LETTER

Reply to Pfister and Hellweg: Water footprint accounting, impact assessment, and life-cycle assessment

In response to our article on the blue and green water footprint (WF) of bioenergy (1), others propose to multiply each blue WF component by a water-stress index and neglect green WFs, because impacts would be nil (2). They propose to redefine the WF from a volumetric measure to an index resulting from multiplying volumes by impact factors. Framing their argument within the logic of life-cycle assessment (LCA), they ignore the primary and established role of the WF in water-resources management (WRM). Redefining the WF does not make sense from a WRM perspective, which requires spatially and temporally explicit information on WFs in real volumes and impacts in real terms.

The WF has been devised as a comprehensive indicator of freshwater appropriation (3). The WF of a product is the volume of freshwater used to produce the product over the full supply chain. It shows, specified in space and time, water consumption volumes by source (green and blue WFs) and polluted volumes (grey WF) by type of pollution.

WF studies serve two discourses in WRM. First, data on WFs of products, consumers, and producers inform the discourse about sustainable, equitable, and efficient freshwater use and allocation (3, 4). Freshwater is scarce; its annual availability is limited. It is relevant to know who receives which portion and how water is allocated over various purposes. We included the green WF of bioenergy (1) because WF accounts show water allocation in volumetric terms. Rainwater used for bioenergy cannot be utilized for food. Second, WF accounts help to estimate local environmental, social, and economic impacts. Environmental impact assessment should include a comparison of each WF component to available water at relevant locations and time minus environmental water requirements and inaccessible flood and remote flows.

Because LCA focuses on aggregated impacts, WF accounting is criticized for its absence of "characterisation factors" weighing WF components based on their relative impact (2, 5). This call for weighing is justified from an LCA perspective. However, by introducing questionable weighing choices and ignoring key factors that influence actual local environmental impacts, such as environmental flow requirements and variability in time, the weighing method proposed by refs. 2 and 6 is disputable and resultant figures are difficult to interpret.

We maintain that volumetric WFs contain highly relevant information, which disappears when translating volumes into arguable aggregated WF impact indices. Aggregated indices without physical interpretation are completely meaningless in a WRM context aimed at reducing WFs and their local impacts. To serve both WRM and LCA, one best distinguishes three steps (Table 1). From an LCA viewpoint, step 1 contributes to life-cycle inventory; steps 2 and 3 are part of life-cycle impact assessment. The proposal to use the term WF for the final aggregated index obtained in step 3 is confusing. This may be instrumental for LCA but not helpful for other purposes (3). The WF can best be used solely in its original and well-established meaning, which means it excludes impact. The nonvolumetric index obtained in step 3 is not a WF, but an aggregated, weighed WF impact index.

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Table 1. The three subsequent water footprint assessment steps and how they feed different discourses

Step	Outcome	Physical meaning	Resolution	Usefulness	Field
1. WF accounting	Blue, green, and grey WFs (volumetric)	Water volume consumed or polluted per unit of product	Spatiotemporal explicit	Discourse on sustainable, equitable and efficient water use/allocation	WRM
2. WF impact assessment	Environmental, social and economic impacts	Various measurable impact variables	Spatiotemporal explicit	Discourse on reducing local impacts	
3. Aggregated WF impact assessment	Aggregated WF impact index	None	Nonspatiotemporal explicit	Discourse on aggregated environmental impacts of products	LCA

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