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Directions for Corporate Water Disclosure

Bridging Local Risks with Global Frameworks

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Karlijn Steinbusch September 10, 2010

Abstract

Water availability faces increasing pressure due to economic growth, population growth, greater affluence as well as climate change. For companies, this could lead to higher business risks as water is often a key ingredient in their operations for example in cooling, steam generation and cleaning. Moreover, companies might be competing over water with other stakeholders in the region when water scarcity is a local issue. On the other hand, companies generally discharge wastewater, which when released untreated, could pollute receiving water bodies. Pressures related to water availability are intensifying throughout the world, resulting in a growing appetite from investor for water disclosure. In order to satisfy investor demands, companies should report how they manage and perform on their water impact.

The research objective of this thesis is to create understanding for companies on what elements of water reporting are needed to assess, manage, and communicate water risks in their operations, geographical context and supply chains. In my research, the water risks disclosure of 101 companies have been investigated in four water-intensive sectors, namely food products, beverage, chemicals, and metals & mining. In addition, ten company representatives were interviewed to learn about the drivers and constraints of water risks disclosure. The chemicals and metals & mining sectors are communicating most on their water risk exposure within the operational activities, when looking at policies, programs and GRI reporting. The food and beverages sectors are disclosing the most on water management in their value chain. In all four sectors, between 25 up to 45% companies disclose information on the identification and management of water risks in water scarce regional. During the interviews, company mentioned that they had identified water risks related to the lack in water availability (both in quantity and quality) halting or ending productions, fines and reputational harm due to water discharge or spills, increased costs due to more stringent legislation and higher costs on the supply side. They have set programs and management systems to control their water use performance and many pursue to improve these figures through corporate-wide or facility-based targets. The GRI supports many companies in identifying what information they could disclose in order to make peer comparisons. Although contested this view, stating that the water-related GRI indicators prove neither high nor low water impacts. The water footprint might be a more exact way of measuring the water impact of a company and some companies are pioneering in the use of this measure. Lastly, suppliers can expect higher demands for water disclosure from purchasing companies.

Executive Summary

In several countries in the world, water availability is an everyday issue. Water is needed for life, food production, and economic development. Water security is facing increased pressure as water bodies, such as groundwater aquifers, are depleted at higher rates than they can replenish in many regions in the world (Davie, 2008). Future trends - such as population and economic growth, increased affluence and climate change – are adding to global water demand (WWAP, 2009). Governments, industries and civil society need to join forces in preventing a global water crisis. Industrial operations consume and pollute water in every day operations when cleaning, processing, or generating steam. Water scarcity, due to water quantity or quality issues, could translate into physical, reputational or regulatory risks for companies (Morrison, Morikawa, Murphy, & Schulte, 2009). As a result, there is a growing thirst from investors for more and better water disclosure (Morrison, et al., 2009), especially for companies in water-intensive industry sectors.

The research objective of this thesis is to create understanding for companies on what elements of water reporting are needed to assess, manage and communicate water risks in their operations, geographical context and supply chains. In Chapter 1, the research questions, methodology, scope and limitations of this study is provided. The research was conducted in cooperation with GES Investment Services, which is the Northern Europe's leading analysis house in Responsible Investment. During an internship, I developed water risk criteria and indicators for GES to screen companies according to their water risk disclosure. With these water criteria and indicators, a total of 101 companies were screened in four water-intensive industry sectors (food, beverages, chemicals and metals & mining sectors). In Chapter 2, an overview of the hydrological model, quality, water availability, and how to manage water resources is given to illustrate importance of water for life. In Chapter 3, a background of environmental risk analysis is given. Elements of water risk assessment, management, communication and the water footprint is provided. The knowledge obtained from the literature review supported the development of the conceptual model, which can be found in Chapter 4.

The research consisted of a quantitative and qualitative study. First, by conducting a documentation analysis an overview was given on the number of companies that reported on elements of the water-related Global Reporting Initiative (GRI) indicators, water scarcity and water impact in the supply chain. Second, for each industry sector the 10% highest and lowest performers on water risk disclosure were contacted. Eventually, ten company representatives were interviewed to discover the drivers and constraints of corporate water reporting. The result of the documentation analysis and qualitative interviews can be found in Chapter 5 and 6. Next a discussion is presented on the findings and methodology in Chapter 7.

A conclusion of the research findings can be found in Chapter 8. If companies want to grasp water risk, they should not only look at exposure within their operations, but also exposure within the geographical context and the value chain. The chemicals and metals & mining sectors are communicating most water risk exposure within the operational activities, when looking at policies, programs and GRI reporting. All sectors similarly have between 25 and 45% companies disclosing information on their assessment and management of water scarce regions. The food and beverages sectors are reporting most on water risk disclosure in their value chain. In Figure 0-1 below, recommendations on elements of water risk disclosure are given. This figure is not a blueprint for water reporting, but could give companies an overview of the elements to keep in mind when formulating their water reporting.

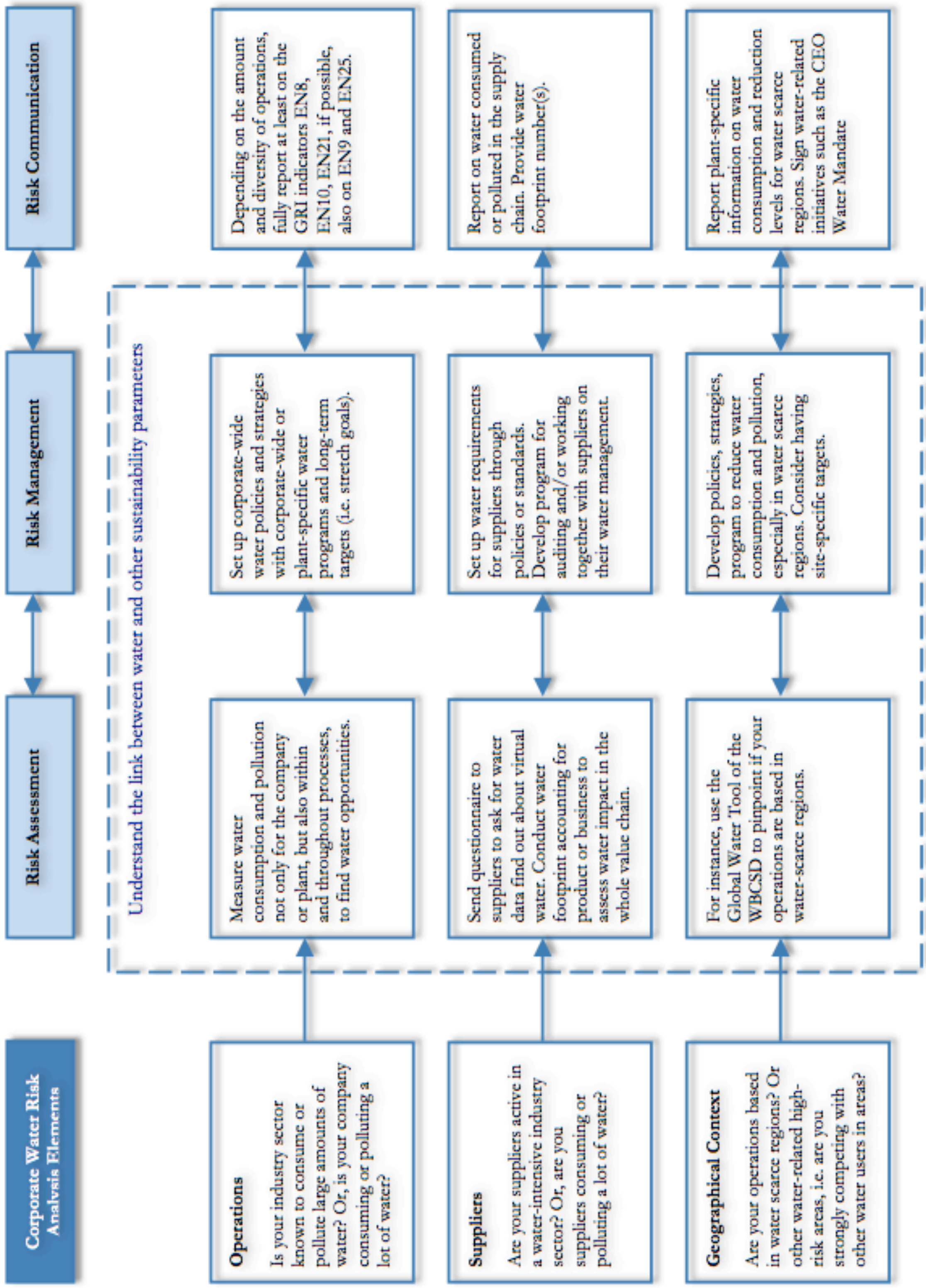

Figure 1-1 Recommendations for Corporate Water Reporting

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Abbreviations

CERES – Centre for Education and Research in Environmental Strategies

CSR – Corporate Social Responsibility

ESG – Environmental, Social and Governance

GRI – Global Reporting Initiative

GWP – Global Water Partnership

SIWI – Stockholm International Water Institute

WBCSD – World Business Council of Sustainable Development

WRI – World Resources Institute

1 Introduction

In this chapter, the problem definition and research objective are first presented. Second, the research questions and methodology are described. Last, the scope and limitations of the research are explained.

1.1 Problem Definition and Research Objective

In 2008, Governor Arnold Schwarzenegger of California announced a state of emergency due to stressed water supplies (Economist, 2009). In the last decade, California constructed one of the most extensive water supply systems in the world. Thousands of kilometers of pipes and canals throughout the state are managed by huge water pumps. North California receives 70% of the state's available water through rain and snow. Due to warming temperatures, the snowpack on the mountains of Sierra Nevada partly retrieved. In addition, three years of drought has led to lower water levels in reservoirs. Perhaps more importantly, the weakest link in the entire water supply system, the Sacramento-San Joaquin Delta, is at risk. The delta consists of small islands, used for agricultural purposes, which are surrounded by dikes. As the islands have sank to 20 meters below sea level, Dutch landscape appears in the heart of Central Valley. Today, sea level risings and heavy storms are threatening to break several dikes, which would cause saline seawater to invade the agricultural fields as well as the water supply system. The delta splits into the California Aqueduct, which is an artificial river that pumps tremendous amounts of water to the Southern California (representing 80% of the state's water demand). The California Aqueduct was build about 40 years ago and stimulated the arrival of more and more people in this originally water poor region. The decreased water levels in the river, for large part caused by water export to the South, threatens the survival of the protected Chinook salmon. As a result, the state court ordered a decrease in water withdrawal. Farmers were left angry, as they need water to irrigate their arid land. In the mean time, the population in the South of California grows by more than 200,000 people on an annual base. A set of new legislation has been implemented to safeguard future water availability, which requires cities to cut water use by 20% in 2020. Still, domestic water consumers use 70% of their water for irrigating lawns, filling pools and other non-basic needs. Water experts believe the solution lies no longer in looking only at the supply side. They point out the need for increased water efficiency – e.g. by recycling more wastewater - and switching to drought-resistant crops. (Bourne & Joel, 2010)

The case presented above captures some of the characteristics of growing water issues worldwide. Water security is facing increased pressure in different regions as water bodies, such as groundwater aquifers, are depleted at higher rates than they can replenish (Davie, 2008). On the other hand, future trends - such as population and economic growth, increased affluence and climate change – are intensifying global water demand (WWAP, 2009). A water availability gap is projected, where water demand is 40% higher than water supply in 2030 (2030 Water Resources Group, 2009). Governments, industries and civil society need to join forces in preventing a global water crisis. Industrial operations use water in every day operations, for cleaning, processing, and steam generation among others. Water scarcity, due to water quantity or quality issues, could translate into physical, reputational or regulatory risks for companies (Morrison, Morikawa, Murphy, & Schulte, 2009). Companies should analyze their water risks to prevent or mitigate any operational discontinuity. Moreover, there is a growing appetite from investors for water disclosure (Morrison, et al., 2009), especially for companies in water-intensive industry sectors.

It is in the interest of companies to analyze their water risk for internal and external communication. But before starting, companies should ask themselves questions on why, how, what and where to report on water disclosure. The research objective of this thesis is to create understanding for companies on what elements of water reporting are needed to assess, manage, and communicate water risks in their operations, geographical context and supply chains.

1.2 Research Questions and Methodology

This research was conducted in cooperation with GES Investment Services, which is the Northern Europe's leading analysis house in Responsible Investment. GES Investment Services is active in the screening of companies according to ESG criteria. In addition, they engage with companies to promote sustainable development in the private sector. During the internship at GES Investment Services, I developed water risk ratings criteria and indicators for screening companies in water-intense sectors. Access to the GES risk-rating database was provided in order to obtain environmental ratings for the companies under study in this research. The aim of internship project was to create a method for rating companies from an investor perspective. Investors have a growing interest to find out how companies perform on and control their water risks. In the research of this thesis, the focus is on the companies' perspective to learn how companies are disclosing their water risks. To obtain my research objective, two research questions with five sub-questions were formulated.

Research Question 1: To what extent do companies in water-intensive sectors report on their water risks?

a) How different do water-intensive industry sectors report on their water risks?

b) How does the level (high or low) of environmental risk disclosure predict a similar level (high or low) for water risks disclosure, or vice versa?

Research question 1 should provide a description to what extent water-intensive sectors report differently on their water risks. Four water-intensive industry sectors are selected in this research, namely the food, beverages, chemicals and metals & mining sector (according to the MSCI industry classification). Each industry sector uses and pollutes water in different ways and severity throughout its operations. In addition, water-intensive sectors can have a significant impact on local environment and communities. Companies could also have higher water impact in other parts of the value chain, such as in the supply chain. As a result, companies can face higher business risks. Documentation analysis was used to compare corporate water disclosure among the different sectors. For each sector between 21 and 29 companies were analyzed on their water reporting, totaling 101 companies. Companies can reveal their water risks in annual reports, corporate social responsibility (CSR) or sustainability reports, environmental reports or other links on their website. The water ratings are provided in the first sections of Chapter 5 and 6, but the criteria and indicator for screening fall under GES intellectual property and are therefore confidential. Any explanations for the different scores between the companies are hence not given. However, the amount and occasionally percentage of companies reporting on exposure to operations, geographical context and value chain are provided. This will allow for a comparison within and between the different industry sectors.

By having access to the GES risk-rating database, the environmental ratings of the companies could be obtained. I hypothesize that companies that score high on environmental reporting have good management and reporting systems in place and therefore are likely to also score high on water reporting. It can be questioned if companies that score high on environmental reporting, score high because they are actually doing well compared to other companies or they are able to report much because they have financial, technological and human resources at display.

Research Question 2: Why are companies reporting more on certain elements of water risk than other elements?

a) Why and what water risks are identified by companies?

b) How are water risks managed by companies?

c) What are the constraints of water risk disclosure?

By understanding the drivers and constraints of water risk reporting, it might become clear why companies are reporting on certain water-related aspects and not others. Companies might report more or less on water pollution than water consumption due to laws, regulations or permits. The answer to Research Question 2 should provide an illustration of current water reporting and future directions. Several highest-rated as well as lowest-rated firms of each sector were asked if they wanted to participate in an interview on their water risks disclosure. Ten representatives of companies in the dataset were interviewed, consisting of four food companies, one beverages company, one chemicals company and four mining companies. These companies can be found in Appendix I. From the 101 companies screened in the dataset, 36 companies were contacted through email for interview request. In the email it was already mentioned that the answers given during the interview would be kept confidential. In addition, a list of 'personalized' questions was attached, e.g. by writing "You mention in you Sustainability Report 2008 that you have a Suppliers Performance Management Program in place. Does this program include assessing the water impact of your suppliers?" The generic list of questions is shown in Appendix II. Almost all representative underwent telephone interviews that took approximately 30 minutes for each interview. During the telephone interview extra questions could arise or interviewees could start discussing topics in later questions, resulting in a semi-structured interview approach. An evaluation of the interviews is provided in the second section of the Results Chapter 5 and 6. In order to keep their answers anonymous, the companies in the food and beverage industry were aggregated, and the companies from the chemicals and metals & mining company were grouped together as well. The answers will be presented as for instance 'Food/Beverages Company D' or 'Chemicals/Metals/Mining Company U'.

Additionally, three experts were contacted to give their view on water disclosure (presented in Chapter 2 and 3). The experts consisted of; (*a*) Magnus Enell, Adjunct Professor at the International Institute of Industrial Environmental Economics and member of the International Water Academy; (*b*) Joppe Cramwinckel, the Water Project Director of the World Business Council of Sustainable Development (WBCSD); and (*c*) Ankit Patel, analyst at the Global Water Intelligence. The International Water Academy is a forum where the private, public and academic sector share information and come together to tackle international problems concerning water resource management (IWA, 2008). The World Business Council of Sustainable Development (WBCSD, 2010a) is a CEO-led global association, which was set up during the Rio Earth Summit in 1992. Today, the WBCSD includes around 210 companies who are involved in sustainable development and by being a member of the organization deal with certain obligations, such as sustainability reporting. The main focus areas for the WBCSD are the business role, energy and climate change, development and ecosystems. After a while, water has been included in the work program as it relates to these four focus areas. Global Water Intelligence (GWI, n.d.) is a monthly magazine informing reader on investment opportunities worldwide and discusses future trends in the water industry.

1.3 Scope and Limitations

The companies interviewed in this research are large multinationals that usually have operations in multiple countries around the world. Except for one interviewee who was an expert on the environmental management of the firm's operations in one particular country, all representatives were able to provide information for the global operations worldwide. The research discusses how stricter water legislation and regulations can turn in to a business risk for companies. Since laws and regulatory requirements are often developed at the national or EU level and the companies in this research are operating in numerous countries, there has not been much focus on explaining elements water laws and regulations (e.g. taxes or pricing).

Limitations of this thesis will be discussed separately for the documentation analysis and the qualitative interviews. During the documentation analysis, companies were screened on their water risk by looking at annual reports, CSR or sustainability reports, environmental reports and information displayed on their corporate website. A CERES (the Centre of Education and Research in Environmental Strategies) – an alliance of investors, environmental and other stakeholder groups – report recommended companies to report more material information for ESG factors and include these in their financial filings (Barton, 2010, p. 12). This way, water disclosure could affect a stock's price once it becomes public. Expressing water risks in financial filings could create more awareness, but as water is in many countries underpriced, the true value of water in monetary terms will be difficult to retrieve. In January 2010, the US Securities and Exchange Commission (SEC) provided guidance for publicly-traded companies on what is needed to disclose material climate-related risk and opportunities, including water risks, to investors (Barton, 2010). Due to time constraints, water disclosure was not searched for in SEC filings. There might be a chance that some companies provide more data in these filings and hence could have received a higher score. Secondly, the selected companies are already scoring medium to high on the environmental criteria. Therefore, the companies in the dataset that are scoring relatively low on water reporting might still score relatively medium or high in total universe of investments. Thirdly, the water ratings are based on the developed water criteria and indicators. It can be discussed that there is always a selection in criteria and indicators, based on the developer's understanding of the issue and what information companies are reporting on. There has to be a range from 'good' water reporters to 'bad' water reporters, in which companies can be placed. Still, a structured method for screening criteria and indicators and reasoning for their existence through a reiterative process can create legitimacy. For the qualitative interviews, companies were first contacted by email to request for a telephone interview. When companies did not answer, a reminder was sent. If no reply was given from emails, the companies were called by phone, but this did not result in any phone interviews. Fourthly, the interviews were semi-structured. Although all topics in the list of questions were discussed per interviewee, they might have been formulated not exactly the same during the telephone calls. Also, the questions might not have been asked in the order that they are stated in the list of questions. The reason for 'jumping' from question 3 to question 8, for example, was that interviewees would already bring up certain elements while answering. The interviewees might also not have given all the information, because of confidentiality reasons.

2 Water for Life

The United Nations established eight development goals in its '2000 Millennium Declaration' for improving the human condition by 2015 (UNESCO, n.d.). Below some of the Millennium Goals are provided, showing their interconnectivity with water:

1. **Eradicate extreme poverty**: Water of appropriate quantity and quality improve health, e.g. through water supply and sanitation services. Research showed that there is a correlation between access to water and sanitation and income level (WWAP, 2009, p. 11). Additionally, water can increase productivity of land, labour and other inputs, leading to affordable food and other basic needs (WWAP, 2009, p. 83).

2. **Promote gender equality and empower women**: Women in developing countries often spend considerable time every day to collect water. This often leads to few girls attending schools and hence lower income opportunities for women as more girls are analphabetic (WWAP, 2009, p. 38).

3. **Reduce by two thirds the mortality rate among children under the age of five**: In 2000, 10.6 million children under the age of 5 died, of which 17% (±1.8 million deaths) was made up from the water-borne disease diarrhoea (WWAP, 2009, p. 88).

4. **Integrate the principles of sustainable development into country policies and programmes**: Many examples depict how consumptive use and water diversion severely degraded downstream wetlands or closed basins, thereby damaging important ecosystems services (WWAP, 2009, p. 128).

5. **Reduce by half the proportion of people without sustainable access to safe drinking water:** Approximately 340 million and 500 million people in Africa lack access to drinking water and improved sanitation facilities, respectively (WWAP, 2009, p. 11).

People need water for survival, but water is suffering increased pressure in different countries. Human activities can affect both water quantity and quality. Groundwater reservoirs might have taken million years to charge them. A water quantity issue can occur when groundwater is depleted at high rates, securing little water availability for future generations. If a water source gets contaminated because of the runoff of nutrients, the water quantity available for usage decreases in that region. Water quality is less threatened when the receiving water body has a large volume for dilution. Still, high water quantity does not guarantee high water quality. As illustrated here, water quantity and quality are to some extend related. The degree, to which water quantity and quality can be affected, is influenced by the hydrological cycle. Modern hydrology refers to, "the distribution of water on the surface of the earth and its movement over and beneath the surface, and through the atmosphere"(Davie, 2008).

In this chapter, the hydrological cycle is described to create better understanding of the characteristics of water flows. Second, water pollution is further explained. Last, water availability and water resource management are discussed.

2.1 The Hydrological Cycle

The global water cycle is illustrated in Appendix III. During *evaporation*, liquid water changes to water vapor (i.e. a gaseous phase) and is transported in the atmosphere. *Precipitation* occurs when water vapor transforms again into the liquid or solid phase (e.g. rainfall or snowfall). Ocean water evaporates more than it receives precipitation. This means that the remaining water vapor moves in the atmosphere and falls to the land surface, known as *runoff*. These three elements of the hydrological cycle – evaporation, precipitation and runoff – differ in quantity over the world depending on the climate. In humid temperate climates one third of the precipitation recharges the groundwater, one third becomes runoff and another third evaporates. In arid climate, about two-third of the precipitation evaporates and a very small portion replenishes groundwater.

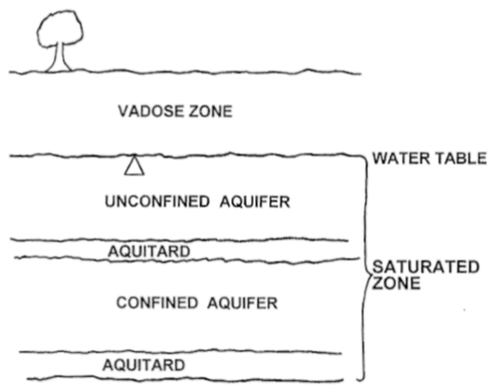
The commonly used spatial unit in hydrology is the *catchment area* or *river basin*, which is defined as "the area of land from which water flows towards a river and then in that river to the sea" (Davie, 2008). This measurement supports analysis in how water moves and spreads at a certain time. The hydrological cycle of the river basin or catchment area looks more in detail to the processes in the that geographical area. Davie (2008) describes that the three main elements of the water cycle can be further subdivided:

- Evaporation is segregated into; evaporation from lakes and rivers; evaporation from the soil; evaporation from plant surface; evaporation from interception (rainwater that did not reach the surface); and transpiration (as part of the photosynthetic process) from plants;
- Precipitation is subdivided into snowfall, hail, rainfall or sleet (i.e. a mixture of the three mentioned before); Rainfall can occur in different periods of time and often influences the demand for irrigation and the amount of runoff during storm event. Precipitation can also affect water quality in the case of acid rain.
- Runoff can take place above and below the Earth's surface; overland flow, throughflow and groundwater flow. Water moving through the ground usually has a higher nutrient level as it flows slower than overland flow. Nutrient leaching has the potential to pollute water sources. Overland flow often has more suspended solids extracted from the surface.

It is chief to notice that all these processes can occur simultaneously in different times in a basin or catchment area. A mathematical narrative of the hydrological processes within a certain time period is provided by the *water balance equation* below (Davie, 2008);

$$P \pm E \pm \Delta S \pm Q = 0$$

where, P refers to precipitation, E stands for evaporation, ΔS depicts change in storage and Q is runoff. The ± symbol explains that the variables can be either positive or negative.



Source: Fjeld, R. A., Eisenberg, N. A. and Compton, K. L. (2006) Exposure Assessment, in Quantitative Environmental Risk Analysis for Human Health, John Wiley & Sons, Inc., Hoboken, NJ, USA. doi: 10.1002/9780470096208.ch9

Figure 2-1 Characterization of Subsurface Formations

Figure 2-1 above illustrates a characterization of subsurface formation (Fjeld, Eisenberg, & Compton, 2006). The vadose or unsaturated zone is the subsurface region above the water table. Runoff taking place in the vadose zone is called *throughflow*. Groundwater moves through the saturated zone below the water table. An *aquifer* in the saturated zone can transmit large amounts of water, whereas an *aquitard* is a poorly permeable area that obstructs water movement (Fjeld, et al., 2006). Aquifers can be further classified as unconfined aquifers and confined aquifers. An unconfined aquifer has the water table as upper boundary. Water pollutants on the soil can trickle down during precipitation, thereby polluting the water in the unconfined aquifer. A confined aquifer (or artesian aquifers) has aquitards as upper and lower boundaries, creating great pressure. Hence, when drilling into them, water may flow above the surface of the ground. The aquitards make it very difficult for pollutants to reach the confined aquifer, but when they do (e.g. because of a leakage) it is very difficult to take them out.

Water is a renewable resource that mostly remains within the hydrological cycle, but moves through areas and time. Still, freshwater availability is limited, when water is withdrawn from rivers and aquifers at greater rates than they can replenish themselves (Hoekstra, Chapagain, Aldaya, & Mekonnen, 2009).

2.2 Water Pollution

Water quality can be affected by point sources and non-point sources that contaminate water bodies. At *point sources*, pollutants are released at specific sites, for instance through drain pipes or ditches. Manufacturing plants, sewage treatment plants and underground mines are typical point sources. On the contrary, *non-point sources* discharge pollutants from broad and diffuse areas. Cropland, farm animals, clear-cut forests, parking lots, and golf courses can results in runoff of chemicals and sediments. Advantages of point sources over non-point sources, is that they are often easy to discover, monitor and regulate. (Miller & Spoolman, 2008, pp. 532-533)

In order to monitor water pollution, the relevant water-quality parameters for testing should be first identified. The water-quality parameters can be divided into physical and chemical parameters as presented in Figure 2-2 below. *Physical parameters* require a physical measurement. It is usually described in the amount of dissolved solids or other physical parameter within the water. *Chemical parameters* measure the concentration of a certain chemical substance in the water body. (Davie, 2008)

Physical Parameters

- Temperature
- Dissolved solids
- Suspended solids and turbidity

Chemical Parameters

- pH
- Dissolved oxygen and biochemical oxygen demand (BOD)
- Trace organics
- Nitrogen compounds
- Phosphates
- Chlorine
- Heavy metals

Figure 2-2 Water-Quality Parameters

Water-quality issues can arise due to a change in the physical parameters in water bodies. First, power utilities and several industrial activities use water for cooling devices and to produce steam for driving turbines. *Thermal pollution* could occur when companies discharge water with a higher temperature than the water temperature in the receiving water body. The higher temperature lowers the concentration of dissolved oxygen in the water and therefore affects the respiration of aquatic fauna. In addition, the increased water temperature foster chemical reactions taking place in the water and dissolve more substances. Second, the *total dissolved solids* (TDS) indicate the quantity of dissolved substances in a water sample. A higher quantity of dissolved solids could imply that the water body is contaminated. Third, *total suspended solids* (TSS) could affect water quality negatively, as fish and aquatic invertebrates (i.e. an animal without a backbone) cannot breed in a habitat of high sediment. Suspended solids occur due to natural erosion of the riverbed and the velocity of water transport of sediment. Quite similar to TSS, the *turbidity* of a water sample calculates the cloudiness of the water due to suspended solids and gas bubbles. It is computed as the quantity of light scattered by the hanging particles in the water. (Davie, 2008)

Different chemical parameters can negatively affect water quality. First, the acidity of water is measured in the *pH value* and depends on the concentration of hydrogen ions present. The pH value can have a number between 1 and 14, where a pH value of 7 represents neutrality. A pH value below 7 depicts an acid solution, whereas a pH value above 7 presents a basic solution. The scale of the pH values is logarithmic (base 10) implying that a pH value of 4 is ten times more acidic than a pH value 5 (Davie, 2008). The more acidic a water sample is, the more dissolved ions are in place. As a result, more metallic ions will be carried in the solution. Industrial combustion activities can add large amounts of sulphur dioxide (SO_2), nitric oxide (NO) and suspended particles high into the atmosphere. There they form secondary pollutants for instance sulfuric acid (H_2SO_4), nitric acid vapor (HNO_3), which could return to the earth as acid rain, also called acid deposition. The low pH value leaches toxic metals from soils and rocks into rivers and lakes. The effect on the environment can be detrimental as fish can not survive in water with a pH value below 4.5 (Miller & Spoolman, 2008, pp. 479-480). In addition, water can contain an acidic solution when water flows through a soil column with high organic content and subsequently forms organic acids. A water body could have a basic solution while extracting carbonate-rich rocks, e.g. limestone of chalk. Fish do not survive in water with a pH above 10 either (Davie, 2008, p. 133). A second chemical parameter, *dissolved oxygen* is needed for aquatic fauna, which breathe through their gills this for survival. Drinking water from the drain is often supplemented with dissolved oxygen to provide a fresh taste (Davie, 2008, p. 134). Third, a commonly used parameter for water pollution is the *biochemical oxygen demand* (BOD). This measure presents the oxygen needed by bacteria and other microorganisms to decay organic matter in water solution. This parameter is related to dissolved oxygen as it indicates how much dissolved oxygen could be removed from water as the organic load breaks down. It is not a direct measure of water pollution, but rather measures the quantity of organic matter in the water sample. Important is to note that other substances such as toxins could hinder the bacteria and microorganisms, thereby showing a low BOD even though there is a high level of organic matter (Davie, 2008, pp. 134-135). Fourth, there are hundreds of trace organics compounds, for example benzene, pesticides and chlorophenols (Tebbutt, 1998). Several trace organics pile up through the food chain becoming a risk for fish, which eat aquatic fauna and consequently humans as well. Endocrine disrupting chemicals can be by-products of industrial activities that could affect the hormonal system of humans (Davie, 2008, p. 136). Fifth, *nitrogen compounds* can lead to nitrification, which is an oxygen-demanding process and also highly toxic ammonia can be released. Common sources of nitrogen compounds are treated sewage, agricultural fertilizers, animal wastes that are applied on fields, aquatic plants that that capture nitrogen plants from the air and atmospheric pollution. The greatest environmental impact nitrates can have is *eutrophication*.

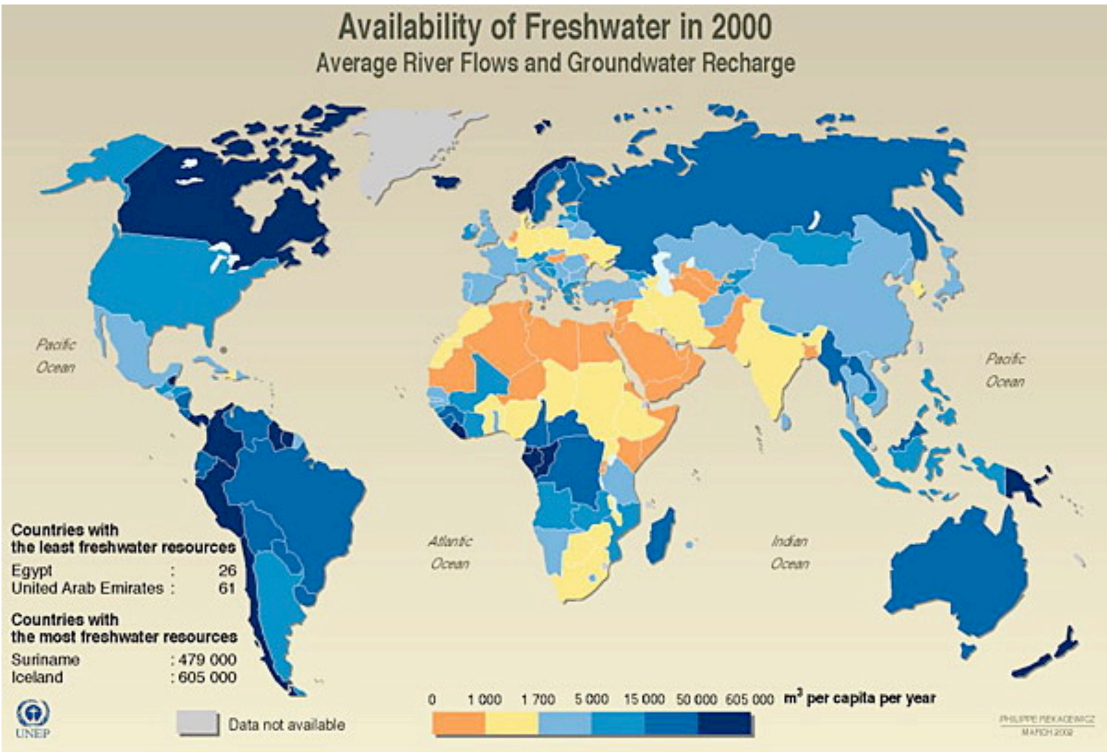
Under this phenomenon, an increase of nutrients (e.g. nitrogen and phosphorus) in a water body boosts the growth of aquatic plants, including algae. Consequently, bacteria that decompose plants deplete the dissolved oxygen, destroying many aquatic flora and fauna. The cyano-bacteria that break up algal blooms can also produce toxins as waste products of respiration. Sixth, *phosphates* are released from detergents and soaps coming from water treatment plants (except when phosphate-stripping units are used) and can also play a part in eutrophication. Phosphates can also be applied as solid fertilizers and when moved to rivers, they can stay their for long periods of time as they join sediments in the river bed. Seventh, *chlorine* is often used to decontaminate drinking water as it destroys bacteria, but it disappears in a short time. Last, *heavy metals* (i.e. metals with an atomic weight greater than 6) are often highly toxic. The following heavy metals are in order of decreasing toxicity levels, mercury, cadmium, copper, zinc, nickel, lead, chromium, aluminum and cobalt (Gray, 1999). Generally, heavy metals are moved into water bodies as a result of runoff from roads, or when storm water overflows combined sewage-storm water drainage systems. (Davie, 2008)

Water pollution can be controlled by taking a preventive or an end-of-pipe approach. In the preventive approach, point sources can be controlled by water quality standards that permit companies to release pollutants up to a certain level. Runoff from agricultural fields can be reduced by setting restrictions on land management practices (e.g. the amount of fertilizer allowed to use). In the end-of-pipe approach, polluted water can undergo wastewater treatment to control the spread of diseases from waste products and to lower organic matter. Non-point sources, such as runoff from roads in urban regions can be collected in storm water drainage systems and transported to artificial wetlands. (Davie, 2008)

2.3 Water Availability

About 71% of the Earth's surface consists of water, for the most part saltwater in the form of ocean water. Water is one of the few substances that can exist in gas, liquid and solid states within the Earth's climatic range. Only a minuscule part of the global water supply, namely 0.024%, is easily available as liquid freshwater in the form of groundwater deposits, rivers, lakes and streams. The remaining part can be found in the ocean, glaciers and polar ice caps and deep unapproachable groundwater. (Miller & Spoolman, 2008)

The World Resources Institute has provided a map (Figure 2-3 below) illustrating a classification of the availability of freshwater for different countries in 2000 (WRI, 2000). Water-rich countries have large quantities of water available for human usage. In the case of *water stress*, water for agricultural, industrial and domestic needs could be competing because there is not enough for all purposes. Water-stressed areas come about where per capita water supply drops below 1,700 m^3/yr (WRI, 2000). During this situation, disruptive water shortages can frequently occur. Even more severe is *water scarcity,* which could impact economic development and human health gravely. In the case of water scarcity, the annual renewable water supply per capita is below 1,000 m^3/yr (WRI, 2000). One setback of the country water analysis is that it does not take a river basin or catchment view. A country might be water rich as well as water poor in different regions, such as Chile and Australia. Due to water insufficiency, problems with food production and economic growth can arise, except for when the region is affluent enough to take on initiatives to deal with water shortages. Wealthy countries could invest in wastewater treatment plants to recycle water discharges. Also, countries could desalinate salt seawater if they are not water locked.



Source: *World Resources 2000-2001, People and Ecosystems: The Fraying Web of Life*, World Resources Institute (WRI), Washington DC, 2000.

Figure 2-3 Availability of Freshwater on a Country Base

Assuming population and economic growth, a study by the 2030 Water Resources Group (2009) has foreseen a worldwide water availability gap in 2030, where water demand is 40% greater than water supply. The report argued that existing water-regulating institutions are currently not likely to close the gap efficiently. Economists theorized that, assuming market conditions hold, an optimal equilibrium of utilities would be reached. Conversely, these market conditions are not met in the water sector, because (*a*) hydrological information access is imperfect, (*b*) there is rarely competition among water service providers plus (*c*) water scarcity is even now inherently an external cost (2030 Water Resources Group, 2009). The study pointed out that intervention is needed to overcome global water crisis. Water supply data (in particular hydrological data) and water demand data (how much is used by agriculture, industrial and domestic users) support the design of a quantitative vision. It would display what changes are needed to reach sustainability and encourage stakeholders to join forces for a shared vision. Nonetheless, the data needed is often not easily available (especially for groundwater). Furthermore, in many countries hydrological data is becoming worse due to national underinvestment in data collection (WWAP, 2009). The 2030 Water Resources Group (2009) argued that in countries facing serious risk of water scarcity and consequently potential economic losses, broad-based coalitions – including large industrial and agricultural water users - should align and invest in better information systems.

2.4 Water Resource Management

Water provides many services, for example the dilution and removal of wastes and pollutants, as a climate ameliorator, and shaping the Earth's surface. For humans, water is an important element of survival for drinking and through food production. On an individual level, we use water when showering, flushing the toilets and washing our food. Water is also embedded in the products we purchase. According to Arjen Hoekstra, the creator of the water footprint, the concept is easy to explain, "Those who buy tomatoes from Spain, should realize that they are adding to the water scarcity there. And if you wear clothes which are dyed in South-East Asia or buy toys from China, than you are also to blame for its contaminated rivers" (Dijk, 2010). The Dutch Water Footprint consists of 2.3 million liters of water consumed per capita per year, of which 89% arises abroad. On average, 2% of the Dutch citizens' water usage is withdrawn within the household, 31% is related to the consumption of industrial products and 67% conveys the consumption of agricultural products. Hoekstra argues that even though most of consumers' water usage takes place outside the household, consumers can exert influence as the public opinion counts (Dijk, 2010).

Freshwater availability affects not only human activities but also the survival rate of species and vital ecosystems. The World Wildlife Fund estimated that populations of species in inland waters declined on average by 35% from 1970 and 2005 (Hails, 2008). In the last century, half of the wetlands are deplete, damaged or demolished (Economist, 2009). Often as a result of a decrease in the amount of freshwater in wetlands, salt seawater marched into the wetlands. Systemic water problems can occur in the case of a disrupted balance between freshwater and saline water.

Water is a common-pool resource within and often amongst countries. Many countries are landlocked and some countries' water withdrawal depends on a river flowing through several countries. As each country subtracts water for domestic, industrial and agricultural purposes, the water available for countries downstream in the river (e.g. the Nile River) decreases. Different actions can help overcome water conflicts; (a) negotating agreements to allocate water among countries, (b) reducing wastewater, (c) increasing water prices to stimulate higher irrigation efficiency, (d) decelerate population growth and (e) increase imports of products that require much water (e.g. agricultural products) (Miller & Spoolman, 2008, p. 313). Detrimental scenarios are starting war against other water-competing countries or enduring the severe consequences of hydrological poverty.

There are several anthropogenic pressures that are projected to threaten future water availability:

- Population Growth: Global population is expected to grow from 6 to 9 billion between 2000 and 2050 (WWAP, 2009, p. 101). This will increase the demand on water for drinking, food and other water-intense products.

- Economic Growth: The BRIC countries – i.e. Brazil, Russia, India and China – countries are forecasted to have great economic development in the next decades. Economic growth will increase demand on water resources as many industries use water as an input for their operations. For instance, hydropower utilities use water in the production of electricity on a large scale, whereas industrial plants regularly consume water for steam production to drive engines. (Miller & Spoolman, 2008)

- Affluence: The environmental impact of people in developed countries is much greater on average than for developing countries. As more people are expected to become more affluent (particularly in China and India), increased consumption and changing diets - towards more water-intensive food such meat – will put pressure on water resources. (Miller & Spoolman, 2008)

- Climate Change: The effects of climate change, including drought, heat waves, reduced water flows from melting glaciers, and flooding, are creating additional pressures on scarce water supplies.

The United Nations World Water Development Report 3 (WWAP, 2009) emphasizes that "it is clear that urgent action is needed if we are to avoid a global water crisis". Although water is important for our survival, it has been poorly managed. There is little stimulus to lessen polluting, when water is already very often contaminated and underpriced. In the hydrological cycle, freshwater is continually assembled, recycled, purified, and allocated through the motion of water in seas, in the air, on the land through solar energy and gravity (Davie, 2008). However, when we deplete our waters with degradable and non-degradable pollutants or deplete the freshwater at a higher internal replenishment rate, we will continue to unsustainably manage our water resources (WWAP, 2009). Magnus Enell (Personal Communication, 19/05/2010) explains that with economic growth, "developing countries will need access to clean water in enough quantities, accompanied by technologies taking care of the discharges from this increased and often polluting demands". So, treatment plants should be built at the same speed as drinking water supplies are developed. "Sewage water must be regarded as the "raw material" for producing clean water, in the same way as waste should be regarded as the raw material for a new production" (Magnus Enell, Personal Communication, 19/05/2010).

Davie (2008) argues that, "water allocation in a resource management context is about how to ensure fair and equitable distribution of the water resource between groups of stakeholders". This depicts water use between domestic, industrial and agricultural purposes, but also for ecological needs. Barcott & Baxter (2003) describes the battle over water rights between farmers and fishermen on the Klamath River in Oregon and California. The fishermen had been appealing to the federal government to discontinue allocating most of the Klamath River's water right to potato and alfalfa growers, but no intervention occurred until decreasing fish populations were observed. The executive director of a local environmental NGO stated, "The administration sees water rights as property rights that come before other rights, including the right of ecosystems to exist" (Barcott & Baxter, 2003). Stakeholder's participation is a prerequisite in the process of water resource management. The Integrated Water Resource Management (IWRM) is one potential process that encourages development and management of water, land and related resources by adopting a participatory approach. Stakeholders from different sectors (domestic, industrial and agricultural) are jointly working to optimize social and economic welfare while safeguarding vital ecosystems. Under the IWRM, eight tools are proposed for change (GWP, 2004):

1. *Assessing water resources* to obtain data on the relationship between water supply and demand requires e.g. measurements groundwater levels and water usage metering;

2. *Plans* for water development initiatives require resources and stakeholder communication among sectors;

3. Focus on *demand management* to use water efficiently by finding options for improving and setting up plans;

4. *Social change instruments* provide education and create awareness on how to save water;

5. *Conflict resolution* should support managing disputes on how to share water, by building trust between sectors

6. *Regulatory instrument* control allocates limits for water use by how much water is available and how the hydrological system can cope with stress

7. *Economic instruments* persuade water efficiency and equity through water pricing

8. *Information management and exchange* to improve understanding on water management and share water data among stakeholders

In this chapter, the water cycle, and aspects of water quality and quantity were presented. Also, the anticipated global water crisis due to decreased water availability has been explained. Fortunately, humans are still able to adopt sustainable water resource management through stakeholder resolution, investing in capacity and setting national policies and programs among others. This research focuses on how the industrial sectors - and in particular water-intense sectors – assesses, manage and communicate water risks to investors and external stakeholders. In the next chapter a background on corporate water risk disclosure is presented.

3 Water Risk Analysis

Companies can obtain significant risk "depending on the probability that risk will materialize, but also on the magnitude of harm which might be caused" (DeSadeleer, 2002). In an environmental context, risk analysis can be subdivided into risk assessment, risk management and risk communication (Fjeld, Eisenberg, & Compton, 2006) as can be seen in Figure 3-1. First, *risk assessments* is the "estimation or calculation of the likelihood of undesired effects due to a risk" (Thompson, 2002, p. 160). Change in temperatures could affect the cultivation of crop, which is major input in the processes of food and beverages companies. For firms, this also includes making quantitative estimates of the business risks resulting from changes in the water availability. Second, *risk management* determines what levels of uncertainty and consequences are acceptable (Thompson, 2002, p. 167). For instance, if a water pollution risk is found to be at an unacceptable level, the company should reduce the likelihood and/or severity of the consequence by controlling the amount of pollutants released. Third, *risk communication* includes "the exchange of information on likely impairment of human health and/or environment, between risk assessors, risk managers, the public, media interest groups, etc."("Environmental Management," 1999). Companies can share information on water risks through different means of communication, e.g. annual or sustainability reports, corporate website, or stakeholder meetings.

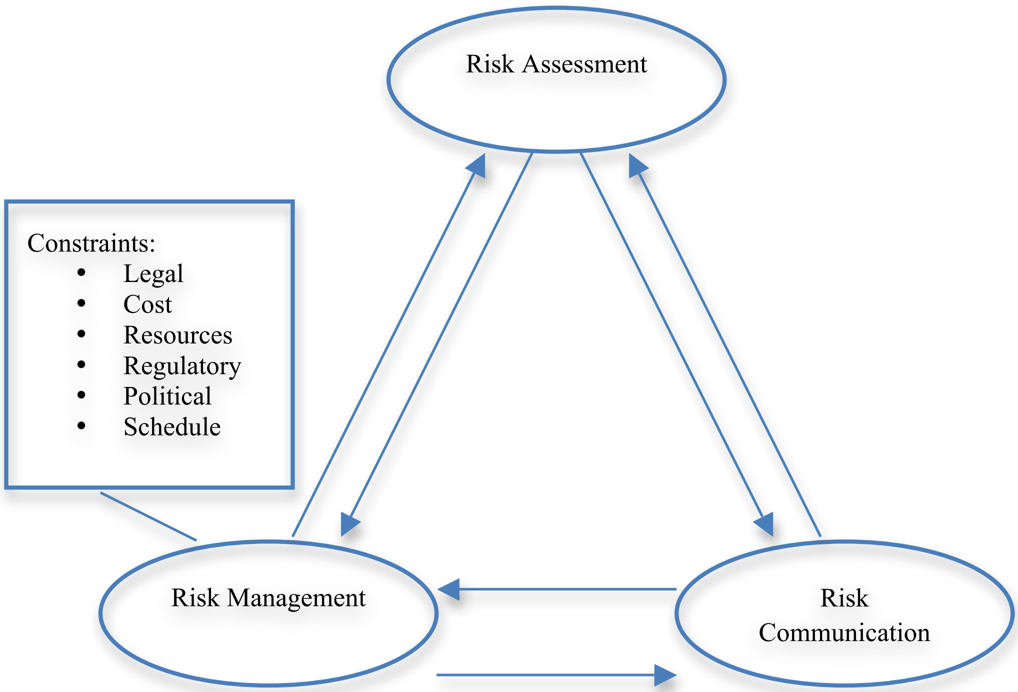


Figure based on; Source: Fjeld, R. A., Eisenberg, N. A. and Compton, K. L. (2006) Exposure Assessment, in Quantitative Environmental Risk Analysis for Human Health, John Wiley & Sons, Inc., Hoboken, NJ, USA. doi: 10.1002/9780470096208.ch9

Figure 3-1 Three Components of Risk Analysis

Activities for all three components need to be performed to execute the full process of risk analysis. This research for a great part looks into the risk communication of corporate water risk disclosure. Nonetheless, the quantity and quality of information provided to external stakeholders relies on the water risk assessment and management. Preferably, all components are part of corporate water reporting.

Managers or investors regularly conduct risk analyses to support the decision-making process. In August 2010, the Norwegian government-owned pension fund (total fund size of €276 billion) made public to begin including stocks from over 1000 water-intense companies (representing €33 billion in value) that comply with pre-defined minimum standards of water risk reporting and management (Chang, 2010). Investors are more and more interested to know if and how the companies, they own, are analyzing water risks.

A recent report by CERES investigated the water risk disclosure of 100 multinationals within eight different water-intensive industry sectors (Barton, 2010). The study outlines that most highly water-dependent companies do not sufficiently unveil their financial risks that could result from water shortages and droughts, as well as future possible regulations. A study by Arthur D. Little identified the following driving forces for companies to take water management seriously (Skidmore, Barrett, Ndebele, & Lyon, 2008):

- **Water availability**: Strategies and plans should be in place to deal with too little, too much or low quality water. In 2007, the Tennessee Valley Authority had to partially close down its Browns Ferry nuclear plant, because the high temperature of water withdrawal from the river did not serve the purpose of cooling anymore (Levinson, et al., 2008).

- **Regulation**: Companies are expected to receive even more stringent regulation, especially in drought areas. on water consumption and pollution in the form of permits, prices fees, penalties etc.

- **Supply Chain**: Water usage is often highest upstream in the life cycle. In case of drought, food and beverage companies can face problems with the supply of ingredients either being destroyed or sold at very high costs.

- **Awareness and expectations**: Investors and consumers have growing interests in water risk disclosure to find out how companies are dealing with water. Not only looking at the business risk in the supply chain but also avoiding impact in water scarce regions.

- **Local vulnerabilities**: Water issues deal with local water security and competition among stakeholder. Companies should not apply corporate-wide policies across all regions (Skidmore, et al., 2008).

In this chapter, water risk assessment, management and communication are discussed in greater detail. At the end of each of these sections, information related to the four water-intensive sectors under study (food, beverages, chemicals, and metals & mining) is given. Finally, a conceptual model is presented, summarizing the important elements for reporting that were found in this literature review.

3.1 Water Risk Assessment

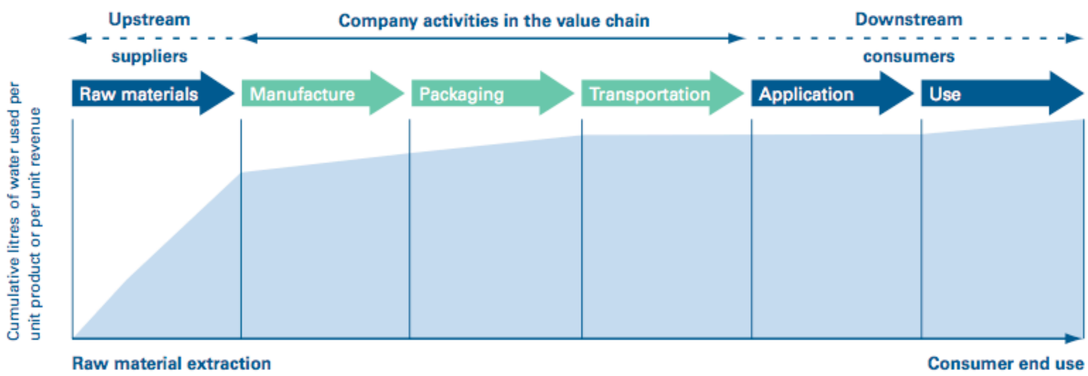
Companies need water for their operations in cleaning, cooling, processing and many more purposes. Water has generally been underpriced in many countries (WWAP, 2009, p. 61) and therefore might not always been perceived as a great cost to businesses. The perception might be changing over time. Climate change and water scarcity are both pressing environmental problems occurring worldwide, although the latter might not have received the same amount of media attention. Nonetheless, the nature of the problems is very different (Skidmore, et al., 2008). Climate change is global issue where the effects may be felt in the long run. The consequences of water scarcity and floodings that arise in a region, are seen almost immediately. Morrison, Morikawa, Murphy & Schulte (2009) identified three business risks due to water scarcity (water shortages or lower quality), see Table 3-1 below.

Physical Risks	• Business activities may be disrupted when water as an input or water-intensive supplies are no longer available due to water shortage • Decreased quality in water supply could require pre-treatment costs
Reputational Risks	• Businesses and local communities can compete over freshwater in their region • More people demand their 'access to clean water as a human right', which is even recognized in several non-binding UN resolutions and declarations • Greater understanding on the ecological impacts of water extraction and waste water releases
Regulatory Risks	• Increase in stringent water policies due to concern by local communities • Higher water prices that offer economic incentives for water efficiency

Table 3-1 Water-Related Business Risks

Companies can identify whether water is of significant risk. Initially, the company can assess the current situation, by making an inventory of the supply and use of water (Brorson & Larsson, 2006, p. 52). The supply of water is dependent on water availability of different water sources and the legislation and regulations presiding over the amount of water (e.g. groundwater) that can be used for industrial purposes (Brorson & Larsson, 2006). The use of water can only be managed if companies understand how and where water consumed and polluted throughout the site. Companies typically know total consumption of their facilities because of water meters and bills. However, detailed information on water use within the processes is not always clear or easily accessible (Brorson & Larsson, 2006). Setting up an environmental management system could support water risk management and is explained more in detail in the next section.

Morrison et al. (2009) pointed out that the largest footprint of the sectors are usually in the production of raw materials, hence upstream in the value chain (see Figure 3-2 below). Extreme weather due to climate change can affect agricultural yields and the costs of supplies for companies. High quality potable water is the primary ingredient in the operations of the beverages sectors. They are often competing with local communities over drinking water. If water scarcity occurs, beverage companies might have to close down facilities.



Source: Skidmore, R., Barrett, M., Ndebele, P., & Lyon, D. (2008). The Water Margin: How strategic management of water can grow business value. Arthur D. Little.

Figure 3-2 Water Consumed in the Life Cycle of a Food Product

The food sector is a major water consumer, as the agriculture represents 70% of global water use. In the Vision 2050 Report of the World Business Council of Sustainable Development (WBCSD, 2010b) the need for a radical increase in water efficiency is expressed by decreasing the water use per unit output from agriculture. The Report that a new Green Revolution, research in water management technology and the encouragement of the concept of "virtual water", i.e. explained more in depth in section 2.4.Much of the agriculture takes place in semi-arid areas which are projected to have stricter drought in the future (Morrison, et al., 2009). The five largest food and beverages companies combined stand for the water consumption of 600 billions liters in 2006 (Levinson, et al., 2008). Due to population growth, the demand of food products will increase. This will also affect water quality (e.g. eutrophication) due to nutrient leaching from fertilizers.

The metals and mining sector uses large amount of water in its processes, such as for cooling and lubricating drilling equipment, and processing ore (Barton, 2010). Competition over water with local communication could occur because mining depend on water availability and operations are unable to move elsewhere. Wastewater is the product of ore mining and refining. Coal sludge spills, cyanide and acid runoff - caused when water and air get in touch with rocks that carry sulfide - has the potential to contaminate surface and groundwater (Barton, 2010). The chemical sector uses large amount of water for the purpose of cooling, cleaning, dissolving and steam generation among others (Barton, 2010). The chemicals sector also has the potential to severely pollute wastewater and thereby the receiving water bodies, in case of contaminated water discharge or spills during the production or storage of chemicals (Barton, 2010; Morrison, et al., 2009).

3.2 Water Risk Management

When making decisions on how to control water risk, companies might run into several constraints (Fjeld, et al., 2006); (*a*) *Legal constraints*, stricter legislation may reduce the amount of pollutants companies are allowed to emit to water; (*b*) *Cost constraints*, Low water quality might necessitate the construction of a water treatment plants, which can be an extremely large investment with a long payback period; (*c*) *Resource constraints*, groundwater reservoirs might become depleted; (*d*) *Regulatory constraints*, where companies can be exposed to higher water costs and fines from local authorities; (*e*) *Political constraints*, state governments can choose to take water right from companies for domestic users; (*f*) *Schedule constraints*, floodings or drought may come unexpected.

Companies have the possibility to improve their environmental (including water) performance by implementing am environmental management system (EMS). This standardized system offers a tool to assess and control environmental activities in a structured way (Brorson & Larsson, 2006). If water is identified as a significant environmental aspect (as explained in the section before), the company can take the following steps: (*a*) develop a policy, (*b*) establish goals and targets, (*c*) set up a program and action plans to meet policy and legal requirements, (*d*) assign resources and responsibilities to the program and action plans, (*e*) conduct audits to look for improved performance and (*f*) audits are evaluated and new action plans are formulated after which the procedure starts again at step '(*a*)'. Therefore, the environmental management system is a continuous improvement cycle (Brorson & Larsson, 2006).

As described in the former section, companies first need to identify any significant water impacts, while looking at water supply and use on-site. Next, companies can set up policies, goals, target, improvement programs, and assign resources for water performance. Consequentially, water performance may be improved through process modifications, water efficiency investments (e.g. closed water cooling systems), awareness campaigns for employees and regular monitoring (Brorson & Larsson, 2006). Companies can also develop internal standards that specify certain water quantity and quality levels that must not be exceeded. If a company wants to also manage its indirect water risk, it is important to know if and how suppliers are managing their own water risks. Companies often could indicate that they are active in value chain water management when describe supplier's standards, programs, trainings. On the other end, companies can try to encourage their users to consume less water by writing product guidelines. Producers of washing machines could provide a brochure on how much water savings they could make, if consumers would run the washing cycle as little as possible. Also, companies could make their water consumption more visible. Real estate companies could place water meters in the tenants' bathrooms.

Industry associations are becoming active encouraging sustainability among their members. In 2006, the Beverages Industry Environmental Roundtable (BIER, 2010) was founded for global beverage companies to work together in defining a common stewardship framework and share knowledge to drive industry best practices and performance. In October 2007, the UK Food and Drink Federation (FDF) developed the Five-Fold Environmental Ambition, in which one of the five objectives aims to: "Achieve significant reductions in water use (i.e. water outside of that embedded in products themselves) to help reduce stress on the nation's water supplies and contribute to an industry-wide absolute target to reduce water use by 20% by 2020 compared to 2007" (FDF, n.d.). In 2008, the signatories of the FDF reduced their total water use by 1.7%, which is 476,000 cubic meters, compared to 2007 (FHC, 2009). The Federation House Commitment (2009) suggests several water-related initiatives to companies:

- **Use of Alternative Water Source:** Harvest rainwater for non-production parts of the site (e.g. flushing toilets) to reduce the purchasing cost of municipal water and avert local flooding. This prevents the treatment (chemicals use) and transportation (energy use) of high quality municipal water for purposes where low quality water is sufficient.

- **Cleaning**: In the food and beverages sectors, up to 70% of the water consumption in-house can be allotted to cleaning purposes, especially when companies take a 'better safe than sorry' approach. Water use reductions can be made through adopting Cleaning In Place (CIP) and/or switching to dry cleaning operations.

- **Reuse and Recycling:** Companies can improve water efficiency by reusing or recycling water. Typical examples in the food and beverage industries are the recycling of condensate for boiler feed and applying recirculation systems.

- **Wastewater Treatment:** A larger capital investment in building water treatment plants and equipment can reduce the pollution level and water discharge costs over the long-term.

- **Process:** Changes in the process can optimise water consumption, often through generating increased efficiency of equipment, fixing water leaks around the plants, and implementing trigger hoses that remove the problem of taps being left on.

- **Domestic:** In toilet areas, use spray nozzles to taps, and place more water-efficient toilets. In the canteens, water reduction measures can also often be made. These low-cost investments generally have short payback periods (FHC, 2009).

- **Other:** Companies can save water through improving their water management system. First, when facilities collect robust data and establish meters to more accurately map water consumption in key lines, companies identify at what part of the process the largest water savings can be obtained. Second, water awareness trainings for employees can create understanding on where water savings can be made and support reaching targets. Also, trainings could provide explanations on how to monitor water consumption between lines and shifts and how employees can become water champions. Third, developing suppliers' guidelines for to lessen water use and water contamination during agricultural stages. Fourth, companies could invest in irrigation research that yields high environmental performance.

If businesses in the UK choose to purchase water-efficient products from their Water Technology List, than the Government offers financial benefits through a capital allowance scheme (FHC, 2009). Companies should find out whether their countries of operations offer similar water efficient procurement lists.

3.3 Water Risk Communication

Water risk communication depicts the interactions among internal management and employees as well as external stakeholders (investors, government authorities, local communities etc). Companies can publish their water risks in external reports such as annual reports, sustainability/corporate social responsibility report, on their website and other media. Companies can communicate to the stakeholders that they are responsible citizens by signing voluntary water-related initiatives, such as the CEO Water Mandate, Alliance for Water Stewardship or Water Stewardship Initiative (WBCSD, 2010).

Investors might want to compare the water risk of different companies in their portfolio. Therefore, a standardized water-reporting framework would help with benchmarking. The Global Reporting Initiative is the most well known organization that developed a standardized framework for sustainability reporting (GRI, 2000b). The GRI clarifies that the content on which companies report, should give a balanced and reasonable demonstration of its sustainability performance. One overall important GRI Reporting Principle of the ten GRI principles is *materiality*. "The information in a report should cover topics and indicators that reflect the organization's significant economic, environmental, and social impacts, or that would substantively influence the assessments and decisions of stakeholdersÓ (GRI, 2000b). Magnus Enell (Personal Communication, 19/05/2010) argued that the GRI covers disclosing risks due to water scarcity. Companies are requested to report on water use if these are a material issue, e.g. factories are based in water scarce regions/countries or that are in competition with other users. Also, Magnus Enell (Personal Communication, 19/05/2010) argued that "The sector supplements should also address the water issue, especially if it is a sector that is water-intense". Still, he also stressed that, "a company, even if it is not water-intense, but acting in a water scarce region/county should report on this (water use), and how they are working with the water issue in general, connected to employees and their families, neighbors, other organizations, etc".

Companies that report their total water withdrawal and discharge can give stakeholders an impression how large water consumers and polluters they are. The GRI covers reporting on water withdrawal and discharge explicitly in five environmental indicators, presented in Table x below. The GRI indicators can be 'core indicators' or 'additional indicators', where the former is likely to be deemed material for more organizations and companies can decide the materiality of reporting on additional indicators (GRI, 2000b). Other GRI environmental indicator, namely EN11-15, cover biodiversity (GRI, 2000a) and is indirectly also linked to water.

GRI indicator	**An explanation on how to answer the environmental indicator**
EN8 (core): Provide data on water consumption by source	The organization should report the total volume of water withdrawn in cubic meters per year (m^3/yr) by the following sources: (a) surface water (including water from wetland, rivers, lakes and oceans), (b) groundwater, (c) rainwater collected directly and stored by the reporting organization, (d) wastewater from another organization and/or (e) municipal water supplies or other water utilities.
EN9 (additional): Provide data on water sources significantly affected by water withdrawal	The organization should (a) identify water sources significantly affected by the reporting organization and (b) report the total number of significantly affected water sources by type (i.e. size of water source in m3, if it is a designated protected area and its biodiversity value).
EN10 (additional): Percentage and total volume of water recycled and reused	The organization should report (a) the total volume of water recycled/reused by the organization in cubic meters per year (m^3/yr) and (b) as a percentage of the total water withdrawal.
EN21 (core): Total water discharge by quality and destination	The organization should (a) identify the planned and unplanned water discharges by destination and indicate how it is treated, (b) report the total volume of planned and unplanned water discharges in m3/yr by destination, treatment method and if reused by other organization, and (c) reporting organizations that discharge effluents or process water should report water quality in standard effluent parameters (e.g. BOD, TSS etc.).
EN25 (additional): Identity, size, protected status and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff	EN25 describes that the organization should (a) identify water sources significantly affected by the reporting organization's water discharges and (b) report water bodies significantly affected by water discharge by type (i.e. size of water source in m3, if it is a designated protected area and its biodiversity value).

Table 3-2 Description and Explanation of Water-Related GRI Indicators

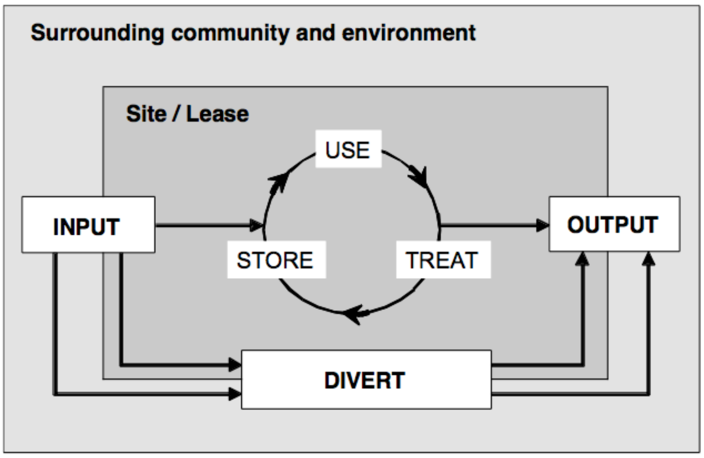
In 2007, the Water Project within the WBCSD developed the Global Water Tool. Companies can use the tool freely to map their (1) total water withdrawal by source, (2) percentage and total water recycled and reused, (3) total water discharged and (4) water efficiency, for each facility. It enables companies to calculate the environmental indicators - EN8, EN10 and EN21 – of the GRI. Additionally, water consumption can be compared against country-derived water availability as well as watershed-based (e.g. assessing for water scarcity). Companies are asked to fill in the latitude and longitude of each facility. Joppe Cramwinckel explained (Personal Communication, 17/08/2010) that the tool is a technique companies can use to create understanding of their water risks in terms of water availability for their business activities. From a global strategic perspective, this risk analyses could give companies an indication of what water concerns might arise. Again, by knowing where a water risk could occur, companies could start managing it. Magnus Enell (Personal Communication, 19/05/2010) explained that the GRI deals with the geographical context of water management, by asking the reporting organizations to go back to country or regional level when measuring the data. Magnus Enell (Personal Communication, 19/05/2010) mentioned that virtual embedded water is not included in the GRI indicators right now, but it will be in the new GRI manual G4.

GRI indicator EN8 distinguishes between different types of water sources. Still, surface or groundwater source can be managed sustainable or unsustainable. Ankit Patel (Personal Communication, 04/08/2010) mentioned that "River basins can be classified into several categories – Open basins (where total committed water resources are less than total renewable water resources), closed basins (where total committed water resources are equal or sometimes higher than total renewable water resources). Again there are few river basins that remain open during part of year when water availability is higher than total potential water use, i.e. many rivers in south Asia. Closed basins could be termed as water scarce basins. Similarly, open basins as water rich basins. Value of water in both types of basins is different. Apparently, water scarce basins require much higher efficiency then water rich basins." It seems difficult the risks of water scarcity under environmental indicator EN8.

Not all companies use the GRI for their water risk communication. In the next section, an example is given on how the mining industry came up with a water accounting framework for their sector. Besides the GRI, companies can also have their facilities can be ISO 14001 certified. This could provide assurance to management and external stakeholders that the company is in control of its processes and activities that might impact the water (Brorson & Larsson, 2006).

3.3.1 Water Reporting in the Mining Industry

Water quantity and quality, groundwater impacts and water availability are issues that can have significant impact on mining operations. The International Council on Mining and Metals (ICMM, 2010) is an organization led by CEOs from 19 minerals and mining companies and 30 mining and global commodity associations to confront sustainable development in their industry sector. Australia's water sector is faced with water reforms through the National Water Initiative (NWI, 2009), which directs greater national regulatory harmony in measuring, planning for, pricing and trading water. The NWI also aims to better water resource accounting to foster sustainable resource management. (Cote & Moran, 2009).



Source: Cummings, J. (2009). A Water Reporting Framework for the Minerals Industry. Minerals Council of Australia.

Figure 3-3 The Minerals Industry Water Accounting Framework

Figure 3-3 above illustrates a concept model for water accounting in the minerals industry with four functional elements that explain the relationship between a site's water use and its surrounding environment and community (Cote & Moran, 2009; Cummings, 2009), where:

- Input refers to water delivered to the site for operational use;
- Use-Treat-Store Cycle refers to the operational cycle of the site where; (*a*) 'use' indicates operational tasks which use water (e.g. dust suppression, dewatering ore, cleaning/ cooling of minerals and equipment); (*b*) 'threat' indicates on-site water treatment activities that improve water quality (e.g. cyanide destruction, physical settling); and (*c*) 'store' refers to on-site facilities that hold or capture water (e.g. stored for operational activities or water quality);
- Output refers to water removed from the site;
- Divert refers to water moved around on-site but which is not used in operations (e.g. creek rerouting, runoff diversions).

Water can be divided into high or low-quality depending on bio-physical characteristics (e.g. salt content) which dictate whether water could be used for different water use purposes. As described by Cummings (2009), water accounting deals with two areas of scope. First, how the site's water use impacts with the surrounding landscape is called the '*Input-Output Model'*. Sources of input can consist of surface water, groundwater (including entrainment, i.e. water carried in extracted materials that is processed by the site) and sea water. Destinations for output can contain surface water, groundwater (e.g. aquifer reinjection), sea water, third-party supply, evaporation, entrainment, seepage, and 'unknown losses'. Second, the 'Operational Model' depicts how the operation's activities and water uses affects water managed on the site. This framework should offer a consistent accounting framework for documenting water use, water efficiency, and water reuse and recycling within the operations (Cummings, 2009).

The GRI developed a sector supplement with additional indicators for the mining and metals sector. Cote and Moran (2009) argue that "despite the use of the GRI Mining and Metals Sector Supplement to guide the calculation of the core water indicators across sites, there remains a gap between a site's operational water balance and a GRI report card for water use, from philosophical, technical and stakeholder requirement's perspective". For example, reporting standards often imply that the volume of reused water can be controlled, by requesting the measured water reuse in percentage terms for a given year. However, Cote & Moran (2009) argue that it is the site's water balance and status of water stocks which influences the amount of reused water in the mining industry. the GRI environmental indicator 10 'Percentage and total volume of water recycled and reused' includes collected rainfall in this concept. Under the Minerals Industry Water Accounting Framework (presented above), rainwater is considered an input and therefore not included in their calculation of total water reused (Cote & Moran, 2009).

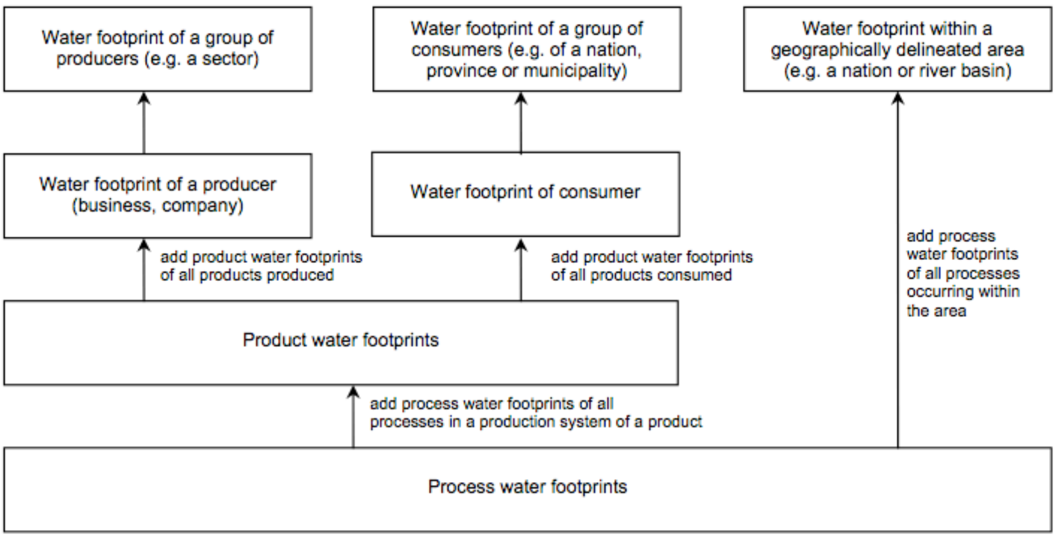
3.4 Water Footprint

In this section, the water footprint is presented which can be used for water risk assessment, management and communication. In 2009, the International Organization for Standardization has started developing a standard, ISO 14046, on principles and guidelines for water footprinting of products, processes and organizations (Raimbault & Humbert, 2010). The ISO 14046 is expected to be ready for use in around 2012. The example below will clarify the concept of water footprint.

The South Korean corporation, Daewoo, signed a deal to rent more than half of Madagascar's arable land to grow grain for citizens in water poor South Korea (Economist, 2009). In part because the citizens of Madagascar were furious that the agreement did not turn into any grants for the people, the Madagascar's president was removed from power in March 2010. As depicted in this example and argued by Chapagain & Hoekstra (2008), water 'virtually' flows through countries and regions by international trade of goods. Hence, embedded water (i.e.

water that that went into the product) is exported to the countries where the product is consumed. Water consumption and pollution commonly addresses the total volume of water used or discharged by various water demanding and contaminating activities in a certain geographical area (e.g. country or river basin). Hoekstra, et al., (2009) argue that science and actual implementation of water management has given little notion to water consumption and pollution throughout the whole value chain. Merely looking at water withdrawal and discharge in a geographical area might not provide a good understanding of global water resource management. Final products often go through several production processes, in which water might go into the product and/or pollute the receiving water bodies. Hoekstra, et al., (2009) argue that water consumption and pollution is connected to what and how communities consume as well as the structure of the global economy that provides products and services to the people. John Anthony Allen, who was awarded the Stockholm Water Prize from the Stockholm International Water Institute (SIWI) explained that "national, regional and global water and food security can be enhanced when water intensive commodities are traded from places where they are economically viable to produce to places where they are not" (SIWI, 2010).

In 2002, Hoekstra developed the water footprint concept that also considers not only direct water use but also indirect use along supply chains. The water footprint can support risk assessment, management and reporting. Hoekstra, et al., (2009) state that, "the water footprint of an individual, community or business is defined as the total volume of freshwater that is used to produce the goods and services consumed by the individual or community or produced by the business". Measuring water footprints start by looking at process water footprints.

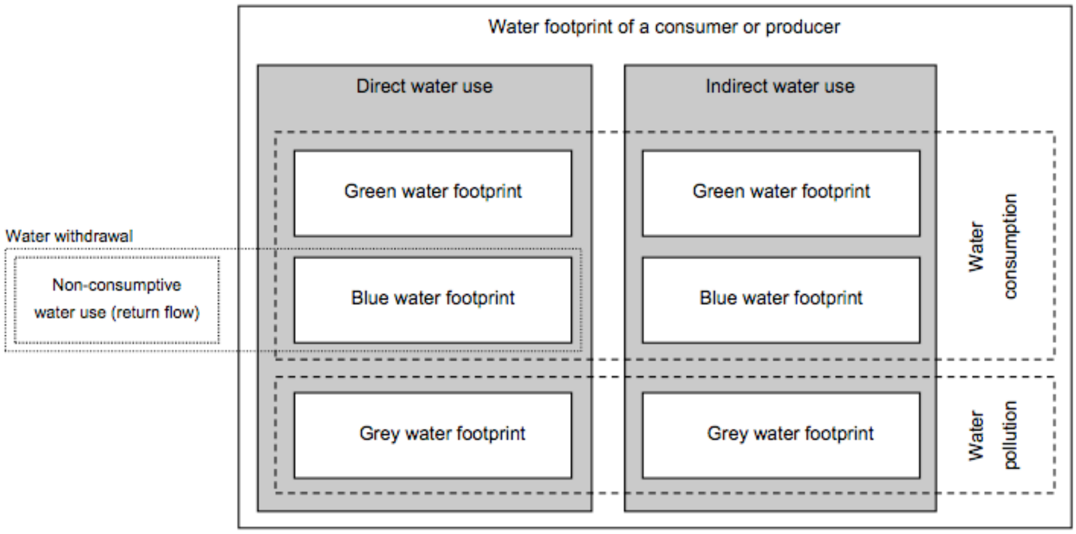


Source: Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. & Mekonnen, M.M. (2009) Water Footprint Manual: State of the Art 2009. Water Footprint Network, Enschede, The Netherlands

Figure 3-4 Process Water Footprint as the Basic Building Blocks for all other Footprints

Figure 3-4 illustrates that calculating the *water footprint of a product* requires adding the process water footprints of all processes in a production system (i.e. upstream and downstream processes) (Hoekstra, et al., 2009). The *water footprint of a company* instructs adding all the water footprints of the products produced.

Several motives for conducting a business water footprint assessment are finding business risk, corporate water reporting, product labeling and constructing quantitative water consumption targets (Hoekstra, et al., 2009, p. 11). The water footprints can also be measured for the consumers, group of consumers, industry and within a geographical area. Companies can choose the scale and scope when doing a water footprint assessment. The former could represent a facility, the entire company or the industry sector, whereas the latter could specify if only the company's operational processes (only direct water use) or also supply chain's processes are included (indirect water use).



Source: Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. & Mekonnen, M.M. (2009) Water Footprint Manual: State of the Art 2009. Water Footprint Network, Enschede, The Netherlands

Figure 3-5 Schematic Representation of the Components of a Water Footprint

In Figure 3-5 above, the schematic representation of the components of a water footprint is given. Total water footprint is calculated by taking the sum of the blue, green and grey water footprints, by looking at both direct and indirect water use. A company's direct water use relates to the processes in their operations and overhead (administrative facilities). The indirect water use refers to processes upstream in the value chain. The water footprint classifies water into three categories:

- *Blue water* refers to fresh surface and groundwater (e.g. freshwater from river, lakes or aquifers).
- *Green water* refers to "the precipitation on land that does not run off or recharge groundwater but is stored in the soil or temporarily stays on top of the soil or vegetation" (Hoekstra, et al., 2009, p. 21). Part of the green water can be used for crop growth, also known as effective precipitation. At some point, green water, which does not runoff or replenishes aquifers, evaporates or transpires through plants.
- *Grey water* refers to the volume of water needed for diluting pollutants to a certain level that the water in the receiving environment continues to be above accepted water quality standards.

A separation between blue and grey water underlines the different hydrological, environmental and social impact of the two types of water, as well as the higher opportunity cost for blue water (A. Chapagain & Hoekstra, 2008). The water footprint of a conventional food product (e.g. cookies or muesli) can be used as simplified example to show that a food product bought in the supermarket has consumed and polluted water at different processes in the value chain. First of all, irrigation of fields and the use of fertilizers were needed to grow the ingredients. Second, the food manufacturing plant uses water for cleaning and processing purposes, where food waste pollutes water discharge (e.g. high BOD content). Last, the final product is placed in the supermarket where water and detergents are used for hygienic reasons. Instead of measuring the amount of water withdrawn and discharges, the water footprint looks at '*consumptive water use'*. This term pertains to one of the following four situations: (*a*) water evaporates, (*b*) water is incorporated in the product, (*c*) water does not return to the same catchment area (e.g. it moves to another catchment area or the sea, or (*d*) water does not return in the same period (e.g. it is taken out in a scarce period and send back in a wet period) (Hoekstra, et al., 2009, p. 20). By assessing how much water is leaving the catchment area over a period of time, the water footprint not only shows volumes of water consumption and pollution, but also the locations.

A full water footprint assessment contains four steps (Hoekstra, et al., 2009, pp. 9-10):

1. Setting goals and steps; decision on the scale, scope and purpose of the water footprint.
2. Water footprint accounting; data collection and measurement of the water footprint.
3. Water footprint sustainability assessment; water footprint is evaluated from environmental, social and economic perspective.
4. Water footprint response formulation: Policies and strategies can be developed.

Similar to life-cycle assessment (LCA), it is not imperative for a water footprint assessment to undertake all four steps. Companies can for instance decide to stop after the water footprint accounting. "If companies have taken an LCA approach for its products and services, it is also important and transparent to report from an LCA perspective", says Magnus Enell (Personal Communication, 19/05/2010). "In the future, the LCA approach will be included much more in products and services, and organisations will use this tool both for improving design but also for a better understanding of the total impact of products and services. However, the LCA tool is still too complicated for the common use in organizations, and it is a problem when consultants are needed for all the evaluation" (Magnus Enell, Personal Communication, 19/05/2010. Similar to the LCA, water footprint assessments are not common tools yet, because moreover they are complicated. The water footprint is a comprehensive method to assess water risks, which makes it also very time-consuming and costly. Databases generally hold information on water withdrawal for industries and sometimes manufacturing processes, but data on 'consumptive water sources' of processes are barely found (Hoekstra, et al., 2009, pp. 20-21).

Critique on the water footprint covers the potential misinterpretation of the water footprint as an indicator of water use. Even though 140 liters of water might be needed to produce one cup of coffee consumed in the Netherlands (Chapagain & Hoekstra, 2007), this might not impact water resources significantly as coffee beans are generally grown in humid areas. The water footprint does not look at the geographical context, e.g. whether water is withdrawn from sustainable water resources. Not as Global Water Intelligence, but Ankit Patel (Personal Communication, 04/08/2010) states as his personal opinion, "Virtual water does not take into account sources of water. 1 Kg of rice produced in tropical environments, e.g. Indonesia, Malaysia, is not comparable with 1 kg of rice produced in say Saudi Arabia. The most important element missing from most of these indicators (i.e. water risks, virtual water etc.) is value of water. Value of water in both of these regions is completely different. A single number of virtual water say 3000 litres / 1 kg of rice is very misleading for consumers. Because no one knows, where the water comes from. Furthermore, water is a miniscule component of overall agriculture inputs. There are other important elements i.e. fertilizers, insecticides, seeds, energy (to lift or pressurize water), labor (mechanical or manual) etc. that play a major role, which is not reflected in ONE number of virtual water."

Magnus Enell (Personal Communication, 19/05/2010) discusses that virtual or embedded water has not been included or dealt with in the GRI Guidelines. "This is fairly new knowledge and field to work with, and in the future it should be included. However, even if it is not directly written with text, I understand that the materiality principle is putting the virtual/embedded water as significant and important information to include. EN8 addresses the water usage and efficiency, and with respect to transparency and liability, information about virtual and embedded water should be included".

The Water Footprint, in contrast to the LCA, only looks at the water, but not to other sustainability factors and their interconnectivity. Water and energy are closely interlinked. Water is required for several energy production purposes, such as hydropower, minerals extraction and mining and fuel production. At the same time, energy is required for securing water availability, e.g. in pumping and treatment, and desalination. (WWAP, 2009, p. 117) Since the 1970s, states in the Middle East have been depending on desalination. This very energy-intense process takes dissolved salts from seawater, through methods as distillation or reverse osmosis, to increase freshwater availability. Today, 300 million people are drinking seawater and brackish groundwater that has been desalinated. This is double the amount than a decade ago. With the projected increased demand for freshwater due to population growth and climate change among others, desalination is likely to accelerate in the future. "Desalination is not a cheap way to get water, but sometimes it's the only way there is", says Tom Pankratz, editor of the Water Desalination Report (Lange, 2010). Concentrated brine is a waste product of desalination that consist of great concentrations of salt and other minerals, which when disposed in the sea or on land can cause significant harm to the environment (Miller & Spoolman, 2008, p. 332).

As another example, the UK Environment Agency disclosed that the carbon footprint of a building increased when water-reuse systems for rain and grey water are being used (ENDS, 2010). The study revealed that the energy used for pumping and treating rainwater and grey water were 40% and 100% higher, respectively than for water provided by the municipality. Chemical company, BASF (2009), states that the company has taken water saving initiatives (such as recirculating water), but they do not want these initiatives to intensify energy use (e.g. for water recooling) or another negative impact on the environment. Certain industry sectors are identified as water-intense and hence face higher water risks (Barton, 2010; Jensen & Namazie, 2007). Ankit Patel (Personal Communication, 04/08/2010) mentions that, "Water is more of a local phenomenon – spatially and temporal. Thus, while identifying water risks one should take into account local environmental needs. Water received from various sources such as unconfined aquifer, deep confined aquifer, local rivers or desalination; each should be treated differently. Similarly, availability of water changes over time, which also affect the supply. There are also macro level issues, which transcend local boundaries, i.e. long distance water transfer or inter-basin transfer. Often corporate water risks oversee such issues".

Investors look at two aspects when it comes to environmental, social and governance (ESG) criteria: risk as a result of bad ESG performance and opportunities through good ESG performance (DVFA, 2009). Magnus Enell (Personal Communication, 19/05/2010) says: "We will always have a range from reactive to active to proactive organisations, regarding adopting new approaches towards environmental protection, consciousness, transparency, materiality, communication, innovation, etc. Hopefully, the market will punish the reactive organisations, at the same time as the market and authorities will push/help the proactive organisations. Still, the market demands, both from customers and the financial sector (banks, investors, shareholders etc.), are too weak".

4 Conceptual Model for Water Risk Disclosure

On the 9th of September 2010, the new Dow Jones Sustainability Index, which for the first time included water risk criteria, was made public (DJSI, 2010). Companies in 13 high water risk sectors companies were evaluated by looking how they are able to assess water risks, and have management systems in place to mitigate any water risk due to water availability, regulatory changes and stakeholder disputes (DJSI, 2010). In this section, I summarize the findings of the last chapter in a conceptual model. In Figure 4-1 below, it can be seen that I have classified three types of exposures that affect corporate water risk.

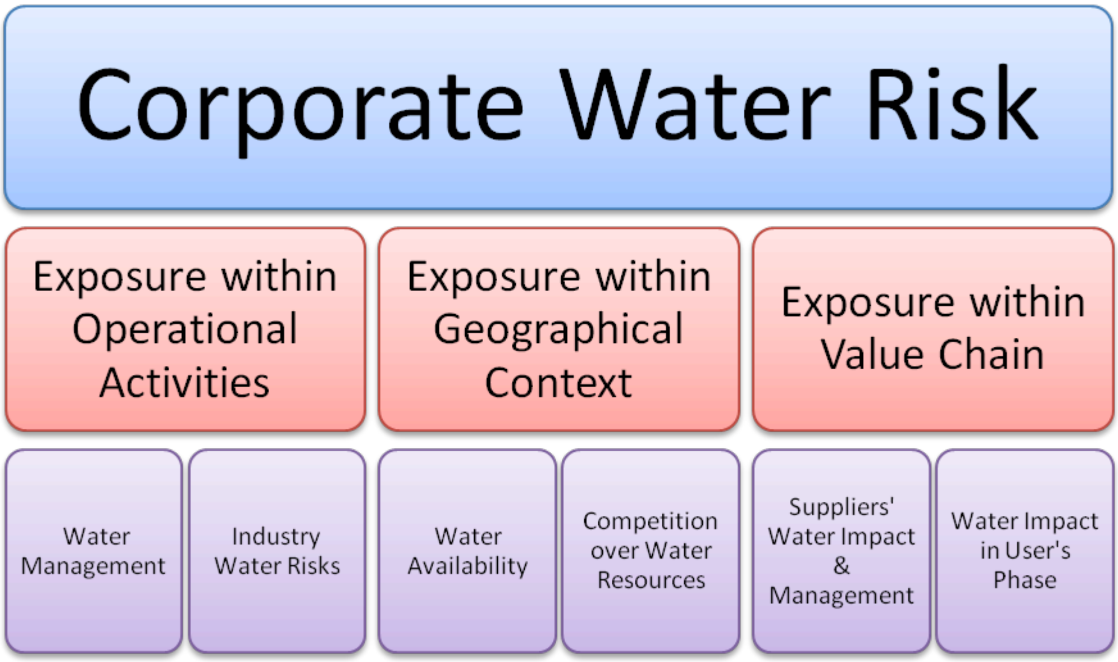


Figure 4-1 Conceptual Model

The conceptual model classifies corporate water risk having three different types of exposure. First, exposure within operational activities can translate in relatively large water consumption and pollution due to 'bad' water management or high industry water risks. Second, exposure within geographical contact explains that water availability and competition of water resources among local users. Third, exposure within the value chain covers suppliers' and consumers' water impact and management. Some elements in this conceptual model are interlinked, making a clear-cut distinction almost impossible. A food company can have most of its water impact upstream, where farmers operate in water scarce arid regions managed with inefficient irrigation methods.

Joppe Cramwinckel discussed (Personal Communication, 17/08/2010) how companies should manage their corporate water issues as follows: First, companies should report their water footprint, and hence detect where in the operations water is consumed and try to quantify water usage. Second, when understanding the water footprint, companies should evaluate their water risk. If a company is operating in a water-rich area, a small amount of water withdrawal has a low water risk. On the other hand, a small amount of water withdrawal in a water-sensitive region, might lead to a high water risk. Third, when knowing where and how much water is consumed in their operations after finding the water concerns in the facilities, companies should decide what actions to take. Implementing a management system, such as

ISO 14001, could be an option. Fourth, when you know the problem areas, companies should look into innovation. Examples are new water processes, recycling; and finally the sustainability impact of water should be understood in its relationship with energy. Companies could replace water usage but thereby increase energy consumption. Also, companies in other industries are competing over water with the agricultural sector, which uses large amounts of water for irrigation. Water should therefore not be viewed in isolation from other sustainability issues. (Personal Communication, Joppe Cramwinckel, 17/08/2010) Joppe Cramwinkel mentions the three elements of the conceptual model in the first part of his explanation. Innovation and placing water in a holistic perspective are also important elements.

The study by Arthur D Little recognized several parameters, which if measures could develop of a strategic water response for the business: (*a*) direct and indirect water footprint; (*b*) water pedigree, which is the sector-specific water impact in value chain; (*c*) vulnerability of operations in different regions; (*d*) threats and impact for operations in water scarce areas in the long-run; (*e*) costs and returns on water investments; (f) stakeholder engagement. Barton (2010) states that business' and investors' consensus on water disclosure suggests that (a) water reporting should be included in companies financial filings as opposed to sustainability reports; (b) relevant management systems and strategies should be discussed; (c) water accounting data should be presented in its geographic context; and (d) the supply chain should be incorporated in the risk analysis. Again in these two studies, exposures operational activities (investments, management system, strategies) and in the geographical context (water scarce, stakeholder engagement) and in the value chain (indirect water footprint, supply chain) are named. Due to these returning water disclosure elements, I have come up with the conceptual model presented above (Figure 4-1).

A study by Sustainable Asset Management (Wild, Francke, Menzli, Schön 2007) pointed out investors should be aware of the most recent technical advances and industry solutions. Also, investors should track political and legislative developments and decisions such as more stringent water quality standards, public spending on water infrastructure and the establishment of fees and tariffs. SAM mentioned that investors could lead to good prospects for investors when companies seek opportunities in sustainable solutions and consequently put forward innovative solutions.

4.1 Exposure within Operations

The company's main water consumption and pollution occur in the operations, although some can also take place in administrative facilities. During operations, chemicals that could pollute water are used for cleaning and other purposes, while large amounts of water are consumed during production activities. Nonetheless, at the headquarter and sales departments water is also consumed when flushing toilets or running the dishwasher, while cleaning services might release pollutants to water for hygienic purposes. In Figure 4-2 below, a simplistic representation of how a company affects the water quantity and quality is provided.

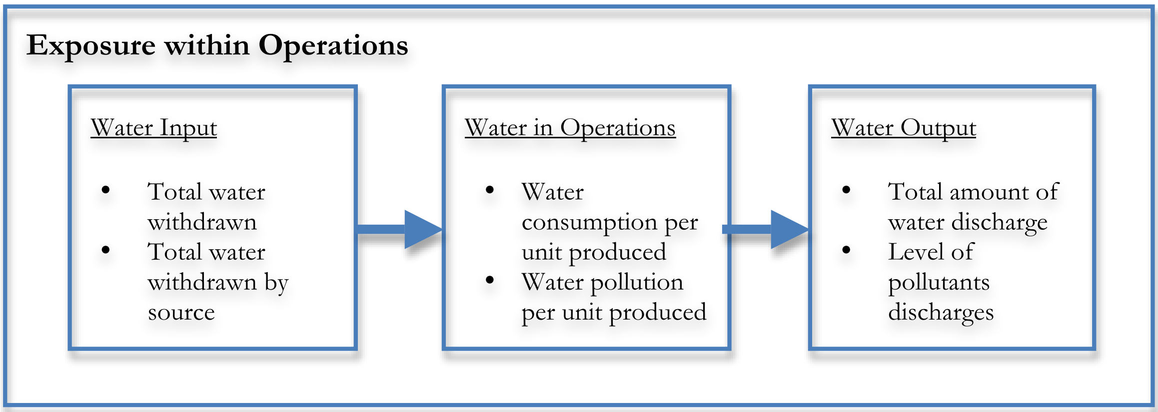


Figure 4-2 Water Management within Company's Operations

First, water enters operations (water inflow). This process can be described as water withdrawal, water consumption and water usage. Companies can take water directly from groundwater, surface water, lakes and the sea, but they can also receive water from municipalities or private water suppliers. The total volume of water withdrawn provides an indication of the organization's relative size and importance as a user of water. Total water consumption can also indicate the level of risk posed by disruptions to water supply or increases in the cost of water. Companies report their total water withdrawal in absolute terms and can also specify the types of water sources used. Total water consumption can be measured in m^3, liters, gallons etc on an annual base. Even though companies might have several operational plants, still most of them report corporate-wide data on their water performance instead of facility-based data. A company that takes a certain amount of water in Finland will have a lower water risk, than when that same amount of water is withdraw in Saudi Arabia. Therefore, to measure water risk it would be better if companies report their water data per facility or location.

Second, water can be managed in the operations (water storage). A company can reduce their water input and water output in the first place by becoming more water efficient for example by implementing more water-efficient technologies. In addition, they can create water awareness by developing water trainings for employees. Another way for a company to be less reliant of receiving water from external sources is through the reuse and recycling of water. Water storage is measured in relative terms, for instance water withdrawal or water discharges per litres, tonnes, gallons or m3 (etc) of product produced or sales. The criterion gives an indication of how efficiency the company is when it comes to water usage and water pollution.

Third, water leaves the operations. Generally, companies release wastewater from its operations. They can contaminate the receiving environment when the water discharge is great in quantity or low in quality (severely polluted). According to Miller and Spoolman (2008), "water pollution is any chemical, biological, or physical change in water quality that harms living organisms or makes water unsuitable for desired uses". As a result, water output is often presented as amount of water discharged or amount of pollutants (e.g. BOD and nitrogen) emitted to water. Water discharge can give an indication of how much the company is polluting the water. Companies often would express this in absolute terms such as m^3, litres, gallons, metric tonnes etc. on an annual base.

4.2 Exposure within the Geographical Context

Water issues affect the local environment. Companies play a dynamic role in the catchment area where they operate in. The catchment area is the area of land from which water flows towards a river then from that river to the sea. When companies withdraw water or release wastewater, it impacts the water availability and water quality in the catchment area. Therefore, it will also affect other stakeholders in that region. Moreover, water issues are of local concern rather than global concern. Some regions are water scarce or water sensitive, these climatic conditions can put extra pressure on firms to manage their water management well.

If water is scarce, it is not only available in small amounts to companies but also to other stakeholders. Companies could reduce their exposure by indulging in stakeholder management. Local authorities have a role to maintain safe drinking water for the communities while water providers are in many cases public companies. Companies can take action to manage or improve the situation for external stakeholders outside the company's own interests. For example, they can build infrastructure for water supply and sanitation for the local community. Companies can become partners of water-related initiatives, such as CEO Water Mandate, RANKAN, Water Stewardship, and other strategic collaboration to protect freshwater.

Companies can lead new water-related science or innovations that offer solutions in their own operation as well as turn into business opportunities. Examples of innovative business opportunities are the development of water efficient products and technologies. They can also become partners of the Global Reporting Initiatives or industry water-reporting initiatives. By doing so, they might cooperate in improving water reporting. In Figure 4-3 below, the key players in the water resource management of the catchment area are given.

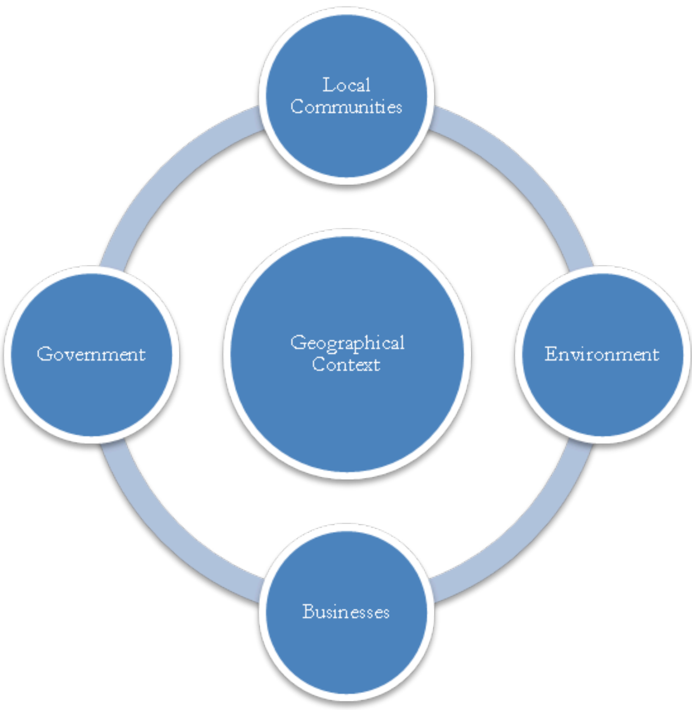


Figure 4-3 Key Stakeholder within the Geographical Context

4.3 Exposure within the Value Chain

Exposure within the value chain could lead to higher corporate water risk. Especially companies that might have agricultural suppliers could have a higher water impact upstream in comparison to their own operational activities. In recent years, more attention has been given to how suppliers are managing their water impact as well as how improvements can be made in the water performance of users of products/services. This extends the water reporting of the company over the complete value chain. For some companies, it is actually their suppliers which consume and pollute most of the water, e.g. in the food and beverage sector. Companies could also have higher water impact downstream in the user's phase. For example, washing detergents or in the real estate industry. A producer of washing machines might consume and pollute water in the manufacturing of the machine. However, over the lifetime of the product, consumers could impact the water more when washing clothes unsustainably, for example washing few items only. Companies do have the possibility to make their products more water-efficient. Real estate companies could place water-efficient toilets and water meters to reduce water consumption downstream.

Chapagain, Hoekstra, Savenije & Gautam studied the water footprint of cotton products (2006). Cotton products have different water impacts at the agricultural and the industrial stage (A. K. Chapagain, et al., 2006). During the agricultural stage, water impact consists of evaporation of infiltrated rainwater, surface and groundwater withdrawal and water contamination by leaching fertilizers and pesticides. Each year, 256 Gm^3 of the global water use is required for the global consumption of cotton products (A. K. Chapagain, et al., 2006). Cotton products are typical trade goods, for which the production stage and final consumption are taken place in different locations. Chapagain, et al., (2006) describe that Malaysia processes raw cotton imported from China, India and Pakistan to subsequently export it to European countries. The EU25 region's water footprint for cotton production lies for 84% outside its borders (A. K. Chapagain, et al., 2006). This implies the international trade of cotton product conveys international flows of virtual water. In 2009/2010, China, India, USA, Pakistan, Brazil and Uzbekistan produced about 85% of the global cotton production (USDA, 2010). Water availability for local water users shrinks in cotton growing and processing countries. Consumers are often not aware of the water embedded in their cotton apparel. Water is generally underpriced and not incorporating as external costs of cotton production. Therefore, consumers of cotton products have little incentive to change their consumption behavior that impacts water systems faraway.

5 Results: Food and Beverages Sector

In this chapter, the findings on water disclosure in the food and beverages sectors are provided. First, a documentation analysis will present the companies' water risk rating, including data on the industries' water-related GRI reporting. Companies can receive a water risks rating score from 0 up to 30 (i.e. the maximum water risk rating score), implying the corporate water risk level. Also, the water risk ratings are compared to the environmental risk ratings in search of any correlation. Second, the findings of the qualitative interviews of five food and/or beverage companies are unveiled.

5.1 Documentation Analysis

The companies are rated according to the criteria and indicators developed for the GES water risk-rating database. This might not be the final GES water criteria and indicators. Nonetheless, the scores and ranking of the companies is assumed to be fairly similar.

5.1.1 Food Sector

In this research, 25 food companies under the MSCI industry classification "Food Products" were investigated. These companies are multinationals producing all sorts of food; from cookies, soups, spices, to muesli. In Table 5-1 the water scores of the food companies are provided. Danisco and Nestlé scored highest with 22 points out of a maximum score of 30. The mean score and median are 11.7 and 11.5 respectively. Ceres (Barton, 2010) screened 13 companies in the food sector according to their water criteria and indicators. It will be really difficult to draw any conclusions from comparing the company water ratings of this study with those scores from Ceres risk-rating model. Especially, because the indicators for screening are unknown for both risk-rating models. However, when looking at the rankings, the highest-rated companies from Ceres are also ranked above this study's sample mean of 11.7, except for Tyson Foods. Unilever is ranked highest in the Ceres list but ranked number 4 in this study's list. There are three companies

Food Companies	**Water Score (0-30)**	**CERES Score (0-100)**	**CEO Water Mandate Signatories**
Danisco	22		
Nestlé	22	29	□
Danone	20.5	20	□
Campbell Soup Company	17.5		
Raisio	16.5		
Chiquita Brands International	16.5		
Unilever	15.5	34	□
General Mills	15	19	
ConAgra Foods	14.5	12	
Associated British Foods	13.5		
Atria Group	12.5		
Kellogg's	12.5	15	
BRF Brasil Foods	11.5		
Podravka Group	11.5		
Kikkoman	9.5		
Kraft Foods	8.5	15	
Cloetta	8		
Sara Lee	8	12	
Tyson Foods	8	17	
Marine Harvest	7		
Heinz	6.5		
Dean Foods	5	12	
Fazer	5		
Hershey Foods	4.5		
Cermaq	2		

Table 5-1 Water Ratings Food Companies

that have signed the CEO Water Mandate, which are Nestlé, Danone and Unilever. All three signatories were scored above average in their industry sector.

Figure 5-1 below illustrates the number of food companies reporting on policies and programs for water consumption and pollution, and the water-related GRI indicators. Companies can set water policies and programs to manage their water consumption. From all 25 companies, 17 companies report to have a policy and/or program in place to control their water consumption. There are 20 out of 25 food companies that are using the GRI guidelines for sustainability reporting. Only 2 companies fully reported their water withdrawn by source (EN8) and 15 more published their total annual water usage (i.e. partially reported). No food company fully reports whether any water bodies are significantly affected due to their water withdrawal (EN9). Just five companies have either fully or partially reported the

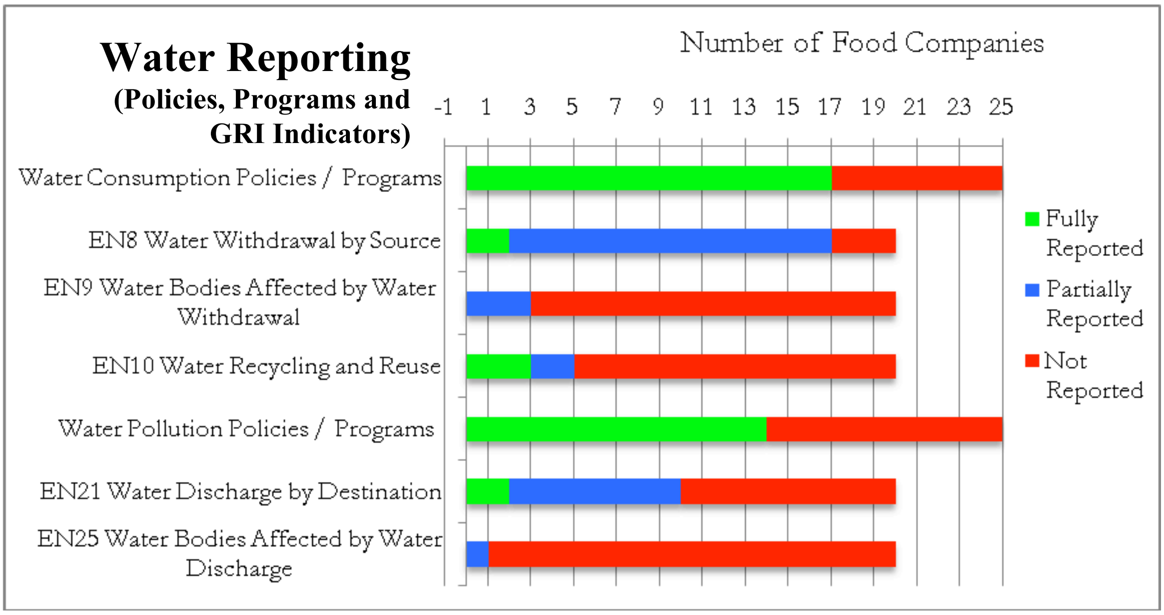


Figure 5-1 Water Reporting in the Food Sector

volume and percentage of water recycled and reused (EN10). From 25 food companies, 14 companies describe having a water pollution policy and/or program in place. Again, only two companies are reporting water discharge by size and destination and 10 companies are merely reporting total volume of water discharge (i.e. partially reporting). There is no company fully reporting on whether there are water bodies significantly affected by water discharge and runoff (EN25). This chart displays that in general the food sector discloses more information on water consumption than water pollution. In comparison to other industry sectors - which will be presented in further sections - the food sector provides the least information on GRI indicators.

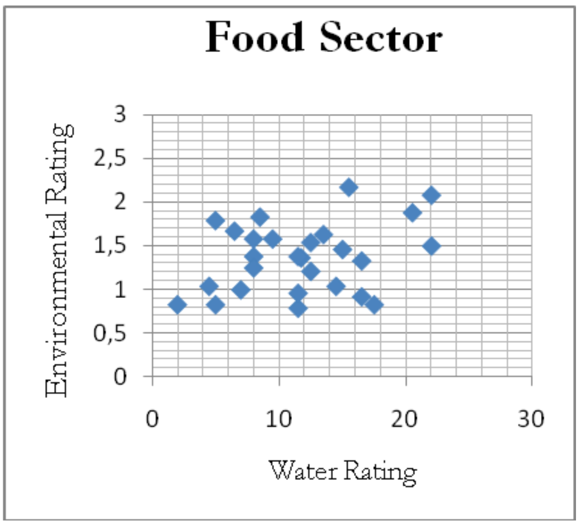


Figure 5-2 Correlation of Water and Environmental Ratings in the Food Sector

The water criteria and indicators for screening companies included more elements than the one mentioned in the last paragraph. The GRI might not properly identify if companies are managing their water risks in water scarce regions. From the 25 food companies, 11 companies (=44%) described whether they are active in any water scarce areas or that this could turn into potential risks for their operations. Six companies (=24%) have made certain initiatives to improve their water impact in those regions. In addition, the GRI is currently not covering water risks in the supply chain. The companies in this sample group are generally purchasing the raw ingredients for their food products. The highest share of water used to produce the final food products often occurs in the agricultural phase, when growing the raw ingredients. If food companies want to reduce the water impact of their final product, they could make greater contributions when focusing upstream in the value chain. Eight companies (=32%) set water requirements for their suppliers. There are also eight companies (=32%) that audit or work together with suppliers to improve their water impact. The food and beverages sector disclose the more information on water management in the value chain in comparison to the chemicals and metals & mining sectors.

Figure 5-2 demonstrates that there is a very weak correlation between water ratings (maximum score of 30) and environmental ratings (maximum score of 3). The mean of the water rating and environmental ratings is 11.7 and 1.4 respectively. There is a correlation of 0.31 between the companies' environmental rating and corresponding water ratings. Hence, companies that score either high or low on their water disclosure do not predict that they will score similar on their environmental disclosure, or vice versa.

5.1.2 Beverages Sector

A total of 21 beverages companies were screened according to their water disclosure. The ratings are presented in Table 5-2. Overall, these companies produce alcoholic and/or non-alcoholic drinks. Coca Cola Amatil and The Coca Cola Company scored highest with 23 points out of a maximum score of 30. The mean score and median are 13.7 and 14 respectively. The mean of the water ratings in the beverage sector is the highest amongst the four other sectors. This implies that the beverage sector takes the lead in water disclosure amongst these four water-intense sectors. There is a relatively large difference between the score of Vina Concha y Toro and Guinness Anchor Berhad and there is only one company scoring below 7. There are 10 companies screened on water criteria and indicators in the study of Ceres, of which nine are also rated in this research (Barton, 2010). When looking at the rankings, the highest rated companies from Ceres are also ranked in the upper-half list of this study. Remarkably, Diageo, who scored most points in the Ceres study, is ranked

Beverage Companies	**Water Score (0-30)**	**CERES Score (0-100)**	**CEO Water Mandate Signatories**
Coca Cola Amatil	23		
The Coca Cola Company	23	34	□
Pepsi Co	21	29	□
Coca Cola HBC	19,5		□
Lion Nathan	18,5		
SAB Miller	17,5	30	□
Anheuser-Busch	17	34	□
Heineken	15,5	25	□
Diageo	15	43	□
Grupo Modelo	14		
Pernod Ricard	14	18	
Fosters Group	13,5		
Carlsberg	12		□
Molson Coors	11,5		□
Asahi Breweries	10,5		
Brown-Forman B	8,5	18	
Dr Pepper Snapple	8	8	
Femsa	8		
Royal Unibrew	8		
Guinness Anchor Berhad	7,5		
Vina Concha y Toro	2		

Table 5-2 Water Ratings Beverages Companies

eighth place here. There are nine companies that have signed the CEO Water Mandate of which seven scored above average in their industry sector.

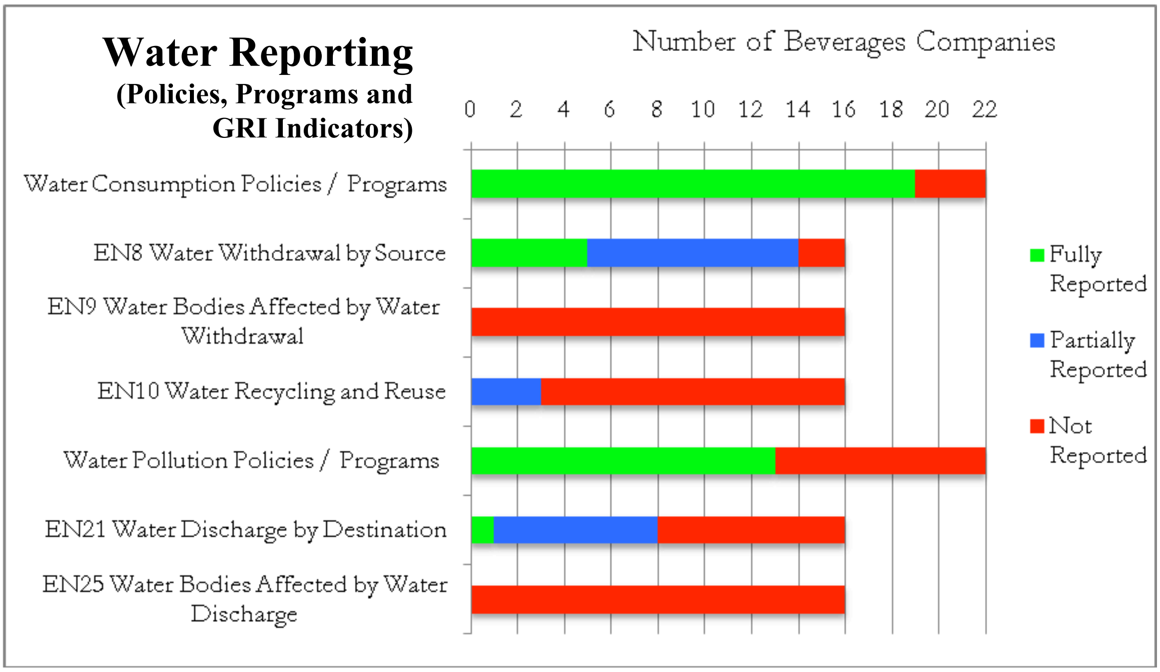


Figure 5-3 Water Reporting in the Beverages Sector

Figure 5-3 above illustrates the number of beverages companies reporting on policies and programs for water consumption and pollution, and the water-related GRI indicators. From all 22 companies, 19 report to have a policy and/or program in place to control their water consumption. This implies that more than 85% of the companies are active in managing their water consumption. There are 16 out of 22 beverage companies that are employing GRI guidelines for sustainability reporting. Five companies fully reported their water withdrawn by source (EN8) and nine more published their total annual water usage (i.e. partially reported). No beverages company fully report whether any water bodies are significantly affected due to their water withdrawal (EN9). Just three companies have partially reported the volume and percentage of water recycled and reused (EN10). If more than 85% of the companies have a water consumption policy and/or program in place, why are there not more companies reporting on EN8, EN9 and EN10? Perhaps, it is difficult to measure this data or companies do not want to disclose this information. From all beverage companies, 13 companies describe having a water pollution and/or program in place. Just one company is reporting on water discharge by size and destination (EN21) and another seven companies are reporting total volume of water discharge (i.e. partially reporting). There is no company fully reporting on whether there are water bodies significantly affected by water discharge and runoff (EN25). Similar to the food sector, this chart displays that in general the beverages sector discloses more information on

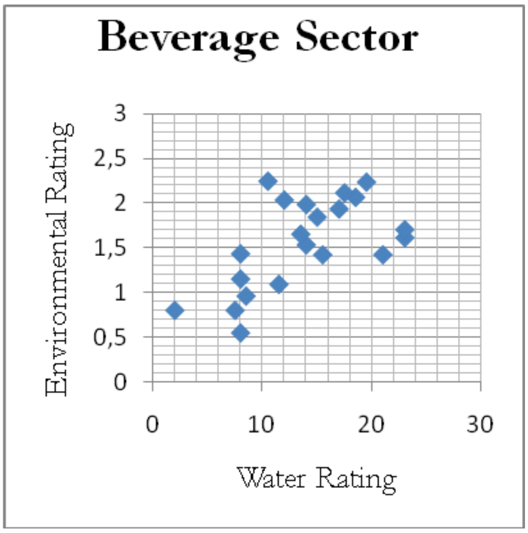


Figure 5-4 Correlation of Water and Environmental Ratings in the Beverages Sector

water consumption than water pollution. Although the beverages sector provides slightly more information on GRI indicators, food and beverages companies all together disclose less than the chemicals and metals & mining sector, which is shown in the next chapter. The beverages sector was screened best on average by the water risk-rating model, indicating that companies score high points on other criteria presented in Figure 5-4.

From the 22 beverages companies, 10 companies (≈45%) described whether they are active in any water scarce areas or that this could turn into potential risks for their operations. Seven companies (≈32%) have made certain initiatives to improve their water impact in those regions. Similar to the food sector, beverage companies are often purchasing the raw ingredients for their drinks. Growing these ingredients could have a great water impact. Seven companies (≈32%) set water requirements for their suppliers. Eight companies (≈36%) are auditing or working together with suppliers to improve their water impact. The food and beverages sector disclose the most information on water management of the value chain in comparison to the chemicals and metals & mining sectors.

Figure 5-4 displays a correlation of 0.60 between water ratings (maximum score of 30) and environmental ratings (maximum score of 3). The means of the water rating and environmental ratings are 13.7 and 1.6 respectively, and are both higher than the corresponding means of the other three sectors. This could imply that beverage companies are better at disclosing water and environmental risks. There is some (although still weak) evidence of a possible causal relationship between water rating and environmental rating in the beverage sector. This implies that companies score similar on their water disclosure as on their environmental disclosure. It could be that companies, which are good at overall environmental reporting, also provide more and better information on how they manage their water risks. Then again, the correlation merely shows weak evidence.

5.2 Qualitative Interviews

In this section, the findings of the qualitative interview of food and beverages companies will be given. One representative of a beverage company and four representatives of food companies participated in the interviews. As agreed upon before the interviews, the statements will be kept confidential. Since, only one beverage company participated, the findings of the food and beverage companies are aggregated. It is not very odd to aggregate these sectors, as it is quite common that some companies produce food and beverages products. The company representatives, their job titles and company names are presented in Appendix I. To keep quotes anonymous, the answers and companies will be presented as 'Food/Beverages Company A', 'Food/Beverages Company B', 'Food/Beverages Company C', 'Food/Beverages Company D' or 'Food/Beverages Company E'.

5.2.1 Exposure within the Operations

All interviewed companies, except for Food/Beverages Company A, identified water as an important element of their sustainability strategy. "We have not seen use of fresh water as a major environmental impact of our operations", said Food/Beverages Company A. Several companies argued that water has been perceived as a cheap resource. Food/Beverage Company D discussed that water used to be payed at a flat rate, and therefore considered cheap. "Over the years, we were using sprinklers the whole day when temperatures were up to 39 degrees. You just didn't care, because it wasn't costly or anything, where that has completely changed now". Food/Beverages Company C stated, "most people, such as the process engineers, bring the steward mentality to the workplace. But because the cost of water - as a relative cost in production over the course of decades - has been so low, it hasn't been looked at as rigorously". Through time it has gained more attention. In the past, Food/Beverage Company D indentified water as simply a cost, which was put in the annual operation strategy. "It was never expressed as 'let's reduce it by so many litres or let's pick a target that we are going to try to maintain. Or, 'as we increase production, let's try to maintain our same level of water use'. It was never that. Water was costing us a million dollar a year, we want to reduce that by 10% in terms of cost". Since 1990, the company has improved their water efficiency by more than 75%. It appears that huge water savings can be made, leading to lower costs.

Overall, important drivers for managing and reporting on water risks were pointed out to be cost and legislation. Changing water legislation turns into higher costs. Food/Beverages Company B felt that legislation and water costs were the main drivers to report on water management. Food/Beverages Company D explained that the main driver was cost initially. "10 Years ago, we didn't thought to say, 'we are going to be corporate citizens and reduce our water'. We looked at the cost of water that we were using and - I can't give you an exact figure - but it was sort of 1% of the total operating cost. It was a significant cost and therefore we were trying to get it down." On the other hand, Food/Beverages Company E found it difficult to see what the internal and external drivers for water reporting were. The company representative felt that is was a combination of everything. For almost 10 years, they have been developing sustainability reports and water consumption was included from the start. This could indicate that it has been identified as a significant environmental impact by top management or the CSR/environmental department.

The food and beverages companies use water in their operations for instance for cleaning, processing, and transportation inside the manufacturing plant. Food/Beverage Company C explained that vegetables are coming in by rail cars or truckloads and they are moved through the plant with water. Food/Beverages Company C mentioned, "For multiple decades, water was only used once. It was just kind of brought in, cleaned, moved things around and then went right back into the river, well or the wastewater treatment plant. It's a different mentality today, but it's pretty new in our sector […] Water is still frankly in lot of places only used once, and in a lot of places – in lack of better word – it is 'wasted'. It is just kind of sloshing around". The low cost was the reason of the inefficient use of water. The company tried to change the mentality by setting very aggressive recycling and water use reduction goals. According to them, this has changed everybody's philosophy about it. Beside water consumption, companies can also face costs for treating polluted water. Food/Beverage Company B explained that it is difficult for them to trace their water impact because wastewater is discharged to the municipality. The company pays the municipality for treating the water, but therefore it is hard for them to know where the water impact is. On the other hand, Food/Beverages Company C also perceived water opportunities to reduce costs, "We use heat. We heat things up. We cool things down. We use water everywhere. Those three, from a chemical perspective give you a lot of opportunities in heat recovery and water reuse. We have several years of opportunities where to reduce our water use, especially in efficiency […]". Nowadays, companies understand that water consumption and pollution can lead to increased costs and legal constraints. Risk exposure within the operations can be reduced by for example improving water efficiency.

Before setting up action plans to reduce water consumption and pollution, companies should understand how great their water impact currently is. Companies were asked how they measured their water withdrawal and discharge and if these are hard facts or estimates. Food/Beverages Company E stated they provide hard facts. "I have an environmental performance management reporting system in place where every plant has to report every two months how much water they use for cooling, steam production and so on". Also the plants have to record their water sources, e.g. municipal water, surface, ground, rain, seawater etc. "Water is also costly […] Therefore we also have an interest in decreasing the amount of water used and wastewater treatment. We use bills in some plants and in other water meters, or both." Food/Beverages Company C felt that measuring water use is on one hand very easy and on the other it is very difficult. "The easy part is measuring the gross water use. Almost every company and plant has a meter, we buy water, we meter from the ground. We meter from the municipality, the city or the township. So it's very easy to measure the gross amounts of water that we use". More difficult is measuring the net water use. "So we know what we take out, we reuse and recycle some, and in some cases we have our own wastewater treatment plants. We don't have any really good measurement on the net amount of water that we use ... the full picture of where it goes. So, here is the water I take out of the city and municipality, here is the water that goes through our plant, here is the little bit of water that goes into our product, here is the water that we clean and send back to the city. Here is the water that's lost and we don't know where it goes. That equation is very hard for us to get and we are just starting on that know. The other thing that doesn't happen very often in this industry is water measurement at the process level. Most food/beverage plants know how much water they take out at the municipality but not measuring it at the cookers or at the process line. We don't have process by process water measurement in factories and that's another opportunity." If the company knows where in the process most water is used, than it would be obvious where the largest water savings can be made.

In order to manage their water consumption and discharge, companies need to make decisions on for example where to expand their operations or take water efficient initiatives. Food/Beverages Company D has developed a water treatment plant in one facility. The state government has provided them with about one third of the capital required in the form of a government grant. The interviewee mentioned that they were only able to make the investment because of this grant as this made the project just viable financially. "If we do this at any of the other sites, there is no payback. The payback is probably something like 12 – 15 years, which is not really viable in terms of return on investments. So, you have either got to do it out of environmental benefits or risk benefits, in terms of not wanting to run out of water." The company is now looking into whether they want to continue setting up more recycling plants. The interviewee explains that placing water treatment plants in smaller facilities will still cost about the same amount of money. However, the smaller facilities are loosing market share. Food/Beverage Company D argues "It is very difficult to justify putting that sort of an expenditure […] 'do we do that? Or do we come up with some other strategy? Or do we shut down some of the smaller […]? Or cancel/move the production elsewhere? Do we source more water from the ground, because that's a possibility?"

If companies set up water programs of management systems, this could support them in reducing their water impact. For food and beverage companies, an investigation in the environmental aspect under the EMS should identify was as a significant aspect. Another way to get more resources assigned to water-related investments is setting up an internal price of water, which is higher than the current water expenditure. The interviewee of Food/Beverages Company C was asked whether internal pricing of water instead of setting water efficiency targets, would be a more effective means to save water. Food/Beverage Company C argued: "The externalities in everything, not just our sector but every sector, is just amazing. When you think about what you pay for some of the things you buy, it's clear that not all the costs are reflected. Is it better to have a target system in place? I don't think it is better, I think it's necessary. It's not a requirement anymore. I think it has to be aggressive and it has to be more than one year as well. There is nothing wrong with companies that set one-year targets. But what happens when they set one-year targets is that those targets are not necessarily stretch-goals, they are prediction of performance. So, they often meet the one-year target basically because they predicted what they think they can do anyway." Company Food/Beverages C summarized, "setting goals that people don't know how to reach today, is what drives innovation".

Companies can report on their water withdrawal and discharge by following the guidelines on the environmental indicators developed by the Global Reporting Initiative. In general, the food and beverages companies state that they find following the guidelines of the GRI useful, although some companies pointed out that some indicators are too difficult and time-consuming. Food/Beverages Company D argued, "I think the aim is to get everybody to report in a standardized manner and I think the way the indicators are defined and expressed is fairly clear on what they are looking for." Food/Beverages Company B explains that they mainly report in a way for themselves to find out how they are doing over different years. The interviewee of Food/Beverages Company C was asked why they are not reporting on EN9 and EN25. These indicators describe water bodies significantly affected by water withdrawal, and water discharge and runoff. The answer was, "There are couple of reasons. Very few people ask us. We had one meeting with some investors, where we did go site by site. They were interested in our water footprint and how we manage it. They didn't really ask about water sources, but we shared it with them anyway. That's the only time we've ever been asked on our water source site. I am a big supporter of GRI, but there are some indicators that nobody seems to be interested in. We do track it at every plant level, but we've only reported it if we're going to get asked". The interviewee of Food/Beverages Company E was asked why the company was not reporting on EN10, which covers the percentage and total volume of water recycled or reused. "We do have the numbers internally. The reason that we are not disclosing it yet, is that it is very difficult to measure accurately". The company has more than 50 facilities around the world and the interviewee explains that it is difficult to define when water is recycled or reused. "It is very complicated to make a water balance. Therefore, we need to be a little more assured before we disclose the ones that are additional." Food/Beverages Company C summarized, "I think they are okay indicators. I think they are fair. They are just too complicated for most companies, number one. And the readers, number two. I think what most people would understand would be useful […] how much do you take out of the planet, where does it go and how much does return to the planet in a form that is either as good or better than what you took out. Some metrics are getting to that point. I think the other thing that is important, which we try to get to, but it's a little more cumbersome is; where do you do this in regions in the world that are water stressed; do you know that and are you aware of how you are managing it. Help us, from the reader, understand if you're okay or that's a risk to the community, to the population or to your business. It's complex to communicate all that, but I think that's pretty much what people want to know both from an investor standpoint and a community standpoint. They try to do that with those indicators, but I think they have just overdesigned them." The company brings up the element of water scarcity, which will be discussed in further detail in the next section.

5.2.2 Exposure within the Geographical Context

The company's water impact depends for a large extent on the water availability in the area of operations. In case of water scarcity, the amount of water available per capita is extremely small. Hence, domestic, industry and agricultural users are competing over this resource. The water availability depends on aspects such as the amount and temporal aspect of rainfall, how much water can be extracted from surface water and groundwater. Some of the operations of Food/Beverages Company D are in drought regions where authorities make it compulsory for industries to set up water efficiency management programs that meet certain criteria. If drought would get more severe, authorities might cap companies' water usage. If as a result production intensity would shrink, this would imply that part of the production would have to be moved elsewhere. "That would increase our cost by millions of dollars per year, because of all the transport costs and everything else in producing at another site. That set the alarm of ringing, so we said 'look we have to do something about our water uses'." The interviewee of Food/Beverages Company D explained that compared to five years ago the focus is not only on cost anymore. "There was never any thought of us running out of water or water restrictions on anything like that. In the last three years, that is totally changed. It's now more about, 'are we using too much water? How do we compare with other sites and best practices? Even our stakeholders, I think they are expecting us to move forward and be more water-efficient". The interviewee explained that their operations in a particular drought area had received a lot of publicity asking if their products are really essential, as they were competing with domestic users. Because of the negative publicity, they decided to place a recycling plant. These examples show that local stakeholders – here authorities, communities, media – can also be drivers for change in water management.

Food/Beverages Company C argued that, "water scarcity in general is very tough to put your finger on, even for companies that want to understand it". The interviewee explains that companies can hire consultants, research the UN research reports, but unless they talk to the municipality or the actual water distributor, they will not be able to understand the situation. In many cases around the world there is no water distributor. Wells and surface waters are allotted to business, agriculture and citizens. The interviewee continued saying that it is important to know what has been in recent history and what is the long-term plan. "There are very few communities on the planet that have that data and that's what you need to manage your business in water scarce environments". There are some states that have measured how much water they have in their ground table and they have allotted the amount they send to businesses, to people and to agriculture. Food/Beverages Company E mentioned that they use the Global Water Tool to localize whether their operations are situated in water scarce areas. "We can map our operations on the map and see 2 operations in future water scarce regions. Then if we want to expand our operations, we will not do so in those locations."

Food/Beverages Company D has some activities in drought areas. In one of their facilities they drilled, looking for groundwater, and tapped into a bore well. Before being allowed to use it they needed to obtain a license from the government to extract the water. The interviewee explained that in these water-scarce areas, where they have operations, the cost of a litre of treated municipal water could be a fixed price but also consist of very complex tariffs with administrative charges. The company needs a license to extract ground water, which still needs treatment with membrane filtration prior to usage. The interviewee explained, "The cost of extraction of water is very small, it is the town water that costs a lot of money [...] The bulk of the cost (of groundwater) is not extracting of water. […] It's more in the power and the membrane. It's the actual cleaning up of the water." Still using groundwater in these areas is cheaper than purchasing treated municipal water. Food/Beverages Company D did a water footprint study in which the recommendations included further increases of bore well water because it is cheaper. Food/Beverages Company E tries to reduce their groundwater and municipal water in order to save that for human drinking water, regardless of being in water-scarce regions. "We try to only use groundwater in the areas where there is plenty of it. But also surface water and rain water systems in some of factories, which actually reduced our water withdrawal by 20%". Companies may have very different strategies when it comes to the use of groundwater.

Food/Beverages Company E reported having a long-term plan for improving operations in water-sensitive regions. First, the interviewee explained that water awareness has to be raised in all the different parts of the factories. Every employee either working in storage, production or administration has to think about how much water is used. "Is it really necessary to do what you do?' Second, they improved efficiency by starting to reuse water and recycle water. "We have places where we take in salt water, desalt the water by reverse osmosis and use that for production. We have also reduced the cleaning and change the way of cleaning. In many operations, we used to wash floors, we changed to vacuum cleaning and it is much better. You don't get so much microorganisms". Food/Beverages Company E remarks that in some occasions they reduced the water use, but increased the energy used. This left them wondering, 'what is worse?'

None of the interviewed companies signed the CEO Water Mandate. Therefore no feedback on this particular initiative was received. Food/Beverages Company D has two plants signing up to a national water-related initiative, which asked them to prepare a water efficiency program. Food/Beverages Company C expressed that they joined the UN Global Compact, as a way to communicate to employees and the rest of the world that you are focused on the big picture in the long-term. After asking what the benefit is of joining the UN Global Compact, the interviewee answered that the ten principles are like a guidepost for companies. "In a lot of other ways I think you can drive improved performance, but the UN global compact sets up a lot of ways to share and define best practices and move the agenda forward. I think that's the value there."

Food/Beverages Company E started to make a risk analysis to try to look into the future and how water availability will change in the next 20 years. They pinpointed their operations on a global map and found out if water consumption is localized in water scarce areas of the future. The interviewee discusses "What is also discussed a lot is our suppliers. If they are all localized in the same place, then we cannot get any raw materials any more and we cannot continue production (in case of water unavailability or reduced rainfall)". Food/Beverage Company E thinks it is not relevant to only look at their own facilities because they should also consider suppliers. In the next section, interview findings on the exposure within the value chain are presented.

5.2.3 Exposure within the Value Chain

Food/Beverages Company C argued that in their industry, water issues are much more embedded. "They go further down in the supply chain, especially when you get to agriculture." Also, Food/Beverages Company D found out through a water footprint study that their external water usage is greater. The five food and beverage companies have started or are planning to improve the water impact in the value chain. Food/Beverages Company E is currently not active in managing water issues in the supply chain, but the interviewee thinks this is where the future trend for water reporting will be. The interviewee would like to send questionnaires to suppliers to ask them the same water-related questions they have asked themselves. Nonetheless, the interviewee argued that 'water audits' might be costly and in some places it is not first priority, "other things, like child labor, are".

Several interviewed companies are trying to assess what the water risks of their suppliers are. Food/Beverages Company B sent a questionnaire to their suppliers asking to report on their environmental performance. "Right now the most important criterion for selecting suppliers is product safety. Environment comes later". In the future, but not next year, they believe they will take initiatives to reduce their water impact upstream and downstream. Last year, Food/Beverages Company C created a sustainability scorecard for their strategic suppliers, not all of them. "We went on to probably 12 to 15 strategic suppliers. […] We asked them not only about their water footprint but also carbon footprint, and their waste footprint. Also, we tested to see how many of them actually could even attempt to share with us their footprint contributable to our company. Very few, one or two of them – these are key, big global strategic suppliers – are able to have the data sophistication to do that. That's part of where the challenge is. I think there will be more advancement in that point forward." Food/Beverage Company C shared that some suppliers are not be 100% subcontracted. "It might be a supplier […], that sells starches or palm oil to companies all over the world. It's very difficult for them to tell us […] how much of the water they use can be contributed to us. Unless they do a revenue model, but that's very crude."

Other companies have started to set purchasing policies or standards that include requirments on for example water consumption or emissions to water. Food/Beverages Company B is active in contract farming. They mention that hence they have a good idea who their suppliers are. The Food and Agricultural Organisation of the United Nations (FAO, 2010) defines contract farming as "agricultural production carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm product or products". Through contract farming, the buyer can set quality (also water) standards for the production and the farmer receives support through for example technical advice and supply of farm inputs (e.g. fertilizers). Food/Beverages Company D has set an environmental purchasing policy that states that their company will, where possible, try to purchase in an environmentally responsible manner. They look for material with higher recycle content and environmentally responsible suppliers. They expect their suppliers to have environmental systems, including a water program. Only, Food/Beverages Company D mentioned having a suppliers review process, where they audit if suppliers adhere to the standards that include many parameters including the environment. "On a quarterly basis we review our suppliers against the standards and we score the suppliers based on whether or not they make those standards, or what they are doing this gap if not complying with our requirements." Food/Beverages D also comments that they are willing to work together with suppliers. "If they would reduce their water usage, they would also reduce ours, because our water footprint is not only what we use internally, but what they use as well."

Several companies have calculated the water footprint of some products. Food/Beverages Company E stated, "We look at water use in our own factories but also water consumption related to total value chain, from raw material until final product on the table of our consumption and that's a trick". The company has calculated the amount of water consumed to for one unit of production. Food/Beverages Company B has measured the water footprint for one of their products, which now actually caries a label. The label indicates how much water was needed to produce the final product. The interviewee believed the water footprint will be calculated for more products in the future. Food/Beverages Company D has just received the result of a water footprint study made by external consultants. "We have just looked at them and we are not really 100% sure on what we are going to do with them. It's given us information on not only the water that we use internally, but also water that is used externally in growing raw ingredients." The consultants have studied the areas where the water is sourced and whether or not those areas are considered to be at risk or what level of risk there is in the water supply in those particular areas". The consultants made recommendations by for example sourcing ingredients from other places or having alternatives or recognizing a certain procurement strategy. Food/Beverages Company D argues that they do no have much control over their suppliers' water impact, but they do have control over where they purchase. Getting ingredients from long-distance away increases the price, but buying ingredient from regions where a lot of irrigation is needed also pushes the price up.

6 Results: Chemicals and Metals & Mining Sector

The findings on water disclosure in the chemicals and metals & mining sectors are presented in this chapter. Similar to Chapter 5, a documentation analysis will present the companies' water risk rating, including data on the industries' water-related GRI reporting. Also, the water risk ratings are benchmarked against the environmental risk ratings in search of any correlation. Second, the qualitative interviews of five chemicals and/or metals & mining companies are discussed.

6.1 Documentation Analysis

The companies are rated according to the criteria and indicators developed for the GES water risk-rating database. This might not be the final GES water criteria and indicators. Nonetheless, the scores and ranking of the companies is assumed to be fairly similar.

6.1.1 Chemicals Sector

In this research, 26 chemicals companies are screened according to the water criteria and indicators. In Table 6-1 the water scores of the chemicals companies are provided. Potash Corp of Saskatchewan scored highest with 24 points out of a maximum score of 30. There is quite a difference in score between the two highest-scoring companies, Potash Corp of Saskatchewan and DSM. The mean score and median are 10.8 and 10.6 respectively. Ceres (Barton, 2010) screened 15 chemical companies according to their water criteria and indicators of which seven companies are also screened in this study. The highest-rated companies from Ceres are also ranked above this study's sample mean of 10.8, except for Syngenta. There are four companies that have signed the CEO Water Mandate. Three signatories, DSM, Akzo Nobel and Dow Chemicals scored above average in their industry sector.

Chemical Companies	Water Score	CERES Score (0-100)	CEO Water Mandate
Potash Corp of Saskatchewan	24	31	
DSM	18		●
BASF	17	20	
Agrium	16		
Johnson Matthey	15		
Akzo Nobel	14		●
Dow Chemicals	14	21	●
Monsanto	14	23	
Teijin	13		
Incitec Pivot	12,5		
The Mosaic Company	12,5	15	
Asahi Kasei	10,5		
Mitsubishi Gas Chemicals	10,5		
Syngenta	10,5	22	●
Orica	10		
Wacker Chemie	10		
Givaudan	9,5		
Shin-Etsu Chemical	9,5		
Showa Denko	9		
Denki Kagaku Kogyo KK	8		
Eastman Chemical	7		
Kuraray	6		
Air Liquide	5	10	
Nitto Denko	5		
Celanese	4,5		
JSR	3		

Table 6-1 Water Ratings Chemical Companies

Figure 6-1 below illustrates the number of chemicals companies reporting on policies and programs for water consumption and pollution, and the water-related GRI indicators. Companies can set water policies and programs to manage their water consumption. From all 26 companies, 14 companies report to have a policy and/or program in place to control their water consumption. There are 20 out of 26 chemicals companies that are using the GRI

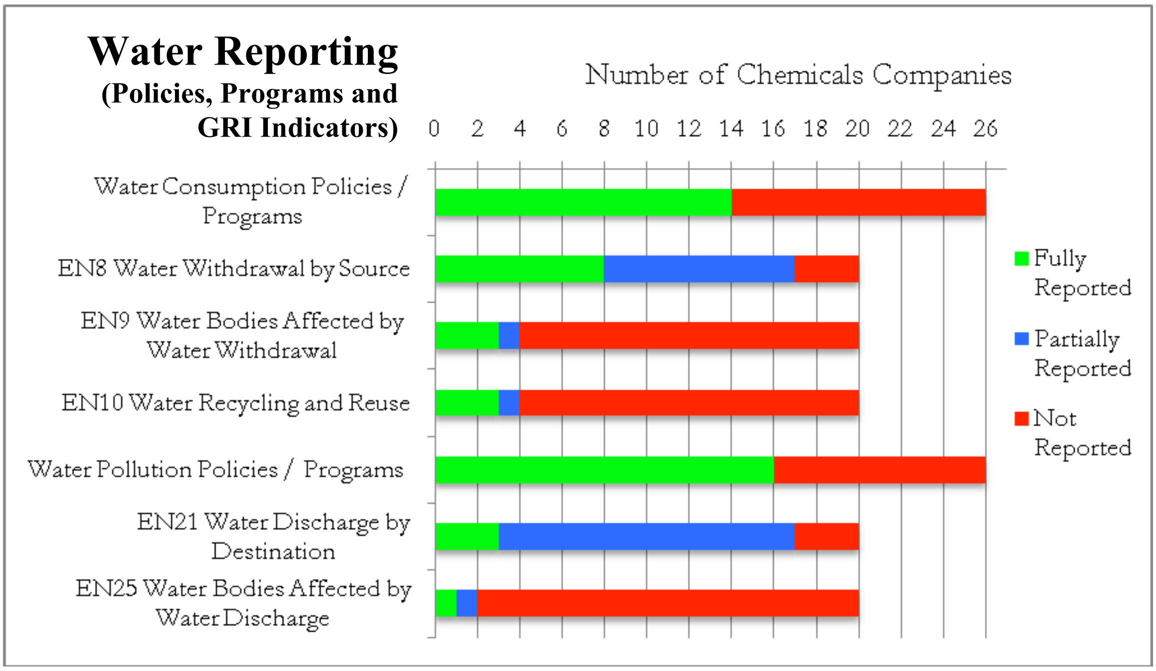


Figure 6-1 Water Reporting in the Chemicals Sector

guidelines for sustainability reporting. Eight companies fully reported their water withdrawn by source (EN8) and nine more published their total annual water usage (i.e. partially reported). Four chemicals company either fully or partially report whether any water bodies are significantly affected due to their water withdrawal (EN9). Also, four companies either fully or partially report the volume and percentage of water recycled and reused (EN10). From all 26 chemical companies, 16 companies describe having a water pollution policy and/or program in place. Again, only three companies are reporting water discharge by size and destination and 14 companies are merely reporting total volume of water discharge (i.e. partially reporting). There is one company fully reporting on whether there are water bodies significantly affected by water discharge and runoff (EN25). This chart displays that in general the chemicals sector discloses more information on water pollution than water consumption.

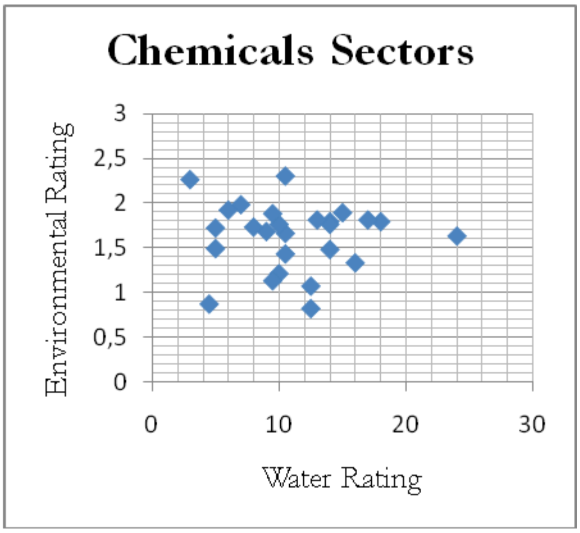


Figure 6-2 Correlation of Water and Environmental Ratings in the Chemical Sector

The GRI might not accurately identify if companies are managing their water risks in water scarce regions. From the 26 chemical companies, eight companies (≈31%) described whether they are active in any water scarce areas or that this could turn into potential risks for their operations. Six companies (≈23%) have made certain initiatives to improve their water impact in those regions. In addition, the GRI is currently not covering water risks in the supply chain. The companies in this sample group are generally purchasing the raw ingredients for their food products. The highest share of water used to produce the final chemical products often occurs in the agricultural phase, when growing the raw ingredients. The chemicals sector has not been focusing on the water impact of in the supply chain. Only one company has been looking at the water impact upstream. It appears that the chemical sector does not see any water risks or need to publish water risk exposed in the value chain.

Figure 6-2 demonstrates that there is a no correlation between water ratings (maximum score of 30) and environmental ratings (maximum score of 3). The mean of the water rating and environmental ratings is 10.8 and 1.6 respectively. There is a correlation of 0.14 between the companies' environmental rating and corresponding water ratings. Hence, a company's high or low score on their water disclosure does not predict that they will score similar on their environmental disclosure, or vice versa.

6.1.2 Metals & Mining Sector

In this research, 29 chemicals companies are screened according to the water criteria and indicators. In Table 6-2 the water scores of the metals & mining companies are provided. Newmont Mining scored highest with 21.5 points out of a maximum score of 30. The mean score and median are 11.7 and 10.5 respectively. Ceres (Barton, 2010) screened 2 chemical companies according to their water criteria and indicators of which seven companies are also screened in this study.

Figure 6-3 below illustrates the number of metals & mining companies reporting on policies and programs for water consumption and pollution, and the water-related GRI indicators. From all 29 companies, 19 companies report to have a policy and/or program in place to control their water consumption. There are 22 out of 29 metals & mining companies that are using the GRI guidelines for sustainability reporting. 16 Companies fully reported their water withdrawn by source (EN8) and four more published their total annual water usage (i.e. partially reported). Ten metals & mining company either fully or partially report whether any water bodies are significantly

Metals & Mining Sector	Water Score	CERES Score (0-100)	CEO Water Mandate
Newmont Mining	21.5	25	
Xstrata	19.5	42	□
Anglo American	19	33	
Newcrest Mining	19		
Gold Corp	18		
Lihir Gold	18		
Barrick Gold Corp	17	38	
Inmet Mining Corp	17		
Lundin Mining	15		
Rio Tinto LTD	14	37	
Cliffs Natural Resources	14		
Outokumpu	11.5		
Sumitomo Metal Mining co	11.5		
Sumitomo Metal Ind	10.5		
Kingsgate Consolidated Ltd	10.5		
Teck Resources ltd	10	27	
JFE Holdings	9.5		
Kazakhmys Plc	9		
Boliden	8.5		
Alcoa	8	35	
Kobe Steel	8		
Nippon Steel Corp	7.5		
Fortescue Metals Group	7.5		
Arcelor Mittal	7		
Avon Metals	7		□
Bluescope Steel	5.5		
Eldorado Gold Corp	4		
BHP Billiton Ltd	3	30	
SSAB Svenskt Stal	3		

Table 6-2 Water Rating Metals & Mining Companies

affected due to their water withdrawal (EN9). Also, 14 companies either fully or partially report on total volume and percentage of water recycled and reused (EN10). From all 22 metals & mining companies, 17 companies describe having a water pollution policy and/or program in place. Again, only 13 companies are reporting water discharge by size and destination and three companies are merely reporting total volume of water discharge (i.e. partially reporting).

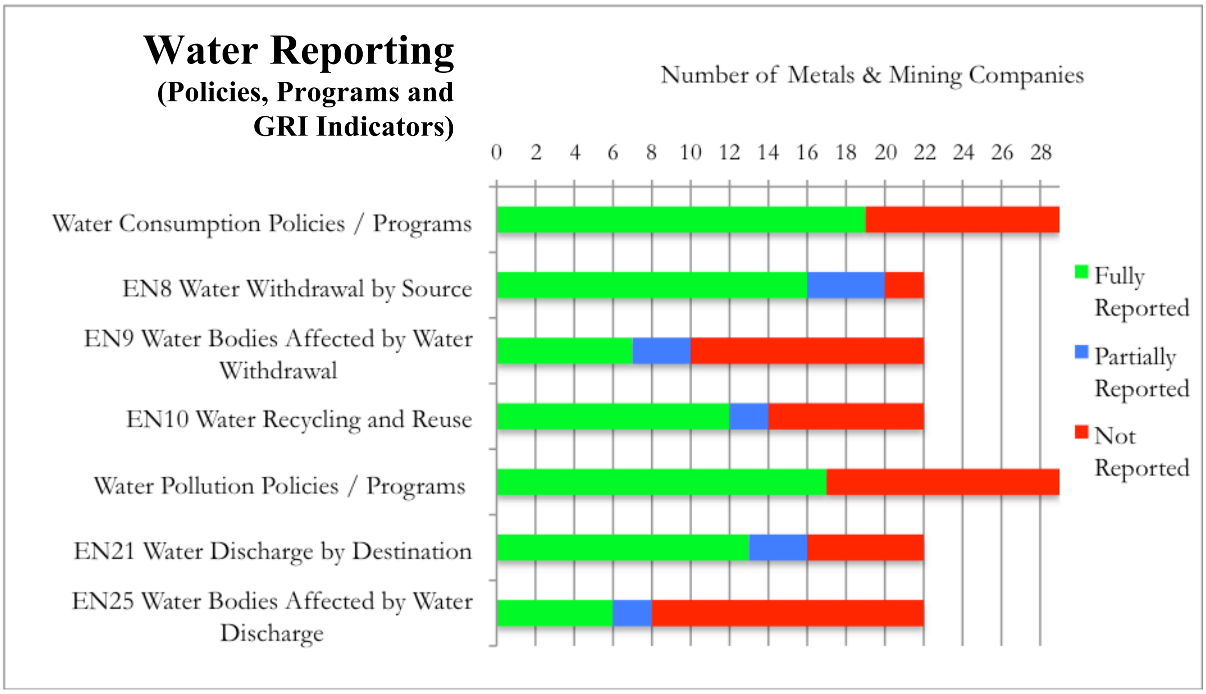


Figure 6-3 Water Reporting in the Metals & Mining Sector

There are six companies fully and two more partially reporting on whether there are water bodies significantly affected by water discharge and runoff (EN25). This chart displays that in general the metals & mining sector discloses most information on the water-related environmental indicators of the GRI.

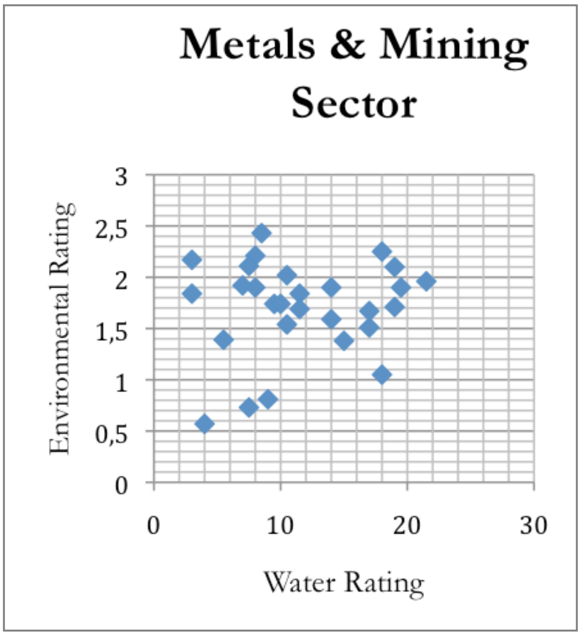


Figure 6-4 Correlation of Water and Environmental Ratings in the Metals & Mining Sector

The GRI might not accurately identify if companies are managing their water risks in water scarce regions. From the 29 metals & mining companies, 13 companies (≈45%) described whether they are active in any water scarce areas or that this could turn into potential risks for their operations. 13 companies (≈45%) have made certain initiatives to improve their water impact in those regions. In addition, the GRI is currently not covering water risks in the supply chain. The companies in this sample group are having purchases in the supply chain. In comparison to the food and beverages industry they might not have such a big water impact in the value chain. Also, the metals & mining sector is already upstream in the value chain of the final product. Only one company has been trying to manage water impact in the supply chain. It appears that the metals & mining sector does not see any water risks or need to publish water risk exposed in the value chain.

Figure 6-4, below, demonstrates that there is a no correlation between water ratings and environmental ratings. The mean of the water rating and environmental ratings is 11.7 and 1.7, respectively. There is a correlation of 0.12 between the companies' environmental rating and corresponding water ratings. Hence, if companies that score either high or low on their water risk disclosure, does not predict that they will score similar on their environmental risk disclosure, or vice versa.

6.2 Qualitative Interviews

In this section, the findings of the qualitative interview of chemicals and metals & mining companies will be given. One representative of a chemicals company and four representatives of metals & mining companies participated in the interviews. As agreed upon before the interviews, the statements will be kept confidential. Since, only one chemicals company participated, the findings of the chemical and minerals & mining companies are aggregated. The company representatives, their job titles and company names are presented in Appendix I. To keep quotes anonymous, the answers and companies will be presented as 'Chemicals/Metals/Mining Company V', 'Chemicals/Metals/Mining Company W', 'Chemicals/Metals/Mining Company X', 'Chemicals/Metals/Mining Company Y' or 'Chemicals/Metals/Mining Company Z'. The aim of the qualitative interviews is to understand how companies assess, manage and disclose their water risks.

6.2.1 Exposure within the Operations

Chemicals/Metals/Mining Company Y stated that, "Water is an important element of our sustainability strategy. There are four major parts of environmental strategy: air emissions, waste accumulation, clean up activities to groundwater or to the ground, and water discharges". All plants have to comply with environmental permits that depict certain constituencies the company has to monitor and measure. Chemicals/Metals/Mining Company W declared that, from an operational point of view, risks relate to water scarcity, water access and water discharge. Chemicals/Metals/Mining Company V argued that the lack of sufficient quality of water is the greatest water risk. Notably, the interviewee described that too much water can be problematic and has to be managed. Chemicals/Metals/Mining Company X has an Environmental Management Systems in place that are ISO 14001 certified that identifies any significant water risks. The company specified that oils spills, caused by transportation on the roads, are the most important water risk. The rainwater takes the oil spills on their industrial area to the sea. In addition, the interviewee clarified that, "Some of the facilities, like the coke plant, have some nasty components in the water treatment plant. If we have a failure in the water treatment plant, we could have things going out to sea, which is not good".

Companies in the chemicals and metals & mining sectors can be exposed to different drivers for managing and reporting on their water usage and discharge. Chemicals/Metals/Mining Company Y did not feel a lot of outside forces been driving their water reporting. The interviewee declared; "But recently, there has been some request for information from investors. We had a group, ethical fund, who came to us 9 – 10 months ago and they wanted us to disclose more information on our water strategy and plans for the future, as well as consider targets for water". Chemicals/Metals/Mining Company X sees legislation as the main driver for water management. Chemicals/Metals/Mining Company W declared that if the businesses would not have water, they couldn't operate. Therefore, it needs to managed and reported for internal risk management, but also increased legislation and strong interests from investors. Chemicals/Metals/Mining Company V clarified that there are several drivers. First, water is a business risk because they need water to maintain their production profile. "That's why we have a strong emphasis on making sure we understand our water usage - where it goes and where it comes from -, how we can be more efficient and that we don't run out of water". Second, they are member of their national industry association, which means that the company is compelled to produce a sustainability report. Third, investors and analysts ask questions about their water use, water requirements and water access and supplies. Chemicals/Metals/Mining Company Z said that the main internal and external driver for reporting on water management are, (1) increased water costs, (2) license to operate (regulation) and (3) reputation.

Companies were asked if it is difficult for them to measure water consumption and pollution and whether these numbers are hard facts or estimations. Chemicals/Metals/Mining Company X argued that they have hard facts and estimations. They have some difficulties in measuring certain parameters on water discharge. "We have some problems to measure the exact volumes. That's a tricky thing. At some places we are using a lot of water, and then we have a great flow of water coming out from the pipes. Then you take a sample and then you have to annualize that for those parameters." The interviewee clarifies that sometimes the parameters are monitored to be for example "less than 0.1 mg/liter to our water". Because of the measured low concentrations the company finds it hard to say how much we are actually emitting. "It is difficult to measure low concentration of pollutants when you have a lot of water volume. It dilutes too much. So we have to take samples in other places in the facilities to make the right calculation of the emissions going out from the plant". Chemicals/Metals/Mining Company X states that the data on water consumption is hard facts. The company mainly withdraws water from rivers and in some cases from wells and municipal water. Water that is taken from the river is pumped through a pipe. On the pump there is a meter, which monitors the amount of water withdrawn. The company also continuously monitors outfalls, water discharges and the amount of water that goes out. They have internal audits and occasionally regulator do inspections and external audits. The company was asked whether their strategy covers choosing between different water sources (rivers, wells, municipal water etc) in their environmental strategy. Chemicals/Metals/Mining Chemicals/Metals/Mining Company X answered that plants decide where they withdraw their water. They mainly withdraw from rivers because many of their plants are close and they require large amounts of water. Chemicals/Metals/Mining Company X uses a lot of seawater for indirect cooling with heat exchangers. "We just use the temperature for decreasing the processes' temperature. The amount of water used for that purpose is big." The company also takes water from the river and after using it, they pump it to a dam to cool it and reuse it again. The company does not receive any municipal water for their operations because they would have to pay for that and it has to be pumped all the way to them. Notably, the company clarifies that if they did not recycle the water they would have some capacity problems, because they would need to take a lot more water from the river. Chemicals/Metals/Mining Company V said that some parts of water consumption are harder to report than others. "Right now, we pump a lot of water in our operations, we can measure that by putting in the appropriate meters. Where we have a problem is in estimating our evaporative loss. Our water ends up either in temporary storage facilities or tanks, or in our towering storage facilities, which have a relatively large surface area. We have a high evaporative loss from those facilities. So, it is difficult to estimate that particular component. Sometimes we have to measure water losses. Another problem that we have is, for example we have a pit line and then when it rains, we have surface runoff. And that flows into the bottom of the pit and we have to pump it out". The company declares that the relationship between the surface water and water runoff is not so clear, so it can be difficult to get a precise overview of the water pathway. It might be difficult to monitor all inlets and outlets of water at the site.

Companies can have programs and management systems in place to manage their water impact. Chemicals/Metals/Mining Company Z expressed that firstly, they have a group-wide program where every operation is expected to optimize the way it does business, including water efficiency. Second, the company developed a new program, which is a set of requirements and standards, including social and environmental conditions, for setting up projects. During the different stages of a project – prefeasibility, feasibility stage etc. – a team of experts goes by with a checklist to go through the set of requirements and decides whether the project can continue to the next stage. In particular, climate change and water variables are present in the checklist. Third, Chemicals/Metals/Mining Company Z set up a program for operational reviews where a multidisciplinary team visits operations to do a baseline assessment of what is happening and to identify what can be done differently. In particularly, the team searched for efficiency improvements or other initiatives that have not been identified by the in-house team. Chemicals/Metals/Mining Company X does not set any specific targets for water in their environmental management system. They operate according to the regulations in the environmental permits.

Chemicals/Metals/Mining Company Z has developed an internal price for water. The interviewee discussed, "When you look at the price of water, the reality is that water costs more than what you pay at the municipality. There is a human cost, opportunity cost and the cost of infrastructure. We are putting even in our database parameters in place that will help us measuring what those other costs of water costs are. So also what they pay in penalty for not complying with water quality of legislation or infrastructure". By creating an internal price for water, they company gives water a higher profile than non-environmental fields. "It is difficult to convince financial people and operational people the value of implementing a particular [...] conservation measure. They do not see a financial payoff. […] So, to help the program we think the full picture is recognized, it could push the agenda further".

Chemicals/Metals/Mining Company Y likes using the GRI framework and hopes that it helps people - e.g. investors and other stakeholders - to know what information they are going to report on. The company uses a consultant for filling in the GRI indicators. The interviewee was asked how come GRI indicator EN 25 "the water sources and related habitats significantly affected by water discharges" is not answered. "You know what I think it was, this was an area where our attorneys were maybe uncomfortable". The interviewee explained that somebody was filing a lawsuit against them because this person thinks that we significantly affect the water with our discharges. "We don't think we do, but I guess I didn't know about a standard to go back to. I mean it just seemed too subjective. I think the attorneys were too uncomfortable making this subjective call". The interviewee explained that it would be helpful if the GRI indicator EN25 was more clear on how to report on this criteria. Chemicals/Metals/Mining Company V also said, "the benefit from GRI is having a means of comparing across different companies". The company reports on EN9 and EN25. They agree that these indicators are subjective in nature, but conclude "there are some meaningful measures there in terms of percentage of takeout, what impact you have on base flows, there is water quality issues which can impact on the receiving environment, so there are some issues there, that are useful to talk about and set some context around your impacts on the environment and impacts on water withdrawal". Chemicals/Metals/Mining Company W did not think the water-related GRI indicators are good indicators. "There is a whole range of issues […] on how to actually interpret the publicly available data that's out there". The interviewee argued that the GRI is not explicit enough in terms of defining the scope of water reporting. "As a result, everyone interprets the reporting requirements slightly different. It's very difficult to find a basis to compare not only within industry sectors but across industry sectors." GRI indicator EN8 covers total water withdrawal by source. Chemicals/Metals/Mining Company W clarified that they use large amounts of low-quality water that would not be used for other purposes. "When you are comparing across industries sectors – unless people have been explicit about the water quality component of that water – you may not be comparing comparable outcomes. The mining industry might appear to have a huge total water footprint, but what it is actually doing is using a lot of poor quality water in contrast to a food/beverages company". Additionally, Chemicals/Metals/Mining Company W pointed out that there is not a transparent standard on how to apply definitions such as 'high-quality water' or 'freshwater', leading to "all this underlying complexity".

Chemicals/Metals/Mining Company X has operations in different countries. In one country they are required by law to report their emissions to water and air to the local administration each quarter of the year. Additionally, they have to make an annual report summarizing their water and waste management, which is publicly available. Some companies are also active in improving reporting standards. Chemicals/Metals/Mining Company V has been working together with a university and industry association to better define and establish a comparable set of indicators for water usage. They report new water coming into their operation separate from water already in the system (i.e. recycled water).

6.2.2 Exposure within the Geographical Context

Chemicals/Metals/Mining Company V, W and Z have operations in water-scarce regions. Chemicals/Metals/Mining Company X and Y are not situated in any drought regions. Chemicals/Metals/Mining Company X discusses that they require an environmental permit to take water out of the river but the permit does not say a maximum amount of water that can be withdrawn. Also, companies do not have to pay for obtaining an environmental permit in this water-rich country. As a result, they can only receive fines if they discharge exceeded amounts of pollutants. The interviewee of Chemicals/Metals/Mining Company X makes clear that because water is easy to use they do not think much about using water. This scenario is very different from companies that have operations in water-scarce regions.

Chemicals/Metals/Mining Company Z states that, "Water scarcity is the most fundamental risk to us. If there is no water, there is no operation". The interviewee describes that water scarcity depicts competition between users but also water scarcity in terms of water quality. Water scarcity would impact severely on the company. They might have to tackle regulation related to water use and regulation when it comes to water quality. The interviewee explains that if their operations are not capable of using less water in the first place, they have to find ways of treating water to an extent that it has a higher quality before putting it back into the system. Chemicals/Metals/Mining Company Z also explains, "One other element of water scarcity is the fact that we do a lot of community work and lot of our operations are dependent on interaction with communities. […] water scarcity adds to the constraints for the already underserved and undeveloped community".

Chemicals/Metals/Mining Company V does not set different strategies for operations in water-scarce and water-rich countries. "We wish to the maximize water recycling or water reuse efficiency and minimize our extraction from the environment. In those environments in which we do have positive water balances, it means we need to discharge water into the receiving environment. So the water strategy there is complemented in that we commit to discharge that water in terms of suitable water quality [...] for the downstream receiving environment". Chemicals/Metals/Mining Company W sets a minimum standard that is mandated globally throughout their operations, which includes for example water management plans. It is the facilities that need to understand how their water use relates to water risks and based on that establish management plans. In that sense, the minimum standard has flexibility, because facilities can set different strategies for water scarce and water abundant operations. Chemicals/Metals/Mining Company Z has water program for water scarcity place. The interviewee makes clear, "One of the most difficult problem of water programs is that it is not a global issue such as climate change. Water is much more of a local issue. To a great extend, tailored to the local circumstances". The company has group policy and approaches, but localized action plans that take into account the nature of the operations, the circumstances of that catchment and human elements of that catchment. "The response will then be tailored towards that specific circumstance". Chemicals/Metals/Mining Company Z has therefore facility-based targets, but there can be setbacks over setting targets in facilities instead of on the group level. The plant managers could set targets too low. The company reviews and scrutinizes targets at the corporate level so that there is not enough stretch.

Chemicals/Metals/Mining Company Z has been conducting hydrological modeling for all operations. The interviewee mentions that "you need to view the water balance of your operations because it is linked to the evaporations ponds […] If there is too much water is the system then you are going to have the risk of waste […] and that is a pollution hazard". Mining companies can collect wastewater (polluted with metals and acidic, etc.) in ponds. When water evaporates it might move pollutants (in severe case, acid rain). When there is too much water in the ponds, polluted wastewater could escape and become a risk for receiving waters. Internal as well external consultants do hydrological modeling. The company has an in-house technical service provider so that they can pull very specialized resources for the niche of the entire group.

None of the interviewed Chemicals/Metals/Mining Company has signed up to the CEO Water Mandate. Chemicals/Metals/Mining Company Z did a group-wide analysis to find out whether they are currently able to meet the requirements and if not now, when we could. "There is a reluctance to sign it before we can fully meet all the requirements. The whole point of the mandate is that it is inspirational. It is a bit of a risk when you aren't able to meet the requirements yet. The benefits would be the legitimacy that signing up to any big initiatives." Chemicals/Metals/Mining Company W has not been able to commit at this stage to the CEO Water Mandate. One reason is that the company has been very much focused on revising their climate change strategy. Also, the interviewee stated, "We focus more now on the water accounting before signing any broader water initiative".

Chemicals/Metals/Mining Company Z has some doubts about the water-related GRI indicators. The interviewee mentions that, "water is managed locally and sees no meaningful indication of performance when aggregating these numbers. "You could use x amount in a water scarce area or in an area that is absolutely fine. Aggregating those numbers doesn't make sense." In addition, the company has different levels of maturity within the group: They have newer acquisitions (i.e. operations) that are not able to derive the numbers for the GRI indicators yet. "We are putting parameters and definitions in the database and trying to think of ways that we can meaningfully aggregate those numbers that can help tell a helpful story. Not to come up with some numbers in the sake of meeting GRI requirements". Chemicals/Metals/Mining Company V discusses one operation in depth in their report because it has quite focus within the local community and broader as well. "They would not prefer the GRI indicators for any sort of information. That's partly the reason why we went - for that particular project - into water accounting. To get some meaningful statistics on our water usage and water use efficiency".

6.2.3 Exposure within the Value Chain

The chemicals and metals & mining companies have suppliers for heavyweight equipment, concrete, power and explosives, among others. Chemicals/Metals/Mining Company Z has supply chain development code which contains certain requirements on responsible water management. In addition, suppliers need to be ISO 14001 compliant and therefore they should have water programs in place if water is identified as having a significant environmental risk. Most suppliers from Chemicals/Metals/Mining Company X are from a water-rich country and therefore they do not assess any water risks in their supply chain. Chemicals/Metals/Mining Company W has not been looking into the water footprint yet. The interviewee explained “It’s not a significant risk area for us, because where we are placed in the supply chain”.

Water footprint does not only discuss the water impact upstream at the suppliers’ side, but also downstream in other business. Especially these sectors that sell chemicals or metals to other companies might have water-intense procedure or capabilities to pollute water. Chemicals/Metals/Mining Company Z explains that water footprinting is more difficult in their industry because commodities are bought in the open market. So if you bought a commodity they also produce on the open market, you would never know whether they have produced it or another company. “As a company, we would not engage in any particular water footprinting exercise because we don’t have an individual product”. Also, Chemicals/Metals/Mining Company V does not engage in water footprinting at the moment. “It is too difficult for us. In the end, I don’t think it would drive out behavior at all. We just go for the cheapest and most reliable products. We wouldn’t differentiate our suppliers on their water efficiency or water usage.” Chemicals/Metals/Mining Company Y states, “We are a supplier company but have some inputs. We could go back, but right now our senior management is not of the mind to go back to suppliers for things like this. […] The one thing we do is we go back and require them to give us a code of conduct or sign a form of business principles. But then people want us to go further and actually audit them and actually make sure to do these things. But we’re not ready to go back and do a bunch of audits”. The interviewee explains that auditing can also be very expensive. “Oh yes, I mean I am a one man shop here in sustainability. I talked to one of our next-door companies in the area who hired somebody last year. All she does is audits around one of these areas. You could hire 3 or 4 more people just to do audits on your suppliers. You can make a whole industry out of this”.

7 Discussion

In this chapter, a discussion is on the findings from the documentation analysis and qualitative interviews.

Two companies in the food sector are seafood companies (i.e. Marine Harvest and Cermaq), which scored relatively low. Water might not be identified as having a significant environmental impact in their operations. This example points out that there might be companies classified in certain water-intensive industry sectors, but might not run into great water risks. During, the qualitative interviews, one compay pointed out that businesses should set stretch goals. Zenger, Folkman & Edinger (2009) explain that a *stretch goal* is a term that refers to those challenging objectives for which people are not certain they can be obtained. These lofty goals could be developed by a leader and experienced individuals. Employees should be involved in the goal setting procedure making sure goals are still realistic. It will require courage and eagerness to take on risk and think 'outside the box'. By setting highly ambitious stretch goals, people are capable of improving performance by an extent that they could have never predicted themselves. Long-term goals could drive innovation, but short-term goals could push goals on the agenda now instead of over five years.

During the research, it was seen that just few companies provided site-based water consumption figures when situated in water scarce regions. Companies need to make trade-offs also in the amount of water data they report in reports or other media. If a mining company has 25 operations worldwide and it would report on the water consumption and pollution of all sites separately, that would require filling many pages in report and could become a burden to the reader. Companies need to decide, 'how much water risk information is enough?' Companies can choose to publish a report following the GRI indicators to provide a means of comparing between and within industry sectors. However, since realizing that these indicators might not always fully touch upon water risk disclosure, companies can also provide publicly available site-specific environmental reports. By doing so companies can increase the data richness and complexity, but scope down in its operational activities. Joppe Cramwinckel (Personal Communication, 17/08/2010) pointed out that a risk analysis could show where questions should be raised, because not all operational facilities there might have a significant water footprint. Requiring complex water data, in areas of immaterial water risks, should be prevented.

The water-related GRI indicators, the water footprint and industry-specific reporting methodologies are difficult to compare between, because they serve different purposes as well. Magnus Enell (Personal Communication, 19/05/2010) points this out when he said, "The Water Footprint is not a better or worse than the GRI water indicator – the Water Footprint is a complimentary possibility to more clearly describe the GRI water indicators". In the Table 6-1 below, some differences between the Global Reporting Initiative and the Water Footprint are presented.

	Global Reporting Initiative	**Water Footprint**
Water volumes measured	Surface water, groundwater, rainwater collected, wastewater from another organization, municipal water. Water consumption and pollution and measure separately.	Surface water, groundwater, precipitation, water required for dilution to agreed water quality standards. Blue water that is returned to where it came from is not included, i.e. wastewater from another organization and municipal water
Method includes geographical context of water availability	Yes, in the Principle of Materiality, but not explicitly. Value and quality of water is not included	To some extent. Critics argue that the water footprint does not take into account the value of water.
Method includes supply chain water management	No	Yes
Level of difficulty and cost of measurement	Low-Medium: Information is often already recorded in-house through water pumps or meters.	High: External consultants are often needed to provide these numbers

Table 7-1 Comparison Water Accounting of GRI and Water Footprint

The water footprint is currently not included in the Global Reporting Initiative. Magnus Enell (Personal Communication, 19/05/2010) mentioned that water will be included in the next manual of the GRI, i.e. the G4 version. "The Water Footprint approach and tool is so new, and therefore has not yet been included in the GRI Guidelines and the way organisations are regarding their water usage and discharges. [...] GRI tries to be a denominator for all different kinds of standards, initiatives, directives etc. The Water Footprint standard (ISO 14046) that will be in use in a couple of years, and will be used effectively by the companies those are water-intense, especially where the water is scarce or limited because of other reasons".

8 Conclusion

Water is projected to become a scarce resource in certain regions and countries in the world. Companies that are based in areas where competition over water is great, have a chance that water issues will turn into business risks for the operations. Nowadays, companies are encouraged to not only look at their direct water footprint, but also identify and manage water use in other parts of the value chain.

Research **Sub-Question 1a** asked to what extent companies in water-intensive sectors report on their water risks. First, the range of water ratings was quite similar in the different sectors. Companies could obtain a score between 0 and 30. The lowest score was 2 and the highest score was 24. The mean scores were around 11 for the food, chemical and metals & mining sector. The beverage sector had a mean score of almost 14. Hence, the beverages sector scored on average higher than the other water-intense sectors under study. In general, the obtained ratings (i.e. within the range of 2 and 24) were very diversified. Except for one, all beverages producers were rated 7.5 or higher. The beverage sector had the highest share of companies (namely nine firms) signing the CEO Water Mandate. This could indicate that the beverage sector is, on average, better in managing their water risk or is more active in water risk disclosure than the food, chemicals and metals & mining sectors.

All sectors, except the chemicals sector, reported to have more water consumption policies and programs in place than water pollution policies and programs. Still, the difference was fairly small. Not surprisingly, more companies reported on the core GRI indicators (i.e. EN8 and 21) than the additional GRI indicators (i.e. EN9, 10 and 25). Although, the beverages sector had the highest mean rating on water risk disclosure, it was the chemical and metals & mining sectors that provided most partially or fully reporting on the GRI indicators. GRI might not have properly included exposure within the geographical context and value chain in its water-related indicators. For all sectors, between 30 and 45% of the companies described that they are active in water scarce areas or acknowledge that water availability can turn into a potential risks for their operations. Also, between 25 and 45% of the companies in each sector have made certain initiatives to improve their water impact in water scarce regions. There might have been companies in the dataset that do not have operations in water risky regions. For both the food and beverages sectors, 32% of the companies have set water requirements for their suppliers. About 35% companies in the food and beverages sectors do audit or work together with suppliers to improve their water impact. The chemical and metals & mining sectors only had one company reporting on exposure within the supply chain. The food and beverages sector clearly discloses more information on water risks in the value chain in comparison to the chemicals and metals & mining sectors.

Research **Sub-Question 1b** inquired how the level (high or low) of environmental risk disclosure predict a similar level (high or low) for water risk disclosure, or vice versa. For the different sector, environmental ratings were compared with water ratings to look for correlation. For the food, chemicals and metals & mining sectors no correlation was found. The beverages sector displayed a correlation of 0.60 between water ratings and environmental ratings. This gives some (although still weak) evidence of a possible causal relationship between water rating and environmental rating in the beverage sector. It could be that beverages companies, which are good at overall environmental reporting, also provide more and better information on how they manage their water risks. Then again, the correlation merely shows weak evidence.

Summarizing the findings of sub-questions 1a and 1b, will answer **Research Question 1**, "To what extend to companies in water-intensive sectors report on their water risks". Water-intensive sectors are rated fairly similar on their water risk disclosure. Still, industries are reporting differently on elements. The chemicals and metals & mining sectors are communication most water risk exposure within the operational activities, when looking at policies, programs and GRI reporting. All sectors similarly have between 25 and 45% companies disclosing information on their assessment and management of water scarce regions. The food and beverages sectors are reporting most on water risk disclosure in their value chain.

Some similarities and differences in reporting were found. To create understanding why there is a discrepancy in water reporting between the sectors, qualitative interviews were conducted. Research **Sub-Question 2a** deals with why and what water risks companies identify. Companies are subject to internal and external drivers for water risk disclosure. Foremost, companies identified cost, legislation and regulations as the most important drivers, but some also mentioned investors and reputation. Multiple companies pointed out that water has been perceived as cheap, but this perception has changed over time. Some water risks that were mentioned are the lack in water availability (both in quantity and quality) halting or ending productions, fines and reputational harm due to water discharge or spills, increased costs due to more stringent legislation and higher costs on the supply side. Companies could have some difficulties in identifying water risks because some elements of water consumption and pollution are not easy to measure. Also, not all companies have an overview of water usage in different processes in the operations. Some companies in the metals & mining sector mentioned that they were active in hydrological modelling. Nonetheless, lack of information on water scarce regions makes it difficult for companies to fully understand the risk.

Research **Sub-Question 2b** asked how companies manage water risks. Companies explained to have programs of management systems in place to improve water use performance. Both internal as well as externals searched for process improvements or other ways to reduce the water impact. Some companies set targets at the corporate level, whereas other established facility-based targets. Several companies pointed out that setting long-term targets leads to greater water savings and possibly innovation. One company used internal pricing of water, arguing the true value of water is not revealed in the true cost of extraction and pumping or the price of municipal water. Companies expect more focus, especial for the food and beverages industry, in water management of the supply side, through questionnaires, standards, audits and working together. Regardless, many companies said that other suppliers' criterion were more important than environment and water. Companies pointed out that a trade-off could occur when reducing water leads to e.g. increase of energy.

Research **Sub-Question 2c** investigated the constraints of water risk disclosure. Many companies that followed the GRI framework found this useful, because it supports comparing within and across sectors. Several companies said that by following the GRI indicators it was clear what they could report on. Some companies found it difficult to report on the additional indicators, thinking they were too vague or subjective. Several companies felt that the GRI framework does not cover water scarcity and supply chain risk well or even at all. One company pointed out that the scope of the some of the GRI indicators do not allow for accurate comparing. For example, when identifying 'total water withdrawal by source', no distinction is made between water with different levels of quality. Just a few companies have started calculating their water footprints for their products or business, but one company mentioned that they were not very certain what the benefit would be.

The three sub-questions 2a, 2b and 2c, cover elements to answer **Research Question 2**, "Why are companies reporting more on certain elements of water risk than other elements?" Companies are reporting more because in they have different drivers – such as regulations or investors – that request certain type of information. Also, some companies face difficulties in providing accurate or specific water data throughout their processes, which could be intensified when regional water data is lacking. Companies manage their water use performance by implementing programs and management systems and pursue to improve these figures through corporate-wide or facility-based targets. Suppliers can expect higher demands for water disclosure from companies. The GRI support companies in identifying what information they could disclose in order to make peer comparisons. Although several interviewees claimed that the information coming from this data does not provide a good overview. The water footprint might be a more exact way of measuring the water impact of a company and some companies are pioneering in the use of this measure.

If companies want to grasp water risk, they should not only look at water within their own operations. By taking a catchment perspective, water risk exposure within the geographical context can be analyzed. Companies should try to perceive current and future water risks by understanding the water availability to local communities, the environment and supplier as well as working together with authorities to understand and control water issues.

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Appendix I

	Date	Interviewee	Company /Organisation	Position	Location	Method
1	19/05/2010	Magnus Enell	International Water Academy	Member, Adjunct Professor IIIEE	Stockholm, Sweden	Telephone and email
2	04/08/2010	Ankit Patel	Global Water Intelligence	Analyst	Oxford, United Kingdom	Telephone
3	06/08/2010	John Hewson	Potash Corp of Saskatchewan	Sustainability Manager	Northbrook, Illinois, United States of America	Telephone
4	06/08/2010	Jette Ingrid Hansen	Danisco A/S	Sustainability Manager, Environment & Climate	Copenhagen, Denmark	Telephone
5	09/08/2010	Lise Bergan	Cermaq ASA	Corporate Affairs Director	Oslo, Norway	Email
6	13/08/2010	Hermien Botes	Anglo American	Internal and External Reporting Manager	Johannesburg, South Africa	Telephone
7	17/08/2010	Joppe Cramwinckel	World Business Council of Sustainable Development	Director Water Project	The Netherlands	Telephone
8	18/08/2010	Greg Morris	Newcrest Mining Ltd	Head of Environment and Community	Melbourne, Australia	Telephone
9	19/08/2010	Klas Lundberg	SSAB	Environmental Plant Manager	Öxelösund, Sweden	Telephone
10	20/08/2010	Dave Stangis	Campbell Soup Company	Vice President, Sustainability / CSR	New Jersey, Unites States of America	Telephone
11	24/08/2010	Jerry Piglas	Lion Nathan	Group Environment Manager	Brisbane, Australia	Telephone
12	27/08/2010	Mira Povelainen	Raisio Group	Development Manager	Finland	Telephone
13	07/09/2010	Erika Korosi	BHP Billiton	Senior Manager Environment	Melbourne, Australia	Telephone

Appendix II

1. Is water an important element of your company's sustainability strategy, and why?
    - What are the main internal/external drivers to report on your water management? For example: top management strategy, new legislation, media, investors, concern of employees or communities?
2. What are your most important water risks?
    - What activities in your operations affect your water management most?
    - Besides water risks, do you perceive any water opportunities as well?
3. How do you decide what element of your water management to report on?
    - Are you closely looking at how industry peers/competitors are reporting? Or do you investigate how companies within your country are reporting their water management?
4. The Global Reporting Initiative (GRI) deals with water reporting under the indicators EN8, EN9, EN10, EN21 and EN 25).
    - If you would grade the water-reporting indicators from the GRI from 1 (very bad) – 5 (very good), what grade would you give it and why?
    - Do you think it is relevant to follow a certain framework for water reporting or do you think you could report more relevant water risks if you were to create water indicators yourself?
5. How do you measure the company's water consumption and wastewater discharge?
    - Is it difficult to construct these numbers for water consumption or wastewater discharge?
    - What are the constraints of reporting your water management? Difficulties to trace the water impact? Difficult to disclose your water risks to stakeholders?
    - Are you active in hydrological modelling? How do you investigate your impact on the catchment area you are operating in?
6. Have you improved your water disclosure (i.e. not water performance, but the quantity and quality of your water reporting) over the past years?
    - What has changed and which drivers encouraged this change?
    - What trend in water reporting do you foresee in the future?
7. Have you signed a water-related initiative, such as the CEO Water Mandate?

  - What are the benefits of joining such a water-related initiative for your company?

8. Are the company's operations active in any water-scarce or water-sensitive regions?

   - How does the company try to improve the operations in water-sensitive or water-scarce regions? Is it similar to your overall effort to reduce water consumption?

9. Are you familiar with the term water footprint?

   - Are you planning to calculate and improve the water footprint of your product(s), perhaps through the guidelines of the Water Footprint Organization?

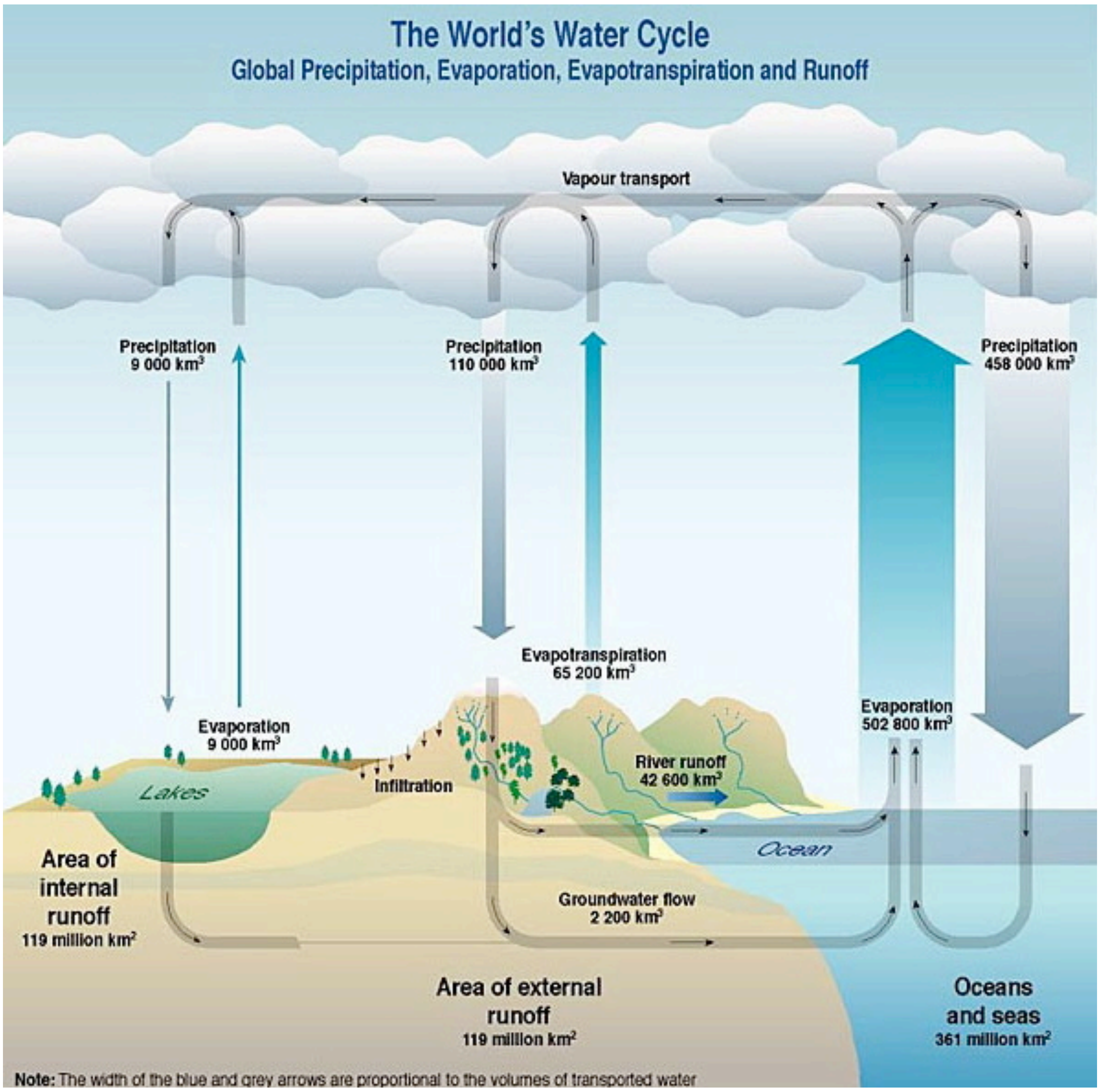
10. Do you have a program or standards for your suppliers to improve or measure the water impact/water performance?

    - Do you foresee standards or codes of conduct on environmental performance of your suppliers in the future?

    - Do you perceive any difficulties in managing the water performance of your suppliers?

Thank you very much!

Appendix III



Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999; Max Planck, Institute for Meteorology, Hamburg, 1994; Freeze, Allen, John, Cherry, *Groundwater*, Prentice-Hall: Engle wood Cliffs NJ, 1979.