



## Area of Concern: A new paradigm in life cycle assessment for the development of footprint metrics

Ridoutt, Bradley G.; Pfister, Stephan ; Manzardo, Alessandro; Bare, Jane; Boulay, Anne-Marie; Cherubini, Francesco ; Fantke, Peter; Frischknecht, Rolf; Hauschild, Michael Zwicky; Henderson, Andrew

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1 **UNEP/SETAC CORNER**

2 **Area of Concern: A new paradigm in life cycle assessment for the**  
3 **development of footprint metrics**

4 Bradley Ridoutt • Stephan Pfister • Alessandro Manzardo • Jane Bare • Anne-Marie Boulay • Francesco  
5 Cherubini • Peter Fantke • Rolf Frischknecht • Michael Hauschild • Andrew Henderson • Olivier Jolliet •  
6 Annie Levasseur • Manuele Margni • Thomas McKone • Ottar Michelsen • Llorenç Milà i Canals • Girija  
7 Page • Rana Pant • Marco Raugei • Serenella Sala • Francesca Verones

8

9 B.G. Ridoutt (✉)

10 Commonwealth Scientific and Industrial Research Organisation (CSIRO), Private Bag 10, Clayton South,  
11 Victoria 3169, Australia; and University of the Free State, Department of Agricultural Economics,  
12 Bloemfontein 9300, South Africa

13 e-mail: brad.ridoutt@csiro.au

14 Tel: +61 3 9545 2159

15 Fax: +61 3 9545 2314

16

17 Stephan Pfister

18 ETH Zurich, Institute of Environmental Engineering, 8093 Zurich, Switzerland

19

20 Alessandro Manzardo

21 Università degli Studi di Padova, Dipartimento Ingegneria Industriale, Centro Studi Qualità Ambiente,  
22 Padova 35131, Italy

23

24 Jane Bare • Andrew Henderson

25 United States Environmental Protection Agency, Sustainable Technology Division, Systems Analysis  
26 Branch, National Risk Management Research Laboratory, Cincinnati, OH 45268, USA

27

28 Anne-Marie Boulay • Annie Levasseur • Manuele Margni

29 CIRAIQ, Polytechnique Montreal, Montreal, Canada

30

31 Francesco Cherubini • Francesca Verones

32 Norwegian University of Science and Technology (NTNU), Industrial Ecology Programme, Department  
33 of Energy and Process Engineering, NO-7491 Trondheim, Norway

34

35 Peter Fantke • Michael Hauschild

36 Technical University of Denmark (DTU), Department of Management Engineering, Division for  
37 Quantitative Sustainability Assessment, 2800 Kgs. Lyngby, Denmark

38

39 Rolf Frischknecht

40 treeze Ltd., Uster, Switzerland

41

42 Olivier Jolliet

43 University of Michigan, School of Public Health, Environmental Health Sciences, Ann Arbor, MI 48109,  
44 USA

45

46 Thomas McKone

47 University of California, Lawrence Berkeley National Laboratory and School of Public Health, Berkeley,  
48 CA 94720, USA

49

50 Ottar Michelsen

51 NTNU Sustainability, Norwegian University of Science and Technology, NO-7491 Trondheim, Norway

52

53 Llorenç Milà i Canals

54 United Nations Environment Programme (UNEP), Division for Technology, Industry and Economics, 15  
55 Rue de Milan, 75009 Paris, France

56

57 Girija Page

58 University of Western Sydney, School of Science and Health, Penrith, NSW 2751, Australia

59

60 Rana Pant • Serenella Sala

61 European Commission, Joint Research Centre, Institute for Environment and Sustainability, Via Enrico

62 Fermi 2749, Ispra, I-21027, Italy

63

64 Marco Raugei

65 Oxford Brookes University, Department of Mechanical Engineering and Mathematical Sciences, Oxford

66 OX33 1HX, United Kingdom

67

68

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69 **Abstract**

70 *Purpose* As a class of environmental metrics, footprints have been poorly defined, have shared an unclear  
71 relationship to Life Cycle Assessment (LCA), and the variety of approaches to quantification have  
72 sometimes resulted in confusing and contradictory messages in the marketplace. In response, a task force  
73 operating under the auspices of the UNEP/SETAC Life Cycle Initiative project on environmental Life  
74 Cycle Impact Assessment (LCIA) has been working to develop generic guidance for developers of  
75 footprint metrics. The purpose of this paper is to introduce a universal footprint definition and related  
76 terminology as well as to discuss modelling implications.

77 *Methods* The task force has worked from the perspective that footprints should be underpinned by the  
78 same data systems and models as used in LCA. However, there are important differences in purpose and  
79 orientation relative to LCA impact category indicators. Footprints have a primary orientation toward  
80 society and nontechnical stakeholders. They are also typically of narrow scope, having the purpose of  
81 reporting only in relation to specific topics. In comparison, LCA has a primary orientation toward  
82 stakeholders interested in comprehensive evaluation of overall environmental performance and trade-offs  
83 among impact categories. These differences create tension between footprints, the existing LCIA  
84 framework based on the Area of Protection paradigm, and the core LCA standards ISO14040/44.

85 *Results* In parallel to Area of Protection, we introduce Area of Concern as the basis for a universal  
86 footprint definition. In the same way that LCA uses impact category indicators to assess impacts that  
87 follow a common cause-effect pathway toward Areas of Protection, footprint metrics address Areas of  
88 Concern. The critical difference is that Areas of Concern are defined by the interests of stakeholders in  
89 society rather than the LCA community. In addition, Areas of Concern are stand-alone and not  
90 necessarily part of a framework intended for comprehensive environmental performance assessment. The  
91 Area of Concern paradigm is needed to support the development of footprints in a way that fulfils their  
92 distinctly different purpose. It is also needed as a mechanism to extricate footprints from some of the  
93 provisions of ISO 14040/44 which are not considered relevant. Specific issues are identified in relation to  
94 double counting, aggregation, and the selection of relevant indicators.

95 *Conclusions* The universal footprint definition and related terminology introduced in this paper create a  
96 foundation that will support the development of footprint metrics in parallel with LCA.

97

98 **Keywords** Area of protection • environmental footprint • environmental labels and declarations • footprint  
99 definition • footprint indicator • ISO 14044 • life cycle impact assessment • UNEP/SETAC Life Cycle  
100 Initiative  
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## 102 **1. Introduction**

103 Over recent years, footprints have emerged as an important means of reporting environmental  
104 performance. However, as a class of environmental metrics they have been poorly defined, have shared  
105 an unclear relationship to Life Cycle Assessment (LCA), and have been the subject of numerous  
106 approaches to quantification which have sometimes led to confusing and contradictory messages in the  
107 marketplace (Fang and Heijungs 2015; Lenzen 2013; Ridoutt and Pfister 2013). In response, the  
108 UNEP/SETAC Life Cycle Initiative (see [www.lifecycleinitiative.org](http://www.lifecycleinitiative.org)) Phase 3 project on environmental  
109 Life Cycle Impact Assessment (LCIA) (Jolliet et al. 2014) has established a task force on footprints. The  
110 purpose of the task force is to propose a universal footprint definition and provide generic guidance for  
111 developers of footprint metrics. The International Organization for Standardization (ISO) has recently  
112 published documents specifically concerning product carbon footprints (ISO/TS14067 2013) and water  
113 footprints (ISO14046 2014). However, the variety of footprint metrics is expanding rapidly and generic  
114 guidance is urgently needed.

115 The initial work undertaken involved forming a consensual understanding of the difference  
116 between footprints and existing LCA impact category indicators (Ridoutt et al. 2015). In short, footprints  
117 are deemed to have a primary orientation toward society and nontechnical stakeholders and report on only  
118 selected topics of concern. On the other hand, LCA impact category indicators report in relation to a  
119 larger framework (Jolliet et al. 2004) and have a primary orientation toward stakeholders interested in  
120 comprehensive evaluation of environmental performance and trade-offs. The task force also identified  
121 four attributes that should characterise all footprint metrics: environmental relevance, accurate  
122 terminology, directional consistency and transparent documentation. In addition, it was recognised that  
123 footprints might be based on life cycle inventory data (provided the environmental relevance criterion is  
124 satisfied), an existing LCA impact category indicator result, or the combination of results from different  
125 LCA impact categories of relevance to the topic of the footprint (see Ridoutt et al. 2015 for further detail  
126 and examples).

127 The perspective of the task force is that footprints and LCA impact category indicators should be  
128 underpinned by the same data systems and models in order to achieve efficiency of calculation and  
129 consistency of results. To avoid confusion and contradiction, it is considered important that a footprint  
130 provides guidance for decision-making that is consistent with LCA results of equivalent scope. For

131 example, a water footprint should provide results which are consistent with the subset of LCA impact  
132 category indicator results concerning water. However, the differences in purpose and orientation mean  
133 that the existing LCA framework (Jolliet et al. 2004) and core LCA standards (ISO14040 2006,  
134 ISO14044 2006) may not be directly applicable to footprint metrics. The purpose of this paper is to  
135 propose a universal footprint definition and related terminology that have arisen from the work of the task  
136 force. In addition, the paper discusses some modelling implications which are peculiar to footprint  
137 metrics and which may deviate from conventional LCA practices at some points.

## 138 **2. Universal footprint definition**

139 The overall architecture of life cycle impact assessment involves relating life cycle inventory results to  
140 impact category indicators which are located along environmental mechanisms which ultimately address  
141 Areas of Protection - also referred to as safeguard subjects (Jolliet et al. 2004). Human health, natural  
142 environment and natural resources are three commonly defined Areas of Protection (Finnveden et al.  
143 2009), although there is no absolute agreement about the number of Areas of Protection or how they  
144 should be individually defined, and the subject has been richly debated over the years (Hertwich and  
145 Hammitt 2001, Klöpffer 2002, Bare and Gloria 2008, Dewulf et al. 2015). The LCIA framework is  
146 important as the basis for classifying (ISO14044 Section 4.4.2.3) and characterising (ISO14044 Section  
147 4.4.2.4) emissions and resource use data, as well as for undertaking any of the optional steps of  
148 normalising, grouping and weighting (ISO14044 Section 4.4.3). The framework facilitates, insofar as  
149 scientific knowledge and the state of characterisation models allow, a comprehensive evaluation of  
150 environmental issues for the product or system under study. However, as mentioned previously (Ridoutt  
151 et al. 2015), the LCIA framework, defined by the LCA community and designed for comprehensive and  
152 systematic evaluation of environmental performance, does not necessarily correspond with the lenses  
153 through which society perceives environmental protection, which tend to be more topical and less  
154 holistic.

155 In parallel with Area of Protection, we therefore define Area of Concern as a basis for a  
156 universal footprint definition (Table 1). In the same way that LCA impact category indicators address one  
157 or more Areas of Protection, footprint metrics address an Area of Concern. For example, a carbon  
158 footprint responds to societal concern about global warming, and the water footprint responds to societal  
159 concern about the over-exploitation and degradation of water resources. A critical difference is that Areas



160 of Concern are stand-alone and not necessarily part of a framework intended for comprehensive  
161 environmental performance evaluation. They are also defined by the interests of stakeholders in society  
162 rather than the LCA community. We perceive this to be the primary explanation for the growing  
163 awareness of and interest in footprints in society. As members of society become informed about  
164 environmental problems, through the wide ranging activities of scientists and science communicators and  
165 even first-hand experience, there is an associated interest in information about how products (and  
166 organisations, see ISO14072 2014; UNEP 2015) contribute to these problems. Footprint metrics provide  
167 this information, based on the life cycle perspective. In this context, the term *society* is considered  
168 broadly, and includes government and non-governmental organisations and business entities as agents  
169 reflecting societal interests. Product footprinting programmes initiated by governments or business  
170 organisations are an expression of this.

171 The Area of Concern paradigm (Table 1) is needed because without it LCA practitioners are left  
172 with a package of environmental constructs which may be excellently devised for comprehensive  
173 environmental assessment, but poorly aligned with the environmental issues as conceptualised by  
174 nontechnical stakeholders – tantamount to speaking in a language the wider society fails to appreciate,  
175 however rich and wonderful that language may itself be. In addition, the Area of Concern paradigm is  
176 needed because the LCIA framework and the requirements of ISO14040/44 were not designed for the  
177 development of footprints as will be explained in the following section.

### 178 **3. Modelling implications**

#### 179 3.1. Double counting

180 In LCA, emphasis is placed on avoiding double counting. This is consistent with the intention of  
181 comprehensively evaluating environmental performance and trade-offs. To double count resource use or  
182 emissions in the inventory phase or to double count the same environmental impacts in overlapping  
183 impact category indicators would clearly bias the evaluation. According to ISO14044 (Section 4.4.2.2.3),  
184 “...impact categories, category indicators and characterisation models *should* avoid double counting.”  
185 Stronger language is used in ISO14046 (Section 6.1) where, “Redundant impact category indicators (i.e.  
186 indicators containing double counting) *shall* not be reported in parallel without clear indication of  
187 redundancy.” The ILCD Handbook (EC JRC 2010, p. 110) uses similarly strong language, requiring that  
188 LCIA methods, “...*shall* be free of double-counting across included characterisation factors...”

189           In the case of individual footprints, potential impacts relating to an Area of Concern need to be  
190 assessed completely and also without double-counting. For example, in regard to product carbon  
191 footprints, ISO/TS14067 (Section 5.12) includes as a principle the, “Avoidance of double counting.”  
192 Greenhouse gas emissions and removals should not be counted more than once and particular attention is  
193 drawn to the need to avoid double counting of renewable energy sources in certified electrical supply  
194 products as well as national grid electricity mixes.

195           However, the situation is anticipated whereby the same environmental impacts are included in  
196 different footprints and a situation of double counting would occur if these footprints were presented  
197 together in a footprint profile (see definition in Table 1). For example, a water footprint and a chemical  
198 footprint might both include impacts related to chemical emissions to water. With footprint profiles,  
199 potential overlapping is allowable because the priority is for each stand-alone footprint to address its Area  
200 of Concern completely thereby making possible the comparison of individual footprints between  
201 products. If, for a particular product, the impacts related to chemical emissions to water were excluded  
202 from the water footprint (because those impacts were already counted in the chemical footprint), the  
203 resultant water footprint would no-longer be complete and could no-longer be simply compared to the  
204 water footprint of another product.

205           In LCIA, the objective is comprehensive evaluation of environmental performance and trade-  
206 offs, double counting is therefore avoided, and impact categories, category indicators and characterization  
207 models are chosen accordingly. Modelling choices are explained in a technical LCA study report. The  
208 Area of Concern paradigm is needed because footprints differ in all these respects. Footprints are defined  
209 by the interests of society. If a water footprint and chemical footprint are presented, it is because there is  
210 demand for reporting on both these environmental topics, not because these two footprints are intended to  
211 represent all of the relevant environmental impacts. Double counting of impacts in overlapping footprints  
212 is not something to be avoided, but an acknowledged possibility when priority is given to each stand-  
213 alone footprint addressing its Area of Concern completely. In addition, footprints, with their orientation  
214 toward society and nontechnical stakeholders, need to be understandable without reference to technical  
215 study reports. Technical reports are required, but for review by technical experts and other interested  
216 parties having access to technical skills, not for the primary audience of stakeholders in society for whom  
217 no assumptions are made about their interest to consult or ability to understand technical documentation.

218 3.2. Aggregation

219 Certain Areas of Concern can be addressed by a footprint that corresponds with an existing indicator used  
220 in LCA. A carbon footprint is one such example; a freshwater eutrophication footprint is another.  
221 However, other Areas of Concern cannot be readily addressed in this way because there are multiple  
222 relevant environmental mechanisms and no single LCA inventory or impact category indicator is  
223 sufficient. For example a water footprint might include multiple environmental mechanisms relating to  
224 water consumption and water degradation (which might involve different Areas of Protection). According  
225 to ISO14044 (Section 4.4.3.1), normalisation, grouping and weighting are optional elements and are  
226 restricted in some contexts (e.g. comparative assertions). In the context of footprints, it is acknowledged  
227 that these steps may sometimes be necessary if there is societal demand for one single metric addressing a  
228 complex Area of Concern (e.g. the abovementioned water footprint case). At this point another potential  
229 conflict with ISO14044 (2006) could arise depending on how Section 4.4.3.4.3 is interpreted. “Data and  
230 indicator results or normalised indicator results reached prior to weighting should be made available  
231 together with the weighted results.” If *together* is interpreted to mean at the same point and time where a  
232 footprint is communicated (such as a product label), the group does acknowledge the potential challenge  
233 in practicality. That said, the task force did consider it essential that aggregation methods and calculations  
234 used in footprinting are documented transparently and made publicly available.

235 The steps involved in creating aggregated footprints introduce additional modelling choices and  
236 there is the potential that these steps could result in footprints which are misleading. As such,  
237 organisations intending to operate footprint programmes are advised to give close attention to this subject  
238 in defining acceptable methods and documentation requirements. The new international standard  
239 concerning footprint communications (ISO14026, in development) is another opportunity to develop  
240 appropriate safeguards. In the Task Group’s ongoing work, further discussions about additional guidance  
241 on the use of weighting in footprints will be a high priority.

### 242 3.3. Selection of relevant indicators

243 The specific details of the goal and scope can vary from one LCA study to another. However, the general  
244 intent is the identification of significant environmental issues (ISO14044 Section 4.5.2). As such, the  
245 selection of relevant impact categories is an important step and, “...shall reflect a comprehensive set of  
246 environmental issues related to the product system being studied...” (Section 4.4.2.2). Similarly, in the  
247 development of Type III environmental labels (e.g. environmental product declarations), the selection of  
248 criteria to report must, in so far as possible, reflect environmental criteria that are important to the product

249 category (ISO14025 2006). This is because Type III environmental labels seek to differentiate between  
250 products based on the most relevant environmental aspects. In contrast, an individual footprint reports  
251 only in relation to a specific Area of Concern, in response to societal interest in that Area of Concern.  
252 From a societal point of view, it is relevant to know about a footprint result regardless of whether it is  
253 large or small. As such, a footprint addressing a particular Area of Concern does not imply that this is a  
254 significant issue for that product life cycle. For example, a retailer might perceive that their customers are  
255 concerned about climate change and in response require all product suppliers to participate in a product  
256 carbon footprint programme. That said, it is also envisaged that operators of footprint programmes might  
257 stipulate particular footprint profiles appropriate to different product categories as a way of highlighting  
258 the priority environmental issues.

#### 259 **4. Final thoughts**

260 Ideally, footprints should develop in parallel with LCA: in close relationship, but each with its own  
261 primary orientation and purpose. This will require the development of new guidance documentation for  
262 footprints as there are elements of the core LCA standards (ISO14040 2006, ISO14044 2006) that are not  
263 directly applicable. This is not surprising since ISO14040/44 predate the more recent popular interest in  
264 footprints and say nothing about them. In any case, the scientific rigour and the consensus building  
265 underlying current LCIA methods represent a strong asset which should be utilized to the extent possible  
266 when developing footprint indicators. The universal footprint definition and related terminology  
267 introduced in this paper are a next step in building a foundation to support the development of footprints  
268 in parallel with LCA. In the meantime, the task force continues its work and will report as further  
269 guidance is developed.

270

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276

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## Tables

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329 **Table 1** Terms and definitions

Term	Definition
Footprint	Metric used to report life cycle assessment results addressing an Area of Concern
Area of Concern	Environmental topic defined by the interest of society
Footprint profile	A list of footprints addressing different Areas of Concern

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