Reshaping of Global Trade-related Carbon Footprint amid Geopolitics

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Escalating geopolitical conflicts, including the Russiaâ€“Ukraine war, intensifying U.S.â€“China trade tensions, and persistent instability across the Middle East, have fundamentally disrupted and reconfigured global supply chains, with particularly acute consequences for energy systems, mineral resource flows, and the trade of strategic commodities. While the structural implications of these disruptions for global value chains have attracted growing attention, their consequences for decarbonization trajectories and the international distribution of embodied carbon remain insufficiently understood. Existing multi-regional inputâ€“output (MRIO) frameworks have largely lacked the temporal granularity and geographic coverage necessary to track near real-time shifts in trade-embodied emissions, especially across the rapidly evolving boundary between emerging and advanced economies. To address this gap, we develop the EMERGING modelâ€”a time-series global MRIO framework spanning 2015 to 2023 and encompassing 245 economies across 133 industries. This database enables systematic, near real-time tracking of global value chain restructuring and provides an empirical foundation for assessing how geopolitically induced trade realignment is reshaping the global carbon footprint.

Our analysis reveals that carbon emissions embodied in global trade increased from 8,386 Mt in 2015 to a peak of 9,066.3 Mt in 2021, before declining to 8,557.9 Mt in 2023. This trajectory reflects both the post-pandemic demand surge and a subsequent structural contraction in cross-bloc trade integration. A pronounced and accelerating decoupling between Global North and Global South economies has emerged over this period, driven primarily by key emerging economiesâ€”particularly China, Eastern Europe, and former Soviet European states. This geopolitically induced restructuring reduced Northâ€“South trade-related carbon emissions by 216.8 Mt over the full 2015â€“2023 period, and by 527.5 Mt relative to the 2021 peak, representing a substantial realignment of embodied carbon flows along geopolitical fault lines. In contrast, trade-related emissions within Global North economies increased by 206.4 Mt over the same period, suggesting a partial re-regionalization of carbon-intensive supply chains among advanced economies. Taken together, these trends signal a structural transition away from Northâ€“South interdependence and toward greater Northâ€“North and Southâ€“South trade integration, fundamentally altering the architecture through which carbon-intensive production is distributed globally.

Decomposing embodied emissions into final demand and intermediate input components reveals that the contraction of intermediate goods flows from China, Eastern Europe, and former Soviet European economies to Global North countries plays a central role in reshaping global carbon footprints. Embodied carbon in intermediate exports from China declined by 77.1 Mt to North America and by 26.1 Mt to Western Europe between 2015 and 2023, reflecting both trade policy shifts and deliberate supply chain diversification efforts among advanced economies. Critically, however, these reductions do not represent an absolute elimination of carbon-intensive productionâ€”rather, they indicate a geographic relocation of such activity to alternative low-cost manufacturing hubs. Southeast Asia has emerged as the most significant new growth center for carbon-intensive exports, with total embodied emissions in regional exports rising from 645 Mt in 2015 to 783 Mt in 2023. This trajectory suggests that geopolitical fragmentation may be displacing, rather than eliminating, carbon-intensive production, with important implications for the aggregate effectiveness of climate mitigation strategies predicated on supply chain restructuring.

We further assess the prospective implications of renewed U.S.â€“China trade escalation in 2025

for global carbon redistribution. Scenario analysis suggests that deepening geopolitical fragmentation is likely to reduce cross-bloc trade-embodied emissions in the short term, while simultaneously increasing intra-bloc carbon concentration as production realigns within competing geopolitical spheres. This dynamic poses substantial new challenges for coordinated global climate governance, as the decentralization of carbon-intensive activity across a more fragmented trade architecture complicates both the attribution and the multilateral regulation of embodied emissions. Our findings underscore the urgency of developing climate governance frameworks that are explicitly sensitive to geopolitical dynamics, and that account for the structural divergence between apparent reductions in bilateral trade emissions and the underlying relocation of carbon-intensive production across the evolving landscape of global value chains.