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P.W. Gerbens-Leenes
A.Y. Hoekstra

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Business water footprint accounting:

A tool to assess how production of goods and services impacts on freshwater resources worldwide

Value of Water

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BUSINESS WATER FOOTPRINT ACCOUNTING:
A TOOL TO ASSESS HOW PRODUCTION OF GOODS AND SERVICES IMPACTS ON FRESHWATER RESOURCES WORLDWIDE

P.W. GERBENS-LEENES[1]

A.Y. HOEKSTRA[1,2]

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[1] Dept. of Water Engineering and Management, University of Twente, Enschede, The Netherlands

[2] Contact author: Arjen Hoekstra, a.y.hoekstra@utwente.nl

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Contents

Summary

Freshwater of adequate quality is a prerequisite for human societies and natural ecosystems. The human use of freshwater is so large that competition among users occurs and water scarcity is serious in several regions. For many companies, freshwater is a basic ingredient for their operations, while effluents may lead to pollution of the local hydrological ecosystem. Initially, public pressure has been the most important reason for sustainable business initiatives, but today many companies recognize that failure to manage the freshwater issue raises risks, including damage to the corporate image, threat of increased regulatory control, financial risks caused by pollution, or insufficient freshwater availability for operations. Especially multinationals, such as the Coca-Cola Company or Marks & Spencer, recognise that proactive management contributes to their profitability and competitiveness in the market and avoids risks (Coca-Cola Company, 2006; Marks & Spencer, 2007). Business water accounting is increasingly regarded as an essential part of sustainable corporate performance accounting. The foundation of the World Business Council on Sustainable Development (WBCSD) and the Global Reporting Initiative (GRI), and the development of standards for environmental management systems (ISO and EMAS) have been important. Since 2000, indicators for business water accounting have been proposed by the OECD, the University of Groningen and the WBCSD. For freshwater, Hoekstra and Hung (2002) and Hoekstra and Chapagain (2008) have developed the concept of the water footprint (WF) that has been applied, among other things, for individual and national consumption comparisons.

This report aims to identify the current state of business water accounting and to design an accounting method for the business water footprint (BWF). It answers the following questions: (i) What are the main developments in sustainable business performance so far? (ii) What is the current state of business water accounting? (iii) How to design an accounting method for the business water footprint? And (iv) How to apply the method for existing situations? The term "business" is interpreted in this study in a broad sense, in order to include any form of enterprise, governmental or non-governmental organization or other form of business activity. Based on the methodology of the WF concept, this report designs an accounting method for the BWF. The method calculates the BWF per business unit, where a business unit is preferably a part of the business that produces one homogenous product (good or service) at one particular spot. The WF of a business unit is defined as the total volume of freshwater that is used, directly and indirectly, to produce the goods and services delivered by that unit expressed in terms of the volume of freshwater use per year. The WF of a business is defined as the total volume of freshwater that is used directly or indirectly to run and support the business.

The WF of a business unit consists of two parts: the *operational* water footprint and the *supply-chain* water footprint. The operational water footprint is the amount of freshwater used at a specific business unit, i.e. the *direct* freshwater use. The supply-chain water footprint is the amount of freshwater used to produce all the goods and services that form the input of production at the specific business unit, i.e. the *indirect* freshwater use. The method addresses three different types of freshwater use: blue, green and grey. The *blue* water footprint is the volume of freshwater that evaporated from the global blue water resources (surface water and ground water) to produce the goods and services. The *green* water footprint is the volume of water evaporated from the global green water resources (rainwater stored in the soil as soil moisture). The *grey* water footprint is the volume of

polluted water that associates with the production of goods and services. The water footprint is a geographically explicit indicator, not only showing volumes of water use and pollution, but also the locations.

Applied to a hypothetical company, the accounting method generates results at different levels of detail dependent on the availability of data. When data are sufficient, it generates detailed information for benchmarking or for defining company goals to decrease its WF.

Although most companies focus on their own performance, the report shows that for freshwater it is important to address complete supply chains. If companies centre on impacts generated by their own activities, large company efforts may still result in small improvements along the total lifecycle of a product. Compared to earlier developed methods for business water accounting, the method based on the water footprint concept, extends existing methods to green and grey water and includes sites of production in a supply chain. It excludes non-fresh water use because salt water is not a scarce resource. The concept explicitly focuses on freshwater, which is considered a critical resource and provides detailed methodology on how to calculate water in agriculture, which is missing in the other tools. Due to the completeness of the WF concept, we therefore used it as a basis for the development of a method for business water accounting and termed this the business water footprint (BWF). Adopting the method by business may make a contribution towards more sustainable freshwater use.

1. General introduction

1.1 Introduction

Freshwater of adequate quality is not only a prerequisite for human societies, but also for natural ecosystems that perform functions essential for human existence and life on earth (Costanza and Daly, 2002). At present, irrigated agriculture is responsible for about 70% of all freshwater abstractions by humans (Gleick, 1993; Bruinsma, 2003; Shiklomanov and Rodda, 2003; UNESCO, 2006), while agriculture as a whole applies about 86% of the worldwide freshwater use (Hoekstra and Chapagain, 2007). In many parts of the world, the use of freshwater for agriculture has to compete with other uses such as urban utilization and business activities (Rosegrant and Ringler, 1998; UNESCO, 2006). Moreover, research has indicated that the effects of climate change lead to major shifts in spatial and temporal patterns of precipitation (IPCC, 2007). Lehner et al. (2001), for example, have shown that in Southern Europe freshwater availability will decrease by 25 to 50 percent over the period 2000-2070. Estimates on human freshwater use indicate that in some regions water scarcity is already serious (UNESCO, 2006; CAWMA, 2007).

For many companies, freshwater is a basic ingredient for their operations, while effluents might lead to pollution of the local hydrological ecosystem. Many companies have addressed these issues and formulated proactive management (Gerbens-Leenes et al., 2003). Failure to manage the freshwater issue raises four serious risks for a company: damage to the corporate image, the threat of increased regulatory control, financial risks caused by pollution, and insufficient freshwater availability for business operations (Rondinelli and Berry, 2000; WWF, 2007).

1.2 Aim and research questions

The efficient use of freshwater and control of pollution is often part of sustainability issues addressed by business. In the last ten years, initiatives were the foundation of the World Business Council for Sustainable Development (WBCSD, 1997) and the Global Reporting Initiative (GRI, 2000), the development of standards for environmental management systems, such as ISO and EMAS standards (OECD, 2001), the development of Key Environmental Indicators (OECD, 2001; Steg et al., 2001) and the introduction of the Global Water Tool (WBCSD, 2007).

A tool that calculates freshwater consumption is the concept of the water footprint (WF). This tool has been introduced by Hoekstra and Hung (2002) and has been developed further by Hoekstra and Chapagain (2007, 2008). Those authors define the water footprint as the total annual volume of freshwater used to produce the goods and services consumed by any well-defined group of consumers, including a family, village, city, province, state, nation or business. The water footprint of a business (BWF) is defined as the total volume of freshwater that is used directly or indirectly to run and support a business. The water footprint of a business consists of two components: the operational water use (direct water use) and the water use in the supply chain (indirect water use). A glossary on water footprint and other terminology used in this report is given in Appendix

1. Compared to other water accounting tools, the concept of the water footprint provides the most extended and complete tool for water accounting. It has already been applied for various purposes, such as the calculation of the water footprint of a large number of products from all over the world (Chapagain and Hoekstra, 2004), but so far there has been no application for business accounting. This report aims to identify the current state of business water accounting and to design an accounting method for the business water footprint. The research questions are:

- What are the main developments in sustainable business performance so far?
- What is the current state of business water accounting?
- How to design an accounting method for the business water footprint?
- How to apply the method for existing situations?

The answer to the first question intends to provide general information on where business stands today. The answer to the second question forms the starting-point for the development of the method. In this way, the report can play a role in raising awareness on the water scarcity issue, as well as provide insight into options for change. The answer to the third question provides a tool for accounting the business water footprint based on the concept and methodology of the water footprint. The answer to the fourth question shows how the method works in practice.

2. Current state of business water accounting

2.1 Sustainable business performance

The way companies address their use of freshwater and their impact on water systems is one of the aspects of sustainable business performance. During the past few decades we have seen a movement recognising that business performance is not only measured in terms of shareholder value but also in terms of the long-term continuity value of business to communities. In the ongoing debate on globalization, concerns have been expressed about the sustainability impacts of business on society, especially of multinational corporations (OECD, 2001). The sustainability concept is determined by three components: a social, economic, and environmental one (WCED, 1987). Public pressure has been the most important reason that private initiatives for sustainable business performance have become an important development in business over the last twenty years; especially a number of large multinationals are interested in the interactions of their operations with the environment and communities (Gerbens-Leenes et al., 2003). Initially, regulatory compliance and fear of legal liability were the main reasons for defining sustainability principles; today, many multinationals recognise that proactive management contributes to their profitability and competitiveness in the market.

Companies change performance in response to specific pressure (Hall, 2000). It has been shown that this pressure differs among sectors (Green et al., 1996; Hall, 2000). In general, large, high-profile companies are under considerable pressure to improve their performance. For example, multinational oil companies are more environmentally responsive than other company types (Moser, 2001). In contrast, firms without pressure may be hesitant to invest in innovation because it does not necessarily improve their financial performance. Therefore, lower profile firms, which are an integral part of any industrial system, lack incentives to change their sustainability performance (Irwin and Hooper, 1992). These pressures need to be responded to on two levels, however, at an industry level and at a corporate level, since it is impossible for a company to develop a good reputation for itself in an industry without credibility. What is more, companies must not only behave in a responsible manner according to their principles, they must also be seen to do so (Humphreys, 2000). In this respect, differences among companies in the emphasis on the components of the sustainability concept makes that the use of this concept leads to the use of different time scales, so that the perspective on sustainable business performance differs according to varying perceptions about the appropriate time horizon in the analysis (Gerbens-Leenes et al., 2003).

2.2 Principles, practices and outcomes

There are three important steps towards the measurement and the reporting of sustainability (Gerbens-Leenes et al., 2003). The first step was in the 1970s. Companies started to issue policy statements or *principles*, codes of conduct, stating commitments on business ethics and legal compliance (OECD, 2001). The first corporate code of conduct was the 1977 “Issuance of guidelines on conducting business in South Africa” by an automobile manufacturer. Later, many other companies adopted these “Sullivan Principles”, or began to issue corporate codes dealing with business ethics. The second step was the development of management systems or *practices* that refer to action strategies and programs. More recently, the third step formulated the *outcomes*, standards providing guidance for business reporting on non-financial performance. However, many companies mainly focus on their own performance, and only some firms feel responsible for their suppliers' activities (Hall, 2000). Moreover, according to an OECD study (2001), the absence of internationally agreed reporting standards on sustainability results in a range from rudimentary reporting to full-scale reporting.

2.3 Initiatives for business water accounting

Business water accounting is often part of the sustainable corporate performance accounting of a company. Important developments for the issue of sustainable, corporate performance were the foundation of the World Business Council for Sustainable Development (WBCSD, 1997), the foundation of the Global Reporting Initiative (GRI, 2000), and the development of standards for environmental management systems, such as the ISO and EMAS standards (OECD, 2001). At the end of the 20th century, many multinationals certified their environmental management systems (EMS) under ISO 14000 standards, and many others were in the process of doing so (Rondinelli and Vastag, 2000). Today, an increasing number of companies publish information on environmental impacts of their activities, the outcomes. Although companies recognize the importance of sustainability issues, they use an enormous variety of indicators for the assessment (Gerbens-Leenes et al., 2003). Often, this also includes the use of freshwater. Moreover, sustainable business practices incline to focus on company performance rather than system performance. If companies mainly centre on impacts generated by their own activities, large company efforts may still result in small improvements along the total lifecycle of a product. Since 2000, initiatives for business water accounting, often part of a larger accounting scheme, have been taken. Three are discussed in the following: OECD's key environmental indicators (OECD, 2001), the Sustainable Corporate Performance project (Steg et al., 2001) and the Global Water Tool (WBCSD, 2007).

2.3.1 OECD's key environmental indicators

In 2001, the OECD Environmental Directorate (OECD, 2001) published a report on key environmental indicators in an effort to reduce the number of environmental indicators and to draw attention to key environmental issues of concern. One of the key environmental indicators was freshwater, divided into two categories: freshwater quality and freshwater resources. Indicators in this respect were wastewater treatment and gross abstractions per capita as percentage of total available freshwater resources.

2.3.2 The Sustainable Corporate Performance Project

In 2001, results of the Sustainable Corporate Performance (SCP) project, a cooperation between the University of Groningen in the Netherlands and the Ahold company, were published (Steg et al., 2001). Its focus was the definition of SCP and the development of a practical measuring system for companies. It defined SCP in relation to the potential addition of economic, social and environmental value to society through corporate activities. Gerbens-Leenes et al. (2003) designed and developed a measuring method for the environmental value using three indicators: land use, energy use and freshwater use. Freshwater use was made up of two parts: direct freshwater use for a company per year (operational freshwater use) and indirect freshwater use, i.e. the freshwater use in the supply chain of the company.

2.3.3 WBCSD's Global Water Tool

In their recent water-scenarios report, the World Business Council for Sustainable Development (WBCSD) includes in one of their scenarios that 'water footprint reporting' will become common practice and even obligatory for businesses in various countries already by the year 2010 (WBCSD, 2006). Shortly after, at the World Water Week 2007 in Stockholm, the WBCSD launched the Global Water Tool, a free and easy-to-use tool for businesses and organizations to map their water use and assess risks relative to their global operations and supply chains (WBCSD, 2007). Six important questions for business were: (i) How many of your sites are in extremely water-scarce areas? (ii) Which sites are at greatest risk? (iii) How will that look in the future? (iv) How many of your employees live in countries that lack access to improved water and sanitation? (v) How many of your suppliers are in water scarce areas now? And (vi) How many will be in 2025? The Global Water Tool calculates water withdrawal from fresh and non-freshwater sources (m^3/year), fresh and non-freshwater discharge by receiving bodies (m^3/year), and total water consumption of a company calculated as the sum of withdrawals minus discharges (WBCSD, 2007).

2.3.4 The CEO Water Mandate

In July 2007, at the Global Compact Leaders Summit in Geneva, a group of committed business leaders officially launched The CEO Water Mandate, representing both a call to action and a strategic framework for companies seeking to address the issue of water sustainability not only in their operations but also in their supply chains (CEO Water Mandate, 2007). At the time of writing, the mandate was endorsed by twenty business leaders and their companies.

3. Methods

3.1 A broad definition of business

We would like to develop a water footprint accounting method that can be applied to various sorts of business. The method should be applicable to small and large private companies but also to public organizations. Besides, we want a method that can be applied to both business at a disaggregated level (units or divisions within a larger corporation or organization) and business at an aggregated level (e.g. a whole business sector or the entire national government). Before we introduce a method for business water footprint accounting, we will therefore first define what we understand by the term "business".

In broad terms, a business is conceived here as a coherent entity producing goods and/or services that are supplied to consumers or other businesses. It can be a (division of a) private company or corporation, but also a (component of a) governmental or non-governmental organization. It can refer to various levels of scale, for instance a specific division of a company, an entire company or a whole business sector. In our broad definition the term business can also refer to a consortium or joint-venture of companies or organizations aimed at the delivery of a certain good or service. In fact, the term business can also refer to any project (e.g. construction of a piece of infrastructure) or activity (e.g. the organization of a large sports event). In this way, the term business has been defined so broad that it can refer to all sorts of corporations, organizations, projects and activities. *A business is any coherent entity or activity that transforms a set of inputs into one or more outputs.*

In order to be able to assess the water footprint of a business, there is an important precondition: the business should be clearly delineated. It should be clear what are the boundaries of the business considered. It should be possible to schematize the business into a system that is clearly distinguished from its environment and where inputs and outputs are well known. The water footprint accounting method that will be introduced in this chapter is designed in a generic way so that it can be applied to any sort of business. Before defining what precisely is a business water footprint, we will first enter into some more detail about one particular type of business: the private company, corporation or enterprise. Since a business water footprint does not only refer to the water use within a business but also to the water use in its supply chain, it is important to have some understanding of the structure of an economy, in which different types of business form a complex network of supply chains. For that reason we spend the next section on a discussion of different business sectors and show how companies or company units can be localized within the supply-network of an economy.

3.2 Business sectors, companies and company units

Business can be categorized into different business sectors. Figure 1 shows the main sectors: agriculture, which is divided into primary and secondary production, manufacturing, trade, retailing, primary extraction, power generation, private and public services, and transportation. Most individual companies can be localized within one particular business sector, although there exist examples of companies that have business in two or even more different business sectors. Some manufacturing companies, for instance, have their own outlets, thus acting as retail company as well.

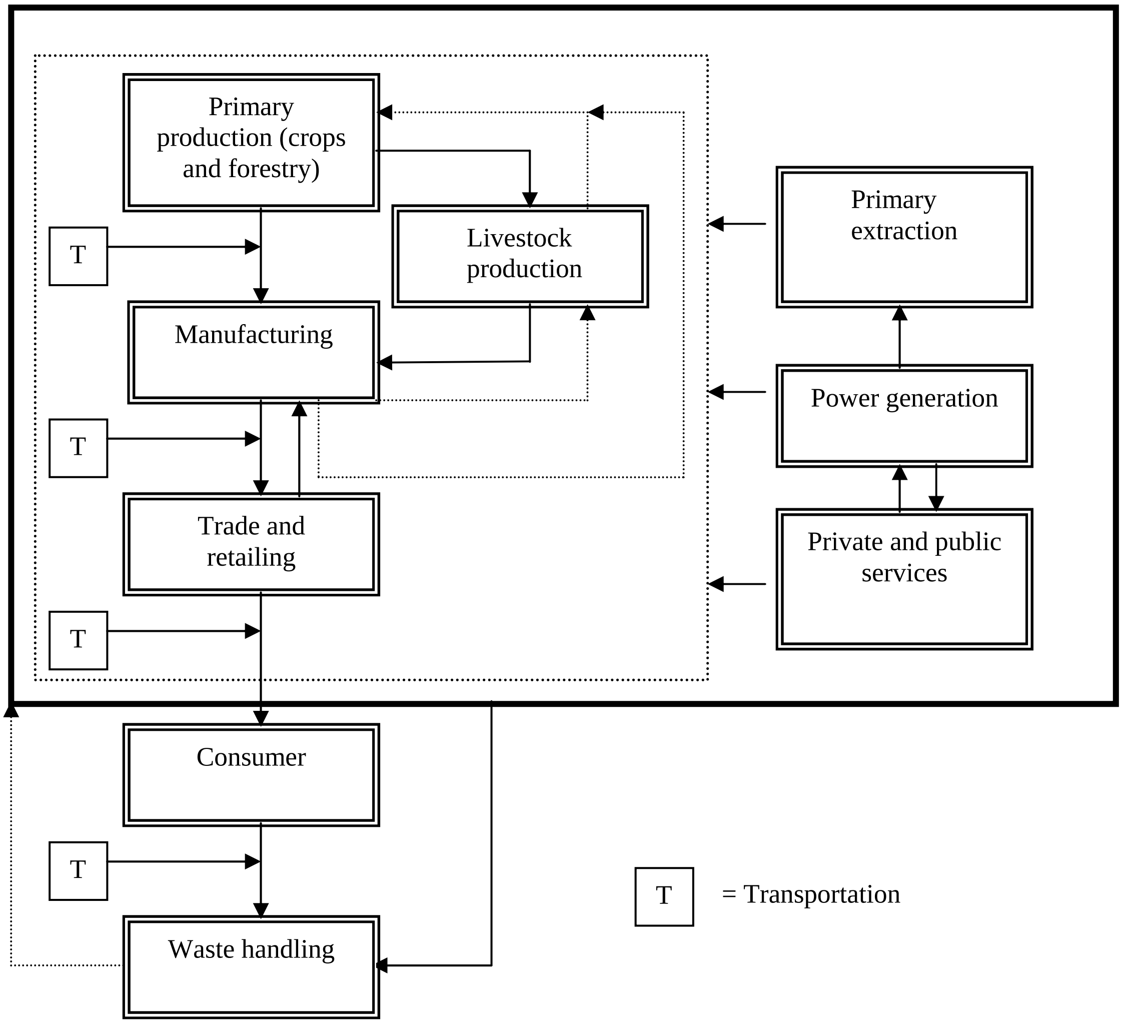

Fig. 1. Overview of a production system, the output to consumers and waste handling. Production processes take place in several business sectors represented by the boxes. A series of processes forms a production chain. The arrows show transportation of physical streams between the links of the chain.

A company can be defined as a legally recognized corporation aimed to sell goods and/or services to consumers or other businesses, usually in an effort to generate profit. Companies can be divided according to their size, way of operating and organisation into three categories: (i) local companies; (ii) overseas independent business companies; and (iii) multinational corporations (Moser, 2001). Many local businesses exist in different countries all over the world. This category comprises both state-owned enterprises (enterprises that are owned by the national government of the country within which the enterprise operates) and privately owned local enterprises (whose headquarters are located in the country of investigation). Other companies operate in more than one country: the overseas independent businesses. They are defined here as foreign enterprises (a) comprising entities operating in up to a maximum of four countries, (b) but within which there is no system for coherent decision-making on policies and strategies throughout the organisation and (c) within which individual entities are unable to exert significant influence over the activities of others. On a global scale, multinational corporations operate that are defined as foreign enterprises (a) comprising entities in two or more countries, (b) which operate under a system of decision-making permitting coherent policies and strategies through one or more decision-making centres and (c) in which entities are so linked that one or more of them may be able to exercise a significant influence over the activities of the others, and in particular to share knowledge, resources and responsibilities with others (Westney, 1993).

Whatever type of company, companies often consist of a number of units. For example, a company can have operations (e.g. factories) at various locations. Or a company may have separate divisions at one location. For the purpose of water footprint accounting, it is often useful to distinguish between different business units. For instance, when a manufacturing company has different factories at different locations, the individual factories are likely to operate under different conditions and derive their inputs from different places. In such a case, it is useful to do water footprint accounting per business unit first and later on aggregate the business unit accounts into an account for the business as a whole.

3.3 The business water footprint

The water footprint of a business is defined as the total volume of freshwater that is used directly or indirectly to run and support the business. The volumes of freshwater use are measured at the place where the actual production and water use takes place (Hoekstra and Chapagain, 2007; 2008). We propose to calculate the business water footprint (BWF) per business unit, where a business unit preferably refers to a part of the total business that produces one homogeneous product at one particular spot. When a business runs at different locations, it is thus preferred to schematize the overall business into business units in such a way that individual business units operate at one location. Besides, operations of a business at one particular spot are preferably schematised in different business units each producing its own product. The water footprint of the business as a whole consists of the sum of the water footprints of the different business units.

The water footprint of a business unit is defined as the total volume of freshwater that is used, directly and indirectly, to produce the products and services of that unit expressed in terms of the volume of freshwater use per year. The water footprint of a business unit consists of two parts: the operational water footprint and the supply-chain water footprint. The first refers to the amount of freshwater used at a specific business unit, i.e. the direct freshwater use. The second refers to the amount of freshwater used to produce all the goods and services that form the input of production at the specific business unit, i.e. the indirect water use. Freshwater use consists of three different components: the green, blue and grey component (Hoekstra and Chapagain, 2008).

- The "green" component of the water footprint refers to the volume of rainwater that evaporated during the production process. This is mainly relevant for agricultural products (e.g. crops or trees), where it refers to the total rainwater evapotranspiration during crop growth (from fields and plants).
- The "blue" component of the water footprint refers to the volume of surface and groundwater evaporated as a result of the production of the product or service. For example, for crop production, the "blue" component is defined as the sum of the evaporation of irrigation water from the field and the evaporation of water from

irrigation canals and artificial storage reservoirs. For industrial production or services, the “blue” component is defined as the amount of water withdrawn from ground- or surface water that does not return to the system from which it came.
- The “grey” component of the water footprint is the volume of polluted water that associates with the production of goods and services. It is quantified as the volume of water that is required to dilute pollutants to such an extent that the quality of the ambient water remains above agreed water quality standards.

The distinction between blue and green water is important because the hydrological, environmental and social impacts and the economic opportunity costs of surface and groundwater use for production differ distinctively from the impacts and costs of rainwater use (Falkenmark and Rockström, 2004; Falkenmark, 2003; Rockström, 1999). The grey component of water use, expressed as a dilution water requirement, has been recognised earlier by for example Postel et al. (1996) and Chapagain et al. (2006).

In a production chain, all chain links and transportation activities between links contribute to the freshwater used to produce a product or service. This means that not only the performance of an individual business is important but also the performance of all companies linked through this business through the production chain or web. Production methods, production locations and water productivities in its supply chain will thus influence the water footprint of a business.

Closely connected to the concept of the ‘business water footprint’ is the concept of the ‘product water footprint’. The water footprint of a product is defined as the total volume of freshwater that is used directly or indirectly to produce the product[1]. By definition, the ‘water footprint of a business’ is equal to the ‘sum of the water footprints of the business output products’. The ‘supply-chain water footprint of a business’ is equal to the 'sum of the water footprints of the business input products'.

3.4 Calculation method for the business water footprint

The calculation of the water footprint of a business is done in six subsequent steps.

Step 1: definition of the business and business units

In this step the business is clearly defined by describing the business units that will be distinguished and specifying the annual inputs and outputs per business unit. Inputs and outputs are described in physical units. Preferably, business units are chosen small enough so that they can be localized at one spot, where the actual production of that unit takes place and one homogeneous product is manufactured. It is most useful to schematise the business based on the various primary products delivered by the business. However, one can also distinguish service units providing only goods or services to primary production units.

[1] The 'water footprint' of a product is the same as what in other publications has been called alternatively the 'virtual water content' of the product or the product’s embedded, embodied, exogenous or shadow water (see for literature reviews: Hoekstra, 2003; Hoekstra and Chapagain, 2008).

As an example, Figure 2 shows a business producing output products X, Y and Z. The business consists of three business units. Every unit has an intake of a number of input products derived from companies in a preceding link of the production chain, and a related indirect freshwater input, as well a direct freshwater input. Business unit 1 produces product X that is sold partly to a business in the next link of the supply chain; the other part is delivered to business unit 2 of the same business. Unit 2 produces product Y, which is partly sold to another business and partly delivered to unit 3. Unit 3 produces product Z, both for delivery to unit 2 and for selling externally.

When a business is large and heterogeneous (different locations, different products), it can be attractive to schematise the business into some major business units and each major unit into a number of minor units again. In this way the business can be schematised as a system with subsystems at a number of levels. Later on the water footprint accounts at the lowest level can be aggregated to accounts at the second-lowest level, etcetera, up to the level of the business as a whole.

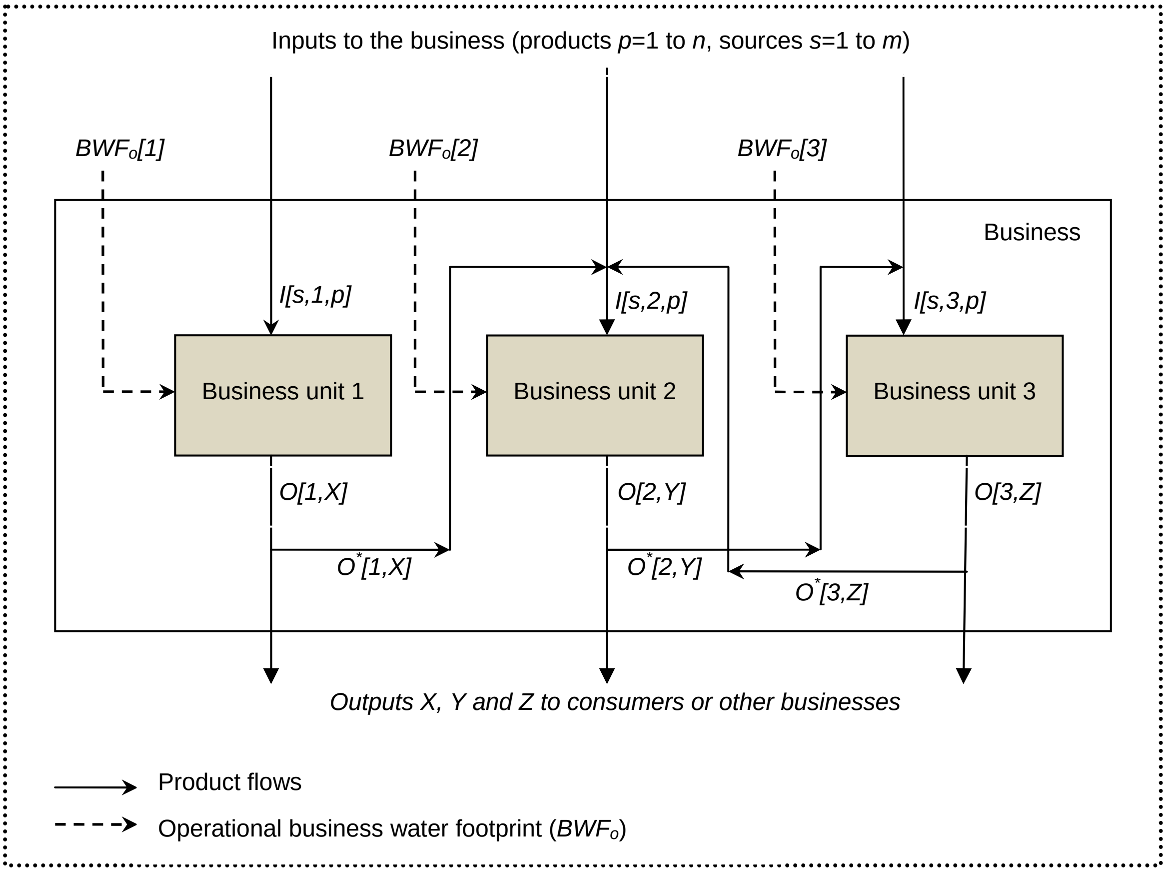

Fig. 2. Business that consists of business units 1-3 producing products X-Z respectively. Product inflow I[s,u,p] refers to the annual volume of input product p from source s into business unit u. Product outflow O[u,p] refers to the annual volume of output product p from business unit u. Product flow O[u,p] refers to the part of O[u,p] that goes to another business unit within the same business.*

Step 2: the operational water footprint per business unit

This step is to calculate the operational water footprint per business unit (per year). It distinguishes three components: the green, blue and grey water footprint.

$$BWF_o[u] = BWF_{o,green}[u] + BWF_{o,blue}[u] + BWF_{o,grey}[u] \qquad (1)$$

in which:

$BWF_o[u]$ = the operational water footprint of business unit *u* (m^3/year).
$BWF_{o,green}[u]$ = the green operational water footprint of business unit *u* (m^3/year).
$BWF_{o,blue}[u]$ = the blue operational water footprint of business unit *u* (m^3/year).
$BWF_{o,grey}[u]$ = the grey operational water footprint of business unit *u* (m^3/year).

Data on green water are calculated using the methodology as described by Hoekstra and Chapagain (2008). Data on blue water use have to be derived from statistics collected by the business units concerned. Data on grey water production have to be calculated from measurements of concentrations of chemicals in the waste flows that are disposed into the natural system at the specific unit and local ambient water quality standards (again following the method as described in Hoekstra and Chapagain, 2008).

Step 3: the supply-chain water footprint per business unit

This step is to calculate the supply-chain water footprint per business unit (per year). It combines information on inputs that are available from data of the business itself with information on the specific water footprint per unit of input that has to be derived from suppliers. Supposed that there are *n* different input products *p* originating from *m* different sources, the supply-chain water footprint of a business unit is calculated as:

$$BWF_s[u] = \sum_{p=1}^{n}\left(\sum_{s=1}^{m}\left(PWF[s,p] \times I[s,u,p]\right)\right) \qquad (2)$$

in which:

$BWF_s[u]$ = the supply-chain water footprint of business unit *u* (m^3/year).
$PWF[s,p]$ = the total water footprint of input product *p* from source *s* (m^3/unit of product)
$I[s,u,p]$ = the annual volume of input product *p* from source *s* into business unit *u* (product units/year)

The value of the product water footprint *PWF[s,p]* depends on the source of the product. When the product comes from another business unit within the same business, the value of de product water footprint is known from the own accounting system (from step 5). When the product originates from a supplier outside the own business, the value of the product water footprint has to be obtained from the supplier or estimated based on indirect data known about the production characteristics of the supplier. The various product water footprints are composed of three colours (green, blue, grey), which should be accounted separately, so that the resulting supply-chain water footprint of the business unit consists of three colour-components as well.

Step 4: the total water footprint per business unit

In this step the total water footprint of a business unit (*BWF[u]*, m^3/year) is calculated by adding the operational water footprint of a business unit and its supply-chain water footprint:

$$BWF[u] = BWF_o[u] + BWF_s[u] \tag{3}$$

Step 5: the water footprint of the output products per business unit

In this step the water footprint for each specific output product is estimated by dividing the business-unit water footprint by the output volume. Allocation of water use over end products can be done in several ways, for example, according to mass, energy content or economic value. In Life Cycle Analysis (LCA) it is common to allocate according to economic value (Weidema, 1999; Weidema and Meeuwsen, 2000). Following earlier studies on water footprints (Hoekstra and Chapagain, 2008), we adopted the allocation methodology from LCA and allocated the total direct and indirect freshwater use over the end products according to their economic value.

$$PWF[u,p] = \frac{\frac{E[u,p]}{E_t[u]} \times BWF[u]}{O[u,p]} \tag{4}$$

in which:

PWF[u,p] = the water footprint of output product *p* from business unit *u* (m^3/unit of product).
O[u,p] = the annual volume of output product *p* from business unit *u* (units/year).
E[u,p] = the economic value of output product *p* of business unit *u* (euro/year).
$E_t[u]$ = the economic value of the total output of business unit *u* (euro/year).

If business unit *u* delivers only one product, the equation is reduced to:

$$PWF[u,p] = \frac{BWF[u]}{O[u,p]} \tag{5}$$

Preferably, a business unit has been defined (in step 1) such that it produces one product only, so that equation (5) can be applied. In this way we avoid the allocation issue. If, however, it is impossible or unfeasible to schematise the business into units that each produces one product only, for example in the case of a chemical process that yields two or more valuable output products, then there is no other choice than allocating the water footprint over the various output products applying equation (4).

Step 6: the water footprint of the total business

In this final step, the water footprint of the business as a whole (*BWF*) is calculated by aggregating the water footprints of its *x* business units. In order to avoid double counting, one has to subtract the virtual water flows between the various business units within the business:

$$BWF = \sum_{u=1}^{x}\left(BWF[u]\right) - \sum_{u=1}^{x}\left(PWF[u,p] \times O^{*}[u,p]\right) \qquad (6)$$

in which $O^{*}[u,p]$ stands for the annual volume of output product *p* from business unit *u* to another business unit within the same business (units/year).

3.5 From footprint accounting to impact assessment and from impacts to policy

The scope of this study is limited to the method of business water footprint accounting. It should be recognised that accounting is only one stage towards well-informed policy making. A next stage is to assess the social and environmental impacts of the business's water footprint. For that purpose it is very useful that the water footprint of a business can be localised. The water footprint is a geographically explicit indicator, not only showing *volumes* of water use and pollution, but also showing the various *locations* where the water is used (Hoekstra and Chapagain, 2008). In carrying out the accounting procedures described above, one should keep in mind that all variables have a spatial dimension that should be recorded.

For the impact assessment, it is also useful that one explicitly shows the blue, green and grey components of the water footprint of a business, because the impact of the water footprint will depend on whether it concerns evaporation of abstracted ground or surface water, evaporation of rainwater used for production or pollution of freshwater. In applying the method for business water footprint accounting as set out in the previous section, one should distinguish all the time between the three colours of the water footprint.

The impact of the water footprint of a business will depend on the vulnerability of the local water systems where the footprint is located, the actual competition over the water in these local systems and the negative externalities associated with the use of the water. Assessing the impact of a water footprint requires an additional analysis, subsequent to the first stage of quantifying, localising and describing the colour of the water footprint. Based on an impact assessment and goals with respect to reducing and offsetting the impacts of the water footprint, one can develop a business water policy (Hoekstra, 2008). Goals of a business with respect to reducing and offsetting the impacts of its water footprint can be prompted by the goal to reduce the business risks related to its freshwater appropriation. Alternatively, they can result from governmental regulations with respect to water use and pollution.

4. Application of the method for a theoretical beverage company

This section applies the method described in the previous section to a hypothetical beverage company. The purpose of this section is to illustrate how the method can be applied, which can best be done by taking a simplified case. We have therefore assumed a company with no more than three input products and three output products. Obviously, by doing so, we do not intend to produce a realistic estimate of the water footprint of a beverage company, because a realistic company will always have more than three inputs and often more than three outputs. In our simplified case we ignore for example the energy requirements and the materials required for packaging and machinery, thus ignoring the water footprint of the company related to this energy and material use. The simplified company produces three beverage brands: two sparkling beverage brands (beverage A with cola taste and beverage B with orange taste) and one orange juice brand (beverage C). Figure 3 shows that the manufacturing system of the beverages takes place at three different business units (A, B and C) at different locations.

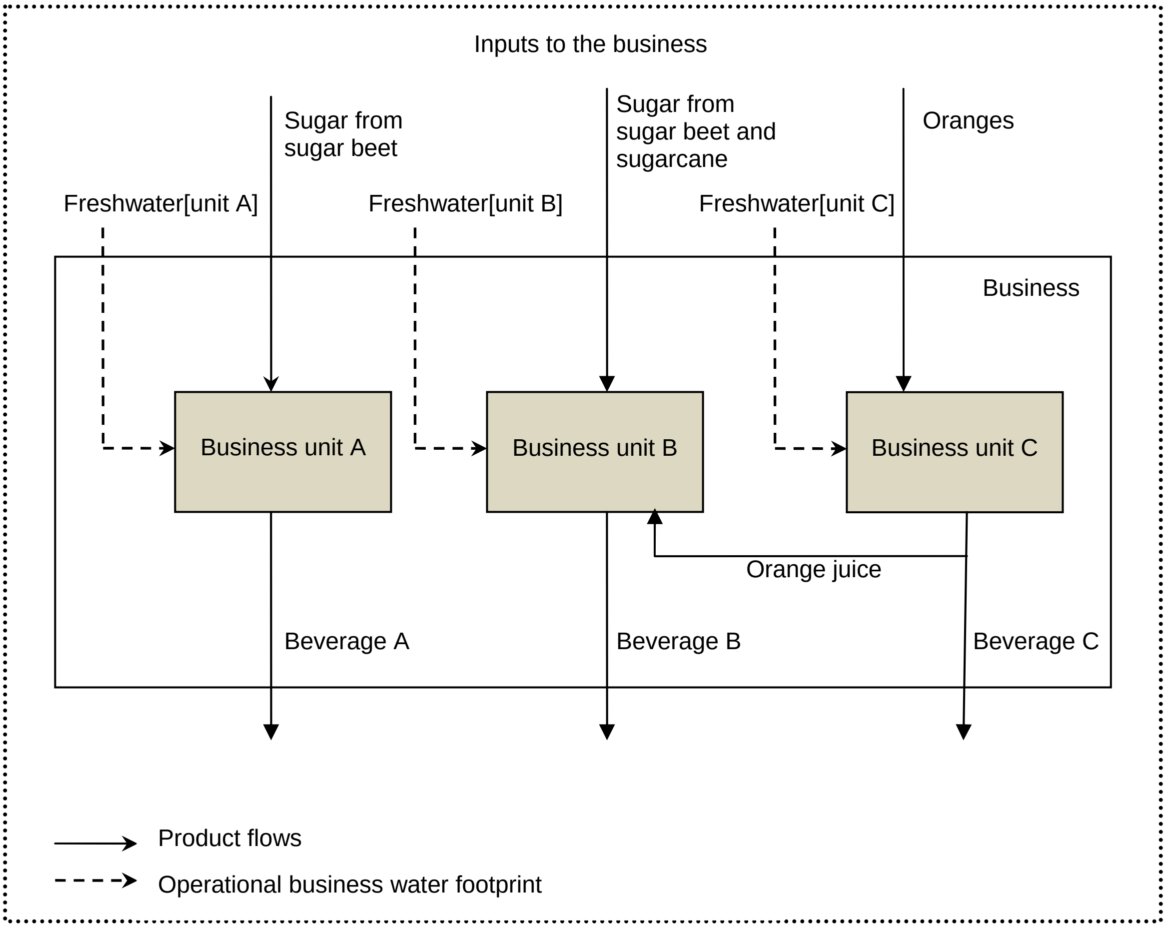

Fig. 3. Simplified beverage company that consists of three business units producing three beverage brands. Unit A produces beverage A, a beverage based on sugar from sugar beet that is sold to a business in the next link of the supply chain. Unit B produces beverage B, a beverage with orange taste based on sugar from sugar beet and cane and orange juice. Unit C produces beverage C, which is partly sold to another business and partly delivered to unit B.

The business water footprint (BWF) will be calculated according to the steps and equations explained before. We show how the method is applied in two different cases:

I. the business is regarded as a black box for which only input and output flows are registered;
II. the three business units that make up the business provide detailed information.

4.1 Case I: the business as a black box

Step 1: definition of the business

The three units of the business have an input in the form of ingredients for the products manufactured derived from companies in preceding links of the production chain, and related indirect freshwater inputs, as well as a direct freshwater input. Since there are no data on input and output flows per separate business unit, the business is treated as a black box. The method calculates the water footprint of the business based on data for the business as a whole. The business abstracts 1500 litres of groundwater per year of which 550 litres does not return to the hydrological system from which it was withdrawn (i.e. it evaporates or is incorporated in the products). There is no use of green water. The wastewater flow of 950 litre per year is sufficiently treated before disposal so that there is no production of grey water.

The business buys the following ingredients per year from different suppliers that obtain the ingredients at different locations:

- 15 kg of sugar from sugar beet from location L_1;
- 5 kg of sugar from sugarcane from location L_2;
- 140 kg or oranges from location L_3.

The business sells:

- 100 litres of beverage A for 46 euros;
- 70 litres of beverage B for 63 euros;
- 50 litres of beverage C for 65 euros.

The suppliers of the sugar provide the following data: 1 kg of sugar is produced from 7 kg of sugar beets or from 9 kg of sugarcane. The product water footprint (PWF) of sugar beet at location L_1 is 800 litres/kg, of sugarcane at location L_2 1600 litres/kg, and of oranges at location L_3 500 litres/kg.

Step 2: the operational water footprint for the business

$$\begin{aligned} BWF_o &= BWF_{o,green} + BWF_{o,blue} + BWF_{o,grey} \\ &= 0 + 550 + 0 = 550 \ \text{litres/year} \end{aligned}$$

Step 3: the supply-chain water footprint for the business

$$BWF_s = \sum_{p=1}^{n}\left(PWF[p] \times I[p]\right)$$
$$= 800 \times 15 \times 7 \ + \ 1600 \times 5 \times 9 \ + \ 500 \times 140 = 226{,}000 \ \text{litres/year}$$

Step 4: the total water footprint of the business

$$BWF = BWF_o + BWF_s$$
$$= 550 + 226{,}000 = 226{,}550 \ \text{litres/year}$$

Step 5: the water footprint of the output products per business unit

Rough estimate of the product water footprint of beverage A:

$$PWF[A] = \frac{46/\left(46+63+65\right) \times 226550}{100} = 599 \ \text{litre water/litre product}$$

Rough estimate of the product water footprint of beverage B:

$$PWF[B] = \frac{63/\left(46+63+65\right) \times 226550}{70} = 1172 \ \text{litre water/litre product}$$

Rough estimate of the product water footprint of beverage C:

$$PWF[C] = \frac{65/\left(46+63+65\right) \times 226550}{50} = 1693 \ \text{litre water/litre product}$$

Step 6: the water footprint of the total business

This step is superfluous in this case, because the business was considered as one unit, so the water footprint of the business was already obtained in step 4.

4.2 Case II: the business schematised into business units

Step 1: definition of the business and business units

The business consists of three separate business units for which data are available. Unit A produces beverage A, unit B produces beverage B and unit C produces beverage C. Input in the form of ingredients for the products manufactured derives from companies in preceding links of the production chain. According to the Business Responsibility Review, groundwater consumption in unit A is 250 litres per year, in unit B 175 litres per year in and unit C 125 litres per year (where "consumption" refers to the part of the groundwater abstraction that evaporates or is incorporated in the product, so that it does not return to the hydrological system from where it was withdrawn). Expressed per unit of product, the groundwater consumption is 2.5 litres per litre of beverage (independent of the type of beverage). There is no use of green water. Each unit applies wastewater treatment so that the sites do not produce grey water. The business buys the following ingredients from different suppliers that obtain the ingredients from different locations:

- 11 kg of sugar from sugar beet from location L_1 for beverage A;
- 4 kg of sugar from sugar beet from location L_1, 5 kg of sugar from sugarcane from location L_2 and 40 kg of oranges from location L_3 for beverage B;
- 100 kg of oranges from location L_3 for beverage C.

The business sells:

- 100 litres of beverage A for 46 euros;
- 70 litres of beverage B for 63 euros;
- 50 litres of beverage C for 65 euros.

The suppliers of the sugar provide the following data: 1 kg of sugar is produced from 7 kg of sugar beets or from 9 kg of sugarcane. Unit C produces 1 litre of beverage C from 2 kg of oranges. The PWF of sugar beet from location L_1 is 800 litres/kg, of sugarcane from location L_2 1600 litres/kg, and of oranges from location L_3 500 litres/kg.

Step 2: the operational water footprint per business unit

$$BWF_o[A] = BWF_{o,green}[A] + BWF_{o,blue}[A] + BWF_{o,grey}[A] = 0 + 2.5 \times 100 + 0 = 250 \text{ litres/year}$$

$$BWF_o[B] = BWF_{o,green}[B] + BWF_{o,blue}[B] + BWF_{o,grey}[B] = 0 + 2.5 \times 70 + 0 = 175 \text{ litres/year}$$

$$BWF_o[C] = BWF_{o,green}[C] + BWF_{o,blue}[C] + BWF_{o,grey}[C] = 0 + 2.5 \times 50 + 0 = 125 \text{ litres/year}$$

Step 3: the supply-chain water footprint per business unit

$$BWF_s[A] = \sum_{p=1}^{n}\left(WF[p] \times I[A,p]\right) = 800 \times 11 \times 7 = 61{,}600 \text{ litres/year}$$

$$BWF_s[B] = \sum_{p=1}^{n}\left(WF[p] \times I[B,p]\right) = 800 \times 4 \times 7 + 1600 \times 5 \times 9 + 500 \times 40 = 114{,}400 \text{ litres/year}$$

$$BWF_s[C] = \sum_{p=1}^{n}\left(WF[p] \times I[C,p]\right) = 500 \times 100 = 50{,}000 \text{ litres/year}$$

Step 4: the total water footprint per business unit

$BWF[A] = BWFo[A] + BWFs[A]$ = 250 + 61,600 = 61,850 litres/year.
$BWF[B] = BWF_o[B] + BWF_s[B]$ = 175 + 114,400 = 114,575 litres/year.
$BWF[C] = BWF_o[C] + BWF_s[C]$ = 125 + 50,000 = 50,125 litres/year.

Step 5: the water footprint of the output products per business unit

There is only one product per business unit, so we can use equation (5) to calculate the product water footprint per product. The product water footprint of beverage A from unit A:

$$PWF[A,A] = \frac{BWF[A]}{O[A,A]} = \frac{61{,}850}{100} = 619 \text{ litres/litre}$$

The product water footprint of beverage B from unit B:

$$PWF[B,B] = \frac{BWF[B]}{O[B,B]} = \frac{114{,}575}{70} = 1{,}637 \text{ litres/litre}$$

The product water footprint of beverage C from unit C:

$$PWF[C,C] = \frac{BWF[C]}{O[C,C]} = \frac{50{,}125}{50} = 1{,}003 \text{ litres/litre}$$

Step 6: the water footprint of the total business

BWF = 61,850 + 114,575 + 50,125 = 226,550 litres/year.

4.3 A comparison between the two cases

A comparison of the results of cases I and II shows that the calculated BWF is the same for the two cases. This was to be expected because the cases represent the same business and the calculations are based on the same data on business inputs and operational water use. If one is purely interested in the water footprint of the business as a whole, a black box schematization of the business as a whole will thus suffice. In the black box approach, however, detailed information per business unit is lacking. Moreover, estimates of the water footprint per individual product can be made, but those estimates will not be very accurate.

The two cases result in different estimates for the PWF's. The estimates in the second case are obviously more accurate than the estimates made in the black box case. The reason is that in the black box case each PWF is estimated based on the total water footprint of the business, which is allocated to the three products according to the production values of the three products. This was done because it was not known which inputs where precisely used to produce which output products. In case II this was known, so that more accurate estimates of the PWF per product could be made.

We can conclude that business water footprint accounting can be done at any level of aggregation – provided that data on inputs are available – but that accounting at a lower level of aggregation provides data at a lower resolution (per business unit), so that the accounts provide a better tool for comparison among comparable units, benchmarking and target setting. Besides, accounting for smaller units makes it possible to make more accurate estimates of the water footprint of individual products.

5. Discussion

We would like to draw attention to three particular issues that are important when calculating the water footprint of a business and that have not yet been raised. First, in contrast to energy, the price of freshwater is very low or negligible and does not indicate the scarcity of the resource. This implies that ingredients with a relatively large product water footprint do not show higher prices than similar ingredients with a relatively small product water footprint. When allocation occurs according to equation (4), the product water footprint of products with a large water use is probably underestimated. Second, companies often derive ingredients from the world market where the origin of the ingredients is unknown. This makes it difficult to assess the product water footprint. Solutions are to apply world average numbers for the assessment, use the weighted average of commodities on the world market, or to try to find the missing information. Third, attention should be paid to energy use. Especially energy derived from hydropower and biomass has a relatively large water footprint (Gerbens-Leenes et al., 2007). When companies use these energy carriers, the water footprint of energy should also be taken into account.

In order to calculate the water footprint of a business there are a number of practical questions that have to be answered. The first question is which inputs should be included and which inputs can be excluded when assessing the supply-chain water footprint? Should the indirect water use of common office materials like pens and paper be included? The general answer would be to include every individual input to the business that in itself is expected to contribute at least 1% (or other percentage) to the total supply-chain water footprint. But in practice it would be most helpful if for various sorts of businesses guidelines were available that tell what should be included and what can be excluded. Obviously the aim should be to include the items that are most significant in their contribution to the overall supply-chain water footprint. Part of this question is whether labour as an input factor in business has a supply-chain water footprint. The argument could be made that employees are an input factor that requires food, clothing and drinking water, so that all the direct and indirect water requirements of employees should be included in the supply-chain water footprint of the business. However, this creates a very serious accounting problem, well-known in the field of life cycle analysis. The problem is that double counting would occur. The underlying idea of natural resources accounting of products is to allocate all natural resource use to the *final* consumer products and based on consumption data to consumers. All natural resource use is thus ultimately attributed to consumers. Consumers are, however, also workers. It would create a never-ending loop of double, triple counting etc. when the natural resource use attributed to a consumer would be counted as natural resource use underlying the input factor labour in production. In short, it is common practice to exclude labour as a factor embodying indirect resource use.

A second question will be how far back one should trace a supply chain in order to estimate the supply-chain water footprint of a specific product. If a retailer for example buys cotton clothes in order to sell them to consumers, the cotton has probably a long history (cotton production, ginning, carding, weaving, colouring, finishing). Each phase of the production process may have taken place at another location. The general answer to this question is that one will have to trace the full supply chain in order to be able to say something about the reality of the product (Chapagain et al., 2006; Chapagain and Hoekstra, 2007). Of course, crude assumptions and estimates can be made if one cannot trace the origin of an input product precisely. This will than at least give a rough estimate, but for developing targeted policy to reduce the actual supply-chain water footprint for a specific input product, one should know the origins of the product all the way back its production chain.

Since 86% of the world water use is located in the agricultural sector, which is part of the supply chain of many businesses, the water footprint of a business that has agricultural products as input is likely to be dominated by the supply-chain water footprint. The contribution of the operational water footprint is relatively small in such a case. Although most companies focus on their own performance, for freshwater it is important to address the complete supply chain. If companies mainly centre on impacts generated by their own activities, large company efforts may still result in small improvements along the total lifecycle of a product.

Since large water footprints are mainly related to agricultural products (Hoekstra and Chapagain, 2008), we can expect that particularly large multinational companies that trade agriculture-based products will have a large business water footprint. We grouped those multinational companies according to their ranking in the Fortune 500 list (Fortune, 2007) into seven business sectors. These are: apparel, beverages, food and drugstores, food consumer products, food services, forest and paper and general merchandisers. Appendix 2 shows an overview of the largest companies per business sector that are expected to have a relatively large water footprint.

This report provides a theoretical framework for business water footprint accounting. Further development of the framework will depend on the willingness of businesses to apply the framework in practice, thus exploring its real potential and providing the necessary inputs to improve and refine the methodology. In the current stage the framework cannot be interpreted as a cookbook with simple guidelines to be followed. Undoubtedly new methodological and practical issues will be raised when applying the framework in practice. Therefore businesses that want to adopt and apply the accounting framework as introduced in this report should be willing to be frontrunner, which requires an explorative attitude.

6. Conclusion

Compared to earlier developed methods for business water accounting, the method based on the water footprint concept extends existing methods to green and grey water and includes sites of production in a supply chain. It excludes non-fresh water use, as included in the tool of the WBCSD (2007), because salt water is not a scarce resource. The water accounting tool of Gerbens-Leenes et al. (2003) does not include water discharge, while the OECD (2001) includes wastewater treatment but excludes the amount of water needed for dilution, and the WBCSD (2007) simply subtracts amounts of water discharged from withdrawals. The water footprint concept provides a detailed method on how to calculate water use in agriculture, which is missing in the other tools. The concept explicitly focuses on freshwater, which is considered a critical resource. This is in line with the accounting tool of Gerbens-Leenes et al. and the OECD, but not with the WBCSD that also includes saltwater resources. Based on the completeness of the water footprint concept, we therefore used it as a basis for the development of a method for business water accounting and termed this the business water footprint.

The application of the method for a hypothetical beverage company shows that it can be applied for different situations. Case I shows that when little information is available on specific business units, it is possible to use general information of the business as a whole to calculate the BWF. Case II shows that when data are available per business unit, more detailed information is generated for the business. This makes it possible to benchmark production processes in different units or set goals to decrease the WF of water demanding processes.

Business water footprint accounting can serve different purposes:

1. To identify the water-related impacts of the business on its social and natural environment;
2. To create transparency to shareholders, business clients, consumers and governments;
3. For comparing water use in comparable business units (within a business or cross-businesses) and subsequent benchmarking and target setting;
4. To identify and support the development of policy to reduce business risks related to freshwater scarcity.

The underlying aim of water footprint accounting within businesses is have an informational basis to enhance the efficient use of freshwater, to reduce the social and environmental impacts of water use and to add to the long-term security of clean freshwater supply.

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Appendix 1: Glossary

Blue component of the water footprint – The volume of surface and groundwater evaporated as a result of the production of the product or service. For example, for crop production, the "blue" component is defined as the sum of the evaporation of irrigation water from the field and the evaporation of water from irrigation canals and artificial storage reservoirs. For industrial production or services, the "blue" component is defined as the amount of water withdrawn from ground- or surface water that does not return to the system from which it came.

Business – A coherent entity or activity producing goods and/or services supplied to consumers or other businesses. It transforms a set of inputs into one or more outputs. It can refer to all sorts of (divisions or aggregates of) corporations, organizations, projects and activities at different levels of scale.

Business unit – Part of a larger business. Where the business can be interpreted as a system with inputs and outputs, a business unit can be seen as a subsystem of this system. Also the subsystem has clearly defined inputs and outputs.

Business water footprint – The total volume of freshwater that is used directly and indirectly to run and support a business. The water footprint of a business consists of two components: the direct water use by the producer (for producing/manufacturing or for supporting activities) and the indirect water use (the water use in the producer's supply chain). The 'water footprint of a business' is the same as the total 'water footprint of the business output products'.

Company – An enterprise aiming to make profit which operates under a system of coherent decision-making on policies and strategies throughout the organization and which can comprise one or more entities, sometimes in different countries.

Green component of the water footprint – The volume of rainwater that evaporated during the production process. This is mainly relevant for agricultural products (e.g. crops or trees) where it refers to the total rainwater evapotranspiration (from fields and plants).

Grey component of the water footprint – The volume of polluted water that associates with the production of goods and services. It is quantified as the volume of water that is required to dilute pollutants to such an extent that the quality of the ambient water remains above agreed water quality standards.

Operational water footprint – The amount of freshwater used for the operations of a certain business, i.e. the direct freshwater use of the business.

Outcomes – Standards providing guidance for business reporting on non-financial performance.

Practices – Codes that refer to the business action strategies and programmes.

Principles – Codes of conduct setting forth business commitments in various areas of ethics and legal compliance.

Product – Commodity, good or service produced or manufactured at a specific business unit often using ingredients from a supply chain.

Product water footprint – The total volume of freshwater that is used directly or indirectly to produce the product.

Supply-chain water footprint – The amount of freshwater used to produce all the products and services that form the input of production of a certain business, i.e. the indirect water use of the business.

Water footprint – An indicator of water use that looks at both direct and indirect water use of a consumer or producer. The water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business. Water use is measured in terms of water volumes consumed (evaporated) and/or polluted per unit of time. A water footprint can be calculated for any well-defined group of consumers (e.g. an individual, family, village, city, province, state or nation) or producers (e.g. a public organization, private enterprise or economic sector). The water footprint is a geographically explicit indicator, not only showing volumes of water use and pollution, but also the locations.

Appendix 2: Overview of largest companies per business sector with a relatively large water footprint

Source: Fortune (2007)

Apparel

Rank	Business	Global 500 rank	Revenues ($ millions)
1	Christian Dior	351	20,094.5
2	Nike	499	14,954.9

Beverages

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	Coca-Cola	285	24,088.0	5,080.0
2	Coca-Cola Enterprises	354	19,804.0	-1,143.0
3	Inbev	439	16,696.9	1,770.3
4	Anheuser-Busch	478	15,717.1	1,965.2

Food and drugstores

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	Carrefour	32	99,014.7	2,846.2
2	Tesco	55	79,978.8	3,544.9
3	Metro	62	75,131.0	1,324.9
4	Kroger	80	66,111.2	1,114.9
5	Royal Ahold	104	56,944.9	1,127.9
6	Walgreen	129	47,409.0	1,750.6
7	Seven & I Holdings	134	45,635.2	1,140.7
8	Groupe Auchan	141	43,900.3	936.0
9	CVS/Caremark	142	43,813.8	1,368.9
10	AEON	152	41,249.1	492.9
11	Safeway	155	40,185.0	870.6
12	Supervalu	167	37,406.0	452.0
13	J. Sainsbury	200	32,438.1	614.7
14	George Weston	234	28,350.4	106.6
15	Woolworths	235	28,275.5	758.0
16	Coles Group	241	27,516.0	869.3
17	Delhaize Group	276	24,481.8	441.5
18	William Morrison Supermarkets	298	23,125.3	459.5
19	Publix Super Markets	326	21,819.7	1,097.2
20	Alliance Boots	328	21,754.0	731.9
21	Rite Aid	418	17,507.7	26.8
22	Migros	451	16,466.4	601.4

Food consumer products

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	Nestlé	56	79,872.1	7,335.9
2	Unilever	120	51,032.9	5,953.3
3	PepsiCo	184	35,137.0	5,642.0
4	Sara Lee	389	18,539.0	555.0
5	Groupe Danone	412	17,656.7	1,697.5

Food production

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	Archer Daniels Midland	174	36,596.1	1,312.1

2	Bunge	255	26,274.0	521.0
3	Tyson Foods	264	25,559.0	-196.0

Food services

Rank	Business	Global 500 rank	Revenues ($ millions)
1	Compass Group	322	22,053.6
2	McDonald's	329	21,586.4
3	Sodexho Alliance	483	15,683.0

Forest and paper

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	International Paper	282	24,186.0	1,050.0
2	Weyerhaeuser	319	22,250.0	453.0
3	Stora Enso	393	18,310.3	734.0

General merchandisers

Rank	Business	Global 500 rank	Revenues ($ millions)	Profits ($ millions)
1	Wal-Mart Stores	1	351,139.0	11,284.0
2	Target	96	59,490.0	2,787.0
3	Sears Holdings	114	53,012.0	1,490.0
4	Foncière Euris	204	32,237.0	95.4
5	Macy's	227	28,711.0	995.0
6	PPR	296	23,191.6	859.8
7	J.C. Penney	352	19,903.0	1,153.0
8	Marks & Spencer	458	16,267.5	1,248.1
9	Kohl's	487	15,544.2	1,108.7

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UNESCO-IHE
P.O. Box 3015
2601 DA Delft
The Netherlands

Website www.unesco-ihe.org
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