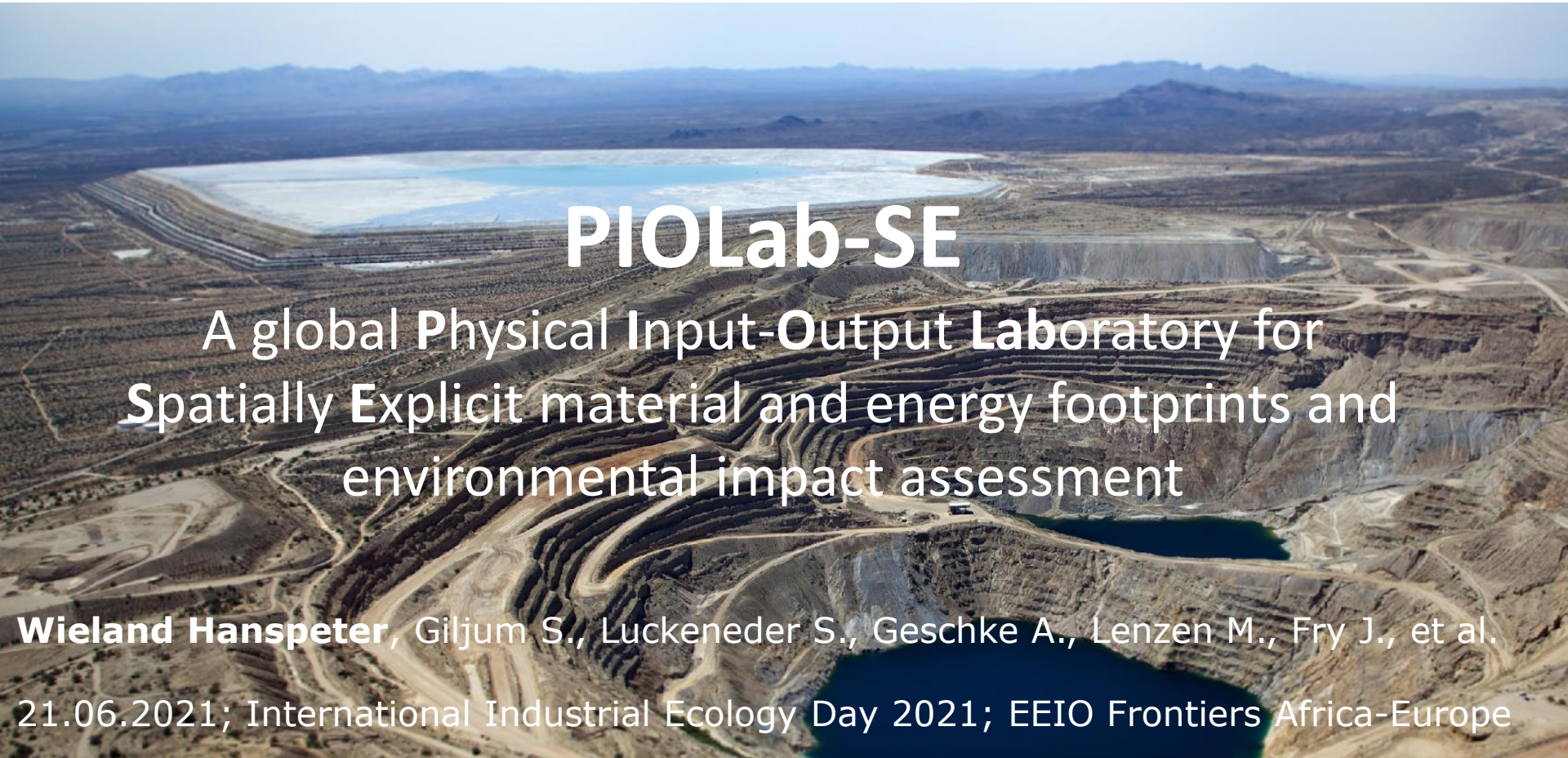


PIOLab-SE

A global **P**hysical **I**nput-**O**utput **Lab**oratory for **S**patially **E**xplicit material and energy footprints and environmental impact assessment

Wieland Hanspeter, Giljum S., Luckeneder S., Geschke A., Lenzen M., Fry J., et al.

21.06.2021; International Industrial Ecology Day 2021; EEIO Frontiers Africa-Europe

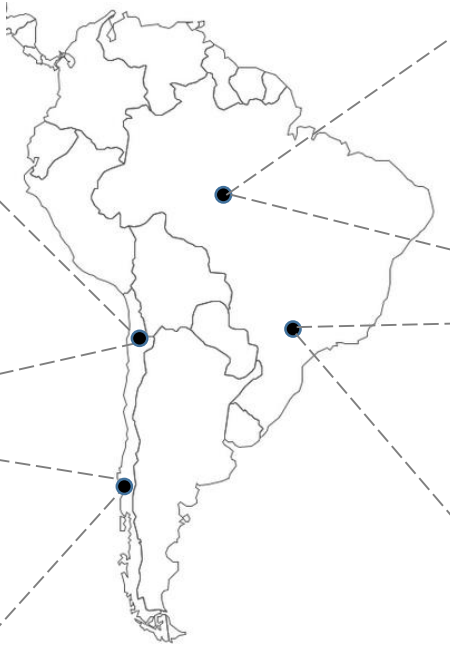
Impacts depend on specific location

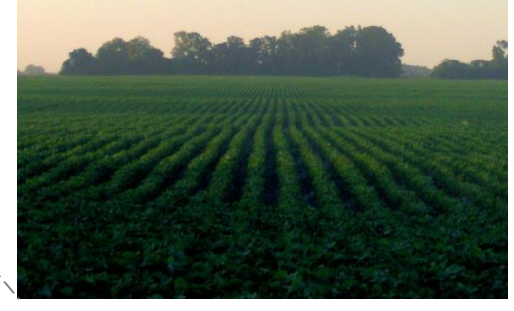
Brazil:
Soybean production

https://www.greenpeace.org/archive-international/en/news/features/amazon-destruction/

Chile:
Copper mining

http://intradayfun.com/2011/01/10-world-biggest-holes-created-by-human-and-nature/





https://es.wikipedia.org/wiki/Archivo:Sembrado_de_soja_en_argentina.jpg

http://www.dw.com/image/0%2C%2C19318441_302%2C00.jpg

Source: own illustration

Industrial Ecology Virtual Laboratory (IELab)

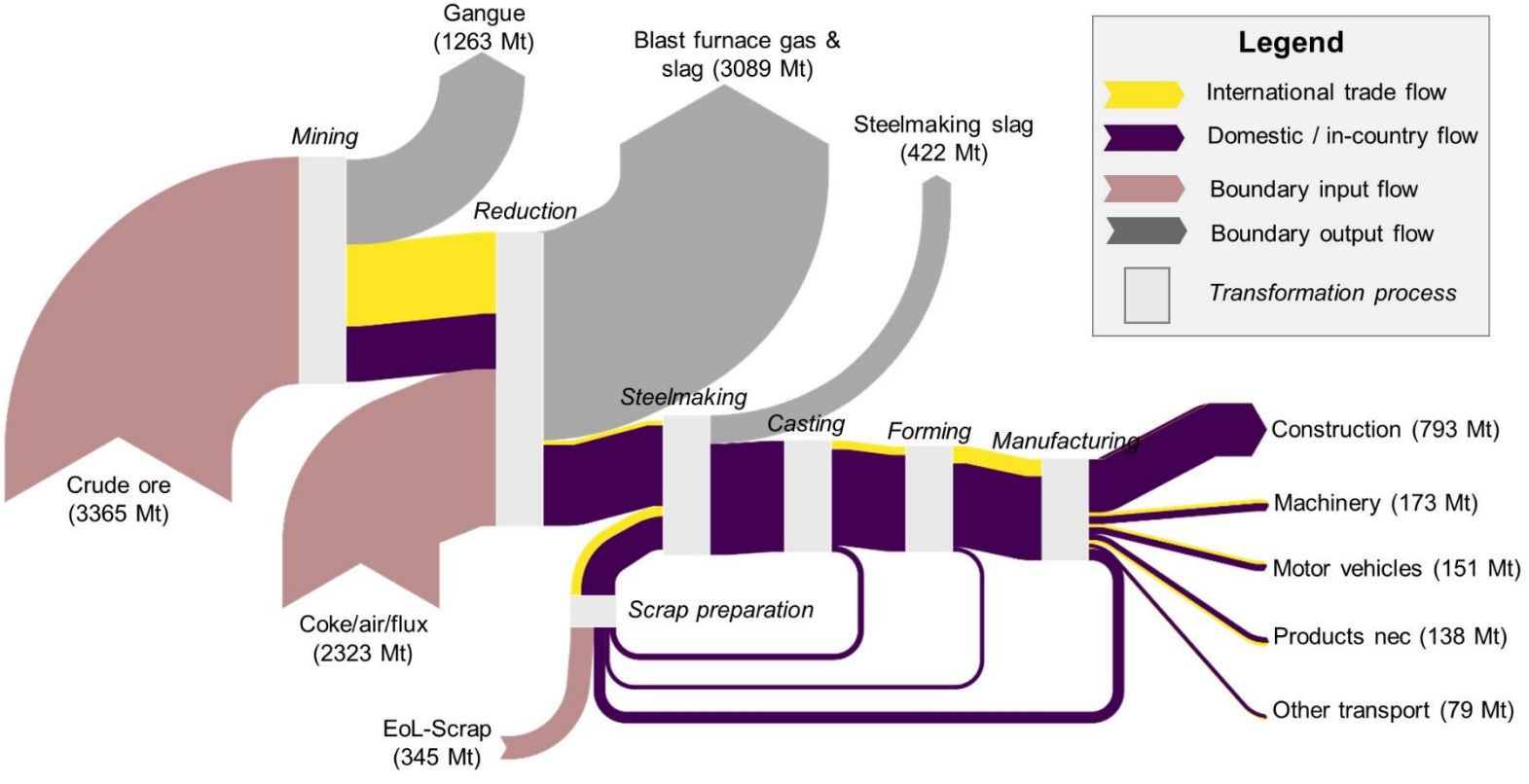
- Generalized raw data management with **root classification**
- **AISHA**: One-step reconciliation engine
  - ➢ Constrained optimization, KRAS
- High performance computers
- **Re-use code/data to compile IO tables for specific research questions**

Source: Geschke 2017

The PIOLab: a virtual laboratory for physical IO

- **Prototype for global iron and steel supply chains**
  - ➢ 32 regions, 30 processes & 39 flows
- **Primary data:** World Steel, BACI, UNEP-IRP MFA accounts, …
- **When primary data unavailable:**
  information from MFA, LCA, Waste IO modeling
- Publication forthcoming in JIE, first PIOTs available on Zenodo

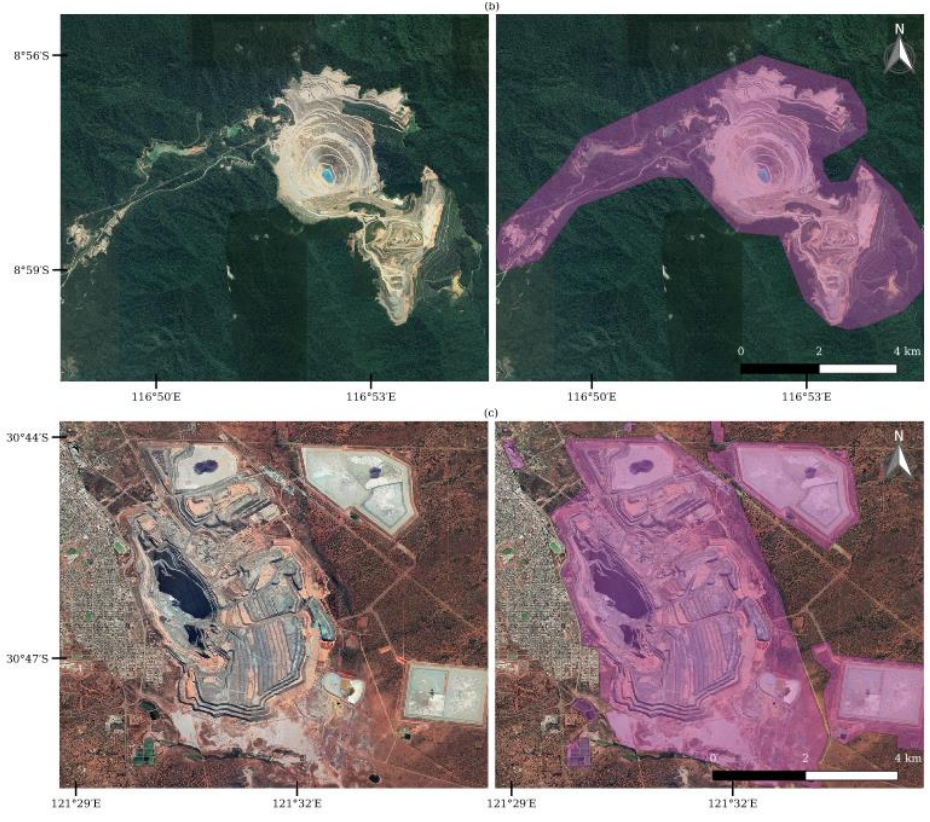
Sankey diagram of global iron-steel PIOT (2014)



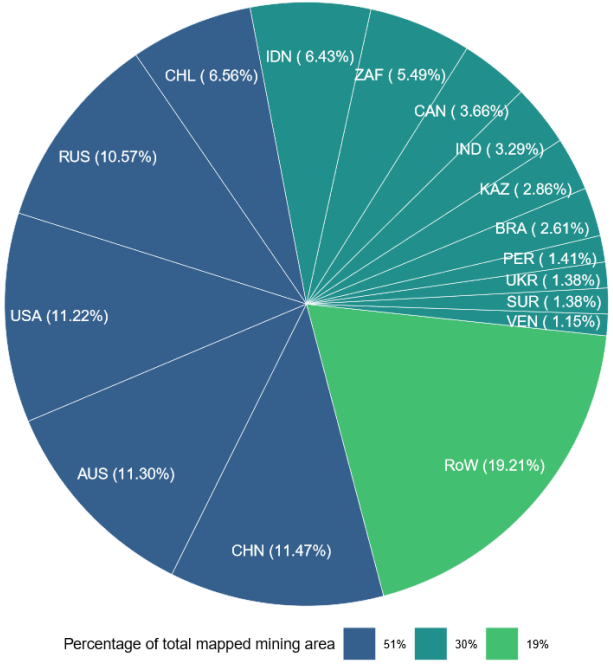
PIOLab-SE (global-subnational IO analysis)

- **Holistic multi-layer physical IO modelling framework for material & energy flows**
- Nested subnational-global PIOTs (30-100 regions) for iron, copper, aluminum, …
- Extends basic PIOLab approach with subnational impact assessment of mining activities
- Main FINEPRINT tool for impact assessment of metal consumption

A global-scale data set of mining areas



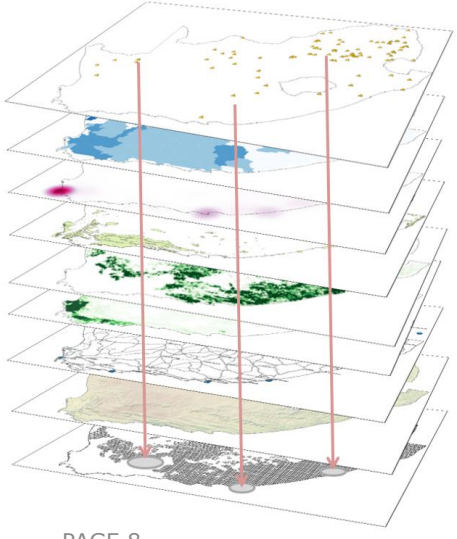
Total land area: 57,277 km^2

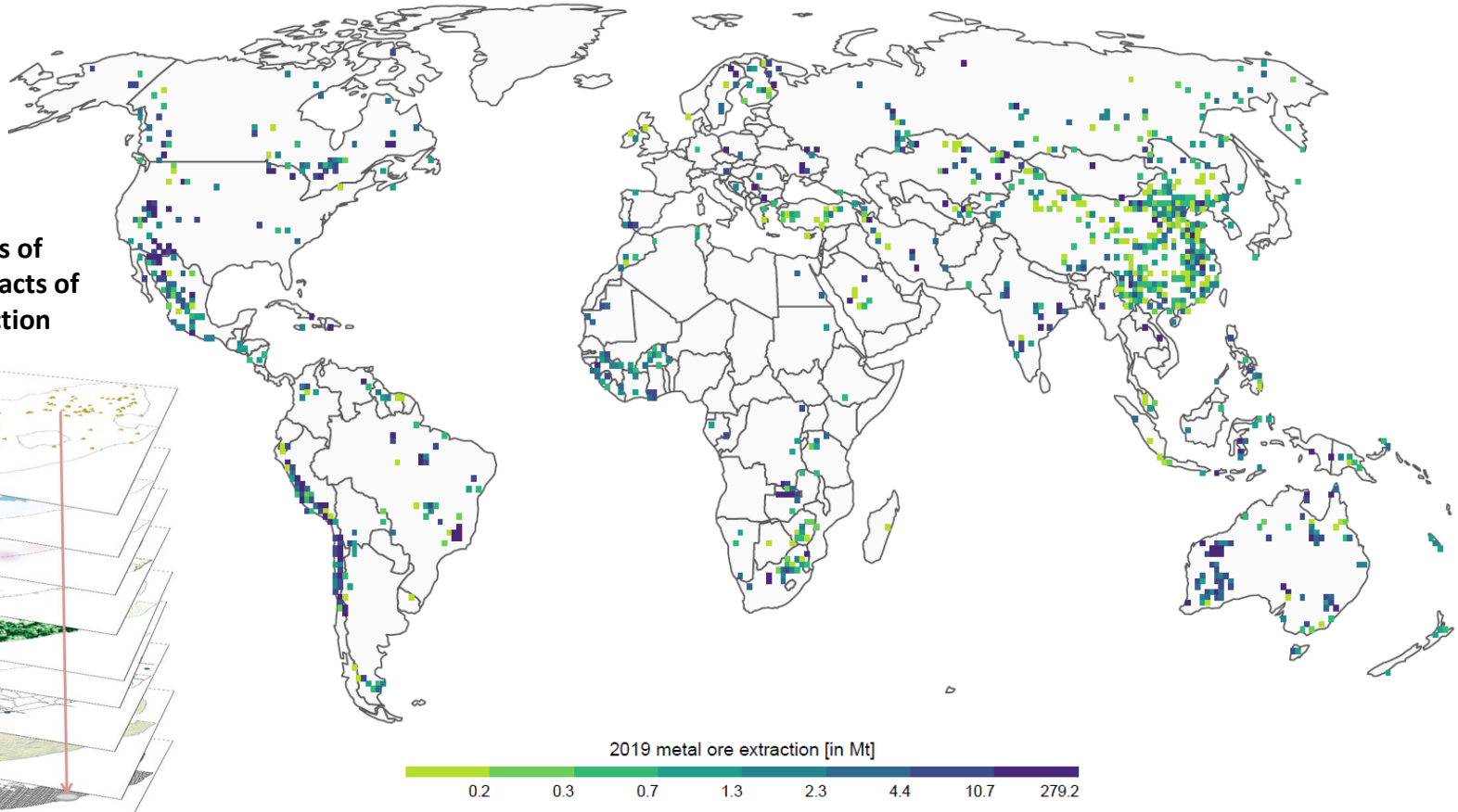


Source: Maus et al., 2020

Metal ore extraction, 2019, 1° grids

Multi-layer analysis of environmental impacts of raw material extraction





Source: Luckeneder et al., 2021

Environmental Pressure Impact Proxy (EPIP) matrix

Type 1
(**pressure**)
e.g. extraction

$$\mathbf{p} = \begin{pmatrix} p_1 \\ \vdots \\ p_m \end{pmatrix}$$

m stands for number of root regions and global extraction equals $\sum \mathbf{p}$

Type 2
(**impact**)
e.g. abiotic resource depletion

$$\mathbf{i} = \begin{pmatrix} i_1 \\ \vdots \\ i_m \end{pmatrix} = \mathbf{p} * \mathbf{c}$$

vector $\mathbf{i}$ is derived from secondary/own modeling results or by weighting pressures $\mathbf{p}$ using impact coefficients $\mathbf{c}$, e.g. from LCA

Type 3
(**pressure-by-states**)
e.g. extraction-by-reserves

$$\mathbf{P} = \begin{pmatrix} p_{1,1} & \cdots & p_{1,n} \\ \vdots & \ddots & \vdots \\ p_{m,1} & \cdots & p_{m,n} \end{pmatrix}$$

n stands for the number of environmental states (e.g. large, medium, small reserves) for which pressures are disaggregated. Row elements of matrix $\mathbf{P}$ sum up to $\mathbf{p}$

Global subnational PIOT example

		WA (Western Australia)			RoW (Rest of the World)			Final use		Boundary output to		Total output
		Mining	Smelting	Manufact.	Mining	Smelting	Manufact.	WA	RoW	SEM	Nature	
WA	Mining		20			40					40	100
	Smelting			100						20		120
	Manufacturing							190	10			200
RoW	Mining		10			490					500	1000
	Smelting			100			1820			200		2120
	Manufacturing							200	1620			1820
Boundary Input from	SEM		90			1590						
	Nature	100			1000							
	Total input	100	120	200	1000	2120	1820					

[kt]

Land use	species-rich biome	20			1500			[km²]
	species-poor biome	140			600			
Water use	water scarce region	200			1100			[1000 m³]
	water abundande region	0			1100			
Extraction from	large reserves	80			200			[kt]
	minor reserves	20			800			

EPIP Type 3

European Research Council
Established by the European Commission

fineprint

WU WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

Thank you!

hanspeter.wieland@wu.ac.at

www.fineprint.global

github.com/fineprint-global

researchgate.net/project/FINEPRINT