ORGANIZATIONAL WATER FOOTPRINT

Analyzing water use and mitigating water scarcity along global supply chains

Silvia Forin, Markus Berger, Jonas Bunsen, Matthias Finkbeiner

UNIVERSITÄTSVERLAG DER TU BERLIN

Coordinated by

Supported by

Funded by

Recommended Citation

S. Forin, M. Berger, J. Bunsen and M. Finkbeiner, Organizational Water Footprint – Analyzing Water Use and Mitigating Water Scarcity along Global Supply Chains. TU Berlin Chair of Sustainable Engineering, 2021. http://dx.doi.org/10.14279/depositonce-11818.

This document is a result of the research project: WELLE – The Water Footprint of Companies: Local Measures in Global Supply Chains

WELLE was funded by the German Federal Ministry of Education and Research (BMBF) – Grant number 02WGR1429A

Project coordination: Technische Universität Berlin – Chair of Sustainable Engineering

Project partners: Deutsches Kupferinstitut Berufsverband e.V., Evonik Nutrition & Care GmbH, Neoperl GmbH, Thinkstep AG/Sphera Solutions, Inc., Volkswagen AG

ORGANIZATIONAL WATER FOOTPRINT

Analyzing water use and mitigating water scarcity along global supply chains

Silvia Forin, Markus Berger, Jonas Bunsen, Matthias Finkbeiner

UNIVERSITÄTSVERLAG DER TU BERLIN

CONTENT

ABBREVIATIONS

BMBF	Bundesministerium für Forschung und Bildung (German Federal Ministry of Education and Research)
GHG	Greenhouse Gas
LCA	Life Cycle Assessment
O-LCA	Organizational Life Cycle Assessment
OWF	Organizational Water Footprint

1

INTRODUCTION

Freshwater is sustaining life on our planet but is under increasing pressure due to population growth, increased water consumption and pollution as well as climate change. Facing freshwater scarcity is one of the major challenges of the 21st century and included in the Sustainable Development Goals as a fundamental target of the international community UN (2015). Also the World Economic Forum has been highlighting the “water crisis” as one of the top global risks for many years (WEF 2020).

Water resources are unevenly distributed across the globe, which makes water scarcity a local problem at many places around the world. At the same time, international trade is expanding, and supply chains have an increasingly transnational character. Water that is used in basins subjected to scarcity, often located in the Global South, is integrated in production processes of industrialized countries (Lenzen et al. 2013; Tukker et al. 2014). Thus, a sustainable use of the world’s limited freshwater resources is a global responsibility.

So far, most organizations only measure water use of their own facilities by means of environmental management systems or other internal accounting methods. These approaches, though giving an overview concerning on-site water demand and potential uction measures at the facility’s location, do not account for the whole sphere of influence of an organization on the world’s freshwater resources. Water footprint studies of industrial products have revealed that water use at production sites is usually the tip of the iceberg only. The largest part of a product’s water use and resulting impacts often occur in supply chains, e.g. in the production of agricultural goods, the mining of mineral resources, or the generation of fossil-based electricity (Berger et al. 2012; 2017; Forin et al. 2019).

In order to address this mismatch between water related hotspots along value chains and the focus of organizations on water use on their premises, the research project “Water Footprint for Organizations – Local Measures in Global Supply Chains (WELLE)” has been launched. It represents a multi-stakeholder research cooperation between TU Berlin, Evonik, German Copper Alliance, Neoperl, thinkstep, and Volkswagen and was funded by the German Federal Ministry for Education and Research (BMBF) within the funding measure GRoW (Global Resource Water). WELLE aims at supporting organizations in:

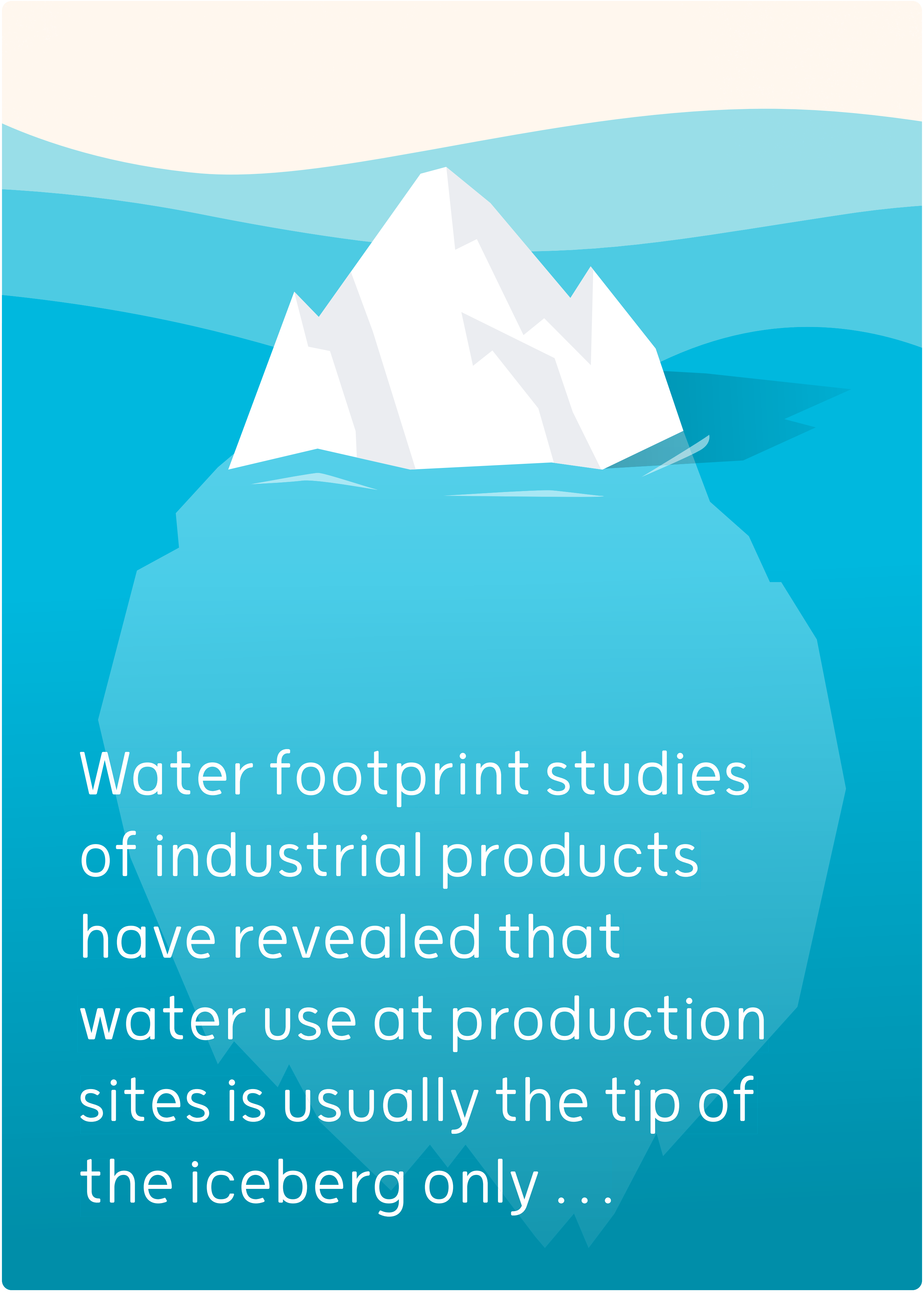
- Analyzing water use and resulting local consequences “beyond the fence” along value chains, i.e. determining the Organizational Water Footprint
- Identifying local hotspots in global supply chains
- Taking action to reduce the Organizational Water Footprint and mitigate water scarcity at critical basins and in cooperation with suppliers and local stakeholders

Typically, an organization is broadly defined as an entity which pursues a specific goal or activity such as producing goods or providing services, for example, companies, public authorities, NGOs, etc.

Within the WELLE project a method for analyzing an organization's Water Footprint has been developed (Forin et al. 2019) along with a database[1] and the WELLE Tool[2] supporting its applicability. The method, database and presents the WELLE Tool have been tested and refined in case studies conducted by the industry partners. While the results of this research project have been published in great detail in scientific journals, this document intends to provide guidance for practitioners who want to analyze water use and the resulting local consequences along the supply chains of their organization. The next section describes the procedure for conducting an Organizational Water Footprint study. Section 3 presents the WELLE Tool, which supports the application of the method. Finally, measures which can be taken to reduce an organization's Water Footprint and to mitigate water scarcity along supply chains are discussed in section 4. Practical examples from a case study conducted by the industry partner Neoperl are used throughout this guidance to illustrate the application of the method and WELLE Tool.

1 https://welle.see.tu-berlin.de/#database

2 http://wf-tools.see.tu-berlin.de/wf-tools/owf


Water footprint studies of industrial products have revealed that water use at production sites is usually the tip of the iceberg only . . .

2

MEASURING AN ORGANIZATION'S WATER FOOTPRINT

The Organizational Water Footprint denotes an organization's water use and resulting local impacts throughout its entire value chain. In other words, the Organizational Water Footprint considers not only an organization's water use at its production facilities, but also the water used for energy generation and raw material production (upstream in the supply chain) as well as water use during the use and end-of-life phases of products (downstream). Additionally, all aspects of the organization itself are included, such as the water used by the cleaning service, the organization's garden and canteen, etc.

It should be noted that the term water use denotes the total freshwater input into an organization. Water consumption (consumptive use) is the fraction of water use which is not returning to the originating river basin due to mainly evaporation and transpiration as well as product integration and discharge into other basins or the sea. Water pollution (degradative use) describes a use of water which reduces water quality.

The Organizational Water Footprint denotes an organization's water use and resulting local impacts throughout its entire value chain

The Organizational Water Footprint method follows the life cycle approach and builds upon the experience of two existing environmental assessment frameworks: Water Footprint and Organizational Life Cycle Assessment (O-LCA). Both frameworks have been standardized by the International Organization for Standardization and rely on the established Life Cycle Assessment (LCA) method. The technical specification ISO/TS 14072 (ISO 2014) refers to the application of LCA to organizations and is specified by the Guidance on O-LCA (UNEP 2015). O-LCA is a multi-impact method, i.e. it considers multiple environmental impacts (e.g. global warming, toxicity, acidification, etc.), not only those caused by water use. Water consumption and water pollution related impacts can be included in Organizational LCA too – among other impacts. The reference standard for Water Footprint, ISO 14046 (ISO 2014), does not exclude organizations but has been developed by taking a product life cycle perspective. A detailed juxtaposition of the two standards has been carried out in scientific literature (Forin et al. 2018). In order to facilitate the determination and analysis of Organizational Water Footprints, this Practitioners Guidance explains the main steps in an application-oriented manner.

Following the LCA framework, the method is divided into four phases:

1. Goal and scope definition section 2.1
2. Inventory analysis section 2.2
3. Impact assessment section 2.3
4. Interpretation section 2.4

FIGURE 1

The four phases of the Organizational Water Footprint method

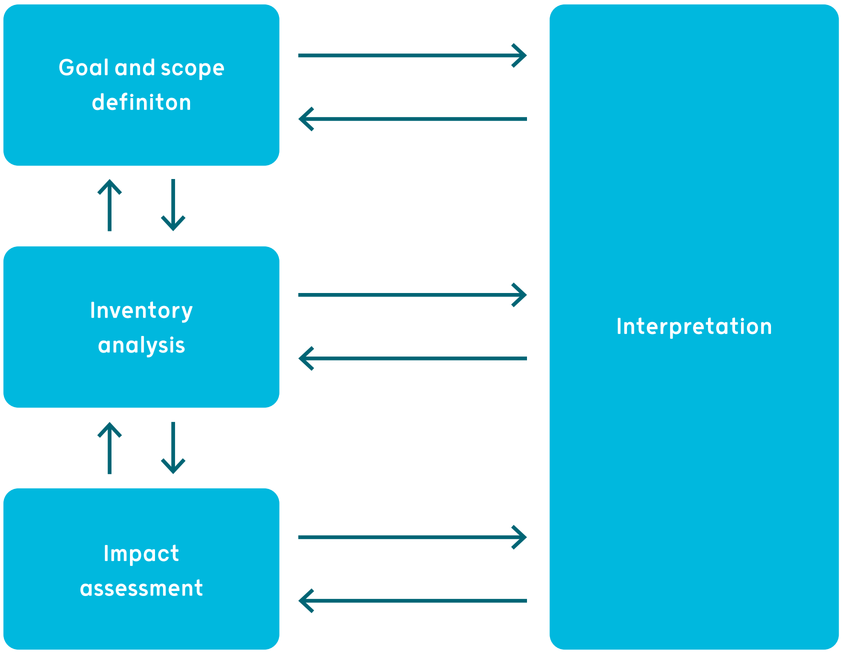


FIGURE 1 shows the four phases. The goal and scope definition and inventory analysis mostly rely on the Organizational LCA method. In the impact assessment phase, methods analyzing the local consequences of water use have been adopted from a Water Footprint background to reflect specific aspects relevant in an organizational context.

The Organizational Water Footprint method illustrated in this Practitioners Guidance sets its focus on performing an organization's water scarcity footprint, i.e. in assessing the impacts of water consumption throughout the value chain in relation to local water scarcity. However, the goal and scope and the inventory phase can also be used as a basis for assessing the impacts of water pollution, not included in this Practitioners' Guidance.

2.1 GOAL AND SCOPE DEFINITION

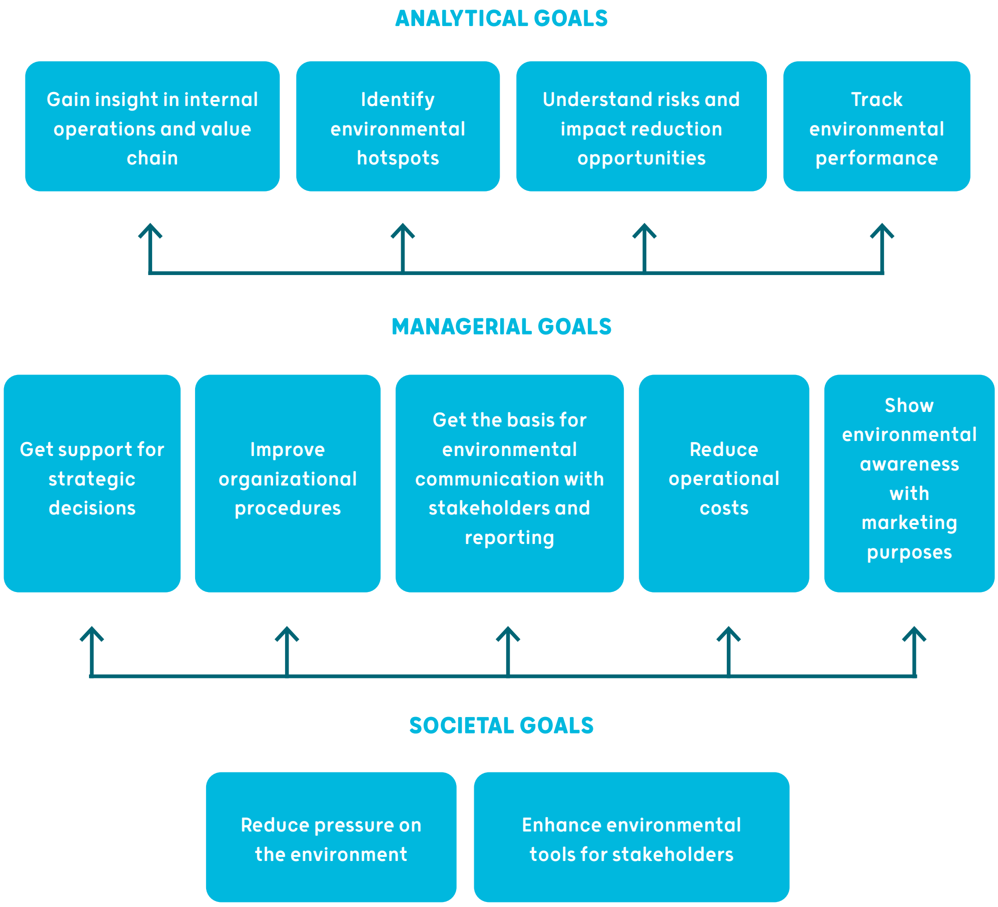
The goal and scope phase sets the framework for the Organizational Water Footprint study and describes why and how the Organizational Water Footprint study is conducted.

2.1.1 GOAL

Organizations can pursue multiple goals when applying the Organizational Water Footprint method – either as a stand-alone study or as a part of an O-LCA. The main opportunities for companies and other organizations are of analytical, managerial, and societal nature UNEP (2015). An overview according to this categorization is provided in FIGURE 2.

FIGURE 2

Potential goals of an organization identified for the O-LCA method



UNEP 2015

Each organization and study is unique according to the main aims and their achievement potential within the temporal framework of an Organizational Water Footprint study. Certain goals listed in FIGURE 2 can only be reached in the long run. This applies for example for enhancing environmental tools with stakeholders and reducing operational costs. For this reason, it is recommendable to formulate short-term and long-term goals (by indicating the time frame) and prioritize them, to better manage expectations at all levels (see TABLE 1). In addition, practitioners should bear in mind that the achievement of each goal requires a specific set of methodological elements listed in TABLE 1 e.g. data collection or reporting.

Due to the water-specific character and the foreseen linkage with concrete measures to mitigate water scarcity, more specific goals can be formulated for an Organizational Water Footprint study. One possibility is to further specify the O-LCA societal goal "Reduce pressure on the environment". For example, the organization can set the goal of initiating a water stewardship process (see section 4) in the main hotspots revealed by the study.

The water (scarcity)-related focus of this method suggests possibilities to prioritize goals. According to other existing initiatives in this sector (CDP 2018), water related issues are of great importance for shareholders, because they can bear severe business risks in certain areas if the organization relies on locally scarce water resources. Therefore, understanding business risks might be of high priority. Moreover, and in contrast to methods setting their focus on on-site activities, Organizational Water Footprint allows for identifying water-related business risks along the whole supply chain, which in turn can support strategic decisions (e.g. the choice of or cooperation with suppliers) and enhancing environmental tools within stakeholders.

Identifying water-related business risks with Organizational Water Footprint can support strategic decisions

Determining the goal also helps designing the study. TABLE 1 shows the implications of different goals for the study design, e.g. for data collection, data granularity and the choice of the reporting flow.

Product related methods such as the Product Water Footprint and product LCA often aim at comparing different products that fulfil the same function. Organizations differ according to their sector, product portfolio and product characteristics, internal procedures, size, and further characteristics. For these reasons, comparing the Water Footprint of different organizations might be misleading. ISO/TS 14072 requires for Organizational LCA to unambiguously state in the goal and scope phase of a study that the results are not intended to be used in comparative assertions for public disclosure. Since Organizational Water Footprint has the same subject of study – organizations – this method also does not foresee comparing different organizations. Notwithstanding this, one of the most useful applications of Organizational Water Footprint is performance tracking, i.e. comparing the organization's Water Footprint for different years (see analytical goal: tracking water-related environmental performance). This allows identifying whether managerial decisions or mitigation measures put into place were effective. Additionally, comparisons can be carried out internally to compare different facilities or production lines within the same organization – and so analyze which processes have the lowest water-related impacts.

To be fully in line with ISO 14046 and ISO/TS 14072, the following elements need to be stated additionally: the intended application, the reasons for carrying out the study, the intended audience, i.e. to whom the results of the study are intended to be reported, and whether the study is a stand-alone assessment or part of a LCA.

TABLE 1

Guiding table to set the goals of the Organizational Water Footprint study

	Goal of Organizational Water Footprint study	Guiding questions and implications for study design	Quantification and time frame (What exactly should be reached? When should the goal be reached?)	Priority (0-5)
Analytical	Gaining insights in water-relevant internal operations and value chain	Which operations or value chain stages need to be analyzed more in depth? › Specific consideration in data collection (granularity)		
	Identifying water-related environmental hotspots along the value chain	At which level should the environmental hotspots be identified (activity level, material supply level, facility level, …)? › Specific consideration in data collection (granularity)		
	Understanding the water-related risk exposure of the organization and its value chain	Where are critical suppliers/activities located? › Regional specificity of impact assessment results (basin level)		
	Understanding how to reduce water-related impacts	Do similar activities use e.g. different technologies, so that the study can allow conclusions on the best technical solution to use? › Specific consideration in data collection		
	Tracking water-related environmental performance	Does the organization plan to repeat the study in subsequent years? › Choice of the reporting flow and activity variable		
Managerial	Supporting strategic decisions	Are strategic decisions planned for the next years affecting water use or its location? How can the study inform decisions? › Focus on specific activities, specific consideration in data collection		
	Improving organizational procedures	Do data management or data gathering processes within the organization need improvement? › Focus on organizing data collection		
	Getting the basis for water-related environmental communication with stakeholders and reporting	Which stakeholder/reporting activities are planned? › Plan the study in order to obtain the type of information you wish to communicate		
	Reducing operational costs	Does water scarcity along the value chain possibly lead to increased costs? › Track expenditures along with environmental data, with the same granularity		
	Showing environmental awareness for marketing purposes	Which stakeholder/reporting activities are planned? › Plan the study in order to obtain the type of information you wish to communicate		
Societal	Reducing pressure on water resources	Is it already known that parts of the supply chain are located in water scarce regions? › Prioritize data collection according to the activities' location		
	Enhancing water-related environmental tools with stakeholders	Which stakeholders and which tools are most important to the organization? › Focus on data collection and communication of assessment methods		
Other	…	…		

2.1.2 SCOPE

Scoping the study means defining what is going to be analyzed and how. According to the O-LCA guidance (UNEP 2015), the object of analysis is defined through three main qualitative and quantitative elements: the reporting organization; the reporting flow[3]; and the system boundary.

REPORTING ORGANIZATION

Defining what is going to be analyzed is the starting point of the scoping phase. To take adequate account of the complexity of an organization, the subject of study, the consolidation method and the reporting period need to be included.

Subject of study

An Organizational Water Footprint study may address either the whole organization or a part thereof, for example one or more business division(s), brands, regions, facilities, or production lines. An Organizational Water Footprint study for a part of the organization can be a pilot assessment which can be extended to a complete Organizational Water Footprint study. The name and the description of (the part of) the organization under study needs to be declared in the scoping phase.

Consolidation method

Operations can have different legal and organizational structures. To provide a consistent framework for the Organizational Water Footprint study, it should be guaranteed that the responsibility for the environmental impacts identified can be attributed to the organization according to consistent criteria.

ISO 14046 and ISO/TS 14072 require consolidating an organization's potential environmental impacts related to water by one of the following approaches:

a. control: the organization assesses potential environmental impacts related to water use of processes and physical units from facilities over which it has financial or operational control;

b. equity share: the organization assesses potential environmental impacts related to water use of processes and physical units from respective facilities, according to its share of equity interest. For example, if the organization owns 60% of the facilities under study, its Water Footprint corresponds to 60% of the overall Water Footprint of those facilities.

If the organization owns and controls all its units, the two approaches are equivalent. The main advantage of the control approach is that only units on which the organization has full control are included. This facilitates both data collection and the implementation of mitigation measures derived from the study results. On the other hand, the equity share approach is

3 ISO 14072 introduces an element of the scoping phase called "reporting unit", conceived as an equivalent to the functional unit for organizations. In this Practitioners Guidance, the reporting unit is split into a qualitative part (the reporting organization) and a quantitative part (the reporting flow), in order to allow a more precise description. Using the reporting unit as scoping element as in ISO 14072 is an option too.

able to capture the financial risk and rewards related to environmental impacts, and is more straightforward for complex organizations. Both the control and equity share approaches refer to direct activities (see section 2.2). Consolidation approaches do not apply for indirect activities, which are determined by tracing back direct activities' value chains.

Reporting period

The reporting period is the time frame for which the organization is being studied, e.g. a certain year. It is convenient to choose the reference period according to the requirements of other reporting schemes, e.g. financial ones.

REPORTING FLOW

The reporting flow is a quantitative measure for the output of the reporting organization and the reference for completing the inventory.

The reporting flow can be defined as the nature and amount of an organization's product portfolio. Organizations with a very diverse portfolio might cluster their products into product groups. If considered relevant, further elements (for each product group), such as quality or duration of products, might be included in the quantification too. The reporting flow can be expressed in physical terms (e.g. number of units for each product, mass, volume) or non-physical terms (revenues, number of employees). The latter solution might be the most suitable for organizations active in the service sector.

Activity variable

The Organizational Water Footprint method, though excluding comparisons between different companies, is suitable for tracking the environmental performance of one organization in different years. To deliver a meaningful interpretation of performance tracking results, environmental impacts need to be set in relation to the organization's output, which also varies depending on the reporting period considered. For performance tracking, certain options for the quantification of the reporting flow are not suitable. For example, measuring the number of units per product type or product cluster might be insufficient for comparisons, since shifts in the product mix between different reporting periods are likely to occur. Aggregated values such as mass, volume, economic performance, or another type of "activity variable" might be preferred in this case.

The Organizational Water Footprint method is suitable for tracking the environmental performance of one organization in different years

For organizations with a diverse portfolio willing to track their performance, defining both the activity variable (unitary value) and the reporting flow (representing the diversity of the portfolio) is advisable: The activity variable delivers a first and easily communicable figure to interpret the environmental performance development, while considering the reporting flow can help understanding changes in overall performance (e.g. due to changes in the production mix).

SYSTEM BOUNDARY

The system boundary defines which processes are included in the analysis in line with the goal of the study.

Since organizations are complex systems, the system boundary should be defined along two dimensions:

- The **organizational dimension** of the system boundary (also called "organizational boundaries" in ISO 14046) defines which parts of the organizations (i.e. which facilities, production lines, supporting activities) are included in the study.
- The **"life cycle" dimension** of the system boundary defines which part of the value chain is considered. According to the cradle-to-grave approach of the Organizational Water Footprint, the whole life cycle should be included in the study and any exclusion needs to be justified. For the downstream processes, in specific cases such as organizations acting at the beginning of the supply chain (e.g. raw material suppliers) which lack information about the further use of their products, the exclusion of the use phase and end-of-life phase is acceptable. This does not apply if the use and/or end-of-life phase are known to require water or energy. The upstream activities should always be included, and any exclusion due to data unavailability needs to be explicitly stated.

ORGANIZATIONAL WATER FOOTPRINT OF NEOPERL – A CASE STUDY ILLUSTRATING THE ORGANIZATIONAL WATER FOOTPRINT METHOD

Neoperl GmbH, located in Müllheim, is a German company that provides technological solutions for the plumbing industry, with a focus on water saving devices. Given the success of Neoperl's flow regulators' Water Footprint study at the product level (Berger et al. 2017), the company decided to evaluate the impacts of their whole value chain on local water resources by carrying out a water scarcity footprint study within the WELLE project.

The aim of the study was to gain insights into the company's water use and resulting local impacts, both within the factory gates and in the supply chain. The results are intended to inform management decisions on impact reduction opportunities and raise attention to global water scarcity. The study was not intended for comparative assertions for public disclosure.

The operations controlled by the reporting organization were assessed cradle-to-gate for the reporting year 2016. The reporting flow, which can be used as an activity variable for cross-temporal performance tracking, was determined based on the amount of products sold during the reporting period.

FURTHER ELEMENTS

Further elements of the study should be defined in the scoping phase in line with ISO 14046 and ISO/TS 14072:

- whether the study is intended for performance tracking
- cut-off criteria, which specify whether inventory data can be excluded, e.g. inputs that contribute less than 1% of the total input
- allocation procedures, which specify the partitioning of process emissions between several co-products
- Water Footprint impact assessment methods, which translate the volumes of water consumed along the supply chain into local impacts on the environment, human health and freshwater resources
- whether relevant local impacts are not covered by the selected impact assessment methods
- whether the results of the Water Footprint assessment will include one impact indicator result (e.g. water scarcity footprint, water eutrophication footprint, etc.), a comprehensive Water Footprint profile and/or a single-score Water Footprint after weighting
- the temporal and geographical coverage and resolution of the study
- data sources and data quality requirements
- uncertainties and limitations
- assumptions and value choices
- type of critical review (if any)

Please refer to Forin et al. (2019), ISO 14046 and ISO/TS 14072 for further details.

2.2 INVENTORY ANALYSIS

In the inventory phase, data is collected for all relevant water inputs and outputs:

- drawn from the environment and entering the system (as defined in the scoping phase) without previous human transformation and
- leaving the system and released to the environment without subsequent human transformation.

The water inputs and outputs are collected for the processes taking place within the system boundary, i.e. not only the organization itself, but also primary and intermediate materials, energy carriers, the use and end-of-life phase. Next to direct withdrawal of water from rivers or aquifers, production processes often use tap water or deionized water. In such cases, the elementary flows related to the water treatment process (e.g. the water withdrawn from an aquifer to produce 1 m^3 of tap water) need to be considered.

Collecting data for a whole organization is a complex task, which requires coordination within the organization itself and with suppliers. To facilitate this task, the Organizational LCA method provides a list of so-called "activities" the organization might be involved in **FIGURE 3**. Each activity includes several processes that possibly require water. Activities help mapping the data need and organizing the data collection. Furthermore, if water flows are tracked for each activity, it is easier to identify hotspots throughout the value chain and prioritize mitigation measures. Data for all activities included in the system boundary should be collected. Their granularity should be chosen according to the goals of the study (see **TABLE 1**).

Methods for environmental assessment at the organizational level propose different schemes and criteria for categorizing an organization's activities. The background is that internal or direct activities, for which an organization is responsible, are easier to assess than external or indirect activities, e.g. at the level of suppliers. Moreover, it is easier for an organization to reduce the impacts of the activities which it controls directly.

Besides GHG-Protocol categorization into scope 1, 2 and 3, other approaches such as Organizational LCA follow the supply chain rationale in the categorization. Therefore, the activities related to an organization are categorized into direct activities, indirect upstream activities, and indirect downstream activities.

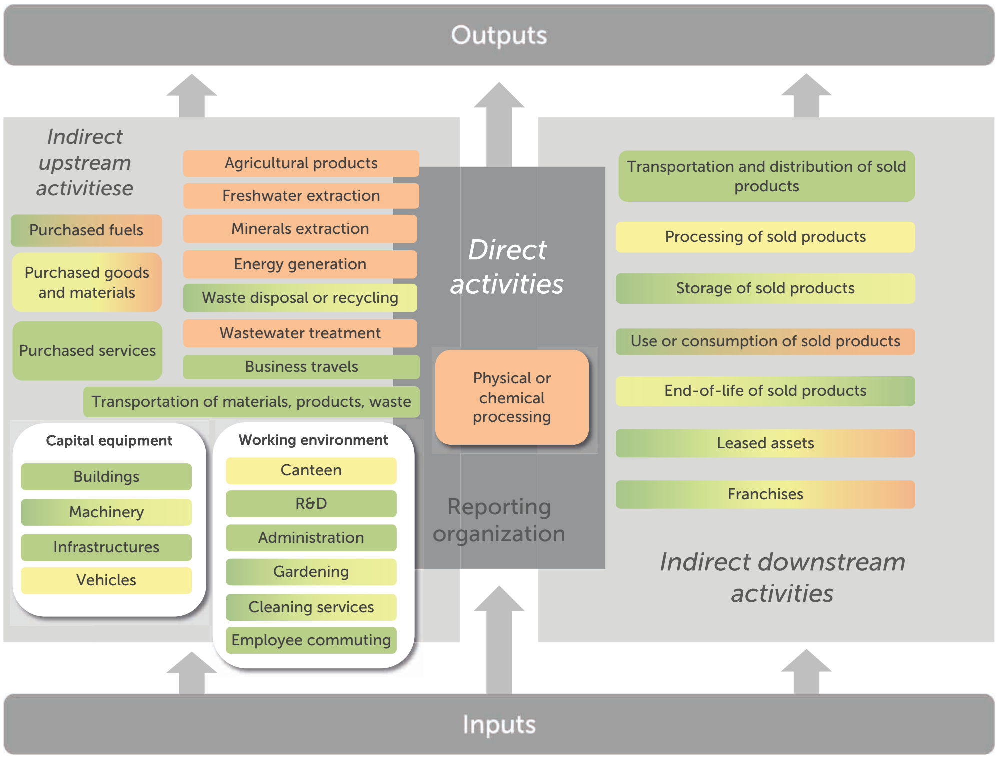
Direct activities are owned or controlled by the reporting organization, i.e. the organization or part of the organization under study (UNEP 2015). The freshwater use associated with direct activities includes the water used in activities owned or controlled by the reporting organization. This means that e.g. tap water used in the reporting organization, also if purchased, is accounted as direct water use. On the other hand, the water used to produce tap water outside the reporting organization is considered as indirect water use.

Indirect activities (not owned or controlled by the organization) are classified as upstream, if they are related to the upstream suppliers or support the tasks of the reporting organization (e.g. outsourced cleaning services, purchased machinery, external treatment of waste generated by the reporting organization). The freshwater use attributed to upstream suppliers represents the amount of water in the production of the purchased products.

Indirect downstream activities take place after the products have left the reporting organization and include distribution, the use and end-of-life phases of products. These include both

FIGURE 3

Categorization of an organization's activities and impact-based prioritization for data collection



Green: low priority; yellow: average priority; orange: high priority.

the water directly required by the organization's products in the use phase (e.g. water for washing machines) and the indirect water use of the use phase (e.g. the water used in energy generation needed to run the washing machine). For companies acting at the beginning of the supply chain (e.g. raw material suppliers) it is difficult to gather information about the use of their products. According to ISO/TS 14072, in such cases companies might exclude (part of) their downstream activities from the system boundary. This exception does not apply if the organization's products are expected to have a high water use in the downstream phases, both direct and indirect (e.g. through energy use).

The most common activities and the related categorization are displayed in **FIGURE 3**. For example, mineral extraction can be performed either directly by the reporting organization (→ direct activity) or by suppliers (→ indirect upstream activity). Business travels can also be carried out with vehicles owned by the reporting organization (→ direct activity) or other vehicles (→ indirect upstream activity). The same applies for transportation/distribution, which can also occur downstream. Among the indirect upstream activities, two particular groups are highlighted: capital equipment and working-environment related activities. They include activities normally left unconsidered in product LCA or Product Water Footprint that are part of the organizational setting. Capital equipment refers to purchased goods (vehicles, machines, etc.) and is therefore in general indirect upstream. Working-environment related activities such as canteen, gardening, cleaning services etc. are often outsourced (→ indirect upstream) but can also be carried out by the organization itself (→ direct).

It is important to consider that **FIGURE 3** includes widespread activities and takes the producing industry as a reference, but is not exhaustive. Therefore, each organization might identify further activities and disregards the ones that do not apply.

Categorizing activities is helpful for data collection, since an overview on categories gives hints on "where to look at" when collecting data and helps "not to forget" relevant activities. Inventory data and impact assessment results can be aggregated at the activity level and help identifying activity-related hotspots. Therefore, it is recommendable to increase the granularity of crucial activities, if a detailed hotspot analysis is considered. For example, data for the direct activity "manufacturing" might be clustered according to facilities or production lines to obtain a more precise overview on critical processes.

PRIORITIZATION OF DATA COLLECTION EFFORTS FOR WATER SCARCITY FOOTPRINTS

Since collecting primary data is a time intensive task, criteria for identifying the most relevant activities are described for the Organizational LCA method (UNEP 2015). The most relevant criteria mentioned are quantitative aspects such as the expected environmental impacts and the relative contribution to the total inputs of the reporting organization. For the particular case of a single-indicator assessment such as water scarcity footprints considered here, these two aspects can be summarized and advice for prioritizing data collection can be provided. A first overview, based on the experience gained in various Water Footprint studies, is indicated by the colors used in **FIGURE 3**: data collection should have the high priority for the activities highlighted in orange, average priority for the activities highlighted in yellow; low priority for the activities highlighted in green (see Forin et. al 2019 for more specific information). The activity's location plays a major role, so it is recommended to accord higher priority to activities whose water use along the value chain takes place in water scarce regions (if known).

The following activities have variable priority levels, depending on specific characteristics (as highlighted by the green-yellow-orange color gradient in **FIGURE 3**:

- Purchased fuels
  - Fossil fuels: low
  - Biofuels: high
- Purchased goods and materials
  - Mineral aggregates (e.g. sand, gravel), plastics: average
  - Otherwise: high
- Waste disposal or recycling
  - Waste disposal/treatment: average
  - Recycling: high
- Machinery
  - If e.g. special metals, electronics, rubber included: average
  - Otherwise: low
- Gardening
  - Large garden surface: average
  - Otherwise: low

- Cleaning services
  - High water need: average
  - Otherwise: low
- Storage of sold products
  - High energy use (e.g. for cooling): average
  - Otherwise: low
- Use or consumption of sold products
  - Water and/or energy use in the use phase: high
  - Otherwise: low
- End-of-life of sold products (see waste disposal or recycling)
- Leased assets and franchises
  - Highly variable depending on the type of goods/services. Please consider similar activities as orientation

For further information on variable prioritization see Forin et al. (2019).

Please note: if a Water Footprint profile including also water quality is planned, the prioritization can change. These recommendations refer to water scarcity footprints only.

Besides the criteria mentioned above based on the (expected) impacts, an organization might consider further criteria for prioritizing data collection (UNEP 2015) such as:

- Spending and revenue (the activity/the supplier involved is economically relevant for the organization)
- Suppliers' closeness (tier 1 and tier 2 suppliers might be easier to reach for obtaining primary data)
- Influence of the reporting organization on decision making (highest for direct activities, for suppliers mainly depending on the contractual conditions of the reporting organization and its market position)
- Risk exposure of the reporting organizations (e.g. operational, regulatory, or reputational risks) (Wagnitz and Kraljevic 2014)
- Preferences of critical stakeholders, if a report or external communication is planned
- Outsourced activities (if the organization plans to determine its Organizational Water Footprint for comparing the own performance in different years, it is recommendable to include activities outsourced during the period considered)

Further details on the criteria above are provided in UNEP (2015).

If primary data is not available or the resources to collect them are limited, secondary data from databases, case studies or trade data can be used to fill the gaps in the inventory. Secondary data might be necessary e.g. if suppliers "at the other end" of the supply chain cannot be identified or their data is not made available.

DATA COLLECTION APPROACHES

Depending on the study design and data availability, data can be collected following two main different schemes.

- **Top-down data collection approach:** the water inputs are considered at the level of the whole organization, by tracking e.g. the facilities' total water use and release, the material and energy purchase, sub-divided into activities in the necessary granularity according to the scope of the study.

- **Bottom-up data collection approach:** the water use values of all products or services provided by the organization (the reporting flow) or of product clusters is calculated individually first. Then it is summed up and added to the water use of non-product-related activities such as capital equipment and working environment. The bottom-up approach allows combining Product Water Footprints and Organizational Water Footprints and identifying particularly water-intensive products, facilitating hotspot analysis.

In several cases, a hybrid approach might be used, e.g. if for only one facility product-related water use data is available. The combination of the bottom-up and top-down approach should be carried out consistently and existing differences e.g. in data quality should be communicated transparently.

DATA RESOLUTION

Local water availability varies across regions and depending on seasonality. Common impact assessment methods include these aspects by providing characterization factors at a river basin scale with a monthly resolution. To take advantage of this progress in impact assessment, also inventory data needs to be collected with the highest possible geographical and temporal resolution. If feasible, water consumption data with a monthly resolution and a precise specification of the water consumption location should be collected. If this level of detail is not available, the country where water consumption takes place (e.g. the country of origin of purchased materials and underlying raw materials) should be documented.

FACILITATING DATA COLLECTION

Since data collection is a time demanding task, it is convenient to take advantage of previous experiences with environmental assessment tools. Inspired by suggestions for Organizational LCA (UNEP 2015), three main options can be suggested.

- Existing on-site assessments including direct water use (e.g. environmental management systems) can be taken as a starting point. The data collection then needs to be extended by including indirect upstream and downstream activities.

- Product Water Footprint studies carried out for some of the reporting organization's products can be used as a data source and aggregated according to the bottom-up approach. The water use related to supporting activities (mainly not accounted for in Product Water Footprints) needs to be added.

- Further data collected for environmental assessment purposes, e.g. GHG Protocol, might prove useful. For example, if GHG Protocol Scope 3 data have been collected for employee commuting or business travels (amount of travels), these can be linked to water use estimates for such activities.

In order to facilitate data collection for water consumption in indirect activities, a water inventory database has been developed in the WELLE project as described below.

OFFSETTING AND AVOIDED IMPACTS

In line with ISO 14046, Water Footprint results do not include offsetting. That is, activities initiated by the reporting organization which provide water (e.g. sea water desalinization) or reduce water consumption (e.g. via water efficient technologies) outside the organization's system boundaries cannot compensate for the Water Footprint results of an organization.

The same applies to avoided impacts within the system boundaries, i.e. water use or water-related impacts that do not take place if compared to a reference scenario. For example, if an organization's products save water compared to other products. A separate calculation of avoided impacts in the framework of an Organizational Water Footprint study is possible as a scenario analysis, but results without avoided impacts need to be displayed separately.

WELLE DATABASE

While most companies can monitor their internal activities rather easily, they rely on external data about the water consumption of their indirect upstream activities (e.g. material and energy supply chains). Thinkstep's life cycle inventory database GaBi 8 can be used for this purpose as it contains water use and consumption data related to the production of materials, the generation of energy, transports, etc. However, information concerning the volumes of water consumed per kg of a material or per kWh electric energy is not sufficient to enable the analysis of water scarcity footprints. Spatial information on where the water consumption has occurred throughout the supply chains is needed in order to combine it with local scarcity data and, in this way, to enable analyzing the resulting local impacts. Such spatially explicit water inventory data is currently available for relevant processes in the GaBi 8 database (energy and agricultural datasets), however, not for abiotic materials, manufacturing processes, transports, etc. Therefore, a WELLE water database has been created by enhancing datasets from the GaBi database as follows:

Relevant datasets were identified by the industry partners participating in the WELLE project. These datasets were investigated comprehensively and modified to provide the required spatially explicit water consumption data.

In general, two approaches were taken. In a "bottom-up" approach spatial information from the underlying LCA models was used to convert unspecific water flows to country specific flows. In the other "top-down" approach unspecific water consumption data was mapped to different countries according to production statistics. For details please refer to Thinkstep (2020). Further, aggregated datasets (unit processes) are provided in a disaggregated form, allowing for the selection of country specific energy and material mixes or market mixes based on several countries.

The WELLE database, which contains spatially explicit water inventories for about 150 material and energy datasets can be accessed online along with a detailed description of the database development[4]. It is also integrated into the WELLE Tool presented in section 3.

4 http://welle.see.tu-berlin.de/#database

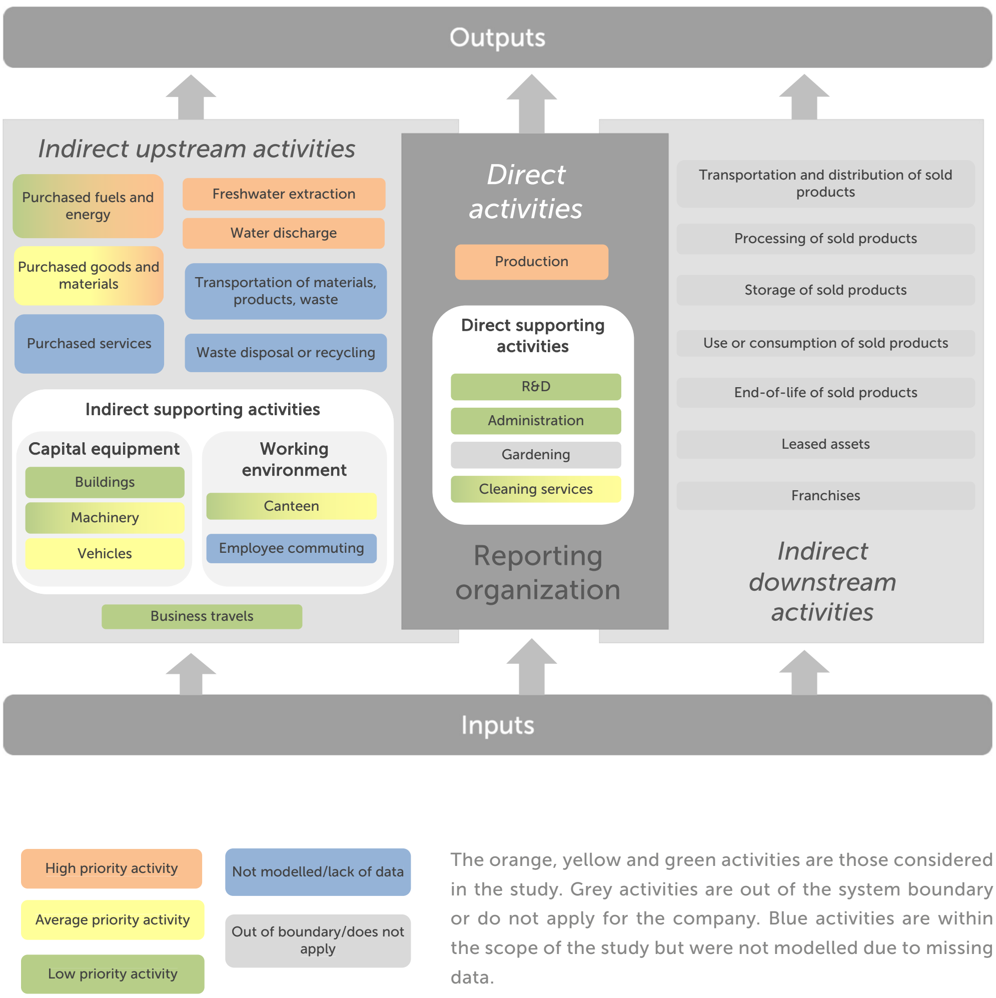
INVENTORY ANALYSIS OF NEOPERL'S ORGANIZATIONAL WATER FOOTPRINT

To facilitate data collection and interpretation of results, company activities were defined and classified into direct activities and indirect upstream activities based on the general categorization scheme (**FIGURE 3**). The outcome is shown in **FIGURE 4**.

Neoperl collected direct water consumption data from internal measurements. The data collection for indirect activities followed the top-down data collection approach described above. For purchased materials and energy as well as for supporting activities, company-own data was collected (purchased materials and energy, business travels, meals in canteens, buildings, machines, etc.). The associated water consumption in supply chains was determined by means of the WELLE database described above and the WELLE Tool presented in section 3.

FIGURE 4

Neoperl's organization model for the organizational water scarcity footprint case study

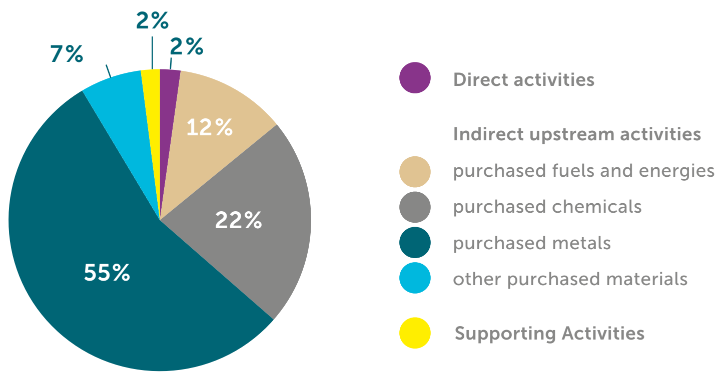


The orange, yellow and green activities are those considered in the study. Grey activities are out of the system boundary or do not apply for the company. Blue activities are within the scope of the study but were not modelled due to missing data.

Neoperl's value chain freshwater consumption in 2016 was around 110,000 m^3. The main contributors to freshwater consumption along Neoperl's value chain are indirect upstream activities, mainly metals (**FIGURE 5**). Within the metal category, disaggregated results show that stainless steel contributes to 74% of water consumption in this category, followed by brass (11%). Water from 34 countries are involved in Neoperl's value chain, with China and Germany dominating the results (28% and 23% respectively) (**FIGURE 6**).

FIGURE 5

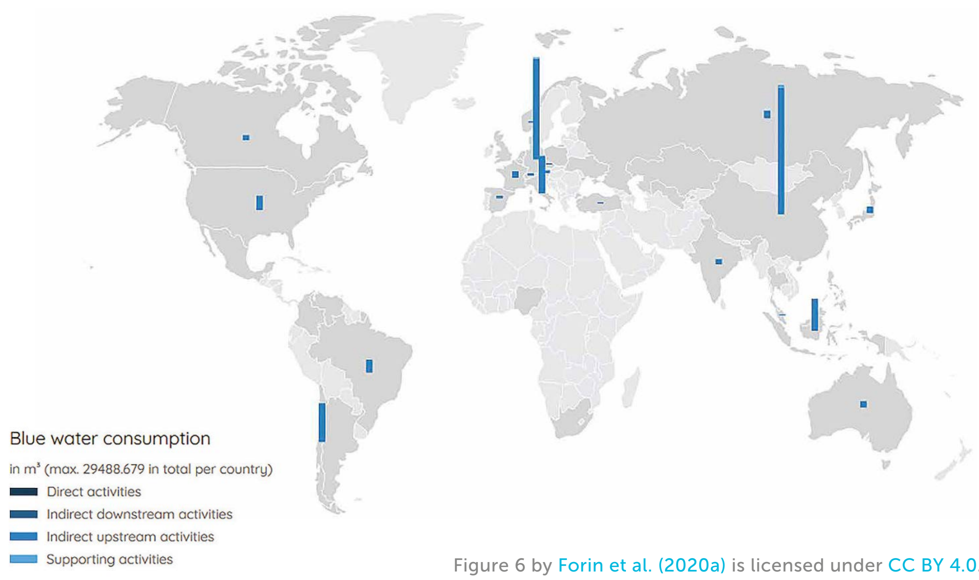
Neoperl GmbH's 2016 Organizational Water Footprint – Potential freshwater consumption by activity



Forin et al. 2020a

FIGURE 6

Neoperl GmbH's 2016 Organizational Water Footprint – Potential blue water consumption by country



2.3 IMPACT ASSESSMENT

The inventory analysis reveals the volumes of water consumed in different regions along an organization's supply chain. However, a water consumption of 1 m^3 in a water abundant region does not compare to consuming the same amount of water in a water scarce area. Therefore, the impact assessment step translates the volumes of water consumption into potential local impacts.

For this, volumetric water flows compiled in the inventory analysis are multiplied with region-specific characterization factors which account for the flows' impacts within designated impact categories. Examples for intermediate (midpoint) impacts along the cause-effect chain of water use include water deprivation for human needs such as domestic use or agriculture as well as depriving ecosystems from water. Impacts on the final (endpoint) steps of the cause effect chain of water use include damage on human health caused by spreading of diseases or malnutrition as well as damages to ecosystems such as loss of terrestrial or aquatic species e.g. by changing flow regimes of rivers or lowering groundwater tables.

> a water consumption of 1 m^3 in a water abundant region does not compare to consuming the same amount of water in a water scarce area.

The ISO 14046 standard does not prescribe the use of specific impact assessment methods but sets requirements which they need to fulfill. Accordingly, methods like AWaRe (Boulay et al. 2018), WAVE+ (Berger et al. 2018) or other relevant impact assessment methods may be applied.

Practitioners who work with very large inventories relative to the water availability in the respective basin should pay attention to potential "non-marginal effects". These can occur if the consumption of large volumes of water in basins with relatively low availability changes the water scarcity value of the entire basin and, thus, renders existing characterization factors inaccurate. See Boulay et. al (2019) and Forin et al. (2020) for further information.

IMPACT ASSESSMENT OF NEOPERL'S ORGANIZATIONAL WATER FOOTPRINT

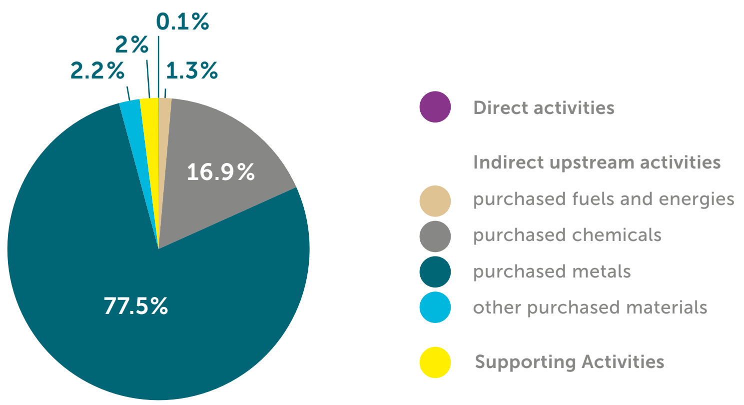
The local impacts of Neoperl's water consumption were calculated by means of the AWaRe method (Boulay et al. 2018), which describes the potential of depriving other users from using water when consuming water in a certain basin.

From an activity category perspective, purchased metals are the main contributors to local water scarcity (**FIGURE 7**). The impacts were mainly caused by stainless steel and brass (49% and 25% of Neoperl's total impacts, respectively). From a spatial perspective, the most affected countries were China (40% of total impacts) and Chile (23%). While impacts in Chile were mainly related to the copper mining in the brass supply chain, China was involved in several materials' supply chains, including the material hotspot stainless steel (**FIGURE 8**).

2.5% of Neoperl's water scarcity impacts are related to supporting activities. The main contributor is machinery, mainly due to the aluminum components. The influence of direct activities is very limited (0.1%), due to the low AWaRe factor at the facility's location in Southern Germany.

FIGURE 7

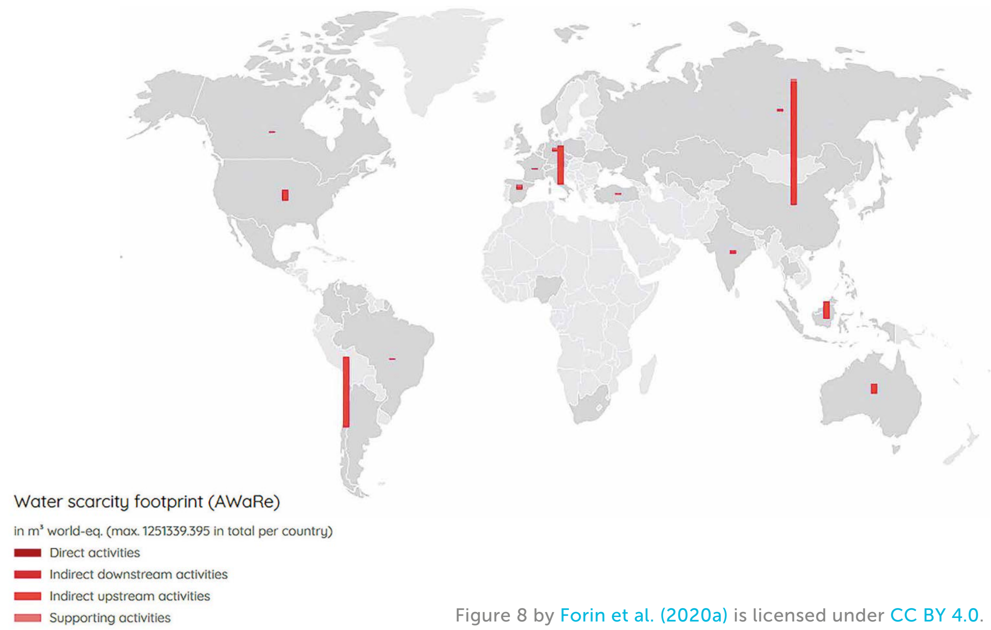
Neoperl GmbH's 2016 Organizational Water Footprint – Water scarcity-weighted potential freshwater consumption by activity



Forin et al. 2020a

FIGURE 8

Neoperl GmbH's 2016 Organizational Water Footprint – Water scarcity-weighted freshwater consumption by country



2.4 INTERPRETATION

Interpreting the results from a life-cycle oriented study includes:

- Presenting and discussing relevant water consumption patterns and resulting local impacts along the organization's value chain;
- Identifying significant issues, which strongly influence the Organizational Water Footprint. This can include certain activities (e.g. a purchased materials) as well as modelling choices (e.g. cut-off criteria) or assumptions (e.g. concerning the location of sub-suppliers);
- Analyzing the completeness of data for significant issues as well as the consistency with the goal and scope definition;
- Performing sensitivity analyses for significant issues, i.e. changing the parameters, modelling choices or assumptions to check, how sensitive the results react to these changes;
- Identifying limitations of the study;
- Drawing conclusions and providing recommendations;
- In case of performance tracking, modifications to the reporting unit, reference period, and system boundary need to be considered. That is, if the organization's performance of two different reference periods is compared, changes in the organization's structure (outsourced activities, mergers, etc.) and in the product portfolio need to be accounted for in order to track the sources of change in overall environmental impacts. Moreover, it should be discussed whether the reporting unit and the system boundary are in line with the goal of the study.

INTERPRETATION OF NEOPERL'S ORGANIZATIONAL WATER FOOTPRINT

Analyzing Neoperl's water consumption and resulting local impacts along the entire value chain allowed for revealing the most relevant activities (purchase of stainless steel and brass) and identifying local hotspots in global supply chains (China and Chile). A comprehensive analysis of these significant issues has shown that the underlying data is complete and consistent with the study's goal and scope definition.

A further significant issue is the modelling of the use phase of Neoperl's products, which partly reduce water use in households. As these water savings cannot be subtracted from the company's Water Footprint directly (see section on avoided impacts above), a scenario analysis has been conducted. Results show that the water consumption reduction potential of Neoperl's flow regulators (30,000,000 pieces produced during the reporting year) is 216 times higher than the company's total water consumption including supply chains.

3

THE WELLE TOOL

An Online application to support an Organizational Water Footprint assessment

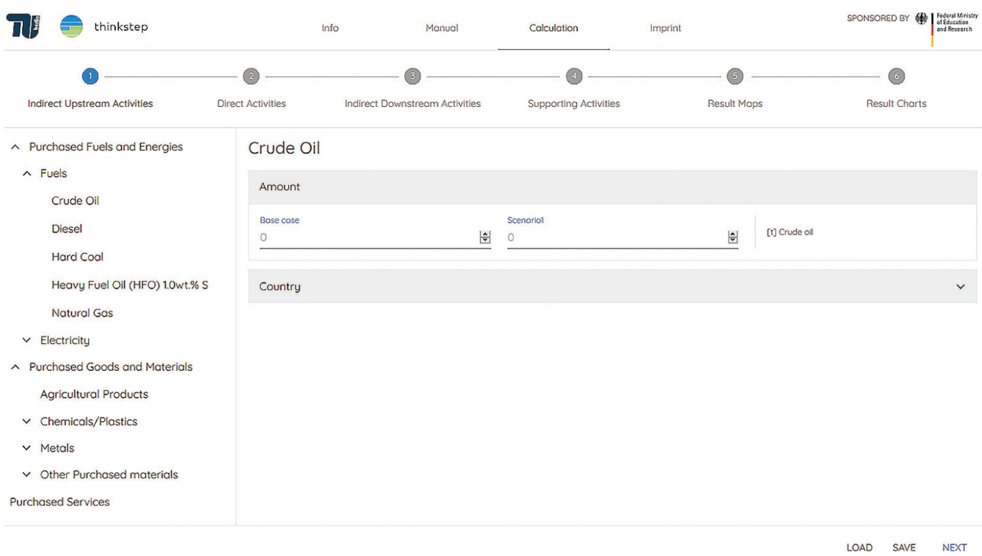
The WELLE Tool is a free online application[5] which assists companies in calculating their Organizational Water Footprint following the Organizational Water Footprint method described in section 2. Users can enter the direct water use at premises as well as indirect upstream activities (e.g. amounts of purchased materials and energy), indirect downstream activities (e.g. volumes of water consumed in products' use phases), and supporting activities (e.g. business trips) as listed in **TABLE 2**. By linking this information to the activity specific water consumption data provided by the WELLE database, the organization's water consumption along its value chain is determined. Further, the WELLE Tool applies country-specific characterization factors to the country-specific water consumption data available in the WELLE database and, in this way, allows for analyzing the resulting local impacts.

In the following, input and result sections of the WELLE Tool are summarized.

5 The WELLE Tool is available via https://wf-tools.see.tu-berlin.de/wf-tools/owf.

FIGURE 9

Input mask of the WELLE Tool



3.1 INDIRECT UPSTREAM ACTIVITIES

Indirect upstream activities comprise an organization's energy and material supply chains. For fuels and energy, users of the WELLE Tool can distinguish between different types of fuel and sources of energy, e.g. crude oil, diesel, hard coal, heavy fuel, natural gas, grid mix electricity, electricity from biomass, hydro power, electricity from lignite, electricity from natural gas, nuclear power, photovoltaic or electricity from wind power. For purchased materials, users of the WELLE Tool can choose from a wide range of materials that are often purchased by companies such as chemicals, polymers, metals, agricultural products, or packaging materials.

3.2 DIRECT ACTIVITIES

Direct activities comprise processes at an organization's premises. Typically, direct activities refer to the manufacturing of products or the provision of services. Users of the WELLE Tool can distinguish between different types of input water such as deionized water, freshwater extraction from natural water sources as well as tap water. Analogously, users can specify water discharge (output) which is separated as the release of freshwater or wastewater.

3.3 INDIRECT DOWNSTREAM ACTIVITIES

Indirect downstream activities comprise downstream life cycle stages of an organization's products or services e.g. processing of sold products, storage of sold products, use or consumption of sold products, end-of-life of sold products as well as leased assets and franchises. Users of the WELLE Tool can enter the water consumption occurring in these downstream activities and the respective locations directly.

3.4 SUPPORTING ACTIVITIES

Supporting activities comprise overhead activities that are required to keep an organization operating. Users of the WELLE Tool can enter activities such as employee commuting, provision of food to employees in a canteen, business travels by plane, train and road transportation (which can also be represented through the amount of purchased diesel), maintaining a work environment (work places, administration, cleaning services, gardening, research and development) as well as capital equipment of an organization (building, machinery, company cars).

FIGURE 10

Screenshot vom WELLE Tool der supporting activities

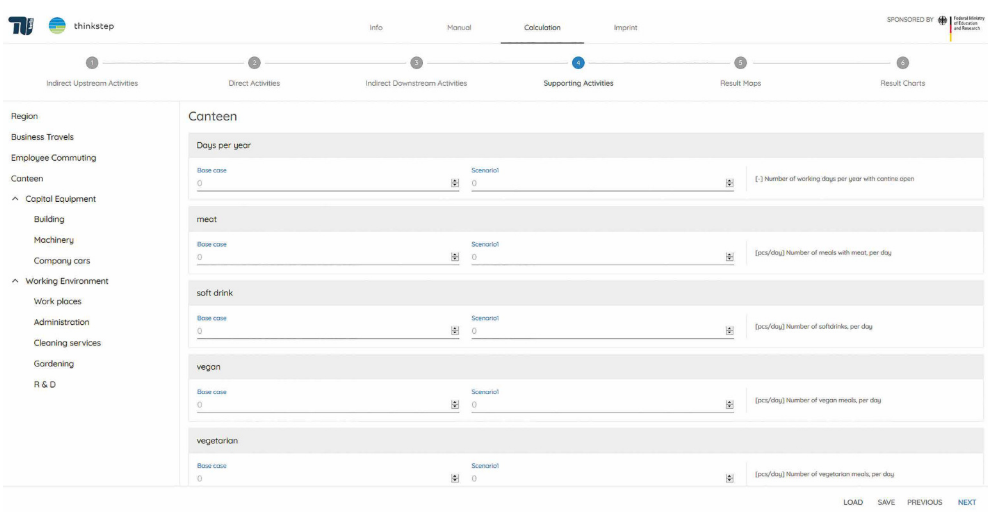


TABLE 2

Input sections of the WELLE Tool.

Indirect upstream activities	Purchased Fuels and Energies	Fuels	Crude Oil
			Diesel
			Hard Coal
			Heavy Fuel Oil (HFO) 1.0wt.% S
			Natural Gas
		Electricity	From Grid
			From Biomass (solid)
			From Hard Coal
			From Heavy Fuel (HFO)
			From Hydro Power
			From Lignite
			From Natural Gas
			From Nuclear
			From Photovoltaic
			From Wind Power
	Purchased Goods and Materials	Agricultural Products	US: Corn grains
			US: Soy bean oil, conditioned
			Generic Agricultural Product
		Chemicals/ Plastics	Acrylonitrile Butadiene Styrene Granulate (ABS)
			Polyvinylchloride Granulate (S-PVC)
			Polyethylene Terephthalate Fibers (PET)
			Polybutylene Terephthalate Granulate (PBT)
			Polyethylene Low Density Granulate (LDPE/PE-LD)
			Polyethylene High Density Granulate (HDPE/PE-HD)
			Polyoxymethylene Granulate (POM)
			Polyamide 6.6 Granulate (PA 6.6) (HMDA)
			Polypropylene Granulate (PP)
			Nitrile Butadiene Rubber (NBR)
			Polysulfone (PSU)
			Epoxy resin (EP)
			Polyethylene Cross-Linked (PEXa)
			Polyethylene Terephthalate Granulate (PET)
			Polyamide 6 Granulate (PA 6)
			Ethylene Propylene Diene Elastomer (EPDM)
		Metals	Aluminum
			Cast Iron
			Steel Alloyed
			Steel Non-Alloyed
			Stainless Steel
			Brass
			Lead
			Silver
			Gold
			Nickel
			Copper
			Tin
		Other Purchased Materials	Wooden Pallet
			Silicone
			Cardboard
			Generic Product/Others
	Purchased services	Generic	Generic

Direct activities	Direct water use	Input	Deionized water
			Freshwater extraction
			Tap water
		Output	Freshwater release
			Wastewater
Indirect down-stream activities			End-of-life of Sold products
			Franchises
			Leased Assets
			Processing of Sold Products
			Storage of Sold Products
			Use or Consumption of Sold Products
Supporting Activities	Business Travels		Travel by plane
			Travel by Train
			Travel by Car and Truck
	Employee Commuting		Travel by Train
			Travel by Plane
			Travel by Car <2 L
			Travel by Car > L
	Canteen	Days per year	Meat
			Soft Drink
			Vegan
			Vegetarian
	Capital equipment		Building
			Machinery
			Company cars
	Working Environment		Work places
			Administration
			Cleaning Services
			Gardening
			Research & Development

3.5 RESULTS

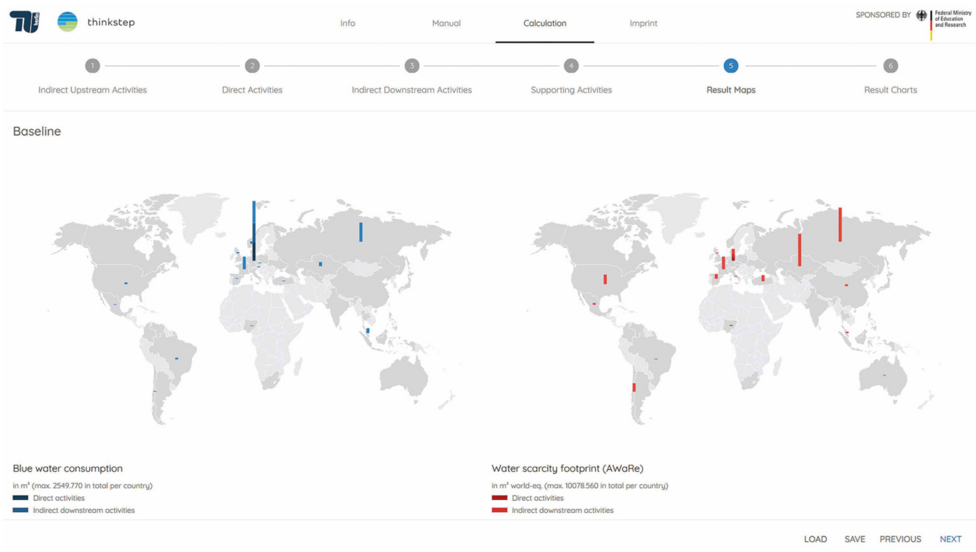
Results are displayed on a world map and in stacked bar charts for the default and an (optional) alternative scenario.

3.5.1 RESULT MAPS

Four maps display the volumetric water consumption (blue Water Footprint) as well as the water scarcity footprint (impact assessment result determined based on AWARE) for both scenarios. Upon clicking on a country, the individual contributions of the four activities. are displayed.

FIGURE 11

Visualization of the regional water consumption impacts

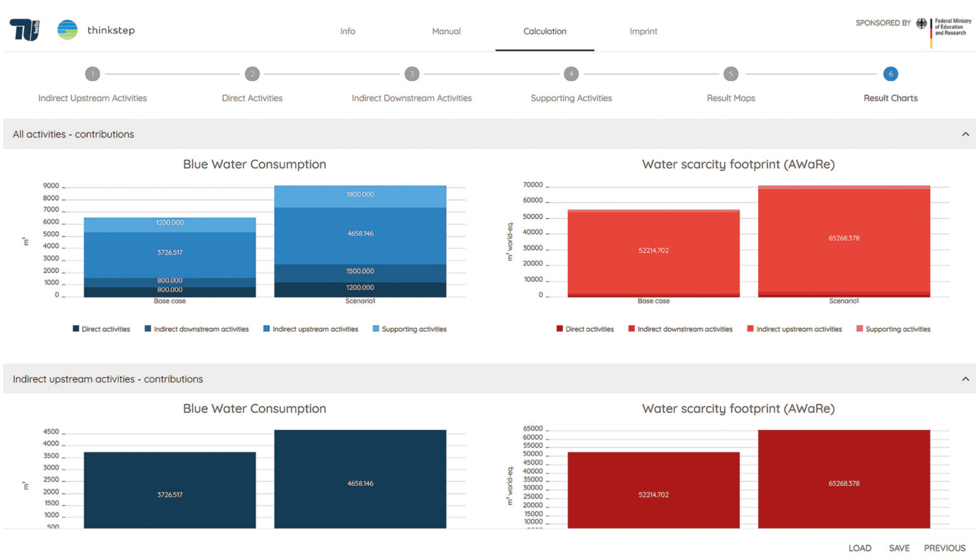


3.5.2 RESULT CHARTS

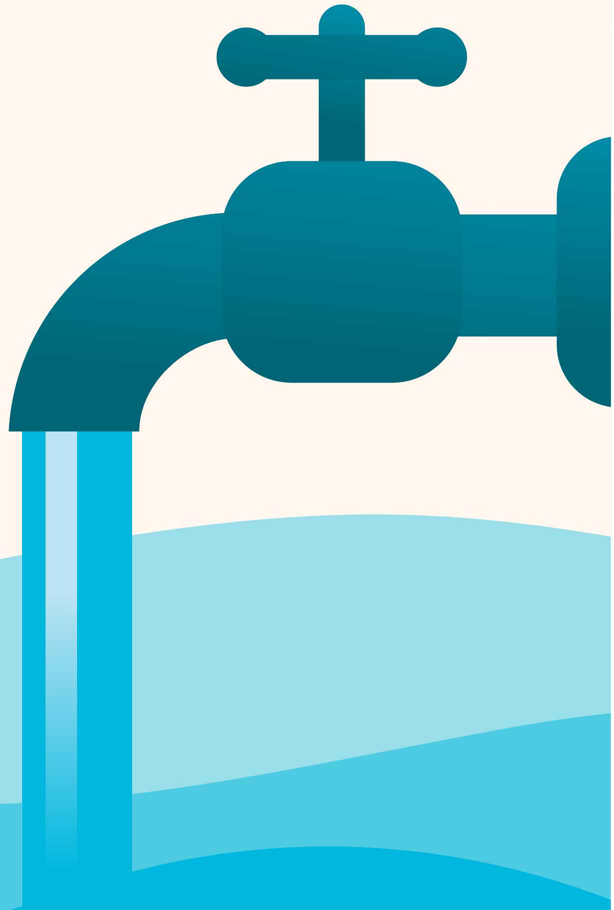
The stacked bar charts display the volumetric water consumption (blue Water Footprint) as well as the water scarcity footprint (impact assessment result determined based on AWARE) for both scenarios within one chart at a time. Separate charts for the input sections *indirect upstream activities, direct activities* and *indirect downstream activities* as well as overall results are available. Different colors allow the user to conclude on what specific activities contribute to the aggregated result e.g. purchased fuels and energies, purchased goods and materials, services etc.

FIGURE 12

Visualization of the water consumption per life cycle stage



4



REDUCING AN ORGANIZATION'S WATER FOOTPRINT AND MITIGATING WATER SCARCITY ALONG SUPPLY CHAINS

So far, a method for determining Organizational Water Footprints has been introduced and a database and online tool for supporting its application have been presented, which have been tested and refined by industry partners in the WELLE project:

- Evonik conducted an Organizational Water Footprint of a chemical and a biotechnological production line of amino acids
- German Copper Alliance analyzed the Organizational Water Footprint of the European copper production
- Neoperl analyzed the Organizational Water Footprint of the entire company (presented in textboxes throughout this guidance)
- Volkswagen conducted an Organizational Water Footprint study of its production site in Uitenhage, South Africa

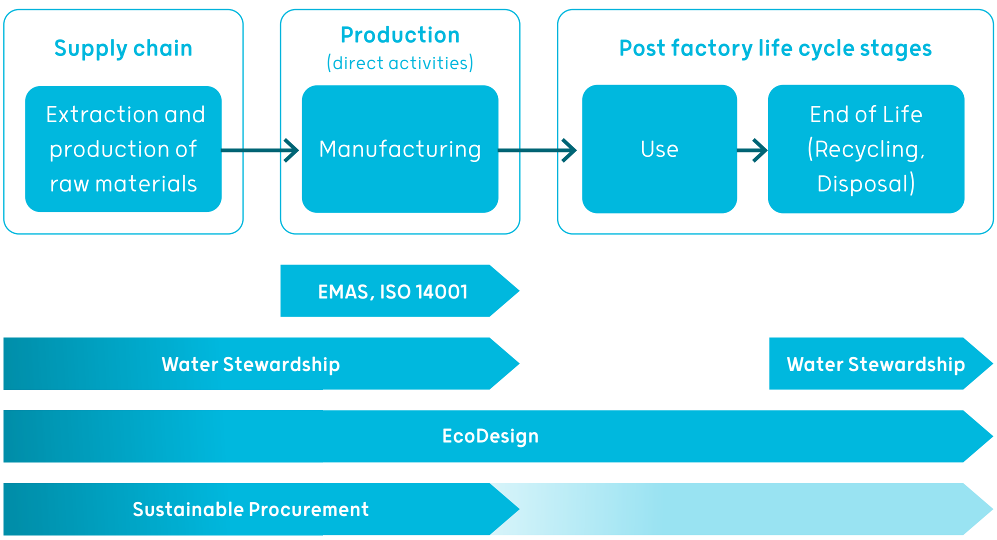
The Organizational Water Footprint results reveal hotspots in terms of water consumption and local impacts along the value chain, which can be used as a starting point to reduce water consumption and mitigate local water scarcity. The four WELLE case studies and other studies have shown that an organization's direct water consumption usually contributes to less than 5 % of its total Water Footprint only.

For this reason, optimization strategies need to consider an organization's entire value chain. Next to on-site focused environmental management systems (EMAS 2011, ISO 2015), water stewardship measures, ecodesign approaches, and a sustainable procurement strategy are advocated (**FIGURE 9**).

While the leverage of reducing an organization's Water Footprint is usually larger in supply chains, the organization's control on water consumption patterns is decreasing along supply chain levels. Ideally, an organization's water scarcity mitigation strategy comprises the con-

FIGURE 13

Measures for reducing an Organization's Water Footprint and the life cycle stages which they target.



current implementation of several measures tackling all water use hotspots regardless of the life cycle stage at which they occur. When trying to reduce an organization's Water Footprint, care should be taken to avoid shifting water-related environmental impacts to other environmental burdens (e.g. from the water to the carbon footprint).

4.1 WATER STEWARDSHIP MEASURES

The International Water Stewardship Standard developed by the Alliance for Water Stewardship (AWS) focuses predominantly on sustainable development of local water resources and defines water stewardship as "the use of water that is socially and culturally equitable, environmentally sustainable and economically beneficial, achieved through a stakeholder-inclusive process that involves site- and catchment-based actions" (AWS 2019). Implementation of local water stewardship or comparable measures at an organization's premises can be useful, if an organization's direct water consumption contributes a relevant share to its total Water Footprint.

If the hotspots of an organization's Water Footprint have been identified in the supply chains, the organization can try to initiate water stewardship process together with suppliers operating in critical basins. In collective action involving the supplier, other water users in the basin, the local administration, the public, NGOs, and other relevant stakeholders, different measures can be pursued including:

- Increasing water use efficiencies
- Reducing losses in the local water system
- Establishing water allocation plans
- Joint investments in water supply and waste water treatment technologies
- Improved water governance

If a direct involvement in water stewardship activities of suppliers seems not possible, organizations may request certificates from suppliers to prove responsible water management. If possible, organizations can support suppliers in receiving such certifications. Incentivizing suppliers to introduce sustainability measures may be an easy task for multi-national corporations but can turn out to be difficult for small organizations purchasing from large companies. In such cases, companies may want to reconsider their procurement strategy or resort to ecodesign approaches.

4.2 ECODESIGN

Ecodesign is defined by the European Commission as "a preventive approach, designed to optimize the environmental performance of products, while maintaining their functional qualities" (EU 2009) and may be applied under specific consideration of water. Organizations can apply ecodesign to decrease the Water Footprint of their products and services, and thus of the organization, by considering water use aspects along the life cycle of a product already in its design phase.

- **Supply chain:** Selection of less water intense materials or use of secondary materials (if associated with a lower Water Footprint)
- **Production:** Apply water efficient manufacturing process, reuse of process and waste water as well as reuse of material clippings during production
- **Post-factory life cycle stages:**
  - **Use:** Design for low water requirements during the use phase of a product or service or provision of consumer guidance for water efficient use
  - **End-of-life:** Recycling or disposal without water intensive or water polluting processes

4.3 SUSTAINABLE PROCUREMENT

As supply chain activities often cause the largest share of an organization's total water use and resulting impacts, the procurement is key in reducing an organization's Water Footprint.

An organization's procurement strategy may be rendered more sustainable in terms of water use impacts by:

- Raising awareness of purchasing departments on the large water use of material production and the relevant influence of purchasing decisions on an organization's Water Footprint
- Close cooperation between a company's purchasing- and environmental management department
- Incorporating environmental indicators and targets in purchasing decisions

REDUCING NEOPERL'S ORGANIZATIONAL WATER FOOTPRINT

Neoperl runs an environmental management system (ISO 14001) and its own production facilities use water as efficiently as possible. Since the largest share of Neoperl's Water Footprint has been identified in the indirect upstream activities, the abovementioned mitigation measures have been explored.

Initiating water stewardship processes at suppliers turned out to be unfeasible considering changing suppliers and purchases from large multinational corporations. Sustainability aspects are already part of Neoperl's purchase strategy but specific water related criteria would be difficult to implement. Finally, Neoperl explored and implemented ecodesign measures focusing on the substitution of water intense materials. As a concrete example, hose stainless-steel reinforcements were partly substituted by polyamide (PA6) which lead to an estimated saving of more than 8,500 m^3 freshwater as well as a potential reduction of the products' water scarcity impact by 97%.

5

SUMMARY

Freshwater is a vital resource for humans and ecosystems but it is scarce in many regions around the world. Organizations measure and manage direct water use at their premises but usually neglect the indirect water use associated with global supply chains – even though the latter can be higher by several orders of magnitude.

Against this background, the BMBF funded research project "Water Footprint for Organizations – Local Measures in Global Supply Chains (WELLE)" has been launched by TU Berlin, Evonik, German Copper Alliance, Neoperl, thinkstep and Volkswagen. The project aims to support organizations in determining their complete Organizational Water Footprint, identifying local hotspots in global supply chains and taking action to reduce their Organizational Water Footprint and mitigate water scarcity at critical basins.

Within the WELLE project a method for analyzing an organization's Water Footprint has been developed (Forin et al. 2019). This Practitioners' Guidance intends to support stakeholders in conducting Organizational Water Footprint studies by presenting the method in a clear and concise way and by illustrating each step with a practical example. Further, the WELLE database, which provides water consumption data of an organization's indirect activities (material and energy purchase, business trips, canteens, etc.) in a spatially explicit way is introduced. In order to facilitate the application of the method and the database, the WELLE Tool has been developed and a manual for its application is presented in this guide. Finally, options to reduce an organization's Water Footprint and to mitigate local water scarcity by means of water stewardship approaches, sustainable purchase strategies and ecodesign measures are presented.

By analyzing their Water Footprints, organizations can determine water use and resulting local impacts at premises and "beyond the fence" along global supply chains. In this way they can reduce water risks and contribute to a more sustainable use of the world's limited freshwater resources.

6 WELLE RESOURCES

6.1 ONLINE RESSOURCES

- WELLE Tool – Calculating an Organizational Water Footprint: https://wf-tools.see.tu-berlin.de/wf-tools/owf/
- WELLE Organizational Water Footprint database: https://welle.see.tu-berlin.de/#database
- WELLE project Website: https://welle.see.tu-berlin.de/
- Water Footprint Tools of the TU Berlin Chair of Sustainable Engineering: https://wf-tools.see.tu-berlin.de/

6.2 READING ADVICE

The Organizational Water Footprint Practitioners' Guidance "Organizational Water Footprint – Analyzing water use and mitigating water scarcity throughout supply chains" was developed as part of the BMBF-funded project *WELLE*. Two ISO standards, namely ISO 14046 and ISO 14072, were critical in developing the Organizational Water Footprint method. Readers are advised to read these standards in order to familiarize themselves with terminology and methodological aspects used in the Organizational Water Footprint Practitioner's Guidance.

- ISO/TS 14072:2014 Environmental management — Life cycle assessment — Requirements and guidelines for organizational life cycle assessment
- ISO 14046:2014 Environmental management — Water footprint — Principles, requirements and guidelines

Additional references on the development and rational of the Organizational Water Footprint method include:

- Forin, Silvia, Markus Berger, and Matthias Finkbeiner. 2018. 'Measuring Water-Related Environmental Impacts of Organizations: Existing Methods and Research Gaps'. *Advanced Sustainable Systems* 2 (10): 1700157. https://doi.org/10.1002/adsu.201700157.
- Forin, Silvia, Natalia Mikosch, Markus Berger, and Matthias Finkbeiner. 2019. 'Organizational Water Footprint: A Methodological Guidance'. *The International Journal of Life Cycle Assessment*, online-first. https://doi.org/10.1007/s11367-019-01670-2.
- Forin, Silvia, Markus Berger, and Matthias Finkbeiner. 2020. 'Comment to "Marginal and Non-Marginal Approaches in Characterization: How Context and Scale Affect the Selection of an Adequate Characterization Factor. The AWARE Model Example"'. *The International Journal of Life Cycle Assessment*, online-first. https://doi.org/10.1007/s11367-019-01726-3.
- Forin, Silvia, Jutta Gossmann, Christoph Weis, Daniel Thylmann, Jonas Bunsen, Markus Berger, and Matthias Finkbeiner. 2020. 'Organizational Water Footprint to Support Decision Making: A Case Study for a German Technological Solutions Provider for the Plumbing Industry https://doi.org/10.3390/w12030847.

7 BIBLIOGRAPHY

AWS. 2019. 'International Water Stewardship Standard – Version 2.0'. Alliance for Water Stewardship. https://a4ws.org/wp-content/uploads/2019/03/AWS_Standard_2.0_2019_Final.pdf.

Berger, Markus, Stephanie Eisner, Ruud van der Ent, Martina Flörke, Andreas Link, Joseph Poligkeit, Vanessa Bach, and Matthias Finkbeiner. 2018. 'Enhancing the Water Accounting and Vulnerability Evaluation Model: WAVE+'. *Environmental Science & Technology* 52 (18): 10757–10766. https://doi.org/10.1021/acs.est.7b05164.

Berger, Markus, Michael Söchtig, Christoph Weis, and Matthias Finkbeiner. 2017. 'Amount of Water Needed to Save 1 M3 of Water: Life Cycle Assessment of a Flow Regulator'. *Applied Water Science* 7 (3): 1399–1407. https://doi.org/10.1007/s13201-015-0328-5.

Berger, Markus, Jens Warsen, Stephan Krinke, Vanessa Bach, and Matthias Finkbeiner. 2012. 'Water Footprint of European Cars: Potential Impacts of Water Consumption along Automobile Life Cycles'. *Environmental Science & Technology* 46 (7): 4091–4099. https://doi.org/10.1021/es2040043.

Boulay, Anne-Marie, Jane Bare, Lorenzo Benini, Markus Berger, Michael J. Lathuillière, Alessandro Manzardo, Manuele Margni, et al. 2018. 'The WULCA Consensus Characterization Model for Water Scarcity Footprints: Assessing Impacts of Water Consumption Based on Available Water Remaining (AWARE)'. *The International Journal of Life Cycle Assessment* 23 (2): 368–378. https://doi.org/10.1007/s11367-017-1333-8.

Boulay, Anne-Marie, Lorenzo Benini, and Serenella Sala. 2019. 'Marginal and Non-Marginal Approaches in Characterization: How Context and Scale Affect the Selection of an Adequate Characterization Model. The AWARE Model Example'. *The International Journal of Life Cycle Assessment*, August. https://doi.org/10.1007/s11367-019-01680-0.

CDP. 2018. 'Treading Water: Global Water Report 2018'. *Carbon Disclosure Project* 2018. https://www.cdp.net/en/research/global-reports/global-water-report-2018.

EMAS, European Commission. 2011. '2011/832/EU: Commission Decision of 7 December 2011 Concerning a Guide on EU Corporate Registration, Third Country and Global Registration under Regulation (EC) No 1221/2009 of the European Parliament and of the Council on the Voluntary Participation by Organisations in a Community Eco-Management and Audit Scheme (EMAS)'. Official Journal of the European Union. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011D0832.

EU 2009. *Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 Establishing a Framework for the Setting of Ecodesign Requirements for Energy-Related Products (Text with EEA Relevance). 285.* Vol. OJ L. http://data.europa.eu/eli/dir/2009/125/oj/eng.

Forin, Silvia, Markus Berger, and Matthias Finkbeiner. 2020. 'Comment to "Marginal and Non-Marginal Approaches in Characterization: How Context and Scale Affect the Selection of an Adequate Characterization Factor. The AWARE Model Example"'. *The International Journal of Life Cycle Assessment*, January. https://doi.org/10.1007/s11367-019-01726-3.

Forin, Silvia, Jutta Gossmann, Christoph Weis, Daniel Thylmann, Jonas Bunsen, Markus Berger, and Matthias Finkbeiner. 2020a. 'Organizational Water Footprint to Support Decision Making: A Case Study for a German Technological Solutions Provider for the Plumbing Industry https://doi.org/10.3390/w12030847.

Forin, Silvia, Natalia Mikosch, Markus Berger, and Matthias Finkbeiner. 2019. 'Organizational Water Footprint: A Methodological Guidance'. *The International Journal of Life Cycle Assessment*, August. https://doi.org/10.1007/s11367-019-01670-2.

Forin, Silvia, Markus Berger, and Matthias Finkbeiner. 2018. 'Measuring Water-Related Environmental Impacts of Organizations: Existing Methods and Research Gaps'. *Advanced Sustainable Systems* 2 (10): 1700157. https://doi.org/10.1002/adsu.201700157.

ISO 14001:2015. *Environmental management systems — Requirements with guidance for use*. https://www.iso.org/standard/60857.html.

ISO 14046:2014. *Environmental Management – Water Footprint – Principles, Requirements and Guidelines*. https://www.iso.org/standard/43263.html.

ISO 14072:2014. *Environmental Management – Life Cycle Assessment – Requirements and Guidelines for Organizational Life Cycle Assessment.* https://www.iso.org/standard/61104.html.

Lenzen, Manfred, Daniel Moran, Anik Bhaduri, Keiichiro Kanemoto, Maksud Bekchanov, Arne Geschke, and Barney Foran. 2013. 'International Trade of Scarce Water'. *Ecological Economics* 94 (October): 78–85. https://doi.org/10.1016/j.ecolecon.2013.06.018.

UNEP 2015. *Guidance on Organizational Life Cycle Assessment.* https://www.lifecycleinitiative.org/wp-content/uploads/2015/04/o-lca_24.4.15-web.pdf.

Thinkstep. 2020. 'Organizational Water Footprint Tool – Database Documentation'. Sphera. http://welle.see.tu-berlin.de/data/WELLE_DB_Documentation.pdf.

Tukker, A, T Bulavskaya, S Giljum, A. de Koning, S Lutter, M Simas, K Stadler, and R Wood. 2014. *The Global Resource Footprint of Nations. Carbon, Water, Land and Materials Embodied in Trade and Final Consumption, Calculated with EXIOBASE 2.1.* TNO. https://www.exiobase.eu/index.php/publications/creea-booklet/73-creea-booklet-web-resolution/file.

UN. 2015. 'Transforming Our World: The 2030 Agenda for Sustainable Development'. *Resolution Adopted by the General Assembly*. https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E.

Wagnitz, Philipp, and Andrea Kraljevic. 2014. *The Imported Risk: Germany's Water Risks in Times of Globalisation.* Berlin: WWF. http://www.wwf.de/fileadmin/fm-wwf/Publikationen-PDF/WWF_Study_Waterrisk_Germany.PDF.

WEF. 2020. *The Global Risks Report 2020.* Geneva, Switzerland: World Economic Forum. http://www3.weforum.org/docs/WEF_Global_Risk_Report_2020.pdf.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at http://dnb.dnb.de.

Universitätsverlag der TU Berlin, 2021
https://verlag.tu-berlin.de

Fasanenstr. 88, 10623 Berlin
Tel.: +49 (0)30 314 76131
E-Mail: publikationen@ub.tu-berlin.de

Layout/typesetting: Sebastian Vollmar; vivid shapes Design, www.vividshapes.com
Cover image: Sebastian Vollmar; vivid shapes Design, www.vividshapes.com

ISBN 978-3-7983-3124-2 (online)

Online veröffentlicht auf dem institutionellen Repositoriumder Technischen Universität Berlin:
DOI 10.14279/depositonce-11818
http://dx.doi.org/10.14279/depositonce-11818