

An integrated metric for Assessing Earth System Impact

European Banking Authority

Workshop on Supervisory Approaches to Nature
Related Risks, Dec 2, 2025

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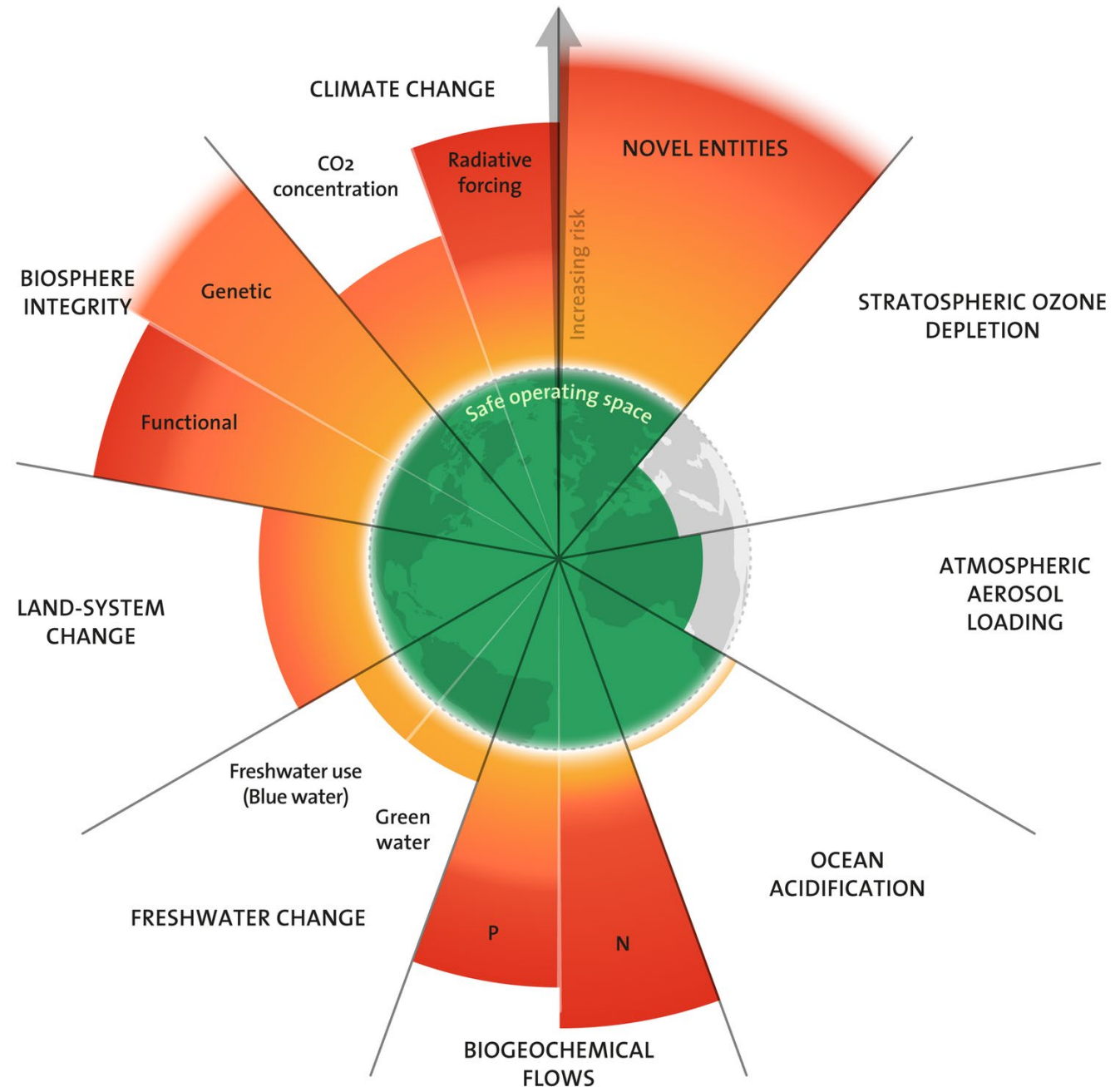


GLOBAL ECONOMIC DYNAMICS
AND THE BIOSPHERE
THE ROYAL SWEDISH ACADEMY OF SCIENCES

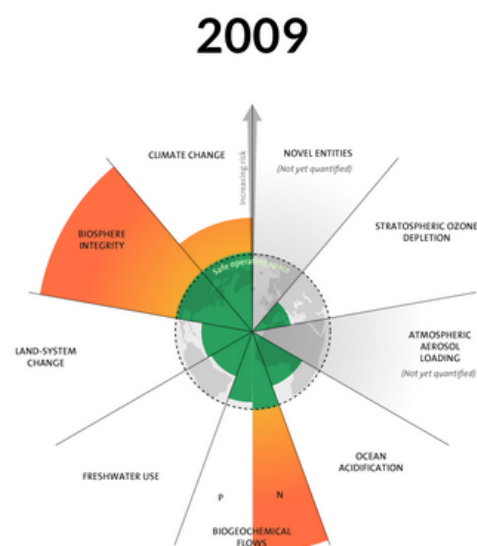


Planetary Boundaries

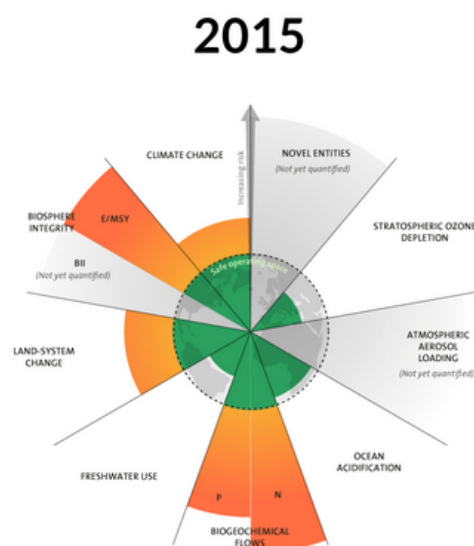
- Represent Earth-system processes that are critical for stabilizing the planet's environment
- The boundaries are quantitative assessments of the safe limits for human pressure on these nine critical processes
- Beyond which, conditions for humans to prosper and develop will be severely compromised



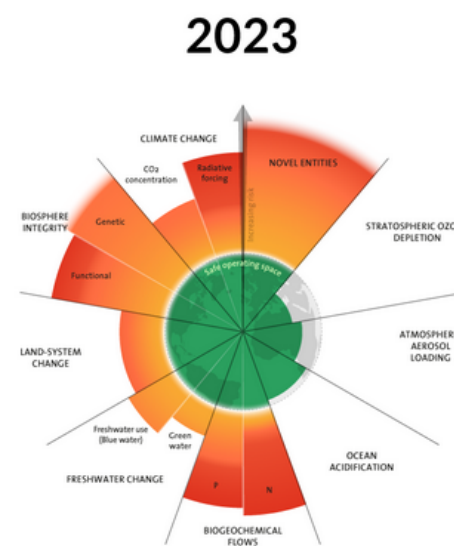
Planetary boundaries



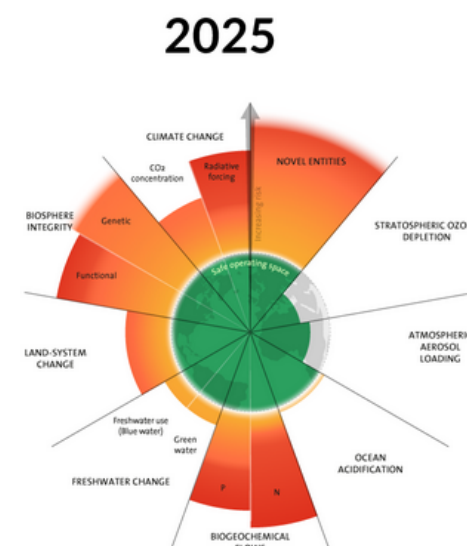
7 boundaries assessed,
3 crossed



7 boundaries assessed,
4 crossed



9 boundaries assessed,
6 crossed



9 boundaries assessed,
7 crossed

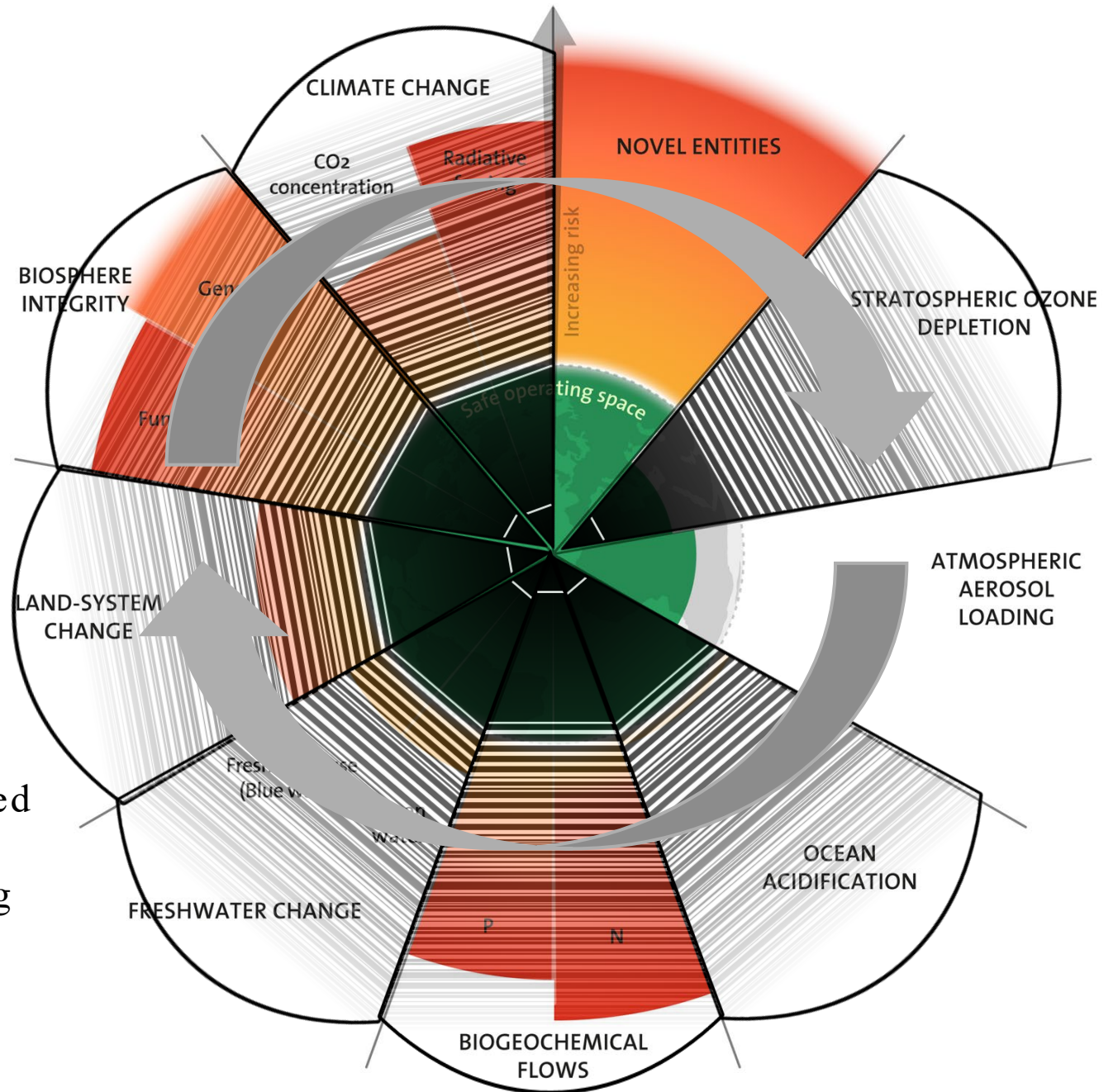
The evolution of the planetary boundaries framework. Licenced under CC BY-NC-ND 3.0 (Credit: Azote for Stockholm Resilience Centre, Stockholm University. Based on Sakschewski and Caesar et al. 2025, Richardson et al. 2023, Steffen et al. 2015, and Rockström et al. 2009).

Global processes - impacts occur everywhere simultaneously

Regional impacts

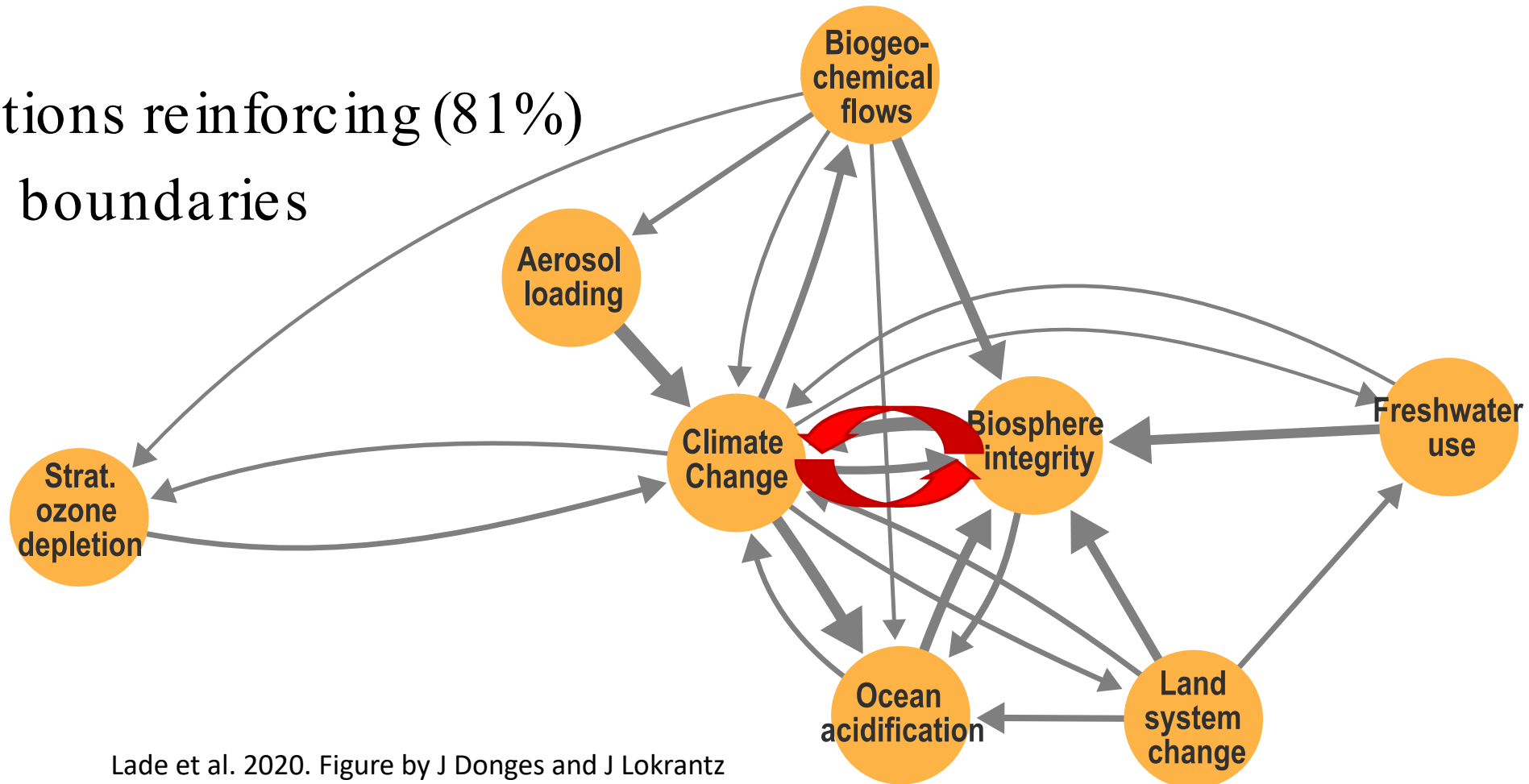
Global threshold is assessed as crossed when enough of these local boundaries are transgressed

Significant financial risk at the regional scale long before global threshold is reached

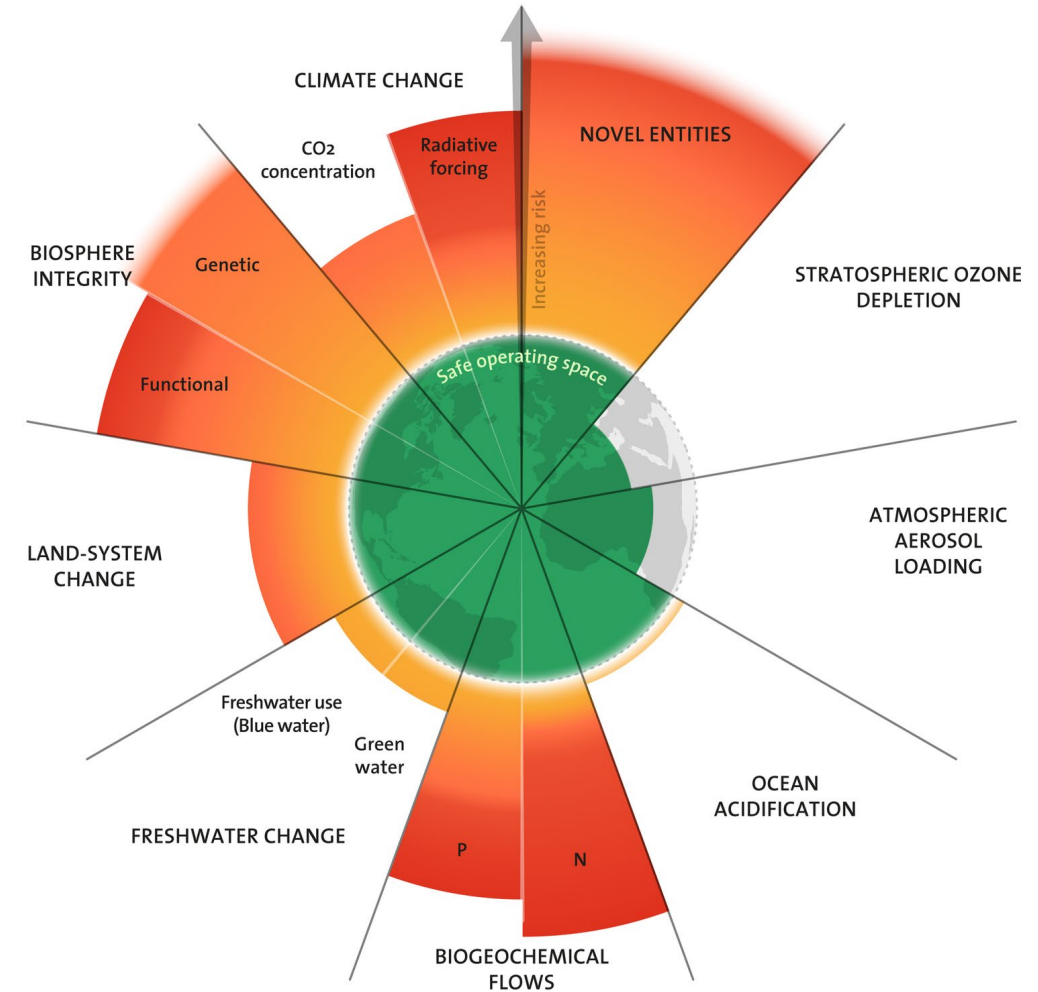


Planetary Boundaries are densely interconnected (literature review, global scale)

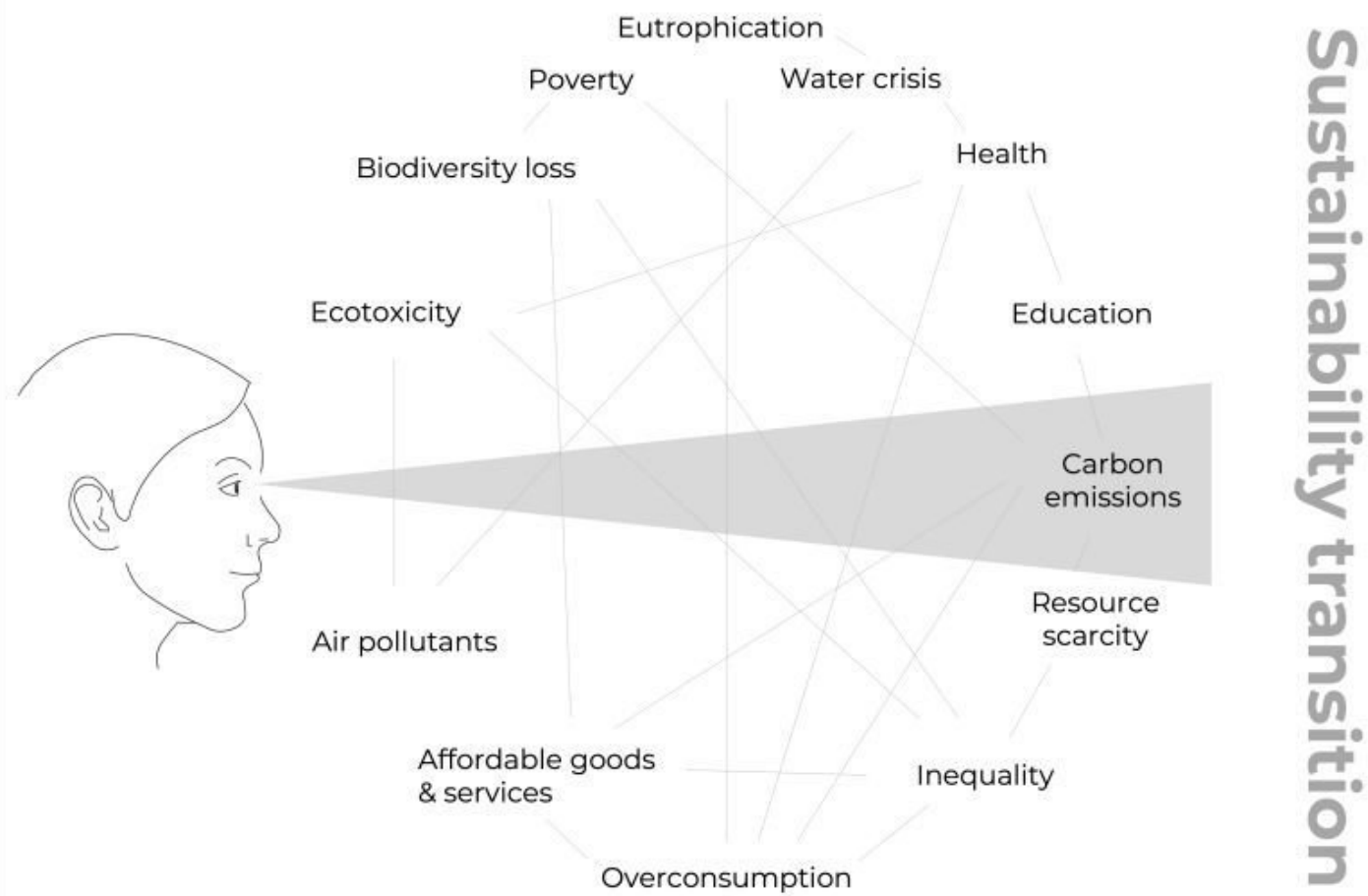
- Evidence for 51% of possible biophysical interactions
- Most interactions reinforcing (81%)
- CC & BI core boundaries



1. Reduced Earth System Resilience
2. PB interactions affect the speed and scale at which boundaries are transgressed



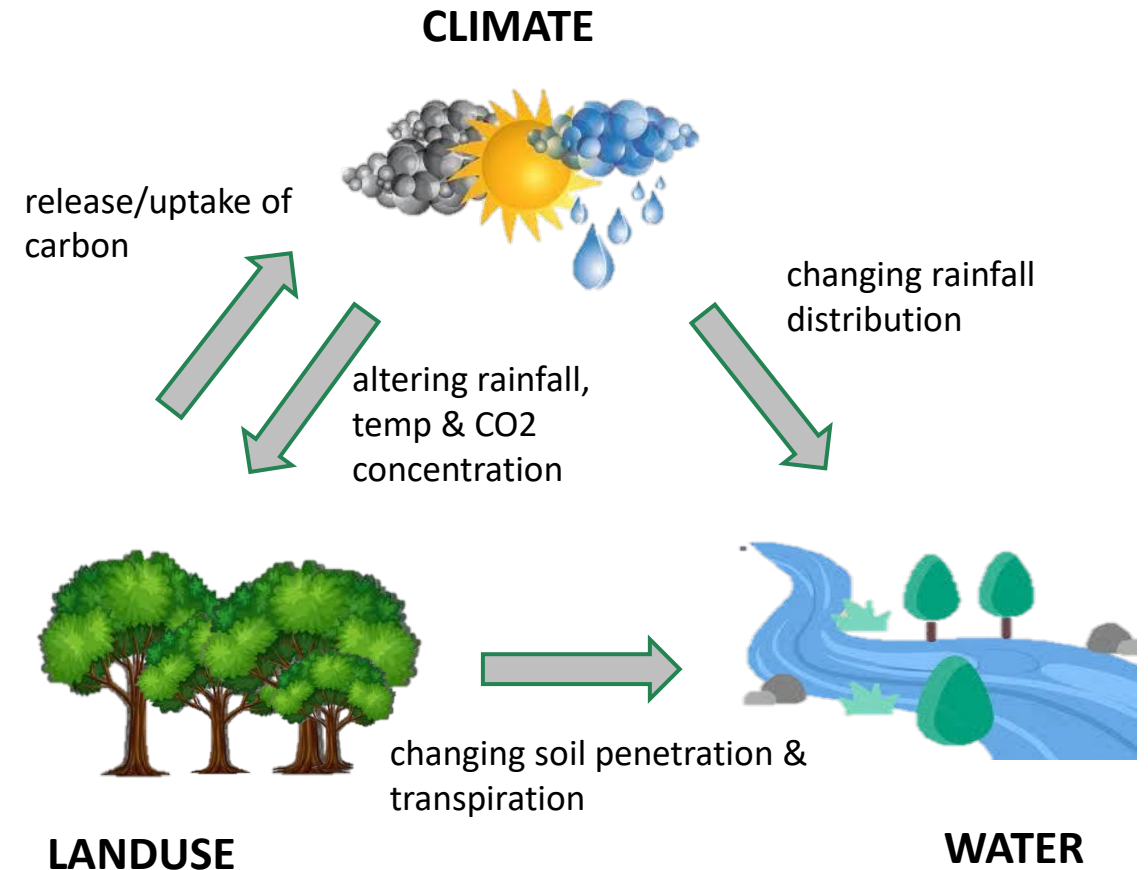
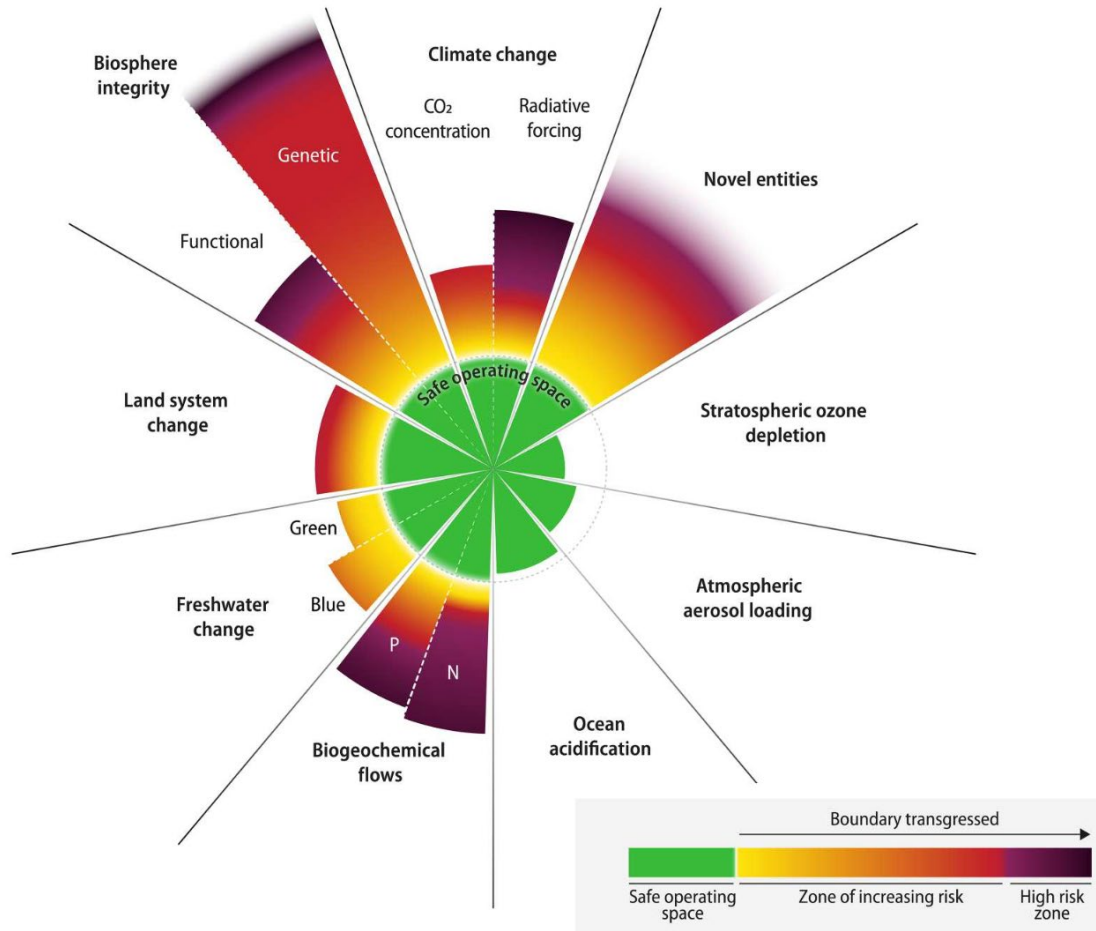
Carbon Tunnel Vision



Sustainability transition

The Earth System Impact score

Going beyond carbon to capture key Earth system interactions



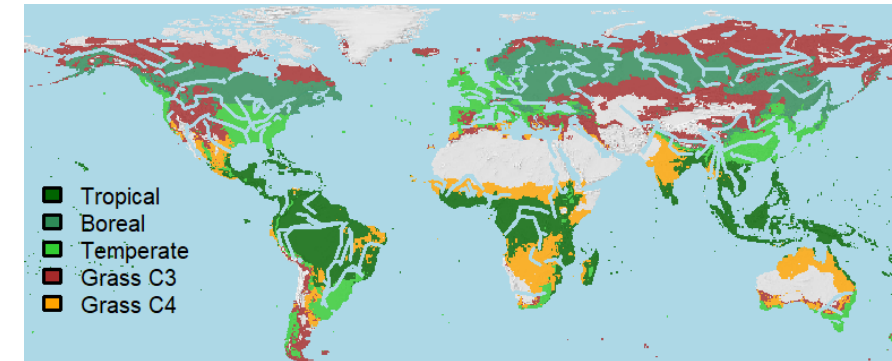
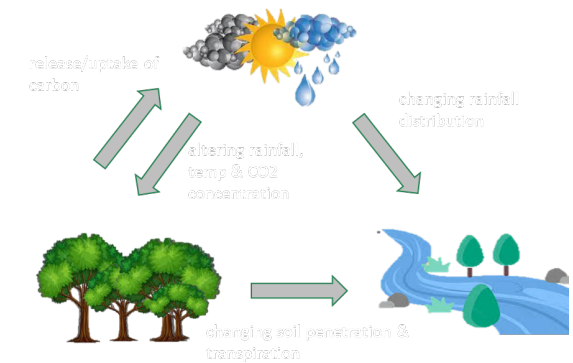
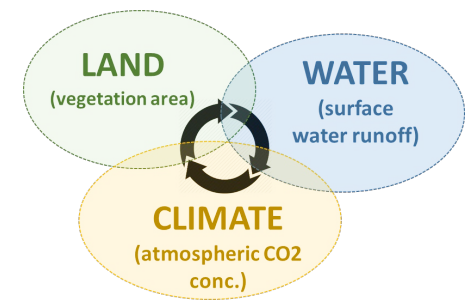
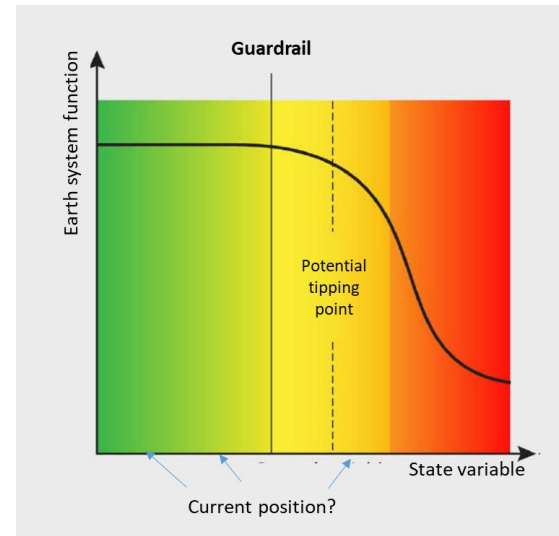
Richardson, K, et al (2023). Earth beyond six of nine planetary boundaries. Science Advances, 9(37)

Lade et al (2020) Human impacts on planetary boundaries amplified by Earth system interactions. Nature Sustainability

Measuring Earth System Impact – a prototype tool

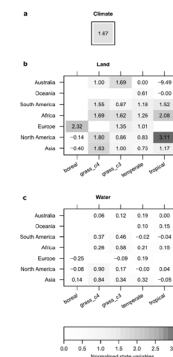
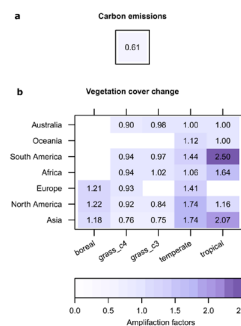
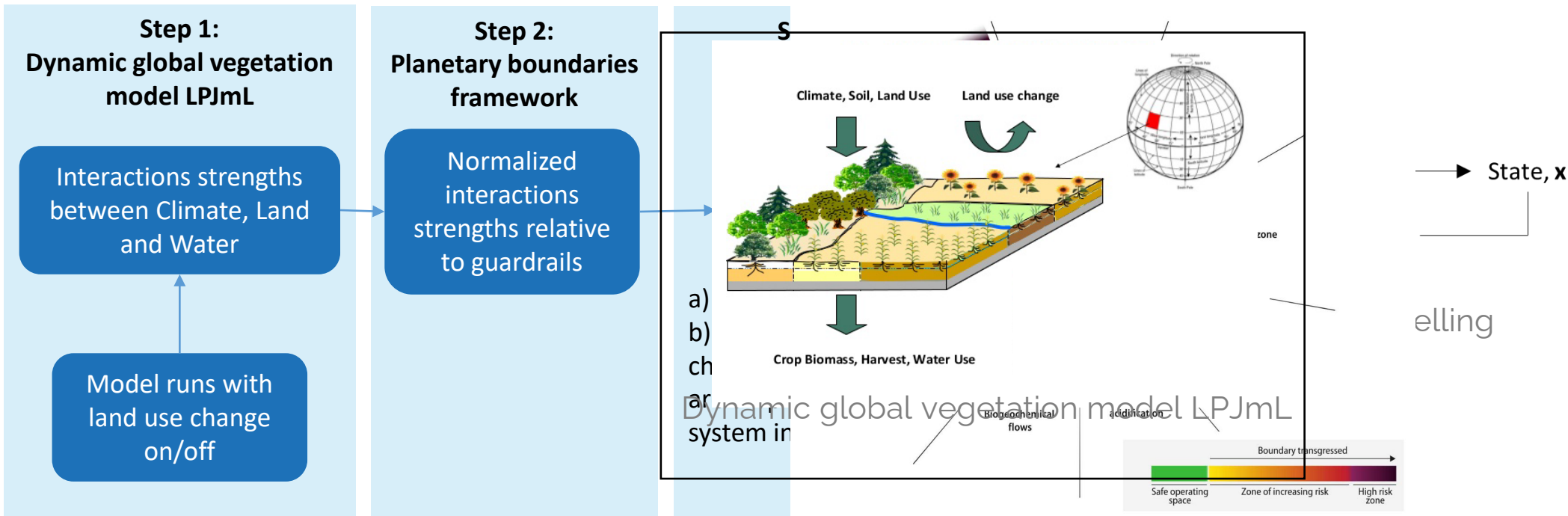
1. Accounts for Earth system components other than climate (CO₂)
2. Accounts for interactions between Earth system components
3. Distinguishes impacts on land and water by region and vegetation type
4. Accounts for current state of Earth system component relative to guardrails - accounts for total availability

E.g. water extraction will have more impact in N Am. plains than Amazon rainforest

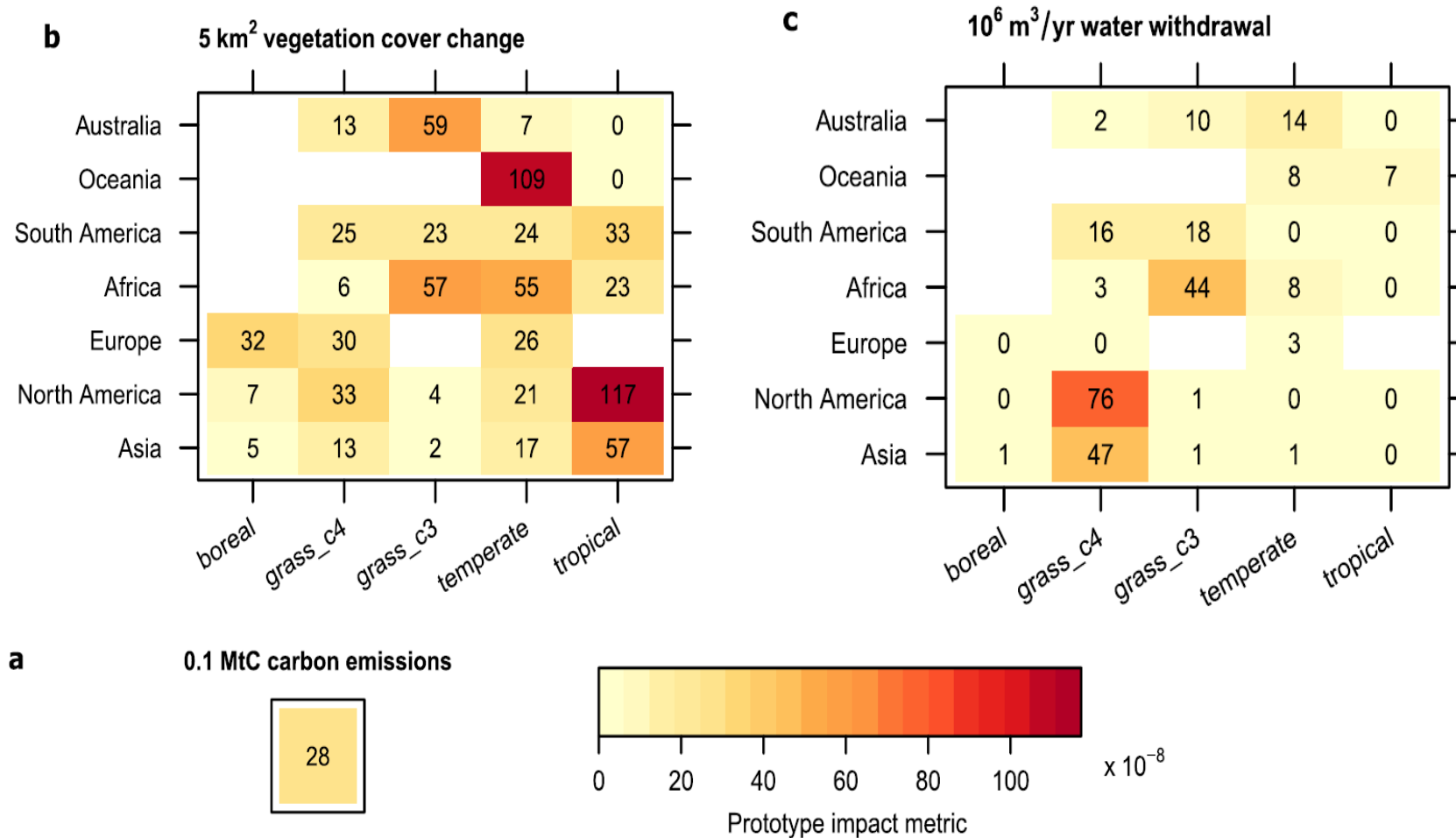


E.g. Land clearing will have more impact in Amazon than a Mediterranean forest

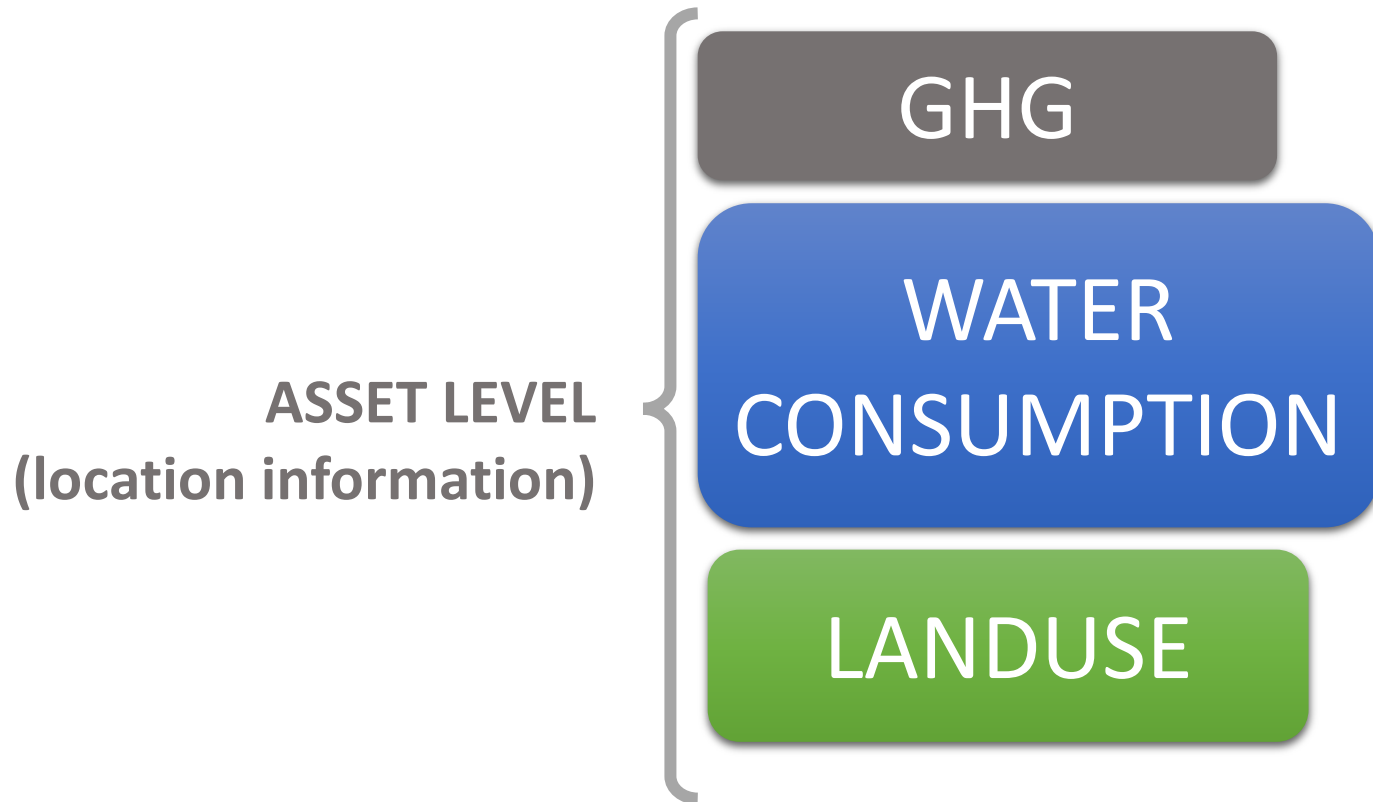
Method - Development of the metric



The Earth System Impact metric/score (prototype version)



Data needs to assess Earth System Impact



Only partially generated by CSRD/ESRS

WHERE...

does the impact occur?

WHAT...





activity is causing the
impact?

HOW MUCH...

impact (pressure) is put
on the environment?



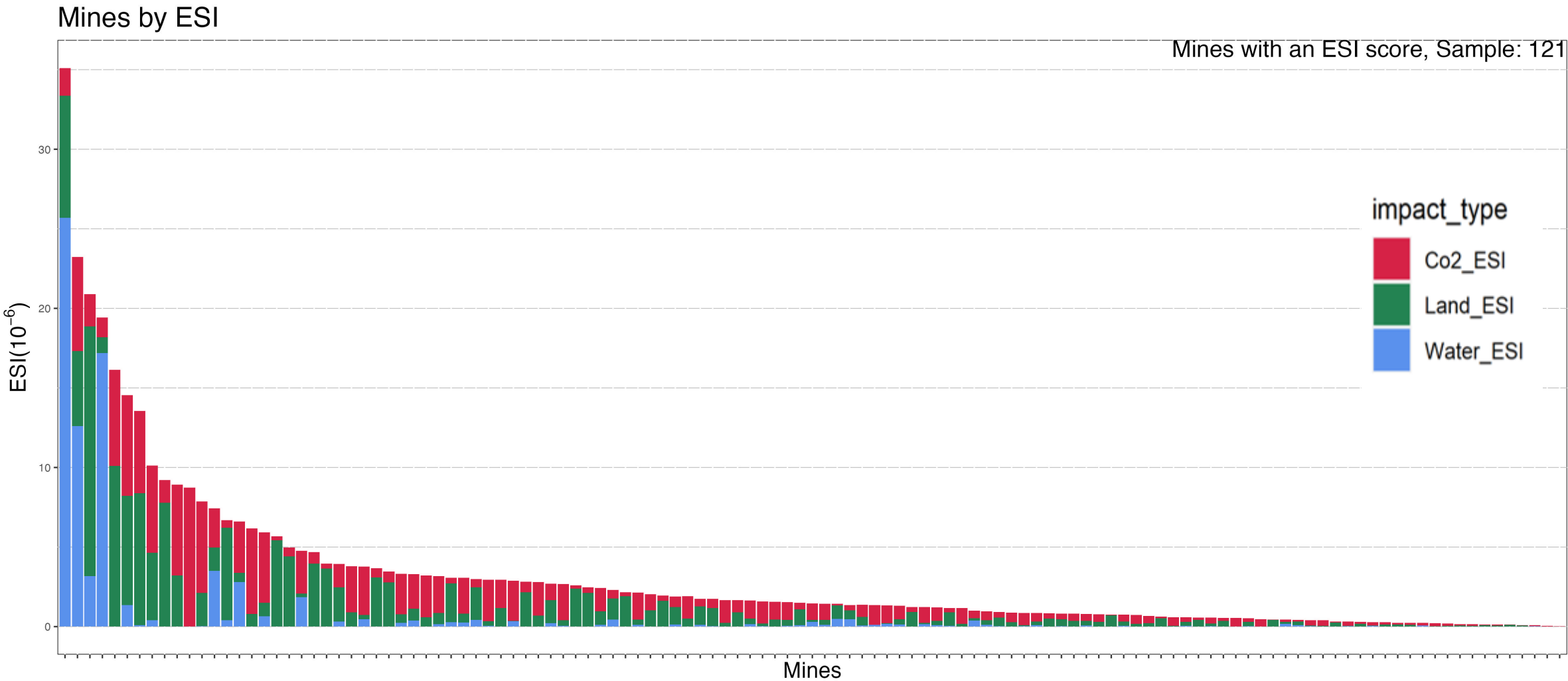
Mining Case Study

				Corporate disclosures used			Contribution to total			Earth system impact
name	Company	metal	Region	CO2 emissions (t CO2)	Water Consumption (000m3)	Landuse (km2)	co2 ESI 	Water ESI 	Land Use ESI 	Total ESI 
Buenavista	SCC	Copper	North America	589,510	30,104	116	1.65	22.94	7.67	32.26
Caridad	SCC	Copper	North America	528,467	23,903	15	1.48	18.21	0.99	20.68
Sishen mine	AA	Iron	Africa	720,000	5,472	139	2.02	2.39	15.73	20.13
Mogalakwena	AA	PGMs	Africa	2,107,135	17,716	42	5.90	7.72	4.72	18.34
PT Vale Indo	Vale	Nickel	Asia	2,157,207	3,165	88	6.04	-	10.08	16.12
Hamersley mi	RT	Iron	Australia	1,908,210	100,112	249	5.34	2.36	6.68	14.38
Dawson	AA	Coal	Australia	1,850,164	3,914	309	5.18	0.09	8.29	13.56
Boyne Island	RT	Aluminum	Australia	4,085,696	1,703	55	11.44	0.00	0.00	11.44

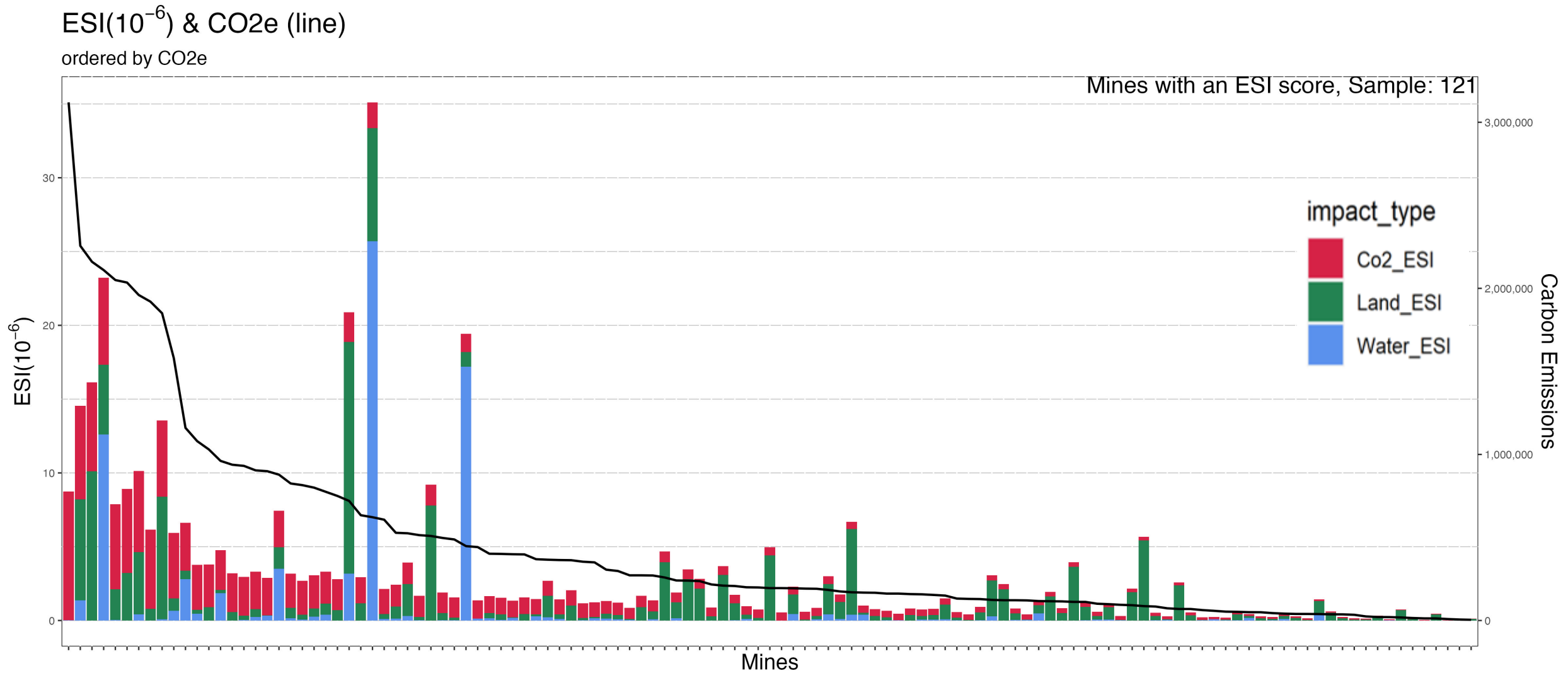
Crona, B., Parlato, G., Lade, S., Fetzer, I., & Maus, V. (2023). Going beyond carbon: An "Earth system impact" score to better capture corporate and investment impacts on the earth system. *Journal of Cleaner Production*, 429, 139523.

Carbon, land or water?

Contributions to total Earth system impact vary across localities



What is the added value of the ESI score?



- ✓ 3 planetary boundaries
 - ✓ their interactions
- ✓ Sensitive to where on the planet impact occurs

Better models are emerging

But only as good as the data used to run them

“to have a holistic and well-documented view of the impact of climate-related and environmental risks on existing risk categories”

ECB, expectation 7.1; 2020





MISTRA

FinBio



Stockholm
Resilience Centre



Stockholm
University



Policy Brief #1

ESI - A Tool to better capture corporate and investment impacts on the Earth system

KEY MESSAGES

Human activities, like emissions and deforestation, affect many Earth's landcover, waterflow, and temperature - three important planetary boundaries. These changes ripple through the Earth system because of interactions between the individual Earth system processes.

Mitigating severe systemic risks related to climate change and nature depletion hinges on our ability to ensure we rapidly reduce the harm being done to our natural carbon sinks.

ESI is a tool that can allow investors to assess the planetary scale impact of an individual company or asset, and aggregate it to portfolio level. It is systemic, context sensitive and science based and can be valuable for guiding improved decision-making.

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This brief is based on a scientific paper published in Social Science Research Network (SSRN)
2023 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4495931



GLOBAL ECONOMIC DYNAMICS
AND THE BIOSPHERE
THE KVA RESEARCH CENTER FOR THE FUTURE

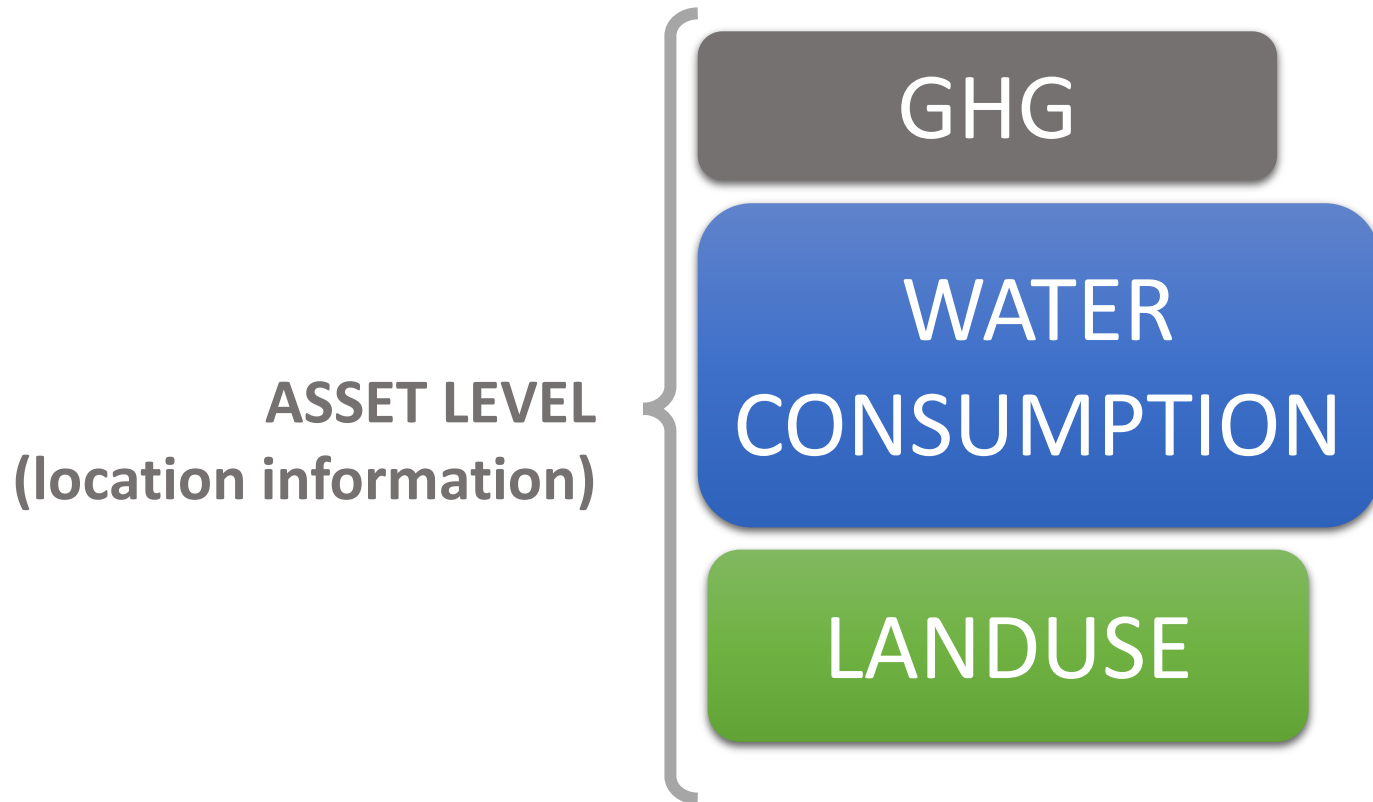


WARNING

- **Directly accounts for 3 Planetary Boundaries**
- **Could downplay the importance of local impacts**
- **Biodiversity?**

ESI can do a decent job of capturing key pressures causing biodiversity loss

Data needs to assess Earth System Impact



Essential Environmental Impact Variables (*Environmentally Material Info*)

Grounded in Planetary Boundaries and designed to capture the most essential environmental impact of companies, in a standardized manner

Wassénus, E., Crona, B., & Quahe, S. (2024). Essential environmental impact variables: A means for transparent corporate sustainability reporting aligned with planetary boundaries. *One Earth*, 7(2), 211-225.