

Viewpoint: Making Sense of the Minefield of Footprint Indicators

Ridoutt, Bradley ; Fantke, Peter; Pfister, Stephan ; Bare, Jane; Boulay, Anne-Marie; Cherubini, Francesco ; Frischknecht, Rolf; Hauschild, Michael Zwicky; Hellweg, Stefanie; Henderson, Andrew *Total number of authors:*

23

Published in: Environmental Science & Technology (Washington)

Link to article, DOI: 10.1021/acs.est.5b00163

Publication date: 2015

Document Version Peer reviewed version

Link back to DTU Orbit

Citation (APA):

Ridoutt, B., Fantke, P., Pfister, S., Bare, J., Boulay, A-M., Cherubini, F., Frischknecht, R., Hauschild, M. Z., Hellweg, S., Henderson, A., Jolliet, O., Levasseur, A., Margni, M., McKone, T. E., Michelsen, O., i Canals, L. M., Page, G., Pant, R., Raugei, M., ... Wiedmann, T. (2015). Viewpoint: Making Sense of the Minefield of Footprint Indicators. *Environmental Science & Technology (Washington), 49*(5), 2601–2603. https://doi.org/10.1021/acs.est.5b00163

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.

- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Viewpoint: Making sense of the minefield of footprint indicators

- 3 Bradley Ridoutt^{*,a}, Peter Fantke^b, Stephan Pfister^c, Jane Bare^{d,‡}, Anne-Marie Boulay^{e,‡}, 4 Francesco Cherubini^{1,‡}, Rolf Frischknecht^{9,‡}, Michael Hauschild^{b,‡}, Stefanie Hellweg^{c,‡}, Andrew Henderson^{h,‡}, Olivier Jolliet^{i,‡}, Annie Levasseur^{e,‡}, Manuele Margni^{e,‡}, Thomas 5 6 McKone^{i,‡}, Ottar Michelsen^{k,‡}, Llorenç Milà i Canals^{I,‡}, Girija Page^{m,‡}, Rana Pant^{n,‡}, Marco 7 Raugei^{o,‡}, Serenella Sala^{n,‡}, Erwan Saouter^{n,‡}, Francesca Verones^{f,‡}, Thomas Wiedmann^{p,‡} 8 9 ^a Commonwealth Scientific and Industrial Research Organisation (CSIRO), Clayton, 10 Victoria 3169, Australia 11 12 ^b Technical University of Denmark (DTU), Department for Management Engineering, 13 14 Division for Quantitative Sustainability Assessment, 2800 Kgs. Lyngby, Denmark 15 16 ^c ETH Zurich, Institute of Environmental Engineering, 8093 Zurich, Switzerland 17 ^d United States Environmental Protection Agency, Sustainable Technology Division, 18 Systems Analysis Branch, National Risk Management Research Laboratory, Cincinnati, 19 20 OH 45268, USA 21 22 ^e CIRAIG, Ecole Polytechnique de Montreal, Montreal, Canada 23 ^f Norwegian University of Science and Technology (NTNU), Industrial Ecology 24 25 Programme, Department of Energy and Process Engineering, NO-7491 Trondheim, 26 Norway 27 ^g treeze Ltd., Uster, Switzerland 28 29 ^h University of Texas Health Science Center, School of Public Health, Division of 30 Epidemiology, Human Genetics and Environmental Sciences, Houston, TX 77030, USA 31 32 ⁱ University of Michigan, School of Public Health, Environmental Health Sciences, Ann 33 34 Arbor, MI 48109, USA 35 36 ^j University of California, Lawrence Berkeley National Laboratory and School of Public 37 Health, Berkeley, CA 94720, USA 38 39 ^k Norwegian University of Science and Technology (NTNU), Division for Finance and Property, NO-7491 Trondheim, Norway 40 41
- ¹ United Nations Environment Programme (UNEP), Division for Technology, Industry and
 Economics, 15 Rue de Milan, 75009 Paris, France
- 44
- 45 ^m University of Western Sydney, School of Science and Health, Penrith, NSW 2751,

46 Australia

47

- ⁴⁸ ⁿ European Commission, Joint Research Centre, Institute for Environment and
- 49 Sustainability, Via Enrico Fermi 2749, Ispra, I-21027, Italy
- 50
- ^o Oxford Brookes University, Department of Mechanical Engineering and Mathematical
 Sciences, Oxford OX33 1HX, United Kingdom
- 53 Sciences, Oxford OA33 THA, United K
- ^p UNSW Australia, Sustainability Assessment Program, School of Civil and Environmental
 Engineering, Sydney, NSW 2052, Australia
- 56
- 57 [‡]Authors listed alphabetically
- 58

59 In recent years, footprint indicators have emerged as a popular mode of reporting environmental performance. The prospect is that these simplified metrics will guide 60 61 investors, businesses, public sector policymakers and even consumers of everyday goods and services in making decisions which lead to better environmental outcomes. However, 62 63 without a common "DNA", the ever expanding lexicon of footprints lacks coherence and 64 may even report contradictory results for the same subject matter (1). The danger is that this will ultimately lead to policy confusion and general mistrust of all environmental 65 66 disclosures.

Footprints are especially interesting metrics because they seek to express the 67 environmental performance of products and organizations from a life cycle perspective. 68 The life cycle perspective is important to avoid misleading claims based only on a selected 69 70 life cycle stage. For example, the water used to manufacture beverages may be important, but if a beverage includes sugar, irrigation water used to cultivate sugarcane could be a 71 greater concern. The focus on environmental performance distinguishes footprints from 72 73 technical efficiency measures, such as energy use efficiency or water use efficiency, which typically only make sense when applied to a single life cycle stage as they lack local 74 75 environmental context.

However, unlike technical efficiency, which can usually be accurately measured and verified, footprint indicators, with their wider view of environmental performance, are usually calculated using models which can differ in scope, complexity and model parameter settings. Despite the noble intention of using footprints to evaluate and report environmental performance, the potential inconsistency between different approaches acts as a deterrent to use in many public policymaking and business contexts and can lead to confusing and contradictory messages in the marketplace.

83 Building on the international standards

One way to achieve consistency in footprints is to start with the foundation of the international standards describing environmental management from a life cycle perspective, i.e. ISO 14040 and 14044. These international standards pre-date the recent broad-based popular interest in footprints and do not address the subject directly. Nevertheless, they are the global consensus documents underpinning life cycle assessment (LCA), which already supports a wide range of complex environmental decision-making in government and industry (2).

91 The major distinction between LCA and footprints is that the former is oriented toward 92 comprehensive assessment of all relevant environmental impacts and evaluation of trade-93 offs, whereas the latter are more limited in scope, addressing only specific environmental 94 subjects of societal concern. This leads to LCA study reports being rich in technical detail 95 and although valuable in this regard, these reports are generally not widely accessible to 96 people outside the field. This is in contrast to footprints which have a primary orientation 97 toward non-LCA experts and society in general. Moreover, LCA practitioners work with a set of indicators defined by the LCA expert community (3). However, these LCA impact 98 99 category indicators (e.g. terrestrial acidification, particulate matter formation. photochemical oxidant formation) are not necessarily the lens through which society views 100 101 environmental protection.

102 All this is to say that while footprints should be based on LCA, they also have their own 103 special characteristics. Already a wide range of individual footprint protocols reference ISO 14044: e.g. ISO TS14067, ISO 14046, PAS2050, GHG Protocol Product Standard, BPX 104 105 30-323-0. A task group established under the United Nations Environment Programme 106 (UNEP) / Society of Environmental Toxicology and Chemistry (SETAC) Life Cycle Initiative is working on generic guidance to support the coherent development and application of 107 108 footprint indicators addressing any subject of stakeholder concern - defined now or in the 109 future (4).

110 **Defining attributes**

Footprints seek to condense complicated environmental information into a metric that society can use to make choices that can be expected to lead to improved environmental outcomes within the scope covered by the footprint. We have identified four defining attributes that should characterise all footprint indicators.

Environmental relevance: When aggregating data, having common units is necessary, but not sufficient; environmental equivalence is needed. To illustrate, it would not be environmentally meaningful to aggregate emissions of different greenhouse gases without first applying factors, such as those published by the Intergovernmental Panel on Climate Change describing the relative global warming potentials. Similarly, to assess the environmental performance of consumptive water use along a supply chain it is necessary to apply a model which accounts for differences in local water availability.

Accurate terminology: A footprint indicator addresses a specific subject of environmental concern and the indicator's name must reflect the scope and not be misleading. Where necessary, a qualifying term should be added. For example, following ISO 14046, the term *water footprint* is applied only when both consumptive and degradative (pollution) aspects of water use are assessed. When only consumptive water use is assessed, *water scarcity footprint* is a suggested alternative.

Directional consistency: Footprints need to follow a consistent logic whereby a smaller value is always preferable to a higher value. This facilitates the easy interpretation of footprints, which is important considering their orientation towards society and nontechnical stakeholders. 132 *Transparent documentation:* Footprint methodologies and public footprint disclosures need 133 to be supported by documentation enabling technical peer review. Study reports should 134 document all methods, data sources and assumptions transparently and without bias.

From a technical perspective, footprint indicators might be based on life cycle inventory data (provided the environmental relevance criterion is satisfied), an existing LCA impact category indicator result, or the aggregation of results from different LCA impact categories of relevance to the topic of the footprint. Examples of these three types of footprints are: phosphorus depletion footprint, carbon footprint, and water footprint respectively.

140 Multiple benefits

141 In the European Union, the proliferation of inconsistent footprint methodologies has been

identified as the underlying issue hampering the functioning of a market for green products

143 (5). The benefits of harmonisation are many: reduced implementation costs for business,

avoidance of market access barriers, a common basis for industry to seek out resource

efficiency opportunities with supply chain partners, and increased consumer understanding and confidence that footprint communications are trustworthy (*5*). The solution we propose

147 is the development of a coherent set of footprint indicators based on LCA.

148 AUTHOR INFORMATION

149 Corresponding Author

150 *E-mail: <u>brad.ridoutt@csiro.au</u>

151 ACKNOWLEDGEMENTS

This work is supported by the United Nations Environment Programme (UNEP) / Society of Environmental Toxicology and Chemistry (SETAC) Life Cycle Initiative. Public and private sector sponsors are listed on the Initiative's website (<u>www.lifecycleinitiative.org/</u>). The views expressed in this article are those of the authors and do not necessarily reflect those of the various affiliated organizations.

157 REFERENCES

160

161

- (1) Fang, K.; Heijungs, R. Rethinking the relationship between footprints and LCA.
 Environ. Sci. Technol. 2015, 49 (1), 10-11.
 - (2) Hellweg, S.; Milà i Canals, L. Emerging approaches, challenges and opportunities in life cycle assessment. *Science* **2014**, *344*, 1109-1113.
- (3) Jolliet, O.; Müller-Wenk, R.; Bare, J.; Brent, A.; Goedkoop, M.; Heijungs, R.; Itsubo,
 N.; Peña, C.; Pennington, D.; Potting, J.; Rebitzer, G.; Stewart, M.; Udo de Haes,
 H.; Weidema, B. The LCIA midpoint-damage framework of the UNEP/SETAC Life
 Cycle Initiative. *Int. J. Life Cycle Assess.* 2004, *9*, 394-404.
- (4) Jolliet, O.; Frischknecht, R.; Bare, J.; Boulay, A.M.; Bulle, C.; Fantke, P.;
 Gheewala, S.; Hauschild, M.; Itsubo, N.; Margni, M.; McKone, T.E.; Mila y Canals,
 L.; Posthuma, L.; Prado-Lopez, V.; Ridoutt, B.; Sonnemann, G.; Rosenbaum, R.K.;
 Seager, T.; Struijs, J.; van Zelm, R.; Vigon, B.; Weisbrod, A. Global guidance on
 environmental life cycle impact assessment indicators: findings of the scoping
 phase. *Int. J. Life Cycle Assess.* 2014, *19*, 962-967.
- 172 (5) European Commission, Communication from the Commission to the European
 173 Parliament and the Council. *Building the single market for green products:*

174

Facilitating better information on the environmental performance of products and organisations. COM/2013/0196 final. European Commission, Brussels, 2013.

175 176

177 FIGURES



- 178
- 179 Figure 1. Many types of environmental footprints pointing in different directions make for
- 180 policy confusion and contradictory messages in the marketplace. This problem can be
- 181 overcome if footprints describing environmental performance are based on life cycle
- 182 assessment (LCA).
- 183 Image license to be obtained: <u>http://www.123rf.com/photo_20503891_imprint-soles-shoes-</u>
- 184 pattern.html?term=footprints
- 185