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Bjørn, Anders; Diamond, Miriam L.; Owsianiak, Mikolaj; Verzat, Benoit ; Hauschild, Michael Zwicky

Published in:
Environmental Science & Technology (Washington)

Link to article, DOI:
10.1021/acs.est.5b02106

Publication date:
2015

Document Version
Peer reviewed version

Citation:

Bjørn, A., Diamond, M., Owsianiak, M., Verzat, B., Hauschild, M.Z., 2015. Strengthening the Link between Life Cycle Assessment and Indicators for Absolute Sustainability To Support Development within Planetary Boundaries. Environ. Sci. Technol. 49, 6370–6371. doi:10.1021/acs.est.5b02106

Strengthening the link between life cycle assessment and indicators for absolute sustainability to support development within planetary boundaries

Authors: Anders Bjørn[1*], Miriam Diamond[2], Mikołaj Owsianiak[1], Benoît Verzat[3], Michael Zwicky Hauschild[1]

[1]DTU Management Engineering, Quantitative Sustainability Assessment, Technical University of Denmark, Produktionstorvet, Building 426, 2800 Kgs. Lyngby, Denmark.

[2]Department of Earth Sciences, University Of Toronto, 22 Russell St., Toronto, Ontario M5S 3B1, Canada.

[3]Quantis Lyon, c/o Locaux Motiv, 10 bis, rue Jangot, 69007 Lyon, France.

*To whom correspondence may be addressed: anbjo@dtu.dk, ph. +45 50808929

The insufficiency of eco-efficiency

Life cycle assessments (LCA) are increasingly used by industry to communicate improvements of environmental performance in a scientifically defendable way. Typically, studies compare new product designs with "last year's model" or a market reference to document that the eco-efficiency of a company's product portfolio is gradually improving or to show that the company is ahead of its competitors in terms of eco-efficiency performance. In both cases the signal to stakeholders is that companies are doing "their share" to foster sustainability. However, while the environmental performance of individual products is being improved, humanity is generally moving further away from a state of environmental sustainability.[1] The reason for this seeming contradiction is that improvements in eco-efficiency are insufficient to offset increasing levels of consumption. For example PricewaterhouseCoopers calculated that the current global eco-efficiency improvement with respect to greenhouse gas (GHG) emission of 0.9% per year needs to increase to 6.2% per year and remain at that level until the year 2100 for emission volumes to be aligned with the IPCC RCP2.6 reduction pathway designed to curb a global temperature increase of 2°C.[2] How can the current LCA practice of assessing environmental performance relative to a reference product be improved to support decisions on the path to environmental sustainability? How can we ensure that LCA is not used to legitimize a business as usual situation of incremental and insufficient eco-efficiency improvements?

Carrying capacity as absolute sustainability reference

To change current practice, LCA indicators need carrying capacity as a reference to compare environmental interventions from a product system to sustainable levels of interventions. Carrying capacities are derived from inherent thresholds in nature's response to, for example, increasing concentrations of pollutants or use of resources. Staying below thresholds is a precondition for environmental sustainability because it safeguards ecosystem services and the biodiversity levels that are required for resilient socio-ecological systems and thus for development within planetary boundaries. With carrying capacity as a reference, LCA may support *absolute environmental sustainability indicators* (AESI). Such indicators are absolute, because carrying capacities are independent of the product system assessed. Initial steps in this direction were recently taken by Bjørn and Hauschild,[3] who developed carrying capacity references for the normalisation step of LCA. These references allow translating an LCA midpoint indicator score to the corresponding fraction of carrying capacity occupied in person equivalents, making it possible to quantify the share of personal carrying capacity taken up, for example, by food consumption or transportation. This type of

analysis is similar to ecological footprint analysis where available land is compared to land area needed to supply resource uses and assimilate emissions of product systems.[4] Using LCA combined with carrying capacity based normalisation has an advantage over the ecological footprint method in that it covers a much broader spectrum of environmental interferences, rooted in the strong methodological development activities in the field of life cycle impact assessment, and is linked to comprehensive inventory databases of unit processes.

Carrying capacity entitlement is key

Beyond scientific technicalities of the impact assessment, the question of carrying capacity entitlement is central because a product can only be considered sustainable if it does not exceed the carrying capacity to which it is entitled. Entitlements are, of course, normative due to the diversity of perspectives on what constitutes needs (and wants) in life. A product's entitlement can also depend on the geographical context and can evolve through time. For instance, some may perceive bottled water to be entitled near zero carrying capacity when consumed in a developed country with reliable access to safe tap water. Bottled water is consequently likely to be assessed as unsustainable in this context. In a developing country, however, this assessment could be different because of the common lack of reliable, safe, publically accessible drinking water. The normative nature of entitlement poses a challenge when combined with the science-based approach of LCA. Yet, we are optimistic that some degree of consensus on entitlements could be obtained: Just as UN's Universal Declaration of Human Rights is broadly accepted, we believe that it is possible to agree upon a rule that carrying capacity should be shared equally amongst people, so that all people can potentially meet their needs. The sector specific GHG reduction scenarios of IPCC, IEA and individual nations' and municipalities' climate strategies could also serve as policy references for how to allocate carrying capacity entitlement between products belonging to different sectors and geographic regions.

The road ahead

The timing of developing AESI is certainly ripe. United Nations is currently developing sustainable development goals for the planet, goals that will be calling for sustainability indicators. In 2012, the World Business Council for Sustainable Development (WBCSD), representing 200 large companies with a combined annual revenue of $US 7 trillion, announced that they are working with planetary boundaries researchers to bridge the gap between business and science. Recently the Dutch energy utility Eneco took the first steps in bridging this gap by using the "One Planet Thinking Model", which is based on linking LCA indicators to the planetary boundaries concept. Preliminary results show that Eneco must improve its eco-efficiency (intervention per kWh produced electricity) for the impact categories fossil depletion and climate change by factors of 2 and 15 respectively to be considered environmentally sustainable.[5] While this is a positive example we do not expect that all companies will find it appealing to adopt AESI in stakeholder communication considering the obvious conflict between the dictum of continuous economic growth versus the need to stay within finite carrying capacity entitlements. Yet developing a comprehensive basket of AESI will leave foot-dragging companies with one less excuse for avoiding to face actual sustainability challenges. We believe that modifying the already widely adopted LCA framework from assessing sustainability in relative terms to assessing it in absolute terms can and must play a major role in this development.

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