IMPACT AND TRADE-OFFS IN VEGETABLE OIL PRODUCTION

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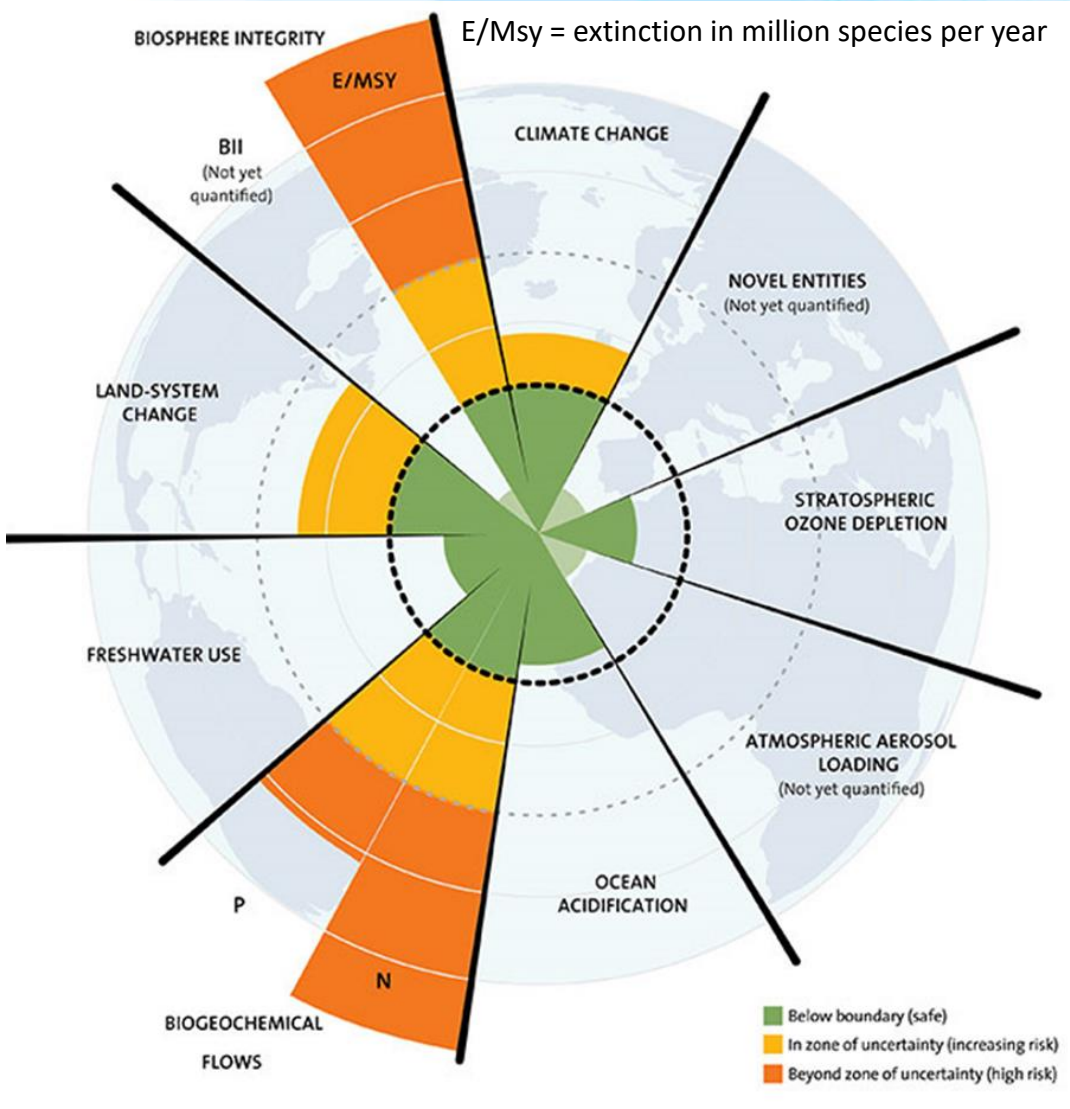
Meeting growing food demands within a safe operating space

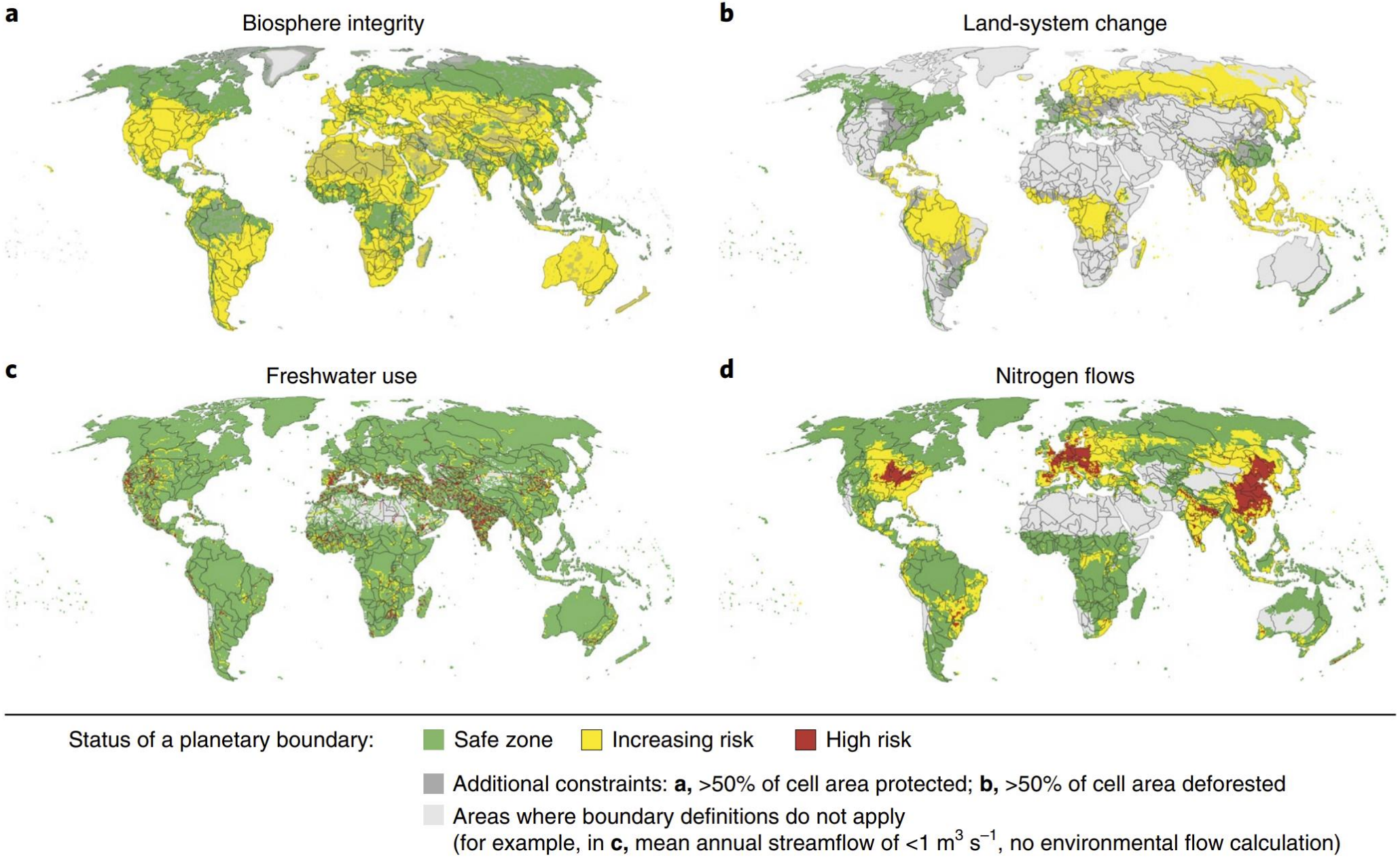
Global agriculture puts heavy pressure on planetary boundaries, posing the challenge to achieve future food security without compromising Earth system resilience, in particular:

1. Biosphere Integrity (mostly agriculture)
2. Land-System Change (mostly agriculture)
3. Biogeochemical Flows (mostly agriculture)

Global demand for crops will roughly double over the first half of 21st century.

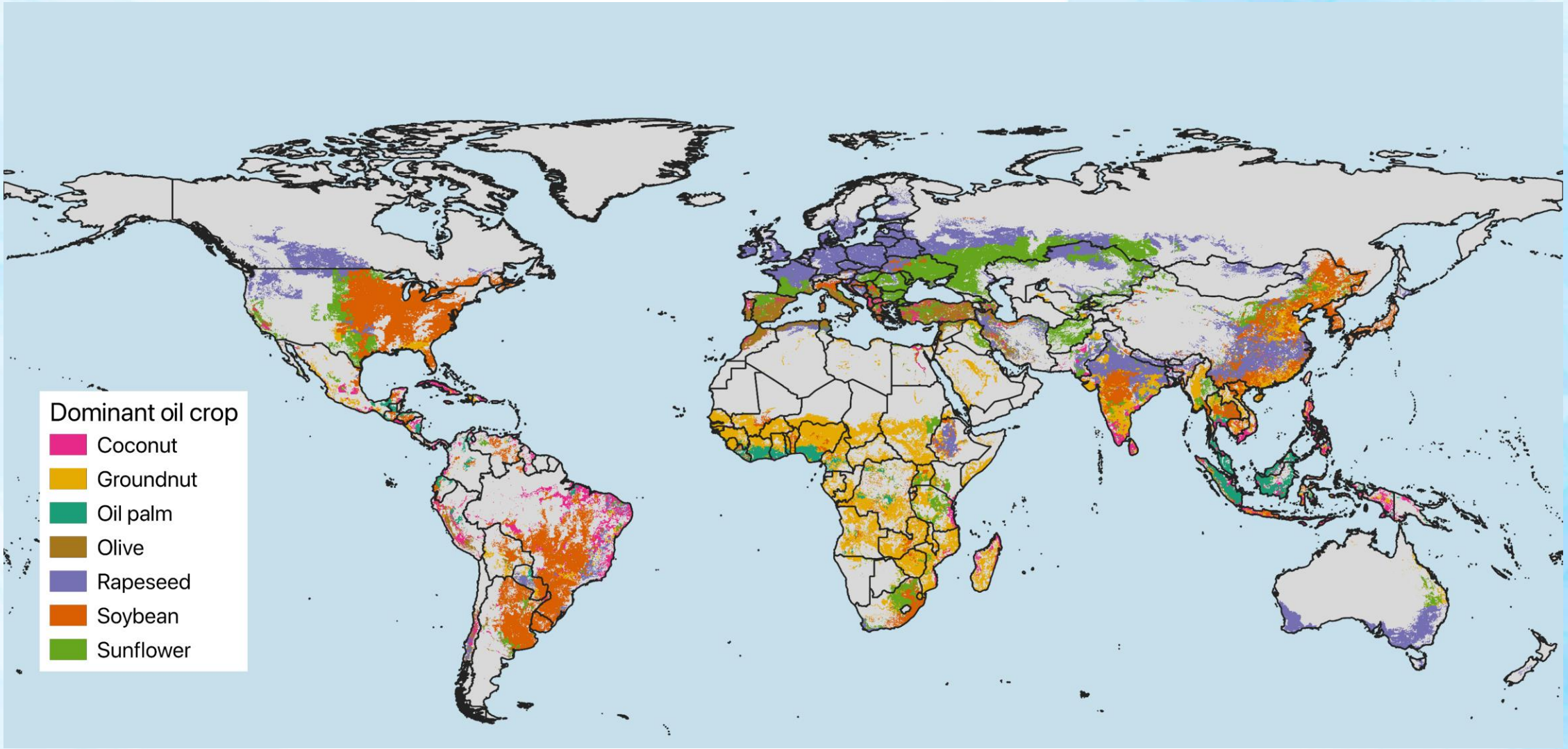
Further PB transgressions could jeopardize the chances of providing sufficient food for a world population projected to be wealthier and reach >9 billion by 2050





Gerten D, et al. 2020. Feeding ten billion people is possible within four terrestrial planetary boundaries. Nature Sustainability **3:200-208.**

Where are the oil crops predominantly grown?

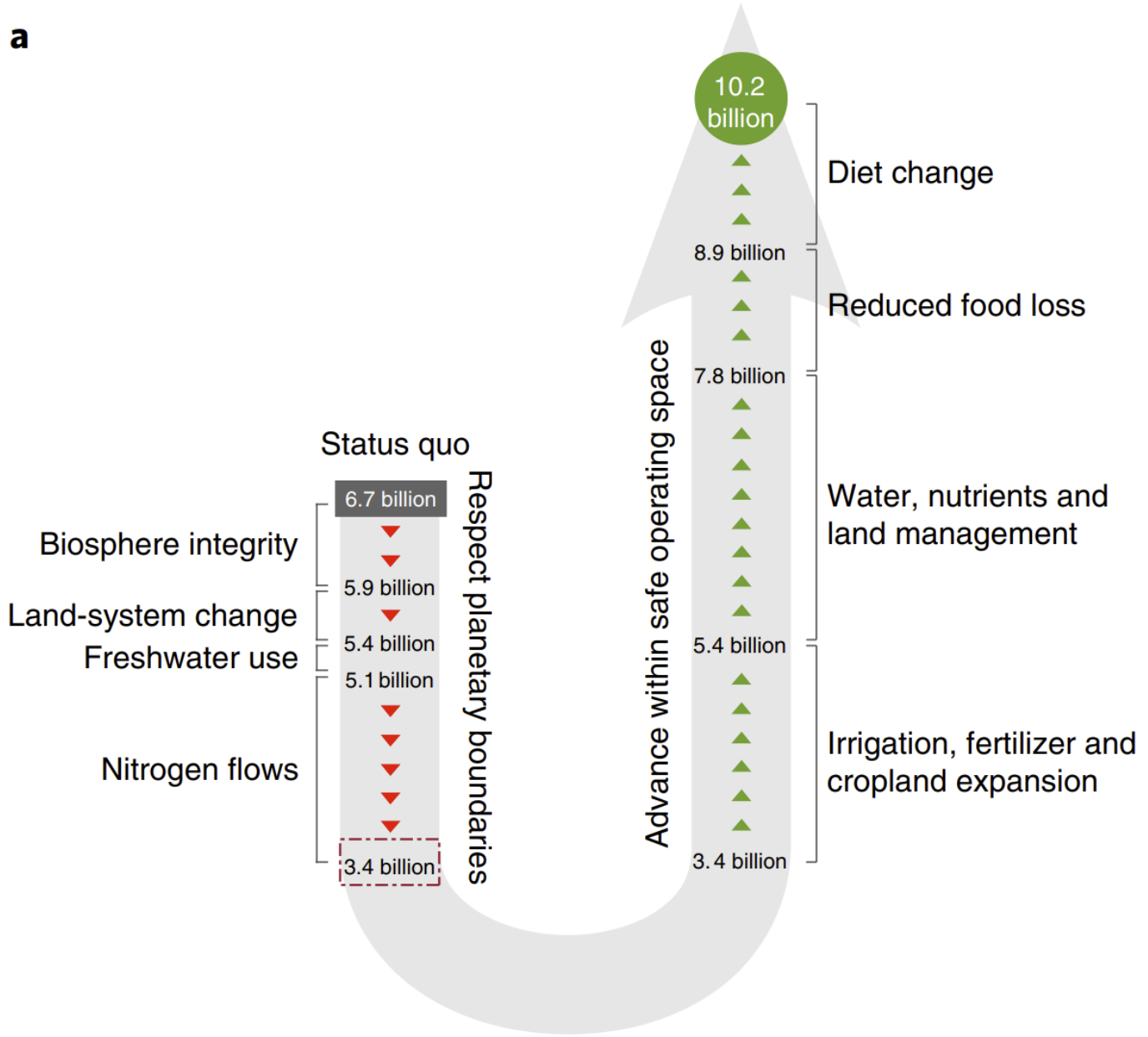


TECHNOLOGICAL- CULTURAL ‘U-TURN’

If planetary boundaries were respected without concurrent transition towards more sustainable production and consumption, the present food system could provide a balanced diet (2,355 kcal per capita per day) for 3.4 billion people only.

Transformation towards more sustainable production and consumption patterns could support 10.2 billion people.

Key prerequisites are spatially redistributed cropland, improved water–nutrient management, yield gap closures, shifts towards less resource-demanding diets, food waste reduction, and efficient international trade.



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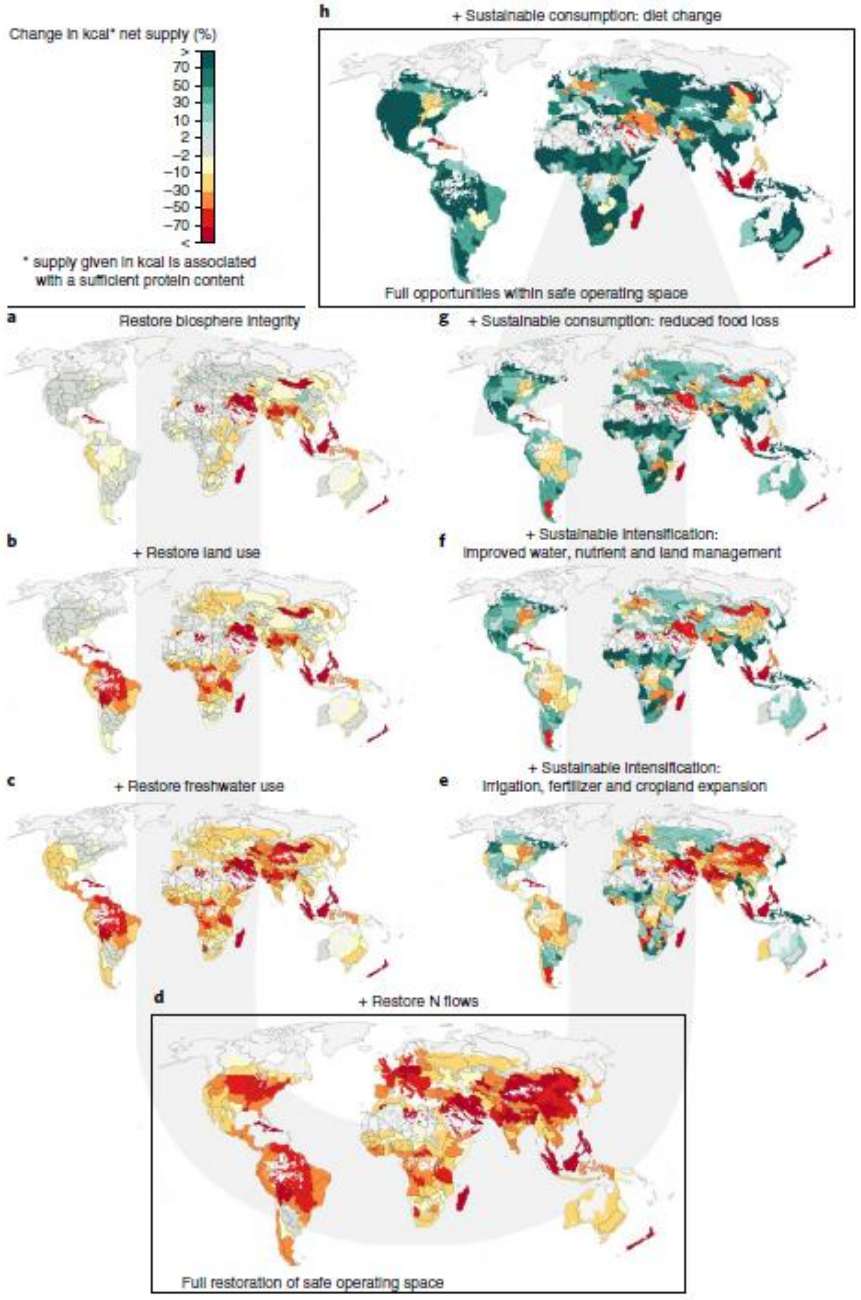


Effects on kcal net supply per food production unit for each step of the technological–cultural U-turn. Shown are percentage changes relative to the 2005 baseline.

Note: Borneo and Sumatra production declines implied by restoring the safe space cannot be compensated even if all considered technological and sociocultural transformations were in place.

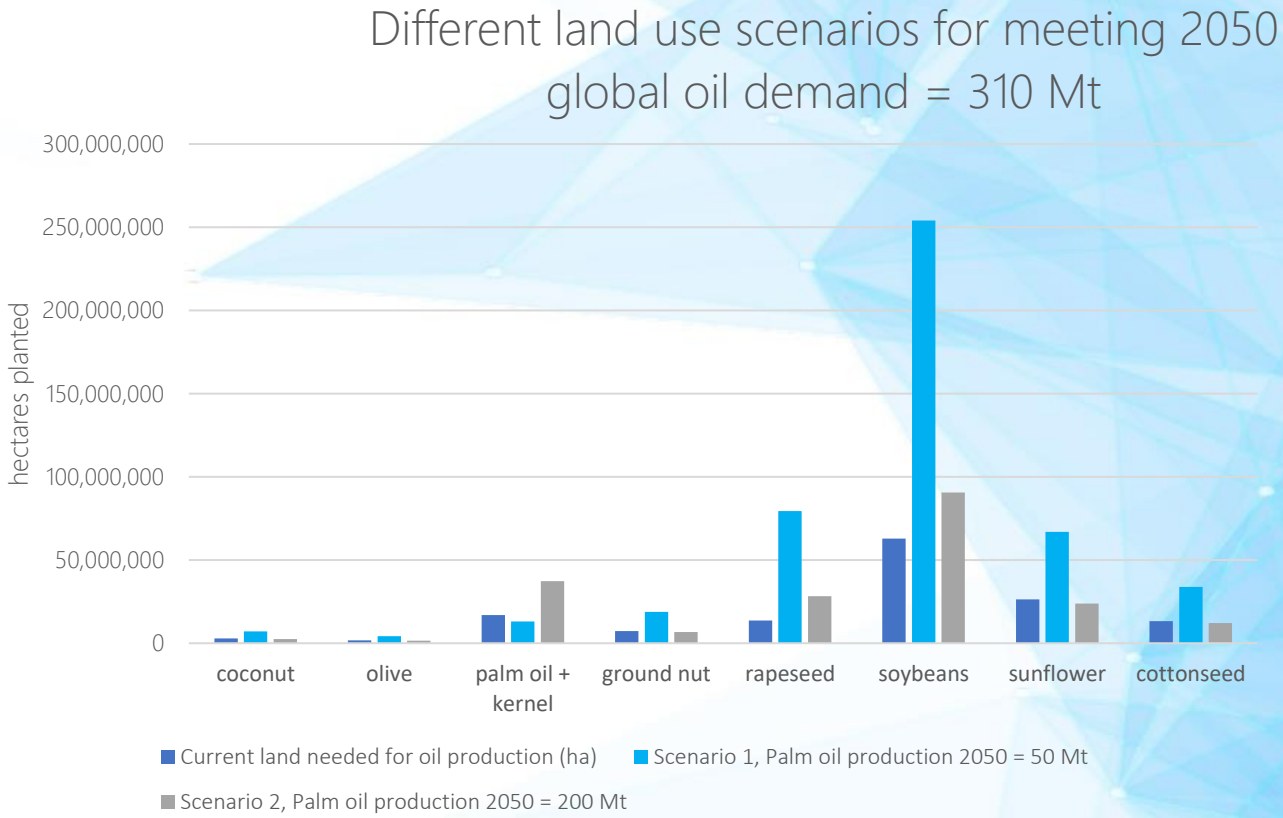
Caveat: global models come with spatial error and data bias

- Yields differences mean different land needs to produce same volume of oil
- Perennial crops vs annual crops (nitrogen needs, soil erosion, associated biodiversity)
- Opportunity for yield improvement lower in perennial crops

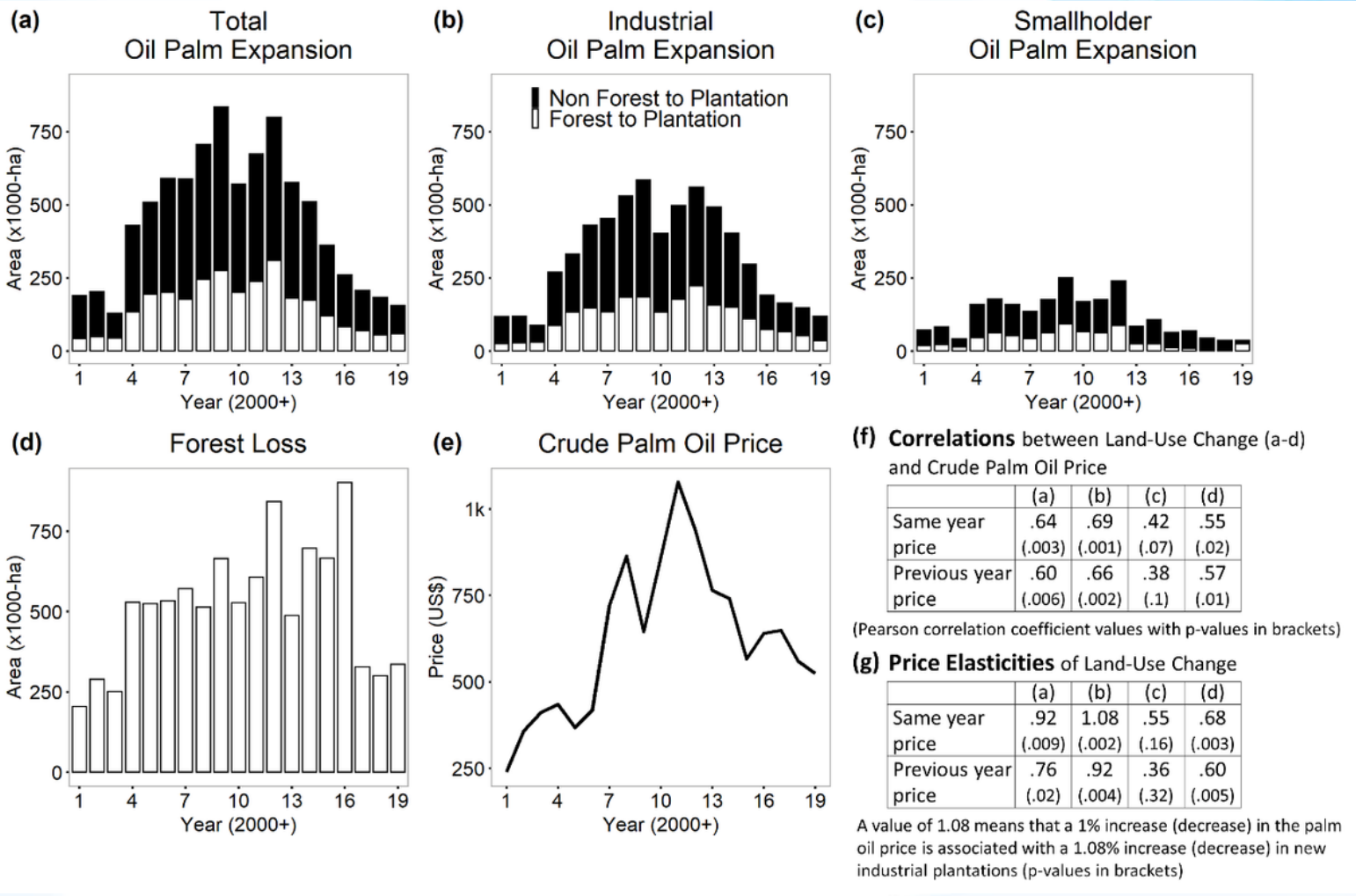
Oil crop	Type of crop	Oil yield (t ha-1)	Main biome impacted	Median Species Richness (nr. of species)
Oil palm	Perennial	1.9–4.8	Tropical rainforest	472
Coconut	Perennial	0.4–2.4	Tropical and subtropical	317
Olive	Perennial	0.3–2.9	Mediterranean	n/a
Soybean	Annual	0.4–0.8	Subtropical	278
Rapeseed	Annual	0.7–1.8	Temperate	227
Cotton	Annual	0.3–0.4	Subtropical	299
Groundnuts	Annual	0.5–0.8	Subtropical	351
Sunflower	Annual	0.5–0.9	Temperate	189
Maize	Annual	0.1–0.2	Temperate	273

What could happen if palm oil is banned from international market? Global demand for vegetable oil 2050 = 310 Mt. Current = 180 Mt

Current land needed (2014) = 144,746,000 ha
Extra land needed 2014-2050, scenario 1 = 194,202,235 ha
Extra land needed 2014-2050, scenario 2 = 58,031,953 ha



Stabilizing oil palm and deforestation in Indonesia provides opportunities for more sustainable management (better biodiversity management, improved water–nutrient management, and maybe yield gap closures)



(f) Correlations between Land-Use Change (a-d) and Crude Palm Oil Price

	(a)	(b)	(c)	(d)
Same year price	.64 (.003)	.69 (.001)	.42 (.07)	.55 (.02)
Previous year price	.60 (.006)	.66 (.002)	.38 (.1)	.57 (.01)

(Pearson correlation coefficient values with p-values in brackets)

(g) Price Elasticities of Land-Use Change

	(a)	(b)	(c)	(d)
Same year price	.92 (.009)	1.08 (.002)	.55 (.16)	.68 (.003)
Previous year price	.76 (.02)	.92 (.004)	.36 (.32)	.60 (.005)

A value of 1.08 means that a 1% increase (decrease) in the palm oil price is associated with a 1.08% increase (decrease) in new industrial plantations (p-values in brackets)

Gaveau DLA, Locatelli B, Descals A, Manurung T, Salim MA, Husnayen, Angelsen A, Meijaard E, Sheil D. 2021. Slowing oil palm expansion and deforestation in Indonesia coincide with low oil prices. Research Square.

Recommendations

- Consumers: **Address biases and perceptions** (consumers are voters and influence policy-making)
- Science: Objective analysis of **land use optimization** to meet future edible oil needs, given **trade offs and synergies between SDGs** across the land sharing-sparing continuum
- Producers: **Improved oil production**, **attention to smallholders**, **more sustainable practices** (e.g., no deforestation, optimized nutrient management, undergrowth).
- Policy-makers: Better land planning, collaboration (civil society organization, industry, policy, North-South), science-based policy-making.
- Responsibility for all is to influence future land allocation to different crops within planetary boundaries

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