The CEO Water Mandate

CORPORATE WATER ACCOUNTING

An Analysis of Methods and Tools for Measuring Water Use and Its Impacts

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Preface

The United Nations Environment Programme's Division of Technology, Industry, and Economics (UNEP DTIE) commissioned this report from the Pacific Institute in its capacity as part of the CEO Water Mandate Secretariat. It is one component of the broader UNEP Water Footprint, Neutrality, and Efficiency (WaFNE) Umbrella Project.

The CEO Water Mandate is a UN Global Compact initiative designed to help the private sector better understand and address its impacts on and management of water resources. Recognizing the urgency of the emerging global water crisis, the UN Secretary-General, in partnership with a number of international business leaders, launched the Mandate in July 2007. Endorsing CEOs acknowledge that in order to operate in a more sustainable manner, and contribute to the vision of the UN Global Compact and the realization of the Millennium Development Goals, they have a responsibility to make water resources management a priority, and to work with governments, UN agencies, non-governmental organizations, and other stakeholders to address this global water challenge.

The Pacific Institute is dedicated to protecting our natural world, encouraging sustainable development, and improving global security. Founded in 1987 and based in Oakland, California, the Institute provides independent research and policy analysis on issues at the intersection of development, environment, and security and aims to find real-world solutions to problems like water shortages, habitat destruction, global warming, and environmental injustice. The Institute conducts research, publishes reports, recommends solutions, and works with decision-makers, advocacy groups, and the public to change policy.

UNEP established the WaFNE Project in order to enhance water efficiency and water quality management through the refinement and pilot testing of water accounting methodologies and supporting management tools. This project will encourage convergence of practice and compatibility among these methods. This four-million dollar project – established in March 2009 – will be implemented over the course of three years with a variety of supporting partners including the UN Global Compact/CEO Water Mandate, Stockholm International Water Institute, Water Footprint Network (WFN), Society of Environmental Toxicology and Chemistry (SETAC), World Business Council for Sustainable Development (WBCSD), World Economic Forum, International Water Association, National Cleaner Production Centre Network, UNESCO, and the UN-Water Secretariat. In addition to the stocktaking exercise, this project will:

- Map and refine methodologies and related management tools for the water footprint and water neutrality concepts,
- Build capacity and raise awareness among the public and private sectors in order to apply "water footprinting" and neutrality concepts on a greater scale and with greater consistency,
- Demonstrate the applicability of harmonized concepts in enhancing water efficiency and improving water quality in water-intensive industries and water stressed regions.

Some of the key outputs from this project include: methodologies and tools for water accounting, dialogue platforms at the global and local level, a capacity platform with online knowledge management and guidance materials for water accounting methods, country level pilot testing of methods, and awareness raising activities. The pilot testing will look at the implementing of corporate water accounting methods – in possibly six countries spanning multiple continents and at least four industry sectors.

As an initial step to the WaFNE Project, UNEP has commissioned a stocktaking exercise of existing methodologies and supporting tools for corporate water accounting. The findings of this stocktaking exercise are the subject of this report.

The authors would like to recognize and thank the members of the Research Advisory Committee for their invaluable insights and contributions throughout the development of this report. A full list of members can be found in Appendix A. We also wish to thank others who helped develop and review this report including representatives from endorsing companies of the CEO Water Mandate, representatives from various civil society organizations, and staff of the Pacific Institute who provided valuable insight and editing suggestions.

The opinions expressed in this report are those of the authors and do not necessarily reflect the views of the Research Advisory Committee, UNEP, the UN Global Compact, or CEO Water Mandate's endorsing companies.

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I. Introduction

Problem Statement

Water as a natural resource is facing numerous challenges at the local, national, and global levels. Human water use is increasingly the source of harmful impacts on the environment, economic growth, human health, and geopolitical stability/security. Rising demands for fresh water stem from a variety of factors, including population growth, industrial activities, increasing standards of living, particularly in emerging economies, and the effects of climate change. Current patterns of human water use are unsustainable; 5 to 25 percent of global freshwater use exceeds long-term accessible supplies, requiring overdraft of groundwater supplies or engineered water transfers (Millennium Ecosystem Assessment 2005). In specific regions, such as North Africa and the Middle East, unsustainable use represents up to one-third of all water use (Millennium Ecosystem Assessment 2005). Additional water stress is projected in Asia, which supports more than half the world's population with only 36% of the world's freshwater resources. If current trends continue, 1.8 billion people will be living in countries or regions with water scarcity by 2025, and two-thirds of the world population could be subject to water stress (UN News Centre 2009).

In recent years, concerns of growing water scarcity, lack of access to water to meet basic human needs, depleted environmental flows, human health concerns, and the implications of climate change on the hydrologic cycle have increasingly brought water to the forefront as a strategic concern for companies around the world. Companies are realizing they are no longer able to easily access relatively cheap and clean water and that they must more closely consider limited supplies and the implications of their water use and discharge on watersheds, ecosystems, and communities. Further, pronounced water scarcity in key geographic regions, along with heightened expectations among important stakeholders including consumers and investors, has created a compelling business case for companies to actively pursue corporate water stewardship as a strategy that drives down water-related impacts and the subsequent business risks. In this context, "impacts" refer to the extent to which the volume of water used by a company in a specific watershed actually affects the availability of that water for other uses (e.g., meeting basic human needs or in-stream flows) or harms human well-being or ecosystems in any other way.

Companies' ability to measure and account for their water usage and wastewater discharges throughout the value chain is a critical component in their risk assessment and mitigation efforts, as well as their broader attempts to become responsible water stewards. Effective water accounting allows companies to determine the impacts of their direct and indirect water use and discharges on communities and ecosystems, evaluate material water-related risks, track the effects of changes in their water management practices, and credibly report their trends and impacts to key stakeholders. Water accounting also allows consumers, civil society groups, and the investment community to compare different companies' water risks and impacts in order to inform their actions and decision making. In sum, the ability to effectively account for corporate water use and impacts is essential in helping companies drive improvement and also become aligned with external stakeholders' efforts to advance sustainable water management.

However, collecting and disseminating meaningful water-related information is a complicated and difficult undertaking. As this analysis will demonstrate, corporate water accounting methods and tools have been under development for the past decade, yet there is near universal agreement that current methods – though a good start – are inadequate in the long-term.

Project Background

Research objectives

In response to this concern for improved corporate water accounting, several methods and supporting tools have emerged. The different origins, functionality, and evolving applications of the various approaches are currently poorly understood by stakeholders. There is a perceived need among businesses, civil society, and academia alike to elucidate the relation of these methods and tools to one another in order to help companies determine which approaches are best suited for particular applications. Improved clarity should also minimize duplication of efforts and promote coordination among the initiatives developing such methodologies.

This stocktaking exercise – a joint effort of UNEP and the CEO Water Mandate – will fulfill the need to clarify commonalities and differences among existing and emerging water accounting methodologies and tools being used in the private sector. Specifically, this report is intended to:

- Elucidate commonalities and differences among emerging methods and practice,
- Identify gaps and challenges, and
- Suggest where accounting methods might benefit from harmonization and increased field testing.

Though this analysis will cover a number of water accounting methods and tools of relevance to businesses, it will emphasize perhaps the two most significant: 1) water footprinting (as managed by the Water Footprint Network) and 2) emerging water-related practice in the field of Life Cycle Assessment. The authors note that the term "water footprinting" in and of itself is the source of confusion in this fast-evolving field and that it is currently being used to mean different things in various settings and arenas. The term "water footprint" was coined almost a decade ago by Professor A.Y Hoekstra of the University of Twente and refers to a specific methodology for water use measurement. Since that time a community of practice has emerged that has built on Hoekstra's methodology. In the last couple of years the term has increasingly been used metaphorically by laypeople broadly referring to the concept of water accounting. In that time span, it has also entered the lexicon of LCA practitioners who have had a newfound interest in water, and who often use the terms similarly to the term "carbon footprinting," which includes characterization of water use volumes according to local or regional context. For sake of clarity, the term "water footprint" will be used in this report only in reference to the formal methodology developed by Hoekstra and is currently managed by the Water Footprint Network unless otherwise specified.

In addition to water footprinting and LCA, this analysis examines in lesser detail the WBCSD Global Water Tool and GEMI's water sustainability tools. It also provides a cursory comparison of the ecological and carbon footprinting methods, particularly as they relate to corporate water accounting. This study does not offer specific recommendations for the advancement of each method, but rather provides general comparisons that will help stakeholders to identify the best prospective applications for each method and support the developers of these methods to work in a more coordinated and integrated fashion.

Research methodology

The project's research methodology included: a review of current literature; interviews with numerous academics, industry representatives and practitioners; attending relevant water accounting gatherings; and conversations with various organizations working in the field. It emphasized an iterative and inclusive data collection and analytical process, whereby key stakeholders were engaged throughout the project to help develop the project work plan, the methodological approach, and report drafting. This engagement was done primarily through a Research Advisory Committee (RAC) which included stakeholders from the private sector (including numerous CEO Water Mandate endorsers); civil society organizations, academia; the standards-setting community; as well as representatives from the Water Footprint Network and the LCA community. A prior iteration of this study was sent out for public comment from November 16 to December 11, 2009 and was discussed at a workshop in Paris November 23-24, 2009 organized by UNEP during which experts were encouraged to provide feedback and debate the contents of the draft and other components of the broader UNEP WaFNE Project. When appropriate, analytical assessments were based on empirical data from pilot testing and other organizational experiences for comparison purposes. Data derived from previous water accounting analyses were used when appropriate.

The methods and tools explored in this analysis were assessed using a number of criteria designed to be broadly applicable to all relevant methods and tools. They informed the development of the analysis, but not necessarily the structure of the final report due to their inherently inter-related and overlapping nature. These criteria are as follows:

Purpose, Objectives, and Applicability:

- For what internal and external purposes is the method or tool intended?
- What are the questions companies are trying to answer with this method?
- To what ends can companies currently use this method effectively?
- What is the level of maturity and market acceptance of the method? What components of the method are currently under development and not yet operational or effective?

Calculations Methods and Outputs

- What broad types of data and information does this method intend to gather/assess?
- How does the method divide/categorize data and information contained in the final product?

Water quality / Industrial effluent

- What broad approach to accounting for water quality does this method take?
- What specific water quality-related data and information is (and is not) accounted for in this approach?

Assessment of impacts to watersheds, ecosystems, and communities

- What criteria do each method use to measure local water resource context data and information?
- What is the method able (and not able) to communicate and quantify through its approach to impacts?

Assessment of water-related business risks and opportunities

- How does the method, if at all, account for and quantify business risks and opportunities associated with water-related impacts on watersheds, ecosystems, and communities?
- Does the method recommend specific actions to reduce water-related business risks?

This analysis does not delve deeply into technical aspects of any of the methods, but rather provides a general overview of the concepts that underpin them. It uses the ten or so stakeholder interviews conducted as the basis for assertions of most and least effective applications of these methodologies and tools.

II. Understanding Water Accounting Needs and Mechanisms

Water accounting – as well as companies' need for and use of it – has evolved significantly over time. Here we explore companies' various needs with respect to water accounting, as well as how those needs have evolved in recent years. In doing so, we describe when and for what reasons companies are seeking to use existing methods and tools, along with the questions they are asking with regard to their corporate water use/discharge and the resulting impacts and business risks. The review is divided into three inter-related categories:

1) Measurement of water use and discharge,
2) Assessment of the local and regional water resource context, and
3) Identification of water-related business risks and impacts.

These categories are somewhat artificial and have a great deal of overlap, but do represent the broad types of methods and tools available and the evolution of corporate water accounting over time. These areas of interest to companies are influenced by a number of factors, including pursuit of operational efficiencies, strategic planning, brand management/corporate reputation, and corporate ethics/philanthropy. However, at their root, they are all driven by the desire to reduce related business risk (and seize opportunities), whether that be through building competitive advantage, ensuring long-term operational viability, or maintaining and/or improving their social license to operate. Because reducing water-related risk is a core driver for emerging water accounting methods and tools, it is revisited in detail in Section IV.

Measurement of Water Use and Discharge

The most basic (and typically first) sphere of corporate water accounting relates to direct water use and discharge. Companies often measure the amount of water they are using and discharging at the facilities they own or operate. These measurements have been demanded since at least the 1970s by law and regulations in many developed countries and this practice is often carried over to facilities in less-developed countries. They have been largely driven by a desire to maximize operational efficiencies (e.g., decrease the amount of infrastructure, cost and/or energy needed for production processes and/or wastewater treatment). To this end, companies typically look at the efficiency of their direct operations in terms of volume of water withdrawn/consumed and amount and quality of wastewater discharged per unit of production. Companies are increasingly applying these same measurements to their key suppliers' water use in order to better assess the water resources required for the products and operations throughout the value chain. Such calculations usually serve as the basis for most companies' social responsibility reporting regarding water use, though the meaningfulness and legitimacy of such aggregated data are widely disputed (JPMorgan 2008, Pacific Institute 2008).

In past decades, companies have typically used internal proprietary software and/or undisclosed metrics to conduct these analyses. Widely-applicable methodologies for corporate water accounting, such as water footprinting and LCA, have become available in the last decade.

Key questions companies ask with regard to the measurement of their water use and discharges include:

- How much water do we use in all of our owned/operated facilities?
- How efficiently is this water used normalized to production?
- How much wastewater is discharged to the natural environmental and of what quality is it when if leaves the facility? What are the major contaminants released?

- How much water do my suppliers use? How efficiently? How much wastewater and of what quality?
- In which segments of my value chain does my company use/discharge the most water?

Assessment of Local Water Context

As global freshwater scarcity has become more pronounced and as the supply chains of most major companies have spread across the globe, concerns have mounted among companies regarding their water practices and continued access to water resources. Companies recognize that their water practices might be impacting communities or ecosystems, thus creating business risks. However, the simple measurement of corporate water use and discharge does not speak to a company's water risks or impacts per se. Water use impacts (and therefore business risks) depend on the highly-variable local contexts (i.e., watersheds, ecosystems, and communities) in which companies and their suppliers operate.

In the 1980s and 90s, companies first started assessing the status of water resources in locations of key operations. These assessments typically only took into account physical water availability (i.e., the amount of natural water available on an annual average basis, perhaps normalized to population). However, this general measure of physical supply is widely considered inadequate to determine the company's actual access to water supplies and services or whether environmental and human needs are being met (Chenoweth 2008, Molle and Mollinga 2003). More recent examinations of watershed status evaluate the percent of available water used for human purposes, the amount of water allocated to meet in-stream environmental flow needs, the adequacy of local water management and governance capacity, and the ability of nearby communities to access (and afford) water services, among other things. Holistic consideration of these factors ultimately leads to a better understanding of a watershed's relative water abundance or scarcity, as well as the local context for the company's water use.

Local watershed data can serve as proxies that allow businesses to better understand and mitigate water-related risks. By utilizing "hot-spotting" techniques to identify facilities located in watersheds considered to be water-scarce, companies can prioritize the locations to invest in operational efficiencies, contingency planning, policy engagement, or community outreach.

Some of the key questions companies are asking with regard to assessing the local water context of their operations include:

- Which of my facilities are located in water-stressed regions (including physical, economic, and social scarcity)?
- What is the nature of our water use and discharge (and possible corollary business risks) in various locations?
- What percent of this watershed's available water do my facilities use?
- What percent of the available water in a particular watershed is used for human purposes and what are the allocations among sectors?
- In which locations are water governance and management capacity a concern?
- How secure/reliable is our access to water in those locations?
- In which locations is there a high potential for reputational risk due to insufficient environmental flows or inadequate access to water services among local communities?

Assessment of Water-related Impacts

It is widely accepted that volumetric measures of water use alone are not an adequate indicator of a company's water-related social and environmental "impacts" as they do not consider local contexts from which water is withdrawn. Thus, the necessary, yet by far most complex component of corporate water accounting is the assessment of impacts to watersheds, ecosystems, and communities caused by corporate water use and discharge.

In this context, "impacts" refer to the extent to which the volume of water used by a company in a specific watershed actually affects the availability of that water for other uses (e.g., meeting basic human needs or in-stream flows) or harms human health or ecosystems in any other way. Water use can potentially have positive impacts as well (e.g., improving water quality or recharging aquifers), however most water accounting methods tend to evaluate negative impacts of water use. Identifying such impacts is essential to enabling companies to make accurate comparisons amongst water use in different watersheds, different products, or different components of the value chain or product life cycle. These comparisons in turn help companies understand which facilities or products pose the greatest threat to nearby ecosystems and communities, and consequently present the most concerning business risks. While the previous two areas of water accounting shed some light on companies' water-related risks, it is through understanding impacts (both quantitatively and qualitatively) that companies have the clearest sense of their risk exposure.

Some of the key questions companies ask in regard to water-related impacts include:

- Which of my facilities or products pose the greatest social and environmental impacts?
- Which components of my value chain or product life cycle result in the greatest impacts?
- How do my operations in a specific watershed affect ecosystem functions and/or in-stream flows?
- How do my operations in a specific watershed affect the ability of communities to access or afford adequate water services?
- How do my operations in a specific watershed affect human health?
- How might these various impacts expose us to business risks?

Corporate Water Reporting

Once an internal assessment of corporate water use and related impacts is completed, companies will often disclose this information (or part thereof) to their stakeholders and the broad public. This reporting allows companies to be transparent and accountable regarding their use of water resources, and also allows various stakeholders to track and provide feedback on corporate practices and performance. Much of this water-related reporting is qualitative, providing descriptions of various corporate water stewardship initiatives, principles, policies, and goals. However, companies are perhaps more intently evaluated based on their reporting of quantitative information.

Theoretically, such quantitative reporting could be about any of the findings from corporate water accounting efforts, including the local water context of their operations and the quantified impacts to watersheds, communities, and ecosystems. In practice, however, companies almost always report a much more limited (and arguably less meaningful) set of information, such as their total water use, total wastewater discharge, water use efficiency, and total amount of recycled water.

The use of harmonized metrics or indicators on corporate water use developed by third party interests is often seen as one factor in credible corporate sustainability reporting. The most widely used and accepted metrics for sustainability reporting are developed by the Global Reporting Initiative (GRI). GRI's most recent reporting framework – known as the G3 Guidelines – contains indicators for the economic, environmental, and social performance of companies, including five specifically focusing on water-related issues:

1. Total water withdrawal by source
2. Water sources significantly affected by withdrawal of water
3. Percentage and total volume of water recycled and reused
4. Total water discharge by quality and destination
5. Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the organization's discharge of water and runoff.

While certainly useful, these indicators are limited in the nature and scope of information they provide. First, as discussed throughout this paper, volume measurements of water used and discharged alone are not able to capture the impacts that vary depending on the relative local water conditions. Furthermore, aggregated company total water use data without regionally-specific volumes obscures important contextual information..

Metrics such as those in the G3 Guidelines are an essential starting point for communicating corporate water accounting results to external audiences. However, as they do not provide methodologies or tools through which to measure or assess water use (but rather a framework and indicators through which to report those types of measurements), they are not included among the accounting methodologies assessed in this report.

Corporate Water Accounting in Context

As shown above, comprehensive corporate water accounting requires a number of different types of information and assessments in order to derive meaningful information. However, in order to contribute to improved corporate management practices and ultimately the sustainable management of water resources, corporate water accounting must also work in unity with a number of other components. While companies have direct control over some of these aspects, they have limited ability to influence others. That said, understanding this broader context – and how water accounting fits into it – is essential for companies seeking to reduce and mitigate water-related risks. Key components of this broader framework are:

External Water Resource Context and Data: A foundational component of this framework is the real-world characteristics and conditions of the watersheds, ecosystems, communities, government, and economy in which businesses exist.

Corporate Water Accounting: Accounting allows companies to understand the water systems in which their business and suppliers operate, as well as the volume, timing, location, and impacts of their water use and discharge. This provides a basis from which to plan strategically, assess management practices, track performance over time, and communicate with stakeholders.

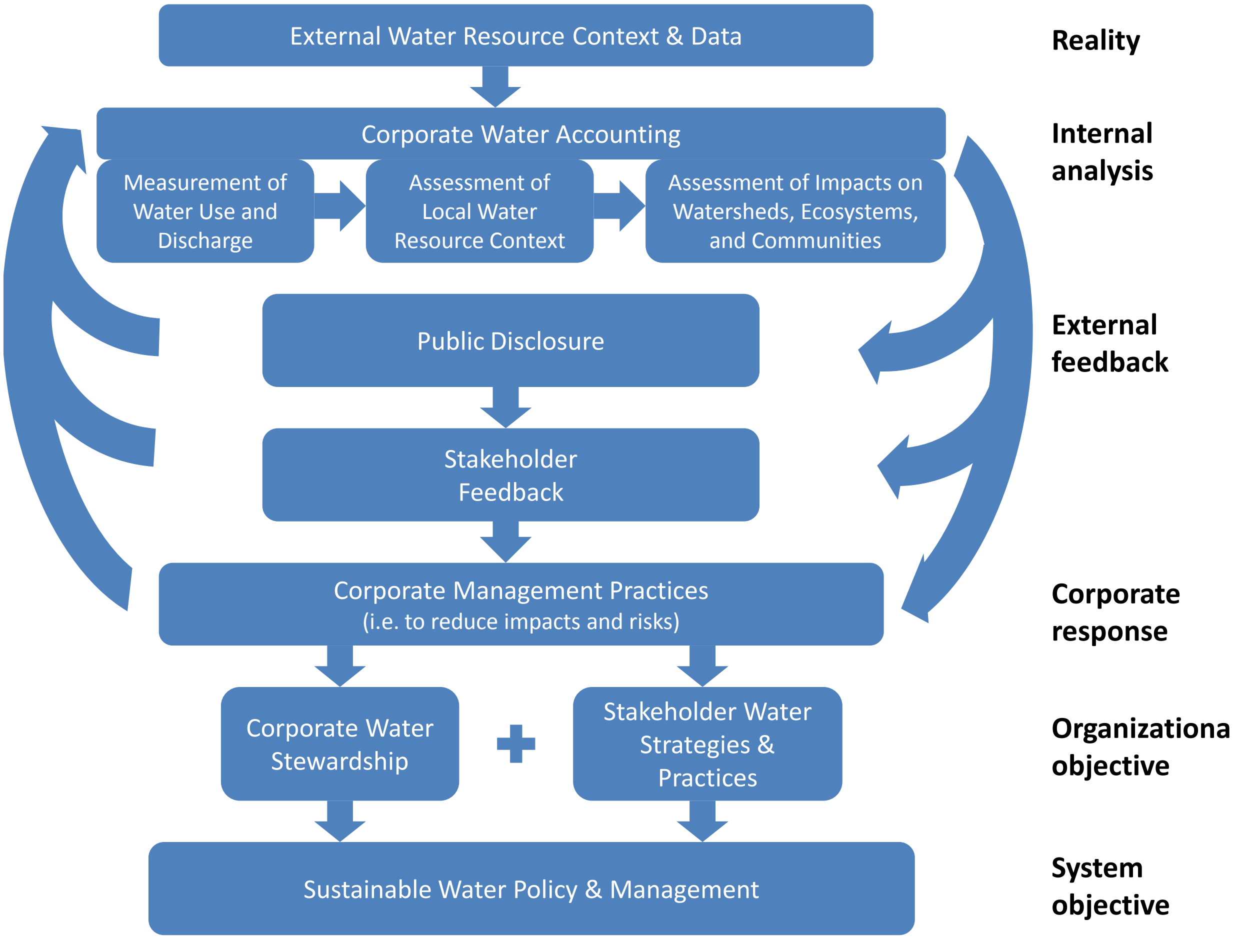
Public Disclosure and Stakeholder Feedback: Once corporate water use and impacts are accounted for, companies disclose quantitative and qualitative information to stakeholders. This allows stakeholders to evaluate companies' approaches to addressing risk and to hold companies accountable for their management practices. Stakeholder feedback in turn helps companies prioritize issues and improve the processes through which they mitigate negative impacts and thereby address physical, regulatory, and reputational risks.

Corporate Water Management and Stewardship: Accounting is intended to inform more responsible and efficient corporate water management practices. Once these management responses successfully address negative impacts on ecosystems and communities, the company may be considered a good steward of water resources.

Stakeholder Water Practices and Strategies: Corporate water stewardship alone cannot ensure sustainable water management within a region. This component is comprised of all the communities, policymakers, water managers, and other stakeholders that must reach their own internal water stewardship in order to achieve collective sustainable water management. Companies can encourage these players to implement responsible water policies.

Sustainable Water Management: When companies and other stakeholders in a watershed are effectively and collectively implementing responsible water practices and managers prioritize needs (i.e. industrial, agricultural, municipal, and environmental) based on resource availability and account for long-term risks (e.g. population growth and climate change) , the system might be considered to have reached a sustainable state – the overarching goal of corporate water accounting and water management in general.

Figure 1: The role of water accounting in advancing sustainable water management



While the primary focus of this analysis is on the water accounting component of this framework, we will touch upon some of these components described above. Specifically, we will consider the degree to which current water accounting methods and tools are positioned to address external stakeholders' water-related information needs. We will also touch upon the emergence of corporate water stewardship approaches such as water offsetting tools targeted at addressing water impacts, and evaluate the state of water resource data that currently hampers the evolution of water accounting practice.

III. Objectives, Structure, and Applicability of Methods and Tools

Current water accounting methods and tools all have different histories, intended objectives and outputs. This section will elucidate these differences (as well as the commonalities) in order to clarify the circumstances for which various methods and tools may (or may not) be appropriate and effective. In doing so, we will attempt to assess the:

- Scope of the method/tool, as well as its intended objectives and subjects/audiences,
- Information captured in the end product/analysis, and
- Purposes for which the method/tool excels and areas where it may be deficient

We focus primarily on the objectives and functionality of the water footprint and LCA methods, though also explore other accounting tools and approaches and the value they add to corporate water accounting not provided by these two major approaches.

Water Footprinting (as Managed by the Water Footprint Network)

Origins

Water footprinting – a methodology introduced in 2002 and developed primarily by researchers at the University of Twente – measures 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, and more recently, a business or its products. Water footprints are intended to allow these entities to better understand their relationship with watersheds, make informed management decisions, and spread awareness of water challenges worldwide. Throughout this decade, the water footprinting method has been further refined, beginning to incorporate ways to achieve more reliable and spatially- and temporally-explicit data and better account for water quality and impacts, among other things.

Water footprinting was originally developed as an indicator of fresh water use for water resources management (WRM) and is currently well-established as a leading water accounting methodology in this field. WRM accounting to this day remains one of the primary roles of water footprinting. In the context of WRM, the spatially- and temporally-explicit water footprint measure allows managers to map various water uses in a system (e.g. agricultural, municipal, industrial) and identify major water uses, as well as the amount of water used by the community, country, region, etc. to produce the goods and services they consume. For WRM, the actual volume of water used is critical information as it allows managers to, for instance, understand how water use relates to overall supply volumes, how water is allocated among users within their system (and if its allocated equitably), which needs (e.g. environmental, basic human) are being met, and which water uses are providing the most economic value per unit volume. Armed with water footprints, water managers are better positioned to make water allocation and other decisions.

Water footprinting (in the context of WRM) was borne out of and is underpinned by the concept of virtual water – the amount of water used to produce individual goods and services (most notably crops) throughout all stages of production. Understanding virtual water content has helped policymakers know which goods or services (e.g., certain types of crops) consumed in their country contribute the most to water scarcity issues. One critical aspect of virtual water is that it also aims to account for the water needed to make the goods and services that are imported into a system. Thus water footprints in the WRM context account for virtual water trade through the notion of internal and external water footprints, which track how much of an area's (e.g. nation's) naturally-occurring water is used for the goods and services consumed in that area and how much foreign water is used for those same purposes. The virtual water concept (measured by means of the water footprint) has proven quite helpful for water managers and policymakers as they consider the merits of domestic food production versus importing (and/or not exporting) water-intensive goods, in conjunction with shifting water allocations to uses with more economic value in water-stressed areas.

Only in the last couple of years have companies begun to use water footprinting to assess their direct and indirect water use, bringing with them different questions and needs of the accounting method. A key distinction is that water footprinting for WRM focuses on the ability of available water supply to meet all needs and to prioritize those needs in the face of scarcity based on societal, environmental, and economic values. In contrast, companies are typically only concerned with the ability of available water supplies to meet their own needs, but are also equally concerned with understanding their water footprint (and potential business risks) across multiple different watersheds. This is because of their desire to understand their indirect water use (i.e., the water embedded in their supply chains) and because of the global reach of most corporations' value chains.

<u>Scope, structure, and outputs</u>

"Water footprinting", as promoted by the WFN, focuses solely on providing a method for companies to measure their water use and discharge; the water footprint itself does not aim to assess the status of watersheds or water-related impacts per se. A water footprint captures the volume, location, and timing of water uses and discharges. Water footprints are divided into three separate components – the blue, green, and grey – all of which are expressed in terms of water volume. These components are meant to be considered both separately and together as a total water footprint (i.e. the sum of the blue, green, and grey water footprints). The three water footprint components are defined as follows:

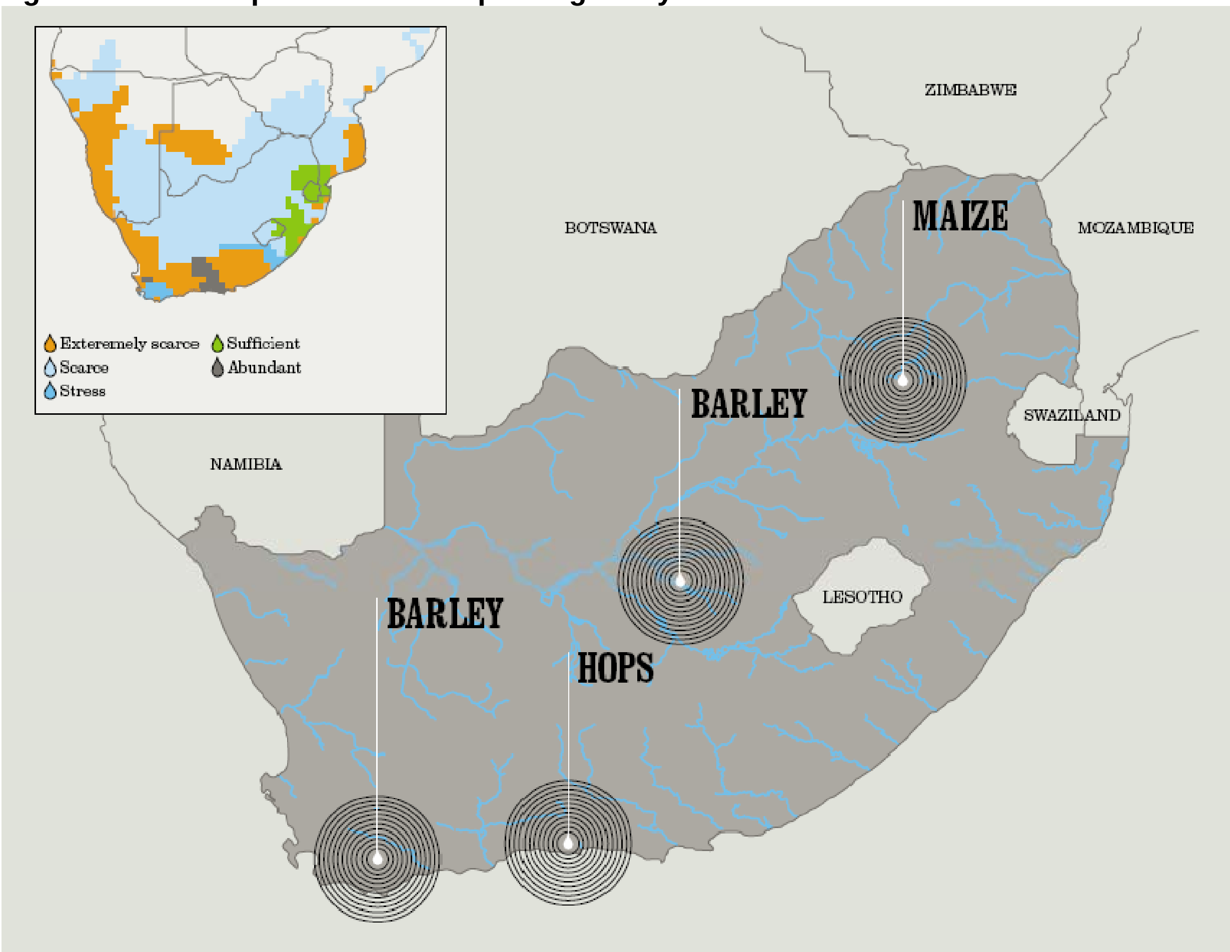
> **Blue water** – the volume of consumptive water use taken from surface waters and aquifers.
>
> **Green water** – the volume of evaporative flows (often found in soils rather than major bodies of water) used.
>
> **Grey water** – the theoretical volume of water needed to dilute pollutants discharged to water bodies to the extent that they do not exceed minimum regulatory standards.

The green and blue components of a water footprint focus on consumptive water use (i.e. the volume of water removed from local water system by evaporation, inclusion in a product, water transfer, or otherwise). They do not include those uses of water that are eventually returned to the same system from which they are withdrawn (i.e. non-consumptive uses). To the degree to which non-consumptive water use is addressed, it is done within the grey water component.

Corporate water footprints measure the total volume of water used directly and indirectly to run and support a business. They are typically scoped to focus at the product level (i.e., volume of water used throughout a product's life cycle), but can also focus on one or more components of a company's value chain (e.g. raw material production, manufacturing, distribution), on a business activity or division, or by a key facility or region of operation. Corporate water footprints are meant to be divided between their operational and supply chain components; however, comprehensive assessments of water use in a company's supply chain through water footprinting are not widely practiced to date due to the difficulty in obtaining data for large supplier networks. The inclusion of spatially- and temporally-explicit data is deemed critical for allowing companies to better understand their relationship to the contexts in which they operate.

Water footprinting studies typically use maps and other visualizations to express data and results. Though such visualizations are not provided for or required by the WF methodology, they have become common practice for WF studies. These maps can illustrate internal data such as facility locations and water use, as well as external data that contextualize the WF data, such as different water users within a system and the relative water scarcity of different regions. This not only allows companies to visually locate (i.e., "hotspot") potential impacts and risks (e.g., linking facility sites with water scarce regions or where their water uses may infringe upon other uses), but is also a particularly powerful communication tool. Corporate sustainability managers have found these maps very effective in communicating with non-technical audiences, both internal (e.g., upper management) and external (e.g., investors, consumers, local communities).

Figure 2: An example of water footprinting study visualization



Source: Water Footprinting: Identifying and Addressing Water Risks in the Value Chain. SABMiller and WWF-UK. August 2009.

<u>Business applications, strengths, and weaknesses</u>

Strategic planning and risk assessment

Our research found that businesses consider water footprinting a useful framework for understanding and contextualizing their water use and for identifying water risk "hotspots" in their products, facilities, and/or supply chain. In this regard, WF is considered quite effective for "big picture" purposes and for helping companies prioritize actions and set long-term objectives and targets. The strengths and weaknesses of WF as a risk/impact assessment tool are explored in detail in Section IV.

WFs are beginning to be used as a reporting/communication tool, though the appropriateness of this use is questioned by some. These concerns are based on the notion that generic and aggregated claims (such as 2,500 liters of water to produce on cotton shirt or 960 liters of water to produce a liter of wine) are inherently misleading and/or meaningless because they obscure essential information regarding the local context and nature of the water use. That said, more detailed reporting of WF studies can help companies be accountable to (and receive feedback from) key stakeholders, as well as help build a good reputation relating to water transparency and responsible water practices. Proponents have also identified WF as an effective awareness raising tool for business, consumers, and policy-makers on water issues worldwide.

Green-blue-grey distinction

For companies that have used water footprinting, the distinction between blue and green WFs appears to be helpful. This is particularly (and perhaps mostly) the case for companies in agriculture-based industry sectors (such as food and beverage, textiles, etc.).[1] With regard to agricultural production, blue water essentially is comprised of irrigated water (whether groundwater or surface water), while green water is comprised of the water naturally occurring in the soil from rainwater. Recently, some companies have adopted the concept of “net green” water – the difference between water evaporated from crops and the water that would have evaporated from naturally-occurring vegetation. This allows companies to better understand their contribution to water availability in a particular area and how much water would be in the system if the company were not there. In particular, it highlights the opportunity costs associated with the company’s green and blue WF as compared to other possible uses in the watershed.

The green-blue distinction is helpful because these two types of water use have substantially different potential risks and impacts on the surrounding environment. Blue water use directly depletes aquifers and surface waters thereby potentially contributing to water scarcity, destruction of ecosystems, and/or reduced access among human communities, among other things. There is often competition for blue water among many users, sometimes leading to business risks when corporate water use hinders – or is perceived to hinder - other uses. To mitigate blue water impacts and associated risks, companies might improve their water use efficiency or engage with affected parties to improve their access to water services. In contrast, the impacts and mitigation strategies for green water use are typically related to land use change rather than infringement upon other water uses. These land use changes – for instance the conversion of forests to arable lands - clearly affect ecosystem function (e.g., habitat and biodiversity) as well as communities access to resources (e.g., timber). As such, companies consider the distinction between green and blue water useful in helping them understand the types of impacts their agricultural production might have on surrounding ecosystems and communities. However, water footprinting currently offers no guidance on how to interpret or value the different impacts of green and blue water use.

The distinction between green and blue is also perceived as useful in its capacity to assess long-term risks related to climate change. Climate change is predicted to have drastic impacts on the hydrologic cycle and the availability of water for human uses. Precipitation patterns will begin to change on a regional basis, often becoming less or more frequent and more concentrated depending on the location. This has many implications for blue water resources

[1] This may also prove true for companies with large land use impacts such as those in the petroleum, mining and forestry industry sectors, among others.

(e.g. infrastructure's ability to cope with longer droughts), but is particularly problematic for those who rely on green water. Less frequent rainfall will ultimately mean less green water stored in the soil. Because of this, those who rely solely on green water use (namely agricultural growers in the Global South who do not have access to irrigation) will simply not be able to sustain crop production through long droughts. This of course poses business risks for companies who rely on those growers as suppliers or utilize the majority of blue water in that same region to the extent that it is unavailable for those growers. For this reason, the green-blue water distinction in conjunction with climate change prediction models has helped companies better assess which of their water uses may be most susceptible to disruptions due to climate change.

Companies interviewed for this analysis indicated that while the individual water footprinting components (especially the blue and green footprint) were quite useful for informing internal management and product design, the total water footprint – the blue, green, and grey components aggregated into one number – was not as meaningful a number. This opposition to the total water footprint is based on the notion that there are substantially different types and severity of impacts associated with the blue and green water footprints and the fact that the grey water footprint, which is a theoretical rather than actual measured volume, should not be aggregated with the other two. Further, while the concept of accounting for industrial effluents and water quality was universally considered important, companies familiar with WF have significant concerns (both conceptual and practical) with the grey water component of the method. This will be explored in more detail in Section V.

Water policy and management interface

Water footprinting has also proven to be useful for companies who look to advance sustainable water management beyond their fenceline. Companies can use WF to highlight where major water uses in the value chain to prioritize where they might focus their external engagement. For instance, if a company determines that the majority of their water use occurs in agricultural production, they could work with local growers (and suppliers) to implement efficiency technologies. Companies could also work with academia to further develop those technologies. Similarly, companies could work with water managers to improve efficiency (e.g. through funding the repair of pipes), which is often cheaper and saves more water than internal efficiency improvements. If companies determine that their water use is hindering environmental flows or community access to water, they could partner with local NGOs to find effective solutions. Water footprinting is particularly well suited to help inform corporate engagement with water policy and management due to the fact that it was originally designed as method for assessing WRM (and therefore many managers and policymakers are familiar with it). Its effectiveness as a communication tool for non-technical audiences also makes it particularly useful to this end.

Life Cycle Assessment

<u>Origins</u>

Historically geared toward and utilized by the private sector, Life Cycle Assessment (LCA) is a systems analysis tool, which was designed specifically to measure the environmental sustainability of products and services through all components of the value chain. However, LCA has been very successfully used as a national and even international policy tool, and is imbedded in many laws in the EU, Japan, Malaysia, Australia and elsewhere. The functional unit can be set to the total impacts in a watershed, or a county or a country, and this greatly aids policy analyses. LCA is an input-output tool, measuring resource use and pollution that can be allocated to a particular product. Properly done an LCA allows companies and other interested parties (including consumers) to make an A-to-B comparison between products.

The first LCA study was published in 1969, coincidentally the year before the adoption of the National Environmental Policy Act (NEPA) in the United States, the first comprehensive national environmental legislation. NEPA is the source of the environmental impact assessment and of national environmental status reporting in the U.S., and has been used widely as a model around the world. In many ways, the LCA study is the product level mirror of the government level environmental impact assessment. It seeks to identify environmental issues in a holistic and science-based way.

Hundreds of thousands of LCA studies have been published in the last 40 years. The area of agricultural LCA has been especially prolific, and several international conferences have been devoted to the LCA of foods.

Scope, structure, and outputs

Unlike water footprinting, which focuses on a single environmental resource (water), LCA was designed as a method that enables cross-media evaluations and comparisons across many different types of environmental resources, emissions, and their impacts. Indeed, the ability to assess impacts across a range of environmental categories is its core function and value. These analyses require a much more elaborate process than the strict measurements seen in water footprinting, typically comprised of four basic stages:

1. *Goal and scope:* The goals and scope of study in relation to the intended application are specified. This includes establishing the boundaries of the system being assessed (i.e. determining what is being measured) and defining the "functional unit" of the study – the product/activity being assessed.
2. *Life cycle inventory*: Environmental inputs and outputs (e.g., water use, GHG emissions) that may have subsequent impacts are measured. In respect to water, this is the stage where the volume, timing, type (i.e., stocks, flows), location of use, and the volume/mass of contaminants released to waterways (among other things) are captured.
3. *Life cycle impact assessment*: The environmental quantities measured are translated into impacts (e.g., contribution to global warming, fresh water depletion, human health concerns). Emissions and resource uses from a variety of different sources are collected and assigned into their relevant impact categories, then characterized by the relevant impact characterization factors developed through resource management and fate and transport models.
4. *Interpretation:* The final stage is designed to further translate the quantification of impacts determined in the previous stage into meaningful conclusions and recommendations to improve the environmental performance of the product or service.

As discussed, LCA provides information on different types of environmental activities (i.e., GHG emissions, water use, habitat destruction, etc.) and different impact categories which those flows can affect (i.e., water scarcity, human health concerns, global warming, etc.). This allows LCA to quantify and compare the multiple types of impacts caused by one type of use or emission, as well as the various resource uses or emissions that contribute to one type of impact (e.g., the various business activities that contribute to eutrophication of water bodies). Typically, life cycle inventory data reflects the volume of water used at a given unit process. The challenge for evaluating the impact of water use is that often one does not know where that unit process occurs.

Business applications, strengths, and weaknesses

LCA is a decision-support tool has primarily been used for three kinds of decisions:

Engineering decisions for product/process improvement: Also called design for environment or eco-efficient manufacturing, this allows companies to identify opportunities for environmental improvement/optimization and measure the improvement along the entire supply chain. With LCA practice this is often linked to hotspot analysis or identifying which parts of the product life cycle have the greatest environmental impacts.

Policy decisions at the company or governmental level: This allows companies to develop more rational and holistic view of the environmental impacts of economic activities. In this context, economic input-output life cycle analysis – though actually not applied at the company level - has proven to be a very useful economy-wide tool, permitting one (typically government entities) to calculate a zero-order estimate of the impacts of marginal production in the different economic sectors. Use of LCA in the context of national rulemaking is countenanced within the WTO as not creating a technical barrier to trade, providing that the relevant international standards are followed.

Environmental purchase and sales decisions: This occurs either as a support for environmental claims or as the supporting information for Type I and Type III ecolabels. In this context, LCA is useful to program operators of ecolabel programs, whether they are governmental or private sector programs. Type I labels are provided for products whose life cycle performance exceed set standards. In contrast, Type III environmental product declarations (EPDs) merely disclose performance in a pre-set fashion by product category rules and they make no claim of environmental superiority. EPD programs require LCA studies to be performed for all products seeking the label. EPDs are becoming a requirement under law in some countries. Almost all EPDs are aimed at the business or institutional customer. If and when the labels become available in a consumer setting, they will have to be accompanied by a substantial educational effort. Studies on nutrition labels, for example, show that even decades on, the consumer is confused about the meaning of the information, and environmental information is even more obscure to the average consumer.

The general framework for and validation of LCA studies is governed by the relevant ISO standards:

- ISO 14040 and 14044 (the life cycle standards)
- ISO 14025 and 21930 (the EPD standards)

In general, these standards require higher and higher levels of verification as the use of the data becomes more public and more widespread. The required/recommended validations are:

- For internal use only, verification by a co-worker who was not involved in the original study
- For external use (what is called a third-party report), verification by a panel of at least three, including LCA experts and interested parties.
- For EPDs, there are two levels of verification the first for development of the product category rules, which requires a panel of experts and interested parties, and the EPD product-specific LCA study, which requires only an independent individual. The standards call out the requirements for LCA experts, including that they be independent (with no conflicts of interest), be technically competent in LCA matters and in the specific

elements of the EPD program and the relevant standards. The review team must also have expertise in the products and processes under consideration.

The limits to the utility of LCA lie primarily in two areas: 1) lack of appropriate data on a global basis, 2) lack of consensus impact assessment models with which to evaluate available data. Although the development of necessary life cycle data is a large and ongoing effort, it is very small when compared to, for example, the efforts undergone in every country to track economic data. There is a great deal of data available through public and private databases, and there is every reason to believe that adequate public data will become available world-wide within the next decade. As the science of LCA advances, it is to be expected that there will be better consensus on the appropriate impact assessment models as well.

In the meantime, techniques for estimating uncertainty in analyses due to missing data have been developed. The more common processes in the economy (such as energy production and transportation) have been studied in great detail. Although there is always room for improvement, these data are very good. For example, the standard deviation of the climate change figures for these common processes is on the order of ten percent.

Water and LCA

Though LCA has existed for several decades, traditionally water use has not been accounted for within this method in any sort of detailed or comprehensive fashion. Historically, if measured at all, water use has been accounted for strictly as an inventory of a product's total blue water use (abstracted and not location-specific) with no subsequent impact assessment. However, given companies' growing concerns of water scarcity in the last decade, developing better ways of accounting for water use within LCA has become a priority area. Further, consensus appears to have been reached among LCA practitioners of the importance of better differentiating between consumptive and non-consumptives water uses in LCA studies. Also recognized is the need to understand and specify the geographic location of water withdrawals, the sources of the water use (e.g. lake/river, groundwater, rainwater) and whether those sources are renewable or non-renewable.

There is currently a great flowering of research on water scarcity and life cycle impact assessment modeling of the resource, health effects, and ecosystem damages from water scarcity. LCA practitioners have put forward different ways of characterizing the impacts for water use in a particular setting, though proposed impact categories have varied from study to study. Some of the impact categories proposed in these methods include water sufficiency for different users, ecosystem quality, resource consumption, and human health, among others. LCA's approach to impact assessment is discussed in detail in Section IV.

However, due to inventory data limitations, the ability of LCAs to deliver detailed and accurate impact assessment for water is not yet clear. That is because, with a few exceptions, most water-related environmental impacts are local and regional in nature, while life cycle inventory data tend not to be identified at a fine enough geographic level (e.g., at the level of watersheds) if at all. Many impact models have been developed that are appropriate for regionalized analyses, but the inventory data do not yet assure that the appropriate level analysis can be performed. Instead simplified models with global averages are used. These can certainly be appropriate for a first-level, screening analysis. In principle, once more localized information is made available the more site-specific and therefore more accurate and environmentally relevant the LCA results will be.

WBCSD Global Water Tool

Origin, objectives and scope

Unlike water footprinting and LCA, which are undertaking to develop and refine water accounting methodologies, the WBCSD Global Water Tool is a implementation platform rather than a accounting method per se. Rather than providing a framework through which water use is assessed it provides an online tool through which companies can better understand and contextualize their water use in the watersheds in which they operate. It is particularly useful for identifying "hotspots" across global operations by comparing site's relative water stress.

Launched in 2007, the WBCSD Global Water Tool is a free online module that aims to couple corporate water use, discharge, and facility information input with watershed and country-level data. This process is intended to allow companies to assess and communicate their water use and risks relative to water availability in their global operations and supply chains. It does not provide an in-depth system for companies to account for water, but rather uses its internal structure to help companies assess risks and other important indicators.

The Global Water Tool is specific to corporate water use and discharge. It compiles water use, discharge, and facility information to evaluate a strict measurement of water use in the context of local water availability (based on the Tool's watershed and country-level databases), and uses this as a platform to assess water-related business risks. It does not provide specific guidance on local situations as each watershed system has unique characteristics which are difficult to account for in a universally-applicable tool. The Tool is specific to corporate water practices and is meant to be applied for a business, its facilities, and supply chain operations.

Structure and outputs

The Tool is divided into a number of distinct parts that while pertaining to similar issues (i.e. corporate water use and management), are not aggregated and do not build on each other in the way water footprints and LCA do. That said, a full use of the Global Water Tool produces the following outputs:

- *Output GRI Indicators***:** GRI Indicators – total water withdrawals (EN8), water recycled/reused (EN10), and total water discharge (EN21) – are calculated for each site, country, region and total.
- *Output Country Data:* Displays site water usage information and connects country water and sanitation availability for each site.
- *Output Watershed Data:* Displays site water usage information and connects watershed information for each site.
- *Combined Country and Watershed Metrics*: Combines site information and external country data and reports metrics for the company's portfolio of operations through graphs.
- *Visualization of Data*: Displays site locations compared to local water context in form of maps or through Google Earth.

GEMI Water Sustainability Planner and Tool

The Global Environmental Management Initiative (GEMI) – a collection of dozens of companies working toward more responsible corporate environmental stewardship – has developed two tools to advance corporate understanding of water issues. Released in 2002, the Water Sustainability Tool is an online tool that helps organizations build a water strategy. It assess a company's relationship to water, identifies associated risks and describes the business case for action, and helps address companies' specific needs and circumstances. It features five modules:

1. Water use, Impact, and Source Assessment
2. Business Risk Assessment
3. Business Opportunity Assessment
4. Strategic Direction and Goal Setting
5. Strategy Development and Implementation

The tool does not provide a method or calculator to measure or quantify water use, impacts, and risks, but rather introduces a number of questions on these topics to facilitate companies' understanding of water sustainability issues. These questions act as the basis for guidance on goal setting and the development of strategic plans.

The GEMI Water Sustainability Planner – released in 2007 – focuses on the needs of a facility user rather than the company as a whole. It helps a facility better understand its dependence on water and the status of the local watershed (including local social and environmental considerations) and identify its specific challenges and opportunities. The planner is divided into three modules:

1. Facility Water use and Impact Assessment Program
2. Water Management Risk Questionnaire
3. Case Examples and Reference Links

It uses input from the facility to give a broad assessment of risks regarding the local watershed, supply reliability, efficiency, compliance with regulations, supply economics, and social context. As with the GEMI Water Sustainability Tool, it does not provide quantitative data but rather qualitative guidance on risks and identification of some of the most pressing risks.

From the perspective of the researchers, both GEMI tools are perhaps best oriented to companies and facilities that are just beginning to understand how water issues affect nearby ecosystems and communities, as well as business risks. They can be used to get a broad assessment of some pertinent questions, but provide no quantitative information with which to compare different water uses, products, or facilities. As such, they are perhaps less useful for companies that are seeking a comprehensive assessment of different water uses and impacts in order to assess hotspots, drive product development, or identify long-term water strategies.

Table 1: Summary of Objectives, Scope, and Structure for Major Corporate Accounting Methodologies and Tools

Criteria	Water Footprint	Life Cycle Assessment	WBCSD Global Water Tool	GEMI Water Sustainability Tool
Definition	A water footprint is a measurement of the total 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/ organization.	A Life Cycle Assessment (LCA) is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence. LCA emphasizes the environmental impacts incurred at different stages in the value chain.	This online tool couples corporate water use, discharge, and facility information with watershed and country-level data. This allows companies to assess and communicate their water use and risks relative to water availability in their operations and supply chains.	GEMI's online tool helps organizations build a water strategy. It assesses a company's relationship to water, identifies associated risks and describes the business case for action that addresses companies' specific needs and circumstances.
Scope / Boundaries	• Water-specific • Comprehensive measurement of corporate water use/discharge only • Measures "evaporated water" (i.e. consumptive uses) only	• Assesses many environmental resources uses and emissions, including but not limited to water • Comprehensive measurement of a water use AND assessment of impacts • Measures consumptive and non-consumptive uses	• Water-specific • Rough measurement of water use and efficiency and assessment of key impacts • Determines relative water-related business risks • Provides information on countries and watersheds	• Water-specific • Rough measurement of water use AND assessment of key water impacts • Assesses water-related business risks
Structure and Output	• Divided into blue, green, and grey footprints • Corporate footprints divided into operational and supply-chain footprints • Results provide in actual volumes	• Inventory results • Impact divided into several different types of quantified impact categories • Impacts by production phase • Results expressed in weighted impacts across different impact categories	Provides many disparate components, including key water GRI Indicators, inventories, risk and performance metrics and geographic mapping.	Divided into 5 modules: 1. Water uses and impacts 2. Prioritized risks 3. Risk mitigation options 4. Determining goals 5. Water strategy
Origins and Level of Maturity	• Well-established with WRM community • Relatively new to private sector • Impact assessment methods and related DSS under development	• Well-established method for the assessment of products, company-level assessments, and system-wide assessments (e.g. water supply or wastewater management systems) • Water has only recently been considered as a potentially major source of impacts • Methods for measuring water use and assessing impacts are nascent and still evolving	• Introduced in 2007 and has since become commonly used among private sector • Version 2.0 – featuring updated data and new types of date – released in 2009.	

IV. Accounting for Risks and Impacts to Watersheds, Ecosystems, and Communities

As one of the core drivers for water accounting, we will look closely at the types of water-related risks businesses are exposed to, as well as the types of accounting tools they use to understand and mitigate them. Specifically, this Section aims to identify the key risks and impacts with respect to companies' water use, and the ways in which water accounting methods/tools are working to (and intended to) identify and address them.

Water-related Business Risks

Companies' growing interest in water is driven by a number of factors, including pure operational efficiency, brand management, and corporate ethics/philanthropy. However, they are all ultimately driven by the desire to reduce related business risks whether that is to maintain social license to operate, build competitive advantage, or ensure long-term water supplies. The severity and type of these risks (as well as the appropriate mitigation strategies for them) depend on geographic location and type of industry sector and water use. That said, water-related business risks are often divided into four general and inherently inter-related categories:

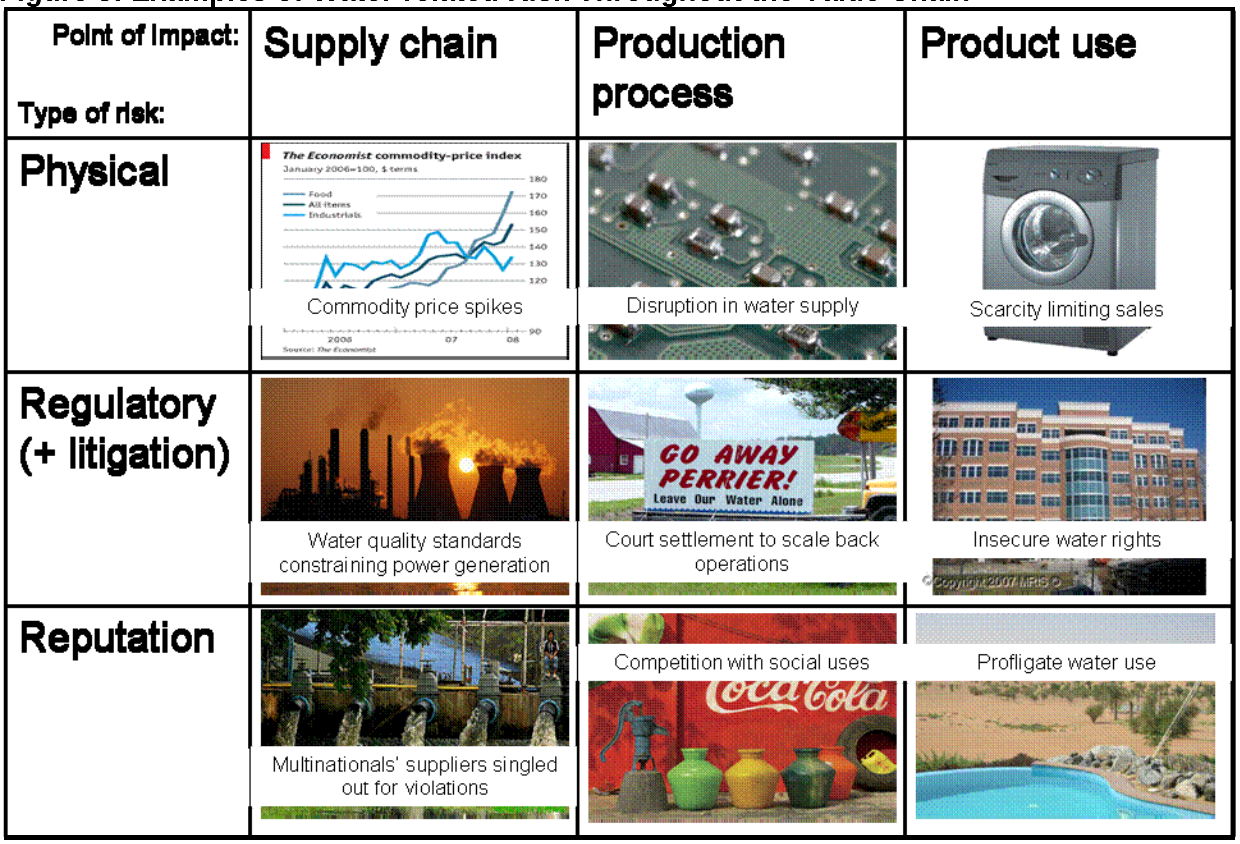
Physical: Physical risks pertain to the inability to access adequate water supplies or services to effectively manage a company's operations. This can be caused by drought or long-term water scarcity (i.e. insufficient and/or unreliable access to water), flooding (causing damage to infrastructure and/or disruptions in supply), or pollution to the extent that such water is rendered unfit for operational use. This is most often a problem for companies with water-intensive operations in water-scarce regions. In many of those regions, climate change is exacerbating the problems of water scarcity.

Regulatory: Regulatory risks are incurred by policymakers and/or water managers changing laws or regulations or management practices in ways that alter companies' access to water supplies/services, increase the costs of operation, or otherwise make corporate water use and management more challenging. Stricter regulatory requirements often result from water scarcity and/or ensuing conflict among various needs (e.g. ecological, urban, agricultural, industrial) or because of public perception of a company's water uses and discharges as wasteful, disproportionately harmful, or inequitable. Regulatory risk can also stem from poor management – and therefore an inconsistently applied regulatory framework – among a region's water managers.

Reputational: Reputational risks come from diminished stakeholder perceptions (i.e., consumers, investors, local communities, etc.) due to inefficient or harmful production activities (or products) that have negative water-related impacts on watersheds, ecosystems, and/or communities. There is a linkage between regulatory and reputational risks where companies fail to meet regulatory requirements. Reputational concerns can lead to decreased brand value or consumer loyalty or changes in regulatory posture, and can ultimately threaten a company's legal and social license to operate.

All of the abovementioned risks lead to financial risks, which are created by increased costs or lost revenue due to the status of the local watershed (i.e. scarcity or pollution) or the mismanagement of water resources. For instance, water scarcity or excessive pollution can lead to higher water prices, higher energy prices, higher insurance and credit costs, or damaged investor confidence and therefore significantly affect the profitability of certain operations. New stakeholder expectations regarding corporate responsibility now expose companies to financial risks based on the perception of inefficient or inequitable corporate management of water resources.

Figure 3: Examples of Water-related Risk Throughout the Value Chain



Source: Treating water – Sector report for engagement: Water exposure of food & beverage companies. Robeco Asset Management in collaboration with the World Resources Institute. April 2009

Companies mitigate business risks through a number of different avenues depending on the nature of the risks, the nature of their operations, and the watershed in which they are located. However, there are a few broad activities that may drive down many types of risks. For instance, improving operational efficiency (using less water or discharging cleaner water per unit production) decreases demand for water supplies and therefore mitigates against scarcity risks and/or increased production costs. This efficiency may also help companies assure their continued water use by providing sufficient economic value per unit water so as to justify that allocation by policy makers. As another example, companies may seek to engage with communities and public water managers within their region in order to simultaneously improve their efficient and continued access to water services and build trust-based relationships that may help prevent future allocation debates and/or garner goodwill and positive reputation as a responsible corporate citizen.

The Interplay between Water-related Impacts and Business Risks

The impacts associated with corporate water use differ drastically depending on the local/regional water resource context (i.e., physical availability of water, in-stream flows, community access to water, etc.). A company using 80,000 gallons a day in a large, water-abundant system will typically have less severe impacts on issues such as community access to water or ecosystem function, than a company using the same amount of water in an arid region, or one where water is not equitably allocated to meet basic human needs. Impact assessments ultimately aim to quantify the ways in which business activities may hinder sufficient supply for basic human needs, community access to water, human health, or the in-stream flows required for healthy ecosystems. A successful impact assessment allows companies to prioritize management practices, tailoring mitigation strategies to address the most negative impacts.

In most cases, companies with significant water impacts will be subject to corollary business risks. However, even companies with relatively insignificant water impacts may face water-related risks. This is typically due to physical and/or socio-political factors that may change *outside* the company's fenceline. For instance, economic development in a region may increase pressure on water resources and thus jeopardize a company's continued water access or new source water pollution may require a company to install expensive on-site pretreatment technology so that the water is of suitable quality for production processes. While not all social and environmental impacts may eventually manifest themselves as business risks, companies often find addressing water impacts a prudent risk management strategy.

Impact assessments attempt to explore the implications of water use on "external" factors such as ecosystem health, human health, community access to water, etc., whereas assessments of business risks may focus more on exploring the implications of this water use on "internal" factors such as the company's access to water supplies and services, investor confidence, consumer perceptions, etc. The extent of these risks is closely related to impacts. Both types of assessments (risk and impact) require companies to overlay water use data with local water resource context data. As such, the process for assessing impacts on watersheds, ecosystems, and communities is often linked to the process for assessing business risks. For this reason, we discuss water impacts and risks together, while attempting to distinguish the different focus of various water accounting methods and tools.

While some water accounting methods (e.g., LCA) are geared toward addressing the environmental and social (e.g. human health) *impacts* a company might have as a result of its water use and discharge, others focus instead on allowing companies to understand and mitigate water business risks (e.g., WBCSD Global Water Tool). Others (e.g., Water Footprint Network) aspire to address both a company's business risks and impacts.

Lastly, a distinction should be made at the outset between the different ways in which water accounting methods and tools define and address "risk." In some instances, the focus is solely on business risks (i.e., WBCSD Global Water Tool). These categories of risks refer specifically to water-related activities or impacts that can potentially damage a company's short-term or long-term viability, reputation, or profitability. However, a company's water use and discharges may pose risks not only to business viability, but also to the ecosystems and communities in which they or their suppliers operate. Such environmental or human health risk assessments are intended to be science-based, and in the LCA context are typically assessed using complex fate-transport modeling and other relatively sophisticated modeling techniques. While distinct from direct business risks, these risks to ecosystems and communities may ultimately have severe implications for business viability. However, it is important to separate water accounting methods/tools focusing on understanding risks to ecosystems and communities from those attempting to provide an understanding of water-related business risks.

Key Steps in Impact Assessments

As noted, the process of quantifying a company's water-related impacts is quite complex. This is primarily due to the many criteria that can comprise the local water resource context and the difficulty in quantifying some of them, particularly the social aspects. Corporate impact assessments might be thought of in two separate stages:

1. Measuring and assessing the local water resource context
2. Overlaying and normalizing corporate water use/discharge within that local context.

<u>Measuring and assessing the local water context</u>
After measuring the volume, timing, and location of their various water uses and discharges, companies must evaluate the local water resource context in order to be able to gauge impacts. Determining the local water resource context can be complicated and in many instances is reliant on subjective evaluations/or priority setting. For instance, determining "water scarcity" requires accounting for not only the physical abundance of water in a watershed, but also the quality of that water, the environmental flow requirements of the system, and the ability of people to access and/or afford adequate water services, among other things. The phrase "social and economic water scarcity" has been coined in order to express the idea that water systems can be considered "scarce" even in the presence of abundant physical supplies due to inadequate potable water and wastewater infrastructure.

Some of the criteria used to assess the local water resource context include:

- The total amount of water physically available for use in that system,
- The total proportion of that physically available water currently being used,
- The allocation of the water being used and its ability to meet demands (i.e. the sufficiency of allocations for environmental/in-stream flows and basic human needs),
- The quality and safety of that water,
- The ability of local communities to access and afford adequate water services.

Because of the range of criteria that could be used to assess local water context, the resulting impact assessments are highly variable. As such, developing a comprehensive, yet efficient, system for measuring the local water resource context (i.e. physical, social, and economic scarcity) is critical to assessing impacts; however, a harmonized and objective approach to doing so does not currently exist, and may never.

<u>Overlaying corporate water use with local water context</u>
Once criteria for assessing the local water context are established and measured, companies must compare these data with their corporate water use and discharge in order to gauge associated impacts. In the process of quantifying impacts, corporate water use and discharge data are adjusted or "weighted" to reflect the criteria measured in the previous stage. These scores allow companies to compare the impacts of various water uses and thus prioritize which business activities, facilities, and production stages are addressed.

This process of quantifying impacts inherently requires a high degree of subjectivity in determining what constitutes a negative impact. For instance, a methodology must determine what constitutes sufficient in-stream flows, what constitutes basic human water needs, or at what point water is polluted to the extent that it is not available for use. Further, companies like to compare different types of impact categories (i.e. impacts to in-stream flows, basic human needs, water quality, etc.), which adds an additional layer of complexity and subjective determination. While such comparison can be quite useful in prioritizing management responses, they are not scientifically valid: comparing impact categories requires a subjective assessment of what types of environmental and social activities provide the most value.

Assessing Impacts with Water Footprinting

As discussed, the WFN's water footprint calculation itself does not attempt to account for the status of a watershed (e.g. water availability) or quantify or otherwise assess water-related impacts. Besides the green-blue distinction, the WF provides little information on the context in which a certain volume of water is used. For instance, with watershed data companies are unable to determine where there water use may infringe on other uses. The WF methodology has been intentionally developed to provide volumetric data in "real" numbers" and avoid any weighting as an inherent component. That said, acknowledging the usefulness of having both "real", volumetric data and weighted impacts the WFN is currently developing the "Water Footprint Decision Support System" (WFDSS). The WFDSS will be the primary method through which companies will be able to conduct "water footprint impact assessments." In addition, presently, a handful of LCA studies have now been published that attempt to use the measurements provided by water footprinting as the basis for an impact assessment.

Currently under development, the WFDSS will be an interactive, open-source software-based system designed to help decision makers compile a range of raw data to identify and solve water-related problems. The WFDSS will allow entities conducting WFs to assess: 1) the condition of the watershed in question (i.e., local water resource context), 2) the impacts of the entity's water use on that watershed, and 3) the appropriate available response strategies to mitigate those impacts. WFN hopes such assessments will soon become a critical component of water footprint assessments worldwide.

Assessing Impacts within LCA

The life cycle inventory data needed for measuring water use on a life cycle basis has been available for some time, although it has not always been clear whether the inventory data referred to total use or consumptive use. More recently, there has been a trend towards reporting more specific data with regard to water source (e.g. groundwater, river, lake, etc.). Several LCA studies have been published that use this inventory data as the basis for evaluating the impact of water usage. Such assessments apply characterization factors to quantify social and environmental impacts.

Such weighted numbers are calculated by overlaying corporate water use and discharge data with characterization factors that reflect the local context (e.g., the respective water availability/scarcity, degree of human capacity to access water for each watershed). Such characterization allows 20,000 gallons of water from a water-scarce region to be quantitatively assessed as having greater relevance than 20,000 gallons of water from a water-rich region.

There is currently a flowering of techniques for water-related impact assessment within the LCA community. The Swiss Ecological Scarcity Method 2006 developed by Frischknecht et al. was among the first to use regional conditions (i.e. relative water stress) as a characterization factor, thus allowing for water use to be assessed within a local context. The relative water stress levels – as determined by the percentage of the total renewable water resources consumed – were each given a weighting factor that could be used to characterize water use volumes, thereby serving as a rough proxy for relative impact.

Mila I Canals (2009) identified two primary pathways through which freshwater use can impact available supply: 1) freshwater ecosystem impact and 2) freshwater depletion, in order to determine which water uses need quantification. It suggests surface and groundwater evaporative uses, land use changes, and fossil water, as the critical water flows to be measured within the inventory phase.

Pfister et al. (2009) further developed methods for assessing the impacts caused by freshwater consumption. This study assessed impacts to: 1) human health (i.e. lack of water for drinking, hygiene, and irrigation), 2) ecosystem quality (i.e. damages to ecosystem functioning and biodiversity), and 3) resource availability (i.e. depleting water stocks) using a further developed water stress index similar to that used by Frischknecht.

Most recent studies have been facilitated by the work of Stephan Pfister, who has produced global maps of water scarcity at the 0.5 minute scale (approximately the 1 km scale). The scale runs from 0 to 1 and includes both the effects of precipitation/evapotranspiration (the equivalent of the "green" water of the Water Footprint Network) and the effect of human withdrawals (approximating the "blue" water component).

On top of this analysis, different authors have added:

- Human health impacts due to drought/malnutrition, in units of DALYs per liter of water
- Socio-economic impacts due to the local ability to pay for water quality improvement
- Biodiversity loss at dams and due to groundwater extraction

A summary of the different methods can be seen at Kounina et al. (2009). In addition, a number of LCA authors have suggested redefining/augmenting the WF from a purely volumetric measure to a weighted index that results from multiplying volumes by impact characterization factors (Pfister et al., 2009; Ridoutt et al., 2009). While such a result allows for regionalized assessments and evaluation of issues such as product design, the WF community argues that such a weighted and aggregated single number is not useful from a WRM perspective, as it can obscure temporally- and spatially-explicit data and also because its functional unit-relative results no longer provide data in real volumes. For WRM, the primary application of water footprinting today, it is quite important to express measurements in location-specific water use volumes.

At the most fundamental level, the challenge for corporations is understanding where their goods come from and where they go. In many cases, companies buy their goods as commodities, and are not aware of the upstream impacts of their purchasing choices. In the same way, the global market means that goods are shipped world-wide through the efforts of entrepreneurs that act as purchase and sales agents, knowing little about either the upstream or downstream water situations relevant to the goods they handle. Until companies take on their social responsibilities in this field, neither these LCA approaches nor the other approaches outlined in this document will have much effect on the issues of water scarcity and the human and environmental impacts they cause.

Assessing Impacts with the WBCSD Global Water Tool

The Global Water Tool does not provide a comprehensive methodology through which to assess water-related impacts. Rather, it uses company location information with country and watershed level data to quantify some basic indicators of water impacts, which are then used as a basis for a qualitative assessment of relative water risks.

The Tool provides companies with a series of data and maps that reflect country-level and watershed-level water data. Examples of the types of local water context data include:

- Access to improved water
- Access to improved sanitation
- Annual renewable water supply per person (1995 and projections for 2025)
- Mean annual relative water stress index
- Ratio of industrial to total water use

Such data overlaid with company water use result in a number of indicators that may serve as rough proxies for impacts. For instance, a company can use the Tool to determine what percent of its operations or suppliers are in regions considered to be under water stress or the percent of its employees live in countries with low/high levels of access to improved water and sanitation. By providing these indicators for each of a company's operations or key suppliers, the Tool helps to identify and characterize the risks that are prevalent at particular sites.

Assessing Impacts and Risks with the GEMI Water Sustainability Tool

Whereas WF and LCA aim to provide comprehensive methodologies for quantifying water-related impacts and the WBCSD Global Water Tool provides basic indicators for locating areas of heightened business risk, the GEMI Water Sustainability Tool provides a set of qualitative questions and information that can help companies identify potential impacts. It does not provide a methodology through which companies can quantify impacts, but rather a compilation of information that can help them better understand what those impacts may be.

Companies may use the Water Sustainability Tool's qualitative assessment of impacts to inform a subsequent assessment of water-related business risks. This step is meant to help companies identify, characterize, and prioritize water-related risks. As with the tool's impact assessment, it is entirely qualitative. It directs companies to consider their various water uses and impacts and assess the degree to which changes to external supply and management could affect their access to this water and the impacts of these uses. Next, it asks them to determine the probability of such changes occurring. The Tool uses these to assess how to help companies prioritize their water uses which require the most attention and corporate resources.

Table 2: Summary of Accounting Approaches to Water-related Impacts

Criteria	Water Footprint	Life Cycle Assessment	WBCSD Global Water Tool	GEMI Water Sustainability Tool
Assesses water-related impacts?	As yet, No. WFs do not attempt to assess impacts. However, methods to quantify WF Impact Assessments (WFIA) have been tested.	Yes. However, methodologies are nascent and need further development and harmonization.	Yes, but not directly or comprehensively. Provides local watershed data.	Yes, but not quantitatively. Only identifies possible business risks due to water pollution
Types of impacts assessed	NA	Water use (proposed): • Ecosystem quality • Resource depletion • Human health Water discharge (established): • Ecotoxicity • Eutrophication • Acidification	Identifies water use hotspots and facilities located in water stressed areas	Focuses on possible impacts of industrial effluent on water quality
Characterization factors used	Approaches proposed or being pilot tested for Water Footprint Impact Assessment	Numerous approaches proposed or in development, from simple approach such as Water stress index to complex approaches such as DALY, PDF-m2-yr or MJ	None	None

V. Approaches to Accounting for Industrial Effluent and Water Quality

Though water quantity has received much of the focus of water management practices and accounting, water quality is equally important to businesses and the ecosystems and communities near their facilities. Untreated water can lead to increased incidence of disease. Highly-contaminated water can lead to the destruction of habitat and decreased biodiversity. Cloudy water decreases light penetration and reduces the productivity of plant systems and ecosystems as a whole. Unclean water can make drinking water supplies unfit for drinking. For these reasons, companies have just as great a stake in accounting for – and improving – their impacts on water quality as they do in accounting for water quantity.

As the previous section demonstrated, accounting for water use/quantity is quite complex and requires meshing a number of different factors in order to be credible and meaningful. That said, accounting for industrial effluent and its impacts on water resources is arguably even more complex and problematic from an accounting perspective. This complexity is due to the many different types of pollutants coming from industrial plants and agriculture (e.g. phosphates, nitrates, mercury, lead, oils, sulfur, petrochemicals, undiluted corrosives, and hard metals, just to name a few), the variety of ways water quality can be compromised (i.e., contaminant loads, temperature, odor, turbidity), and the various approaches to accounting for the resulting impacts to ecosystems and communities.

Measurable water quality characteristics can be grouped into three broad categories:

- *Physical characteristics* (e.g. temperature, turbidity/light penetration, and flow velocity),
- *Chemical characteristics* (e.g. pH, salinity, dissolved oxygen, nitrate, phosphate, biological oxygen demand [BOD], toxics, chemical oxygen demand [COD]), and
- *Biological characteristics* (e.g. abundance of coliform bacteria, zooplankton, and other organisms that serve as an indicator of ecosystem health).

Companies aiming to account for their water pollution and its effects on water quality must determine a range of factors including the volume of wastewater they discharge, the types and loads of pollutants within that wastewater, the effects of those pollutants on local waterways, and the impacts of those changes on ecosystem function and human health/access to safe water.

Dilution Water and the Grey Water Footprint

<u>Definition and Objectives</u>
Water footprints deal with industrial effluents and water quality exclusively within the "grey water" component. The grey WF is calculated as the volume of water that is required to dilute pollutants to such an extent that the quality of the water remains above agreed water quality standards. Whether this water is discharged back to surface or ground water, it is considered "used" because it is unavailable for use due to the fact that it is functioning in-stream as a dilution medium. For this reason, the grey WF is a theoretical volume, rather than a real volume as compared to the blue and green WF.

The methodology for determining the grey WF is perhaps the least developed of the three WF components. In fact, many corporate WF studies to this point do not include a grey water component. Those that do include grey water have done so in different ways. However, they all utilize some permutation of the same basic equation:

For total corporate grey water footprints: WF_{grey} of business $(m^3) = \frac{Load}{Standard}$

This basic equation underlying grey WF involves the use of one water quality standard which is used to assess how much water is needed to dilute pollutants in order to meet legal standards. As there are in almost all instances more than one (and typically dozens) of types of pollutants being released to waterways from industrial plants and as a result of agricultural practices, this requires the entity conducting the WF to select the pollutant with the highest required dilution volume. In theory, this dilution volume will then be sufficient for all pollutants discharged. This process also requires the company to identify the most appropriate regulatory standards for that particular pollutant and for the location of the discharge. Though understanding the mass/volume of contaminants and effluents is a necessary step in determining the appropriate dilution volume, this mass/volume is not a necessary component of the final analysis, which is expressed in terms of volume of dilution water.

At the time of this writing, the authors were unaware of how the WFDSS would address the grey WF on a watershed basis.

<u>Limitations</u>
Approaching water quality accounting through the assessment of dilution water volume has some fundamental disadvantages/limitations. In fact, numerous companies surveyed for this analysis indicated that the grey WF – in its current form – is not useful for their water accounting needs. The most notable of these limitations are the obscuring of contaminant load data and the base referencing of local water quality standards.

Specifically, focusing on the contaminant with the highest dilution water requirement is deemed a questionable approach, because in reality, industrial effluent typically contains a number of different types of contaminants all of which have different implications and impacts for the surrounding environment. Further, a dilution approach cannot account for potential additive, synergistic, and long-term effects of the various types of persistent, bio-accumulating pollutants that may be discharged by a company.

Linking dilution water requirements to water quality standards is also problematic because these standards vary from watershed to watershed and in many cases do not exist (or are not available) at all. Not only does this mean that the required dilution volumes are dependent on political factors rather than scientific determinations, but this requirement adds additional complexity to the system, prompting questions such as:

- Which standard does one use (e.g. national regulations, recommendations from intergovernmental organizations)?
- What do companies do in the absence of national standards or if national standards do not mitigate pollution to level that protect communities and ecosystems?
- Does such an approach not lead to an accounting bias in favor of countries with less stringent water quality standards, and/or incentivize companies to favor/give preference to operations in such countries?

Lastly, the dilution approach is deemed a circuitous route to addressing industrial effluents. Rather than directly account for the initial corporate water use/discharge, the grey WF focuses on a theoretical corporate response, which may or may not occur. In doing so, dilution - rather than prevention - is implicitly promoted as the desired solution to industrial effluent. Many consider pollution prevention to be highly preferable to dilution due to the fact that many pollutants persist and bioaccumulate and impacts occur even when dilution volume is considered adequate to meet regulatory standards. Furthermore, this approach obscures and de-emphasizes important information about the type and amount of pollutants released to waterways, as well as potential ways to reduce these pollutants. Finally, the WF grey water accounting method does not address water pollution transported to waterways through air pollution – the predominant source of water pollution in many industrialized nations.

In the grey water approach, the water footprints typical inclination toward real numbers that require little human subjective assessments is replaced by a methodology that requires highly variable and subjective standards. Because of these fundamental difference between the grey water component (a theoretical volume characterized based on water quality standards) and the green and blue water footprints (real volumetric measures), many of those surveyed for this analysis indicated that aggregated the grey component along with the green and blue components is misleading and meaningless.

Direct Assessment of Contaminant Load into Waterways / LCA Approach to Water Quality

In the context of pollution, LCA methods are aimed at a number of different environmental impact categories independent of whether the emissions occur to water or to some other medium. The most common impacts associated with water quality in LCA are:

- Eutrophication (overgrowth of algae due to excess nutrient addition)
- Acidification due to emissions of acidifying substances, (mostly into the air)
- Ecotoxicity
- Human toxicity

These impact categories are measured in terms of equivalents of eutrophication potential (phosphorus or nitrogen units), acidification potential (hydrogen ion or sulfur dioxide units), and ecotoxicity potential (cubic meter-years). Because these units are not the same, these impacts cannot be added up without a value judgment for normalization and weighting of the impacts, for example as is done for eco-indicators or end-point indicators.

There is research going back to the 1990s that evaluates ecotoxicity potential with impact units of cubic meter years, adding up the impacts of the many different toxic substances. These analyses are based on a so-called unit earth or fugacity standardized fate and transport model for toxic pollutants (regardless of their medium). Information on the ecotoxicity of the individual pollutants and their persistence in different environmental compartments must be known or estimated. This kind of model is the most closely related to the Water Footprint Network's grey water.

A companion USE-tox method calculates human health in units of DALYs (Disability Adjusted Life Years). It too is based on a fugacity model linked to mammalian ecotoxicity, and then weighting the results using the expert opinion of the World Health Organization. Most recently, this kind of analysis is the basis of the USE-tox model developed under the SETAC-UNEP umbrella. It only accounts for toxicants that have an acute effect: they must actually kill organisms in a relatively short period of time. If a substance does not have an acute effect, it cannot be accounted for within any of the ecotoxicity models currently being employed in the life cycle impact assessment field.

It is possible to report loads of pollutants to waterways through the simple addition of the mass of emissions to water, but this is not practiced within the LCA field because there is no way to describe the environmental mechanism to support the calculation. In effect, one is saying that there is no science behind the analysis.

The use of these life cycle impact models and the reporting on the product basis supports all the basic purposes of LCA (decisions for engineering, policy, and purchase and sales), as described above. It helps businesses understand the risks of different environmental effects for processes within the control of the business and also for those outside the direct control of a business. Of particular interest are the impacts of a product downstream (the use and recycle/disposal phases). Although manufacturers do not control the actions of their customers, in the case where a manufacturer designs a product with the use and disposal phases in mind, these phases can be shown to have fewer polluting impacts.

Limitations

Life cycle assessment is limited to the impacts for which there is good enough science to perform impact assessment. It is further limited in that it is a relative method, normalized to the functional unit. In this sense, it is not typically applicable to a whole ecosystem or whole watershed analysis, and therefore is of limited use to water resource managers. On the other hand, the broad application to the entire life cycle of the product allows managers to understand where it is possible to manage or influence the overall outcome of a product.

WBCSD Global Water Tool

The WBCSD Global Water Tool does not measure or otherwise assess water quality or industrial effluent.

GEMI Water Sustainability Tool

The GEMI Water Sustainability Tool encourages companies to analyze their pollution to water bodies (which they perhaps confusingly refer to as “water impacts”). It does not provide any method or guidance for the measurement of industrial effluents or quantification of impacts to water quality. It looks at both pollution caused by a company’s direct discharges to the environmental as well as more indirect avenues of pollution such as air deposition and the leeching of chemicals. It provides a series of questions (categorized by value chain stage) that help companies better understand their effects on the pollution of water bodies.

Table 3: Summary of Accounting Approaches for Water Quality and Industrial Effluent

Criteria	Water Footprint	Life Cycle Assessment	WBCSD Global Water Tool	GEMI Water Sustainability Tool
Assesses water quality?	Yes	Yes	No	Yes
Basic approach	Dilution volume	Direct measurement of mass or volume of contaminants	N/A	Qualitative analysis
Types of criteria assessed	Most harmful contaminant (often nitrogen) based on discharge quantities and local regulatory standard	Impact categories: • Eutrophication • Acidification • Ecotoxicity • Climate change • Human health	N/A	Types of pollution caused by different pieces of value chain
Potential limitations	Only accounts for primary pollutant (i.e. disregards additive and synergistic effects). Uses standards based on local regulatory framework rather than science.	Does not typically quantify impact to specific local receiving bodies; results are relative to functional unit	N/A	No measurement or quantification

VI: Corporate Water Accounting and Other Sustainability Accounting Methodologies

Water use is by no means the only aspect of sustainability that poses risks for companies and must be measured and assessed. For example, companies must also understand the contribution of their greenhouse gas emissions to climate change and the impacts of their energy use on business costs, the environment, and human health. As such, several accounting methodologies akin to those analyzed in this report have been developed for other sustainability issues, such as greenhouse gas emissions.

The interactions and linkages between many of these sustainability issues is becoming more and more clear, particularly between water, carbon, and energy. Climate change – heightened by corporate GHG emissions – drastically changes the hydrologic cycle, leading to more frequent and severe drought and flood events and contributing to water scarcity. Transporting or pumping water for irrigation or desalinating it for other uses is often incredibly energy intensive. Likewise, creating energy often (as in the case with hydroelectric dams) severely damages ecosystems, displaces communities, and creates human health concerns. These inextricable links between these three sustainability issues have become known as the “Water-Energy-Carbon Nexus”. Companies are now increasingly concerned with understanding the ways in which these environmental uses and emissions interact with and affect one another and how these linkages might inform a company’ assessment of impacts and risks.

This section will provide a synopsis of those methods for other sustainability issues as a basis from which to explore how public perception and understanding of those methods might confuse water accounting as well as how different sustainability accounting methods interact with one another and are compatible. It will focus on carbon accounting and ecological footprinting as they are perhaps among the most established and widely-recognized of these methods.

Carbon Accounting

Carbon accounting (commonly referred to as “carbon footprinting”) measures the total amount of greenhouse gas (GHG) emissions caused directly and indirectly by an individual, organization, event, or product. This measurement is divided by the various types of GHG emissions (e.g., carbon dioxide, methane, ozone, nitrous oxide) and can be assessed for any type of carbon emitting entity (e.g., individual, city, nation, product, company, etc.). A carbon footprint of a company or product ideally includes emissions from all stages in the value chain. A specific methodology for corporate carbon footprinting has been developed in the WRI-WBCSD GHG Protocol (and subsequently adopted as the basis for an ISO standard). Several methodologies exist for product carbon footprinting.

Three different scopes have been described for carbon footprinting. Scope 1 is the direct GHG emissions of an organization. Scope 2 is Scope 1 plus upstream GHG emissions associated with the production of energy used by the organization. Scope 3 is Scope 2 plus the life cycle GHG emissions of all the products purchased by an organization. The Scope 3 carbon footprints are simply the climate change results of all LCAs. In the USA, the federal government has recently been tasked with performing Scope 1 and Scope 2 footprints of all federal facilities within 90 days, with plans for Scope 3 emissions due within 240 days.

Carbon accounting is fundamentally an assessment of impacts, rather than a strict measurement. After measuring the amount of emissions for each type in real masses, each mass is multiplied by a characterization factor that "weights" that mass based on the type of gas emitted, using the factors developed by the Intergovernmental Panel on Climate Change (IPCC). Once this weighting occurs, all the masses are expressed in terms of carbon dioxide equivalents which allows for comparison and aggregation of different types of emissions across different products, facilities, and companies. The characterization factors are based on the relative global warming potential (GWP) – their contribution to climate change per unit - of each greenhouse gas. Companies use this to evaluate the extent to which their entire business, their products, or their facilities contribute to climate change in order to prioritize areas for improvement and to assess business risks.

Carbon footprinting has led to the concept of carbon offsets: the idea that one can pay others to pollute less for less money than one can afford to pollute less oneself. This is the basis of the Cleaner Production Mechanism of the Kyoto Protocols and of the voluntary "green tags" or carbon credits in the electrical utility industry. They are also potential actors in any cap and trade carbon management system, such as that recently adopted in the EU.

Of particular concern in these offset schemes are the issues related to "additionality." Are there actual improvements in the atmosphere due to the expenditures for offsets? Also, there are still questions about the actual methods of accounting for carbon emissions, especially as they relate to land use changes and biofuels.

Carbon accounting and carbon footprinting at least have the advantage that the emissions mix in the entire atmosphere. GHG impacts, unlike water use impacts, are not location specific. In this regard, the potential to offset water use is much more questionable than the potential to offset carbon emissions – and even these are controversial.

The carbon footprinting approach is fundamentally different from water footprinting (as defined by the WFN) which only provides volumetric measures of different types of water from different locations. There are no characterization factors in water footprinting that allow different types and sources of water to be compared based on their impacts. Thus, carbon footprinting can be an integral part of a LCA, whereas water footprints as defined by the WFN currently cannot. That said, a number of LCA practitioners, applying the characterization methods of Frischknecht or Pfister, are including water resource results (which they are dubbing "water footprints") as part of broader LCAs showing the trade-offs among different impacts (e.g., water use and land-use related impacts). Due to the present confusion around terminology, any conclusions made about "water footprinting" based on one's understanding of carbon footprinting should be scrutinized carefully.

Ecological footprinting

The Ecological Footprint (EF) is a resource accounting tool used widely as a management and communication tool by governments, businesses, educational institutions and NGOs that measures the biological capacity of the planet their activities or products require (Global Footprint Network 2009). Biological capacity is defined as the area of productive land and sea required to produce the resources consumed by humans and to neutralize the subsequent waste. As such, it can be considered an impact assessment (though quite different in appearance than impacts assessments for water use) rather than a straight measurement like that seen in water footprinting. As with carbon footprinting, despite the similarities in terminology, ecological footprinting and water footprinting have very little in common methodologically.

The ecological footprint is categorized into a number of different individual footprints (i.e., Carbon, Food, Housing, and Goods and Services), which divide the total ecological footprint by the source of environmental impacts. All of these components are expressed in the amount of global hectares of land and sea used by those activities. Ecological footprinting does not include water footprinting or any other form of water accounting. Ecological footprinting is typically used more as an advocacy or communication tool, rather than a rigorous method through which to assess impacts or risks.

Compatibility of Sustainability Accounting Methodologies

Neither carbon accounting nor ecological footprinting assess water use or pollution. Similarly, water footprinting and other water accounting methods do not account for carbon or other sustainability issues such as energy use. However, as mentioned earlier, the links between these different sustainability issues in terms of impacts to watersheds, ecosystems, and communities – as well as in terms of business risks – are undeniable.

Insofar as companies and products are concerned, LCA is the most well-established and well-suited system through which to assess different sustainability issues and their common and different impacts. Done properly, carbon accounting is streamlined as part of an LCA such that GHG emissions and their contribution to climate change can be integrated into broader product assessments. Emissions data are used as an inventory that is characterized by a GWP characterization indicator. Because of this, LCA allows carbon-related impacts to be compared and aggregated with other types of environmental impacts incurred in a product’s life cycle.

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Appendix A: List of Research Advisory Committee Members

Name	Organization
Representatives from companies	
Emmanuelle Aoustin	Veolia Environnement
Denise Knight	Coca-Cola
Henrik Lampa	H&M
Llorenc Mila-i-Canals	Unilever
Andy Wales	SABMiller
Representatives from international NGOs, institutes, and initiatives	
Anne-Leonore Boffi	WBCSD
Jim Fava	UNEP-SETAC Life Cycle Initiative
Sébastien Humbert	Quantis / ISO Working Group on Water Footprinting
Derk Kuiper	Water Footprint Network
Stuart Orr	WWF International
Frederik Pischke	UN-Water
Brian Richter	The Nature Conservancy
Brad Ridoutt	CSIRO
Other experts	
Jim Christiansen	Danish Standards
Luiz Fernando Cybis	Universidade Federal Do Rio Grande Do Sul
Wang Hongtao	Sichuan University
Atsushi Inaba	AIST-Japan
Annette Koehler	UNEP-SETAC Life Cycle Initiative / ETH Zurich
Claudia Peña	Centro de Investigación Minera y Metalúrgica
Vinod Sharma	Indira Ghandi Institute of Development Research
Ex officio members	
Jason Morrison	Pacific Institute
Gavin Power	UN Global Compact
Guido Sonnemann	UN Environment Programme
Rita Schenck	Institute for Environmental Research & Education
Peter Schulte	Pacific Institute

Appendix B: Key Players in Corporate Water Accounting

Various organizations and initiatives have attempted to help companies responsibly and comprehensively account for their water use and discharges and to achieve sustainable water management in general. Often these attempts are in the form of developing methodologies that act as a framework for accounting. However these attempts can also be in the form of online tool, standards, guidance, software, or certification schemes. This section will provide brief descriptions of the organizations and initiatives attempting to advance responsible corporate water accounting through such methodologies and other tools.

<u>Water Footprint Network</u>
The Water Footprint Network (WFN) was launched in order to coordinate efforts between academia, civil society, governments, the private sector, and intergovernmental organizations to further develop and disseminate knowledge on water footprint concepts, methods, and tools. To these ends, WFN engages in the following activities:

- Developing standards (methods, guidelines, criteria) for water footprint accounting, impact assessment, and the reduction/offsetting of related impacts;
- 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 communication and dissemination of knowledge about water footprinting;
- 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; and
- Providing advice on the application of the water footprint and by checking and certifying the use of the water footprint.

While "water footprint" is often used as an umbrella term for water accounting methodologies, it is actually a specific type of analysis developed by A.Y. Hoekstra and now managed by WFN. All mention of water footprints in this report will refer to the WFN methods and nothing else.

<u>Global Environmental Management Initiative (GEMI)</u>
The Global Environmental Management Initiative (GEMI) is an organization of companies promoting global environmental and social sustainability through the development and sharing of tools and information. In 2007, GEMI released "Collecting the Drops: A Water Sustainability Planner" which provides tools and detailed guidance on:

- The process for assessing the facility's specific water uses/needs in comparison to the availability of water in the region;
- The impacts these operations poses on the available water resources;
- The identification of factors that may pose risk on the operation's ability to produce.

This includes guidance for preparing a facility water block flow diagram and water balance requiring data on water supply, process/facility losses and total volumes discharged and a web-based questionnaire that help companies assess their water-related risks. This tool uses quantified water use and discharge data as an input to create specific management recommendations and make companies aware of risks. It does not (nor does it intend to) provide any sort of advanced methodology that companies can use to better account for their water use and discharge.

World Business Council for Sustainable Development (WBCSD)

The WBCSD – a business association of roughly 200 global companies with efforts to promote sustainable development - launched its Global Water Tool in 2007. This tool – developed in collaboration with CH2M HILL - allows companies to:

- Compare their water uses (direct operations and supply chain) with water and sanitation availability information on a country and watershed basis,
- Calculate water consumption and efficiency,
- Determine relative water risks in order to prioritize action,
- Create key water GRI Indicators, inventories, risk and performance metrics and geographic mapping.
- Perhaps the most important aspect of this tool is that it – unlike water footprint and LCA methodologies –explicitly assesses the business risks associated with water use and discharge.

Overview of LCA entities (particularly in respect to water accounting)

Another methodology through which companies understand their water use and discharge is Life Cycle Assessment (LCA). LCA is the investigation and valuation of the environmental impacts of a given product or service caused or necessitated by its existence. LCA emphasizes the environmental impacts incurred at different stages in the value chain and is often referred to as a "cradle-to-grave" analysis. LCA allows product developers to identify product life stages that create the most damaging environmental impacts in order to prioritize them for improvement. Due to the various environmental impacts and life cycle stages being assessed, LCA allows product designers to consider these impacts holistically and minimize impact trading (i.e. creation new impacts in the process of mitigating other impacts).

Whereas the water footprint concept and methodology are housed solely within the WFN and developed by a small number of coordinated players, LCA methods have no single base organization and are developed by a number of entities.

UNEP/ SETAC Life Cycle Initiative

The UN Environment Programme (UNEP) and The Society of Environmental Toxicology and Chemistry (SETAC) - a global non-profit professional society aiming to develop principles and practices for sustainable environmental management – have worked together since 2000 on a partnership known as the Life Cycle Initiative. This initiative aims to:

- Collect and disseminate information on successful applications of life cycle thinking;
- Share knowledge about the interface between Life Cycle Assessment and other tools;
- Identify best practice indicators and communication strategies for life cycle management;
- Provide a basis for capacity building;
- Expand the availability of sound LCA data and methods;
- Facilitate the use of life cycle based information and methods.

In respect to water-related LCA efforts, the UNEP/SETAC Life Cycle Initiative launched a working group on the assessment of water use and consumption within LCA. This group was established to provide companies with a framework with which to develop an LCA indicator for water quantity and quality, integrating this indicator within the ISO 14040, and developing an assessment scheme for water within the LCA framework. It is also working to use this scheme to harmonize how water is addressed within the LCA community.

Commonwealth Scientific and Industrial Research Organisation (CSIRO)
Australia's CSIRO has taken an active role in advancing the LCA methodology – specifically on water issues and on other environmental issues. In regard to general LCA work, CSIRO has developed and maintained a database of LCA information, published manuals on the principles and practice of LCA. CSIRO Minerals has recently facilitated the implementation of LCA analyses by mining companies in Australia, which helped these companies assess the implications of different metal production and processing routes on water use and the components of their value chain which have the greatest water-related impacts.

PE International
PE International – the world' largest working group in LCA – develops the world's leading LCA analysis software, GaBi. GaBi provides a universal software tool for quantifying the environmental performance at the organization, facility, process, and product levels. This includes LCA, but also a number of different environmental accounting and analysis systems (e.g. GHG accounting, life cycle engineering, environmental reporting, strategic risk management, etc.). In addition to the GaBi software tool, PE International provides consulting services based on LCA analyses and water footprinting assessments.

Quantis
Quantis (www.quantis-intl.com) is a consulting company providing expertise in life cycle assessment (LCA) and offering solutions for organizations worldwide that are engaged in sustainable development. Quantis is also one of the leaders in the development of water assessment indicators within LCA, being actively involved in the UNEP-SETAC Life Cycle Initiative's project as well as convening the new ISO standard on water. Quantis has offices in Lausanne (Switzerland), Paris (France), Boston (United States) and Montreal (Canada).

International Organization for Standardization (ISO)
ISO, the world's most recognized standards-making body (including the ISO 14000 Environmental Management series) is the developer of the most widely used standards for the implementation of LCA (i.e. the ISO 14040 series). These ISO standards on LCA describes the principles and framework for LCA including the definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements. This standard provides a framework for a general LCA analysis and does not include water-specific elements. ISO is currently developing a standard for the principles, requirements, and guidelines for the measurement and communication of the water footprint of products, processes, and organizations. While this standard refers to itself a standard for "water footprints", it is important to note that "water footprints" in this context refers to the broader range of water accounting tools and not specifically water footprints as developed by WFN. This standard intended to establish a framework and set of principles that enable existing water accounting methods to be consistent with one another and with other standards. This will consider regional concerns (e.g. relative scarcity, extent of economic development, etc.). ISO has explicitly stated that it does not

intended to establish its own methodology, but rather provide guidelines for the important elements that water accounting methods should address.

<u>Other supporting organizations and initiatives</u>

Alliance for Water Stewardship
The AWS is an initiative developing a global freshwater stewardship certification program. This certification program will provide a voluntary "eco-label" that rewards responsible water use management with competitive advantage. Such a certification system will require quantification of water use, discharge, and impacts, however the Alliance intends to build on existing methodologies (namely the water footprint as developed by WFN) as a key component of its measurement, and will attempt to minimize duplication of efforts and confusion in this space. The Alliance intends for this certification scheme to be applicable both to water "users" (businesses) and water "providers" (utilities). The initiative is currently in the standards development phase in which they are defining what constitutes water stewardship.

Global Footprint Network
The Global Footprint Network (GFN) is an initiative to encourage and facilitate the use of the Ecological Footprint (EF) in order to promote global dialogue about and action addressing ecological limits and sustainability. It is comprised of individuals, cities, nations, companies, scientists, NGOs, and academia from all over the world. Established in 2003, the Network works to continuously improve the EF methodology, engages with national governments to establish the EF as a globally-accepted metric, develops footprint standards, and brings various sectors together to advance these concepts, among other things.

Global Reporting Initiative
The Global Reporting Initiative (GRI) is a network-based organization that has developed the world's most widely-used corporate sustainability reporting framework. The most recent version of this framework (known as the G3 Guidelines) includes five water-related criteria among a list of environmental, social, and economic criteria. These guidelines do not call for the reporting of quantified impacts. They also do not provide a comprehensive methodology for accounting for their criteria, but rather establish a harmonized framework through which companies communicate to stakeholders.

The Greenhouse Gas Protocol Initiative
The GHG Protocol – a partnership between the World Resources Institute and the WBCSD - is perhaps the most popular accounting tool for GHG emissions worldwide. It works with the public, private, and civil society sectors to advance credible and effective programs for mitigating climate change. The GHG Protocol developed the only widely-accepted methodology for corporate carbon footprinting and is one of the many methodologies for product carbon footprinting. It provides the standard for corporate carbon accounting as well as calculation tools for carrying this out. ISO has adopted the Protocol's Corporate Standard as the basis for its standard on corporate carbon accounting.