

TRACING THE EVER-CHANGING GLOBAL SUPPLY CHAIN OF NATURAL RESOURCES: USED AND UNUSED EXTRACTION MATERIALS INDUCED BY CONSUMPTION OF IRON, COPPER, AND NICKEL

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Although the materials refined from minerals play a crucial role in modern society, the rising demand for them has been tailored to the current high levels of mineral extraction and emission. In today's global economy, sustainable resource management requires a consumption perspective of resource use and insight into actual resource use through the global supply chain.

In this study, we focused on iron, copper, and nickel, whose global demands have risen rapidly in recent years, to examine the global distribution of extraction amounts of used and unused materials. The global demand for metals has rapidly increased as the global economy has grown, and huge amounts of social material stocks have been created. We estimated the distribution of material extraction related to iron, copper, and nickel around the world, and detected the linkages between national consumption and natural resource extraction, including hidden flows, by using a global link input–output model (GLIO, a hybrid multiregional IO model). We used the total material requirement (TMR) indicator to estimate the amount of used and unused extraction caused by mining in the economy. Unused extraction (i.e., hidden flows) refers to material flows that take place in the course of resource extraction but that do not directly enter the economic system, for example, waste rock and overburden from mining operations that are not used but have an environmental impact. We also discussed future demand for resources.

The estimated global amount of used and unused extraction caused by mineral extraction of iron, copper, and nickel more than doubled from 1990 to 2017 (iron: 2.8 to 7.7 Pg; copper: 2.7 to 5.9 Pg; and nickel: 0.19 to 0.42 Pg). By incorporating global material flow into a global link input–output model (GLIO, a hybrid multiregional IO model), we estimated the total used and unused extraction caused by iron, copper,

and nickel mining induced by Japanese final demand to be 0.44 Pg, 0.52 Pg, and 0.043 Pg in 2011, respectively, equivalent to 7.1% of the total global extraction amount caused by iron mining, 11% of the amount caused by copper mining, and 10% of the amount caused by nickel mining. Whereas the world extraction total caused by iron, copper, and nickel mining rapidly increased from 2005 to 2011, the extraction amount induced by Japanese final demand for the same period either stayed about the same (iron) or decreased slightly (copper, 99% of the 2005 amount; nickel, 92%).

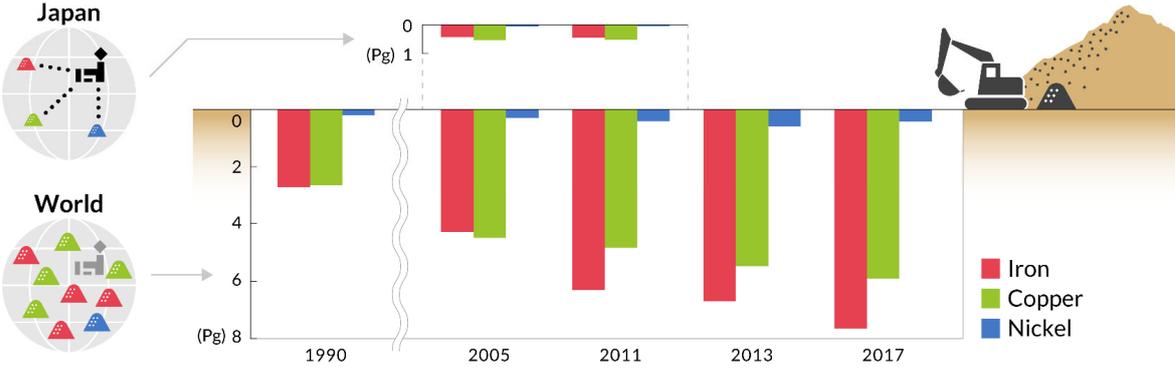


Figure 1. Global amount of used and unused extraction caused by iron, copper, and nickel mining.