Ecological Indicators 72 (2017) 352–359

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Letter to the Editor

Understanding the LCA and ISO water footprint: A response to Hoekstra (2016) "A critique on the water-scarcity weighted water footprint in LCA"

ARTICLE INFO

Keywords:
Water footprint
Life cycle assessment
Environmental product declaration
Virtual water
Green water
Blue water
Grey water

ABSTRACT

Water footprinting has emerged as an important approach to assess water use related effects from consumption of goods and services. Assessment methods are proposed by two different communities, the Water Footprint Network (WFN) and the Life Cycle Assessment (LCA) community. The proposed methods are broadly similar and encompass both the computation of water use and its impacts, but differ in communication of a water footprint result. In this paper, we explain the role and goal of LCA and ISO-compatible water footprinting and resolve the six issues raised by Hoekstra (2016) in "A critique on the water-scarcity weighted water footprint in LCA". By clarifying the concerns, we identify both the overlapping goals in the WFN and LCA water footprint assessments and discrepancies between them. The main differing perspective between the WFN and LCA-based approach seems to relate to the fact that LCA aims to account for environmental impacts, while the WFN aims to account for water productivity of global fresh water as a limited resource. We conclude that there is potential to use synergies in research for the two approaches and highlight the need for proper declaration of the methods applied.

1. Introduction

The concept of water footprinting has emerged relatively recently, introduced under the terminology of *virtual water* (Allan, 1997) and coined as water footprint by Hoekstra and Hung (2002). It was adopted and further developed in a methodology guide (Hoekstra et al., 2011) by an NGO called the Water Footprint Network (WFN). They consider water footprint as a volumetric approach, focusing on water productivity: "The water footprint of an individual, community or business is defined as the total volume of freshwater used to produce the goods and services consumed by the individual or community or produced by the business". In parallel, the Life Cycle Assessment (LCA) community's vision on water resources quickly matured to integrate water use into LCA (Bayart et al., 2010), by expanding the coverage of environmental exchanges covered in LCA to include water resources. These developments in LCA have framed the main concepts in the international standard on water footprint (ISO 14046). There, the water footprint is defined as "metric(s) that quantifies the potential environmental impacts related to water" and therefore does not primarily report the volume of water used, but the potential impacts caused. Moreover, an international working group, founded under the UNEP/SETAC Life Cycle Initiative, has been fostering a methodological development to address Water Use in LCA (WULCA) and has recently achieved international consensus on a water scarcity index for use in water footprinting (Boulay et al., 2015; Boulay et al., 2016).

The fact that the two aforementioned groups use the same name to describe a slightly different water accounting approach has created debate over their relative merits and limitations. Nonetheless, a major difference is in the terminology used and communication made rather than on the fundamental principles. Ridoutt et al. (2015) recently outlined general principles for LCA-based footprints, emphasizing the importance of aggregating data only when there is environmental equivalence. Similarities, complementarities and more importantly, the difference in the metric called "Water footprint" in WFA (Water Footprint Accounting, as proposed by the WFN) and in LCA (the impact assessment metric) have already been identified in a joint publication between the two approaches (Boulay et al., 2013). Challenges in the application of these complementarities were further identified in a reply (Pfister and Ridoutt, 2013). Now, three years later, the article "A critique on the water-scarcity weighted water footprint in LCA" was published by Hoekstra (2016), the initiator and co-founder of the WFN, and current chair of the WFN Supervisory Council. Since the article contains some misinterpretation of research in the water footprint field outside of the studies affiliated with the WFN, there is an urgent need to inform readers about these issues and present a more comprehensive picture.

We therefore aim to (1) clarify any misconceptions, (2) highlight differences among the approaches and (3) provide a conclusion fostering a healthy discussion with regards to which approach provides a best fit for answering different questions.

2. What is LCA and ISO-compliant water footprint?

LCA has a long history in science as well as in practical application, which is reflected by ISO standards (ISO 14040/14044) initially

http://dx.doi.org/10.1016/j.ecolind.2016.07.051

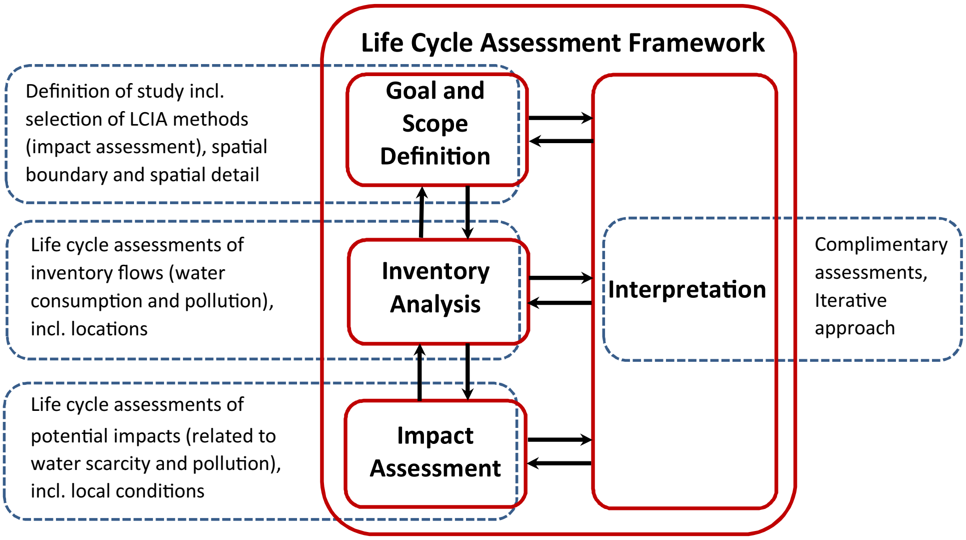

Fig. 1. LCA framework including the relevant steps for water footprint (based on ISO 14040).

published in the 1990s. It consists of four main phases: (1) Goal and Scope Definition, which includes system description and methods chosen, (2) Inventory Analysis (LCI), which accounts for all environmental exchanges, such as water use, in the product system, (3) Impact Assessment (LCIA), which assesses the potential impacts of LCI results on the environment, and (4) interpretation (Fig. 1). It is an iterative approach, where interpretation of LCI and LCIA results might lead to changes in Goal and Scope Definition, inventory results and impact assessment. The ISO water footprint (ISO 14046), which builds upon LCA principles, contains the same elements and principles, but is focused on water availability and degradation. It is important to note that there are generally two levels of impact assessment in LCA: "midpoint metrics", which describe a potential impact in the middle of the cause effect chain (e.g. water scarcity) and "endpoint metrics", which denote a damage occurring at the end of a cause effect chain (e.g. health or ecosystem damages resulting from water consumption). The latter obviously involves more parameter and model uncertainties, but reports more tangible results and allows for comparing and aggregating damages resulting from different environmental interventions, such as water consumption, water pollution, or greenhouse gas emissions.

In LCA, the focus is on interpreting the assessment at different levels, where accounting for water flows and related impacts are complementary steps. Assessing potential environmental impacts helps to aggregate the effects on a basis that ensures a degree of comparability across locations. Even if water consumption (LCI) and related impacts (LCIA) are sometimes correlated, this step adds to the interpretation of environmental impacts and helps to identify major contributors to water consumption and potential impacts in a very complex product system. Thus, both steps of LCI and LCIA are important for identifying hotspots regarding environmental consequences of human use of water resources. Therefore, the statement that LCA and LCA-based water footprints chose not to assess water use itself is incorrect (Hoekstra, Section 2.2), as life cycle water use is assessed in the LCI phase.

2.1. Why account for water use: global vs. local perspective

If any type of impact assessment is applied in LCA, an impact pathway is followed by tracing the resource consumption and emission in a product system and accounting for its effects in the environment. Resources and emissions are aggregated based on similarity in the impact mechanism they cause. For example, emissions causing radiative forcing are typically aggregated based on their potential to contribute to the greenhouse effect, as it drives global climate change. In the case of a water shortage, potential damages to ecosystems and the population result, and the shortage is therefore a local problem, which is why water consumption is important in LCA. On the other hand, the argumentation by Hoekstra (2016) implies that the main goal of the WFN approach is to account for global water use as if the global water resources are limited – although there is no global fresh water shortage.

Hoekstra (2016) repeatedly states that water is a global resource because it is virtually traded via products – including between water abundant and water scarce regions. Due to this global dimension, the volumetric footprint, which expresses the global freshwater appropriation of a product, would thus represent the most meaningful indicator for decision making. Yet, this implies that, for example, the evapotranspiration of 2 m^3 of soil moisture (green water) in Canada is "worse" than the consumption of 1 m^3 of groundwater (blue water) used for irrigation in Morocco – regardless of local scarcity and impacts (Berger and Finkbeiner, 2013). Even though this may be correct when water is considered from a purely global perspective, this example highlights the need for additional interpretation of volumetric consumption figures – which is also acknowledged by Hoekstra on p. 571. Hence, both volumetric and impact-based footprints provide specific information that complement each other. The concepts should thus be seen as complementary rather than competing, as in the case of inventory and impact assessment in LCA of ISO-based water footprints.

Following the logic of global virtual water trade, Hoekstra (2016) recommends that water intensive goods should be produced in water abundant regions and then exported to water scarce regions. It is also argued that water-inefficient production in water rich regions, which is usually considered unproblematic in impact based water footprints, are very problematic in reality. If higher water efficiency could be achieved, this would lead to higher production yields. Since this gain in production could be exported, the need for production (and related water consumption) in water scarce countries could then be reduced. In addition to the fact that this would only be valid if water was the limiting production factor, which it is not in many cases (Nemani et al., 2003), we have some doubts on the robustness of the argumentation for global water management. It requires the assumption that either water can be efficiently redistributed from water rich to water scarce regions