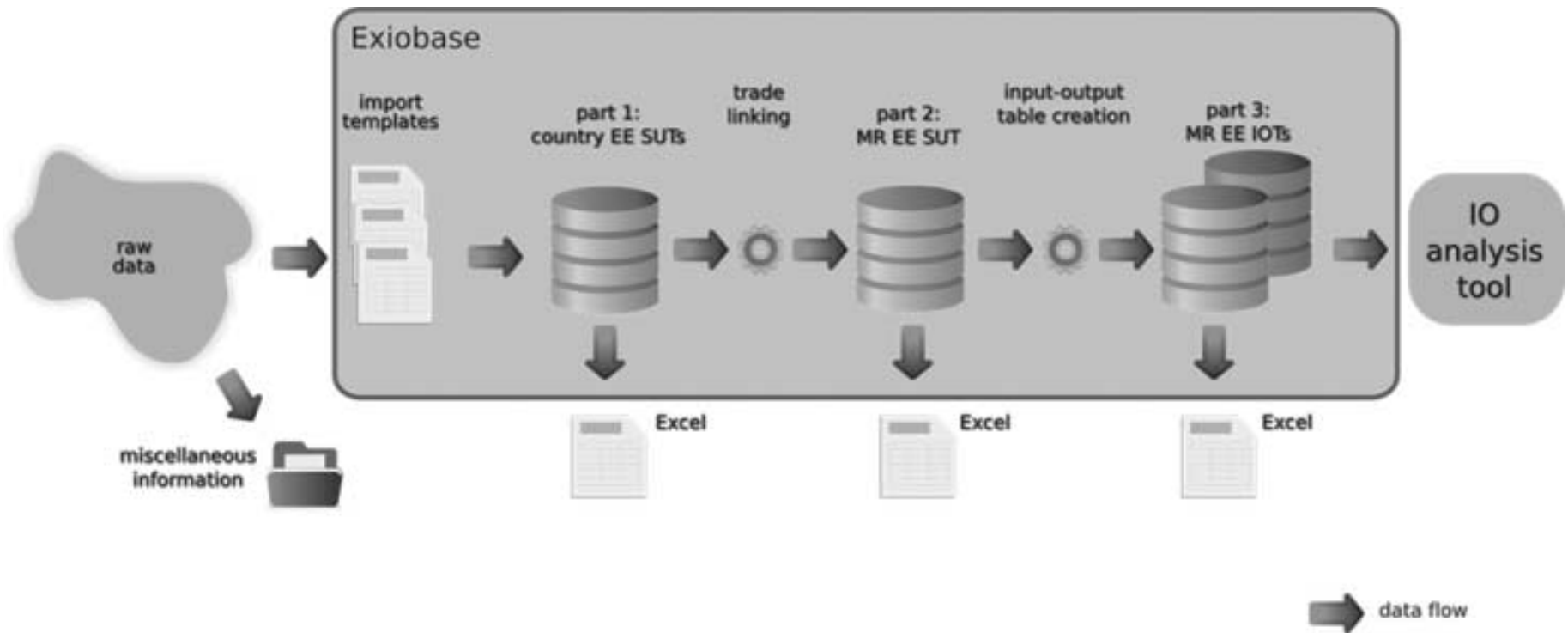
Tukker et al., 2013
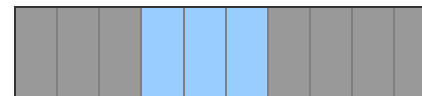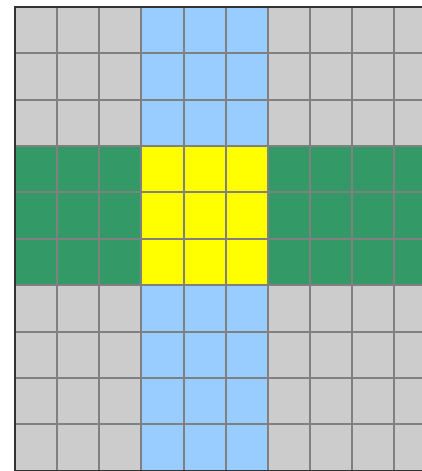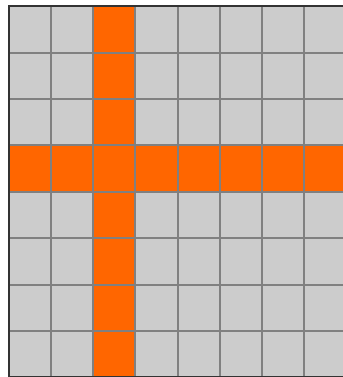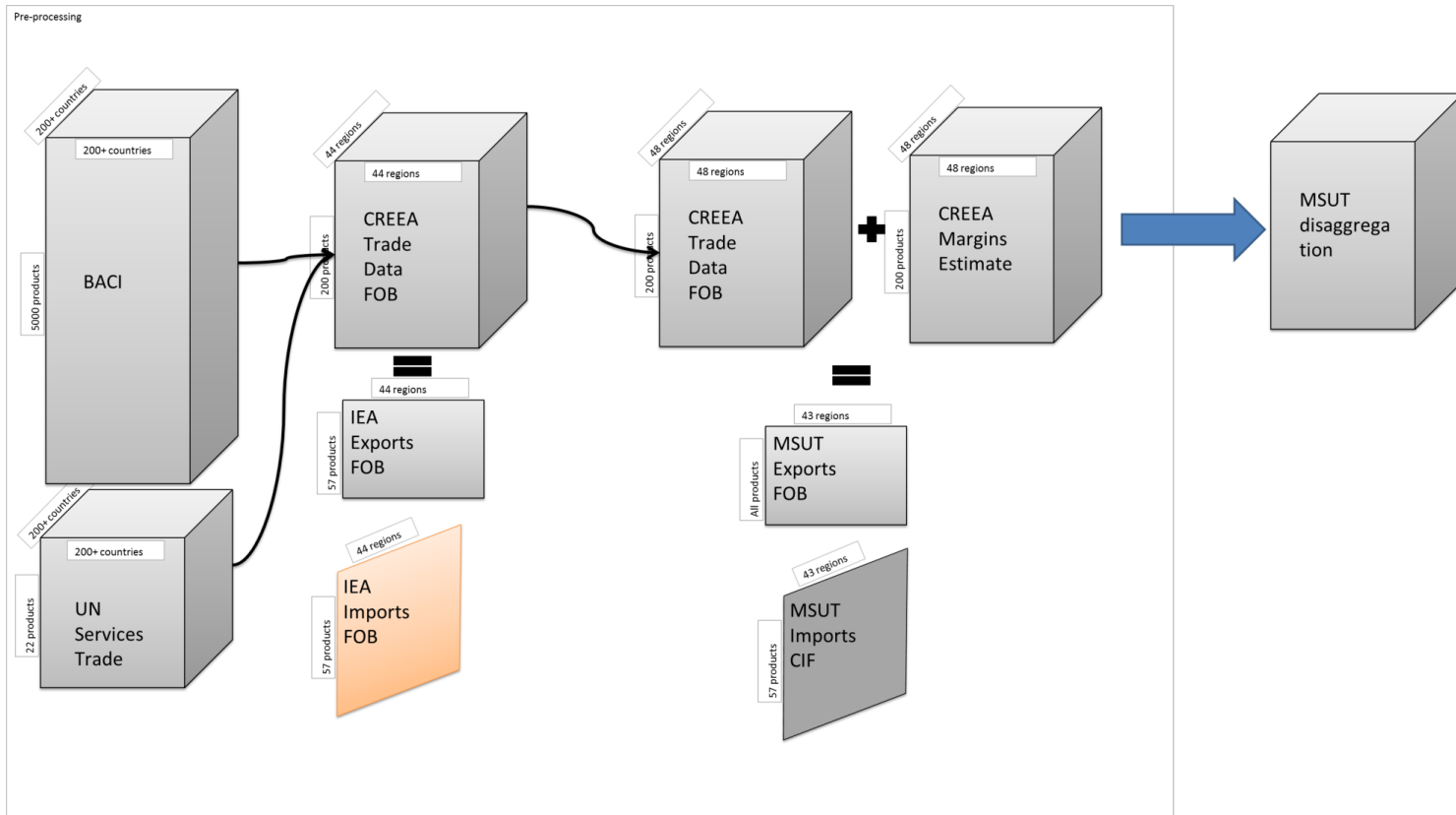
Left : Original aggregate table;   Right : Draft big table

CREAA 7.2 (2014)

Trade pre processing before estimation of MSUT values

CREAA 7.2 (2014)

Raw Data

Trade shares

Initial Estimate (IE)

Concordance-matrices

(Un)certainty

Constraints

MRIO-Balancing:
„minimize the information loss from the Initial Estimate subject to constraints"

AISHA

Final MRIO
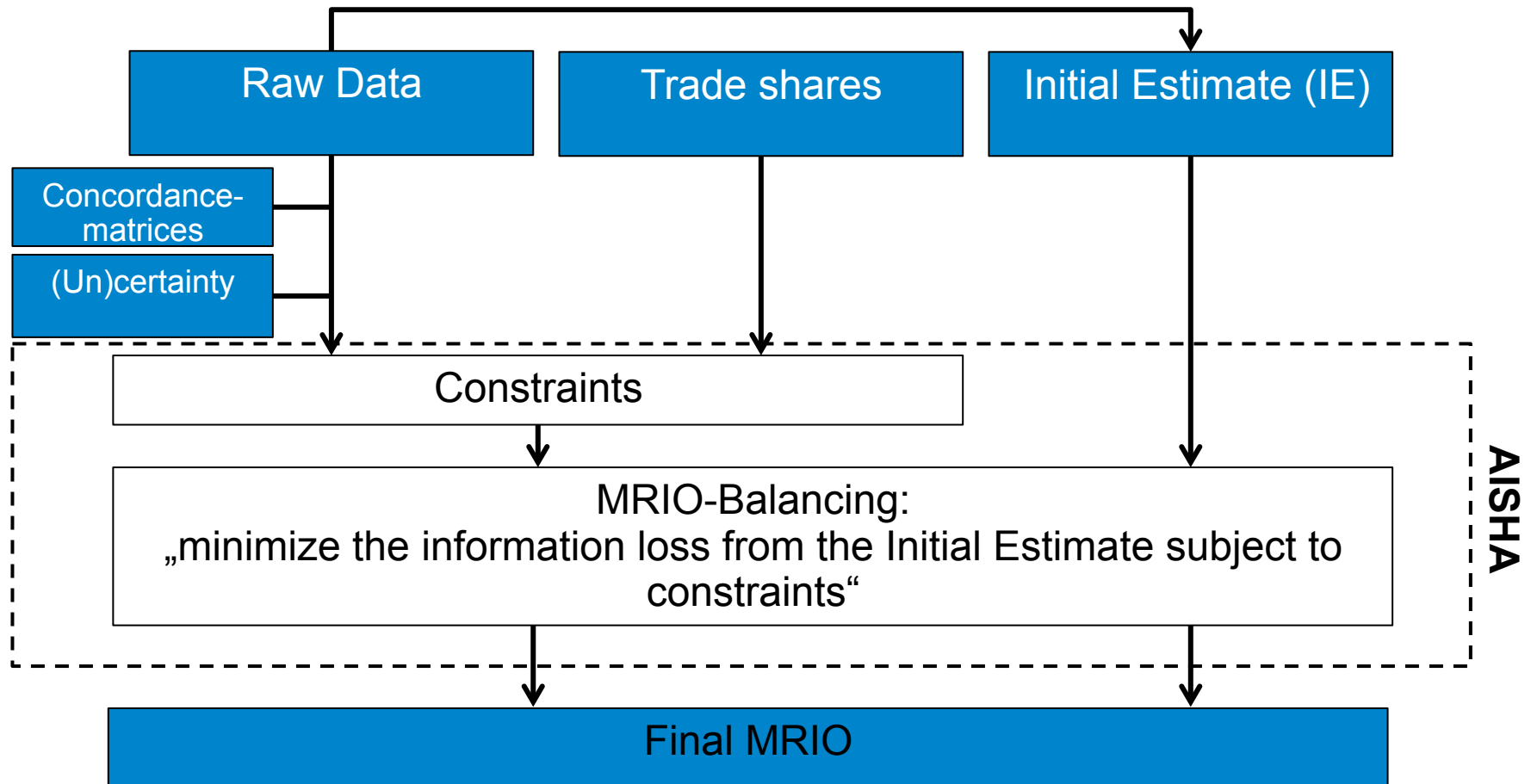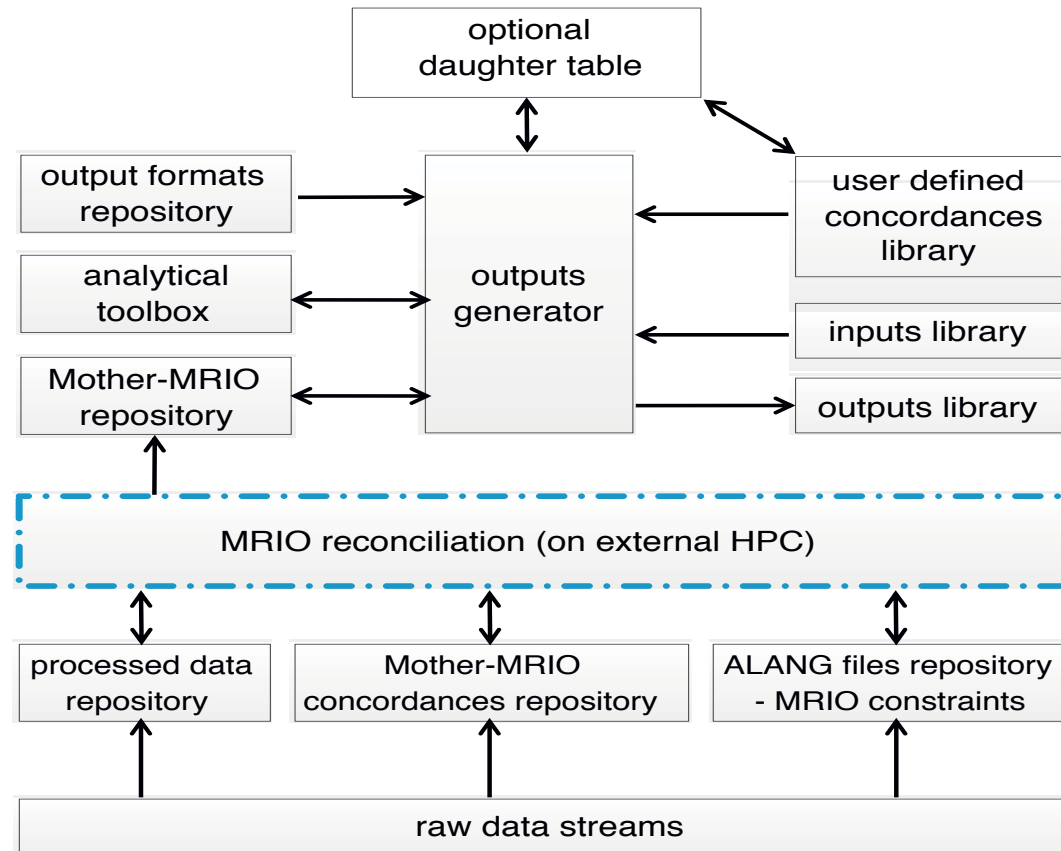
Fig. 1. Schematic of structure and functionality of the Industrial Ecology Lab.

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TABLE 1. Databases used for this study.

No	IE data set	Const. data set	Construction	Short	Notes
1	EXIOBASE v1.0	EXIOBASE v1.0	EXIOBASE v1.0	XXX	Database not constructed during this project, but used as a reference
2	EXIOBASE v2.0	EXIOBASE v2.0	EXIOBASE v2.0	CCC	Database not constructed during this project, but used as a reference
3	Eora	Eora	Eora	EEE	Database not constructed during this project, but used as a reference
4	EXIOBASE v1.0	EXIOBASE v2.0	Eora	XCE	
5	EXIOBASE v2.0	EXIOBASE v2.0	Eora	GCE	see Section 2.4.1
6	Eora	EXIOBASE v2.0	Eora	ECE	
7	EXIOBASE v1.0	Eora	Eora	XEE	
8	EXIOBASE v2.0	Eora	Eora	GEE	see Section 2.4.1

Notes: The databases numbered 1–3 were used as reference tables for this study. The databases 4–6 were reconciled according to the EXIOBASE v2.0 constraints set, the remaining databases were reconciled according to the Eora constraints set.
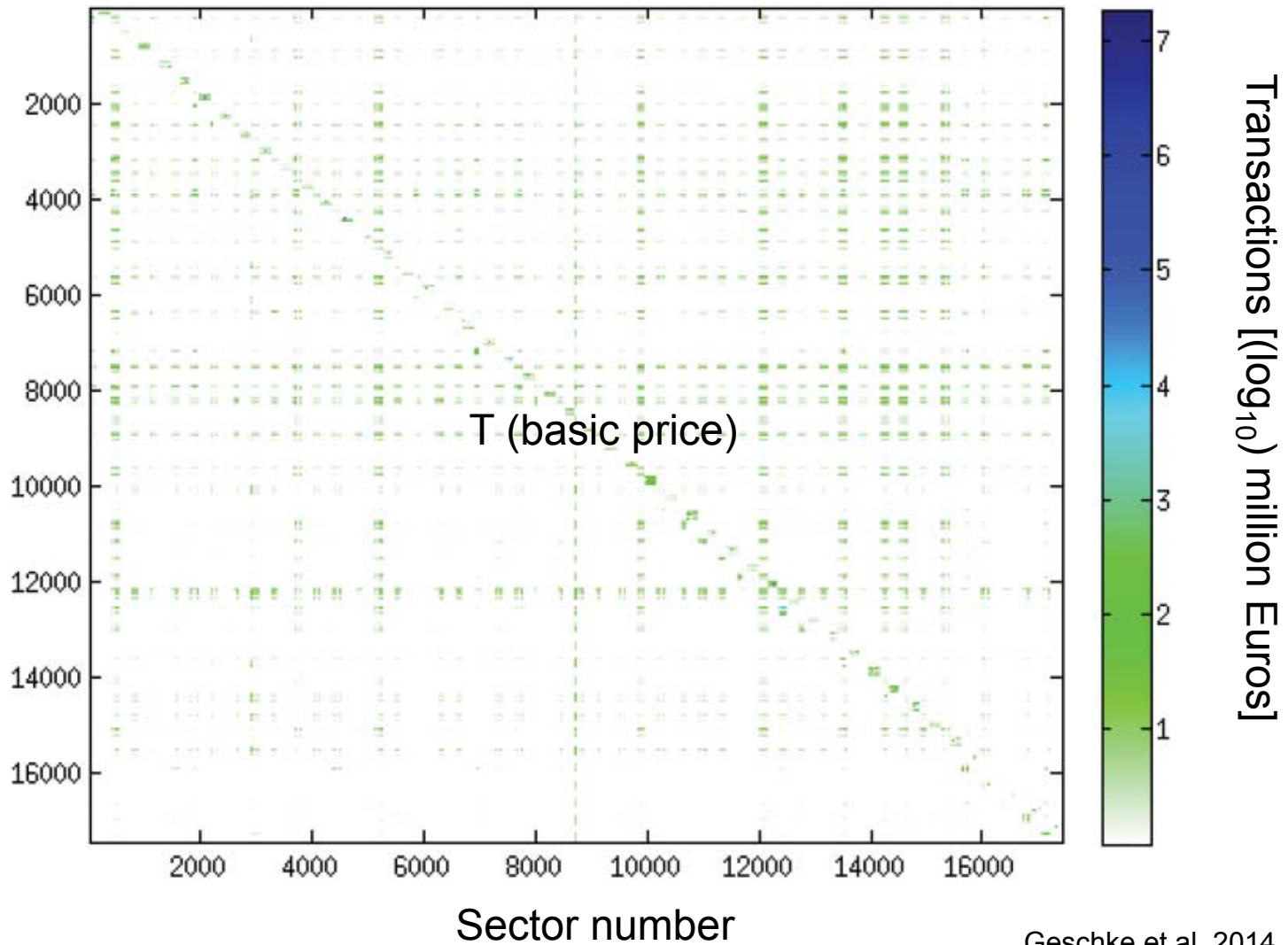
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A. TUKKER AND E. DIETZENBACHER

TABLE 1. Review of the main GMRIO databases.

Database name	Countries	Type	Detail ($i \times p$)*	Time	Extensions	Approach
EORA	World (around 150)	MR SUT/IOT	Variable (20–500)	1990–2009	Various	Create initial estimate; gather all data in original formats; formulate constraints; detect and judge inconsistencies; let routine calculate global MR SUT/IOT
EXIOPOL	World (43 + RoW)	MR SUT	129 × 129	2000	30 emissions, 60 IEA energy carriers, water, land, 80 resources	Create SUTs; split use into domestic and imported use; detail and harmonize SUTs; use trade shares to estimate implicit exports; confront with exports in SUT; RAS out differences; add extensions
WIOD	World (40 + RoW)	MR SUT	35 × 59	1995–2009, annually	Detailed socio-economic and environmental satellite accounts	Harmonize SUTs; create bilateral trade database for goods and services; adopt import shares to split use into domestic and imported use; trade information for RoW is used to reconcile bilateral trade shares; add extensions
GTAP-MRIO	World (129)	MR IOT	57 × 57	1990, 1992, 1995, 1997, 2001, 2004, 2007	5 (GWP), Land use (18 AEZ), energy volumes, migration	Harmonize trade; use IOTs to link trade sets; IOT balanced with trade and macro-economic data
GRAM	World (40)	MR IOT	48 × 48	2000, 2004	Various	Use harmonized OECD IOTs; neglect differences like ixi and pxp; use OECD bilateral trade database to trade link
IDE-JETRO	Asia-Pacific (8: 1975) (10: 1985–2005)	MR IOT	56 × 56 (1975) 78 × 78 (1985–1995), 76 × 76 (2000, 2005)	1975–2005	Employment matrices (2000, 2005)	Harmonize IOTs based on cross-country survey information; link via trade, manual balancing to reduce discrepancies within a certain bounds

i = number of industries, p = number of products,   The follow-up project CREEA constructs the EE GMRIO for 2007.

International databases	Type of data	Years	Classifications	No of countries	Industry levels	No of products	No of services	Comments
Trade Analysis System on Personal Computer (PC-TAS HS revision 2)	Import/Export	2007 - 2011	HS1996	176	6-digit	5114	0	No services data
Trade Analysis System on Personal Computer (PC-TAS SITC revision 3)	Import/Export	2006 - 2010	SITC rev 3	181	5-digit	3121	0	No services data
Industrial Statistics Database 3- and 4- level of ISIC (INDSTAT4 2012)	Output/Employmt	1990 - 2011	ISIC rev 3	59	4-digit	148	146	Limited country coverage
Industrial Commodity Statistics Database ICS	Output	1950 - 2008	CPC v1.1	200	5-digit	1152	970	Lack of monetary value data
UN Comtrade Database	Import/Export	1962 - 2013	SITC rev 1-4, HS1992-HS2012	292	5-digit(SITC), 6-digit(HS)		0	No services data
OECD database	Import/Export	1988 - 2013	SITC rev 2-3, HS1988-2007	41(SITC), 37(HS)	5-digit(SITC), 6-digit(HS)			Limited to OECD country data and trade partner
UN Main Aggregates Database	Value Added	1970 - 2012	ISIC rev 3	218	n/a	3	4	Aggregated to 7 ISIC classifications
UN Official Country data	Value Added	1970 - 2013	ISIC rev 3	66	n/a			Aggregated to 27 ISIC classifications
UN Service Trade Database	Import/Export	2000 - 2013	EBOPS	199	n/a			Limited services classification
UNCTAD Database	Import/Export	1980 - 2013	SITC rev.3	237	3-digit	3121	0	Aggregated classification on services

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