Exploring the balance between positive and negative effects of global supply chains on freshwater consumption: A global and regional scale perspective.

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The expansion of global supply chains (GSCs) has led to the concentration of demands for freshwater resources in specific regions, creating excessive pressure on local human health and ecosystems through overconsumption of freshwater. At the same time, industrial production activities in each country involved in GSCs generate not only negative effects (e.g., environmental interventions) but also positive effects (e.g., creation of economic value-added) for the local economy. As for these opposing effects in production activities, previous studies have mainly focused on clarifying the decoupling status between positive and negative effects at the national level. However, there is no framework in the existing literature that investigates relationship between these two effects of a specific GSC at the globe and each region involved in the GSCs, and indicates pathways for industries towards GSC structures that balance them.

Focusing on freshwater consumption, this study addresses the following research questions: How are the positive impacts (i.e., economic value added) and negative impacts (i.e., freshwater overconsumption) of specific GSCs interrelated at global and regional scales? What are the key factors for transitioning each GSC toward a sustainable structure? The novelty of this study is to explore the balance between positive and negative effects of specific GSCs on freshwater consumption at both scales.

Through this process, we estimated global water overconsumption data in 2015 using WaterGAP 2.2d model, which are based on the regional carrying capacity of water consumption across 11,000 watersheds to maintain regional human living and ecosystem and integrated it into GLORIA multi-regional input-output database which includes inter-sectoral transactions of 120 sectors in 164 countries. This approach allowed us to assess water overconsumption in each country involved in specific GSCs and compare it with economic value-added generated in those country.

We found that global water overconsumption totaled 240 billion cubic meters (mÂ³) in 2015, with nearly one-quarter of total water consumption exceeding regional carrying capacity. Especially, production activities in the agriculture sectors, which are highly water-consumption-intensive, played a dominant role in water overconsumption, accounting for 92% of total overconsumption. The industrial GSCs with the highest levels of water overconsumption were located in India (43 billion mÂ³), China (40 billion mÂ³), and the U.S. (37 billion mÂ³). The top 20 industrial GSCs in the relevant countries, including those, accounted for 87% of the global total.

Next, we estimated the regional contribution-weighted value-added and water overconsumption for each GSC. In this estimation, the value-added and water overconsumption volumes of each country which are generated by a specific GSCs were weighted based on their respective contributions to the total of those in each relevant country, indicating water sustainability of the GSCs at a global scale. Our results showed that, for example, the USAâ€™s industrial GSCs were economically inefficient in terms of water overconsumption, whereas Indonesiaâ€™s industrial GSCs were efficient compared with other GSCs worldwide.

In addition, focusing on the gap between the volume and regional contribution of both value-added and overconsumption in the agricultural sectors of each country within each specific GSC, we assessed the economic efficiency of water overconsumption at a local scale. For example, within the

USAâ€™s industrial GSCs, agricultural production in the U.S. yielded a relatively low contribution to domestic value-added but a high contribution to overconsumption. On the other hand, by involving agricultural production activities in countries such as Honduras and Costa Rica, the USAâ€™s industrial GSCs contributed to value-added creation while placing substantial pressure on local water resources, implying the economic inefficiency of water overconsumption of this GSC.

Finally, we decomposed these efficiency factors to 120 sector level for each region within specific GSCs and identified key factors related to the efficiency or inefficiency from both global and local perspectives. Based on these findings, we suggested policy implications to improve efficiency within each GSC, including guidelines for selecting suitable procurement partners.