

Ridoutt, B, Pfister, S, Manzardo, A, Bare, J, Boulay, A, Cherubini, F, Fantke, P, Frischknecht, R, Hauschild, M, Henderson, A, Jolliet, O, Levasseur, A, Margni, M, McKone, T, Michelsen, O, Mila i Canals, L, Page, G, Pant, R, Raugei, M, Salla, S and Verones, F

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

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doi: [10.1007/s11367-015-1011-7](https://doi.org/10.1007/s11367-015-1011-7)

This version is available: <https://radar.brookes.ac.uk/radar/items/c5620ae8-0078-4f64-adb6-3a8ee4d37afe/1/>

Available on RADAR: December 2016

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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**

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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 footprint
75 metrics. The purpose of this paper is to introduce a universal footprint definition and related terminology
76 as well as to discuss modelling implications.

77 *Methods* The task force has worked from the perspective that footprints should be underpinned by the same
78 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 society
80 and nontechnical stakeholders. They are also typically of narrow scope, having the purpose of reporting
81 only in relation to specific topics. In comparison, LCA has a primary orientation toward stakeholders
82 interested in comprehensive evaluation of overall environmental performance and trade-offs among impact
83 categories. These differences create tension between footprints, the existing LCIA framework based on the
84 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 footprint
86 definition. In the same way that LCA uses impact category indicators to assess impacts that follow a
87 common cause-effect pathway toward Areas of Protection, footprint metrics address Areas of Concern. The
88 critical difference is that Areas of Concern are defined by the interests of stakeholders in society rather than
89 the LCA community. In addition, Areas of Concern are stand-alone and not necessarily part of a framework
90 intended for comprehensive environmental performance assessment. The Area of Concern paradigm is
91 needed to support the development of footprints in a way that fulfils their distinctly different purpose. It is
92 also needed as a mechanism to extricate footprints from some of the provisions of ISO 14040/44 which are
93 not considered relevant. Specific issues are identified in relation to double counting, aggregation, and the
94 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

1 98 **Keywords** Area of protection • environmental footprint • environmental labels and declarations • footprint
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3 99 definition • footprint indicator • ISO 14044 • life cycle impact assessment • UNEP/SETAC Life Cycle
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1 102 **1. Introduction**

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3 103 Over recent years, footprints have emerged as an important means of reporting environmental performance.
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5 104 However, as a class of environmental metrics they have been poorly defined, have shared an unclear
6
7 105 relationship to Life Cycle Assessment (LCA), and have been the subject of numerous approaches to
8
9 106 quantification which have sometimes led to confusing and contradictory messages in the marketplace (Fang
10
11 107 and Heijungs 2015; Lenzen 2013; Ridoutt and Pfister 2013). In response, the UNEP/SETAC Life Cycle
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13 108 Initiative (see www.lifecycleinitiative.org) Phase 3 project on environmental Life Cycle Impact Assessment
14
15 109 (LCIA) (Jolliet et al. 2014) has established a task force on footprints. The purpose of the task force is to
16
17 110 propose a universal footprint definition and provide generic guidance for developers of footprint metrics.
18
19 111 The International Organization for Standardization (ISO) has recently published documents specifically
20
21 112 concerning product carbon footprints (ISO/TS14067 2013) and water footprints (ISO14046 2014).
22
23 113 However, the variety of footprint metrics is expanding rapidly and generic guidance is urgently needed.

24
25
26 114 The initial work undertaken involved forming a consensual understanding of the difference
27
28 115 between footprints and existing LCA impact category indicators (Ridoutt et al. 2015). In short, footprints
29
30 116 are deemed to have a primary orientation toward society and nontechnical stakeholders and report on only
31
32 117 selected topics of concern. On the other hand, LCA impact category indicators report in relation to a larger
33
34 118 framework (Jolliet et al. 2004) and have a primary orientation toward stakeholders interested in
35
36 119 comprehensive evaluation of environmental performance and trade-offs. The task force also identified four
37
38 120 attributes that should characterise all footprint metrics: environmental relevance, accurate terminology,
39
40 121 directional consistency and transparent documentation. In addition, it was recognised that footprints might
41
42 122 be based on life cycle inventory data (provided the environmental relevance criterion is satisfied), an
43
44 123 existing LCA impact category indicator result, or the combination of results from different LCA impact
45
46 124 categories of relevance to the topic of the footprint (see Ridoutt et al. 2015 for further detail and examples).

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50 125 The perspective of the task force is that footprints and LCA impact category indicators should be
51
52 126 underpinned by the same data systems and models in order to achieve efficiency of calculation and
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54 127 consistency of results. To avoid confusion and contradiction, it is considered important that a footprint
55
56 128 provides guidance for decision-making that is consistent with LCA results of equivalent scope. For
57
58 129 example, a water footprint should provide results which are consistent with the subset of LCA impact
59
60 130 category indicator results concerning water. However, the differences in purpose and orientation mean that

1 131 the existing LCA framework (Jolliet et al. 2004) and core LCA standards (ISO14040 2006, ISO14044 2006)
2
3 132 may not be directly applicable to footprint metrics. The purpose of this paper is to propose a universal
4
5 133 footprint definition and related terminology that have arisen from the work of the task force. In addition,
6
7 134 the paper discusses some modelling implications which are peculiar to footprint metrics and which may
8
9 135 deviate from conventional LCA practices at some points.

12 136 **2. Universal footprint definition**

13
14 137 The overall architecture of life cycle impact assessment involves relating life cycle inventory results to
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16 138 impact category indicators which are located along environmental mechanisms which ultimately address
17
18 139 Areas of Protection - also referred to as safeguard subjects (Jolliet et al. 2004). Human health, natural
19
20 140 environment and natural resources are three commonly defined Areas of Protection (Finnveden et al. 2009),
21
22 141 although there is no absolute agreement about the number of Areas of Protection or how they should be
23
24 142 individually defined, and the subject has been richly debated over the years (Hertwich and Hammitt 2001,
25
26 143 Klöpffer 2002, Bare and Gloria 2008, Dewulf et al. 2015). The LCIA framework is important as the basis
27
28 144 for classifying (ISO14044 Section 4.4.2.3) and characterising (ISO14044 Section 4.4.2.4) emissions and
29
30 145 resource use data, as well as for undertaking any of the optional steps of normalising, grouping and
31
32 146 weighting (ISO14044 Section 4.4.3). The framework facilitates, insofar as scientific knowledge and the
33
34 147 state of characterisation models allow, a comprehensive evaluation of environmental issues for the product
35
36 148 or system under study. However, as mentioned previously (Ridoutt et al. 2015), the LCIA framework,
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38 149 defined by the LCA community and designed for comprehensive and systematic evaluation of
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40 150 environmental performance, does not necessarily correspond with the lenses through which society
41
42 151 perceives environmental protection, which tend to be more topical and less holistic.

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44
45 152 In parallel with Area of Protection, we therefore define Area of Concern as a basis for a universal
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47 153 footprint definition (Table 1). In the same way that LCA impact category indicators address one or more
48
49 154 Areas of Protection, footprint metrics address an Area of Concern. For example, a carbon footprint responds
50
51 155 to societal concern about global warming, and the water footprint responds to societal concern about the
52
53 156 over-exploitation and degradation of water resources. A critical difference is that Areas of Concern are
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55 157 stand-alone and not necessarily part of a framework intended for comprehensive environmental
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57 158 performance evaluation. They are also defined by the interests of stakeholders in society rather than the
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59 159 LCA community. We perceive this to be the primary explanation for the growing awareness of and interest

1 160 in footprints in society. As members of society become informed about environmental problems, through
2
3 161 the wide ranging activities of scientists and science communicators and even first-hand experience, there
4
5 162 is an associated interest in information about how products (and organisations, see ISO14072 2014; UNEP
6
7 163 2015) contribute to these problems. Footprint metrics provide this information, based on the life cycle
8
9 164 perspective. In this context, the term *society* is considered broadly, and includes government and non-
10
11 165 governmental organisations and business entities as agents reflecting societal interests. Product footprinting
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13 166 programmes initiated by governments or business organisations are an expression of this.

14
15 167 The Area of Concern paradigm (Table 1) is needed because without it LCA practitioners are left
16
17 168 with a package of environmental constructs which may be excellently devised for comprehensive
18
19 169 environmental assessment, but poorly aligned with the environmental issues as conceptualised by
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21 170 nontechnical stakeholders – tantamount to speaking in a language the wider society fails to appreciate,
22
23 171 however rich and wonderful that language may itself be. In addition, the Area of Concern paradigm is
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25 172 needed because the LCIA framework and the requirements of ISO14040/44 were not designed for the
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27 173 development of footprints as will be explained in the following section.

28 29 174 **3. Modelling implications**

30 31 175 3.1. Double counting

32
33 176 In LCA, emphasis is placed on avoiding double counting. This is consistent with the intention of
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35 177 comprehensively evaluating environmental performance and trade-offs. To double count resource use or
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37 178 emissions in the inventory phase or to double count the same environmental impacts in overlapping impact
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39 179 category indicators would clearly bias the evaluation. According to ISO14044 (Section 4.4.2.2.3),
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41 180 “...impact categories, category indicators and characterisation models *should* avoid double counting.”
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43 181 Stronger language is used in ISO14046 (Section 6.1) where, “Redundant impact category indicators (i.e.
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45 182 indicators containing double counting) *shall* not be reported in parallel without clear indication of
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47 183 redundancy.” The ILCD Handbook (EC JRC 2010, p. 110) uses similarly strong language, requiring that
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49 184 LCIA methods, “...*shall* be free of double-counting across included characterisation factors...”

50
51 185 In the case of individual footprints, potential impacts relating to an Area of Concern need to be
52
53 186 assessed completely and also without double-counting. For example, in regard to product carbon footprints,
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55 187 ISO/TS14067 (Section 5.12) includes as a principle the, “Avoidance of double counting.” Greenhouse gas
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57 188 emissions and removals should not be counted more than once and particular attention is drawn to the need
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1 189 to avoid double counting of renewable energy sources in certified electrical supply products as well as
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3 190 national grid electricity mixes.

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5 191 However, the situation is anticipated whereby the same environmental impacts are included in
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7 192 different footprints and a situation of double counting would occur if these footprints were presented
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9 193 together in a footprint profile (see definition in Table 1). For example, a water footprint and a chemical
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11 194 footprint might both include impacts related to chemical emissions to water. With footprint profiles,
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13 195 potential overlapping is allowable because the priority is for each stand-alone footprint to address its Area
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15 196 of Concern completely thereby making possible the comparison of individual footprints between products.
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17 197 If, for a particular product, the impacts related to chemical emissions to water were excluded from the water
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19 198 footprint (because those impacts were already counted in the chemical footprint), the resultant water
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21 199 footprint would no-longer be complete and could no-longer be simply compared to the water footprint of
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23 200 another product.

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25 201 In LCIA, the objective is comprehensive evaluation of environmental performance and trade-offs,
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27 202 double counting is therefore avoided, and impact categories, category indicators and characterization
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29 203 models are chosen accordingly. Modelling choices are explained in a technical LCA study report. The Area
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31 204 of Concern paradigm is needed because footprints differ in all these respects. Footprints are defined by the
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33 205 interests of society. If a water footprint and chemical footprint are presented, it is because there is demand
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35 206 for reporting on both these environmental topics, not because these two footprints are intended to represent
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37 207 all of the relevant environmental impacts. Double counting of impacts in overlapping footprints is not
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39 208 something to be avoided, but an acknowledged possibility when priority is given to each stand-alone
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41 209 footprint addressing its Area of Concern completely. In addition, footprints, with their orientation toward
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43 210 society and nontechnical stakeholders, need to be understandable without reference to technical study
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45 211 reports. Technical reports are required, but for review by technical experts and other interested parties
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47 212 having access to technical skills, not for the primary audience of stakeholders in society for whom no
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49 213 assumptions are made about their interest to consult or ability to understand technical documentation.

50 214 3.2. Aggregation

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53 215 Certain Areas of Concern can be addressed by a footprint that corresponds with an existing indicator used
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55 216 in LCA. A carbon footprint is one such example; a freshwater eutrophication footprint is another. However,
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57 217 other Areas of Concern cannot be readily addressed in this way because there are multiple relevant
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59 218 environmental mechanisms and no single LCA inventory or impact category indicator is sufficient. For
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1 219 example a water footprint might include multiple environmental mechanisms relating to water consumption
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3 220 and water degradation (which might involve different Areas of Protection). According to ISO14044
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5 221 (Section 4.4.3.1), normalisation, grouping and weighting are optional elements and are restricted in some
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7 222 contexts (e.g. comparative assertions). In the context of footprints, it is acknowledged that these steps may
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9 223 sometimes be necessary if there is societal demand for one single metric addressing a complex Area of
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11 224 Concern (e.g. the abovementioned water footprint case). At this point another potential conflict with
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13 225 ISO14044 (2006) could arise depending on how Section 4.4.3.4.3 is interpreted. “Data and indicator results
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15 226 or normalised indicator results reached prior to weighting should be made available together with the
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17 227 weighted results.” If *together* is interpreted to mean at the same point and time where a footprint is
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19 228 communicated (such as a product label), the group does acknowledge the potential challenge in practicality.
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21 229 That said, the task force did consider it essential that aggregation methods and calculations used in
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23 230 footprinting are documented transparently and made publicly available.

25 231 The steps involved in creating aggregated footprints introduce additional modelling choices and
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27 232 there is the potential that these steps could result in footprints which are misleading. As such, organisations
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29 233 intending to operate footprint programmes are advised to give close attention to this subject in defining
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31 234 acceptable methods and documentation requirements. The new international standard concerning footprint
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33 235 communications (ISO14026, in development) is another opportunity to develop appropriate safeguards. In
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35 236 the Task Group’s ongoing work, further discussions about additional guidance on the use of weighting in
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37 237 footprints will be a high priority.

39 238 3.3. Selection of relevant indicators

41 239 The specific details of the goal and scope can vary from one LCA study to another. However, the general
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43 240 intent is the identification of significant environmental issues (ISO14044 Section 4.5.2). As such, the
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45 241 selection of relevant impact categories is an important step and, “...shall reflect a comprehensive set of
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47 242 environmental issues related to the product system being studied...” (Section 4.4.2.2). Similarly, in the
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49 243 development of Type III environmental labels (e.g. environmental product declarations), the selection of
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51 244 criteria to report must, in so far as possible, reflect environmental criteria that are important to the product
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53 245 category (ISO14025 2006). This is because Type III environmental labels seek to differentiate between
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55 246 products based on the most relevant environmental aspects. In contrast, an individual footprint reports only
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57 247 in relation to a specific Area of Concern, in response to societal interest in that Area of Concern. From a
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59 248 societal point of view, it is relevant to know about a footprint result regardless of whether it is large or
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1 249 small. As such, a footprint addressing a particular Area of Concern does not imply that this is a significant
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3 250 issue for that product life cycle. For example, a retailer might perceive that their customers are concerned
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5 251 about climate change and in response require all product suppliers to participate in a product carbon
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7 252 footprint programme. That said, it is also envisaged that operators of footprint programmes might stipulate
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9 253 particular footprint profiles appropriate to different product categories as a way of highlighting the priority
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11 254 environmental issues.

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14 255 **4. Final thoughts**

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16 256 Ideally, footprints should develop in parallel with LCA: in close relationship, but each with its own primary
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18 257 orientation and purpose. This will require the development of new guidance documentation for footprints
19
20 258 as there are elements of the core LCA standards (ISO14040 2006, ISO14044 2006) that are not directly
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22 259 applicable. This is not surprising since ISO14040/44 predate the more recent popular interest in footprints
23
24 260 and say nothing about them. In any case, the scientific rigour and the consensus building underlying current
25
26 261 LCIA methods represent a strong asset which should be utilized to the extent possible when developing
27
28 262 footprint indicators. The universal footprint definition and related terminology introduced in this paper are
29
30 263 a next step in building a foundation to support the development of footprints in parallel with LCA. In the
31
32 264 meantime, the task force continues its work and will report as further guidance is developed.

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34 265
35
36 266 **Acknowledgements and disclaimer** This work is supported by the United Nations Environment
37
38 267 Programme (UNEP) / Society of Environmental Toxicology and Chemistry (SETAC) Life Cycle Initiative.
39
40 268 Public and private sector sponsors are listed on the Initiative's website (<http://www.lifecycleinitiative.org/>).
41
42 269 The views expressed in this article are those of the authors and do not necessarily reflect those of the various
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44 270 affiliated organizations.

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Tables

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321 **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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