



# WATER FOOTPRINT - DESCRIPTION AND THE STATE-OF-THE-ART

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10.02.2011

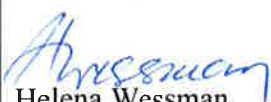

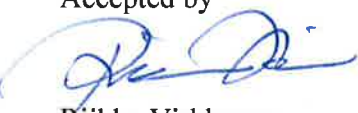




## WATER FOOTPRINT – DESCRIPTION AND THE STATE-OF-THE-ART

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Confidentiality: Public

Report's title Water footprint – description and the state-of-the-art	
Customer, contact person, address Cewic – hanke/Oulun seudun ammattikorkeakoulu / Eija Laine Typpitie 1, 90620 Oulu	Order reference Decision of Office holder with the number 211/2010 is received by email on 14 <sup>th</sup> of October 2010
Project name Cewic Vesi- ja hiilijalanjälkiselvitys	Project number/Short name 73198 Cewic CF and WF
Author(s) Helena Wessman	Pages 14
Keywords Environment, water footprint, methodology	Report identification code VTT-R-01114-11
<p>Summary</p> <p>The aim of the report is to give the industry an overview of principles and the most commonly used approaches to define the water footprint. This knowledge concerns i.e. production industry using high water volumes in their process, but also industries, institutes or actors working with better water quality or reduced water volumes. Water footprint is a tool to understand and guide development of "water-saving" products and services. Water footprint is based on life-cycle thinking and defines the sum of the water used in the various steps of the production chain, including direct and indirect water use (operational and supply-chain water footprints). The terminology will be defined in the ISO Standardization process but due to methodology used by Water Footprint Network (WFN) the water footprint has been divided into terms of blue water, green water and grey water.</p> <p>The availability of water data is often a crucial issue in assessing the water use. Parts of the most developed methods can often be omitted due to lack of data or an incomplete understanding of the issue, which will make it impossible to collect the correct data. The common feature for the existing methods is that they all are under development at the moment. This has also realized by the industrial actors, who are involved in several methodology developments at the same time in order to find the most suitable approach. Many companies in different fields are investigating their water use and beginning to realize that accounting their water use will be a necessary part of their environmental policy in the near future. Each method is still seen as immature and often parts for these methods are omitted or the method used is modified to be fit for use.</p>	
Confidentiality	Public
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Distribution (customer and VTT) Cewic – hanke/Oulun seudun ammattikorkeakoulu / Eija Laine, original VTT, original	
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## Abbreviations

GRI	Global Reporting Initiative
WBCSD	The World Business Council for Sustainable Development
WFN	Water Footprint Network
WF	Water Footprint
WSI	Water Stress Index
	Water Stewardship Initiative
GEMI	Global Environmental Management Initiative
EMS	Environmental Management System
AWS	Alliance for Water Stewardship
EWP	European Water Partnership
CEPI	Confederation of European Paper Industries
NCASI	National Council for Air and Stream Improvement
LCA	Life cycle assessment
LCIA	Life cycle impact assessment
ISO 14000	The family of ISO Environmental management standards
ISO 14001	Standard for Environmental Management systems
ISO 14040	Life cycle assessment – principles and framework
ISO 14044	Life cycle assessment – requirements and guidelines

## Abbreviations

GRI	Global Reporting Initiative
WBCSD	The World Business Council for Sustainable Development
WFN	Water Footprint Network
WF	Water Footprint
WSI	Water Stress Index
	Water Stewardship Initiative
GEMI	Global Environmental Management Initiative
EMS	Environmental Management System
AWS	Alliance for Water Stewardship
EWP	European Water Partnership
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LCA	Life cycle assessment
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ISO 14040	Life cycle assessment – principles and framework
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## 1 Introduction and the aim of the study

The aim of the report is to give the industry an overview of principles and the most commonly used approaches to define the water footprint. This knowledge concerns i.e. production industry using high water volumes in their process, but also industries, institutes or actors working with better water quality or reduced water volumes (please see ‘Water footprint in practice, future activities’ in Chapter 4).

Water footprint can be calculated for product, for process or production site or for organization. There are different approaches to define the water footprint, depending on the purpose of the study. The commonly used procedures will be introduced in Chapter 3. Preparation work for ISO Standard has been going on since November 2009 and the actual standardization is planned to begin during 2011.

The main driver for water footprint is the increased concern of water scarcity and decreased water quality. Water management and supply of safe drinking water have become a global issue. Due to changes in the climate, there has been an increase of either extreme dry and warm seasons in some countries or rainy seasons connected with floods in other areas. Water scarcity varies greatly between countries, even between regions inside the country (see Fig.1).

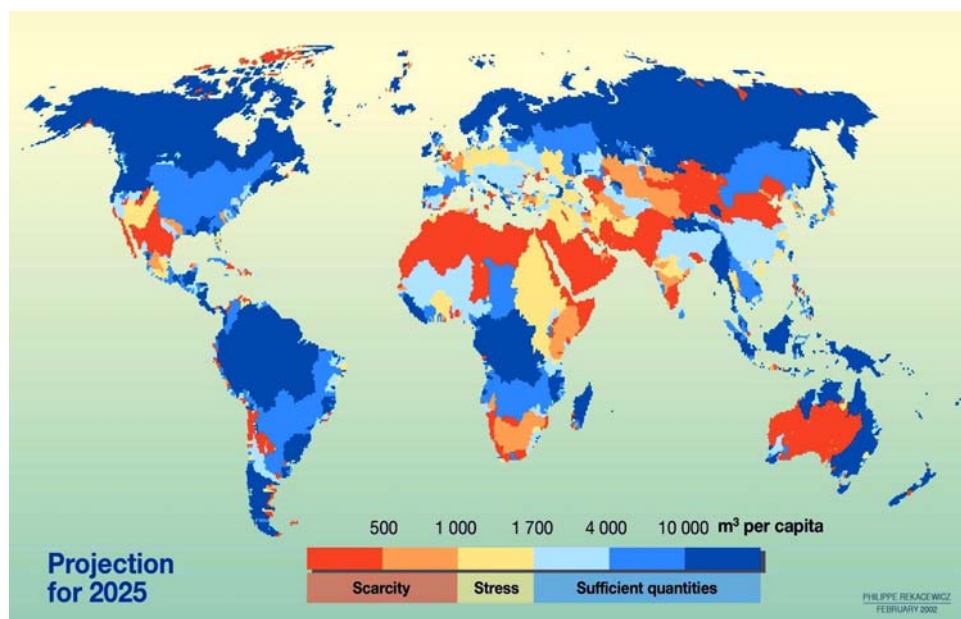


Figure 1. Projection for water availability in 2025 (Revenga et al., 2000).

In the Nordic countries where water shortage is not common the water footprint may seem to be irrelevant. However, industry and its stakeholders have more global perspective on corporate environmental performance. Water footprint brings opportunities for e.g. chemical industry and process industry to improve their processes sustainability performance but in general it is also a tool for more efficient sustainability communication. Water footprint and its importance for the industry will be discussed in Chapter 4.

## 2 Principles of water footprint

Water footprint is a tool to understand and guide development of "water-saving" products and services. Water footprint is based on life-cycle thinking and defines the sum of the water used in the various steps of the production chain, including **direct and indirect water use** (operational and supply-chain water footprints). The terms '**virtual water**' content and '**real water**' content of a product are part of the water footprint idea (Hoekstra et al 2008). The adjective 'virtual' refers to the fact that most of the water used in producing a product is not contained in the product or directly linked to the production process. It refers to the sum of the water used in the various steps of the production chain. Products can be classified as water-intensive, and their trade can be followed between countries or continents. In global sense, all European countries import or export water in virtual form. For instance, despite regular water shortage in Southern Europe, this part of Europe produces water-intensive crops for export, such as tomatoes.

The terminology will be defined in the ISO Standardization process but due to methodology used by Water Footprint Network (WFN) the water footprint has been divided into terms of **blue water, green water and grey water** (see Fig. 2). The methodology of WFN is explained in more detail level in Chapter 3. Water footprint is a local indicator, which means that information on **regional water scarcity or water stress**, threshold levels and the type of water source(s) should be defined. Country specific data is lacking in most cases but there are indexes available such as Water Stress Index, FAO or UNICEF.

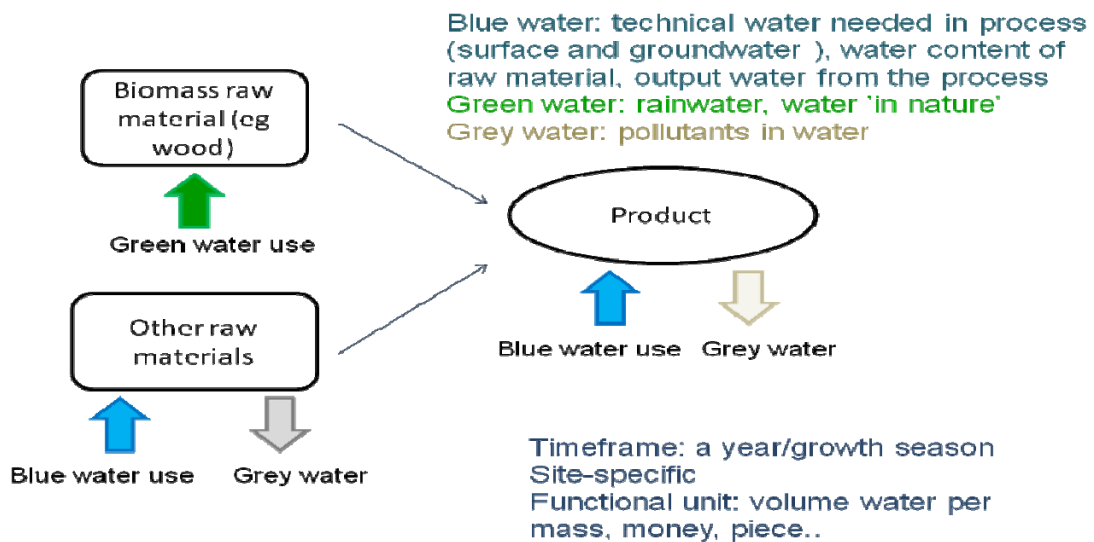


Figure 2. Framework for product's water footprint.

**Green water** definitions are the most difficult because water conditions in nature vary between countries, regions and season and data either does not exist or is not specific enough. Green water definition and data behind it would be important for industries using biomass as raw material (bio-energy production, forest products, food products, textiles etc). Applicability of the green water and how it is now defined in WFN methodology has been under wide discussion. Green water has also been left out from water footprint calculations because of the lacking or low quality data.



**Blue water** often expresses water footprint calculation if data on green water does not exist. A production plant can usually provide the data for blue water at least in general level. Difficulties will be related to the allocation inside the process and assessing the amount of evaporated water or cooling water. Since the water footprint is rather new indicator, the data might be insufficient. Framework for the blue water of the production process is presented in Fig. 3.

Definition for **grey water** is unstable at the moment. There is a clear need from the industry to introduce quality instrument to water footprint. However, methodology is different and depending on the approach, grey water expresses only volumes or can tell also something about water quality changes. There are national quality thresholds and waste water parameters like chemical oxygen demand (COD), adsorbable organic halogen compounds (AOX) or nutrients (phosphorous or nitrogen) for instance and these thresholds compared to the quality of discharged water should be taken into account in water footprint. It should be noted that temperature is also a parameter for water quality change.

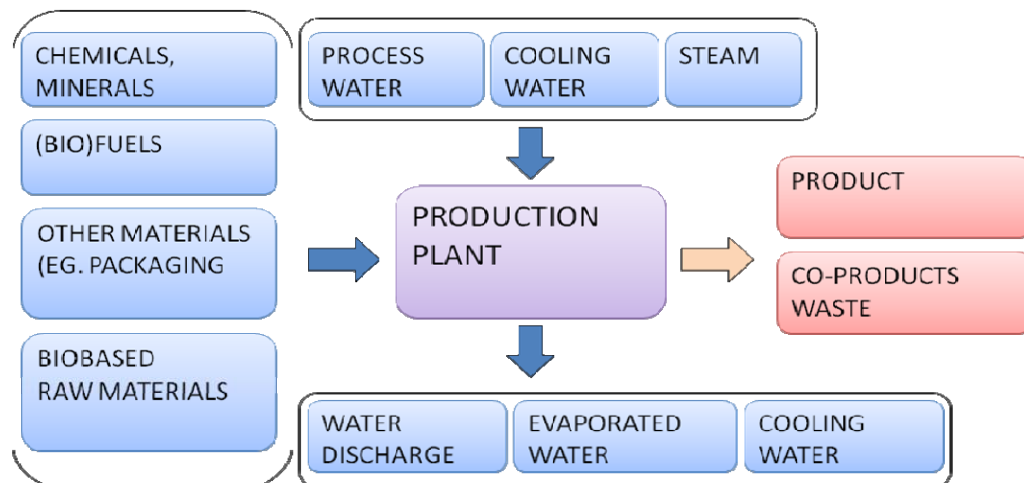


Figure 3. Framework for the technical water ('blue water') of a production process.

**Data availability** and **data quality** are the restricting factors for transparent and comprehensive water footprint at the moment. Water footprint is fairly new indicator and the existing LCA databases do not include water balance data tailored for processes. Sector or industry specific datasets are lacking. Additionally, local or regional data for green water and grey water are lacking as well and water footprint studies are based on general statistics. However, the industry has been actively involved in the development work (see Chapter 3) and has started to collect the process data. Harmonizing methodology development and standardization is expected to decrease the data collection problems.

### 3 Methodology development and the main actions

The main (public) water footprint method developers have been presented in Figure 4. There is a division between organizational level (WBCSD, GEMI and GRI) and product/process level (all others). ISO standard will be focusing for products, processes and organization and UNEP is closely developing water accounting to-

gether with GRI. EWP methodology (for European standard) is still under development.

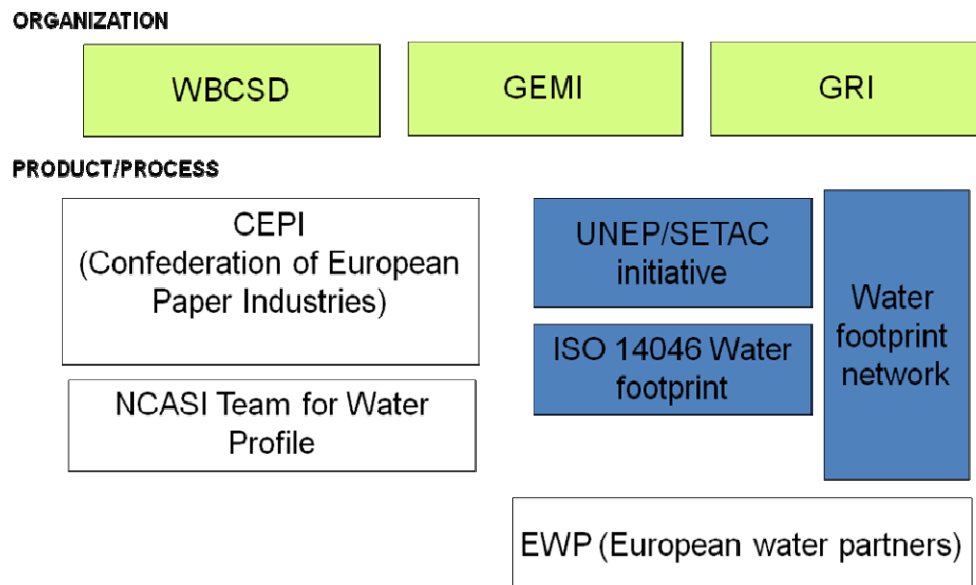


Figure 4. Main development actions in water footprint methodology.

### 3.1 Water Footprint Network (WFN)

The concept of ‘Water Footprint’ was first introduced by Dr. Arjen Hoekstra and other researchers of the University of Twente in the Netherlands in 2002 and is managed by the Water Footprint Network, which is also leading the methodology development and is aiming at own standard on water footprint. WFN has developed a water footprint calculator and provides also a free manual that can be found in [www.waterfootprint.org](http://www.waterfootprint.org).

WFN has listed its activities as follows:

- Developing standards (methods, guidelines, criteria) for water footprint accounting, water footprint impact assessment and the reduction and offsetting of the negative impacts of water footprints
- Developing practical tools to support people and organizations interested in water footprint accounting, impact assessment and water footprint reduction and offsetting
- Providing for, or arranging for third parties to provide for, meetings, publications, education, research and development with regard to the water footprint concept
- Promoting the exchange, communication and dissemination of knowledge about water footprint
- Supporting government bodies, international institutions, non-governmental organizations, businesses and other organizations in implementing water footprint accounting and developing a sustainable and fair water policy
- Providing advice on the application of the water footprint and by checking and certifying the use of the water footprint.

According to WFN the blue water expresses the volumes of technical water used in the process, i.e. volumes of total water input from surface water, ground water etc., product water content, evaporated water during the process and the cooling water etc. Green water is the water from the nature (e.g. evaporation of crops or trees, rainwater and water content of raw materials). Grey water is the polluted water (waste water to the recipient area), expressed as the minimum amount of water needed in order to dilute the polluted water before discharging. This means that the grey water is volume based, not expressed directly as quality parameters.

Calculating water footprint in the WFN method is divided into four steps:

- Setting the goal and scope
- Accounting the water footprint
- Water footprint sustainability assessment
- Water footprint response

Water footprint is possible to calculate for a product or for geographically defined area. Furthermore it is possible to calculate the water footprint for a consumer or a producer or expand it to larger groups or communities. Each step of the products life cycle receives its own calculation formulas that have been presented in the Water Footprint manual (2009) ([www.waterfootprint.org](http://www.waterfootprint.org)).

Several industrial companies and federations like CEPI, Unilever, Coca-Cola, StoraEnso, UPM, Raisio, and many LCA and environmental consultants are members of WFN.

### 3.2 ISO 14046 - Water footprint: Requirements and guidelines (ISO/TC207/SC5/WG8)

Preliminary work for ISO Standard started in November 2009. The first Committee Draft for the standard is expected to come out for the next ISO Plenary Meeting in Oslo June, 2011. If the actual standardization work will begin after Oslo meeting, the final Standard is expected to come out in three years (in 2014). ISO Standard for Water Footprint will be compatible with the existing LCA standards, especially with 14044 LCA – Requirements and Guidelines, and the on-coming standard 14067 for Carbon Footprinting.

At the moment there are app. 20 countries or associations actively involved in developing the standard and more are expected to join the future official standardization work. Nordic countries except Iceland are involved. This is important cooperation because countries with similar local water conditions have similar needs and definitions for water footprinting. In Finland, the responsible standardization body is SFS Finnish Standardization Association, [www.sfs.fi](http://www.sfs.fi). Contact person for further information in SFS is Ms. Sari Sahlberg [sari.sahlberg@sfs.fi](mailto:sari.sahlberg@sfs.fi).

At the moment there are some points that have been agreed from the beginning and can be pointed out – remembering that they represent the state-of-the-art:

- Water footprint includes environmental issues and human health (socio-economic issues excluded)
- Water footprint is a tool for products, processes and organizations

- Water footprint standard will follow the requirements of ISO 14044 and is based on life-cycle perspective
- Because of the regional importance, impact assessment has important role in water footprint (defining water stress or other potential environmental impacts or impacts on human health)
- Water footprint takes into account the changes in both water volume and water quality
- Positive aspects (i.e. beneficial impacts for the environment) can be taken account in calculation
- Water footprint can be a stand-alone or a more comprehensive indicator

### 3.3 World Business Council for Sustainable Development (WBCSD) and the Global Water Tool

Unlike the WFN approach to water footprint the WBCSD tackles water use from a scarcity point of view, which is relatively simply defined: water scarcity applies to situations where there is not enough water for all users (agricultural, industrial or domestic). Four categories for water scarcity have been used and shortly expressed as follows:

- Little or no water scarcity: abundant water resources compare to the use
- Physical water scarcity: development is approaching sustainability limits
- Approaching physical water scarcity: areas of which over 60% of water flows are withdrawn
- Economic water scarcity: human, institutional or financial capital is limiting access to available water sources

The Global Water Tool is clearly a tool used in organization level. It is a free online tool, which helps the companies to map their water use and assess the risks of global operations and supply chains. The tool compares the water volumes of company with local water supply and consumption information and it can also be used to follow the water-efficiency. Furthermore, the tool produces indicators for Global Reporting Initiative to report and manage the water use and provides the Water Stress Index data of the sites. The data used in the Global Water Tool has been provided by:

- Food and Agriculture Organization (FAO)
- World Health Organization and UNICEF Monitoring Programme (JMP)
- University of New Hampshire (UNH)
- World Resource Institute (WRI)
- International Water Management Institute (IWMI)
- United Nations Population Division

Global Water Tool is an excel-based programme that can be downloaded from the WBCSD website ([www.wbcsd.org](http://www.wbcsd.org)).

### 3.4 Global Reporting Initiative (GRI)

Global Reporting Initiative is an individual organization, whose goal is to create a globally accepted procedure to report organization's social responsibility. GRI indicators are widely in use in industrial Corporate Responsibility Reporting.

Nowadays GRI works in accordance with the United Nations Environmental Program (UNEP) to develop GRI guidelines in collaboration with different interest groups. GRI water indicators can be seen as basic guidelines for water use accounting. Table 1 summarizes the relevant indicators.

*Table 1. GRI indicators concerned with water accounting ([www.globalreporting.org](http://www.globalreporting.org)).*

<b><u>Indicator</u></b>	<b><u>Type</u></b>	<b><u>Brief description of the indicator</u></b>
EN8 - Total water withdrawal by source	core	The total volume of water withdrawn provides an indication of the overall scale of potential impacts and risks associated
EN9 - Water sources significantly affected by withdrawal of water	additional	This indicator measures the scale of impacts associated with the organization's water use
EN10 - Percentage and total volume of water recycled and reused	additional	The rate of reuse and recycling acts as a measure of efficiency and success of the organization in reducing total withdrawals and discharges
EN21 - Total water discharge by quantity and destination	core	The amount and quality of the water discharged by the reporting organization is directly linked to ecological impact and operational costs
EN23 - Total number and volume of significant spills	core	Spills of chemicals, oils, and fuels can have significant negative impacts on the surrounding environment, potentially affecting soil, water, air, biodiversity, and human health
EN25 - Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff	additional	This Indicator is a qualitative counterpart to quantitative Indicators of water discharge that helps to describe the impact of these discharges

### 3.5 Global Environmental Management Initiative (GEMI)

The Global Environmental Management Initiative is a non-profit organization of North American companies towards a more sustainable environmental stewardship. GEMI has developed two tools to enhance corporate understanding of global water issues. Both of these tools are freely available online on GEMI's webpage.

First of the tools was released in 2002, called 'Connecting the drops: Water Sustainability Tool'. It consists of five Modules that assess company's relation to water, identifies the risks and describes different strategy options. Second of the tools is called 'Collecting the drops: Water Sustainability Planner' and was released in 2007. It aims to understand water dependence and the status of the water-shed at a local level. It consists of three modules that include facility water use and impact assessment program, water management program and case studies. Case studies will help the user to see achievements gained with the tool by using clear and easily comprehensible examples.

### 3.6 European Water Partnership (EWP)

European Water Partnership is developing a voluntary certification programme, a water stewardship standard in European level. The first draft of the standard has been published in 2010 and tested on-line in three different locations: BASF SE (Ludwigshafen, Germany), Coca-Cola Erfrischungsgetränke AG CCE AG (Genshagen, Germany) and in Holmen Paper (Madrid, Spain). The results of these tests will be published during 2011. The standard follows the EU Environmental Policy which will make it easily adapted to EMAS and ISO 14001.

The EWP Standard consists of four principles:

- Achieve and maintain sustainable water abstraction in terms of water quantity: water as raw material, water sources
- Ensure the achievement and maintenance of good status in terms of chemical quality and biological elements: waste water quality
- Restore and preserve water-cycle related high conservation value ecosystems: local aspects
- Achieve equitable and transparent water governance: continuous improvement

### 3.7 Approaches of the paper industry

The Confederation of European Paper Industries (CEPI) is a member both in WFN and EWP. CEPI has published research papers on calculating the water footprint by WFN together with working with EWP test case in Holmen Paper in Madrid. CEPI has asked the American National Council for Air and Stream Improvement (NCASI) to assist with assessment of pulp and paper industry water use data.

The study of NCASI is called Water Profiling, and the water profile has been divided into three stages (see Fig 5):

- Forests and forest management, including water coming into the forest (precipitation or groundwater) and water leaving the forest (evapotranspiration, groundwater recharge or stream flows)
- Manufacturing (water input for process and cooling, water coming by recovered paper or non-fiber inputs)
- Effluents (compatibility of the effluent with the receiving water body and the ecosystem)

Pulp and paper industry is still seeking to find the best possible practice for data collection and most of all, defining the green water and the grey water.

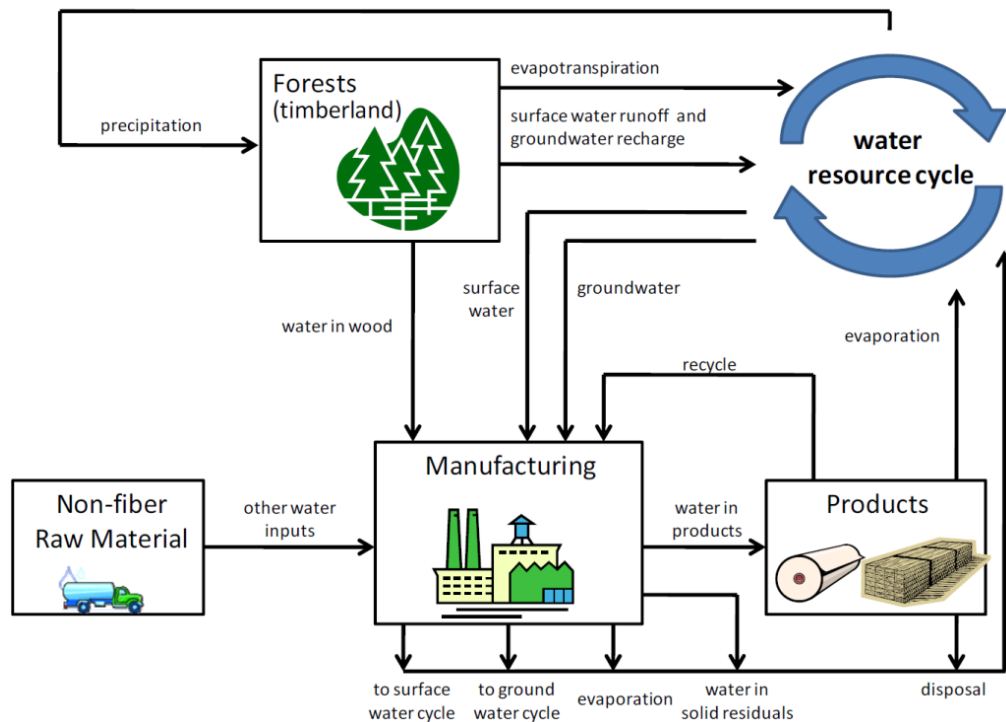


Figure 5. Framework for the Water Profiling approach by NCASI.

## 4 Discussion

### Site specific effects

Production location affects water footprint in product, process and organizational level. For instance in Nordic countries, there is no lack of water and water purification technology and process water management are of high quality. Taking into account the local/regional or country-specific effects by using Water Stress indicators will bring benefits for industry located in low water stress areas.

### Data quality and availability

The availability of water data is often a crucial issue in assessing the water use. Parts of the most developed methods can often be omitted due to lack of data or an incomplete understanding of the issue, which will make it impossible to collect the correct data. The data collected at production sites is usually concerned with the quality and quantity of effluents released and does not take into account the virtual water entering the system.

Water footprint is based on life-cycle thinking, which means that the whole product's value chain will be included. However, data from the whole value chain, including all the suppliers might be difficult to get. This concerns both volume based and quality (environmental parameters) based data. This is partly due difficulties in specifying detailed water flows in all parts of the process. Data for evaporated water and water in the cooling system or moisture content of chemicals and waste-streams need sector specific guidelines.

Systematic, industry specific data collection perhaps in cooperation with industrial federations would be the best solution to harmonize data collection and respective definitions.

### **Methods available**

The existing methods can be categorized into water footprint tools for organizational use and tools/methods used also for calculating water footprint for products and processes. The tools for organization level are not very scientific, and these are for instance GEMI and WBCSD tools that can freely downloaded from the internet. GRI indicators however, give basic guideline for water accounting.

Water Footprint Network Tool is based on water volumes. WFN has a scientific approach and it has launched the terms green, blue and grey water. From scientific point of view there are some lacks in the methodology. Green water is the biggest part of water footprint in all products using biomass as raw material, and therefore does not encourage to reduce the blue water, i.e. improved water saving technology. Quality changes in different environmental parameters are excluded in the volume based WFN approach. Regional aspects are not included detailed enough.

European Water Partnership and ISO Standardization work are aiming at larger harmonization with terminology and the framework. EMAS and/or Water Eco-labelling might be based on these approaches in the future. ISO approach is based on environmental impacts and human health with consideration of regional water stress, water volume and water quality.

The common feature for the existing methods is that they all are under development at the moment. This has also realized by the industrial actors, who are involved in several methodology developments at the same time in order to find the most suitable approach.

### **Water footprint in practice, future activities**

Intention was to include some good calculation practices in this report. However, good examples were difficult to find. Based on discussions with different industries, product specific calculations do exist but so far they are not publicly available. It was also mentioned that data behind the water footprint studies was not the best quality but further actions are going on to improve the data.

Many companies in different fields are investigating their water use and beginning to realize that accounting their water use will be a necessary part of their environmental policy in the near future. Methods to ease the water use accounting are being developed and different parties struggle to be the leader in this development, but currently as the methods are still under development, none of them is widely accepted as such. Each method is still seen as immature and often parts for these methods are omitted or the method used is modified to be fit for use.

As mentioned before, data quality and the missing data are limiting the use of water footprint and may lead to incorrect conclusions. What the industry should do is to start collecting data for their process water use, including raw materials, side streams, waste etc. Data gaps should be identified and common industrial guidelines should be built in co-operation.

Water footprint is relevant tool for industries that aim at increasing water use efficiency and improved water quality. But as important the water footprint is for actors or industries that provide water purifying technology for the process industry or for municipal purposes (i.e. pollution reduction, minimizing the water use).



Keeping the different applications in mind, water footprint can be used in communication in many ways; benchmarking process water use or its quality in product value chain or in organizational level.

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