Quantifying the trade drivers of planetary boundaries

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Author: Guilherme Riccioppo Magacho
Co-Authors: Gabriel Santos Carneiro

This paper aims at understanding the limits outlined by the planetary boundaries in terms of global trade. The latest Planetary Boundaries update portrays an alarming global ecological situation in which six of the nine boundaries are transgressed. By identifying the processes that are critical for maintaining the stability and resilience of the Earth system as a whole, the framework equates a multi-level range of ecological dynamics. However, there are mismatches between the levels of the Earth System and social dynamics. As planetary boundaries are defined at global level, it is not clear yet what their social drivers and implications are, especially in relation to a global economy that is structured around flows of trade between national units.

Global economic relations are structured around unequal patterns of ecological, productive and financial exchanges. Some countries are â€œnature suppliersâ€• to the global economy, feeding natural resources and raw materials into global productive chains. On the other hand, there are countries that are mostly consumers of these products, exerting the demand that keeps the global economy operating. When different natural resources are observed, countries switch positions along a multidimensional spectrum. One country could be, for example, an exporter of â€œwaterâ€• and an importer of â€œlandâ€• at the same time. Therefore, different countries and economic sectors contribute directly and indirectly by pressuringe/easing planetary boundaries through their commercial relations with other economies. The dynamics of cross-border global trade illustrates a dependence relationship, as the exports of nature generate income, jobs, fiscal revenues and foreign exchange that are crucial for the general macroeconomic picture of a country, while imports are essential for sustaining certain levels of well-being profited by society from the economic system.

In this paper we aim at analysing environmental footprints in global trade in order to understand which countries and economic activities (economic sectors) pressure each Planetary Boundary. Using the GLORIA environmental extended multi-regional input-output (MRIO) database constructed in the Global MRIO Lab, which accounts for 164 countries and 120 sectors, we calculate environmental footprints embodied in trade relations.

Drawing on the ecological variables employed in the original planetary boundaries works, we select key variables available in GLORIAâ€™s satellite accounts to estimate separately the pressure exerted on each one of the six exceeded planetary boundaries. Land use is measured in terms of hectares used in production. Change in biosphere integrity is measured in terms of potentially disappeared fraction (PDF) of biodiversity loss. Climate change is measured in GHG emissions in kilotonnes. The global freshwater boundary is measured both with water stress and blue water consumption calculated in million m3 H2O equivalents. Nitrogen and phosphorus loading calculations are made by estimating the amount of embodied nitrogen and phosphorus measured in tonnes in agriculture sectors. Based on the suggestions made by Persson et al. (2022), the novel entities boundary is estimated through the amount of embodied non-energy materials employed in the chemicals sector.

Based on GLORIAâ€™s environmental satellite accounts, we estimate the direct and indirect (embodied in domestic and imported inputs) pressure that countriesâ€™ final demand exert on the multidimensional spectrum of boundaries. These estimates allow us to identify embodied footprints on trade, and hence the countries that are â€œnature resources exportersâ€• and those that are

â€œnature resources importersâ€• in different dimensions.
The novelty of this research lies in exploring in detail which economic sectors and countries are exerting more pressure over the planetary boundaries. The results indicate that there is a group of countries that plays an important role as resource suppliers, and another group composed predominantly of users of most resources. Nevertheless, there are also countries that are suppliers of some resources and users of others, which shows the importance of a multidimensional approach. Results also show that the pressure of global trade on each planetary boundary is linked to the production and trade in specific economic sectors.
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Main policy implications point towards the need of a stronger international cooperation on global trade that would address the economic activities that exert pressure on the different boundaries. While there have been some advances on global cooperation for environmental issues, particularly with the recurrence of COP meetings, discussions on global trade have been in deadlock for a long-time. Our results show that avoiding planetary boundariesâ€™ overshooting requires the ecological issues and global trade to be addressed together.