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EDITORIAL

A critical view on scientific consensus building in life cycle impact assessment

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1 Introduction

Finding scientific consensus has been an important driving force for research in life cycle assessment (LCA) over the last 20 years, as marked by reports from the Society of Environmental Toxicology and Chemistry (SETAC), United Nations Environment Programme (UNEP), International OrganiZation for Standardization (ISO), and the Joint Research Centre (JRC). In the beginning of the 1990s, the life cycle framework itself was the main topic of debate (Fava et al. 1993, 1994), while life cycle impact assessment (LCIA) methods became part of the scientific consensus discussions in a later stage (Udo de Haes et al. 2002). Operational standards on how to perform an LCA came also in place (ISO 14040, 2006; ISO 14044, 2006; Finkbeiner et al. 2006). Recently, LCIA scientific consensus building entered a new phase with the report on recommended practice for life cycle impact assessment methods in a European context (Joint Research Centre 2011; Hauschild et al. 2013), including the global consensus model for addressing toxic impacts in life cycle assessment, i.e., the USEtox model (Rosenbaum et al. 2008). Recently, the search for scientific consensus within the UNEP/SETAC initiative has been extended, specifically looking for global guidance on a range of LCIA methods (www.lifecycleinitiative.org/activities/phase-iii/), and new developments in the ISO-standard arena (Finkbeiner et al. 2013).

Over the years, it has been argued that without scientific consensus, LCA would be easily misused by companies for green washing purposes, as companies may just pick the evaluation method that favor their own product, and that the scientific credibility of LCA would be at stake. The intention of LCA to contribute to solving environmental problems in our society is most likely also an important driver of the "scientific consensus agenda". Although my intention in this editorial is not to argue against the significant scientific consensus achievements within the LCA community, I do have a number of concerns that specifically focus on developments in the LCIA domain.

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2 Hiding uncertainty

My first concern is that scientific consensus should not be interpreted as an increase in certainty of the model results. One good example is the development of the USEtox model. The scientific consensus process started with the comparison of a number of toxicity models which widely differed in their outcomes. After harmonizing the toxicity models in terms of data input, the uncertainty before and after harmonization decreased orders of magnitude, as reported by Rosenbaum et al. (2008). The harmonization effort was the main basis of the new USEtox consensus model (Hauschild et al. 2008). This procedure, however, may give the false impression that harmonization reduces uncertainty. As an alternative strategy, Joos et al. (2013) performed a multi-model analysis to provide carbon dioxide impulse response functions for the computation of global warming potentials (GWPs). Instead of selecting one single best model, they provided a best estimate on the basis of a multi-model mean of 15 climate models and the confidence range of the mean. Such an alternative scientific consensus approach employed by the climate scientific community may in fact be more robust than the selection or construction of one single scientific consensus model.

Another issue is that not all recommended LCIA methods quantify the influence of value choices on the model outcomes. For example, the choice for a specific time horizon

appears to be a very important value choice in quantifying the relative impact of long living substances (e.g., De Schryver et al. 2011). This is an aspect that to some extent is addressed in the reporting of global warming potentials, but, for instance, not in the reporting of toxicity potentials (TPs) of metals by the USEtox model (Rosenbaum et al. 2008). Furthermore, a 100-year time horizon is selected as default for the GWPs, while for the TPs, an infinite time horizon is considered recommendable, also for metals. This example points to the fact that value choices are not consistently quantified and dealt with in defining recommended practice across various impact categories. Overselling the credibility and reliability of LCIA methods that have a stamp of scientific consensus is a real danger in these cases.

3 Recommending immature methods

My second concern is that it is not always so clear-cut if an impact category is "ready" for scientific consensus. For instance, the LCIA methods to assess the environmental impacts of land use and mineral use are changing rapidly with significant recent scientific advancements (e.g., De Baan et al. 2013; Vieira et al. 2012). Furthermore, for a number of impact categories, such as photochemical ozone formation, fine particulate matter formation, and eutrophication, there are only a limited number of models used by the LCIA community (Joint Research Centre 2011). However, there are much more alternative models outside the LCIA domain that could also be used for the same purpose with possibly more reliable results. Building scientific consensus on the basis of rapidly changing insights or a limited number of models has the drawback that the consensus result may have an insufficient scientific basis. This is particularly true for novel impact categories and impact categories that are studied by only a limited number of scientists in the LCIA community in combination with relatively little involvement from model experts outside the LCIA field. From my own experience, this in fact holds for the majority of impact categories involved.

Instead of taking the gigantic task to deal with all the environmental impact categories in the LCA community itself, it may be a more sensible option to significantly strengthen the collaboration with more specialized and larger research communities, such as the International Panel for Climate Change (www.ipcc.ch), the International Union for Conservation and Nature (www.iucn.org), the World Health Organization (www.who.int), the International Resource Panel (www.unep.org/resoucepanel), the task force on hemispheric transport of air pollution (www.htap.org), and the International Panel on Chemical Pollution (www.ipcp.ch). The advantage is a close connection and collaboration with specialists in the specific fields of expertise. This may help to further improve the scientific quality of LCIA methods and the search for a credible scientific consensus.

4 Blocking scientific progress

My third concern is that too much focus on consensus may slow down scientific progress, even though defining scientific consensus indeed provides (apparent) stability in LCIA methods. Although stability may be preferable from a practical point of view and method updates can in principle be performed, these updates also take a lot of (bureaucratic) time. Significant and necessary improvements in LCIA on, for instance, global scale analysis combined with spatial differentiation may not be implemented in practice for years due to the fact that recommended practice is "deciding" otherwise. Instead of spending much time on building scientific consensus, it may be more appropriate (and rewarding) in this stage of LCIA development to focus much more on major remaining scientific challenges, such as finding an optimal spatial resolution in connection with life cycle inventories and defining appropriate damage indicators for ecosystem quality and resource scarcity. Healthy competition between several LCIA methodologies instead of promoting scientific consensus all the way could in fact improve the quality of LCA studies. If the results of two or more LCIA methodologies point in the same direction in product comparisons and/or improvements, the conclusions may be much more robust than relying on a single scientific consensus method.

5 Conclusions

Although there is no doubt that the LCIA research community should aid the practical application of LCA, this is in my opinion not always a synonym for seeking for scientific consensus. Scientific consensus can hide important uncertainties; existing LCIA methods are not always sufficiently mature for recommended practice; and scientific consensus may hold back new developments instead of enhancing them. Providing multi-model consensus with uncertainty ranges instead of recommending one single method, working much closer together with international communities from related scientific fields, and sometimes just "agree that we disagree" should in my opinion be much more important ingredients in LCIA research than they are right now.

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