Data structure in MFA and its effects on results: a comparison of P in Denmark and Austria

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Publication date: 2015

Document Version
Publisher's PDF, also known as Version of record

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1) Background & aim

A considerable range of recent Material Flow Analyses (MFA) of phosphorus on a country scale have been published. While these may differ due to the region examined, authors’ choices in building MFA models are a different set of factors often disregarded in direct comparison of regional resource households.

In terms of system boundaries, and external trade and national accounts, country or multi-country level MFA studies are quite consistent across substances and countries (Fischer-Kowalski et al. 2011), although there is considerable freedom in the layout of the respective models and selection of data behind the model. In comparisons of MFA studies, differences resulting from system layout and data structure (sources, aggregation/disaggregation) tend to get little attention, but are taken at face value (see e.g. Chowdhury et al. (2013) for the case of phosphorus). Metadata are rarely discussed; this work aims to shed some light on the influence of modelling choices and the underlying data structure of MFA studies on their outcome.

2) Materials & methods

Building upon MFA studies of phosphorus in Denmark and Austria, we examine the effect of the layout of an MFA system and its underlying data structure on the outcome of regional MFAs.

The research (Klinglmair et al. 2015; Zoboli et al. 2014) we draw upon for this case study share a similar geographical (country) scale, with good data availability in both countries examined. We use 2011 as a reference year for comparison.

The models are comparable in complexity (AT: 56 processes, 122 flows, DK: 52 processes, 156 flows). Both studies use the STAN 2.0 software (Cencic & Rechberger 2008) for handling of uncertainties, data reconciliation, and visualization.

In particular, the following characteristics of MFA models are of interest here: 1) system boundaries, 2) aggregation/disaggregation of processes, i.e. which processes are shown as discrete entities, 3) aggregation/disaggregation of flows, 4) choice of data sources, 5) uncertainty assessment.

3) Results

Data sources

An obvious first step is a run-down of data sources used in studies to be compared; both cases are comparable here, with a preponderance of technical reports published by official or academic sources (for a more detailed discussion of data characterization in MFA, see Schwab et al. (2014)).

Consistency

“Consistency” here means consistency of the input data with the constraints imposed by the model. The effect of the data reconciliation process can be quantified as the change of individual flow values after data reconciliation in STAN (which uses the method of least squares) in % of input value; the mean of these deviations gives a measure of the extent of data reconciliation, with $\bar{D}$ being the mean deviation, $m$ the total number of flows, $x$ the entered flow value, and $\bar{x}$ the reconciled flow value. $\bar{D}$ was found to be 6% in the Austrian case, 10% in the Danish case; this value can serve as a proxy of model “quality”.

Handling of uncertainties

Data reconciliation in STAN results in the reduction of the uncertainties associated with reconciled values. Ideally, all uncertainty ranges should be smaller in the balanced system than entered; ideally, uncertainty ranges ought to be adjusted iteratively.

References


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