

The Water Impact Index: a simplified single-indicator approach for water footprinting

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Abstract

Purpose Along with climate change-related issues, improved water management is recognized as one of the major challenges to sustainability. However, there are still no commonly accepted methods for measuring sustainability of water uses, resulting in a recent proliferation of water footprint methodologies. The Water Impact Index presented in this paper aims to integrate the issues of volume, scarcity and quality into a single indicator to assess the reduction of available water for the environment induced by freshwater uses for human activities.

Methods The Water Impact Index follows life cycle thinking principles. For each unit process, a volumetric water balance is performed; water flows crossing the boundaries between the techno-sphere and environment are multiplied by a water quality index and a water scarcity index. The methodology is illustrated on the current municipal wastewater management system of Milan (Italy). The Water Impact Index is combined with carbon footprint to introduce multi-impact thinking to decision makers. The Water Impact Index is further compared to results obtained using a set of three life cycle impact

indicators related to water, from the ReCiPe life cycle impact assessment (LCIA) methodology.

Results and discussion Onsite water use is the main contribution to the Water Impact Index for both wastewater management schemes. The release of better quality water is the main driver in favour of the scenario including a wastewater treatment plant, while the energy and chemicals consumed for the treatment increase the indirect water footprint and carbon footprint. Results obtained with the three midpoint indicators depict similar tendencies to the Water Impact Index.

Conclusions This paper presents a simplified single-indicator approach for water footprinting, integrating volume, scarcity and quality issues, representing an initial step toward a better understanding and assessment of the environmental impacts of human activities on water resources. The wastewater treatment plant reduces the Water Impact Index of the wastewater management system. These results are consistent with the profile of the three midpoint indicators related to water from ReCiPe.

Keywords Life cycle impact assessment · Water footprint · Water quality · Water scarcity · Water use

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1 Introduction

Water is essential to sustain life and ecosystems. Yet, water demand and pollution from human activities are continuously increasing (OECD 2012). Environmental issues pertaining to water are recognized as one of the major environmental concerns for the coming decades (UNESCO 2006).

Life cycle assessment (LCA) currently addresses water use-related impacts to some degree. The release of substances in water bodies has been largely integrated in life cycle impact assessments (LCIA) through different impact categories. At the midpoint level, existing LCIA methodologies such as

ReCiPe (Goedkoop et al. 2009) or Impact 2002+ (Jolliet et al. 2003) propose indicators for characterizing water ecotoxicity, eutrophication or acidification. At the damage level, water pollution generally affects ecosystem quality and human health-related damage categories.

The consideration of water as a natural resource and subsequent issues of *freshwater scarcity* and *availability* are inadequately addressed in LCIA methodologies (Koehler 2008) and have been the focus of several recent developments. Early in 2007, the UNEP SETAC Life Cycle Initiative launched the Water Use in LCA (WULCA) working group (Koehler and Aoustin 2008). One outcome was a framework identifying cause-effect chains that should be addressed for considering impacts of off-stream freshwater use in LCA (Bayart et al. 2010). Characterization factors have also been proposed by several authors. The second phase of the WULCA working group delivered a review of these existing methods (Kounina et al. 2013). More recently, a weighted water footprint, integrating both consumptive and degradative water use, has been proposed by Ridoutt and Pfister (2013). Berger and Finkbeiner (2013) also promoted several research pathways to improve water footprinting.

These efforts have been important to assess comprehensively impacts of human activities on water resources and broadening the relevance of LCA to the broader scope of environmental impacts being considered. These methodologies have also been questioned, particularly by non-LCA experts on grounds that the units of impact category indicators are inaccessible to a non-alert audience (Ernst and Young 2013). The French platform on eco-labelling also argues that the number of environmental indicators should be limited (AFNOR 2011). These observations highlight the need for a single indicator that incorporates and integrates multiple variables to address water-related impacts. The purpose of this paper is to address these concerns by proposing a single indicator, the Water Impact Index, to address the water footprint associated with the environmental impacts of water use, both in terms of quantity and quality.

2 Methods

2.1 The Water Impact Index: goal and scope

2.1.1 Specification for this new metric

The Water Impact Index intends to assess in a simplified approach the *water deprivation* cause-effect chains, related to water use, as described in Bayart et al. (2010). The Water Impact Index expresses changes in freshwater availability and quality generated by a human activity and evaluates how the environment would potentially be deprived of freshwater resources at a local scale.

The Water Impact Index takes into account both the quantity and quality of water withdrawn and returned into the environment as well as the local scarcity of freshwater resources. The main feature of the indicator is to remain as simple as possible for the sake of clarity and transparency for non-LCA experts, yet relying on life cycle thinking. This metrics should then be able to give a preliminary assessment of the relative magnitude of potential impacts related to freshwater availability generated by a human activity.

2.1.2 Scope of application

The proposed Water Impact Index could serve a number of purposes, including but not limited to the following:

- *Screening assessment of water use*: identification of water hotspots in the value chain and of major improvement leverage opportunities.
- *Decision support*: The methodology may be used to support decision makers by providing a single indicator for impacts related to water availability.
- *Communication*: The Water Impact Index may be used for communication purposes, both for consumers and for corporate reporting.

However, using the Water Impact Index does not provide a comprehensive assessment of water-related environmental impacts. This initial screening approach should be followed by a more detailed LCA study using a wider range of impact categories.

2.2 Calculating the Water Impact Index of a unit process

Figure 1 illustrates a unit process withdrawing water from different sources ($W_1; W_2; \dots; W_i$), and returning water to different water bodies ($R_1; R_2; \dots; R_j$). The Water Impact Index of a unit process is calculated according to Eq. (1).

$$\text{Water Impact Index} = \sum_i [W_i \cdot Q_{W_i} \cdot \text{WSI}_i] - \sum_j [R_j \cdot Q_{R_j} \cdot \text{WSI}_j] \quad (1)$$

where:

- W_i and R_j are quantities of water withdrawn from water body “ i ” and returned to water body “ j ”, respectively (in volume unit).
- Q_{W_i} and Q_{R_j} are quality indices of water withdrawn from water body “ i ” and returned to water body “ j ”, respectively (unitless).
- WSI_i and WSI_j are water scarcity indices for water bodies “ i ” and “ j ”, respectively (unitless).

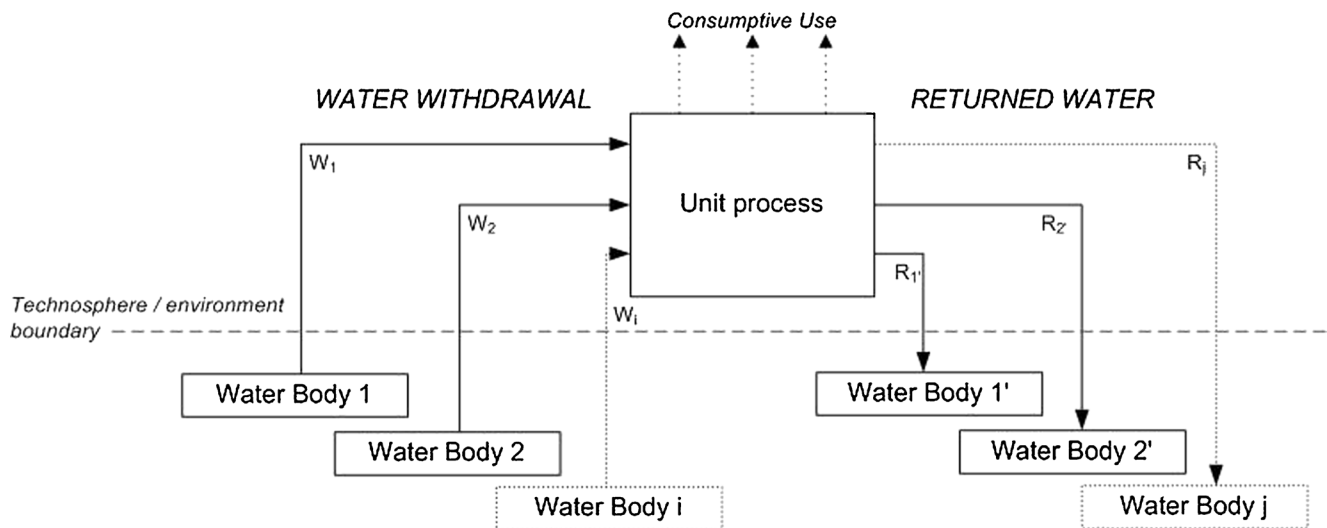


Fig. 1 Water used by a unit process

In this multiplication, or geometric aggregation, each term is implicitly affected by an exponent of 1, meaning that an equal weight is considered for quantity, scarcity and quality of water. The indicator is then proportionally affected by the variations of each parameter. This value choice implies that, for instance, an increase of water consumption inducing a 10 % decrease of returned water would have the same effect on the result than a decrease of output water quality by 10 %.

The Water Impact Index is expressed in *volume unit water impact index equivalent*. For instance, a result of a cubic metre equivalent corresponds to the lost availability of a cubic metre of good-quality water, in a region facing severe hydrological stress (quality index and water scarcity index both equal to 1), or to the lost availability of 2 m³ of good-quality water, in a region facing moderate hydrological stress (quality index equal to 1 and water scarcity index equal to 0.5).

This formula sets up a general framework for the Water Impact Index. The following paragraphs define explicit operational options for calculating each term of the equation. This framework is however not tied to these specific solutions, and it should evolve with the state of knowledge.

2.2.1 Consideration of water withdrawal and returned water by the unit process

A mass balance between water withdrawn from and returned into the different water bodies is calculated. The water withdrawn is accounted for with positive values (reduction of freshwater availability) whereas the water returned is accounted for with negative values (increase of water availability), so the impact increases with the quantity of water withdrawn and decreases with the quantity of water released. The net consumption of a process, generated by freshwater evaporation or integration into a product (so-called

consumptive use), is considered as a net loss of freshwater availability.

2.2.2 Quality index

The volume of water is weighted by a quality index that intends to express water quality into a single grade, scaled between 0 (worst quality) and 1 (best quality). For a specific pollutant, the higher the concentration, the lower the specific quality index is. In other words, multiplying volume by quality index means that withdrawing high-quality water results in lower water availability for other users than withdrawing low-quality water. Alternatively, the higher the quality of the water returned to the environment, the higher the increase in water availability is, compared to returning water of low quality back into the environment.

Q_{W_i} and Q_{W_j} are calculated according to Eqs. (2) and (3):

$$Q_{W_i} = \text{minimum}_p \left(1; \frac{C_{ref_p}}{C_{W_{i,p}}} \right) \quad (2)$$

$$Q_{R_j} = \text{minimum}_p \left(1; \frac{C_{ref_p}}{C_{R_{j,p}}} \right) \quad (3)$$

Where:

- C_{ref_p} (or reference concentration for pollutant p) corresponds to the concentration of a specific pollutant p in water that should not be exceeded in order to protect the environment (in units of concentration). These reference concentrations are also called “ambient water quality

standards” in order to distinguish them from drinking water quality standards and effluent standards (Hoekstra et al. 2011). A set of reference concentrations for pollutant of main concerns in several countries can be found in the [Electronic supplementary material](#).

- $C_{wi,p}$ and $C_{Rj,p}$ correspond to the effective concentration of pollutant “ p ” in the water withdrawn from water body “ i ” and returned into water body “ j ”, respectively.

The quality index is calculated according to the most penalizing pollutant. This “one out, all out” principle is used in the Water Framework Directive for which the surface water status is determined by the poorer of its ecological status and its chemical status (Directive 2000/60/EC 2000). The widest spectrum of pollutants suspected to be found in the water should be investigated, and typical pollutants of some activities should be studied carefully (i.e. pesticides and nutrients for agriculture, chemical oxygen demand (COD) for the food and beverage industry, etc.). Consolidating several pollutants into a composite quality index is further discussed (Section 4).

The [Electronic supplementary material](#) provides the most stringent water quality standards for surface freshwater within various countries, for a set of pollutants covering different environmental issues. Quality standards can differ across countries according to several reasons (specificities of local ecosystems, environmental background concentrations or restrictiveness of the legislation). The influence of these variations on the results should be cautiously assessed especially in a study implying inputs from various countries. In a first iteration, the same ambient water quality standards could be used to characterize both direct and indirect water uses, and then specific quality guidelines of the supply chain’s countries could be applied for a more detailed assessment.

2.2.3 Water scarcity index

The water scarcity index addresses the potential local physical lack of water in a given area. Following current recommended practices (Ridoutt and Pfister 2013) and as it presents a global coverage, the Water Stress Index proposed by Pfister et al. (2009) is used. This index is readily available and ranges from 0.01 (no scarcity) to 1.0 (high scarcity), and it is calculated as a function of the water withdrawal-to-availability ratio, the variability of freshwater availability and the storage capacity of the study area. Further improvements and updates of the stress index can be expected and should be adopted.

2.3 Illustrative example

An illustrative case study on the wastewater management system in Milan (Italy) is presented in order to illustrate the operability of the methodology and its usefulness as a decision support tool. The Water Impact Index is combined with a

carbon footprint to introduce multi-impact thinking for decision makers. Historically, the majority of Milan’s sewage was sent to the Vettabbia stream without any treatment. Since 2005, this water has been sent to the Nosedo Wastewater Treatment Plant (WWTP), which has a capacity of 1.5 million person-equivalents. Two thirds of the treated water is returned to the Lambro River. The remaining portion is reused for irrigation. Before Nosedo’s WWTP construction, farmers used to withdraw water from the Vettabbia stream for their irrigation needs.

The functional unit includes the handling of Milan’s wastewater (148.8 million m³/year) and irrigation water supply (49.6 million m³/year) over a year. The current wastewater management system (*WWTP+reuse* scenario) is compared with the previous scenario without WWTP (*no WWTP* scenario) (Fig. 2). For the no WWTP scenario, system boundaries include wastewater discharge into the river, withdrawal of water for irrigation (foreground processes) and the energy needed for wastewater collection (background processes). For the WWTP+reuse scenario, the treated water discharged into the Lambro River is considered (foreground process), as well as energy and chemicals required for wastewater collection and treatment (background processes). The treated water used for irrigation is considered as an intermediate flow and is therefore not considered for this scenario. Infrastructure and raw water withdrawal for drinking water production are excluded from system boundaries. The energy consumed by pumps for irrigation remains the same in the two scenarios; it is then excluded from system boundaries.

Primary data, based on average exploitation for the year 2009, have been collected from the operators for calculating the Water Impact Index of foreground processes (or direct Water Impact Index). These data include volumes of water withdrawn from the environment and returned into the environment (Table 1), as well as several quality parameters (COD, BOD, nitrogen, total phosphorous, total suspended solids, ammonia and six metals) to compute quality indexes (Table 2). The exact location of the plant has also been used for estimating the WSI as set by Pfister et al. (2009).

Evaporated water over the wastewater treatment plant has been estimated based on open water surfaces of the plant and average evaporation data from the European Watch project (Harding and Warnaars 2011).

Chemicals and energy consumed by the plant are used to calculate carbon footprint with the EcoInvent database (Swiss Centre for Life Cycle Inventories 2009) and 100-year temporal horizon, and global warming potentials (Solomon et al. (2007)). The Water Impact Index of background processes (i.e. indirect Water Impact Index) is calculated, thanks to the Water Database (Quantis 2011). Due to a lack of information on background process, two basic assumptions are made and will be then briefly discussed:

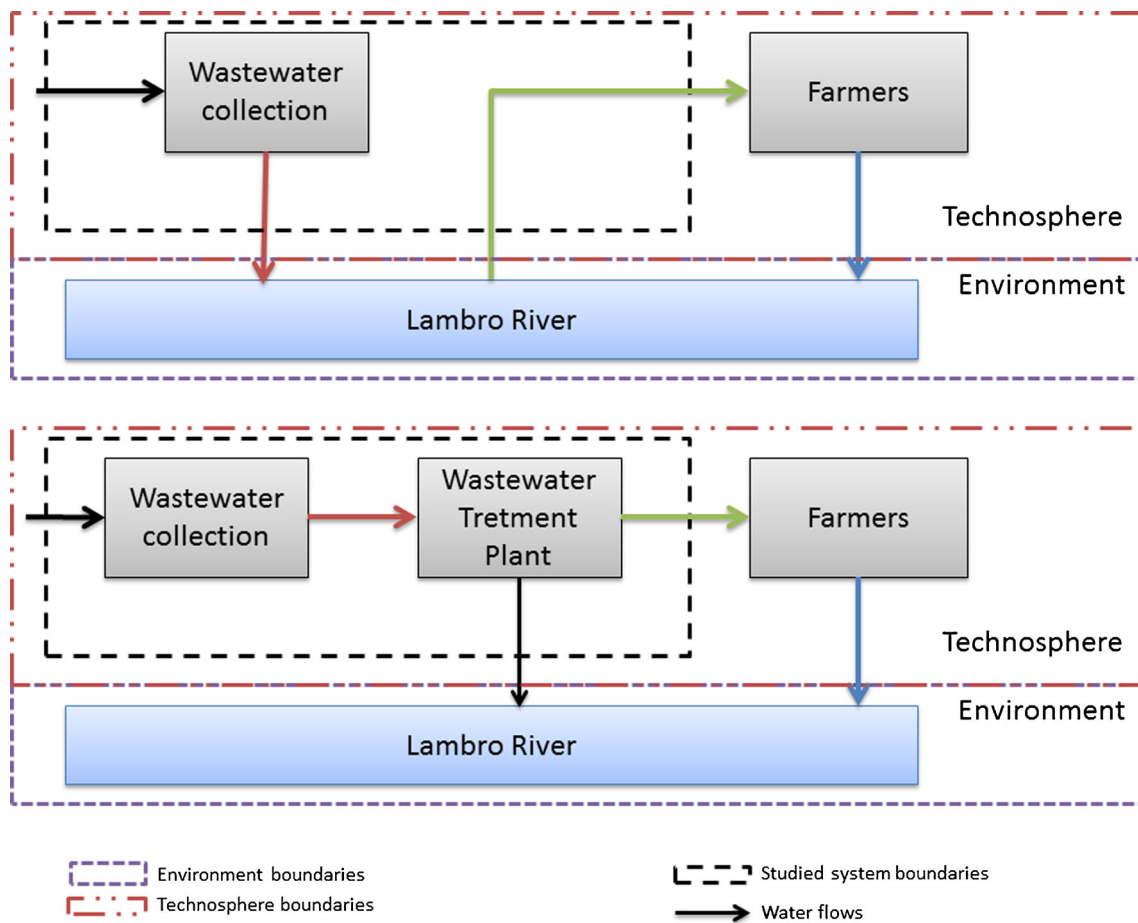


Fig. 2 Compared scenarios. *Above*, without wastewater treatment plant (no WWTP). *Below*, with wastewater treatment plant and reuse by farmers (WWTP and reuse)

- The quality of water withdrawn from the environment is assumed to be high ($Q_w=1$).
- Without precise information on the exact water use location of unit processes, average country-based WSI values have been used (Average WSI in Italy of 0.27 and average WSI in France of 0.18).

Results obtained with the Water Impact Index are then confronted to three water-related midpoint indicators from the ReCiPe LCIA methodology, namely freshwater eutrophication, freshwater ecotoxicity and water depletion (Goedkoop et al. 2009).

3 Results

3.1 Using the Water Impact Index as a decision support tool, complementary to carbon footprint

For both scenarios, direct water use is the main contributor to the indicators, both from a volumetric approach (Table 1) and the Water Impact Index calculation (Table 3). Small variations can be observed on the direct water balance between the two scenarios, due to evaporated water over the wastewater treatment plant and water incorporated in the sludge.

Table 1 Water balance of the studied scenarios (in m^3 /year)

		No WWTP	WWTP+reuse
Direct water uses	Returned water	-148,870,680	-99,190,453
	Water withdrawal	49,595,227	0
Freshwater consumed for background processes	Energy	268	89,320
	Chemicals	0	367,849
Total		-99,190,185	-98,733,283

Table 2 Quality indexes of direct water uses (unitless)

	No WWTP	WWTP+reuse
Returned water	5.5×10^{-3}	5.5×10^{-2}
Water withdrawal	2.0×10^{-2}	

Regarding the no WWTP scenario, the Water Impact Index is mainly generated by river water withdrawal for irrigation. Although the volume of wastewater discharged into the Vettabbia stream is high (148.8 million m³/year), the associated negative Water Impact Index is small with $-41\,241\text{ m}^3$ water impact index equivalent (a negative Water Impact Index indicates an increase of water availability). This result is due to the low quality of the water discharged, which has then a limited effect on freshwater availability increase. As energy consumption for wastewater collection is very low (mainly gravitational network), the indirect Water Impact Index is not significant for this scenario. This result is also reflected into the carbon footprint evaluation (Table 4).

Regarding the WWTP+reuse scenario, the total volume of water discharged into the Lambro River is lower (99.2 million m³/year). However, the quality of the water discharged into the environment is improved. The quality index increases by a factor of 10 reflecting the effluent quality improvement provided by the WWTP. On the other hand, energy and chemical consumption for wastewater treatment increase the indirect Water Impact Index, which represents 11 % of the direct Water Impact Index benefit obtained through the discharge of treated water. This significant contribution can be explained by the difference in Water Stress Index values considered for direct and indirect Water Impact Index calculation (0.05 for Milan area, 0.27 on average for Italy where electricity and part of chemicals are produced, and 0.18 on average for France where the remaining part of chemicals is produced). However, the indirect water use for energy and chemical production still generates a lower additional Water Impact Index than the benefit obtained through improvement of water quality and reduction of raw water withdrawal.

Table 3 Water Impact Index of Milan's wastewater management system—comparison of scenarios no WWTP and wastewater treatment+reuse (in m³ equivalent/year)

		No WWTP	WWTP+reuse
Direct Water Impact Index	Returned water	-41,241	-277,733
	Water withdrawal	49,992	0
Indirect Water Impact Index	Energy	40	10,717
	Chemicals	0	20,441
Total		8,791	-246,575

Negative numbers express an increase of water availability

Table 4 Carbon footprint of Milan's wastewater management system—comparison of scenarios no WWTP and WWTP+reuse (in tons CO₂ equivalent/year)

	No WWTP	WWTP+reuse
Electricity	76	25,500
Chemicals	0	1,500
Total	9,482	28,663

Finally, electricity and chemical consumption are responsible for the increase of the carbon footprint (Table 4).

From a decision maker's perspective with environmental concerns, taking into account only carbon footprint would have not been in favour of the WWTP solution. The introduction of a volumetric-based water footprint would have comforted this point of view, whereas the Water Impact Index moderates the conclusion by accounting for water quality issue and supports decision making with a more vivid picture of environmental impacts related to both solutions. The approach usefully introduces multi-impact thinking.

3.2 Comparison with conventional LCIA methodology

The Water Impact Index methodology proposed here is a simplified water footprint approach, and results must be consistent with those obtained using a more traditional LCIA approach. Results obtained with the three water-related mid-point indicators from the ReCiPe LCIA methodology depict similar tendencies than the Water Impact Index (Table 5). For the three impact categories, the additional indirect impacts generated by energy and chemical consumption are compensated by a larger reduction of direct impacts.

More specifically, the reduction of phosphorous and metals discharged in treated wastewater effluent returned to the environment reduces, respectively, eutrophication and ecotoxicity impacts. The reduction of water withdrawal for irrigation supply reduces the water depletion impacts. The relative contribution of the processes is different as the impact

Table 5 Water footprint profile of Milan's wastewater management system—comparison of scenarios no WWTP and wastewater treatment+reuse

	Freshwater eutrophication (kg P-eq/year)		Freshwater ecotoxicity (kg 1,4-DB eq/year)		Water depletion (m ³ /year)	
	No WWTP	WWTP+reuse	No WWTP	WWTP+reuse	No WWTP	WWTP+reuse
Direct water use	5.06×10^5	8.93×10^4	8.78×10^5	5.86×10^5	4.96×10^7	0
Indirect water use	1.47×10^1	6.24×10^3	2.22×10^2	9.84×10^4	1.99×10^2	1.01×10^6
Total	5.06×10^5	9.55×10^4	8.78×10^5	1.57×10^5	4.96×10^7	1.01×10^6

category only accounts for water withdrawn, without considering returned water or local scarcity issues.

From a decision support point of view, the conclusion obtained using the ReCiPe methodology and the Water Impact Index is the same; the wastewater treatment plant reduces the overall water footprint of the wastewater management system.

3.3 Uncertainties and sensitivity analysis

Two main assumptions were made on the quality and the local scarcity for indirect water withdrawn, due to lack of specific data on background processes.

The quality of indirect withdrawn water was assumed to be high ($Q=1$); this conservative assumption equally affects the indirect contribution of both scenarios which could be overestimated. However, it does not significantly affect the results as the indirect contribution to water footprint is low compared to the contribution of direct water uses.

An average country WSI (0.27) has been selected for each background process, assuming that electricity and chemical production are equally spread over the Italian territory. The uncertainty surrounding the aggregation of the WSI at country level is significantly high for Italy (Pfister and Hellweg 2011). However, as the background processes account for a small contribution on the total result, result tendencies would remain the same, even with the highest possible WSI for background processes.

The Water Impact Index depends on input water quality (Q_{in}); Table 6 shows the sensitivity of this parameter in the no WWTP scenario, where water is withdrawn from the river.

Abstracting water of higher quality increases the impact on water resource, so the absolute result of the no WWTP scenario is widely impacted by different input qualities. However, in this case study, a change in water quality does not invert the conclusion between the two scenarios; the relative benefit of reusing water is only enhanced if it enables to avoid abstracting water of higher quality.

4 Discussion

The methodology presented in this paper is pragmatic, focusing on its applicability for practitioners. Its main feature is to integrate volume, scarcity and quality into a single indicator targeting ecosystem quality. It is conceptually quite similar to the midpoint indicator proposed by Boulay et al. (2011). Both indices tackle, however, two distinct areas of protection, human health for Boulay et al. (2011) and ecosystem quality for the Water Impact Index. Indeed, Boulay et al. (2011) integrates the quality of water by classifying water into different categories that are functional for specific human uses (drinking water, agriculture, industry, etc.), while the Water Impact Index aims at reflecting the quality of water regarding targets that should be met to ensure good ecological status of natural water bodies. While designed to target two distinct issues, the two methods could implicitly overlap, and a quantitative comparison of their complementarities and differences would be the topic for further research.

As a simplified approach, the Water Impact Index obviously presents some limitations and cannot replace a

Table 6 Sensitivity of the Water Impact Index in the no WWTP scenario (in m³ equivalent/year) regarding withdrawn water quality

	No WWTP	Poorer water quality abstracted	Higher water quality abstracted
Water quality of withdrawn water (Q_{in})	0.02	0.001	1
Direct Water Impact Index	Returned water	-41,241	-41,241
	Water withdrawal	49,992	2,500
Indirect Water Impact Index	Energy	40	43
	Chemicals	0	0
Total	8,791	-38,698	2,458,402

comprehensive water footprint. Further developments to enhance the relevance and the robustness of the Water Impact Index should be encouraged.

The quality index is calculated according to the most penalizing pollutant and is then affected by a so-called masking effect on the variation of other pollutants. This approach still lacks consensus, as it cannot take into account the addition of other pollutants into a water flow. If the specific quality index associated with these additional pollutants remains higher than the quality index calculated for the most penalizing pollutant, then the Water Impact Index does not capture the additional environmental impact. Another approach could be to avoid this masking effect by combining the different pollutants into a single water quality index. This aggregation could be done using characterization factors of LCIA methodologies; however, LCIA methodologies such as Impact 2002+ or CML 2011 do not provide a common unit for impact categories addressing water pollution (Guinée et al. 2001; Jolliet et al. 2003). What is more, the quality index relies on existing ambient water quality standards and is bound to the availability of such values. The quality index could therefore be overestimated if no Cref is available for some pollutant, as impacts can be underestimated in traditional LCA when no characterization factors are available for some substances. In addition, these standards might not always be defined with the same philosophy across different countries.

Secondly, neither the size nor the background pollution of receiving water bodies is considered in the methodology proposed and in any LCIA methodology. The flow rate of the receiving river does have an incidence on potential impacts of effluent discharges. Pollutants discharged would be more or less diluted into water bodies. Similarly, it would be valuable to consider the pollutant background level in order to distinguish the assimilation capacity among different receiving water bodies. While it seems feasible to integrate these two concepts for calculating the Water Impact Index (but also life cycle assessment results) of foreground processes, it would be more complex for background processes because of the lack of generic data for these parameters. These aspects could however be considered through local assessment such as risk assessment, and the two approaches should be considered as complementary.

Further developments are also expected regarding the water scarcity index. The distinction among different water resources and their interactions (i.e. groundwater, surface water) would have a benefit in some prospective case studies. Defining seasonal water scarcity indices would also allow improving the quality and the usefulness of Water Impact Index assessments. Some water scarcity metrics already propose these distinctions (see Boulay et al. (2011) for surface/groundwater distinction and Hoekstra et al. (2012) or Pfister and Bayer (2013) for monthly water scarcity). However, the

combination of these two aspects is not achieved yet. Furthermore, there are large uncertainties associated with underlying data on groundwater recharge (Döll and Fiedler (2008)) and the spatial resolution at large watershed level might be inadequate to properly assess monthly scarcity (Pfister and Bayer (2013)), so the relevance of pursuing these aspects of refinement still needs to be proven.

5 Conclusions

Improvements of LCA schemes regarding the integration of environmental impacts generated by water use are required to better measure and understand the pressure of human activities on water resources. In the meantime, the development of meaningful single indicators for water footprint is also needed for decision makers.

This paper proposes a new metric, the Water Impact Index that simplifies water use assessments. It consists of combining the volume of water used, the change in water quality and the local water scarcity into a composite single indicator. This operational methodology is illustrated on a municipal wastewater management system to demonstrate the possibility of using the Water Impact Index as a simplified decision support tool for improving water management of a product system. In this case, conclusions derived from Water Impact Index assessment results match those from a more traditional LCIA approach. However, a more extensive statistical validation of the comparison between the Water Impact Index and more traditional available LCA methodologies is also warranted. The third project of the WULCA group is expected to address this issue with a quantitative comparison of methodologies for assessing water use impacts in LCA.

Water footprinting is still a new concept, and there is no clear methodological consensus when compared, for instance, to carbon footprint. It is also a gaining momentum, and the need for research in this field has been highlighted. This paper is a building block that aims at expanding the range of available water footprint methodologies. Nevertheless, the best methodology to be used often depends on the study's goal and scope. Therefore, the main principles described in this paper could easily be used for designing customized water footprinting approaches.

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