The role of regional disaggregation and scarcity weighting in the analysis of global virtual water flows

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Today, the problem of water shortage affects 40% of the global population. In the past, water policy schemes focused more on the development of irrigation infrastructures for expansion of irrigated area. However, these expansionary policies are not sufficient as demand for water continues to increase. Moreover, the development of further irrigation projects is questionable, given growing concerns over the adverse environmental effects of large dam projects. In the coming decades, population growth and economic development, coupled with rising scarcity of water, may lead to further increase in costs of water supply development. This is threatening the economy of many river basins, and thus drawing countries that share these basins into possible water conflicts. Global climate change may put further pressure on the existing hydrological systems with increasing water demand as the variability of water supply are expected to change. Coping with the effects of climate change on water will require stronger demand management measures to enhance the efficient usage of water.

It is conceivable that in future, the assessment of international trade in virtual water will gain importance, similar to the assessment of internationally traded embodied carbon, which is high on the agenda in the debate about countries' responsibility for climate change. A tool that is increasingly applied to the assessment of carbon embodied in international trade is multi-region input-output (MRIO) analysis. MRIO analysis was already one of the items on Leontief's original toolbox, but its computational and labour intensity meant that only few globally comprehensive and sectorally detailed models have been developed so far. Today, there exist only a handful of truly global MRIO tables with environmental satellite accounts, that are capable of being applied to questions pertaining to international trade of emissions, energy and embodiments of natural resources. Of particular appeal appears to be capability of these MRIO models to elucidate the consumer responsibility of countries for global greenhouse gas emissions, also termed their carbon footprint. In 2008, Wiedmann et al. dispelled belief upheld and expressed by the UK government that British CO2 emissions had been declining over the years, by showing that in reality emissions had only been outsourced abroad to countries such as China, and were growing instead. Whilst greenhouse gas emissions have certainly been the main focus of environmentally-extended (MR)IO analysis, the inter-regional trade of virtual water is attracting more and more interest.

The advantage of IO analysis over bottom-up techniques is its ability to cover the complete environmental repercussions facilitated through complex supply chains underpinning the production of commodities worldwide. Thus, IO analysis is able to quantify carbon or water footprints without systematic truncation errors that affect bottom-up methods such as process analysis. This has recently been shown by Feng et al in a comparison of global water footprints calculated using IO analysis and a bottom-up method. However, one drawback of IO analysis is that industry sectors and commodities are usually represented in more or less aggregated groups, thus preventing assessments for specific products or activities.

The problem of a lack of detail is especially true for World IO tables. Existing MRIO tables distinguish in the order of 100 regions, each broken down into typically 50 sectors. Some of the regions in these tables are single countries, some are groups of countries. There are two specific problems arising from the lack of regional detail in world input-output tables, when these are applied to the environmental indicator of water. First, many areas of critical water problems exist in developing countries that are not distinguished in existing MRIO databases. Second, existing MRIO databases group together countries characterised by widely varying degrees of water scarcity. However, calculating global water footprints by adding the use of scarce water in one region to the use of abundant water in another region makes little sense, because such footprints would not be able to indicate regions and/or commodities in need of policy measures to mitigate water-related problems. This problem is evident for example in the global virtual water study by Feng et al, and it is these regional aggregation and water scarcity aspects that are our main interest.

This work is therefore concerned with the quantification of global virtual water flows, using MRIO tables at high country and sector detail. For this purpose, we make use of the Eora MRIO database. An MRIO analysis of global virtual water flows will benefit especially from high country and sector detail, because only then it is possible to separate water-scarce from water-abundant regions.