Accounting for Risks: Identifying Water Risks in the Food and Beverage Industry Using an Ecosystem Services Benchmarking Framework

by

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A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Environmental Studies
in
Sustainability Management

Waterloo, Ontario, Canada, 2015

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

Global population growth and economic development has placed unprecedented demand for freshwater resources. However the supply of freshwater is becoming increasingly uncertain, due to the variability of the hydrological cycle, climate change and ecosystem degradation. This thesis questions the effectiveness of current sustainability frameworks in screening for material water risks. A new framework was developed based on an ecosystem perspective of water resources. The advantage of this approach is that it focuses on the valuation of water through the context of risk and encourages broader ecosystem perspective to managing those risks throughout the value chain and within a river basin.

The study applied a mixed method approach to examine the interaction between Corporate Water Risk Management with general sustainability performance (using KLD Social Ratings) and with Corporate Financial Performance. A sample of sixty-one food and beverage firms was compiled from a universal database that combined data from the Compustat database and KLD (2012) Historical Summary. Their corporate disclosures were appraised using the Corporate Water Risk Management framework.

Regression analysis showed significant and positive relationships with accounting performance measures but non-significant association with market measures. Firm size was shown to have a strong influence on the accounting performance correlations. For the market measures, it was determined that there are many factors influencing market values and thus more sophisticated models are required to isolate the relationship between CSP activities and market performance.

ACKNOWLEDGEMENTS

I would like to extend my gratitude to Dr. Olaf Weber for his direction and guidance throughout the research process and for Dr. Michael Wood for his insightful feedback

I would also like to extend a heartfelt thank you to my husband Dave for his tireless support and to my parents, Walter and Clementina Saunders for their heroic example.

DEDICATION

I dedicate this thesis to my mother.

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List of Abbreviations

BIER - Beverage Industry Environmental Roundtable

CDP- Carbon Disclosure Project

CFP – Corporate Financial Performance

CSP - Corporate Social Performance

CWRM - Corporate Water Risk Management

EBITDA- Earnings Before Interest, Taxation, Deprecation, and Amortization

GRI - Global Reporting Initiative

IPCC - Intergovernmental Panel on Climate Change

KLD - Kinder Lydenberg Domini

MMR- Mixed Method Research

PRI - Principles for Responsible Investment

TARWR - Total Available Renewable Water Resource

TBL - Triple Bottom Line

WBBR - Water Based Business Risks

WEF - World Economic Forum

WHO - World Health Organization

WWDR4 -World Water Development Report #4

WWF - World Wildlife Federation

1.0 Introduction to the Global Water Crisis

Even though 70% of the earth's surface is comprised of water, only 1% consists of usable freshwater resources, essential to providing life-sustaining services for human and ecosystem functions (Berger & Finkbeiner, 2014). Until recently, the natural processes of the hydrological cycle has ensured that the global water supply is constantly replenished and stored in surface lakes and rivers and in underground reservoirs. But human-induced climate change, characterised by frequent fluctuations of extreme drought and flooding, has added uncertainty to the water cycle's natural ability to restock its resources.

Alongside the uncertainty over the global water supply is the growing global demand for freshwater. Over the last century, human water use has increased at twice the rate of population growth (Morrison et al., 2009). With global population projections to exceed 9 billion by 2050, there is a deepening concern that we are on the threshold of a global water crisis; whereby the global demand for freshwater will exceed the hydrological cycle's natural ability to meet the demand (Morrison & Schulte, 2010).

In 2013, the World Economic Forum declared the water crisis among the top three global risks of highest priority (as cited by Schulte et al., 2014). By 2015, the Forum intensified the alarm, announcing the water crisis as "the biggest threat" the planet will face over the next decade (WEF, 2015). Economic development and population growth will compound pressure on the water supply, and further exacerbate uncertainties pertaining to water availability, water quality and water demand. As such, the sustainable management of freshwater resources to supply societal, economic and ecosystem needs has emerged as one of the more critical management challenges.

Industry's response to recent surveys reveal an emerging awareness over the uncertainty of the global water supply and its impact on business growth and financial performance. In 2011, the Carbon Disclosure Project (CDP) - Water survey of Global 500 companies found 59% of respondents were concerned that *exposure to water related risks* had the potential to cause significant business impact. While more than one third of respondents in the same survey reported a recent water related business impact that incurred financial costs as high as $200 million (USD) (CDP, 2011). In another study involving US-based firms, 60% of the respondents stated water challenges will affect their business growth and profitability within the next 5 years; while more than 80% responded that it will affect their decision on where to expand (Schulte et al., 2014). The US Stock Exchange has also weighed in on this concern, stating; *changes in the quality and availability of water can have material effects on companies* (Barton, 2010).

However developing strategies to mitigate the full social, economic and ecological costs that a modern global water crisis could impose, requires a pragmatic research approach. A key research subject first involves understanding industry's complex relationship with freshwater resources and the potential sources of business risks and secondly, an appreciation for how such risks can impact financial performance. In order to address these key concepts, this research focuses on the food and beverage industry due to its recognition as a water-intensive industry and the "hidden" risks, embedded in its agricultural supply chain.

Fundamental to this research is the de-construction of the prevailing definition of corporate sustainability in order to formulate metrics to screen for corporate water risk management. This thesis applies a natural capital definition to sustainability, which not only views water as a shared natural asset but also uses risk to build an understanding of its financial value.

It is suggested that corporate leaders and financial stakeholders carefully revisit the tools and methods used to account for their exposure to water risks, in order to establish the future viability of their business operations. This research proposes that firms engaged in forward-looking water risk management strategies that recognizes water as a natural capital will result in more resilient businesses, better financial performance and more responsible business operations.

1.1 Water Use in the Economy

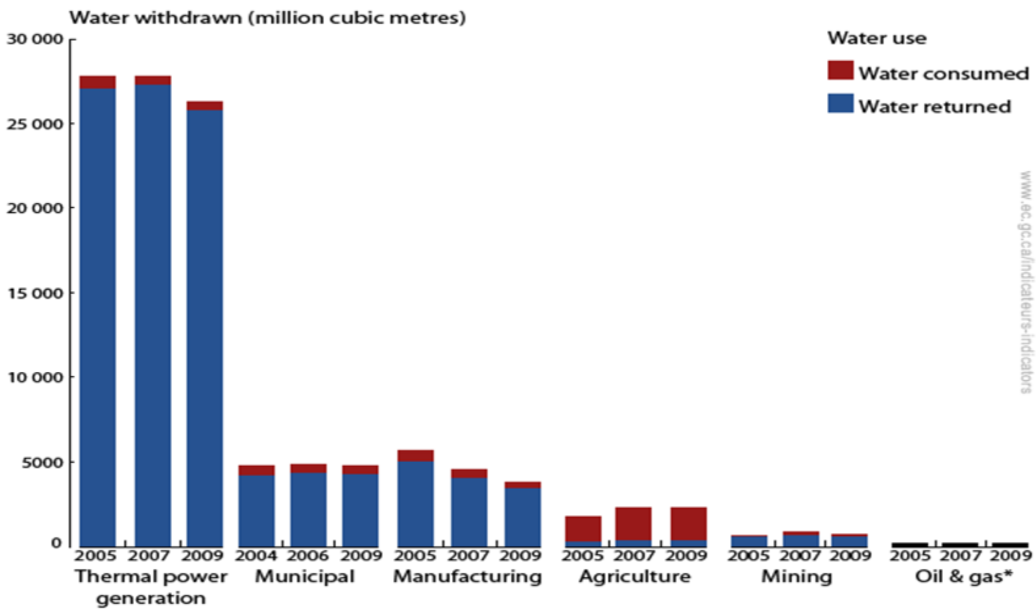
Direct and Indirect Dependence on Water Resources

Virtually every industry is either directly or indirectly dependent on water resources. Most industries with a direct dependency, either use precipitation or abstract surface or ground water for the production of raw materials or as part of their operations (SEEA-Water, 2012). Some industrial examples include, agricultural production, cooling in industrial processes, extraction of fossil fuels, or as an ingredient for a finished good (Schulte et al., 2014). Meanwhile fishing, shipping and sectors within the tourism industry are directly dependent on the physical presence and quality of water bodies (SEEA-Water, 2012).

Environment Canada (2009) reported that approximately 38 billion cubic metres of freshwater were withdrawn from Canada's rivers, lakes and groundwater.

Figure 1 provides a comparison of volumetric water use by industry in terms of a) the amount of water returned and, b) the amount of water consumed. Consumption refers to the total water intake, minus discharge into surface bodies and drainage into groundwater (Bruneau & Renzetti, 2010). Consumption occurs when water is embedded in the final product, or evaporates during production. Unlike water that is returned, consumed water cannot be used by downstream users within a watershed (SEEA-Water, 2012).

Figure 1. Water withdrawal by industry in Canada



Source: Environment Canada. 2009

*Volume of water withdrawn and consumed by oil and gas industry was unavailable

Although the volumetric water intake for thermal power generation is high (99.3%), approximately 99% of the water is discharged back into the watershed for other downstream users with relatively minor changes to the water quality. Conversely, agriculture consumes approximately 84% of the water it withdraws and ranks as the sector with the highest overall water consumption (Environment Canada, 2009).

Indirect Water Use

Water is also used indirectly at different stages of the value chain. Indirect water use not only affects suppliers, but also production facilities and customers (Levinson, 2008). Investment in municipal infrastructure (used to mobilize, store, treat, distribute and return water to the environment), is one primary example of indirect water use, as it provides essential services for households, institutions and even industry (SEEA-Water, 2012; Levinson, 2008). Since indirect water use tends to provide benefits which are primarily "hidden" from plain sight, it is often when the water source becomes compromised, when its value becomes apparent. This was the case in 2001, when water shortages in Northwestern United States limited the production of hydroelectric power, resulting in the closure of several aluminium plants (Levinson, 2008).

Water Intensive Industries

Different industries depend on freshwater to varying degrees. Certain industries are especially dependent on freshwater and as such, are more susceptible to the detrimental impacts arising from water availability or water quality issues. Water-intensive industries describe a cross-section of industries where water is used as a major input (CDP, 2011), or is a significant part of the industrial processing (Morrison et al., 2009) or where a water-intensive raw material is a major input (Signori & Bodino, 2013). These industries include: agriculture, food and beverage, hydroelectric power, oil and gas, semi-conductors, homebuilding, chemicals, mining, forest products and the apparel industry (Morrison et al., 2009).

The food and beverage industry is particularly vulnerable, as it is exposed to water based risks in both its direct operations and in its agricultural supply chain.

1.2 Water Based Business Risks

One approach to assess the value of freshwater assets to the economy is through an understanding of the potential sources of Water Based Business Risks (WBBR). These are commonly manifested under the contexts of contaminated water resources, limited water supply or the lack of infrastructure to treat and transport water. It is equally important to recognize that water risks are not limited to onsite production, but can be randomly distributed throughout the value chain (WWF, 2009).

It is anticipated that claims for freshwater will be intensified in emerging economies, which are facing both population and economic growth. Economic growth and individual wealth is often associated with a change from a starch based diet toward a preference for meat and dairy based diets, which are more water intensive.

Early research from the financial services firm JP Morgan with World Resources Institute (Levinson, 2008) codified WBBR into three broad categories.

Physical risks refer to declines or disruption in operations due to a stressed supply of fresh water. It primarily affects sectors in which a reduction of water quality and quantity results in reduced production. Industries notably susceptible to physical risks include: agriculture, beverages and food processing and power generation. ***Reputational risks*** refer to conflicts between businesses and local communities competing for clean and reliable water. Such conflicts can also restrict growth opportunities. Multinational corporations operating in developing countries are particularly vulnerable to reputational risks arising from water use which affects the livelihoods of local citizens. ***Regulatory risks*** refer to more stringent local and national water policies that can result in increased costs for water or limits industrial activities. In the past, many industries were able to acquire water on site at little to minimal costs by onsite drilling to abstract ground water. But regulatory tools, such as permits, pricing are used more frequently to control consumption and discharge, as the water supply has become more uncertain. Industries that are most vulnerable are those which use or discharge large volumes of water with a relatively low value production (Table 1).

Litigation was at one time regarded as an outcome arising from regulatory risks, though more recently it is appearing as a distinct risk category. ***Litigation risks*** refer to lawsuits or other legal action that arise in response to the impacts of a company's operations or products on the water supply (Barton, 2010). Exposure to litigation risks is dependent on the extent of the water allocation laws of the jurisdiction where a company is operating. As we see with litigation risks, WBBR can be interconnected and can occur at different points along the value chain (Levinson, 2008).

Table 1: Water based business risks in production and supply chains

Water Based Business Risks (WBBR)		
Physical Risks[1]: • Temporary non-availability of water disrupts supply chain and/or operations • Water scarcity drives up input prices • Intensifying competition for scarce water constrains growth • Increased capital expenditure on water treatment, extraction or alternative technologies to address water problems increases costs • Non-availability or scarcity of water required for using product or service limits growth	**Regulatory Risks[1]:** • Suspension/withdrawal of water license or discharge permits in supply chain • Reallocation of water to more urgent needs during droughts disrupts operations • Growth constrained due to suspension of suppliers' water license • Non-issuance of water license or restrictions on use of particular products or services (due to water intensity) raises costs or limits growth	**Reputational Risks[1]:** • Competition with household water demand constrains suppliers' growth • Responsibility "by association" for suppliers' water pollution damages brand or reputation, hinders growth • Increased capital expenditures on wastewater treatment to meet or exceed standards • Competition with household demands or pollution incidents damages brand or reputation, hinders growth • Public outcry regarding water intensity of product damages brand reputation, hinders growth
Litigation Risks[2] can arise in response to impacts of Physical, Regulatory Risks on local communities and watersheds		

Sources: [1]Levinson, 2008, pg.10; [2]Barton, 2010, pg.19

1.3 Reconsidering Water from a Natural Capital Perspective

The economy's dependence on freshwater has led the claim "the economy runs on water" (Morrison et al., 2009, pg. i). Yet, most industries neither recognize the value of freshwater availability to their business nor acknowledge freshwater ecosystems as an essential asset. As a consequence, many industries tend to use more water than necessary (WWDR4, 2012). In 2006, it was estimated that the combined direct water use among five global food and beverage companies (Nestle, Unilever, Coca-Cola, Kraft and Danone) approached 600 billion litres of water. This figure was equivalent to providing 95 litres of water per day for each person of the global population (Levinson, 2008). By contrast, the World Health Organization (WHO) established 20 litres of water, per capita per day as their high-end benchmark to satisfy the requirements for basic food and personal hygiene for most people under most conditions (WHO, 2014).

Renzetti (1999) and Schulte (2014) indicate that the misuse of water sources is linked to the commercial and household cost of water, which is significantly underpriced when compared to the cost of electricity. Young (2005) further suggests that as long as water is regarded as a utility, its importance to business, society and ecosystems will continue to be undervalued. An apparent solution might be to introduce water pricing mechanisms. However water pricing faces social as well as practical challenges. On the one hand, there is the argument that water is *too valuable to be priced*. Pricing water as other commodities appears to contradict efforts from the United Nations which has declared clean water a human right. The other challenge, from an investor's standpoint, is that water pricing does not reflect the costs of increasing water scarcity (P. Klop, personal communication, June 26, 2015). One solution is to frame the cost structure of water to include data that reflects risks. Nevertheless, this would require a reconfiguration of how industry comprehends water, in order for this to be accomplished.

When industry regards water as a utility, the management approach focuses primarily on the internal monitoring and measurement of direct, operational water use to improve efficiency.

Conversely, a natural capital perspective encompasses a broader framework, providing insight on the complexity of the hydrological cycle by incorporating the ecological, social, political, and economic contexts of operations throughout the value chain.

Natural capital refers to the stock of natural resources, such as soil, water, forests, and wildlife. It also includes the ecosystem products and services that underpin the global economy by providing either direct inputs or indirect benefits (Bonner, 2012). Business is dependent on ecosystem services. Sectors with agricultural supply chains, including the food and beverage or tobacco companies, are directly dependent on these services and the raw materials that the environment provides (Grigg, 2008).

Ecosystems perform multiple, essential services to support the constant movement of water. All freshwater relies on the sustainable, healthy, maintenance of ecosystems. This is because ecosystems are a natural infrastructure, providing essential services which includes recycling water through hydrologic processes, regulating water quantity, improving water quality, providing natural storage and mitigating the extremes of flooding and drought (WWDR4, 2012). The advantage of preserving ecosystem functions as part of the natural infrastructure is that when compared to hard-engineered solutions, it is more resilient to extreme weather conditions and more cost-effective, both in terms of initial investment and operational costs (Burnett & Wada, 2014).

Reddy (2015) states that recognizing water under an ecosystem management perspective will facilitate the evaluation of the costs and benefits of a business' water strategies for the present and into the future. Furthermore, considering industrial water use within an ecosystem framework can assist companies with identifying external water risks that exist beyond their direct operations, where, even companies that are committed to water and waste water efficiency can be vulnerable (Schulte, 2014).

1.4 Understanding the Complexity between Hydrological Processes and Industry

Industry and water share a complex relationship. While hydrological processes are critical for supplying industry's use of freshwater, these same processes can likewise contribute to issues that can affect the viability of a company.

One study showed the presence of artificial sweeteners in the Grand River system in Southwestern Ontario. This occurred despite the fact that a production facility does not exist within the watershed (Spoelstra et. al., 2013). The assumption was that the sweeteners were passed through human waste, which current wastewater treatment technology is unable to remove. The presence of these sweeteners pose a potential risk to aquatic ecosystems, as they can become toxic as they degrade (S.Schiff, personal interview, April, 2014). The precedence for the potential for litigation risks based on product ingredients was established in 2009, when 43 different water management agencies in the US sued the makers of a weed killer to pay for the removal of chemicals from the drinking water supply (Barton, 2010).

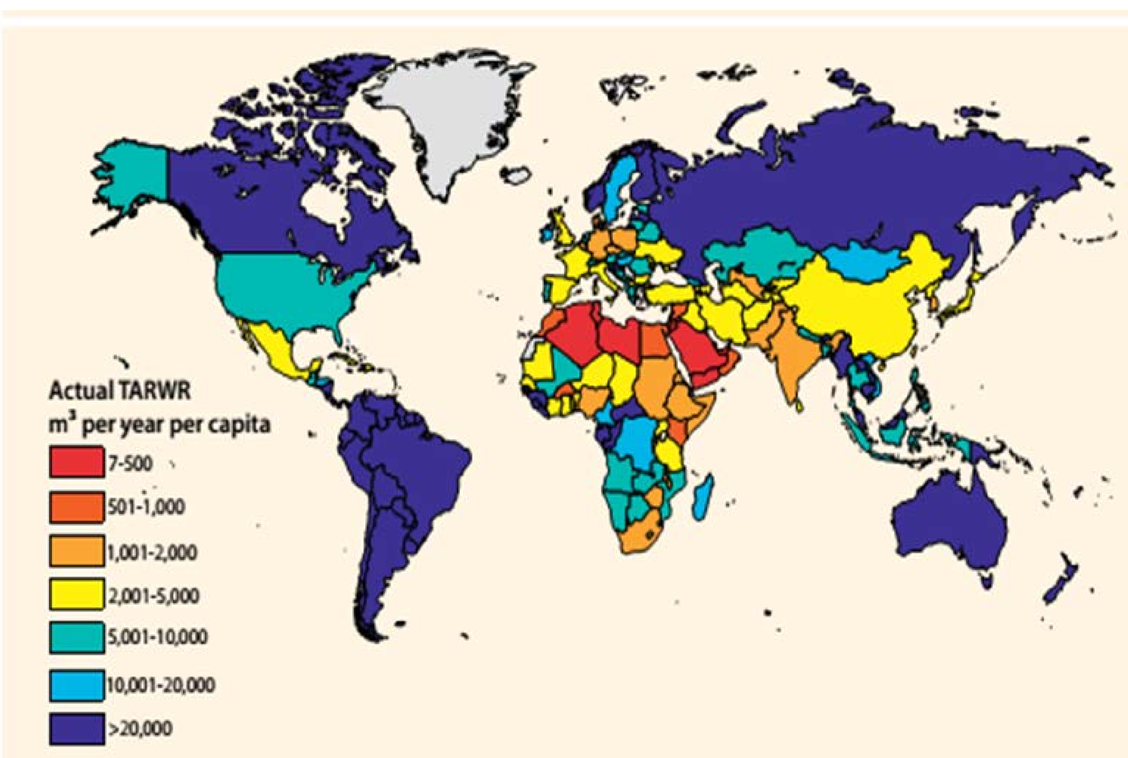
Three aspects of the water cycle play an important role in understanding the relationship between industry and water. These are: water variability, water flows and groundwater resources. These aspects are significant because they are often a contributing factor of water based business risks.

Spatial and Temporal Variability of Freshwater Resources

The hydrological cycle is the dynamic process that ensures the renewability of freshwater resources. However, freshwater resources and the hydrological cycle is highly variable in terms of its spatial distribution. It is not uncommon to discover that the geographies most compatible for human settlement are not necessarily the geographies with the most abundant resources. For example, in Canada though 85% of the population live along the Canada/U.S. border, 60% of its freshwater drains toward the Arctic region (Environment Canada, 2014).

This spatial variation is evident across the globe, designating some geographies as water rich or water poor, depending on the amount of precipitation the region receives. The Total Available Renewable Water Resource (TARWR) by population provides a visual synopsis of this geographic variability (Figure 2). More significantly, it delineates areas of potential water stress as it measures water renewability relative to the water availability per person (WWDR4, 2012).

Figure 2. Total annual renewable water resources by country (1985-2010)



Source: UN World Water Development Report, 2012, pg. 79.

In addition to its spatial variation, precipitation also varies according to season. Certain geographies experience more precipitation in the spring and winter than in the summer or fall. Human-induced climate change has intensified the geographical and seasonal variability of the water supply. Climate change continues to challenge the reliability of scientific predictions for future water supply based on past hydrological performance (IPCC, 2008).

Due to the contextual nature of the water supply, the impact of using a specified volume of water in a region that has abundant water resources is not comparable to the same volume used in an arid region, with a low water renewability rate. In other words, increasing the volume of water withdrawn by 1 cubic metre within a dry region could exponentially increase their water scarcity problems. Whereas an increase by the same amount in a water abundant region, would have marginal to no impact on the watershed, due to the high renewability rate (Berger and Finkbeiner, 2012). It is for this reason, why it is said that while the water crisis is a global issue, its impact is directly felt at the local or watershed scale.

The spatial and temporal variability of water can impact firms in several ways. It can put into question the integrity of the supply chain, especially if the firm sources material from water stressed regions. Multinational corporations with operations in water scarce, low income countries, may encounter conflicts regarding their responsibility for improving access to basic water needs for the local population while accessing water for their own financial benefit (Barton, 2010; WWDR4, 2012). When scarce water resources is coupled with high population density the risk factor intensifies. Water variability should also be a factor considered in corporate water strategies. Firms with facilities in different locations need to take into consideration the local context of their facilities, instead of implementing generic, company - wide water strategies (Schulte, et al., 2014).

Degraded Water Quality, Water Flows and Productivity

Degraded water quality can cause significant social and environmental consequences for communities and ecosystems that share the same watershed with industry. The UN World Water Development Report (WWDR4, 2012) states that effluent from industrial processes tend to be more concentrated, more toxic and more difficult to treat than other pollutants. Industrial wastewater also requires extensive time to degrade or move through the hydrological cycle. Since water flows, industrial effluent can affect large volumes of freshwater, posing a threat to downstream communities and natural systems.

Though regulatory tools are used to govern industrial effluent and address water quality concerns, they are not intended to eradicate the discharge of contaminants into water resources. Rather, they establish maximum limits of toxic materials that are permissible to be discharged, resulting in minimal harm to human, animal, and ecological health (Lambooy, 2011). But population and industrial growth can potentially lead to an increase in the concentration of pollutants for downstream users as various industries, with conforming effluent levels simultaneously discharge effluents into a shared river basin (WWDR4, 2012).

The consequences of degraded water quality on industrial operations, depends on whether the degraded water is an output or an input. When degraded water is an output, non-compliance with the regulatory limits can render a company and its stakeholders liable for remediation costs and subject to penalties that could include orders to shut down operations for a period of time (Levinson, 2008; K. Jones, personal communication, June 13, 2014).

When degraded water is an input, companies must contemplate the costs associated with technology to pre-treat their water supply. Many industries depend on high quality water as an input and may need to invest in pre-treatment technology to raise the water quality to a desired standard (Morrison et al., 2009).

Groundwater Resources

To circumvent the vulnerability of surface freshwater resources, communities and industry often turn to groundwater resources (Gleick, 2014). One estimate suggests that 95% of the earth's freshwater is in underground stores (WEF, 2015). The advantage of using groundwater is that it is correlated with higher socio-economic benefits, because it is less sensitive to water shortage and water quality issues that affects surface waters (Llamos & Garrido, 2007). Globally, nearly half of the drinking water and 48% of irrigated water is sourced from groundwater (Siebert, 2010). But groundwater can take centuries to replenish, leaving shallow aquifers at risk of depletion. The pursuit for groundwater can potentially incur additional technological costs for pumping lifts to access new sources of water deeper below the surface (WWDR4, 2012). Additionally, groundwater pumping is also linked to instability of the earth's surface, causing subsidence or sinkholes (WEF, 2015).

1.5 Water Risks within the Food and Beverage Industry Value Chain

As a water intensive industry, food and beverage processing is not only dependent on freshwater but can also have a detrimental impact on freshwater resources. Freshwater is a key requirement throughout its value chain. It is required for the growth and production of raw materials, for the manufacturing of raw materials into consumable goods, and for the distribution of products to retail markets (PRI, 2014).

Water issues in the food and beverage industry consist of a complex network of interdependent relationships. Not only do the relationships transcend global and local boundaries but they are also sensitive to the spatial and temporal variability of hydrologic processes.

Global Overview: Population Growth, Economic Growth and Urbanization

Population growth, combined with economic development and urbanization is expected to drive the global demand for food to unprecedented levels. This demand is predicted to increase by 50% by 2030 (Bruinsma, 2009), creating more stress on water and energy sources. The demand is expected to be particularly acute in emerging economies, such as India or China, where the increase in national GDP will result in changes to the local population's lifestyle and dietary preferences (WWDR4, 2012). These changes will be manifested in an increased consumption of water-intensive food, including meat and dairy products as well as value-added, processed foods.

However, while the demand for food products is relatively predictable, the supply side is erratic, largely due to the influence of weather fluctuations on food production (KPMG, 2013).

Food and beverage processing and risks to water quality

Food processing is the most lucrative stage in the food value chain, earning margins of 10-20% (KPMG, 2013). However, the industry's profitability is contingent on crop prices and the security of the supply of commodity raw materials (PRI, 2014).

Food processing is also complex, comprised of many distinct subsectors, each with their own characteristics (KPMG, 2013). A final food product, (a cake, for example) undergoes several processes for each agricultural commodity in its ingredient list and passes through a multi-tiered supply chain before arriving at a retail destination (PRI, 2014).

Still, some processing facilities can produce multiple food products. For instance a fruit and vegetable facility could be equipped to process pastes, jams, canned foods, compotes or frozen foods. As a result, the amount of water consumed and wastewater generated is linked to the type of processing used, whether it be preservation, pasteurization, freezing or pickling as well as the type of technology (Strzelczyk, 2010).

Wastewater from processing operations

Effluent from food processing often contains large quantities of carbohydrates, fats, oils, greases, proteins and mineral salts which is too complex for complete biodegradation or for treatment through municipal wastewater facilities (Guzel-Sedim, et al, 2004; McAdams & Cabral, 2009). Wastewater from dairy, meat, poultry, and seafood processing plants are especially concerning as they can cause significant water pollution due to heavily loaded waste. The main issue with food processing waste is that organic matter provides a food source for microbial growth, which can subsequently cause a decreasing amount of dissolved oxygen in the water (eutrophication). Hazardous cleaning and sanitizing compounds are also released into the sewage systems, effecting aquatic ecosystems (Guzel-Seydim et al., 2004).

Agricultural Inputs

Inefficient agricultural products are a key input for food and beverage processing facilities. With the exception of water bottling operations, agricultural inputs accounts for the largest water use within the beverage processing supply chain (BIER, 2011).

Globally, agriculture withdraws the largest volume of water compared to other industry sectors. It is estimated that it uses up to 70% of the global freshwater resources. In developing nations, it is estimated to be closer to 90% (WWDR4, 2012).

Agriculture is also an important contributor to the global economy. Valued at 5 trillion USD and employing approximately 450 million farmers, farming represents the largest employment sector in the world (KPMG, 2013). Consequently, agriculture also represents the most risky activity in the food and beverage value chain due to its vulnerability to climatic conditions. Erratic weather patterns, affiliated with climate change, will increase the volatility of crop yields and the global economy, presenting significant challenges for a sustainable food supply (PRI, 2014).

Agricultural practices also can contribute to ecosystem degradation and pose a risk to human health. Run off from pesticides, manure and other pollutants can enter both surface and ground water systems, causing algae blooms, eutrophication and even water related illnesses. This results in freshwater that is toxic for both aquatic habitats and human consumption. In addition, agricultural expansion can lead to deforestation and habitat destruction to accommodate plantations (Othman & Ameer, 2010). Consequently, natural habitats such as wetlands and riparian corridors are important for mitigating flood risks and functions as a natural water filter, purifying water as it enters the aquifer (van der Kamp & Hayashi, 2009).

Table 2 summarizes water risk exposure for the food and beverage industry during three stages of the value chain.

Table 2: Water risks in the food and beverage value chain

Supply Chain Procurement of agricultural inputs	**On-Site Operations** Production Facility	**Backward Link** Customer
• Dependency on water-intensive agricultural inputs • Susceptibility to extreme weather events will contribute to price volatility on global market • Impact of water consumption depends on where product is grown and irrigation technology used • Agricultural run-off (pesticides, fertilizers) can degrade surface and groundwater supply, damage aquatic ecosystems and create exposure to regulatory risks with insufficient management • Deforestation to expand agricultural lands contributes to diminished water quality and replenishment of water resources through hydrological cycle	• Need reliable water source for cleaning, processing and as a major ingredient • Vulnerable to water quality issues and pre-treatment costs • Operations in a water-stressed area can face risks in terms of competition of limited water resources • Wastewater often contains biological oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), fats/grease/oils and nutrients in varying concentrations (mag) • Capital costs for technology to treat and dispose of waste water to regulatory standards	• Corporate reputation in terms of accountability to local populations, particularly in water stressed regions • Impact of consumer product on water quality and aquatic environment.

Freshwater dependence is ubiquitous throughout our economy. By focusing on the processes involved in the food and beverage industry, we gain a broader understanding of the intricacies of the water cycle and its intimate association to industry. However food and beverage processing is likewise complex, primarily due to the multi-channel supply chain which is significantly dependent on agriculture. The sustainability accounting mechanisms used to pre-empt and mitigate environmental risks becomes vastly important for the food and beverage industry and needs to adopt a perspective which recognizes water as a natural capital on par with physical assets.

2.0 Sustainability Accounting: Managing Environmental Risks

Insurance and weather derivatives are financial tools often used to mitigate financial losses arising as a consequence of water risks. Both serve to protect companies from the impacts of unexpected weather events on revenues (Larsen, 2012). Weather derivatives are a relatively new market mechanism, used to hedge a firm's exposure to risk events caused by a natural phenomenon, such as flooding or droughts. It mitigates risks by allowing companies to accurately plan their revenues for the year (Leggio, 2007). While both insurance and weather derivatives can protect a firm against financial loss, they do not ensure long-term economic productivity (Larsen, 2012). In fact, Weather Index Insurance was found to create a disincentive to invest in irrigation technologies, because it only applies to farming practices that are dependent on precipitation (Fuchs & Wolff, 2011). By contrast, management strategies, such as the implementation of modern irrigation technology could not only enhance agricultural productivity for the long term, but also increase water efficiency and water recycling capabilities (WWDR4, 2012)

Though financial tools are necessary to address the occasional impacts of environmental events on financial performance, they are not structured to be a long-term solution to a persistent problem. Thistlethwaite (2011) found environmental liabilities to be underreported due to concerns that full disclosure could threaten the solvency of many large corporations and the insurance industry. Therefore a more optimal approach to yield long term financial stability, is to engage in corporate strategies that not only measure and manage water risks; but also, capitalize on potential opportunities.

Weber (2010) states that correctly identifying sustainability risks will improve credit decision making by reflecting real credit risks, thus also improving the validity of economic forecasts. Reddy et al., (2015) found by framing freshwater assets into financial terms facilitated business planning around future water scarcity, improved understanding of risk and helped identify and evaluate solutions.

2.1 The Measurement and Management of Environmental Impacts

In order to understand why a new framework is needed to capture water risk exposure for the food and beverage industry, it is essential to first understand, the underpinnings of sustainability accounting.

Traditional Accounting and Environmental Reporting

Early inceptions of sustainability accounting used methods analogous with traditional accounting principles (Gray, 1993; Lamberton, 2005) to track the adverse impacts of human activity on the environment, specifically concerning natural capital.

Gray (1993) states that sustainability accounting evolved from three different types of traditional accounting systems. *Sustainable cost* is derived from the financial accounting principle of capital maintenance, and refers to the (hypothetical) monetary cost of restoring natural capital stocks to its state prior to an organization's impact. *Natural capital inventory* accounting stems from the application of inventory control used in management accounting, and is based on inventories of changes or depletions of natural capital. Finally, *input-output analysis* stems from material accounting techniques and is often the basis of environmental audits or life cycle analysis. Unlike the above examples, the Triple Bottom Line (TBL) which is the current convention to sustainability accounting, encompasses a three-dimensional accounting system, which combines the economic, social and environmental aspects of sustainability.

The financial accounting structure served as an initial model to establish the framework for the Global Reporting Index (GRI). This was originally done to institutionalize sustainability reporting so as to establish its legitimacy (Etzion & Ferraro, 2010). But this relationship became less apparent once the GRI adopted a TBL definition of sustainability. Currently, the GRI represents a standardized framework founded on the TBL definition of sustainability. Where the GRI Guidelines makes an effort to mirror financial reporting is in terms of qualitative attributes of auditability, comparability, inclusivity, rigour and transparency (Willis, 2003; Lamberton, 2005). Lamberton (2005) also draws a comparison between the tools used to capture sustainability accounting data and financial accounting data, in his observation that the use of performance indicators and valuation methods are estimations of environmental assets and liabilities.

Yet early efforts to transpose financial reporting principles to environmental reporting led to superficial results (Etzion & Ferraro, 2010) because of the inherent differences of the two systems. Schaltegger et al (1996) explains these differences as follows:

> "Nature reacts according to the interconnectedness and interaction of all substances whereas traditional accounting divides, separates and counts everything independently on a balance sheet" (pg.32).

Financial accounting systems are primarily designed to communicate financial performance to investors rather than pricing or measuring damage to the environment resulting from the production process (Thistlethwaite, 2011). Hence, methods of assessing a firm's value based solely on the examination of traditional accounting data presents the risk of overestimating a firm's value since the environmental risk profile is not fully captured. Traditional accounting measures past financial performance to predict future expectations of financial performance and is regulated to consider only actual internal financial impacts (Schaltegger, et al. 1996). As such traditional accounting measures how effectively a firm uses its assets to generate value (Peloza, 2009). The bias toward traditional accounting data in investment decision-making produces an information asymmetry, whereby future valuations and strategies are based on past results, rather than a comparison of future costs and future income (Schaltegger & Figge, 2000).

Materiality

The concept of materiality, borrowed from traditional accounting, is likewise relevant; though it plays a different role in sustainability accounting (Etzion & Ferraro, 2010). Material information refers to any information an investor would consider germane in determining a firm's current and future financial value (Thistlethwaite, 2012). Yet, even within traditional accounting, materiality remains a challenging concept to define; evidenced by the fact that a single, commonplace definition of materiality does not exist within financial or accounting circles (Iyer & Whitecotton, 2008). The Financial Accounting Standards Board (FASB, 1980) describe materiality as:

> "The omission or misstatement of an item in a financial report is material if, in the light of surrounding circumstances, the magnitude of the item is such that it is probable that the judgment of a reasonable person relying upon the report would have been changed or influenced by the inclusion or correction of the item…(however) magnitude by itself, without regard to the nature of the item and the circumstances in which the judgment has to be made, will not generally be a sufficient basis for a materiality judgment."

However, Iyer and Whitecotton (2008,) refer to the FASB's description of materiality as the "essence of the concept" (pg.50) as the interpretation of materiality is based on the professional judgement of corporate managers or independent auditors using *surrounding circumstances* as the scope.

Another distinction is the type of information considered in assessing material information. The Securities & Exchange Commission (SEC) proposed that quantitative along with qualitative factors be considered in assessing materiality (SEC, 1999). While this interpretation suggests the potential to include environmental aspects in evaluating financial materiality, this is not the case. Under the traditional accounting system, environmental performance only becomes material when a liability resulting in a financial obligation emerges (Thistlethwaite, 2012).

Unlike traditional accounting, where the threshold for materiality is the financial impact on financial stakeholders, materiality within a sustainability framework encompasses an external range of stakeholders as well as social, environmental and economic impacts. It assists managers with identifying priority impacts in terms of its risk to the community, the natural environment and to stakeholders (Lamberton, 2005). A significant advantage of incorporating environmental factors in materiality assessments is that it can provide investors and businesses with information to minimize the potential of an environmental risk from developing into a financial obligation or liability. In other words, it reflects a perspective, which assesses the effect of present environmental performance on future economic value (Thistlethwaite, 2012).

The Global Reporting Index & Materiality

Early renditions of the GRI considered material measures irrelevant to sustainability reporting. The assumption was that material information was more applicable to financial accounting because it provided information for a single stakeholder, such as, investors. Meanwhile, sustainability reports had a diversity of stakeholders and was a more accessible and transparent information framework (Etzion & Ferraro, 2010).

However materiality eventually became "recontextualized" for the, GRI (G3) (2006) guidelines, after sustainability reports were scrutinized by external organizations for omitting material information. Within a sustainability reporting framework, a generally accepted definition of materiality was:

> "…that which is of greatest interest to, and which has the potential to affect the perception of, those stakeholders who wish to make informed decisions and judgements about the Company's commitment to environmental, social and economic progress (as cited in Etzion & Ferraro, 2010 p.1103)"

A materiality matrix was introduced in the G3 (2006) guidelines of the GRI to help companies detect an environmental, social or governance issues' materiality to sustainability (Etzion & Ferraro, 2010).

Shortcomings with the GRI framework in managing water risks

Recent updates to the GRI framework, the G4 (2013), included indicators which capture information on water use, water quality and impacts on ecosystem functions and communities. However, many of the indicators relevant to Industry's relationship to water are dispersed across several categories, which makes it difficult to demonstrate the multi-dimensional relationship between water scarcity, business risk and ecosystem management. As such, the GRI is limited in its capacity to contribute to an understanding of the financial value of water for stakeholders, investors, and industry. The G4, like its predecessor, encourages corporations and their stakeholders to identify issues they consider to be material. While this serves to encourage stakeholder engagement, it can also result in oversight. If a corporation considers water to be a utility, it may disregard potential material risks in its watershed and in its supply chain.

Barton (2010) identified several other shortcomings with GRI's ability to measure and report water risks. It stated:

1. Although water risks varies with geography, GRI reporting metrics fails to capture geographical implications on supply, ecosystems and communities.
2. The GRI metrics focus on total water consumption and withdrawal and not on local impacts.
3. Water risks in the supply chain is overlooked.

Other shortcomings are that it does not assist companies in developing strategies to reduce risks (Larsen, 2012), nor can it serve as a protocol, or a screening criterion for investment decision making (Willis, 2003). At its core, the GRI is primarily a communication tool for companies to share information about their sustainability performance. As such, sustainability information gained from the GRI needs to be reformulated in order to facilitate financial decision-making (Weber et al., 2008.)

Corporate Social Performance Investment Screening

Investors have shown a growing interest in investments screened according to ethical, environmental and social criteria (Minor 2007, Eurosif 2010). Corporate Social Performance (CSP) investment screening is a process of applying CSP activities to investment decision making. It quantifies detailed CSP related information to score or index a company's CSP. The index is used by investors to screen companies to target for investment (Van den Bossche et al., 2010) by operationalizing social performance data to represent impact (Mattingly & Berman, 2006).

Kinder, Lydenberg Domini Research & Analytics (KLD), now MSCI ESG, is an independent social ratings service that uses a proprietary methodology to evaluate a company's environmental, social and governance performance. This information is subsequently used to generate annual company ratings (Chatterji et al., 2009).

Social ratings agencies, such as KLD, typically measure past environmental outcomes in tandem with recent management actions in order to anticipate future outcomes. However, as Van den Bossche et al., (2010) state, the scores can reflect the social rating firm's subjectivity. Without reasonable transparency, investors who rely on those scores could potentially misallocate their resources (Chatterji et al., 2009).

The TBL focus of sustainability accounting systems and screens were not intended to capture material water risks. This results in a sizable information gap, whereby a firm's exposure to material water risks is not being included with the variables that influence the determination of a firm's current or future value.

3.0 Water Based Business Risks and Financial Performance

The impact of WBBR on a firm's financial performance was demonstrated in the case involving Coca-Cola Co. operations in India. Reputational damage arising from unresolved water disputes prompted the social ratings firm, KLD, to de-list Coca-Cola Co. from its Broad Market Social Index in 2006. This was followed by the sale of more than $50 million USD of Coca Cola Co Stock by TIAA-CREF, the largest US retirement fund (Chatterji et al., 2009).

Levinson (2008) outlines three sources of operational costs resulting from water risks.

1. Financial losses in the form of lost revenues due to interruptions in the production process.
2. Higher costs related to supply chain disruptions, changes in the production processes; capital expenditures on technology to abstract water, improve water efficiency or pre-treat water or to treat waste water to achieve regulatory compliance. As well as increased price for consuming or discharging water
3. Delayed or suppressed growth due to increased competition or conflicts over water.

Other areas that can reflect financial impact include: declines in stock exchange price and asset values, cash flow liquidity problems, (Barton, 2010) higher energy prices, higher insurance and credit costs and lower investor confidence (WWF, 2009).

Financial stakeholders are also predisposed to the financial perturbations of water risks, depending on their affiliation with the company. According to Nikolaou et al. (2014), investors, can face financial risks and losses if they invest in a water intensive business located in arid regions or if the production relies on a water-risky supply chain. Meanwhile the banking and insurance sectors are exposed to higher financial risks, if a business is unable to fulfill loan repayments, or environmental liabilities are transferred from the business to the financial institution (Nikolaou, et al., 2014) or when frequent claims are filed from losses arising from extreme weather events (Thistlethwaite, 2011).

3.1 The Relationship between Corporate Social Performance and Corporate Financial Performance

As Schaltegger and Figge (2000) suggest, any impact on natural capital will also impact a firm's cash inflows and outflows, hence having a direct influence on its financial performance. Cohen et al., (2012) propose that certain non-financial performance data have value relevance for investors and in fact are leading indicators of future economic performance. They cite research by Coram et al. (2009) who used information obtained from a balanced scorecard. Their research showed that voluntary disclosure of nonfinancial information such as customer satisfaction ratings affected estimates of the trend of future stock prices.

Although the theoretical relationship between CFP and CSP remains unclear, event research has shown that investments made in companies engaged in CSP outperformed conventional investment in times of financial crisis (Weber et al., 2011, Peylo & Schaltegger, 2014). Thus when negative events occur, CSR activities provides an informal insurance (Gardberg & Fomburn, 2006; Godfrey, 2005) that preserves shareholder value. However, Godfrey et al., (2009) observed that this protection only occurs when the CSR activities are aimed at a firm's secondary stakeholders or society at large.

But despite many decades of research to explain the connection between corporate social performance (CSP) and corporate financial performance (CFP), it has yielded uncertain results (Guenther & Hoppe, 2014). Stakeholder theory suggests that the marketplace *rewards* firms with high corporate environmental stewardship with higher financial and economic results (Freeman, 1984). Most studies have demonstrated a positive but modest relationship between

CSP and CFP (Margolis & Walsh, 2001; Schalteggar & Figge, 2000; Weber et al. 2008). A meta-analysis performed by Orlitzy, Schmidt and Rynes (2003) identified this relationship as positive, though their conclusion also included several contingencies. Still, a few studies have demonstrated a negative or inconclusive relationship (Peloza, 2009).

The multi-dimensionality of the CSP construct

The main challenge for researchers in pursuit of a theory to explain the CSP and CFP interaction is that each are multi-dimensional constructs. CSP embodies the social, environmental and governance dimensions of the triple bottom line definition (Ameer & Oldtham, 2012). It is also integrally complex, as it comprises measures from a broad range of disciplines, from organic chemistry to sociology (Guenther & Hoppe, 2014). As such, Weber et al. (2008) emphasize the importance of selecting the appropriate sustainability and financial indicators to explore the relationship between CSP and CFP. Scholtens (2008) observed that different combinations of CSR components can have different interactions with financial risks and return.

CFP Indicators

A similar challenge is the diversity of indicators used to measure a firm's financial performance. Financial performance, like CSP, is a multi-dimensional construct and likewise, is subject to uncertainty over the selection of optimal financial performance indicators (Scholtens, 2008; Guenther & Hoppe, 2014). Scholten (2008) cites two categories of financial metrics; accounting-based and market based. Peloza (2009) refers to these as "end state" or outcome metrics because they measure value created at the end of a period.

In practice the analysis of future trends tends to be limited to a period of five to ten years (Epstein, 1995; Schaltegger, et al., 1996). But as Schaltegger and Figge. (2000) argue, if expectations are limited in predicting future uncertainties (eg. deforestation to increase agricultural production and its resultant impact on water supply and quality) then calculations will not reflect the true shareholder value.

Accounting –based metrics

Accounting-based metrics demonstrate how efficiently a firm uses its assets to generate value. They are often used either over the long term, or to value initiatives that are expected to generate value in the short term (Peloza, 2009). A study by Rameer and Othman (2012) found that companies which placed emphasis on sustainability activities within their operations had higher financial performance measured by return on assets (ROA), profit before taxation (PBT), and cash flow from operations (CFO) compared to those without such assurances. They further found a consistent increase in ROA, PBT and CFO over a 5 year period.

Temporal Sequence

Margolis and Walsh (2001) mention the dilemma of causality in determining the nature of this association. This dilemma is in fact an effort to establish the direction and justifications between CSP and CFP. Does a firm's prior CSP lead to improved financial performance, as the stakeholder theory suggest? Or, is CSP an afterthought, which a firm engages in after it achieves financial success? Scholten (2008) supports the notion that CFP precedes CSP. The slack resources theory suggests that prior high levels in CFP provides the marginal profits to allow engagement in socially responsible programs (Waddock & Graves, 1997).

Other Contingencies

Guenther and Hoppe (2014) discuss the effects various contingencies can have on the interaction between CSP and CFP. Most notable are the effects of lag times, industry and risk. Lead-lag time effects can occur when changes implemented in the CSP in one time period is reflected in financial performance metrics in a different time period. Stock market based valuations are sensitive to this effect (Guenther et al., 2011).

Capital investment in risk concerns have also shown to reduce a company's CFP (Kristofferson, et al., 2005). This is evident with cost-based tactics. A company may invest in new technology to treat effluent to pre-empt regulation. This will not only reduce their risk, but will also increase the cost of capital for the company. However, cost based metrics which measures the effect of CSP on a company's risk profile has an inherent bias towards focusing on cost savings rather than cost increases (Peloza, 2009).

The inherent complexity of CSP and CFP constructs require researchers to approach their study of the topic from a limited perspective. Fundamentally, the relationship between CSP and CFP can vary, depending on which combination of CSP and CFP indicators are selected, which theories are followed, which contingencies are considered and which empirical design is chosen (Guenther & Hoppe, 2014).

4.0 The Rationale for Ecosystem Benchmarking System for Corporate Water Disclosures

While financial accounting uses monetary value to assess financial impacts and performance, sustainability accounting uses indicators to measure performance against established objectives. It also relies on multiple measurement tools to capture quantitative and qualitative information on social, economic and environmental impacts (Lamberton, 2005). However, accounting for a multi-dimensional concept makes the direct assessment of sustainability a difficult task. The ability to draw a link between the various performance indicators and their contribution to sustainable development remains a significant challenge (Baker, 2002 as cited in Lamberton (2005). Instead of demonstrating the dynamic relationship among the various dimensions, organizations tend to interpret the multidimensionality as competing priorities (Lamberton, 2005). In some instances, companies with weak environmental performance will avoid disclosing their performance, focusing on other areas, such as their social performance (Roca & Searcy, 2012).

The Purposes of Sustainability Indicators

Sustainability indicators help structure knowledge by reducing large quantities of data to simpler terms (Ott, 1978). One intention for having environmental, social and economic indicators is to provide a balanced information set (Lamberton, 2005) to improve organizational decision-making and environmental management. (Rametsteiner, et al., 2011).

Yet the identification, measurement, and application of appropriate indicators remains a foremost obstacle for policymakers, bureaucrats, scientists and citizens (McCool and Stankey 2004). One explanation for this is because the development of sustainability indictors is a dynamic process, often involving a negotiation between scientific knowledge, and societal or political norms and priorities (Rametsteiner et al., 2011). Chee Tahir and Darton (2010) restate this point of view by describing indicators as a reflection of issues.

The idea of indicators as issues, can be readily applied to the notion that indicators developed at the organizational level or within an industrial sector tend to be more meaningful, than those formed for a standardized framework (Rametsteiner et al., 2011) This is because a more cohesive understanding of issues and sustainability benchmarks can be gained at a micro level, which in turn, can contribute to enhanced business performance over the long term (Lamberton, 2005, Szekely & Knirsch, 2005). In recent years, the GRI has responded to this observation, by delivering supplemental guidelines, targeting specific industry sectors (Cohen et al., 2012), including one for the food and beverage industry.

Yet, broadly established sustainability frameworks can offer a basic, contextual understanding of sustainability performance. The information they provide enables comparability of sustainability policies across different entities, and can facilitate a company's ability to establish targets and develop internal benchmarks (Szekeley & Knirsch, 2005

Whether developed for a specific sector or for a wider context, indicators are not comprehensive in addressing all sustainability issues (Chee Tahir & Darton, 2010). The selection of indicators requires a trade-off between which indicators to include and exclude (Gilbert 1996, Rametsteiner et. al, 2011). While an understanding of the sustainability issues ought to proceed the identification of indicators, articulating the rationale used for selecting the indicators is likewise crucial.

A fundamental step in building the rationale is articulating which definition of sustainability is being used (Chee Tahir & Darton, 2010). As Lamberton (2005) suggests, this helps determine the breadth and complexity of the accounting framework and the selection of indicators.

4.1 Accounting for Water as an Ecosystem Service

An ecosystem accounting framework is one that revisits the natural capital origins of sustainability accounting. The concept is also emerging within traditional accounting circles (Bonner, 2012; Kharrazi, 2013). Applying an ecosystem lens to sustainability accounting heightens the awareness of future limits to natural resources. This creates an advantage for corporate decision makers in forecasting regulatory changes and in identifying risk-mitigation strategies and opportunities (Bonner, 2012). As more financial accountancies consider natural capital and ecosystem impacts in their risk evaluations, the connection between these issues and its effect on profit, asset value and cash flow (Bonner, 2012) will become more entrenched.

Husemann (2003) suggests that addressing water shortages only through technological applications limits the complexity of water issues. By contrast, an ecosystem perspective recognizes that sustainability is more than increasing the efficiency of internal processes (Kharrazi, 2013). Reddy et al. (2015) propose the need for businesses to expand their water efficiency strategies to include basin specific actions, including ecological protection, restoration and environmental flows.

Diaz and Bell (1997) describe sustainable ecosystem management as a holistic method of managing ecosystem patterns and processes to ensure they continue to provide benefits and commodities. Rather than replace the multiple dimensions of the triple bottom line philosophy, an ecosystem centred framework incorporates the sustainability domains of environment, society and economy within a systems model, which is better suited to demonstrating their interdependencies.

Although accounting for ecosystem services can be a more complicated approach than current practice (Waage, 2008), the World Business Council (2013) found the main business advantages to be an overall enhancement in decision-making, revenue maintenance, cost reduction, risk management and corporate reputation. However, one of the main drawbacks for many managers is the lack of disclosure guidelines and valuation methodologies to support sustainable ecosystem management (TEEB, 2010).

A sustainability framework centred on ecosystem management facilitates the assessment of direct exposure to WBBR for the food and beverage industry. First, it aligns water based business risks with the complexity of the water cycle. And secondly, it reinforces the connection between water and firm performance, by recognizing that the management of water ecosystems is inseparable from long-term financial performance for the food and beverage industry.

5.0 Objective and Research Questions

Given the context of the global water crisis, two of the main findings emerging from the literature review are: a) the materiality of freshwater resources particularly for the food and beverage industry and b) the insufficiency of current sustainability accounting systems to incorporate ecosystem management to screen for material water risks.

This research applies principles from sustainability accounting theory to evaluate corporate disclosures from the perspective of ecosystem management. It also used the results from this evaluation to test the relationship between corporate water risk management, social ratings scores and corporate financial performance. The purpose of this research is to identify the interaction between corporate water risk and corporate financial performance. It takes into consideration the slack resources theory for its CSP-CFP assessments, that CFP precedes engagement in CSP activities (McGuire, 1988).

A mixed method research design was used to examine the following research questions:

1. What indicators do companies in the food and beverage industry use to manage water risk?
2. What is the relationship between corporate water risk management and overall sustainability performance?
3. What is the connection between water risk management and corporate financial performance?

6.0 Method

The study adopted a mixed method research design. This approach was adopted primarily due to the pluralistic nature of the study which required the collection of qualitative and quantitative data. Mixed method research (MMR) allows for the independent evaluation of data for corporate water risk performance and for corporate financial performance prior to synthesizing the data to demonstrate whether a convergence or divergence occurred (Creswell, 2014).

The qualitative data required transformation or "quantitizing", which Teddlie and Tashakkori (2012) describe as a signature analytical process for MMR. Data transformation often involves an iterative process that enables the researcher to develop a profound understanding of the variables (Teddlie & Tashakkori, 2012).

Another purpose for selecting MMR is that it is often associated with a pragmatic paradigm. Pragmatism is often centred on a real world challenges (Creswell, 2014). This is consistent with the philosophical worldview guiding this research, which was motivated by the anticipated global water crisis and the potential impact on the food and beverage industry, financial stakeholders, communities and ecosystems.

The study undertook the following processes in conducting the research

1. The development of metrics to screen corporate disclosures for water risk management.
2. Descriptive analysis of corporate water risk management scores, sustainability ratings and financial data.

3. Correlative and regression analyses of the relationships between corporate water risk management (CWRM), sustainability ratings and corporate financial performance.

6.1 The Development of the Corporate Water Risk Accounting Framework

The framework for corporate water risk accounting was based on a natural capital definition of sustainability (see Section 1.3). This definition was used to guide the scope and selection of indicators. As with Nikolaou et al.(2014), the indicator system applied a scoring-benchmarking method to appraise various disclosure documents for performance in corporate water risk management.

The benchmarking system was created through an iterative process adapted from the method outlined by Gioia et al. (2012). This process was used to identify leading indicators that could assess the strategic management of watersheds for the long term (Figge et al, 2002).

The literature review also contributed to this process as it identified many of the preliminary areas of concern affecting water resources for the food and beverage industry, which the framework needed to address. The areas of concern consisted of agricultural supply chain, climate change, impacts on local communities and watershed, sustainable water supply, water variability and water quality.

Five categories were previously identified as priority areas to assess a firm's exposure to water risks (Barton, 2010). The categories (water accounting, stakeholder engagement strategies, risk assessments, direct operations and supply chain) were used to cluster the areas of concern into workable themes.

Second order concepts were derived from a deductive procedure which involved the review of various corporate tools, scholarly articles on ecosystem services benchmarking and corporate water accounting (Appendix A). Unlike water accounting tools, ecosystem management tools tend to place an emphasis on the economic valuation of natural capital (Waage, 2008; Reddy, 2015). Statements were extracted from the resources for comparison and similar themes were clustered together.

The final process involved amalgamating the themes from both processes into workable categories. This resulted in the following five categories: Water Value, Water Inventory, Water Accounting, Sustainable Supply Management and Supply Chain.

Indicator Taxonomy

The framework was structured to be an interpretive and evaluative tool. Each category included a definition which was a summary statement derived from the thematic clustering of statements. The categories were operationalized with a series of defining statements. These defining statements were granular definitions of each category, which served to frame the scope for the assessment and provide clarity for evaluating disclosure statements. Table 3 outlines the CWRM framework used to scorecard corporate disclosures.

Table 3: Corporate water risk management benchmarking framework

Corporate Water Risk Benchmarking Framework	
Water Risk Category	Defining Statements
1. *Water Value*: Recognizes water as a non-substitutable priority resource and employs water-focused strategies to gain competitive advantage.	WV_1 : States dependency on freshwater as a major input in operations
	WV_2: Identifies factors (climate change, over abstraction, water pollution, etc.) that pose risks to their financial performance.
	WV_3: Identifies new opportunities/markets to respond to water risks in direct operations
2. *Water Inventory*: Maps the locations(s) of their facilities in terms of exposure to water stress and identifies water source(s) used in operations	WI_1: Maps facilities exposed to water stress
	WI_2: Identifies facilities' water sources (surface, ground, rain, etc.)
	WI_3: Monitors changes in local water supply/quality over time
3. *Water Accounting*: Audits internal use and external impacts of direct operations on the watershed	WA_1: Collects data on water use in facilities
	WA_2: Establishes standards/goals for water use or efficiency targets
	WA_3: Assess impact of water use on local ecosystem/watershed (water quality)
	WA_4: Assess impact of water use on local communities (human health, cultural aspects, etc.)
4. *Sustainable Supply Management*: Corporate policies and initiatives are in place to guide management of shared water resources	SSM_1: Publically available corporate policies or strategies for water resource management
	SSM_2: Establish standards for corporate water stewardship
	SSM_3: Assigned accountability for water and ecosystems services management to staff, committee and or management
	SSM_4: Directly contributes to initiatives that promote ecosystem/wetland preservation in watershed
	SSM_5: Collaborates with community stakeholders on water related issues
	SSM_6: Incurred penalties or non-monetary sanctions due to liabilities regarding water
5. *Supply Chain*: Procurement strategies to minimize water risks in the supply chain for key agricultural inputs	SC_1: Identifies factors (climate change, overabstraction, water pollution, etc.) that pose a risk to key agricultural inputs
	SC_2: Maps the location of key agricultural inputs to identify exposure to water stress
	SC_3: Established sustainable supplier standards or procurement codes containing biodiversity/ecosystem services management
	SC_4: Incorporates water policy in procurement codes
	SC_5: Strategies to minimize risks in the supply chain

Corporate performance was assessed across four criteria: keyword, performance, quantitative measures and benchmarks as summarized in Table 4. This measured the relative intensity of focus attributed to the statements (Cohen et al, 2012). This resulted in 84 observations to measure a firm's water management strategy and performance.

Table 4: Criteria used to assess corporate performance of water risk management.

Criteria	Scope	Example Statements from Corporate Disclosure	Category & Defining Statement
Keyword	Refers to formal (policy or strategy statements) or informal (aspirational) statements, whereby the firm acknowledges their relationship to water or water related impacts.	*Water is important to our operations (1.1)…* *Climate change poses a threat to our agricultural supply chain (5.1)…*	*Water Value* *1.1 -States dependency of freshwater as a major input in operations* *Supply Chain* *5.1- Identifies factors that pose risks to key agricultural inputs*
Performance	Refers to actions or efforts a firm is engaged in; or reported case studies involving initiatives to reduce or mitigate a water based business risk or impact	*Our employee-led Sustainability Committee consults with management on initiatives to promote water conservation projects in the community and on-site (4.3)*	*Sustainable Supply Management* *4.3-Assigned accountability for water and ecosystem services to staff, committee or representative on Board of Directors*
Quantitative Measures	Refers to disclosed quantified measures of performance	*The recent opening of the Mexico facility has increased our overall water usage by 15% across our facilities in 2014 (3.1)*	*Water Accounting* *3.1-Collects data on water use in direct operations*
Benchmark	Refers to internal evaluations of a firm's performance against industry best management practices. This was assessed through memberships or certifications with industry organisations	*We have engaged in partnerships with: Bonsucro, Sustainable Agriculture Initiative (SAI), The Rainforest Alliance, Global G.A.P (Good Agricultural Practice).(5)*	Supply Chain 5.5-Strategies to minimize risks in the supply chain

The scorecard also included a “Tools and Resources” column. The tools provided implicit measures of how a firm manages and measures water risks in their direct operations or in the supply chain (APPENDIX B). For instance, membership in BIER (Beverage Industry Environmental Roundtable) was known to provide members with industry specific information on benchmarks. Other organizations, such as Bonsucro, facilitated sustainable agricultural practices for sugar cane plantations, thus minimizing water and biodiversity risks in the agricultural supply chain.

6.2 Scoring System

Interpretative content analyses were conducted using the firm’s most current corporate disclosures. The purpose for the content analysis was to describe the various corporate disclosures in quantitative terms (Gioia et al., 2014). Various corporate disclosures (see Section 6.3) were screened for statements regarding a firm’s water use and management across their value chain. These statements were assessed against defining statements of water risk management practices. A three point scale was used in order to simplify the scoring process and to minimize subjectivity (Nikolaou et al., 2014). A score of 1 was assigned when an action had been taken, 0 was assigned when there was no evidence that action had been taken, and -1 was assigned when a penalty was pending or levied. Table 5 provides an example of how a statement would be assessed using the CWRM framework. The assumption in this example is that there were no further statements to demonstrate that an action (performance) was implemented.

Table 5: Example of score allocation

Example: *The recent acquisition of XYZ plant has caused our water use to increase by 15% in 2013*

Water Accounting	**Defining Statement**	**Keyword**	**Performance**	**Quantified**	**Benchmark**	**Sub-total**
3.1	Collects data on water use in direct operations	1 *Water use information is being disclosed*	0 Evidence of actions to manage or reduce water use has not been disclosed	1 Water use is being measured and disclosed	1 Membership in BIER, establishes industry benchmarks and best practices for operational water use	3

Subtotals were calculated by adding points allocated for each of the defining statements for the category. A total score was obtained by adding the subtotals.

CWRA (Corporate Water Risk Assessment) = $\sum^{3} WV_i + \sum^{3} WI_i + \sum^{4} WA_i + \sum^{6} SSM_i + \sum^{5} SC_i$,

where $O \leq CWRA \leq 84$

Reliability

Pretesting was performed using the disclosure documents from five firms representing each of the three sub-industries (2 –Beverage firms, 2 –Food & Meat Processing 1- Agricultural Products). Keyword search was used to locate statements that referred to water management, ecosystem management, business risks, climate change, agricultural supply chain, water quality and so forth. Statements taken from the disclosures were compared to the framework to refine the categories and defining statements (Spiggle, 1994).

When a new concept (or tool or resource) was encountered during the course of the review, (eg. Bonsucro), it would initiate further research to determine the role it served in improving a firm's water management strategy. If it contributed towards water, ecosystem or biodiversity management, it would be assessed as part of the firm's disclosure documents. Previously assessed corporate disclosures would subsequently be reviewed by keyword search to correct for any bias in scoring.

One of the more significant challenges with this process was adjudicating statements that could be allocated to more than one category. This challenge was resolved by deconstructing the statement to see how it applies to the firm's operations. For example, one firm disclosed the development of drought resistant seeds. This prompted the following question: *Are the drought resistant seeds used in company owned farms, or by the suppliers or both?* Once a decision was made the points were assigned to a single category.

6.3 Data Collection of Corporate Water Risks

Three types of publically available disclosure formats were appraised. These included: voluntary reports (eg. sustainability reports, supply chain policies, company websites), questionnaires (eg. Carbon Disclosure Project-Water Program (CDP-W), and mandatory filings (eg. 10-k's, Annual Reports). One of the advantages of using multiple data sources as Creswell (2014) states is that it contributes toward the convergent validity of observations for the content analysis.

Table 6 provides an inventory of the types of disclosures assessed according to year of publication. Thirty-two CSP reports published between 2013 and 2014 were reviewed. Seventeen submissions to the CDP-Water questionnaire were reviewed along with 57 mandatory filings and 62 websites.

Table 6: Inventory of corporate disclosures

Types of disclosures	2009	2010	2011	2012	2013	2014
CSP Reports	1		1	2	14	13
Mandatory Filings				1	7	49
CDP-Water					2	15
Websites						62

6.4 Financial Indicators

Market-based metrics reflect the bidding and asking processes of the stock market. As such, it is indicative of the role of shareholders as a primary stakeholder in determining a firm's share price or market value (Cochran &Wood 1984). Market based data was operationalized into performance metrics, CAGR (Compound Annual Growth Rate) and P/E (Price to Earnings ratio) to assess a firm's financial performance in the stock market.

Accounting returns offer insight on the internal efficiencies of the firm. They are influenced by a manager's decisions regarding the allocations of funds to projects and policy choices (Orlitzky & Schmidt, 2007). Earnings Before Interest, Taxation Depreciation and Amortization (EBITDA) was operationalized into a performance metric; EBITDA margin, which offers insight regarding a firm's operational productivity.

In CSP-CFP studies, the relationship between accounting-based indicators and CSP tends to be stronger than with market-based indicators (Orlitzky et al., 2003). Table 7 summarises the accounting and market indicators selected.

Mean values for each indicator was calculated over a 6-year period starting January 1, 2009 ending December 31, 2014.

Table 7: Descriptions of financial indicators

Performance Metrics	
Compound Annual Growth Rate (CAGR)	CAGR is the compounded growth rate over time. It was calculated using the share price starting January 2009 ending December 31, 2014. It is used as an indicator for share price profitability.
Price to Earnings Ratio (P/E)	Price to Earning ratio is calculated by dividing share price by share earnings. P/E is used as an indicator for share price profitability.
EBITDA Margin	EBITDA margin is calculated by dividing EBITDA by Total Revenue. It is an accounting performance metric that indicates operational profitability
Accounting Variables	
Current Assets	This item represents cash and other assets that are expected to be realized in cash or used in the production of revenue within the next 12 months.-
Revenue Total	Financial Services Definition This item represents the gross income received from all divisions of the company.
Operating activity net cash flow	This item represents the net change in cash from all items classified in the Operating Activities section on a Statement of Cash Flows.
EBITDA	Earnings before interest, tax, depreciation and amortization
Market Risk	
Share Price standard deviation divided by share price	The relative standard deviation of the mean share price over a 6 year period divided by the share price is used as a proxy variable to indicate volatility of share price or market risk
Control Variables	
Total Assets	This item represents the total assets/liabilities of a company at a point in time. It is used as a control variable as an indicator for firm size.
Number of employees	This item represents the total number of employees employed by the firm across all their facilities. It is used as a control variable as an indicator for firm size.

Source: Wharton Compustat

6.5 Data Collection of Financial Variables

Market value and accounting variables were obtained using the *Compustat Monthly Updates North America* dataset. A search was conducted by using a text file that contained a list of the ticker symbols for each of the 63 firms in the search field. Four identifying variables

(Company name, stock exchange code, ticker symbol, GIC sub-industry) were selected to verify the company profile and to segment the data according to industry sub-category. Market value data was collected using the *Security Daily web query*. This generated daily postings of the share price and share earnings over a 6-year period.

Accounting data were obtained using the *Fundamental Annual* web query. This query posted annual values for Current Assets, Total Revenue, Operating activity net cash flow, EBITDA, Employees and Total Assets. Both market and accounting data were taken from between January 1, 2009 to December 31, 2014, which encompasses both lagging and concurrent time periods as most of the corporate disclosures reviewed. Research from Orlitzky et al. (2003) has shown that relationships between social and financial performance are as often likely to be concurrent as they are to be lagging or leading.

Datasets were screened for duplicate listings on other stock exchanges. Financial data from the stock exchange listing with the least amount of data fields were deleted from the sample.

7.0 The Sample

A sample of 63 firms was identified from a universal dataset for which financial and sustainability data could be obtained. The dataset was created by merging corporate listings from the *S&P Capital IQ's COMPUSTAT North America* database with the *KLD 2012 Historical Spreadsheet.*

The COMPUSTAT database holds financial, statistical and market data on most publicly held corporations in Canada and the United States. KLD Social Ratings data is considered a reliable standard for the quantitative measurement of the CSP construct in scholarly research ((Mattingly & Berman 2006).

The universal dataset was sorted using the Global Industry Classification Standard (GICS), an industrial classification system that categorizes all major publically traded companies. The GICS taxonomy consist of 4 levels: Sectors, Industry, Industry Group and Sub-sectors. As food & beverage companies are listed in the same Industry Group as tobacco (3020) further segmentation, using the sub-industry classification was required to delete it. The final list of sub-industries consisted of the following GICS sub-industry groups: Brewers, Distillers and Vintners, Soft Drinks, Agricultural Products, Packaged Foods and Meats. Table 8 provides a description of the sub-categories. Brewers, Distillers and Vintners and Soft Drinks were combined to create the Beverage category.

Table 8: Descriptions of the GICS sub-industries for the food and beverage industry

GICS (Global Industry Classification Standard) Effective after close of business (US, EST) Friday, February 28, 2014		
Sub-Industry		Description
Brewers	30201010	Producers of beer and malt liquors. Includes breweries not classified in the Restaurants Sub-Industry.
Distillers & Vintners	30201020	Distillers, vintners and producers of alcoholic beverages not classified in the Brewers Sub-Industry
Soft Drinks	30201030	Producers of non-alcoholic beverages including mineral waters. Excludes producers of milk classified in the Packaged Foods Sub-Industry.
Agricultural Products	30202010	Producers of agricultural products. Includes crop growers, owners of plantations and companies that produce and process foods but do not package and market them. Excludes companies classified in the Forest Products Sub-Industry and those that package and market the food products classified in the Packaged Foods Sub-Industry.
Packaged Foods & Meats	30202030	Producers of packaged foods including dairy products, fruit juices, meats, poultry, fish and pet foods.

Source: www.msci.com/gics

Of the 63 food and beverage firms, two were removed because their corporate disclosures were no longer publically available on either the KLD or Compustat database. *Hillshire Brand Company* had fully merged with Tyson Foods Inc. in August 2014, creating a single entity. *Griffin Land & Nursery* had sold its agricultural division and is currently operating as a holding company within the real estate industry. The final sample, derived from the universal dataset, consisted of sixty-one food and beverage firms, each with publically accessible data on their financial and sustainability performance.

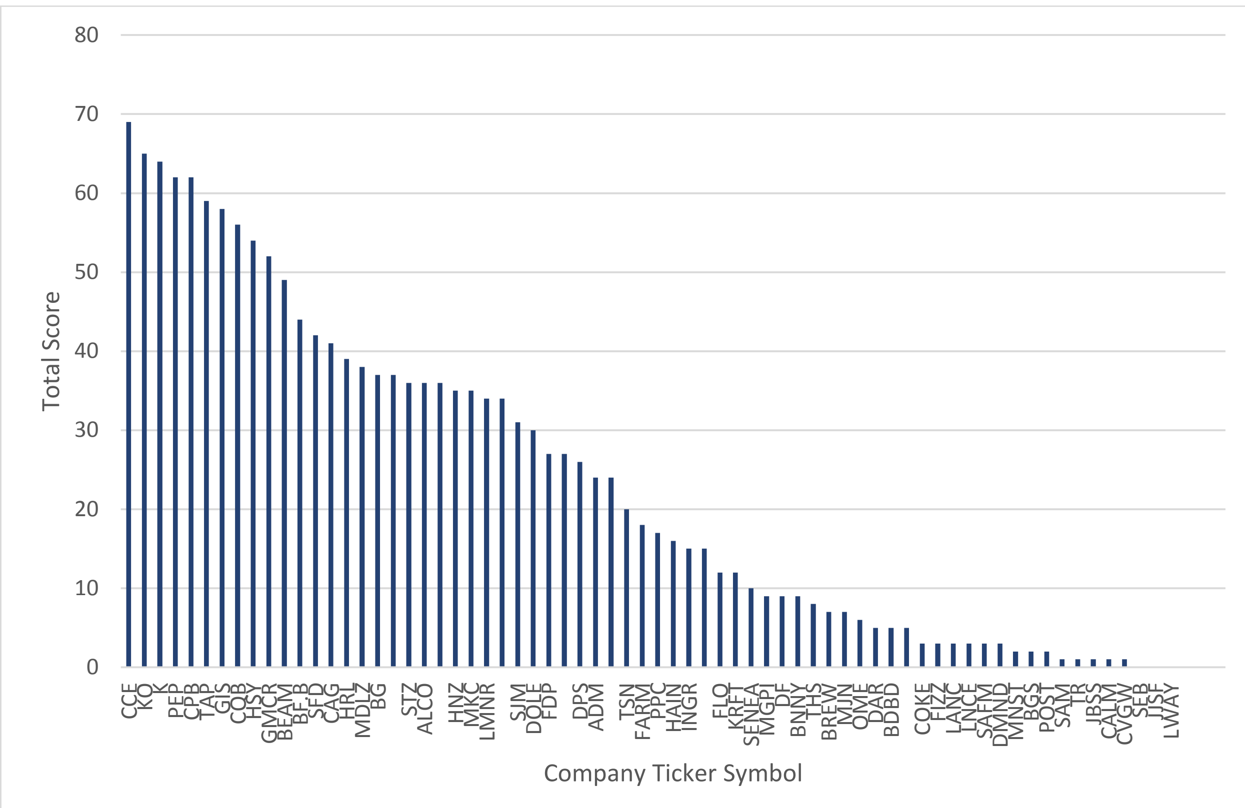
8.0 Results

Descriptive statistical analyses were conducted to gain an overview of each firms' current standing within the industry and to compare each firm's sustainability and financial performance against their competitors (Riley, 2003).

Descriptive Analysis of Corporate Water Risk Management Scores

Figure 3 shows the distribution of CWRM scores for firms from the sample (n=61). Firms were identified using their stock exchange ticker symbol.

Figure 3. Distribution of CWRM scores for food and beverage firms



Overall CWRM scores ranged from a minimum value of 0 to a maximum value of 69. The mean score was 23.2 with a SD of 21.6. Forty-six percent, or 25 firms, obtained a CWRM score ≤ 10.

Five of the top ten scoring firms belonged to the Beverage sub-industry (Table 8), the remaining firms belonged to the Packaged Food and Meats sub-sector. Table 9 lists the firms in order of their CWRM score.

Table 9: Total corporate water risk scores

Industry	Company Name	Ticker	SCORE	Industry	Company Name	Ticker	SCORE
Bev	Coca-Cola Enterprises Inc.	CCE	69	Agr	Ingredion Inc.	INGR	15
Bev	Coca-Cola Co	KO	65	Food	Flowers Foods Inc.	FLO	12
Food	Kellogg Co	K	64	Food	Kraft Foods Group Inc.	KRFT	12
Bev	Pepsico Inc.	PEP	62	Food	Seneca Foods Corp	SENEA	10
Food	Campbell Soup Co	CPB	62	Food	MGP Ingredients Inc.	MGPI	9
Bev	Molson Coors Brewing Co	TAP	59	Food	Dean Foods Co	DF	9
Food	General Mills Inc.	GIS	58	Food	Annie's Inc.	BNNY	9
Food	Chiquita Brands Intl Inc.	CQB	56	Food	Treehouse Foods Inc.	THS	8
Food	Hershey Co	HSY	54	Bev	Craft Brew Alliance Inc.	BREW	7
Food	Green Mtn Coffee Roasters	GMCR	52	Food	Mead Johnson Nutr.	MJN	7
Bev	Beam Inc.	BEAM	50	Food	Omega Protein Corp	OME	6
Bev	Brown-Forman -Cl B	BFG	44	Agr	Darling International Inc.	DAR	5
Food	Smithfield Foods Inc.	SFD	42	Food	Boulder Brands Inc.	BDBD	5
Food	Conagra Foods Inc.	CAG	41	Bev	Coca-Cola Btlng Cons	COKE	3
Food	Hormel Foods Corp	HRL	39	Bev	National Beverage Corp	FIZZ	3
Food	Mondelez International Inc.	MDLZ	38	Food	Lancaster Colony Corp	LANC	3
Agr	BUNGE LTD	BG	37	Food	Snyders-Lance Inc.	LNCE	3
Bev	Constellation Brands	STZ	36	Food	Sanderson Farms Inc.	SAFM	3
Agr	Alico Inc.	ALCO	36	Food	Diamond Foods Inc.	DMND	3
Food	Heinz (H J) Co	HNZ	35	Bev	Monster Beverage Corp	MNST	2
Food	Mccormick & Co Inc.	MKC	35	Food	B&G Foods Inc.	BGS	2
Agr	Limoneira Co	LMNR	34	Food	Post Holdings Inc.	POST	2
Food	Smucker (Jm) Co	SJM	31	Bev	Boston Beer Inc. -	SAM	1
Food	Dole Food Co Inc.	DOLE	30	Food	Tootsie Roll Industries	TR	1
Agr	Fresh Del Monte Produce Inc.	FDP	27	Food	Sanfilippo John B&Son	JBSS	1
Bev	Dr Pepper Snapple Group Inc.	DPS	26	Food	Cal-Maine Foods Inc.	CALM	1
Agr	Archer-Daniels-Midland Co	ADM	24	Agr	Calavo Growers Inc.	CVGW	1
Food	Tyson Foods Inc.	TSN	20	Food	Seaboard Corp	SEB	0
Food	Farmer Bros Co	FARM	18	Food	J & J Snack Foods Corp	JJSF	0
Food	Pilgrim's Pride Corp	PPX	17	Food	Lifeway Foods Inc.	LWAY	0
Food	Hain Celestial Group Inc.	HAIN	16				

Corporate Water Risk Performance According to Sub-Category

Firms were also segmented according to their sub category for further comparison. Table 10 provides a descriptive summary of the distribution of scores under each sub-industry category. Results for the Beverage (n=14) and Packaged Food and Meats (n=40) sub-industries show very high standard deviations, indicating highly variable distribution of scores relative to the mean. Agricultural Products (n=7) had a low standard deviation by comparison (SD=11.9).

Table 10: Descriptive analysis according to sub-industry category

Descriptive Data	Beverage	Agricultural Products	Packaged Food and Meats
N	14	7	40
Min	1	5	0
Max	69	37	64
Mean	31.1	25.4	20.15
SD	26.7	11.9	20.6
Median	31	27	11

The highest scoring firm in the Beverage (n=14) sub-industry was Coca Cola Enterprise (69). Boston Beer (1) received the lowest score for this sub-industry. For Agricultural Products the highest scoring firm was Bunge ltd. (37) and Darling International (5) was the lowest. For the Packaged Food and Meats category, the highest scoring firm was Kellogg Co (64) and the lowest scoring firms were Lifeway Foods (0), J & J Snack Foods Corp (0) and Seaboard Corp. (0).

Analysis of Corporate Disclosures

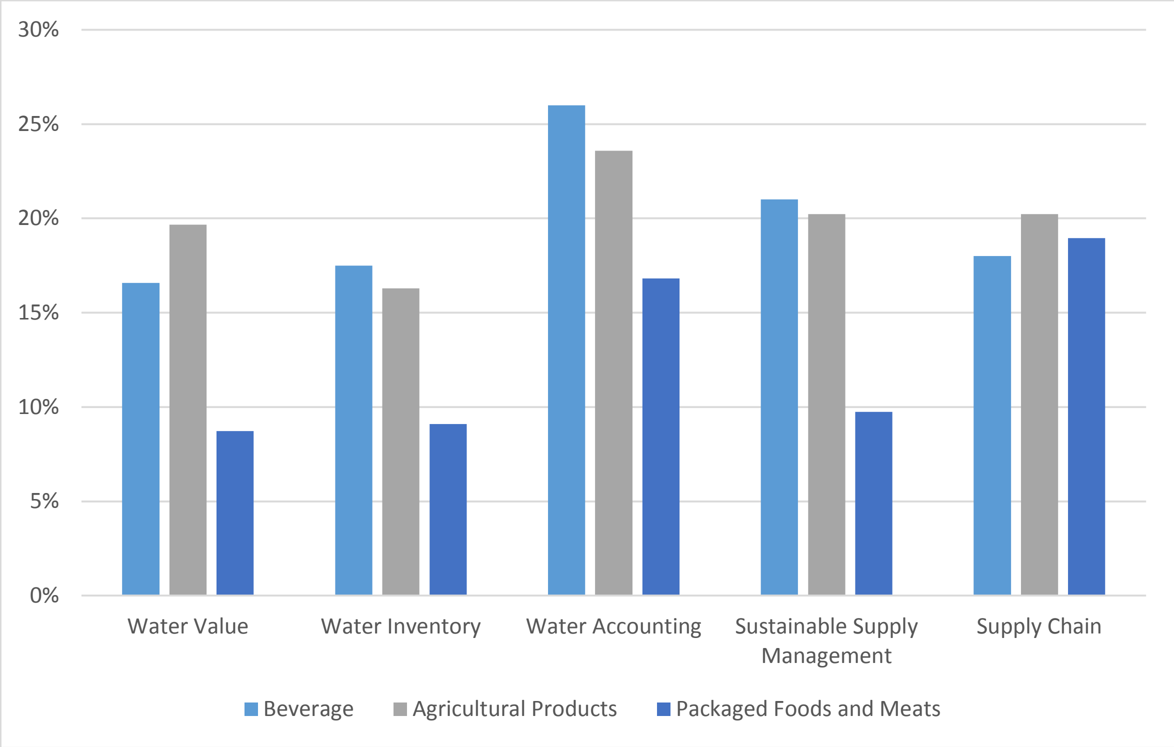
Table 11 compares leading and lagging disclosure categories for each sub-industry.

Table 11: Leading and lagging disclosure categories according to sub-industry

Sub-Industry	Water Value	Water Inventory	Water Accounting	Sustainable Supply Management	Supply Chain
Beverage	17%	18%	26%	21%	18%
Agricultural Products	20%	16%	24%	20%	20%
Packaged Food and Meats	9%	9%	17%	10%	19%

The leading disclosure category for Beverage industries was Water Accounting (26%); the lagging disclosure category was Water Value (17%). The leading disclosure category for Agricultural Products was Water Accounting (24%), lagging was Water Inventory (16%) and the leading disclosure category for Packaged Food and Meats was Supply Chain (19%) while lagging in both Water Value and Water Inventory (9%) disclosure categories (Figure 4)).

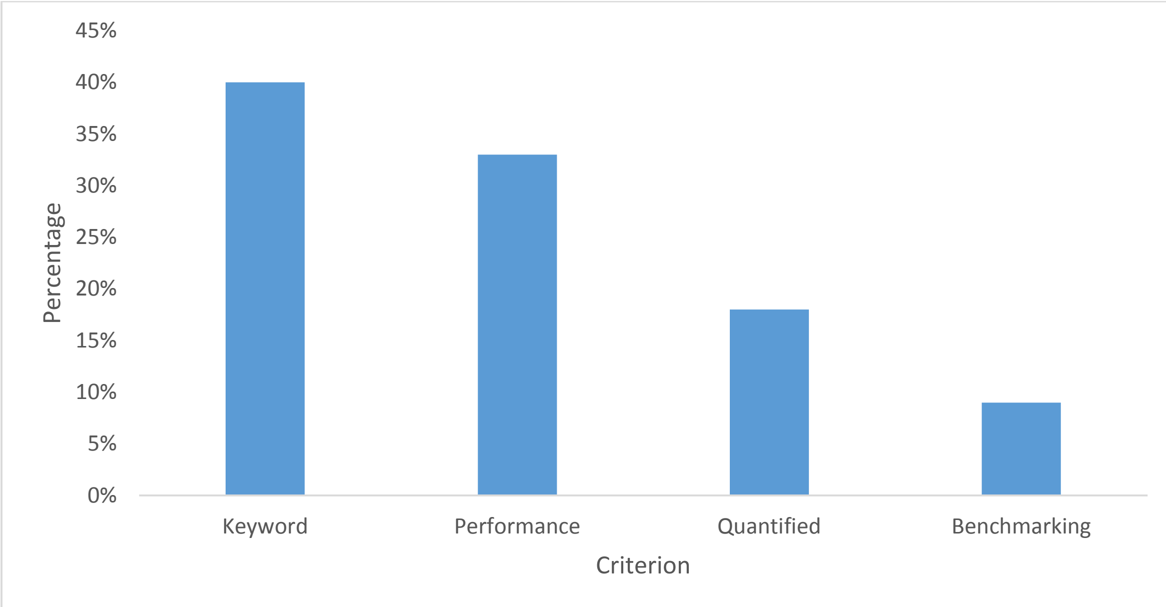
Figure 4. Distribution of disclosure by category and sub-industry



The leading performance disclosure in the Supply Chain category for the Packaged Food and Meats sub-industry reflects their dependence on agricultural commodities. This is consistent with the sub-sector's use of external resources to facilitate sustainable agricultural initiatives for their key agricultural commodities.

Figure 5 shows the focus of the disclosures. Firms overwhelmingly disclosed qualitative information (keyword and performance) (73%) while only 23% percent provided quantitative information (quantified and benchmark)

Figure 5. Disclosures according to indicator criterion



8.1 Descriptive Analysis for KLD Data

A descriptive summary of the KLD Strength and Concern scores for 2012 and 2013 is presented in Table 12. The KLD_{2012} strength scores (n=61) had a mean of 2.23 with a max scores of 10 and min score of.0. The KLD_{2012} concerns score had a mean score of 1.25 with a max and min score range of 8 and 0 respectively.

Table 12: Summary of KLD strength and concern scores for 2012 and 2013

KLD_{2012} (n= 61)			KLD_{2013} (n=49)	
	Strengths	**Concerns**	**Strengths**	**Concern**
Min	0	0	0	0
Max	10	8	14	7
Mean	2.23	1.25	4.2	1.65
SD	2.88	1.68	4.7	1.54
Median	1	1	1	1

8.2 Descriptive Analysis for Financial Data

Data for number of employees (n=59) and total assets (n=60) were used as control metrics indicating firm size. Mean values were calculated using data from the Compustat database from January 1, 2009 to December 31, 2014. The number of employees for this sample ranged from a max of 269,500 to a min of 112. The mean value was 21,900. Total assets ranged from a max of $78,448, 330 USD to a min of $56,000 USD and had a mean value of $17,865,620. Table 13 is a summary of the descriptive analysis for the control variables.

Table 13: Descriptive statistics for firm size variables

	Mean Employees	Mean Total Assets (USD)
N	59	60
Min	.112	56,000
Max	269.5	78,448,330
Mean	21.9	17,865,620
SD	43.01	9,720,256
Median	6.43	2,932,995

Table 14 provides a summary of the descriptive analysis for market (share price) and accounting (current assets, EBITDA, net cash flow and total revenue) variables expressed in USD.

Table 14: Descriptive summary of financial variables

	Mean Share Price	Mean Current Assets	Mean EBITDA	Mean Net Cash Flow Operating	Mean Total Revenue
N	61	60	60	60	60
Min	6.0765	10,076	5,300	2,363	65,965
Max	2113.038	26,540,830	12,076,170	9,832,330	78,599,830
Mean	73.075	3,123,113	1,288,766	938,825	98,17,282
SD	266.47	5,965,513	2,478,294	1,903,254	17,626,630
Median	37.118	1,138,248	351,076	253,721	3,138,502

9.0 Analyzing the Relationships: Corporate Water Risk Managemetnt, Social Rating and Financial Performance

Five hypotheses were developed to test the associations of CWRM with social ratings scores and with CFP. These relationships were tested using correlation tests with significance and regression analyses.

9.1 CWRM and KLD Correlations

Hypothesis 1a: Firms with high KLD strength scores will present high CWRM scores.

Hypothesis 1b: Firms with high KLD concern scores will present low CWRM scores.

KLD strength and concern scores were considered independently rather than a net score. Mattingly & Berman (2006) identified that KLD strengths and concerns were non-convergent and thus do not represent opposing sides of the same underlying construct.

Scatter plots were graphed to evaluate the bi-variate relationships between CWRM scores and KLD strength and concern scores (Figures 6 to 9). The KLD scores were the independent variable and CWRM scores the dependent variable. All the graphs showed positive linear clusters but the KLD strengths graphs were more linearly defined.

Figure 4. KLD2012 strengths ratings and CWRM scores

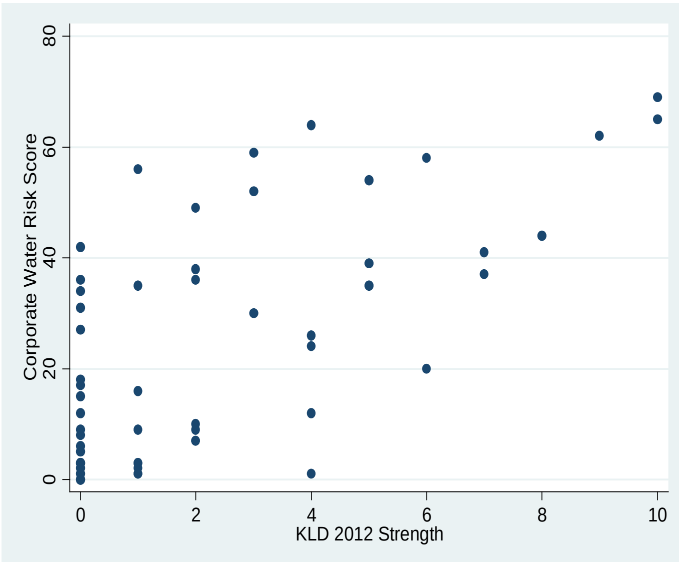


Figure 5. KLD2013 strengths ratings and CWRM scores

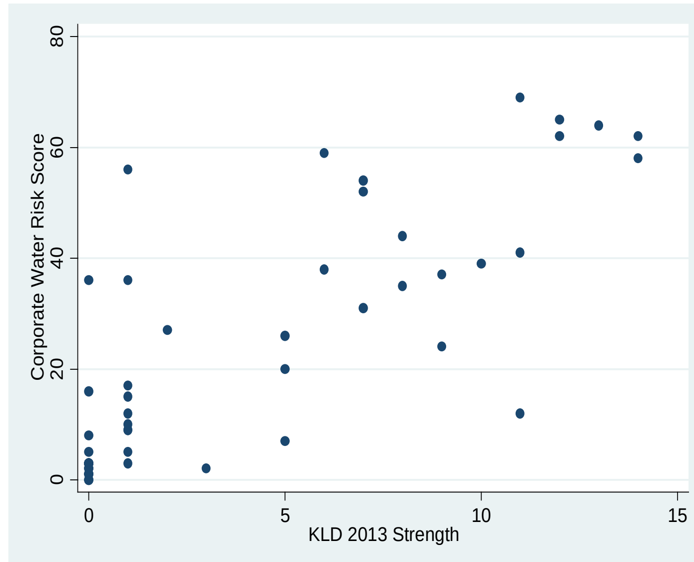


Figure 6. KLD2012 concern ratings and CWRM scores

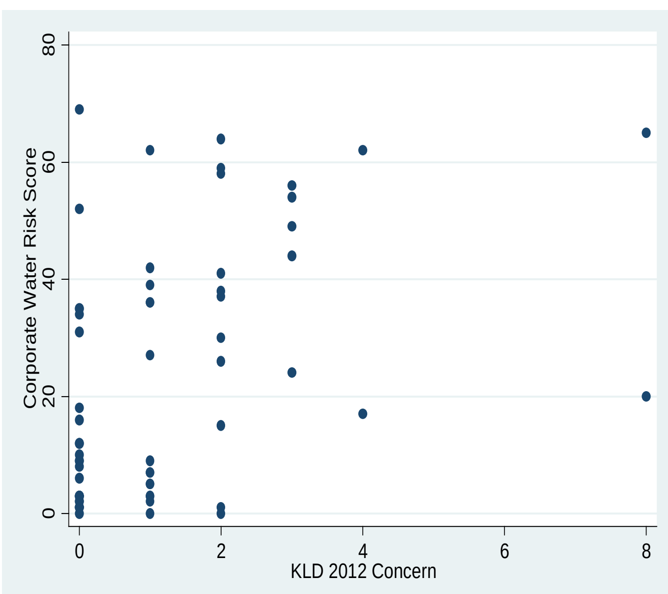
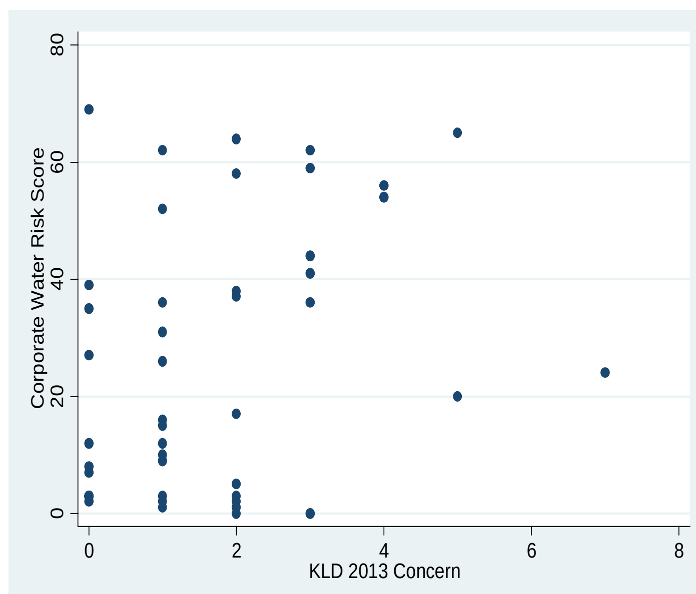


Figure 7. KLD2013 concerns ratings and CWRM scores



The correlation matix (Table 15) presents KLD_{2012} strength scores (n=61) as positively and significantly correlated (r=.6959) with CWRM scores at $p < .05$ and $p < .01$ levels. Similar results were found for the strength scores for KLD_{2013} (n=49).

The concern scores for 2012 and 2013 unexpectedly presented a positive and significant correlation with CWRM scores at the $p < .05$ level only. It was anticipated that KLD concern scores would reflect a negative association with CWRM scores (i.e., firms with a low KLD Concerns scores would score high in CWRM performance). This association could be explained by Mattingly's (2006) observation, that KLD strength and concern scores are indeed independent constructs and do not co-vary.

Table 15: Correlation matrix for KLD_{2012} and KLD_{2013} strength and concern scores and CWRM, with significance levels

	CWRM	KLD_{2012} Strength	KLD_{2013} Strength	KLD_{2012} Concern	KLD_{2013} Concern
CWRM	1.0000				
KLD_{2012} Strength	.6959**	1.0000			
KLD_{2013} Strength	.7921**	0.8308**	1.0000		
KLD_{2012} Concern	.4275*	0.5227*	1.0000	1.0000	
KLD_{2013} Concern	.3276*	0.3719*	0.2630	0.7252*	1.0000

*p < .05, **p < .01

9.2 CFP and CWRM scores

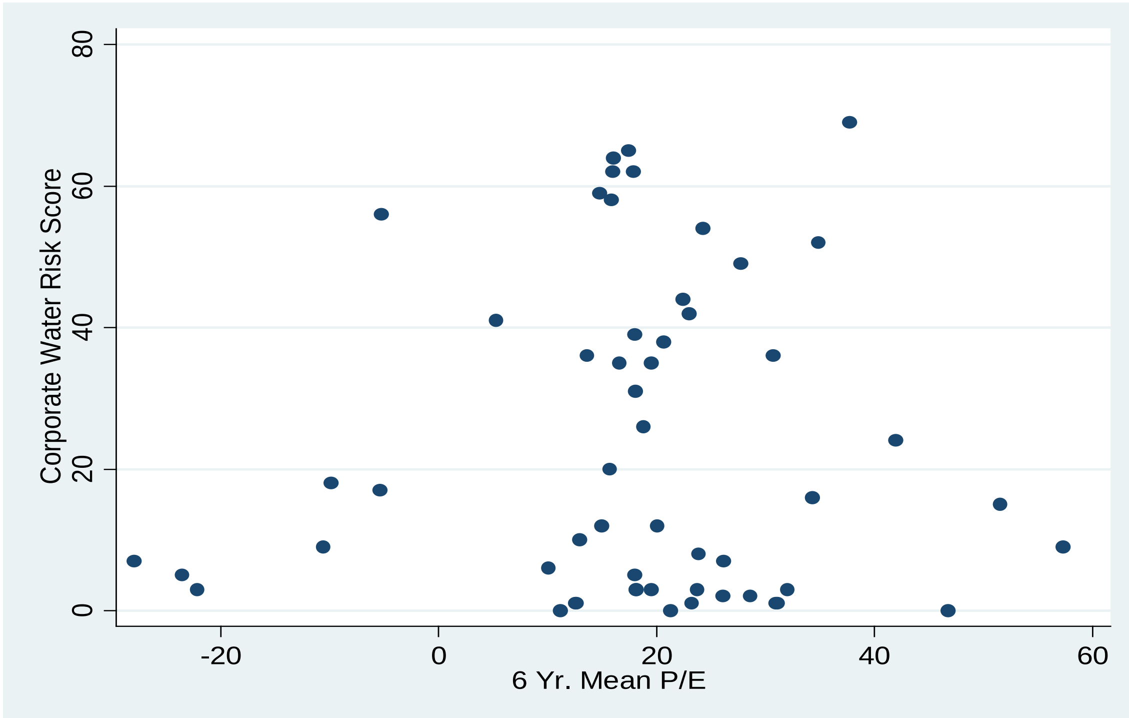
Hypothesis 2: Firms with higher market value performance will present high CWRM scores.

Market value performance was tested using two market performance indicators, mean Price to Earning ratio (P/E) and Compound Annual Growth Rate (CAGR). Both indicators were calculated using data posted over a 6 year period from the Compustat database. In each case, CWRM scores were the dependent variable.

A total of 56 firms remained in the sample after 5 outliers were removed. Box plots were graphed as a preliminary step for each analysis to detect outliers. Mean values which fell beyond the maximum and minimum range for each box plot were identified as outliers and were omitted from the analysis.

The mean P/E ratio was calculated for each firm using share price and share earnings data from January 1, 2009 to December 31, 2014. A scatter plot was used to assess the bi-variate relationship for CWRM and P/E (Figure 10). The graph presented a predominantly vertical cluster, which suggests that changes in the P/E ratio has little to no effect on CWRM scores. The correlation value (r=.0503) presents a positive though very weak association. The p-value resulting from a bi-variate linear regression (p=.648) further confirmed that there was no significant relationship to determine whether P/E performance correlates with CWRM scores. The low R^2 value =.0039 indicates that the CWRM and P/E bi-variate model were found for only .4% of the variability in CWRM scores.

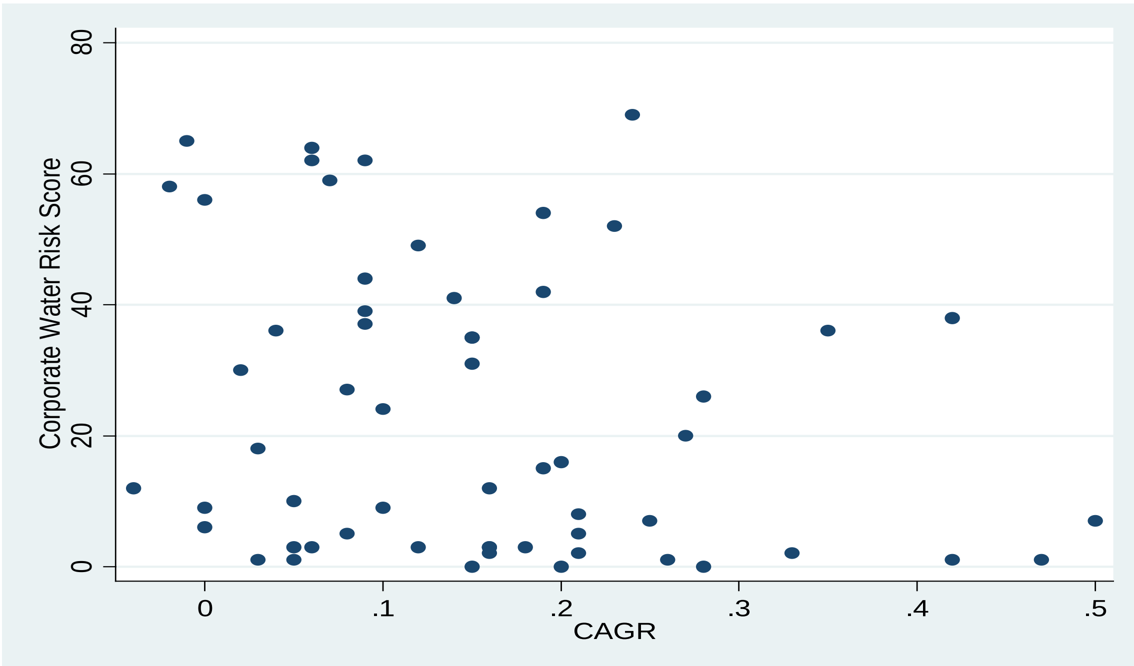
Figure 10. Graph showing bi-variate relationship for mean P/E ratio and CWRM



CAGR and CWRM

A total of 59 firms remained in the sample after 3 outliers were removed. A scatter graph was used as the initial step to examine the bi-variate relationship between CAGR and CWRM scores. Figure 11 presents a negative linear cluster, suggesting a negative association. The correlation value (r= -0.2443) confirmed this observation. The p-value results from a bi-variate linear regression (p=.0646) confirms that this negative linear relationship is not significant at the $p < .05$ level, though presents a weak significance at the $p < 0.1$ level. Thus CAGR is neither positively nor significantly associated with CWRM and in fact, presented the opposite direction to what was hypothesized. The low R^2 value (.0597) indicates that the bi-variate CAGR model can explain only 6% of the variability of CWRM scores.

Figure 11. Graph showing bi-variate association for CAGR and CWRM scores



9.3 Water Risk Management and Market Volatility

Hypothesis 3: Firms with higher market volatility have lower CWRM scores.

A total of 57 firms remained in the sample after 3 outliers were removed. The relative SD of the mean share price was used as a proxy indicator for share price volatility. CWRM was the dependent variable while volatility was the independent variable,

The scatterplot of the bi-variate relationship between volatility and CWRM as shown in figure 12 present a negative association. The correlation value presents a negative association as hypothesized ($r = -.2155$), though the p-value presents a non-significant correlation ($p = 0.1074$) at the $p < .05$ level, and a possible weak association at $p < 0.1$. A bi-variate linear regression showed that stock price volatility accounted for only 5% of the variability in CWRM scores.

Figure 12. Graph showing volatility and CWRM scores

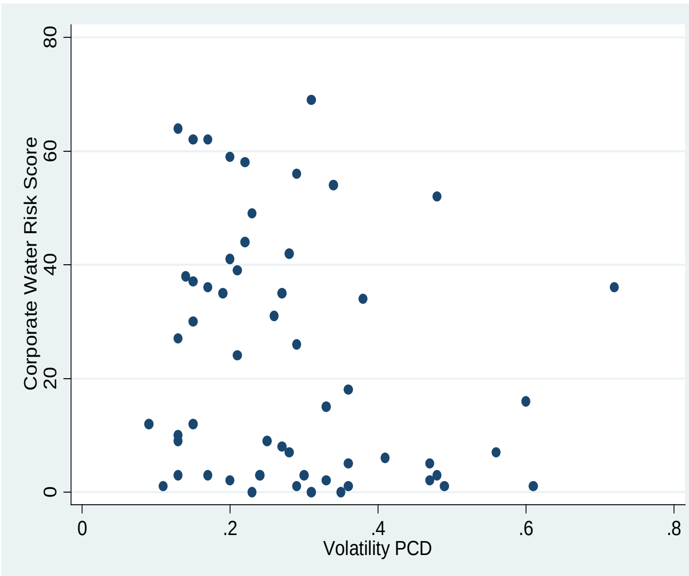
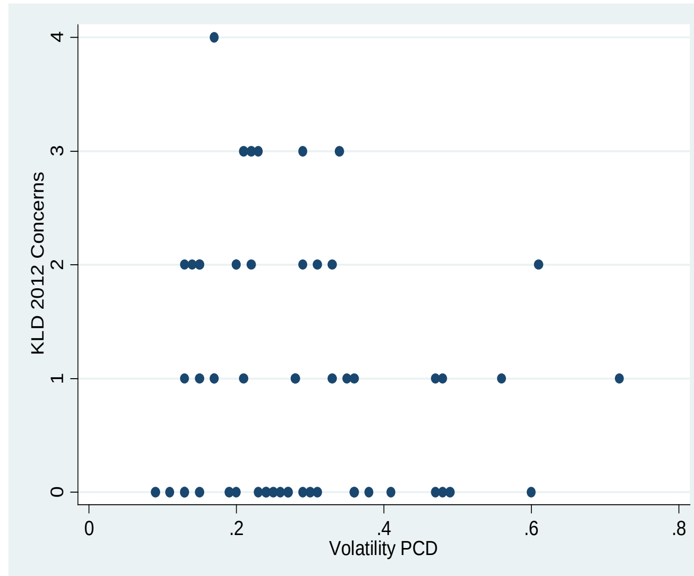


Figure 13. Graph showing volatility and KLD2012 concern scores



A similar model was replicated using KLD_{2012} concern scores as the dependent variable. This is represented in figure 13. The model likewise presented a negative, non-significant association for KLD concern scores and share price volatility. Table 16 compares the p-values and R^2 values for the KLD Concern and the CWRM models. The CWRM model presents a lower R^2 value. This result suggests that CWRM model performs better as a screen for corporate management of water risks than the KLD Concerns, though this relationship is marginally significant at the $p< 0.1$ level.

Table 16: Volatility matrix for CWRM and KLD_{2012} concern scores

	CWRM	**KLD_{2012} Concern**
N	57	57
R	-0.2155	-0.1120
P value	.1074	.4069
R^2	.0464	.0125

9.4 Accounting Variables and CWRM Scores

Hypothesis 4: Firms with higher operational performance will present higher CWRM scores..

Pairwise correlations were performed with the accounting variables prior to building a regression model. This was done to test for significant associations with CWRM and to also test for potential multi-collinearity among the accounting indicators. Table 17 presents significant, positive correlations between CWRM scores and accounting variables and very high and significant correlations among the accounting variables. This suggested the potential for multi-collinearity and guided the selection of independent variables for the model.

Table 17: Correlation matrix with CWRM and accounting variables with significance

	CWRM	Mean Current Assets	Mean Total Assets	Mean EBITDA	Mean Net Operating Cash Flow	Mean Revenue Total	Empls	EBITDA Margin
CWRM	1.000							
Mean Current Assets	.3361*	1.000						
Mean Total Assets	.4144*	.9068*	1.000					
Mean EBITDA	.4368*	.8587*	.9448*	1.000				
Mean Net Operating Cash Flow	.4224*	.8719*	.9379*	.9943*	1.000			
Mean Total Revenue	.2830*	.9443*	.8339*	.7713*	.7612*	1.000		
Employees	.4496*	.6067*	.7316*	.7892*	.7656*	.5988*	1.000	
EBITDA Margin	.2982*	.0544	.1858	.2730*	.2712*	-.0811	.1006	1.000

*p<.05

A regression model was formed to test this hypothesis using CWRM as the dependent variable and mean current assets as the independent variable. A summary of the results is presented in Table 18. The sample size for this model was n=59, due to missing values. The accounting data was log transformed prior to running the regression models.

Bi-variate regression results presented a positive and significant p-value at all levels and an R^2 of .2742 as shown in Table 19, which suggests that CWRM is highly correlated with firm's operational performance.

Table 18: Bi-variate regression matrix with CWRM and mean current assets showing R^2, p values and t values

Dependent Variable:	N	59	R^2	.2742
CWRM score	Prob > F	.0000		
Independent Variable:	t	P> | t |		
Mean Current Assets	4.56	0.000		

A subsequent model included categorical variables to control for any effects from the three sub-industry categories. The regression matrix is presented in Table 19. Multiple regression results with categorical variables likewise presented a significant and positive linear relation for CWRM and mean current assets at all p-levels. The p-values for Beverage and Agricultural Products were non-significant but still presented a positive association. The overall fit of the model increased with an R^2 value of .3137. However, this did not change the observation that industry has is little no impact on CWRM.

Table 19: Regression matrix with CWRM and current assets, with categorical variables, showing R^2, p values and t values

Dependent Variable:	N	59	R^2	.3137
CWRM score	Prob > F	.0002		
Independent Variable:	T	P> | t |		
Mean Current Assets	4.56	0.000		
Categorical Variables:				
Agricultural Products	.75	.455		
Beverage Industry	1.73	.089		
_cons	-2.27	.027		

The model was repeated, using *Employee* as a proxy variable to control for firm size. Table 20 shows the results of this model. Controlling for size further increased the overall fit of the model, increasing the R^2 value to .3599 (adj. R^2 =.3124). The p values increased for current assets and for the categorical values at the $p < .05$ level, but was weakly significant at the $p < .1$ level for current assets. However, the net effect of firm size, caused an increase for the p value for current assets but a decrease in the p values for the categorical variables. The p-value was significant for the control value at $p < .05$ level, which suggests the strong influence of firm size on CWRM scores.

Table 20: Regression matrix with CWRM and current assets with categorical and control variables showing R^2, p values and t values

Dependent Variable:		N	59	R^2	.3599
CWRM score		Prob > F	.0001		
Independent Variable:		t	P> | t |		
Mean Current Assets		.54	0.595		
Control Variable: Employee		1.97	.054		
Categorical Variables:					
Agricultural Products		.95	.348		
Beverage Industry		1.82	.074		
_cons		0.00	.998		

9.5 CWRM and EBITDA Margin

Hypothesis 5: Firms with higher operational efficiency will also have higher CWRM scores.

A regression model was formed to test this hypothesis using CWRM as the dependent variable and EBITDA margin as the independent variable. The model also included categorical variables to control for the three sub-industry categories. The sample size for this model was n=59. Table 21 shows the results of this model.

Table 21: Regression matrix with CWRM and EBITDA Margin with categorical variables showing R^2, p values and t values

Dependent Variable: CWRM score	N	59	R^2	.1188
	Prob > F	.0713		
Independent Variable:	t	P> | t |		
EBITDA margin	2.00	0.050		
Categorical Variables:				
Agricultural Products	1.06	.455		
Beverage Industry	1.73	.089		
_cons	-2.27	.027		

The multiple regression results presented an R^2 of .1188. Only the p-value for the EBITDA margin was significant at the $p<.05$ level. The categorical variables showed no significance. A subsequent multiple regression controlled for firm size using the employee variable is shown in Table 22. This significantly increased the R^2 value (.4049). The p-values for EBITDA margin and for employees were significant and positive. The net effect of the employee variable is that it reduced the p-values for the EBITDA margin and for the categorical variables.

Table 22: Regression matrix with CWRM and EBITDA Margin with categorical and control variables showing R^2, p values and t values

Dependent Variable:	N	59	R^2	.4049
CWRM score	Prob > F	= .0000		
Independent Variable:	t	P> | t |		
EBITDA margin	.2.10	0.595		
Control Variables: Employee	5.10	.000		
Categorical Variables: Agricultural Products	1.38	.174		
Beverage Industry	1.17	.246		
_cons	-.33	.739		

A third regression model included mean total assets, which is another proxy for firm size. Table 23 provides a summary for this model. While the overall R^2 value increased (.4134) it also increased the p-values for the independent, control and the Agricultural Product categorical variables. The *employee* variable was still weakly significant at the $p<0.1$ level.

Table 23: Regression matrix with CWRM and EBITDA margin with categorical and control variables showing R^2, p values and t values

Dependent Variable:	N	59	R^2	.4134
CWRM score	Prob > F	= .0000		
Independent Variable:	t	P> | t |		
EBITDA margin	.55	0.128		
Control Variables:				
Employee	1.67	.100		
Mean Total Assets	.88	.384		
Categorical Variables:				
Agricultural Products	1.38	.174		
Beverage Industry	1.22	.227		
_cons	-.94	.352		

These results suggest that while accounting variables show a significant correlation with CWRM, firm size tends to have a strong influence in leading towards engagement.

Conclusions

Awareness over the uncertainty of the global supply of freshwater has gained traction amidst growing concern regarding climate change impacts, population growth and economic development. As a water-intensive industry, it was anticipated that more advanced corporate water stewardship would be uncovered in the food and beverage industry. However, with 46% of the firms in this sample obtaining a CWRM score of $\leq$ 10, it suggests that this is not the case. The explanations for this under-performance run parallel with some of the barriers identified by the TEEB for Business report (2010). First, many companies do not regard water as a material issue and continue to view water as a utility. As well, there is still a persistent lack of understanding on the links connecting business risks and opportunity, natural capital, and the importance of a holistic approach to sustainable supply management. Furthermore, there is also a lack of consensus on a preferred methodology for water accounting (Appendix B). These factors, combined with the complex nature of water ecosystems, can be prohibitive factors for corporate decision-makers to fully adopt water stewardship.

However, when firms were segmented according to industry, beverage firms were shown to be industry leaders both in terms of representing the highest performance scores and in terms of disclosures on water accounting, water inventory and sustainable supply management. But at the same time, nearly half of the beverage firms scored < 10.

A common trait among high scoring beverage firms was an affiliation with *BIER- the Beverage Industry Environmental Roundtable*. BIER is a. partnership of leading global beverage industries that establishes standards and benchmarks for environmental sustainability for the beverage sector (BIER, 2014).

This observation suggests that industry-specific, self-regulating organizations like BIER can play an important role in helping management decipher the complex relationship between freshwater and industry. For instance, one of the advantages of BIER membership is access to regularly published guidelines for its members to be used as a normative document in conjunction with more technical water accounting tools. Another advantage is that it helps to build the business case for water stewardship and shares this information with their corporate members who are competing members in the market place. As a result, they are influenced by their peers to adapt the normative principles to their own business operations (Wright & Rwabizambuga, 2006).

Sustainability indicators founded on an ecosystem management perspective of water could be regarded as more rigorous than conventional sustainability indicators due to its broader scope that incorporates the communities, water ecosystems and global supply chains. However one of the key contributions of this framework is that it encourages the conceptualization of water's value as a natural asset through risk. Though water pricing remains controversial, a risk frame can provide insight on water's relative value within the context of its water dependency.

Corporate water accounting tools continue to evolve (Appendix B). One recent development includes a tool that incorporates the pricing of water risks. The *Water Risk Monetizer* is a risk adjusted water costing tool to help firms understand the impacts of their risk exposure on their financial performance without entering into the controversial moral and practical debate over pricing water as a commodity.

Similar, but Different

The highly significant correlations between CWRM and KLD social ratings suggests that although they may be similar, they are still different.

The high correlations could almost suggest that one could be used as proxy for the other. Clearly the CWRM scores has tapped into the same construct as the KLD scores (Scharfman, 1996). One possible explanation is that this result is more of a reflection of management's motivation and decision making. Hence managers who have embraced the business case for sustainability as explained by the good management theory, for example might also be early adopters of CWRM.

However, it was the positive and significant correlations with KLD concerns scores that was more surprising. It supports Mattingly and Berman's (2006) notion that KLD strengths and concerns ratings are non-convergent and do not measure opposing sides of the same construct. Strike et al. (2006) research discovered that internationally diversified corporations are prone to operate both responsibly and irresponsibly. They adopt a resource based view of the firm to explain that firms can simultaneously create value by acting responsibly and destroy value by acting irresponsibly. Therefore, their research emphasizes the need to disaggregate a firm's poor corporate social performance from their good performance. Where the CWRM fits into the spectrum, is that its focus is on corporate water stewardship and screening for corporate strategies that would mitigate water related business risks.

The advantage that the CWRM scorecard has over the KLD scores is its transparency and granularity. The theoretical underpinnings for the CWRM has been outlined to justify, why water requires an accounting and investment screening framework that makes water a priority. As Scharfman (1996) points out, there was no specific theory used to develop the criteria used by KLD, yet these criteria have become standard screens of social performance for investors.

The granularity of the CWRM assessment not only provides information on who is a top-scorer, but also insight in terms of the intensity of their focus and commitment to water risk management. In other words, it enables the public to also screen for industries who have gone beyond just using keywords or even "greenwashing" but have substantiated their actions with quantified results and the use of benchmarks. It reveals crucial information for investors on how well the leaders manage water risks and how well positioned they are to seize opportunities.

What influences market performance?

One of the main assumptions of financial markets is that they are efficient and rational (Orlitzky, 2013). The efficient market hypothesis assumes that investors incorporate all public disclosures about a firm's activities, including CSP activities in determining a firm's value. It was expected that CWRM would be positively associated with the firm's share price, but as our results show, it is likely that other variables, more influential than sustainability tend to impact investment performance.

A study by De Bakker, Groenewegen, and Den Hond (2005) on CSP-CFP relations concluded that the methodology used in some performance research could not sufficiently isolate the influence of CSP on CFP. This, they conclude, would dilute the true benefits or costs of sustainability. Hence, the relationship between sustainability and financial performance is likely unseen due to an *amalgamation of effects* (Peylo & Schaltegger, 2014).

However, when a disruptive financial, environmental or even social event occurs, share prices of socially responsible firms are less effected (Godfrey, 2009). The volatility analysis tends to suggest this is the case, though our study was not able to demonstrate an association that is significantly strong.

But while the efficiency of financial markets are questionable, the efficiency of accounting indicators is relatively clear. Accounting indicators are considered markers of a firm's efficiency and these indicators confirmed a positive relationship between CWRM and accounting performance in terms of net cash flow and the operational profitability indicator (EBITDA margins). However firm size, which in this case was indicated by the number of employees seemed to be a strong factor. Stakeholder theory suggests that larger firms tend to be more visible, and thus attract the attention and scrutiny of a wide range of stakeholders. Thus, this broad spectrum of stakeholders will inevitably influence the sophistication of the firm's sustainability policies (Hart & Sharma, 2004). In addition, larger firms have acquired the necessary slack resources, in the form of human and financial capital, to implement environmental and social initiatives. Such would enable them dedicate time and attention to sustainability –related details and strategies to protect their legitimacy and reputation (Gallo & Christensen, 2011).

Industry sub-categories did not have as strong an effect as expected, but this could be attributed to the effects of sample size and the variance among the scores.

Final Discussion and outlook

Where does this leave CWRM?

Stakeholders, including potential and actual investors are generally less informed about firm processes and outcomes related to CSR than business executives (Orlitzky, 2013). One of the challenges going forward is developing a model that would embed CWRM into investment decision making.

Water has become one of the more popular environmental issues receiving media coverage in 2015. Long periods of drought in California has disrupted communities and industry, causing forest fires and unprecedented water restrictions which has negatively impacting the region's agricultural sector. Further research could study the impact of CWRM on the financial performance of firms located in California. Will it have an insurance-like effect? Will its influence on share prices be more pronounced? It appears that research on the impact of water based risks on corporate financial performance is just beginning to unfold.

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APPENDIX A: Resources Used for Ecosystem Benchmarking Framework

Ecosystem Tools	**Water Risk Tools**
Ecosystem Service Benchmark (UNEP Finance Initiative)	Aqua Gauge (Ceres)
Guidelines for Identifying Business Risks and Opportunities Arising from Ecosystem Change Version 2.0 (WBCSD 2008) Finding Solutions to Water Scarcity: Incorporating Ecosystem service values into Business Planning at Dow Chemical company's Freeport Facility (Reddy et al., 2014) Guide to Corporate Ecosystem Valuation (WBSCD) The Economics of Environment and Biodiversity….,	Aqua Gauge (Ceres) Alliance for Water Stewardship Business Guide for Water Valuation (WBCSD) WWF Water Risk Filter

APPENDIX B: A Review of Water Accounting Tools and Resources

Water accounting is a recently developed addition to the realm of sustainability accounting systems and is essential in identifying material water risks. Yet, despite its significance, there are a number of challenges with current water accounting systems. Chief among them, is the lack of consensus for a universal standard for water accounting and impact indicators, as well as the inherent complexity of freshwater resources.

The New Approach to Water Accounting

Earlier interpretations of corporate water management focused on the internal monitoring and measurement of the direct operations of an industrial user. However, the concept now includes a broader framework, encompassing the ecological, social, political, hydrological and economic context of not only direct but also indirect operations.

One advantage of this broader framework is that it provides companies with better insight on the impacts of their water use and wastewater discharge on communities, ecosystems and watersheds. If left unmanaged, these impacts can give rise to a range of physical, regulatory or reputational business risks, with the potential for negative financial impacts (Barton, 2010).

Water Stewardship

Improved insight serves as the basis for strategic business planning and corporate water stewardship. The Alliance for Water Stewardship (AWS) defines water stewardship as the use of water that is socially equitable, environmentally sustainable and economically beneficial achieved through a stakeholder-inclusive process that involves site and catchment based action (AWS, 2014). The UN CEO Water Mandate (CEO Water Mandate) explains that corporate water stewardship includes both identifying and managing water-related business risks along with the sustainable management of shared freshwater resources. It further explains the advantages of corporate water stewardship to be reduced operational costs; protection from ensuing water stress; and improved corporate image in the eyes of consumers, investors, and nearby communities (CEO Water, 2012)

The Methodological Shift in Corporate Water Management

The conceptual shift to an external approach for corporate water management has necessitated the development of new water accounting tools to account for the multi-dimensional relationship between industrial use and freshwater resources. However, accounting for water is inherently complex. An Irbaris (2009) report observed that water provides a unique set of measurement and reporting challenges. It is both a local and a global issue. There is also different types of water as well as different usages. The Association of Chartered Certified Accountants (ACCA, 2010) expressed that many of these issues arise from:

a) the lack of a universally accepted methodology
b) the lack of mandate for corporate water reporting
c) the piecemeal ability to access reliable data from suppliers on water performance, as well as;
d) the dynamic variability of local and regional issues in water catchments' (ACCA, 2010, p. 5)

Therefore, the complex nature of water and the lack of consensus on a methodology to account for water are contributing factors in the proliferation of water accounting instruments.

Clarification of Sustainability Accounting Terms

In each case, the terms, water accounting (or water footprinting), carbon footprinting and ecological footprint are embedded with subtle or conceptual distinctions which separates their respective methodologies. An understanding of the characteristics of each is important because even though water can emerge as part of their respective results, neither their methodologies nor their results can serve as a proxy for corporate water accounting.

Ecological footprint is a sustainability accounting system that measures how much land and sea is used to exclusively produce all the resources a human population consumes and needs in order to assimilate the waste created using prevailing technology (Chambers et al., 2000). It is essentially an impact assessment, used to compare human demand on nature to the availability of natural capital. However, ecological footprint does not include water accounting, and is only capable of capturing freshwater impacts indirectly. (CEO, 2013).

Carbon footprinting (or carbon accounting) refers to the total amount of GHG (greenhouse gas) emissions caused directly and indirectly by an individual, organization, event or product. It too represents a type of impact assessment, in which the carbon footprint is a measure of the carbon intensity of products and supply chains relative to its contribution to climate change. (CEO Water, 2011)

Although GHG emissions is one of the primary drivers of climate change and is intricately connected to the water crisis, there are distinct characteristics to the water crisis that cannot be addressed through carbon accounting.

The foremost characteristic of water issues is that they are fundamentally local. A facility’s water use and wastewater discharge will primarily affect the watershed where it is located, unlike carbon where impacts from emissions is not necessarily felt where carbon is emitted (WWF, 2011). Therefore, an essential metric in water accounting are indicators that delineates the temporal and spatial variability of water. This not only includes data on where water is withdrawn and where wastewater is discharged, but when, due to the seasonal and spatial variability of precipitation (BIER, 2011).

Another feature, which distinguishes water from carbon accounting, is that water is a shared public interest. Water is crucial to providing human life sustaining needs, facilitating ecological systems and supporting economic development. The governance structures, which mandate how local water resources are managed and shared among various stakeholders, constitutes relevant factors to be taken into account when assessing local water risks (WWF, 2011).

Deciphering Water Footprints, Water Footprinting & Water Accounting.

Another prevailing challenge in corporate water accounting is confusion over terminology. Corporate water accounting describes a system that enables companies to measure and interpret information on the water systems where their business and suppliers operate. It includes an inventory of a broad scope of on data on the volume, timing, location, and impacts of water use and discharge. It also incorporates data on water risk management practices, stakeholder engagement and disclosure frameworks to ensure transparency. (CEO Water, 2012)

Water accounting and water footprinting are often used interchangeably, representing a universal term that describes various water accounting tools. However, water footprint (WF) also refers to a specific water accounting methodology defined by the Water Footprint Network (WFN). Because of this varied understanding, statements made about “water footprinting” need to be examined. This research will use the term *water accounting* when referring to water accounting tools generically, and *water footprint* or WF only in reference to the methodology ascribed to the WFN.

This research reviewed twenty-four water accounting tools and resources with specific application to the food and beverage industry, many of which are publically available. The most consistent result from this review was the discovery that not any of the tools were comprehensive. However, many of the tools are complementary and provide a puzzle piece in the progression toward corporate water stewardship. The process also revealed the frequency with which the tools are being updated, thus indicating that the tools are being adapted as new knowledge emerges.

The tools are profiled according to seven categories: Mapping tools, Impact and Risk Assessments, Disclosure frameworks, Protocols and Standards, Benchmarks, Volumetric Measurements, and Statistical Information. These categories represent both the type of information that these tools provide for the user, and their contribution toward corporate water stewardship. However, the categories are not exclusive, as many of the tools fulfill more than one function.

For companies engaging in water accounting, deciding which tool to use can create a dilemma. However, Signori and Bodino's (2013) response to this dilemma is that there is no such thing as the *perfect* tool. Therefore it is incumbent upon a company or user to make a decision based on the tool which is most compatible to the company's needs. This underscores the importance of reviewing the offerings of each tool in order to facilitate making a selection.

The following is a summary of the seven tool categories. Proceeding the summary, is a discussion of the foundational methodologies for water accounting, water footprint (WF) and impact assessments using life cycle assessments (LCA). Many of the current water accounting tools are derivatives of the concepts underpinning these two methodologies.

TABLE A: WATER ACCOUNTING RESOURCE CATEGORIES		
Mapping Tools • Aqueduct • Corporate Water Gauge • Aquamap (FAO) • WFN tool • Water Risk Filter • Growing Blue	Impact & Risk Assessments • Aqueduct • Gemi – Collecting the Drops • Gemi- LWT • Growing Blue Water Impact Index (WIIX) • LCA • World Business Council on Sustainable Development- Global Water Tool • Water Risk Filter • ISO 14046 (proposed)	Protocols & Standards • Alliance for Water Stewardship (AWS) • BIER • European Water Stewardship (EWS) • UK Federation House Commitment • WFN
Volumetric • Growing Blue • WFN • Water Footprint Assessment Tool (WFAT) • Water Risk Filter		
Benchmarking (Industry) • BIER • Aquagauge • UK Federation House Commitment	Statistical Resources • Aquastat- FAO • CDP	Disclosure • Aquagauge • Global Reporting Initiative (GRI) • CEO Water Mandate • Carbon Disclosure Project- Water

Water Footprint Methodology- A Volumetric Approach

Water Footprint (WF) is an established water accounting methodology introduced in 2002 but it wasn't until 2004 when it was considered fully developed (Chapagain & Orr, 2009). It is guided by a global standard under the auspices of the Water Footprint Network (WFN). The WF is a calculation of the total volume of water used during the production of goods and services (Chapagain & Orr, 2009). The purpose is to quantify and conceptualize the human appropriation of water, by incorporating direct and indirect use of water resources geographically and temporally. (Hoekstra & Chapagain, 2009). One of the key concepts within WF is that of consumption, which it defines as water loss from ground and surface water resources within a catchment area. This occurs when:

a) water evaporates
b) water is incorporated (or embedded) into a product, or
c) water is returned to another catchment area or the sea. (Hoekstra, 2009)

The WF method further designates water into three components. The blue water footprint is the volume of consumed surface and ground water used in the production of a good throughout its value chain. The green water footprint is the volume of evaporated of green water resources, such as rainwater, either stored in the soil or as moisture transpired from vegetation. The grey water footprint is the theoretical volume of freshwater needed to assimilate the waste flows to at least achieve ambient water quality standards (Chapagain & Orr, 2009). One of the main advantages of the WF method is its flexibility, which makes it possible to calculate the water footprint for an individual, business or a nation.

However one of the issues with WF is the calculation of grey water. Grey water is based on the dilution factor for the pollutant with the highest required dilution volume. This is problematic because most companies discharge multiple pollutants. Not only does this approach underestimate potential impacts of other contaminants on the surrounding environment, but also the risk of bioaccumulation from long-term exposure. As a result, many WF studies have either excluded or adapted the grey water component to satisfy their own purposes.

Impact Assessment an LCA Approach

While the focus for the WF is on the volumetric appropriation of freshwater sources, Life Cycle Assessments (LCA) focuses on impacts and addresses the consequences resulting from water consumption (Berger & Finkbeiner, 2013). LCA is a systems analysis based tool that measures the sustainability of a product or service throughout its value chain. While LCA is often used to calculate carbon footprint, results on water resources emerging from an LCA carbon footprint cannot serve as a proxy for water accounting (CEO Water, 2011). This is because conventional LCA adopts an inventory approach, however water accounting methods need to reflect a broad range of metrics.

LCA practitioners have identified several indicators to assess impacts across multiple environmental categories. But in the absence of a defined LCA standard for water accounting, these are often modified according to the context of the study (Berger & Finkbeiner, 2013).

Since 2011, ISO has been working on ISO:14046, an initiative to standardize procedures and methodological requirements for water accounting based on LCA. It is anticipated that the proposed standard will assess societal, environmental, legal, cultural, political and organizational diversity, and economic conditions. It is also expected to incorporate accounting for water volumes and the quantification of water scarcity and pollution. However until a universal standard is achieved, an LCA approach faces the significant challenge of harmonization of impact models (CEO Water, 2011).

Comparing a Volumetric against an Impact-Oriented Approach

Nevertheless, the one pervasive question is determining which is the better methodology? A volumetric or an impact-oriented approach? Jeffries' (2012) case study comparing WF and LCA methodologies for two unique products, tea and margarine showed that while each produced different outcomes, the results were compatible in their ability to identify geographical areas pre-disposed to water risks. Yet Berger and Finkbeiner's (2013) assessment of WF and LCA showed that each method produced different results. He suggests that an impact-oriented approach should be used in decision-making since a volumetric approach is not sensitive to addressing locations where incremental increases in water use can result in significant risks.

As each of these tools continue to evolve, they are gradually adopting concepts from the other domain. The Water Footprint Assessment Tool developed by WFN includes an assessment of selected impact indicators and ISO14046 is expected to incorporate data typically associated with the WF methodology, such as, a geographical component and consumption.

Industry Specific Benchmarks

Industry-specific benchmarks help companies prioritize risks by tailoring water accounting indicators relevant to the industry. The benchmarks are established by industry-led organizations, which offer its members technical and peer support to achieve both environmental and cost savings. Published case studies are used as a disclosure tool to help communicate success not only to other industry members but also to the public.

The Beverage Industry Environmental Roundtable (BIER), established in 2006 is a partnership of leading global beverage industries that establishes standards and benchmarks for environmental sustainability within the beverage sector (BIER, 2014). In 2011 it published an industry guideline for water accounting based on industry-specific insight. *The Practical Perspective on Water Accounting for the Beverage Industry* is not a technical tool, but rather a normative document, intended to be used in conjunction with more technical water accounting tools.

The BIER standard combines volumetric and impact-oriented concepts in its guide for water accounting. It helps beverage industries identify priority areas using a 1% *de minimis* volume threshold. The *de minimis* threshold is based on 1% of the accumulated water, consumed throughout the product's value chain. Any activity or individual material that totals 1% or more of the total consumption is emphasised in the analysis.

The Beverage Industry Perspective on WF

One of the key adaptations, which BIER addresses, is the approach to WF. Accounting for blue and green water is a priority, particularly in terms of the indirect operations. Blue water is a significant component of most non-agricultural, indirect water use especially in regards to energy, packaging, etc. The green water footprint is more essential to segments within the beverage industry which rely on agricultural inputs.

In terms of the grey water footprint, BIER advises that beverage companies collect quantified data on the volume and quality of wastewater discharge, instead of calculating the dilution factor to achieve ambient water quality standards, *Perspectives on Water Impacts*

BIER also provides insight on the major categories of the beverage industry value chain, where water impacts are most likely to arise. This is comprised of:

*Beverage ingredients***:** includes water, agricultural and chemical components (preservatives and sweeteners)

Packaging materials: includes primary, secondary and tertiary packaging

Retail, marketing and consumption: includes the point of sale retailer, display cases, adware, refrigeration units, vending machines, restaurants and end use by the consumer

Disposal, reuse and recycling: includes package components and waste streams generated throughout the lifecycle

*Transportation and distribution***:** includes all transportation of product through each stage of he value chain

The industry perspective that BIER provides also offers insight on the different segment within the beverage industry, which consists of: bottling companies, carbonated soft drinks, bottled water, breweries, distilleries and wineries (BIER, 2013). Understanding the distinctions between the various segments enables the creation of credible benchmarks which recognizes the differences between their respective WF and impacts.

While the BIER perspective on water accounting serves as a management guide to help establish benchmarks for best management practices for the industry, it is limited in its scope of indicators that help identify water-related risks, particularly within the social contexts.

Mapping Tools

Mapping tools help users locate facilities or suppliers operating in regions pre-disposed to water risk. In the absence of an established standard for geo-locating water risks, each tool is based on the developers' selection of data sets, calculations, mapping techniques and indicators. As a result, each tool is created using an inherently subjective process. Therefore an important criteria in choosing a mapping tool is the developers' disclosure of the data sets which forms the basis of their risk models and the relevance to the indicators used to identify water related risks.

Aqueduct (WRI, 2014) is a publicly available global mapping tool. It was developed by the World Resources Institute with partners representing corporate, investor, academic, and non-profit research sectors. The tool combines research data and hydrological modelling to geo-locate water risk hotspots. It measures water risks, based on twelve individual global indicators of water risk, organized according to the water related business risk categories: physical, regulatory and reputational risks.

Users of this tool can select indicators to provide a customized depiction of a site's water risk. Also, indicators can be aggregated to create an overall risk score that can be compared against other locations. In addition, the tool can generate sector specific water risk maps, according to nine water-intensive industries (including agriculture, food and beverage, etc.).

WRI acknowledges the methodological limitations of global data sets that describe water related risks with a simple score (WRI, 2014). The limitations of this tool is particularly evident with their regulatory/reputational risk evaluation, which is based on three indicators. This could result in an underestimation of the potential for regulatory or reputational risks. However, the tool does provide comprehensive disclosure, clearly defining their indicators, calculations, information sources and references to support their methodology.

Impact & Business Risk Assessments

As mentioned, impact assessments often include aspects of a lifecycle approach to evaluate direct and indirect exposure to water-related risks, which can lead to business risks. Impact assessments requires a detailed assessment of a facility's relationship with their local freshwater resources. Impact indicators can cover a broad range, but generally include metrics characterising freshwater availability, surface and groundwater quality, and vulnerability of ecosystems (Berger & Finkbeiner, 2013). It also encompasses social measures, such as the vulnerability of a population to human health damages, human access to clean freshwater and the identification of community stakeholders (WWF, 2014).

Two tools developed by the Global Environmental Management Initiative (GEMI) help companies explore their exposure to water –related risks. *Collecting the Drops* and the *Local Water Tool* (LWT) help companies gain an understanding of the external impacts of their water use and discharge as well as their exposure to business risks. These tools also facilitate the company's ability to identify opportunities in managing their water related risks.

Both tools apply an inventory approach to gather contextual information that help establish the facilities' relationship with water. It furthers the company's ability to assess their vulnerability to water-related risks, using an impact assessment. The *Collecting the Drops* tool uses a questionnaire to assess risks within six categories: watershed, supply reliability, efficiency, compliance, supply economics and social context. The questionnaire includes a benchmark for users to score the significance of the risk exposure.

The LWT is an excel-based repository for water risk information. It incorporates many of the same data requirements as *Collecting the Drops* however, unlike its predecessor it quantifies water risks using a system of weighted risk indicators. The LWT also includes enhancements that enables the seamless exchange of information between complementary tools. First, it facilitates a company's ability to disclose water related information by including water metrics are present in the Global Reporting Initiative, Dow Jones Sustainability Index, CDP Water and Bloomberg Sustainability Index. The LWT can also be used seamlessly with the Global Water Tool, developed by the World Business Council on Sustainable Development, a tool which companies can use to assess water risks in their global operations and supply chain..

Veolia's Water Impact Index (*WIIX*) is a technical tool, which quantifies water impact around the globe using data on chemical use, product usage, energy consumption, production and waste disposal. The WIIX tool helps companies determine whether the factors affecting the water quality and availability is a result of on-site activities or, or is a consequence of upstream or downstream activities. However WIIX is limited in terms of its geographical data sets and the range of impact metrics it accounts for. It tends to focus on physical risks of water quality and water availability within a catchment area, and lacks information to demonstrate how these risks can create social impacts or translate to business risks.

Statistical Resource

Statistical resources collect and analyze data that can be used for research purposes. Aquastat is a global database created by the UN Food and Agriculture Organization (FAO). It manages a statistical information on water resources water use and agricultural water management. It publishes country based fact sheets on precipitation, climate, irrigation and water use, waste water, geography and population, renewable water resources, health, environmental, agriculture, the human development index, GDP, and infrastructure. It also includes information on state of water governance and resource management for selected countries regions and river basins, highlighting particular challenge in the local development of water resources (FAO, 2014)

Protocols/Standards

Though protocols and standards are not water accounting tools, they provide a measure of a company's commitment to responsible water management. Launched in 2014, the Alliance for Water Stewardship (AWS) promotes and operates a corporate water stewardship system under a global, multi-stakeholder, governance structure. This structure is represented by: the World Wildlife Federation (WWF), the United Nations Environmental Program (UNEP), Carbon Disclosure Project- Water, the Pacific Institute and Veolia (AWS, 2014a)

It focuses on the delivery of four broad water stewardship outcomes:

a) Good water governance
b) Sustainable water balance
c) Good water quality
d) Healthy status of important water related areas (ie. floodplains, discharge and recharge areas, etc). (AWS, 2014)

The AWS standard is organized to help users in the agricultural and other water-intensive industries further their understanding of their water use and catchment context, encourage stakeholder involvement, manage their water –related risks, and work collectively to address shared water resource challenges (AWS, 2014).

Companies voluntarily commit to these standards and self-evaluate their performance according to specific criteria. There are four levels of performance, reflecting their degree of effort and compliance with international standards for best management practices.

Disclosure Frameworks

Corporate water disclosure is ‘the act of collecting data on the current state of a company’s water management, assessing the implications of this information for the business, developing a strategic response, and ultimately reporting this information to stakeholders (investors, NGOs, consumers, communities, suppliers, employees, and others)’ (CEO Water , 2012)

Metrics in GRI G4 Guidelines and CDP Water Disclosure Information Requests, do not provide methodologies or tools to measure or assess water use but instead, offer a framework and indicators to report types of measurements . Disclosure improves the ability of stakeholders to evaluate a company’s sustainability, and thus fosters greater corporate accountability and increases stakeholders’ trust, confidence and goodwill (Signori & Bodino, 2013).

There is an increasing demand from investors for more robust corporate management and disclosure of the material risks and opportunities related to water (Signori & Bodino, 2013). The US Securities and Exchange Commission (SEC), for example, provided interpretative guidance on disclosures related to business or legal questions regarding climate change (SEC, 2010).The guidance clarifies what publicly listed companies need to disclose about material climate-related risks, including physical risks, such as water (ACCA, 2010).

Still, the majority of leading companies have weak management and disclosure of water risks and opportunities (Barton, 2010). The main challenges in water disclosure, as identified also by CDP Water have been recognized also within the financial accounting sector (cited in ACCA, 2010, p. 9):

- Ability to measure: There is no universally accepted method for calculating the impact of water use by businesses.
- Local/regional issues: The impact of using one megalitre of water will vary for different geographical and climatic regions. Other factors to be considered include: the water source; availability of water within the catchment; urban or rural infrastructure support and pricing; the volume and quality of water returned; and its impact on the surrounding environment, such as groundwater; and alternative beneficial uses'.
- Water in the supply chain: Companies need to consider the water use along their supply chain 'where there can be substantially larger, compounding impacts than from their own facilities. Supply chain considerations include both upstream issues with suppliers and downstream issues in terms of the water used when consumers use their products and services'.
- Globally accepted standard: This is due, once again, to the lack of consensus for a universally accepted standard for measuring water use and its impact. This is due, in part, to complexities in 'collecting and disseminating meaningful water related data and measuring the impact on surrounding environments'.

Aquagauge (Ceres, 2014) is an excel-based tool offered by Ceres, designed primarily for financial investors to interpret and evaluate water management information disclosed by companies. This tool helps investors scorecard a company's disclosure of their water risk management against broad definitions of leading practice in terms of: measurement, management, stakeholder engagement and disclosure.

The Water Risk Filter- A Comprehensive Approach to Water Accounting

The World Wildlife Federation in collaboration with the German financial institution, DEG recently launched the Water Risk Filter (WWF, 2014).

The Water Risk Filter is a risk assessment tool is the most comprehensive tool reviewed for this research. It incorporates a thorough scope of measurement tools, including: mapping, questionnaires, mitigation responses, country profiles and case studies to help companies gain an understanding of their water related business risks and guide actions to mitigate risks (WWF, 2014)

It quantifies risks using weighted risk indicators (WWF, 2014). The selected indicators are based on their potential for a financial impact. The Water Risk Filter is structured according to a risk framework, which delineates risks caused by the company's operations, from risks linked to a facility's location. Though the Water Risk Filter was developed with the intention of being an internal risk assessment, it also has the functionality to automatically produce a formatted CDP report that responds to approximately 85% of the questions (WWF, 2014).

Conclusion

Corporate water management is a complex, iterative process that requires firms to continually assess and reassess their water situation and impacts to guide strategic decisions. While a comprehensive tool does not currently exist, firms should consider tools that will facilitate attainment of advanced corporate water stewardship.

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Appendix 6b: Sample Scoring of

Criteria	Scope	Example of Corporate Disclosure	Category & Defining Statement
Keyword	Refers to formal (policy, strategy statements) or informal (aspirational) statements, whereby the firm acknowledges their relationship to water or water related impacts.	*Water is important to our operations (1.1)…* *Climate change poses a threat to our agricultural supply chain (5.1)…*	*Water Value* *1.1- States dependency of frewshwater as a major input in operations* *Supply Chain (5.1)* *5.1- Identifies factors that pose risks to key agricultural inputs*
Performance	Refers to actions or efforts that being made or case studies to reduce or mitigate a water based business risk or impact	*Our employee-led Sustainability Committee consults with management on initiatives to promote water conservation projects in the community and on-site (4.3)*	*Sustainable Supply Management* *4.3-Assigned accountability for water and ecosystem services to staff, committee or representative on Board of Directors*
Quantitative Measures	Refers to disclosed quantified measures of performance	*The recent opening of the Mexico facility has increased our overall water usage by 15% acros our facilities in 2014 (3.1)*	*Water Accounting* *3.1-Collects data on water use in direct operations*
Benchmark	Refers to internal evaluations of a firm's performance against industry best management practices. This was demonstrated through memberships or certifications with industry organisations	*We have engaged in partnerships with: Bonsucro, Sustainable Agriculture Initiative (SAI), The Rainforest Alliance, Global G.A.P (Good Agricultural Practice).(5)*	Supply Chain 5.5-Strategies to minimize risks in the supply chain

Table 7c List of companies according to sub-industry sector

Beverage Companies N=14	Agricultural Products N=7	Packaged Foods and Meats N=40
Molson Coors Brewing Co Craft Brew Alliance Inc Boston Beer Inc -Cl A Beam Inc Brown-Forman -Cl B Constellation Brands Mgp Ingredients Inc Coca-Cola Btlng Cons Coca-Cola Co Pepsico Inc Coca-Cola Enterprises Inc Monster Beverage Corp National Beverage Corp Dr Pepper Snapple Group Inc	Alico Inc Archer-Daniels-Midland Co Limoneira Co Fresh Del Monte Produce Inc Darling International Inc Ingredion Inc Bunge Ltd	Campbell Soup Co Dole Food Co Inc Conagra Foods Inc Farmer Bros Co Flowers Foods Inc General Mills Inc Heinz (H J) Co Hershey Co Hormel Foods Corp Kellogg Co Lancaster Colony Corp Snyders-Lance Inc Mccormick & Co Inc Seneca Foods Corp Seaboard Corp Smucker (Jm) Co Tootsie Roll Industries Inc Tyson Foods Inc -Cl A Chiquita Brands Intl Inc Pilgrim's Pride Corp J & J Snack Foods Corp Kraft Foods Group Inc Sanderson Farms Inc Lifeway Foods Inc Sanfilippo John B&Son Green Mtn Coffee Roasters Hain Celestial Group Inc Dean Foods Co Cal-Maine Foods Inc Omega Protein Corp Mondelez International Inc Calavo Growers Inc B&G Foods Inc Diamond Foods Inc Treehouse Foods Inc Boulder Brands Inc Post Holdings Inc Mead Johnson Nutrition Co Annie's Inc Smithfield Foods Inc