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Rethinking the Relationship between Footprints and LCA

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Over the past two decades, a rapid expansion of footprint-style indicators has been observed by academics, companies, governmental bodies, and nongovernmental organizations, particularly in the arena of environmental and sustainability discourses. Although footprints nowadays have reached worldwide popularity, a dedicated footprint research community is far from being established. The ambiguous relationship with life cycle assessment (LCA), for which there is such a community, poses a substantial obstacle to achieving that goal.

There has been a growing interest in discussing the relationship between footprints and LCA. Many researchers have stressed the unique contributions of LCA to the identification and quantification of footprints, with the intention of legitimizing footprint analysis from a life-cycle perspective. The strengths of LCA in assessing environmental impacts would allow many footprint topics (e.g., greenhouse gases, water use, and biodiversity) to be addressed under an LCA framework, in particular those that can be measured in relation to a functional unit.

Nevertheless, footprint practitioners tend to stand alone in some way. One example is the ecological footprint (EF)—the ancestor of the footprint family. From an LCA perspective, the classical EF approach, namely National Footprint Accounts (NFA), corresponds to a more rough type of inventory analysis in which hundreds of primary bioproducts are simply tabulated and converted into the land use elementary flow. The lack of transparency in defining system boundaries and the exclusion to characterize inventory results make the NFA an unsuccessful LCA, at least in the eyes of LCA experts.

Probably the most important thing that LCA users have learned from the EF is the name—a good name sometimes means everything. Therefore, the advent of the carbon footprint (CF) is not surprising. It begins with the task of competing for public and corporate concerns on global warming—an issue that the EF attempts to address as well but fails to receive due attention. The CF's prosperity moves LCA back to central stage, even though Hammond[1] suggests calling the CF "carbon weight" with the belief that footprints should be area-based indicators in line with the EF.

Meanwhile, environmental input-output analysis (EIOA) has proved useful in accounting for the CF at national and international scales.[2] Increasingly, IO methods have also been found suitable for computing the EF and many other footprints for nations, such as the water, material and biodiversity footprints. These, however, do not diminish the dominant role of LCA in contemporary footprint analysis, especially in the domain of product footprints where a great amount of theoretical and practical work has been done by the LCA community on various environmental issues associated with production and consumption. Consequently, Ridoutt and Pfister[3] argue for a "universal" footprint definition that is entirely based on LCA, that is, footprints which are not consistent with a comprehensive LCA (including the description of the goal and scope, inventory analysis, impact assessment, and the interpretation of the inventory and impact assessment results) are disqualified from the footprint family.

Saying that footprints must be area-based or that footprints must be LCA-based is due to a lack of mutual understanding. The reality is that nonarea-based footprints are now ubiquitous, and that LCA is not the only way to implement an inventory analysis, in addition to which a footprint is not necessarily committed to an impact assessment. Moreover, there are certain important types of questions for which footprints are desirable but for which a life-cycle perspective is not or only partially appropriate. Such a methodological limitation has been demonstrated in the case of organizational footprints.[4]

The footprint family has been envisaged in such a way that it can be easily extended to capture a broader scope of sustainability issues. Some emerging footprints, such as the celestial, employment and inequality footprints, open the door for footprint developers to establish and measure human well-being in terms of happiness and equality, which remains the ultimate goal of sustainable development. These social and economic dimensionsin LCA, however, suffer from difficulties

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in data availability, societal impact assessment, and result interpretation.

One thing that LCA can learn from footprint analysis is the comparison of a footprint and the indicator of carrying capacity. The EF has a tradition of benchmarking man's land occupation with available planetary area and thereby determining whether the situation is sustainable or not. So do the blue water footprint and chemical footprint—the two can be readily compared with blue water availability and chemical boundary, respectively. The convergence of footprints and planetary boundaries makes sense in that it allows for the evolution of environmental impact assessment to environmental sustainability assessment, which is more informative for policy purposes but lacking or at least inconspicuous in current LCA frameworks.

Admittedly, facilitating the calculation of footprints with mature methodological frameworks is preferred, and because of this, many footprints have learned and borrowed much from LCA, IOA, or a hybrid of both. Even so, narrowing footprints down to an LCA context potentially creates blind spots, where exhaustive inventory data for compiling and/or consensus models for characterization of impact pathways are not available—and vice versa—some typical impact categories (e.g., acidification, ozone depletion and ionizing radiation) are out of the scope of footprint family in its current form.

To sum up, footprints are not to be interpreted as a new name for the good old impact category indicators defined in LCA and, more importantly, that LCA does not substitute but complements footprint analysis. The nuanced ways that footprints and LCA deal with anthropogenic stressors should not be viewed as merely a source of controversy but rather as an opportunity for complementary use, and for development and refinement of these tools. For instance, an initiative has been launched to investigate the possible synergies between classical water footprint and water-use LCA.[5] More investigations are needed into the relationship of individual footprints and LCA scopes. Examples include the EF and land use, chemical footprint and toxicity, as well as nitrogen footprint and eutrophication. This relies on the collaboration between the footprint community—which is ever-expanding but fragmented and the LCA community—which is sophisticated but more fossilized because its members stick to standards by ISO, EPA, EU, and so on.

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Notes

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