Constructing Municipal Greenhouse Gas Emission Coefficients for a Subnational EEIO Model of South Korea under Spatialâ€“Sectoral Resolution Mismatch

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Introduction
Municipal EEIO analysis requires sectoral GHG emission coefficients that must usually be constructed from heterogeneous source data. In South Korea, this creates a spatialâ€“sectoral mismatch: the municipal GIR provides fine regional coverage, but does not map directly to the 76-sector domestic MRIO.

Thus, building a municipal-sector environmental extension requires explicit concordance and allocation choices. Recent research shows that uncertainty in allocating GHG emissions to IO sectors can be quantified systematically from raw inventories and auxiliary allocation data, but this has not been extended to the municipal extension-building stage (Schulte et al., 2024).

Related work has also emphasized transparent mapping, allocation, and validation when transforming environmental flows into EEIO-compatible satellite accounts (Ingwersen et al., 2022), while Korean studies have regionalized national GHG inventories and separately developed high-resolution EEIO models without focusing on the municipal-sector extension-building stage addressed here (Yang et al., 2022; Yoo et al., 2021).

This study therefore asks how municipal-sector GHG coefficients can be constructed from GIR data for a 229-municipality, 76-sector South Korean MRIO, and how concordance and allocation choices affect the resulting coefficients.

Material & Methods

We construct a territorial Scope 1 GHG satellite account for a 229-municipality, 76-sector domestic MRIO of South Korea derived from the official 17-region Bank of Korea IO table by gravity-based regionalization and RAS balancing. Emissions are taken from the municipal greenhouse gas inventory of the Greenhouse Gas Inventory and Research Center of Korea. The allocation covers direct production-related emissions, excludes LULUCF and household direct emissions, and uses the fuel-supply basis for road transport.

The framework combines a documented GIR-to-MRIO concordance with proxy-based allocation: fuel-combustion categories are distributed by municipal expenditure on energy commodities, while non-combustion categories are distributed by sectoral output. Household emissions embedded in aggregated municipal fuel-combustion categories are estimated and removed before allocation.

Extending recent MRIO uncertainty work (Schulte et al., 2024), we distinguish three uncertainty sources: raw GIR values, proxy-based allocation shares, and concordance choices for GIR categories that do not map uniquely to MRIO sectors. These are represented by category-specific uncertainty ranges informed by the South Korean National Inventory Report and IPCC guidance, constrained variation around baseline proxy shares, and alternative admissible sector-allocation scenarios derived from the concordance table.

Results

The output of this work is a municipal-sector GHG emission extension for South Korea consistent with a 229-municipality, 76-sector domestic MRIO. Preliminary results show substantial municipality-level heterogeneity in sectoral GHG emission coefficients relative to nationally uniform sector averages, especially in emission-intensive sectors such as electricity and renewable energy, steel, coal and petroleum products, and basic chemicals.

This suggests that nationally uniform coefficients may mask important subnational variation and distort the spatial pattern of production-based emissions in EEIO applications.

The study contributes a transparent municipal-sector extension-building framework for South Korea and an uncertainty design that extends existing input-data approaches by incorporating uncertainty from concordance and allocation choices (Ingwersen et al., 2022; Schulte et al., 2024; Yang et al., 2022; Yoo et al., 2021).

References

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