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A comparison of EXIOBASE, GTAP and EORA models to calculate material footprints

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Short abstract (max 150 words)

Domestic Material Consumption (DMC) is currently the most commonly used material flow-based indicator on the international level. However, the necessity to develop more comprehensive indicators of global material flows, so-called material footprint indicators, has been articulated by a large number of stakeholders. Multi-regional input-output (MRIO) models extended by world-wide data on material extraction have become a key method to assess material footprints. This paper will perform the first quantitative comparative assessment of selected MRIO databases to calculate material footprint indicators, notably the EORA, EXIOBASE and GTAP databases, using a globally harmonized data base of global material extraction currently developed for the UNEP-IRP as the physical satellite. Thereby, we will investigate why results for certain countries or world regions differ significantly when calculated with different MRIO models. The paper will present recommendations for the required steps to further harmonize available methods and on the interpretability of the respective results.

Key words

Demand-based indicators, input-output analysis, international trade, material flow analysis, raw material consumption

Long abstract (600-1200 words plus references)

Domestic Material Consumption (DMC) is currently the most commonly used material flow-based indicator on the international level and informs the European Resource Use Strategy, the Japanese Sound Material Cycle high level policy and the Chinese circular economy promotion law, among other initiatives. The indicator is scientifically well tested, robust and reliable. In recent years, the necessity to develop and apply more comprehensive indicators that apply to final demand has been articulated by a large number of stakeholders, including policy makers, civil society as well as academia. This need has eventuated because of fast growing trade flows of raw materials and products and the related indirect (embodied) material flows which are not captured by direct

material flow indicators. Increasing globalization of material flows necessitates that new indicators measuring the raw material equivalent of imports and exports, hence the material footprint of consumption, need to be developed to complement direct indicators such as the DMC and to provide a more comprehensive picture of material use related to global production and consumption networks.

To address this need, the scientific community has developed different methodological concepts which all aim at calculating indicators that, in contrast to DMC, also inform about indirect material flows related to international trade. Multi-regional input-output models extended by world-wide data on material extraction have become a key method to assess material footprints and various MRIO databases have already been tested with regard to material footprints, including EORA (Wiedmann et al., 2013), GTAP (Giljum et al., 2014b), EXIOBASE (Giljum et al., 2014a; Tukker et al., 2014), WIOD (Arto et al., 2012) and the OECD database (Bruckner et al., 2012; Wiebe et al., 2012).

So far, results for certain countries or world regions differ significantly when calculated with different material footprint approaches or using different data sources (Eisenmenger et al., submitted; Schoer et al., 2013), thus making it difficult to derive clear and unambiguous policy messages. In order to move the discussion towards a harmonization of approaches for calculating material footprint indicators, there is a clear lack of knowledge regarding the effects of certain assumptions within the method used on the overall results.

This paper will perform the first quantitative comparative assessment of selected MRIO databases to calculate material footprint indicators, notably the EORA, EXIOBASE and GTAP databases. The comparison will be undertaken for the year 2007, as this currently is the only available common base year across the three databases. One key feature of this comparative work will be that a globally harmonized data base of global material extraction currently developed for the UNEP-IRP will be used for the calculations in all three models. Applying this harmonized data base across all three models will facilitate identifying which deviations in the results are due to the different approaches applied, because differences due to the use of different data on material extraction can be excluded.

The comparison of the three selected MRIO frameworks will therefore focus in particular on questions of aggregation and disaggregation:

- to which extend is the material footprint calculation influenced by the regional and sectoral detail of the MRIO database,
- to which extend is the calculation influenced by the level of detail of the material flow satellite and the concordance between material flow categories and economic activities (sectors/products),
- to which extend do different final demand categories influence the results including a detailed analysis for the material footprint of final consumption, capital investment and exports.

The well-structured comparison of currently available approaches and frameworks will allow identifying the causes for potential differences in model results and to qualify approaches and models with regard to their validity, robustness and reliability. Based on the comparative analysis the paper will present a set of recommendations for the required steps to further harmonize available methods and on the interpretability of the respective results. Such information will be of critical

importance for policy debates on sustainable resource use, resource efficiency, resource depletion, waste reduction, sustainable consumption and production and green economy.

References

Arto, I., Genty, A., Rueda-Cantuche, J.M., Villanueva, A., Andreoni, V., 2012. Global Resources Use and Pollution:Vol. I, Production, Consumption and Trade (1995-2008), JRC scientific and policy reports European Commission Joint Research Centre (Institute for prospective technological studies), Luxembourg.

Bruckner, M., Giljum, S., Lutz, C., Wiebe, K., 2012. Materials embodied in international trade - Global material extraction and consumption between 1995 and 2005. Global Environmental Change 22, 568–576.

Eisenmenger, N., Schaffartzik, A., Wiedenhofer, D., Giljum, S., Bruckner, M., Schandl, H., Wiedmann, T., Lenzen, M., Tukker, A., de Koning, A., submitted. Consumption-Based Material Flow Indicators – Seven Approaches, Seven Results for the Austrian Raw Material Consumption. Environmental Science & Technology.

Giljum, S., Lieber, M., Lutter, S., Schütz, H., 2014a. Case study report: Material Footprints. Deliverable 8.2 of the FP7 CREEA project. Available at www.creea.eu.

Giljum, S., Martinez, A., Bruckner, M., 2014b. Material Footprint Assessment in a Global Input-Output Framework. Journal of Industrial Ecology. Forthcoming.

Schoer, K., Wood, R., Arto, I., Weinzettel, J., 2013. Estimating Raw Material Equivalents on a macro-level: Comparison of multi-regional input output analysis and hybrid LCA-IOA. Environmental Science & Technology 47, 14282−14289.

Tukker, A., Bulavskaya, T., Giljum, S., de Koning, A., Lutter, S., Simas, M., Stadler, K., Wood, R., 2014. The Global Resource Footprint of Nations. Carbon, water, land and materials embodied in trade and final consumption, Leiden/Delft/Vienna/Trondheim.

Wiebe, C., Bruckner, M., Giljum, S., Lutz, C., Polzin, C., 2012. Carbon and materials embodied in the international trade of emerging economies: A multi-regional input-output assessment of trends between 1995 and 2005. Journal of Industrial Ecology 16, 636–646.

Wiedmann, T., Schandl, H., Lenzen, M., Moran, D., Suh, S., West, J., Kanemoto, K., 2013. The material footprint of nations. Proceedings of the National Academy of Sciences (PNAS).