Unequal distributions of consumer responsibilities in driving grid-level freshwater boundary exceedances

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Freshwater use has exceeded freshwater boundaries in many regions, with site-specific depletion is driven by consumption both within and beyond the regions of production. The consumer responsibilities are unevenly distributed across households, posing risks to both sustainability and equity. This study examines the unequal distribution of consumer responsibilities by attributing regional freshwater boundaries (RFB) exceedances to consumers across different income levels using the multi-regional input-output (MRIO) model. The analysis reveals significant disparities in consumer contributions to RFB exceedance. Populous middle-income countries disproportionately contribute to the global RFB exceedance footprint, while high-income countries exhibit distinct non-agricultural contributions. Low- and middle-income countries show agricultural-dominated RFB exceedance footprints, with marked inequality in middle-income countries. These findings highlight the urgent need to address water inequality to achieve Sustainable Development Goals (SDGs), particularly SDG 6 (Clean Water and Sanitation), SDG 10 (Reduced Inequalities), and SDG 12 (Responsible Consumption and Production). By identifying inequitable consumption patterns, this research provides critical insights for policymakers to promote equitable resource allocation, sustainable freshwater management, thereby ensuring a safe and just society.