Supplementary Information for "Disaggregating the role of international and domestic trade in the global land system"

Table S1 *- Estimates of the impacts of international and domestic markets on the land system. Column 1 lists the first author, year of publication, and in brackets a differentiating information in the case of multiple estimates: specifically, where studies included multiple scenarios (e.g. different metrics or allocation methods), we list the distinguishing methodological choice. Chaudhary and Pendrill both published multiple studies on this topic within the same year (2016 and 2019, respectively), and so the journal title is added to differentiate these results.*

Author, Year (Other)	***Publication Title***	***Title***	***Export %***	***Domestic %***
Weinzettel, 2013	*Global Environmental Change*	*Affluence drives the global displacement of land use*	*24*	*76*
Yu, 2013	*Global Environmental Change*	*Tele-connecting local consumption to global land use*	*27*	*73*
Kastner, 2014	*Environmental Research Letters*	*Rapid growth in agricultural trade: effects on global area efficiency and the role of management*	*21*	*79*
Chen, 2015	*Land Use Policy*	*Global supply chain of arable land use: Production-based and consumption-based trade imbalance*	*33*	*67*
MacDonald, 2015 (Harvest cropland)	*BioScience*	*Rethinking Agricultural Trade Relationships in an Era of Globalization*	*20*	*80*
MacDonald, 2015 (Agricultural land)	*BioScience*	*Rethinking Agricultural Trade Relationships in an Era of Globalization*	*13*	*87*
Bergmann, 2016 (Final demand)	*Annals of the American Association of Geographers*	*Land in motion*	*26*	*74*
Bergmann, 2016 (Consumption)	*Annals of the American Association of Geographers*	*Land in motion*	*32*	*68*

Bergmann, 2016 (Capital investment)	*Annals of the American Association of Geographers*	*Land in motion*	*59*	*41*
Chen, 2018	*Science of The Total Environment*	*Global land-water nexus: Agricultural land and freshwater use embodied in worldwide supply chains*	*37*	*63*
Wood, 2018	*Journal of Industrial Ecology*	*Growth in Environmental Footprints and Environmental Impacts Embodied in Trade: Resource Efficiency Indicators from EXIOBASE3*	*26*	*74*
Wu, 2018	*Land Use Policy*	*An overview of arable land use for the world economy: From source to sink via the global supply chain*	*40*	*60*
Pendrill, 2019 (ERL)	*Environmental Research Letters*	*Deforestation displaced: Trade in forest-risk commodities and the prospects for a global forest transition*	*26*	*74*
Pendrill, 2019 (GEC - Physical)	*Global Environmental Change*	*Agricultural and forestry trade drives large share of tropical deforestation emissions*	*29*	*71*
Pendrill, 2019 (GEC - Monetary)	*Global Environmental Change*	*Agricultural and forestry trade drives large share of tropical deforestation emissions*	*39*	*61*
Tramberend, 2019	*Ecological Economics*	*Our Common Cropland: Quantifying Global Agricultural Land Use from a Consumption Perspective*	*31*	*69*
Dorninger, 2021	*Global Environmental Change*	*The effect of industrialization and globalization on domestic land-use: A global resource footprint perspective*	*26*	*74*

Hong, 2022 (Land use emissions)	*Science*	*Land-use emissions embodied in international trade*	*27*	*73*
Hong, 2022 (Land use)	*Science*	*Land-use emissions embodied in international trade*	*22*	*78*
Cabernard, 2024 (Attributional)	*Nature Sustainability*	*Biodiversity impacts of recent land-use change driven by increases in agri-food imports*	*32*	*68*
Cabernard, 2024 (Marginal)	*Nature Sustainability*	*Biodiversity impacts of recent land-use change driven by increases in agri-food imports*	*94*	*6*
Chaudhary, 2016 (GEC)	*Global Environmental Change*	*Land use biodiversity impacts embodied in international food trade*	*17*	*83*
Chaudhary, 2016 (World Development)	*World Development*	*National Consumption and Global Trade Impacts on Biodiversity*	*25*	*75*
Lyu, 2025 (Attributional)	*Environmental Research Letters*	*Welfare-based allocation of telecoupled biodiversity loss in global crop trade*	*40.6*	*59.4*
Lyu, 2025 (Welfare-based)	*Environmental Research Letters*	*Welfare-based allocation of telecoupled biodiversity loss in global crop trade*	*27.4*	*72.6*
Marques, 2019 (Biodiversity impact)	*Nature Ecology & Evolution*	*Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth*	*25*	*75*
Marques, 2019 (Carbon sequestration)	*Nature Ecology & Evolution*	*Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth*	*21*	*79*

Gong, 2026	*Research Square*	*Global patterns, supply-chain flows, and driving factors of forest loss footprints from 2001 to 2022*	*38.15*	*61.85*
Chandrakant, 2026 (Deforestation risk)	*Nature Food*	*Global patterns of commodity-driven deforestation and associated carbon emissions*	*25.1*	*74.9*
Chandrakant, 2026 (Deforestation emissions)	*Nature Food*	*Global patterns of commodity-driven deforestation and associated carbon emissions*	*19.5*	*80.5*
Bjelle, 2020	*Journal of Economic Structures*	*Adding country resolution to EXIOBASE: impacts on land use embodied in trade*	*25.8*	*74.2*

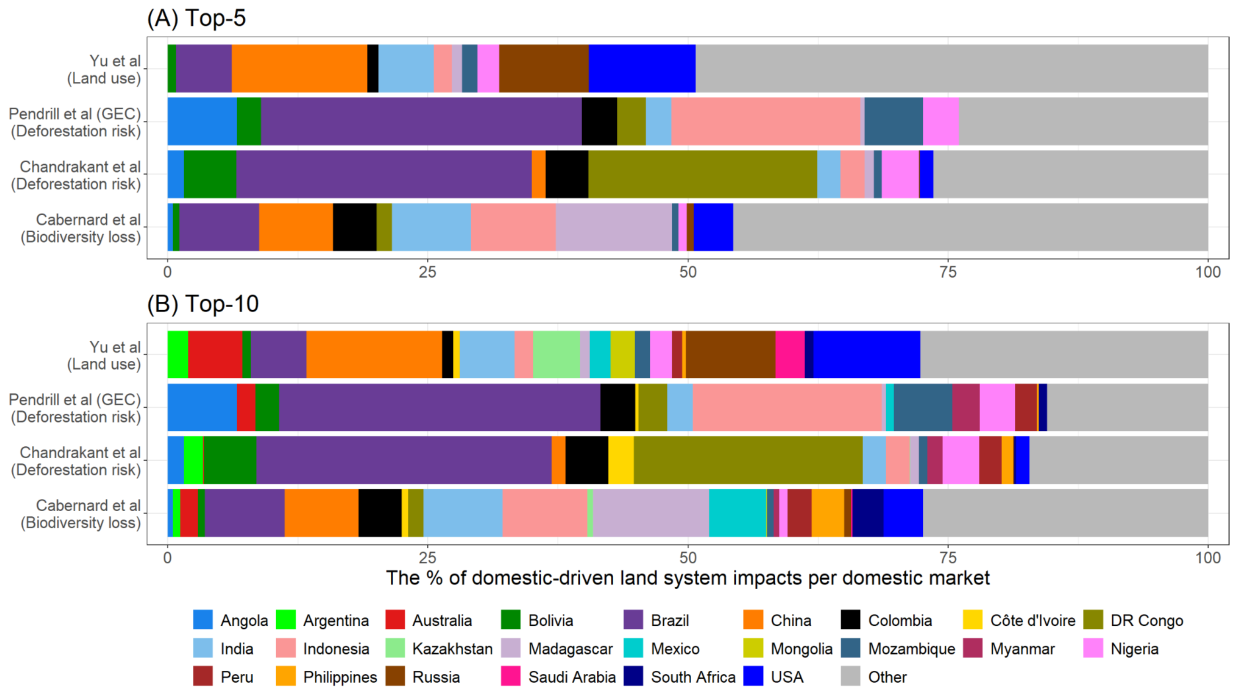

Figure S1 *- (A) The top-5 domestic markets in all contexts are highlighted (13 countries in total). Brazil appeared in the top-5 domestic markets in all studies and China, India, Indonesia, and Nigeria appeared among the top-5 in two studies each. (B) The top-10 domestic markets in all contexts are highlighted (24 countries in total). Brazil and India appeared in the top-10 domestic markets in all studies; Colombia, Indonesia, and Nigeria were identified among the top-10 in three of the four datasets; and Bolivia, China, the Democratic Republic of Congo (DR Congo), and the United States of America each appeared among the top-10 of two studies.*

Methods to map domestic value chains

Since no globally consistent data exist for subnational trade flows (in contrast to national-level data from FAO or Comtrade, for example), disaggregating domestic markets requires a combination of new data or methods to identify the origin of products consumed across each country, at a scale that is informative for decision making. In practice we support a middle-ground approach (Godar et al., 2016) - for example mapping flows at regional/state or municipal/district scale, depending on the use-case. In many cases, state-level analyses will be sufficient to support subnational decision-making, though municipal or city-level analyses better speak to the growing number of city-led sustainability initiatives, such as the C40 or FAB City networks, which encourage consumption-based footprinting, action, and learning across cities.

There are four broad, partly overlapping approaches to mapping subnational product flows: leveraging logistic surveys, downscaling MRIO analyses, gravity models, and using product traceability data. Studies based on the FoodS3 model (Goldstein et al., 2025; Smith et al., 2017) have mapped the livestock supply chain in the United States by calculating the commodity demand at nodes along the supply chain (e.g. cattle feedlots, slaughterhouses), of production, processing, and demand (Goldstein et al., 2025; Smith et al., 2017). These flows are matched through mass-balance and cost-minimizing transport optimization. Cost-minimization approaches are likely to oversimplify the reality of trade connections, though these models have been validated against freight data - in particular, the 'freight analysis framework' dataset. Other teams have instead used these freight data as a starting point, for example, the 'Food Flow Model' (Karakoc et al., 2022; Lin et al., 2019). In this case, the authors applied network constraints and mass balance to downscale the food flows to county level for the United States (Karakoc et al., 2022; Lin et al., 2019). Where freight data are not systematically collected or available, researchers have used surveys at key logistic nodes (eg. major roads into/out of cities) to reconstruct domestic food flows (Karg et al., 2023). Alternatively, studies have used subnational input-output models to map the land embedded in inter-regional trade within China and Brazil (Afonso et al., 2025; Fan et al., 2022; Haddad et al., 2024; Wang and Wang, 2023). Where official subnational input-output matrices are not available, authors may use gravity assumptions to downscale these models, modelling trade between regions as a function of transport frictions (i.e. distance or travel time) and their economic 'gravity' (often measured as subnational Gross Domestic Product). Similarly, gravity assumptions and a mass-balance approach has been used to model global cereal flows at subnational scale, suggesting that 73% of cereals are sold into domestic markets - with 48% produced and consumed in the same tier-1 subnational region (i.e. a 'State' in the United States or India and 'Federative Unit' in Brazil) and 25% of cereals being consumed in a different subnational region from where they are produced (Jain, 2026). Finally, studies using product traceability data at national scale are rare, though tax invoices, product barcodes, or sanitary information are all data sources that might be used to track products along the supply chain - one example of which being the 'do Pasto ao Prato' ('from Pasture to Plate') initiative tracing beef products in Brazil (www.dopastoaoprato.com.br) based on the crowdsourcing of sanitary inspection codes of animal products.

Domestic value chain governance

Though land use impacts within domestic markets are, in theory, already governed by national legislation (e.g. land use regulations), there are increasing calls for value chain approaches to complement to traditional state-led governance within domestic markets (Marx et al., 2024; van der Ven et al., 2021). Notably, domestic area-based regulation does not preclude consumer demands for more transparent and sustainable supply chains, and public procurement policies can shape supply chain sustainability and governance. Domestic regulations evidently do not prevent all harms within domestic markets (see Figure 1). Consumer surveys published by the retail association in Brazil suggest, for example, that 75% of shoppers want more information about the origin of products, with 29% explicitly reporting to want certification and 20% requesting information on sustainability impacts (Abras, 2019). Surveys focussing on consumer behaviour related to sustainable land use - specifically, compliance with the Brazilian 'Forest Code' - suggest that 82% of consumers would prefer to buy products which are in compliance with these land use regulations, and 60% report being willing to pay more for products which were in compliance (IPAM Amazônia, 2018) - creating the financial opportunity for certification, which usually seeks to capture a price premium from sustainability labelling. Moreover, public procurement can be a powerful lever for greening supply chains (Reeve et al., 2026) . Governments have increasingly committed to sustainable procurement as a means to ensure that public contracts contribute to governments' broader environmental and social policy goals. Value chain governance, such as certification, plays an important role in operationalizing sustainable procurement (Marx et al., 2024), though only a minority of countries have any monitoring of the impact or benefits of their procurement criteria (United Nations Environment Programme, 2022), which would notably require tracing procurement at subnational scale.

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